SURGERY OF THE BILIARY TRACT

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OLD PROBLEMS
NEW METHODS
CURRENT PRACTICE

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PREFACE

After the Second World War the number of biliary diseases has abruptly risen and lithiasis has become in many regions the most frequent surgical disease of the abdomen. At present, though there are perspectives of rational conservative treatment and though endoscopic techniques permit removing some of its complications even without laparotomy, the basic treatment method still remains, and probably shall remain for long the classical surgical intervention. On the contrary, the indications for such intervention are always widening, as its risks become always smaller and the requirements for prevention higher.

Many books have been written on the surgery of biliary ducts, but recent knowledge is growing so rapidly that it forces within short periods its new integration and critical assessment. Attention is mostly paid to interventions on the biliary ducts with their wide scope of problems and to the prevention and treatment of postoperative disturbances. New and more perfect diagnostic possibilities and some more suitable technical procedures as well require comparison and verification, introduce new aspects on old problems, and even change some established rules.

If a book shall treat all relevant questions and at the same time emphasize some new or unsolved problems, the text inevitably will become asymmetric, but such asymmetry may help to underline important and urgent matters. The authors, who for years have experienced all struggles and errors of biliary surgery, have tried to correct some opinions and to fight some recognized mistakes in order to prevent the operation from becoming a new complication of the disease only. They themselves, however, might have entered into new insecurities.

Prague, 1979 B. NIEDERLE, M. KECLÍK

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SURGICAL ANATOMY

The bile ducts originate within the liver where, hidden from view, they form the intrahepatic tree. They then emerge at the liver hilus as the main bile duct. The latter, together with the gallbladder represent the extrahepatic portion of the biliary tract which is surgically more accessible.

Knowledge of biliary anatomy has been advanced in particular by cholangiography, angiography and endoscopic methods of investigation. These were instrumental in demonstrating the segmental structure of the liver, provided accurate information on the anatomical structure of the choledocho-pancreatico-duodenal junction and facilitated the differentiation of the bile ducts and vascular variants from anomalies. Nevertheless, much anatomical data on the relationship between, and the dimensions of some sectors or their microstructure cannot be considered final, and is continuously being corrected by new methods.

It is with these limitations in mind that the following comments and schematic outlines may be found of assistance to the surgeon, providing him with more accurate anatomical concepts. This should enable the surgeon to perform his operations more rapidly and, more importantly, with greater safety.

Liver and The Intrahepatic Biliary System

Bile, produced by the liver cells, is drained by the fine capillaries (canaliculi) and collected from the lobules into delicate ductuli. These unite to create channels of increasing size and of higher epithelial cells, finally draining into segmental ducts. The latter drain separate well defined regions — the afore-mentioned segments, and run parallel with the corresponding arteries and portal veins. They unite in a relatively regular fashion and two main radicles are formed, the right and left hepatic ducts. These arise, together with the main vessels, from the cleft in the centre of the inferior surface of the liver, the porta hepatis, thus forming the liver hilus.

In biliary tract surgery interference with the liver parenchyma cannot always be avoided, thus some remarks about its segmental structure, blood supply and the liver ligaments are in order.

Remarks on peritoneal attachments of liver

Projection of the liver on the body surface has significance in the performance of percutaneous transhepatic cholangiography or liver biopsy. *Fig. 1.*

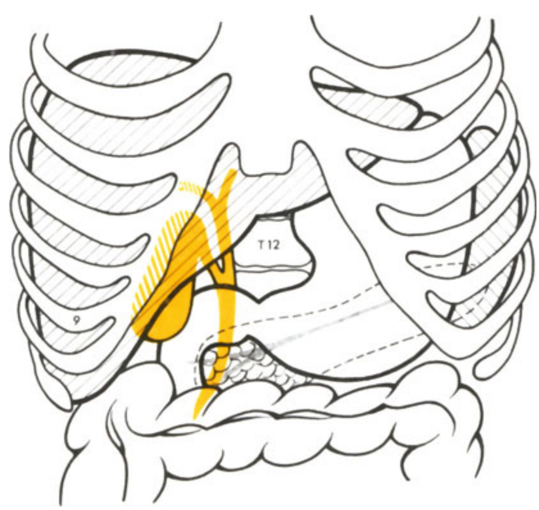

Fig. 1: Projection of liver and biliary tract on body surface.

The liver is securely tethered, particularly posteriorly where the hepatic veins join the inferior vena cava as it passes through the groove of the liver. Elsewhere it is secured to the diaphragm, stomach and abdominal wall by the hepatic ligaments. They are duplications of the peritoneum which cover the entire surface of the liver, with the exception of the insertions of the ligaments and the gallbladder bed. Beneath the peritoneum is a thin connective tissue layer — Glisson's capsule. This is thickest in those areas where the liver is not covered by peritoneum. One such bare area lies between the diverging insertions of the coronary ligament on the liver and diaphragm. Here a needle may be inserted into the liver for percutaneous cholangiography, without traversing the abdominal cavity. *Fig. 2.*

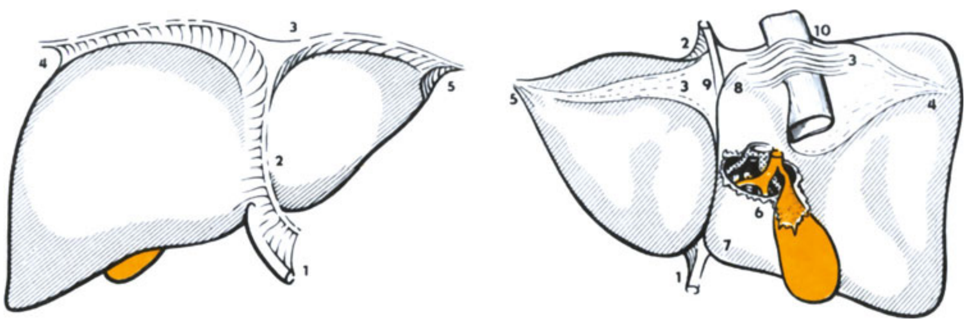

Fig. 2ab: Hepatic ligaments and porta hepatis. Liver superior (a) and inferior (b) surfaces: 1 – Ligamentum teres, 2 – falciform ligament, 3 – coronary ligament, 4 – right triangular ligament, 5 – left triangular ligament, 6 – porta hepatis, 7 – quadrate lobe, 8 – caudate lobe of Spigel, 9 – ligamentum venosum, 10 - sulcus for inferior vena cava.

For mobilization of the left liver lobe severence of the left triangular ligament in front of the oesophagus is necessary. Though this is avascular, it may harbour bile ductuli, thus it should be transfixed before tying.

The round ligament (ligamentum teres) running from the notch in the liver edge towards the umbilicus, and attached flatly against the abdominal wall to the right of the midline, should not be severed unnecessarily: the liver may be lifted by it during surgery.

There is an intimate relationship between the gastrohepatic ligament or lesser omentum and the biliary tract. Its layers enclose the liver hilus and are attached round the porta hepatis. Its reinforced free margin, the hepatoduodenal ligament, harbours the large hepatic vessels in conjunction with the common bile duct. *Fig. 3.*

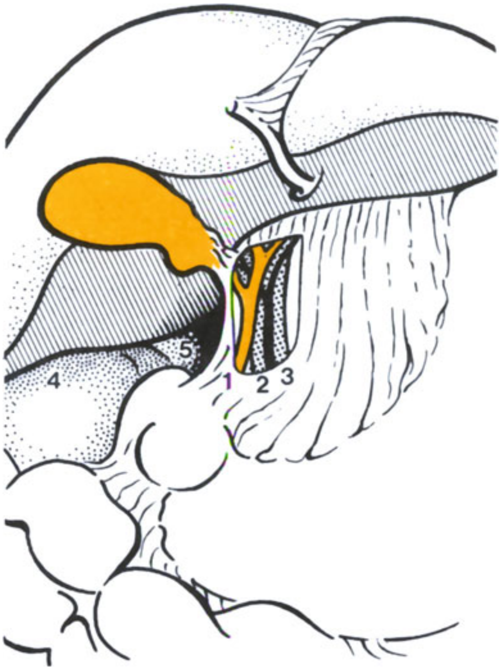

Fig. 3: Lesser omentum with through-view of biliary stalk in hepatoduodenal ligament. 1 – Main bile duct, 2 – hepatic artery, 3 – portal vein, 4 – hepatorenal recess of Morrison, 5 – epiploic foramen of Winslow.

Remarks on hepatic circulation

The liver receives a double blood supply: arterial blood from the hepatic arteries (25 per cent) and venous blood from the abdominal viscera conveyed by the portal vein (75 per cent). From the liver all venous blood is drained via the hepatic veins into the inferior vena cava, and the lymph via the lymphatic vessels into the thoracic duct. *Fig. 4.*

The proper hepatic artery provides the sole arterial blood supply of the entire liver in only about one-third of cases. As a rule it is supplemented, or in part replaced, by other sources: in particular by an independent branch of the superior mesenteric artery to the right lobe, or by a branch of the gastroduodenal artery. Other variants occur[21] e.g. a branch of the left gastric artery to the left lobe or a separate hepatic branch direct from the aorta, sometimes life saving in ligation of the proper hepatic artery.

As we have no information when operating, as to whether or not some unusual artery is only accessory, it should always be spared. Division of the common hepatic artery before the origin of its branches to stomach and duodenum is less likely to produce ill effects than ligation of the proper hepatic artery, its branches to the liver, or of another artery in the hilus. Recent evidence[3] suggests, however, that not infrequently, even in such cases, a rapid and sufficient collateral circulation originates outside or inside the liver, although few if any of these collaterals can be relied on because they are unpredictable.

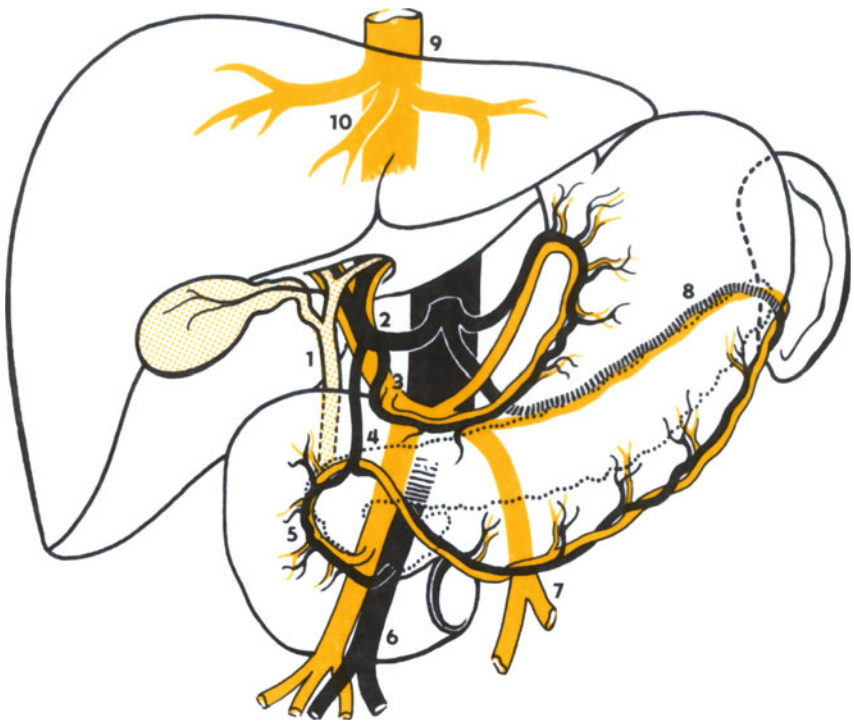

Fig. 4: Hepatic vessels. 1 – Common bile duct, 2 – hepatic artery, 3 – portal vein, 4 – gastroduodenal artery, 5 – pancreatico-duodenal artery, 6 – superior mesenteric artery and vein, 7 – inferior mesenteric vein, 8 – splenic artery and vein, 9 – inferior vena cava, 10 – hepatic veins. (Schematic drawing after Puestow.)

The portal blood supply to the liver is of no less nutritional significance and it is a long established fact that interruption or ligation of any branch of the portal vein carries the risk of inducing atrophy of the region involved.

Partial obstruction or transection of hepatic veins draining blood from the liver causes venostasis in the parenchyma. However, the categorical demand for resection of any liver segment whose venous drainage has been damaged no longer applies.

Liver lymph originates almost exclusively from an exchange of fluid and solutes between liver cells and sinusoids.[9] This parenchymatous lymph (Magnenat, 1964) is characterized by its high protein content and is most important for liver homeostasis. From the sinusoids it seeps through the spaces of Disse into the periportal zones where lymphatic capillaries arise. Here, there is also a small influx of biliary filtrate from intrahepatic bile ducts. However, its composition resembles that of lymph from other tissues. Lymphatic vessels create an extensive plexus around the hepatic vessels and are also connected with the periductal plexuses. They leave the hilus and continue as extrahepatic lymphatics. This entire system drains into the thoracic duct. Alterations in the composition and flow of liver and biliary lymph are thus reflected in the thoracic duct lymph.[2]

A negligible proportion of liver lymph, the so-called capsulary lymph, originates independently in the liver capsule and flows separately into mediastinal lymph nodes and the lymphatic trunk.

Remarks on segmental structure of liver

Liver segments are almost independent, anastomoses being infrequent and inconstant. Segmental borders cannot be distinguished on the liver surface. The liver can, however, be fairly accurately subdivided into two functional lobes, the right and left, by an assumed plane transecting the greatest mass of the liver parenchyma. This divides the liver convexity following a line running from the fundus of the gallbladder to the left border of the inferior vena cava, — and the inferior surface of the liver following a line through the gallbladder bed, halving the hilus and caudate lobe, and directed backwords towards the groove of the

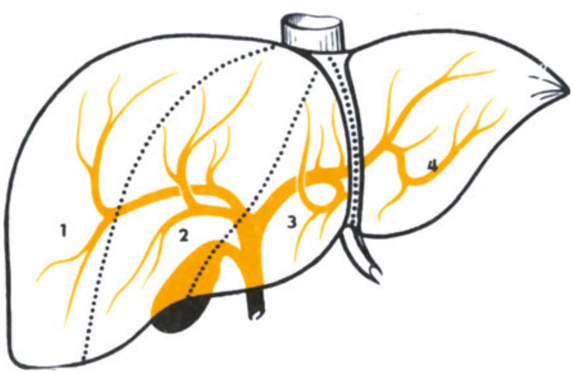

Fig. 5: Schematic drawing of biliary tree and projection of liver segments on liver surface. 1 – Right posterior segment, 2 – anterior, 3 – left medial segment, 4 – lateral.

inferior vena cava. This principle plane completely separates the supply area of the right hepatic duct, artery and portal vein, from that of the left. This functional line of division differs fundamentally from the old anatomical one, where the boundary was the attachment of the falciform ligament.

Each of the two lobes, following this modern concept, may be further subdivided into two segments by sections drawn at right angles to the liver surface and always directed away from the anterior border, posteriorly towards the inferior vena cava. In the left lobe this segmental fissure is accurately depicted by the attachment of the falciform ligament, and inferiorly by the ligamentum teres fossa and ligamentum venosum fossa, thus creating a medial and a lateral segment. A similar fissure in the right lobe separates the anterior from the posterior segment lacking, alas, any external landmark. *Fig. 5.*

Further subdivisions of segments have been described, however these are not such pronounced, independent entities. — Each segmental pedicle harbours, as a rule, a single corresponding artery, portal vein and one bile duct. One or other of this triad of elements may be duplicated.

Whereas the portal vein is the "scaffolding", in a sense, upon which the liver is built, the hepatic veins, removing blood from the liver, do not follow this segmental pattern. Their course is separate and they drain blood from neigh-

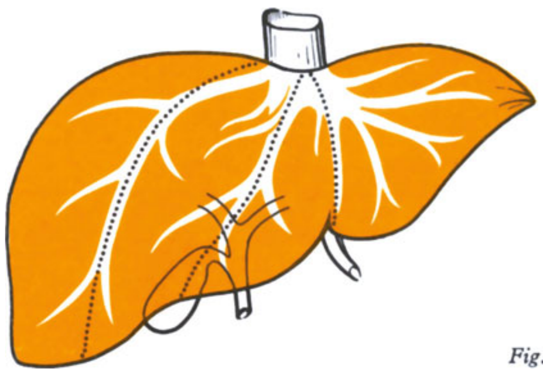

Fig. 6: Intersegmental course of hepatic veins.

bouring segments, running posteriorly between them, uniting eventually into three main intersegmental veins which open separately into the inferior vena cava. These veins are very vulnerable in segmental liver resections, and care should be taken to preserve them in order to maintain the drainage of the remaining segments. *Fig. 6.*

Extrahepatic Biliary System

Bile ducts emerging from the liver in porta hepatis unite in the hilus forming the common hepatic duct. At its hilar exit the gallbladder with cystic duct joins it from the right side, and the main duct continues further as the common bile duct, also known as ductus choledochus. This descends together with the main hepatic vessels in the margin of the lesser omentum to the duodenum, where

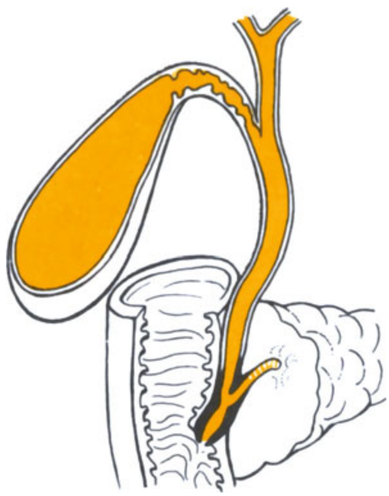

Fig. 7: Extrahepatic biliary tract (Freely after Voroběv).

they then separate. The duct passes independently behind the duodenum entering the pancreatic groove, and penetrating the descending portion of the duodenum, where it terminates at the major papilla of Vater. *Fig. 7.*

The two principal parts of the extrahepatic tract, the main bile duct and its side arm — the gallbladder, differ not only in their morphology and function, but to a certain degree also in their pathology, clinical manifestations and surgical therapy.

Main Bile Duct and Papilla

Hepatic ducts

Successive confluence of bile ducts inside the liver creates four main segmental ducts which, as a rule, form two hepatic ducts in the hilus. *Fig. 8.* The left is always present, created by the union of lateral and medial segmental ducts. The right duct usually originates similarly by union of anterior and posterior segmental ducts. The two main hepatic radicles unite forming the common hepatic duct. *Fig. 9.*

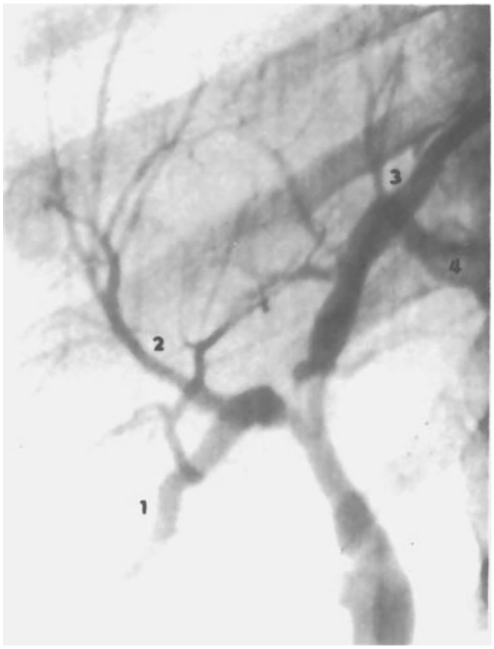

Fig. 8: Typical segmental distribution of hepatic ducts. 1 – Branch for posterior segment, 2 – anterior, 3 – medial, 4 – lateral. (Cholangiogram following cholecystectomy.)

Although the pattern of confluence varies individually, three main types exist (Kune, 1972). *Fig. 10.* Most commonly left and right hepatic ducts are linked as a "bifurcation" (type 1). In about a quarter of cases, however, a separate right

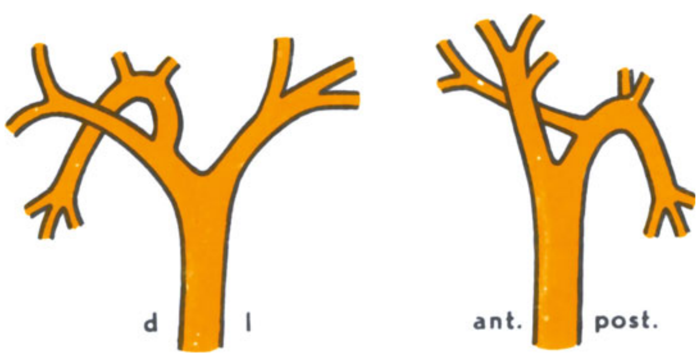

Fig. 9ab: Union of segmental hepatic branches and ducts, (a) anteriorposterior and (b) lateral view.

hepatic duct is not present and both corresponding segmental ducts open directly into the left hepatic duct, either together as a "trifurcation" (type 2) or each separately (type 3). — Thus if more than two ducts emerge from the liver this

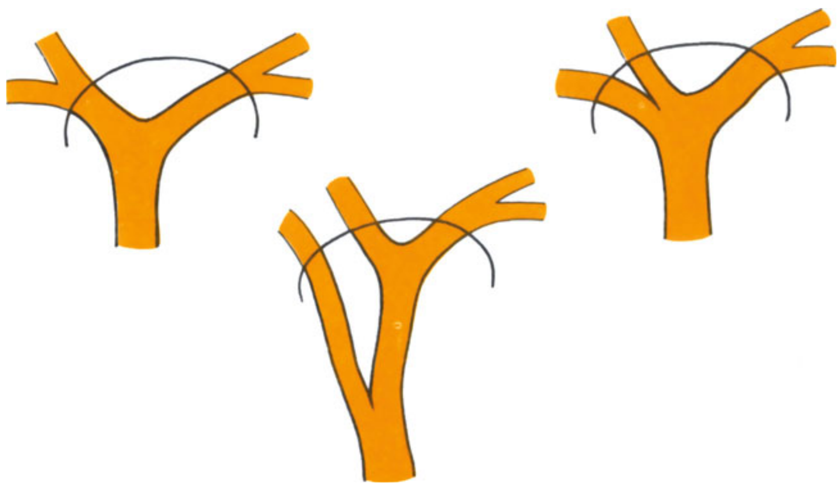

Fig. 10: Three main types of duct union. (a) Bifurcation, (b) trifurcation, (c) segmental branches from right join left hepatic duct separately.

signifies the presence of a specific type of union only. Ligation of the supposedly accessory duct could produce dire consequences.

A crucial point at operation is the length of hepatic ducts accessible in the hilus and how soon they unite to form the common hepatic duct. This may be close to their exit from the liver, thus only short sections are situated outside it, whereas sometimes confluence is lower down and accessible portions measure 2–4 cm, and occasionally even segmental ducts are visible. An enlarged liver, however, may obscure them. — On the contrary, the common hepatic duct in its entire length always lies extrahepatically. It measures 2–5 cm to the cystic duct and is approximately 6 mm wide.

Common bile duct

After being joined by the gallbladder with cystic duct the common hepatic duct continues under the designation common bile duct or choledochus. *Fig. 11.*

A "normal" choledochus measures approximately 8 cm in length. However, this varies considerably, from 5–15 cm, according to cysticus orifice and papilla position. The papilla is most commonly situated in the descending duodenum (90%), according to endoscopic evidence in its midportion (Classen et al., 1973, Anacker et al., 1977). Rarely it is more proximal in the upper duodenal bend (4%), this is termed "short choledochus", — or in the third, horizontal part of the duodenum (6%), producing a "long choledochus". *Fig. 12.*

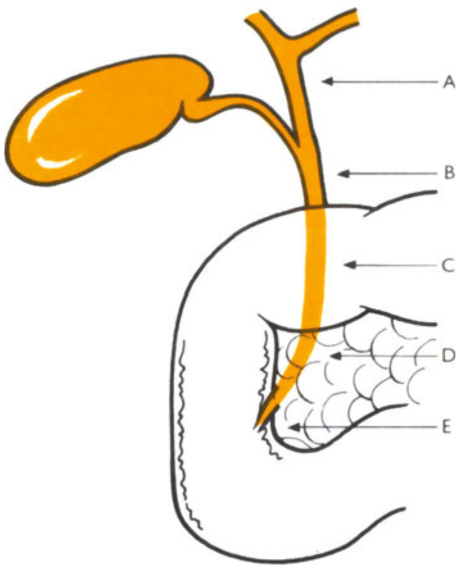

Fig. 11: Main bile duct: A – Common hepatic duct, B–E – common bile duct (B – supraduodenal segment, C – retroduodenal segment, D – pancreatic segment, E – sphincteric or intramural segment with papilla). Section D–E is designated as "terminal choledochus".

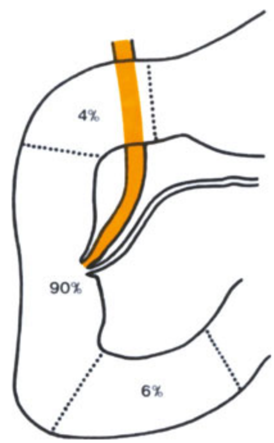

Fig. 12: Site of papilla in the duodenum.

The common bile duct is subdivided into several portions:

- supraduodenal
- retroduodenal
- infraduodenal or pancreatic
- intraduodenal i.e. intramural or sphincteric with papilla.

The supraduodenal portion of the choledochus descends in the hepatoduodenal ligament, covered in front by peritoneum alone and thus readily accessible at operation. This ligament forms the anterior margin of the epiploic foramen of Winslow, bounded below by duodenum, behind by inferior vena cava and above by the liver. A finger introduced into this aditus of the lesser sac, with the thumb in front — the so-called Pringle's manoeuvre — gives information about lesions and stones in this choledochus portion and about the hepatic artery position. *Fig. 13.*

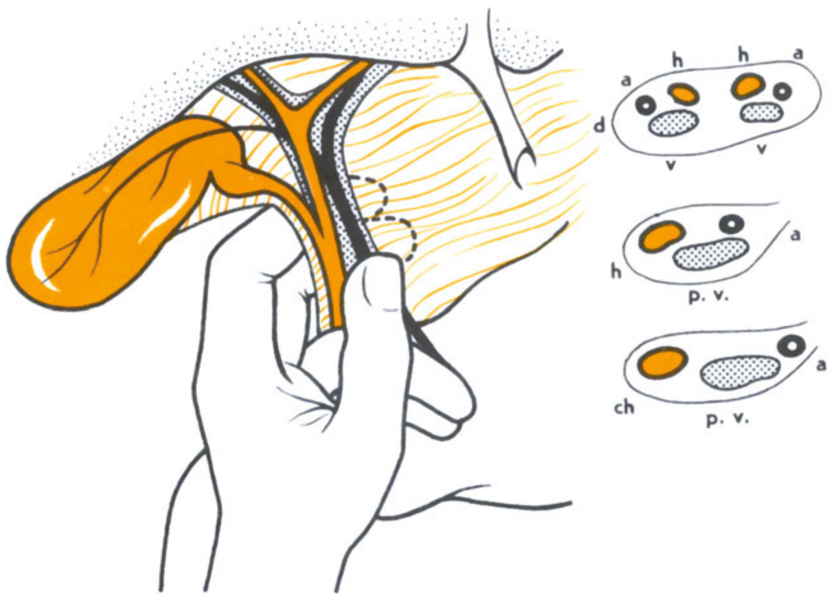

Fig. 13: Palpation of biliary stalk from the foramen of Winslow. Relations of vessels and ducts.

This supraduodenal section is usually 2.5 cm long, calibre ranging widely from 4–13 mm is considered normal.[17] Width increases a little with age (Mahour), however marked choledochus dilatation is chiefly an important indicator of the presence of gallstones, or biliary stasis. The variation range of pathologic dilatations unfortunately partly overlaps the wide limits of normal values.

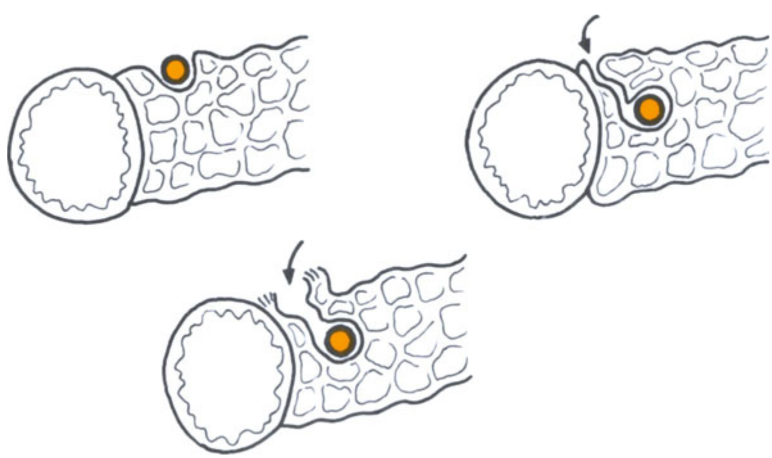

Fig. 14abc: Pancreatic course of common bile duct. (a) In a groove, (b) in a tunnel, (c) exposure of duct from behind without cutting gland.

The retroduodenal portion of the choledochus is already extraperitoneal. It dips behind the first part of the duodenum, abandons the main vessels and is directed downwards to reach the dorsal aspect of the pancreas. Duct dissection is tricky here, as it is frequently crossed in front by the superior pancreaticoduodenal artery, sometimes also by the gastroduodenal artery and some hepatic branch of the superior mesenteric artery. The choledochus encirclement is completed by the pancreaticoduodenal vein traversing it from behind on its way to the portal vein. *Fig. 31.*

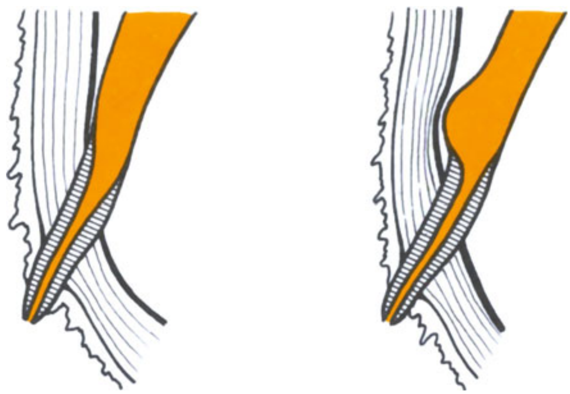

Fig. 15: Sphincteric segment of common bile duct: (a) Continues in its axis, (b) sets excentrically.

The infraduodenal or pancreatic portion marks the beginning of the so-called "terminal choledochus". It is embedded in the posterior aspect of the pancreas and approaches the second portion of the duodenum obliquely from the left side. The choledochus groove varies in depth, leaving the duct exposed in some instance, sometimes an overgrowth of pancreatic tissue from the left border creates a tunnel.[18] Palpation is difficult, only a finger inserted behind the pancreatic head may suggest the presence of small calculi or of a probe. *Fig. 14.*

The intraduodenal or better intramural section of the choledochus, penetrating the intestine, is the only part equipped with musculature and represents its sphincteric portion. It cannot be palpated either, unless a probe is inserted. Together with the pancreatic section it is referred as "terminal choledochus". Leaving the pancreas a 10 mm or longer segment runs parallel with the descending duodenum medially, penetrates its wall obliquely and terminates inside the gut as the papilla of Vater. This lies as a rule somewhat proximal to the middle of the descending part, at least according to endoscopic or surgical experience. In contrast, autopsy evidence suggests a slightly more distal site.

Whereas external measurements of the sphincteric portion are constant, its lumen narrows noticeably, by about 1–3 mm. This occurs abruptly before penetration of the wall, sometimes a little excentrically, if the duct suddenly curves into it. Narrowing is due to the wall thickening produced by the sphincter of Oddi. *Fig. 15, 16.*

The lumen alters markedly according to functional phases of the sphincter mechanism and can intermittently be completely closed. The length of the narrow sphincteric segment varies. According to Kune it measures up to the papilla 7–38 mm, according to Hand 11–26 mm, which is closer to our experience.

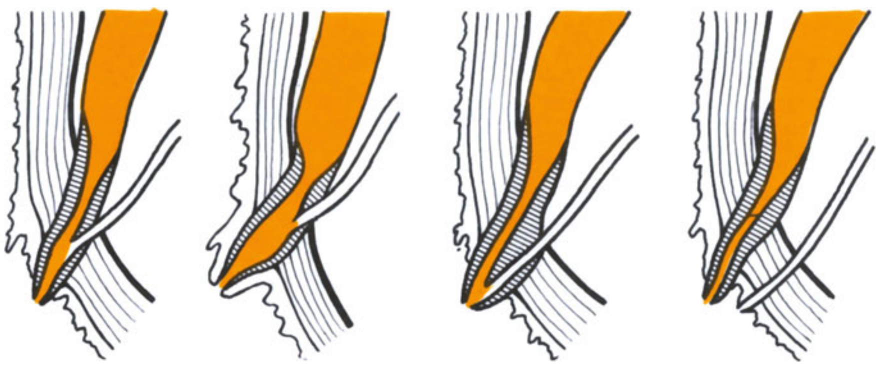

Fig. 16: Variations of union of common bile duct with main pancreatic duct. (a) Common channel, (b) ampulla in sphincter region, (c) both ducts open into papilla, (d) ducts open separately into intestine.

Adherence of the duct to the intestine and its oblique course through its wall, reduce the risk of extensive, even complete, papillosphincterotomy, threatening transection of the entire intestinal wall. It also facilitates direct lithotomy from the duodenum, if the stone is lodged at the entrance to the sphincteric portion. Only a "short" or "long" choledochus, opening into the 1st or 3rd portion of the duodenum, traverses the wall more perpendicularly, in which case the sphincterotomy risk is greater and reflux is more likely to occur. However, not even in such cases does the duct traverse by a kind of "window" in the intestinal wall, but remains anchored to it by muscle fibres, which enhance anatomical and functional relations.

Papilla of Vater

Major papilla appears normally as a small nipple-like structure protruding with a longitudinal fold between the circular folds of the intestine. It can even be palpated from the interior of the duodenum on its posteromedial aspect as a firm conical eminence. Externally, through the intestinal wall, however, only an enlarged or fibrotic papilla is palpable. — The healthy papilla is of small size, its height ranging between 1–7 mm. The orifice is circular or slit-like and if intact is freely permeable for a probe 3–5 mm in diameter.

Relationships and the type of union between the terminal choledochus and pancreatic duct are important for the surgeon. The pancreatic duct of Wirsung runs in the pancreatic axis from left to right curving downwards suddenly as it approaches the bile duct. It runs parallel with it for 1–2 cm and joins it in its sphincteric segment in over 85% of cases (Anacker, 1977). Confluence is from the medial and posterior aspect, and only exceptionally from in front or laterally. Typical sphincterotomy thus carries no risk. This "common channel" varies in length, is often only a few millimetres, but exceptionally up to 2 cm long (Gierman). Its spindle-shaped dilatation referred to as "ampulla" is found in only about 10% of patients.

Not infrequently both ducts open separately at the papilla or in a parapapillary diverticulum. Wirsung's duct rarely terminates independently in the duodenum,

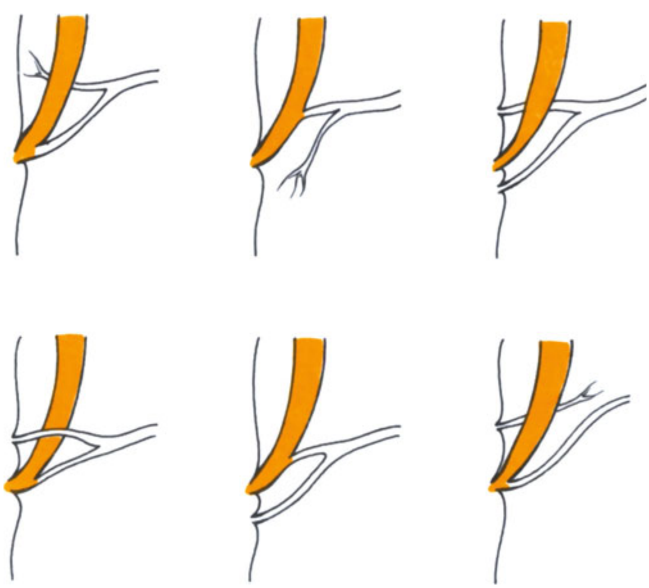

Fig. 17a–f: Variations of the intraduodenal openings of bile and pancreatic ducts. Single opening (a, b) – 48,5%, three openings (c) – 4.5%, two openings (d,e,f) – 47% of cases. (Freely after Anacker et al.)

and quite exceptionally its orifice might be absent altogether. In such cases it is substituted always by the accessory duct of Santorini. Its orifice, the minor papilla, is usually situated proximally to major papilla of Vater. Retrograde ascendent pancreatico-cholangiography discloses, apart from the three main modes of duct confluence, a wide variation of yet other types.[1,20,24] They are significant not only for the interpretation of roentgenograms and the understanding of diverse consequences of papillary obstruction, but also for surgical treatment. Fig. 17.

Histology of main bile duct and papilla

The structure of the entire main bile duct wall, with the exception of its sphincteric portion, is similar: fibrous connective tissue with elastic fibres and sporadic, negligible muscle fibres. The internal surface is smooth, covered by single layer cylindrical epithelium over a network of delicate connective tissue, forming folds only at the papilla. Small glands are present in the duct, secreting mucus which is added to the bile, their orifices appearing as minute depressed pores.

It is only the sphincteric portion and papilla which differ histologically from the rest of the common duct — by their musculature and mucosal folds. Its wall is abruptly thickened by smooth muscle fibres creating a genuine sphincter clearly defined by ciné-radiography. It was discovered in 1887 by the Italian physiologist Oddi, but actually it was a rediscovery of Glisson's sphincter. An accurate description was given by Boyden, 1965.

According to Hammersen (1972) it is rather a sphincter system of circular fibres, which produce a separate sphincter choledochi, a less distinct one for pancreatic duct, and more distally a common sphincter papillae surrounding both ducts. These may contract independently, and serve as a pump for active transport of bile and pancreatic secretions into the duodenum. Circular fibres are joined in the papillary region by recurrent longitudinal and spiral fibres, which by their contraction stretch the papilla slightly widening its orifice. Following sphincterotomy these circular fibres retract and the incision gapes which to some extent prevents recurrence of stenosis.

Duct mucosa is thrown into folds in the sphincter segment. These are longitudinal at first. Distally, and mainly in the papilla, transverse folds combine to create a kind of shutter. A valvular mechanism is thus produced preventing reflux from the intestine. Mucosal epithelium has a single layer composed of several cell types. Small mucous glands, most numerous at the orifice, facilitate a smooth emptying. They do not normally penetrate as far as the musculature. Födisch who described in 1972 the stratified structure of the papilla in detail, refutes a comparison with prostate tissue. Microscopic fragments of exocrine and insular pancreatic tissue may be found. Transition between papillary and duodenal mucosa is abrupt, sometimes small frondlike projections or mucosal folds protrude from the orifice of a normal papilla.

The papilla remains unchanged only during early life, with increasing age alterations are more frequent, a normal papilla in old age is rarely encountered. Fibrous, adenomatous and other lesions are not only evidence of ageing but are more often secondary to lithiasis and inflammation.

Gallbladder and Cystic Duct

A healthy gallbladder has a capacity of approximately 50 ml, measures 8–10 cm in length and 3–5 cm in width. However, its size fluctuates considerably, so-called normal size is found in about one-third of cases. Its fundus projects beyond the liver edge by 1–2 cm and is situated behind the 9th rib cartilage.

About one-quarter of the gallbladder is embedded in the liver. It is covered by peritoneum which is reflected to the hepatic serosal surface. In its hepatic bed the gallbladder is in direct contact with the liver, separated only by Glisson's capsule, a layer of vascular connective tissue which cannot be dissected from the liver without inducing hemorrhage. Sometimes the gallbladder is embedded deeply appearing to be absent, but more often its bed is shallow, or it may hang by a mesentery, which facilitates its removal. It may be, quite exceptionally, merely suspended by cystic duct and artery, and thus liable to twisting. *Fig. 18.*

Direct biliary communications into the liver are very rare. More commonly, however, some aberrant vestigial hepatic ductuli enter the gallbladder bed and a slender subvesical canaliculus of Luschka, passing from liver to hepatic duct, may lie in this position. If these channels are missed during cholecystectomy transient bile oozing may occur.

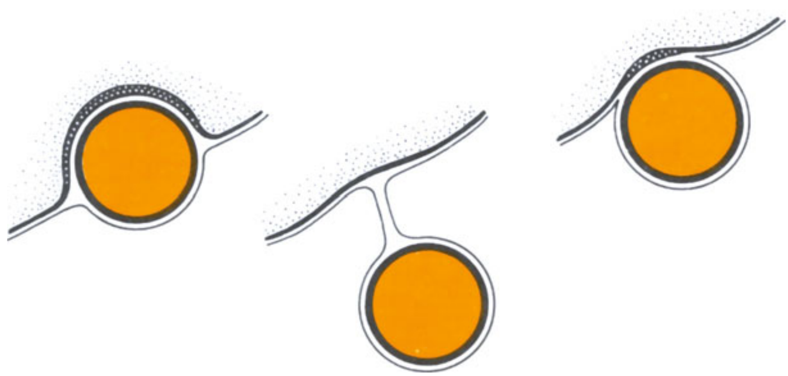

Fig. 18: Attachment of gallbladder to liver groove. (a) Deep, (b) shallow, (c) free suspension.

As it emerges from its fossa the gallbladder narrows, forming the infundibulum and neck. This continues as the twisting and glabrous part of cystic duct whose mesentery harbours the gallbladder artery and a typical lymph node. This represents the so-called triangle of Calot, delimited by the cystic duct, the hepatic duct and, cephalad, the liver. *Fig. 19.* A gallstone lodged in the neck may distend it, producing the so-called Hartmann's pouch, intensifying the knee-bend, as the cystic duct constantly issues on top. The gallbladder and cystic duct peritoneal covering continues to enclose the hilus and blends into the free edge of lesser omentum.

The c y s t i c d u c t and hepatic duct join at a sharp angle. The former coming from the right measures 2–5 cm in length, and its calibre is 2–3 mm. In only about 20 % of cases do both run parallel and close together, thus impeding dissection

Fig. 19: Cystic triangle of Calot bordered by hepatic duct (1), cystic duct (2) and liver undersurface (3). Cystic node (4), right hepatic artery (5) and cystic artery (6) lie in it.

and probing of hepatic ducts. As a result complete cystic duct removal is frequently not achieved and the adjoining hepaticus may be injured. The third variety of union presents similar pitfalls where a long cystic duct spirals round the hepatic duct downwards, more often from behind than from in front, and joins it more distally. *Fig. 20.*

Fig. 20: Variations of union of cystic and hepatic ducts. (a) Angular, (b) parallel, (c) spiral

Histology of gallbladder and cystic duct

The gallbladder wall is composed of connective tissue sparsely interlaced with smooth muscle fibres. Low pressure suffices, however, for the expulsion of bile. Healthy mucosa has an areolar structure with folds which smooth out as the bladder fills. It is lined by tall columnar cells, forming a single epithelial layer. Mucous glands are found only in the neck. Water and electrolytes are absorbed through interstitial channels.

Fig. 21: Spiral Heister's folds of cysticus visible on cholecystocholangiogram.

Transverse mucosal folds in cystic duct are designated as Heister's valvulae. Lacking musculature, they are not real valves, not even the last cystic fold, erroneously called sphincter of Lütke. They span only part of the circumference suggesting a spiral, visible on the cholecystogram. *Fig. 21.*

Blood Vessels

The anatomical relations between the extrahepatic bile ducts and the main hepatic vessels during their course in the lesser omentum are of great interest for surgeon.

As a rule these large hepatic vessels approach the choledochus behind the superior duodenal border accompanying it upwards towards the hilus. The common hepatic artery arches towards it from the left, running medially to the duct, whereas the portal vein is situated beneath it. As the artery turns upwards, it gives origin to the gastroduodenal, supraduodenal and right gastric arteries, and it continues in the lesser omentum as the hepatic artery proper. This divides early into two branches and the right hepatic artery passes usually behind the common hepatic duct or its right branch into the triangle of Calot, where the cystic artery for the gallbladder springs from it.

The mutual position of the hepatic artery and the main bile duct in the hepatoduodenal ligament is not constant. The hepatic artery may be situated underneath the duct, rarely in front of it, or even on its lateral aspect, and may thus be unexpectedly exposed to injury. It must also be taken into account that the common bundle may harbour yet another artery supplying the liver, arising from the superior mesenteric or the gastroduodenal arteries. *Fig. 22.*

Fig. 22abc: Hepatic arteries and their course in the hepatobiliary bundle. – (a) Proper hepatic artery (1) originating from common hepatic artery (2), – (b) right hepatic artery (3) originates in addition also from superior mesenteric artery (4), – (c) right hepatic artery (3) originates from gastroduodenal artery (5), left hepatic artery (6) from common hepatic artery (2).

As far as the portal vein is concerned, this is created by the union of the upper mesenteric and splenic veins behind the pancreas and approaches the choledochus from behind, always lying deepest in the hepatoduodenal ligament. It may be as long as 7–10 cm, its width reaching 8–14 mm. However, in view of its position and thanks to a lesser degree of variability in its course, the risk of injury is not so great as with the arteries.

Higher, in the hilus, the vessels are covered by the common hepatic duct and the branches of the hepatic artery enter the porta hepatis usually behind the corresponding bile ducts. They may however, find themselves also lateral or even in front of them.

The portal vein, always more deeply situated, divides later than the artery, forming 2–3 branches. These also penetrate the liver behind the ducts, but the left portal branch may course obliquely in front of the left hepatic duct, hiding it. The course of individual portal branches in relation to the portal vein axis may assume some significance for metastatic dissemination into limited hepatic regions and for selective chemotherapy (Brisard, 1977).

Blood supply proper to the extrahepatic bile ducts and the gallbladder is mainly ensured by the same arteries as to the liver and they are drained by the portal vein.

As far as the gallbladder is concerned, it has a single artery as a rule, the cystic artery, arising usually from the right hepatic artery. It traverses the dreaded Calot's triangle, running in the mesentery behind the cyst duct, reaching the gallbladder invariably at level of the neck. There it divides into two or more branches. A wide range of variations exists, however: cystic artery may be duplicated or even triplicated and its origin also varies. It may arise from the proper hepatic artery or from its left branch, or from the more remote common hepatic artery, gastroduodenal or superior mesenteric arteries, its course differing accordingly. The surgeon must be prepared in about one-fifth of cases to accounter the

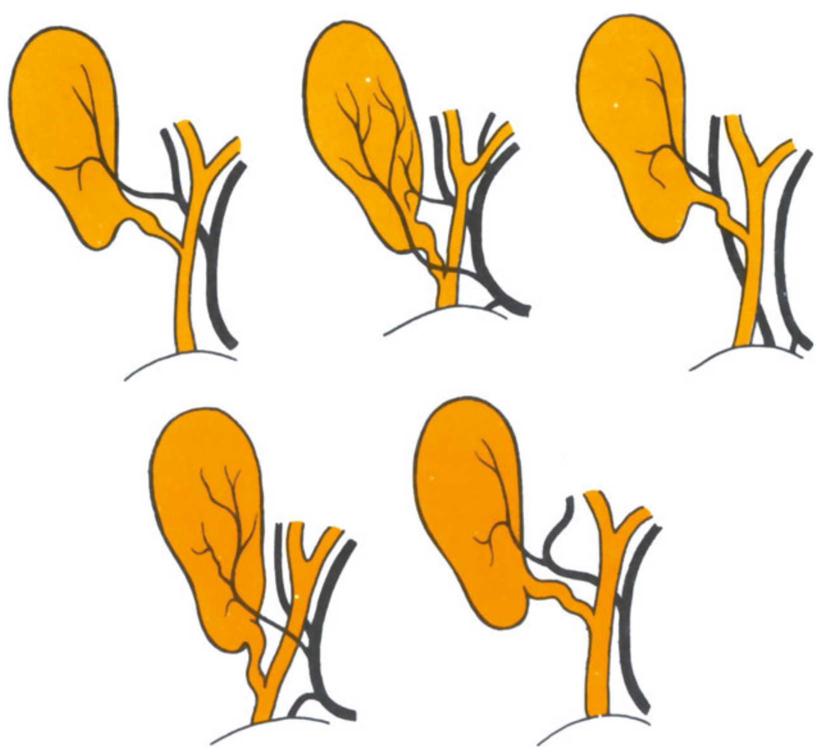

Fig. 23: Variations of cystic artery. (a) "Typical" course, (b) double, (c) originating from superior mesenteric artery, (d) crossing anterior to bile duct, (e) right hepatic artery accompanies cysticus.

cystic artery in front of the hepatic artery and even in front of the cystic or bile duct. It may approach the gallbladder from above, below or from in front. *Fig. 23.*

Ignorance of these variations may produce injury and unexpected hemorrhage which may result in hepatic duct damage or interference with the liver blood supply. Incorrect ligation may occur if the cystic artery is mistaken for another artery running close to the cystic duct.

Most of the venous return from the gallbladder is by small veins to its bed in the liver, as well as through the venous plexus at the cystic orifice. Infrequently a cystic vein is present which passes directly into the portal vein.

Blood circulation of the hepatocholedochus is provided by fine, mostly anonymous vessels from the neighbourhood. Papilla and sphincteric duct portion are supplied from small branches of posterior pancreaticoduodenal arcade, the main duct from small arteries arising seriatim from hepatic artery and more centrally from its branches. Connection with gastroduodenal artery is also possible. Each small branch probably supplies a particular segment of the duct. As anastomoses are not reliable, extensive duct dissection may, it is said[23], produce necrosis of the wall.

Venous blood from ductus hepatocholedochus drains into portal vein from the epicholedochal venous plexus, an aid for duct identification in some cases, particularly its supraduodenal portion.

Lymphatic Drainage

Lymphatic vessels from the subserosal and epithelial network of the gallbladder communicate with hepatic capsular lymphatics in the gallbladder bed and drain

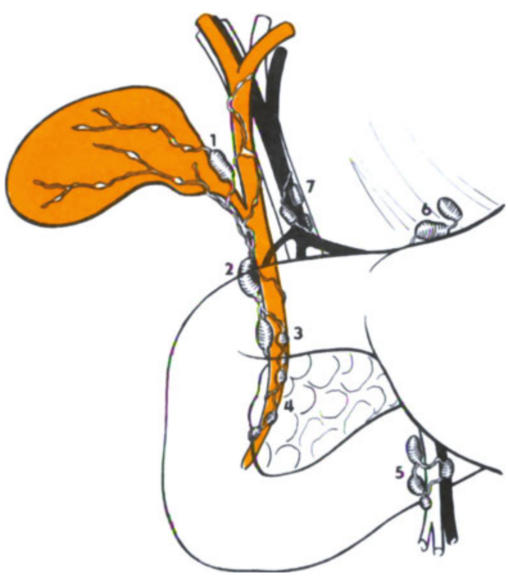

Fig. 24: Lymphatics of biliary tract: 1 – Cystic node, 2 – choledochal, 3 – pancreaticoduodenal nodes, 4 – retropancreatic, 5 – upper mesenteric, 6 – paraaortic, 7 – adjacent to hepatic artery.

into the bile duct lymph vessels. They link with them mostly via the cystic or "sentinel" node at the neck of the gallbladder. The lymphatics of the extrahepatic bile ducts receive also drainage from several right-sided hepatic lymph vessels leaving the porta hepatis.[7] They connect partly with celiac and supramesenteric nodes and partly they continue as a chain of small nodes alongside the common bile duct and portal vein towards the pyloric and retropancreatic nodes. One largish node amongst the upper group of duodenopancreatic nodes, the so-called nodulus lymphaticus choledochi, is regularly situated between bile duct, duodenum and pancreas. If no clear view is obtainable, it may serve as a useful landmark for the localization of the choledochus, which lies medially and in front of it. *Fig. 24.*

Innervation

Autonomic nerves for the biliary tract arise chiefly from the celiac plexus. The parasympathetic (vagal) fibres, mixed with the postganglionic sympathetic fibres belonging to the 7th–10th spinal segments, accompany the hepatic and gastroduodenal arteries together with the hepatic branches coming directly through the gastrohepatic ligament from the anterior vagal trunk.

The nerve control of the biliary tract is not yet clear but is not decisive for its function. Vagal nerves stimulate the tonus of the gallbladder and of the sphincter of Oddi. Secretory fibres to the duct epithelium are also vagal. On the other hand pain conduction is almost exclusively through afferent sympathetic fibres going to celiac ganglia and splanchnic nerves, and often also by way of the right phrenic nerve.

Anomalies and Variations

There is a high incidence of vascular and ductal aberrations in the disposition of the biliary system. They are often rather variations than anomalies, as "it is difficult to know what is normal and what is abnormal" (Hand).

It is only some anomalies which may produce disorders or lead to serious complications, these will be dealt with in a later clinical chapter (p. 411). Here we mention only clinically silent variations or rare anomalies, which might at most be the source of trouble for diagnosis or at operation.[25]

Significant anomalies of the gallbladder are rare.

Hypoplasia, even aplasia of the gallbladder, first reported by Bergman as early as 1701, may lead to erroneous interpretation of cholecystograms, as non-visualization of the gallbladder. If no bladder is found at operation, abnormal localizations must, of course, be excluded, as for instance a gallbladder hidden in the liver, or situated on the left side, or exceptionally, extraperitoneally, or even subcutaneously. We must ascertain whether or not it has only shrunk secondarily to protracted inflammation in cholelithiasis.

Double gallbladder with separate cystic ducts is extremely rare (0.004%).[28] More often at least a single cystic duct is present, or division of bladder is in-

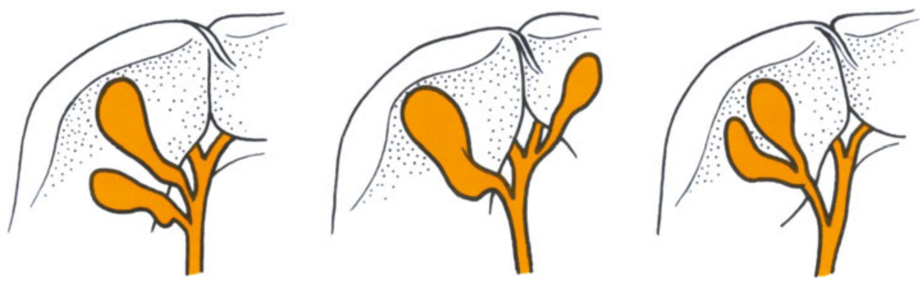

Fig. 25: Twin gallbladder. (a) Both on right, (b) one located on left, (c) with a common cystic duct.

complete, vesica bilobaris. *Fig. 25.* If vesica duplex is present, this in itself is not an indication for surgery. It must be borne in mind, however, that in lithiasis both gallbladders need not be involved to the same extent, or that after removal of one, the other — missed at operation — might cause symptoms.

Congenital gallbladder septa or fundus folding producing a Phrygian cap

Fig. 26: Phrygian cap shaped gallbladder.

appearance have no clinical significance, but similar deformities are frequently erroneously reported as due to adhesions. *Fig. 26.*

Cysticus anomalies are mainly concerned with its type or site of union. The risk of overzealous dissection of the cystic duct running parallel with the common duct or crossing it in spiral fashion has been already mentioned. A long duct might extend as far as the papilla or, quite exceptionally, open directly into the duodenum. In other cases it might join, instead of the common hepatic duct, the right hepatic duct or even its segmental branch, and rarely the left hepatic duct. — The right hepatic duct on the other hand, may occasionally open into the cystic duct, discernible by its characteristic mucosal folds. — Cases in which the gallbladder is interposed in the course of the hepatic duct are a rarity.[29] The surgeon must detect any unusual type of union in time, to avoid ligating the hepatic duct instead of the cystic duct during cholecystectomy. *Fig. 27.*

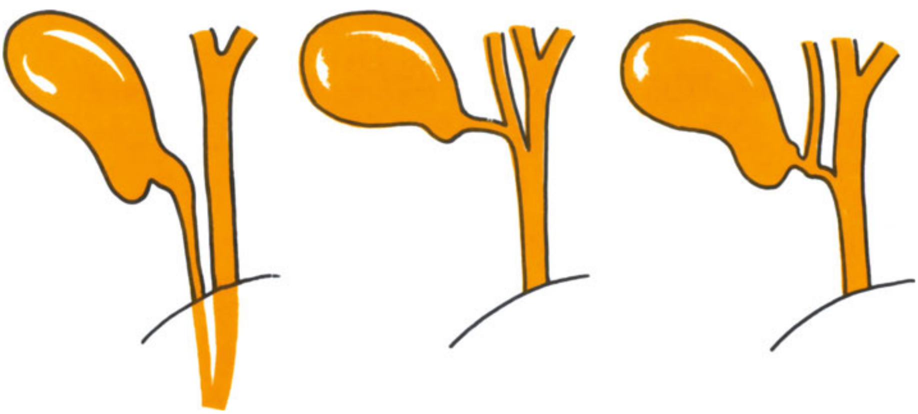

Fig. 27abc: Anomalies of cystic duct. (a) Long cystic duct entering hepatocholedochus retroduodenally, (b) cystic duct entering right hepatic duct, (c) segmental hepatic duct entering cystic duct.

Many aforesaid variations exist concerning external bile ducts, their confluence in the hilus, their junction with the duodenum, their relation to pancreatic ducts etc. They are common as compared with the real and at the same time asymptomatic anomalies. The incidence of a true accessory, not only aberrant hepatic duct is low (1.4% after Benson). Choledochus duplex is a rare event, its opening into the stomach has also been reported (Quintana). Congenital orificial stenosis of the papilla or, in contrast, papillary epispadia are really sporadic anomalies.

Vascular anomalies and especially variations are much commoner than duct anomalies and can be revealed in every other biliary operation. Some of them, the more significant ones, have been already mentioned or depicted and will be dealt with again in connection with different surgical procedures (p. 194). They can and must be recognised by careful dissection in order to prevent vascular injury with its dreaded consequences.

Duodenum and Pancreas

Though their relationship to the biliary tract is close, only a few remarks must suffice in this treatise on biliary surgery.

Only the first, horizontal part of the duodenum encircling the pancreatic head in a C loop, is intraperitoneal. — The second descending part, harbouring Vater's papilla is adherent to the pancreas, by a membrane on the posterior abdominal wall. Incision of the peritoneum alongside the intestine allows for blunt stripping

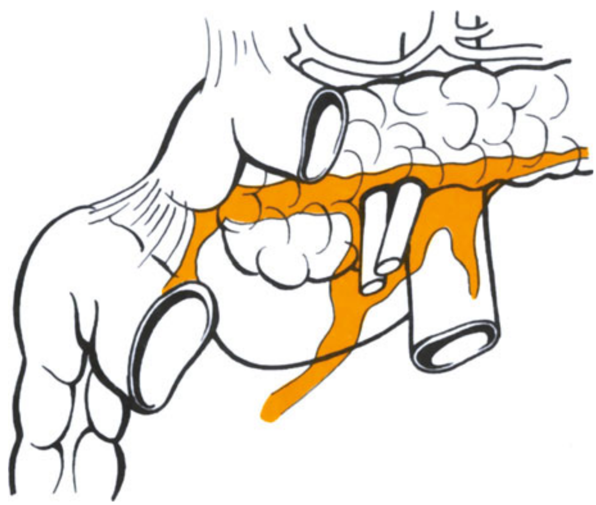

Fig. 28: Attachment of mesotransversum to duodenum and pancreas.

of duodenum and pancreatic head from their base in front of the kidney and inferior vena cava. This Kocher's manoeuvre facilitates some operations. Mesocolon transversum is attached across the descending part of duodenum in front, continuing on the pancreas. This insertion must be pulled down in duodenotomy directed at the papilla. *Fig. 28.* — The third, lower horizontal part of the duodenum is partly accessible under the colon, up to the superior mesenteric vessels. They emerge from underneath the pancreas and run from above in front of the duodenum in the small intestine mesentery. — After this crossing the duodenum curves obliquely upwards in its fourth, ascending part. It is obscured by the root of the small intestine mesentery and suspensory duodenal muscle, i.e. Treitz ligament.

Peristalsis in the duodenum may be arrested by three physiological sphincters. According to Albot and Kapandji their presence can be demonstrated by radiology near the bulbus top, in the midportion of the descending part, and in the third part of the duodenum called Ochsner's sphincter. Contraction of the sphincters modifies the pressure in the appropriate intestinal segments and pressure fluctuations may be transmitted under certain conditions to the biliary ducts. This may provide an explanation for the abundant drainage of duodenal contents through a transpapillary choledochus drain if this has not been inserted sufficiently far, beyond Ochsner's sphincter, into the fourth part of the doudenum.

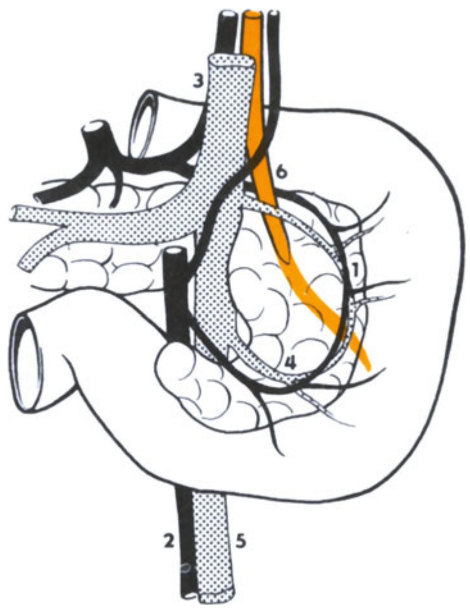

Fig. 29: Vessels of duodenum and head of pancreas. Posterior view. 1 – Posterior pancreaticoduodenal artery, 2 – superior mesenteric artery, 3 – portal vein, 4 – pancreaticoduodenal vein, 5 – superior mesenteric vein, 6 – common bile duct. (Freely after Hess).

As far as the pancreas is concerned, a fragile and highly vascular organ, it may be noted that surgery is easier if it is affected by sclerosis. Suture and haemostasis are easier in the firmer fibrotic tissue. The junction of pancreatic and bile duct with the duodenum has been already mentioned. This junction, by its pattern, localization and exposure to injury acquires a key position in biliary tract disease and its surgical treatment.

Blood supply to this region, duodenum and pancreatic head, is the most variable in the body. *Fig. 29.* — Arterial blood is supplied from above by the gastroduodenal, and from below by the superior mesenteric arteries. These are interconnected by two arcades, anterior and posterior pancreaticoduodenal arteries, sending short direct branches to the duodenum. They should be spared during surgery, despite the fact that the duodenum is the only part of the intestine with an arterial supply from two sides. — Venous blood is drained from duodenum and pancreatic head exclusively into the portal vein. It collects in the pancreaticoduodenal vein coursing with the arterial arcades along the intestinal concavity, but is unpaired, and opens into the superior mesenteric vein. — Lymphatics of pancreatic head and duodenum are interconnected, linked to bile duct lymphatics. This facilitates reciprocal transit of inflammation and dissemination of neoplasms.

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CLINICAL AND PATHOLOGICAL PHYSIOLOGY

Knowledge of biliary tract physiology is as yet incomplete. No true picture of events taking place during digestion and periods of rest, in health or in disease, is available. Continual biliary tract function studies are not feasible, bile obtained at operation or from drainage tube provides information only about a particular situation, which in addition is non-physiological. Animal experiments are of limited value as their biliary function differs, but mainly because human biliary pathology has no equivalent in animals.

A description of biliary tract physiology as related to surgery cannot dispense with a separate description of the functions of its individual components, without interfering with the concept of its functional entity. Any clinical application, however, must bear in mind that many present concepts were constructed from speculative conclusions rather than from factual evidence.

Secretion and Composition of Bile

Bile secretion is one of the principal liver functions. It is an active process, with energy consumption, realized by cell membrane enzymes, not a mere filtration. The daily amount of bile secreted into the intestine is estimated at 700 to 1200 ml, considerable fluctuations occurring during the day. Bile production by the liver is continuous, flow into the duodenum, however, is irregular as a rule, depending on the filling or emptying of the gallbladder and on sphincter of Oddi function. There is neurohumoral regulation of bile secretion.

Composition of bile (Hargreaves, 1968)

	Bile in liver	Bile in gallbladder
Specific gravity	1.008 — 1.016	1.008 — 1.059
pH value	5.7 — 8.6	6.1 — 8.6
Water	97 — 98 %	84 %
Bile acids	1.24 — 1.72 %	2.3 — 7.7 %
Bilirubin	17 — 71 mg/100 ml	50 — 1000 mg/100 ml
Cholesterol	86 — 176 mg/100 ml	100 — 900 mg/100 ml
Lecithin	250 mg/100 ml	350 mg/100 ml
Proteins	180 mg/100 ml	450 mg/100 ml

Fig. 30: Chemical composition of physiological bile.

Liver bile is an aqueous solution of electrolytes and organic substances. *Fig. 30.* Some of these originate in the liver, others are derived from the blood stream or their origin has not yet been established. The two fractions of the bile are produced independently: 1) by active secretion of bile acids, accompanied by excretion of cholesterol and phospholipids, 2) by active secretion of sodium ions. In both cases water is attracted according to the osmotic gradient. The quantity of both fractions is about identical under normal conditions in non stimulated bile flow.

Bile acids are the most important bile components from the functional angle.[63] They are natural choleretics and regulators of specific bile element secretion, forming micelles with cholesterol and phospholipids, which are particles capable of keeping the former in solution. They contribute with pancreatic lipase substantially to lipolysis and fat absorption.

Bile acids are excreted as sodium salts after conjugation with glycine and taurine, and are subject to an enterohepatic circulation. Thus, after passing into the intestine they are largely and rapidly reabsorbed, taken up by the liver from portal blood, and afterwards excreted into the bile. For this reason the bile contains a mixture of primary bile acids, produced by the liver (cholic acid and chenodeoxycholic acid) and of secondary acids originating in the gut by the bacterial reduction of primary acids (deoxycholic acid and a small quantity of lithocholic acid). The amount of bile acids in the enterohepatic circulation fluctuates depending on gallbladder function: bile storage reduces its quantity, evacuation increases it.[35] The bile acid pool is relatively modest (approximately 3 g), in view of their rapid recirculation, however, 5–10 times this amount is available daily. About 0.5 g daily are lost in the faeces, but are rapidly replaced by synthesis in the liver.

Metabolism and excretion of lipidic bile elements is linked in a peculiar fashion (Metzger, 1973). Cholesterol is the parent precursor material for the bile acids, 40% of its daily turnover are used up for their formation. By feed-back mechanism bile acids influence its synthesis, excretion and absorption. Bile acids likewise regulate phospholipid synthesis in the liver. Secretion of these substances is parallel to a degree, and they are present as mixed micelles in the bile. Secretion of bile acids is subject to very wide fluctuations;[14] if their amount in the enterohepatic circulation declines markedly, e.g. during the gallbladder filling phase, biliary secretion of cholesterol may relatively increase to such an extent, that micelles become oversaturated and excess cholesterol may precipitate as crystals.

Bilirubin is excreted from the blood into the bile in a constant amount of approximately 300 mg daily as a mere waste product of haemoglobin degradation. Its concentration fluctuates depending on choleresis. It becomes water soluble by conjugation with glucuronic acid, thereby losing fat solubility. It is excreted by an independent mechanism[24] in both basic liver bile fractions, but its secretion fails to cause choleresis (Shull et al., 1977). Reduction to several products by bacterial action takes place in the gut and these are excreted in the faeces. A small quantity is, however, reabsorbed, taken up by the liver, and excreted by the kidneys in minute amounts. Stercobilinogen, is the clinical comprehensive term for these products in the stools, and urobilinogen for those in the urine. Ehrlich's reaction is positive in the urine.

Original liver bile alters its composition as it flows through the bile ducts. Electrolyte exchange between blood and bile takes place there. *Fig. 31.* In the distal segments a secretin-stimulated secretion by the duct epithelium takes place which is rich in bicarbonate and chlorides. This is admixed to the original liver bile. It is not yet clear whether in man some of the water is absorbed in the ducts, but it seems probable. Bile is further profoundly modified in a functioning gallbladder. Concentration increases rapidly by water loss — four to ten times. Ionic composition is modified, pH declines, but bile remains isotonic with plasma. The rate of water absorption declines with the degree of concentration.

Concentrating capability of the gallbladder is not constant even in health; it is lower at night; is affected by hormones, e.g. in pregnancy, and enhanced by some very weak stimuli, such as the administration of water. The concentration capability of the gallbladder is reduced in cholecystitis, when some mucus is added and where, perhaps, large organic anions are resorbed (Ostrow, 1971). Bilirubin and bile acids are deconjugated in the presence of infection and

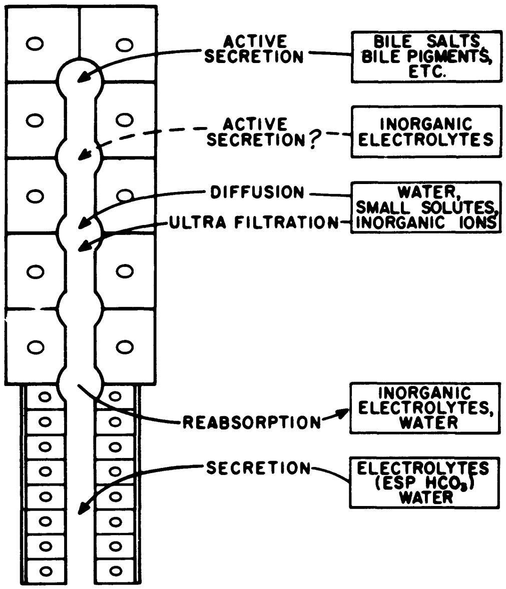

Fig. 31: Electrolyte exchange between blood and bile in the bile ducts (after Wheeler). – With permission J. B. Lippincott Publishers, Philadelphia.

toxic products originate from normal bile components, such as lysolecithin and litocholic acid (Sjödahl, 1976). Advanced biliary stasis in a blocked hydropic gallbladder may eventually lead to the disappearance of typical elements. A thin, but viscid mucous "white bile" is present. This may also be found in the ducts in cases of advanced obstruction. Rarely, from reasons not clearly understood, bile in the ducts may thicken to such an extent as to obstruct flow by itself, giving rise to the "inspissated bile syndrome".

Bile entering the duodenum at the papilla of Vater is thus no longer a uniform fluid, but a mixture of liver and gallbladder bile and pancreatic secretion. Here it mixes with the food and gastric juices, already neutralized, an almost constant pH of 6 being maintained in the papillary region of the duodenum.

Motor Activity of the Biliary Tract

Biliary ducts possess a vital function, conveying bile from the liver to the gut. Bile flow rate in the ducts is determined by the pressure gradient between secretory pressure in the liver and fluctuating resistence of Oddi's sphincter; the maximum secretory pressure in man is supposed to be 30 cm H_2O. This is never achieved under ordinary circumstances, as bile flow through the ducts is directed into the gallbladder and duodenum at much lower pressures.

The gallbladder is attached to the common bile duct as a cul-de-sac. If relaxed and almost empty, pressure is lower than in the choledochus. Thus it receives liver bile and thereby reduces intraductal pressure. Its storage capacity is enhanced by bile concentration. Only as it fills completely does pressure in the choledochus rise and exceed the so-called "opening pressure" of Oddi's sphincter, and liver bile flows directly into the duodenum. The same applies if a diseased gallbladder has lost its storage function or has been surgically removed. The gallbladder is not essential therefore for bile drainage into the gut.

Intraductal pressure is in the range of 5–15 cm H_2O. It is determined by the ratio between the amount of bile actually produced and the volume of the biliary tract, estimated by Sterling at 5–6 ml bile. Even under normal conditions pressures measured may vary considerably, as "there are no constants in the physiology of the biliary tract, and no gallbladder or papilla are identical" (Caroli).

Bile ducts — apart from the sphincteric terminal segment — lack a muscular coat, so that effective peristalsis is not possible, and bile motion is assisted merely by elastic distension.

Sphincter of Oddi regulates the rhythmical bile flow into the intestine. Its resistance produces ductal pressure required for gallbladder filling, and prevents reflux of duodenal contents. The sphincter is never at rest. It contracts and opens rhythmically at intervals of 3–7 seconds. This produces a succession of alternating images showing a channel of varying shape and width, including complete interruption. This is important for the interpretation of cholangiograms. *Fig. 142.* This "papillary play", its rhythm and amplitude, in association with sphincter condition, determine the rate of bile flow into the duodenum. An abrupt rise in duct pressure, the injection of irritants, or mechanical manipulation in the spincter region, all induce spasm.

The sphincteric segment of the choledochus joins the pancreatic duct in approximately 85 % of cases in the "common channel". Reflux of secretions is possible here, from the choledochus into Wirsung's duct and vice versa. In view of the fact, however, that pancreatic duct pressure, even at rest, is always higher than choledochal pressure, and as a rule remains higher even after food ingestion, reflux of bile is unlikely, under normal circumstances, to be either abundant or protracted. Peroperative cholangiograms sometimes reveal a partial or transient filling of Wirsung's duct. This usually occurs during the relaxation phase of the sphincter and cannot be considered a sign of papillary stenosis. It is most likely due to the rapid injection of contrast medium (De Rosa, 1969).

The principal regulator of biliary tract motor activity is the enterohormone cholecystokinin — pancreozymin. It is released in the gut by the influence of fat and protein containing foodstuffs, producing blood level rise. According to some observations, a role in its release may be played by a short intramural nerve connection. It causes an almost simultaneous gradual, tonic contraction of gallbladder and relaxation of Oddi's sphincter. *Fig. 32.* Thus the gallbladder evacuation produced in this way fails to increase intraductal pressure. Gallbladder size and shape during contraction is variable. It never empties completely, and evacuation

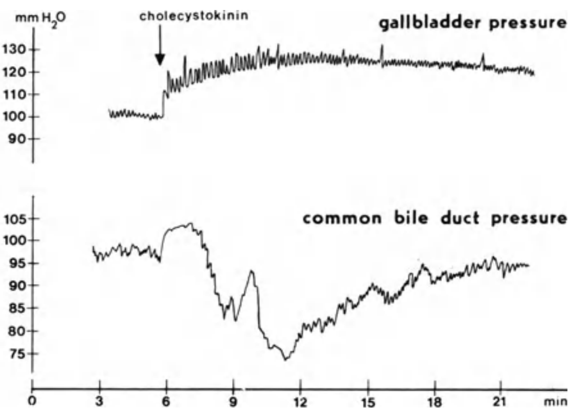

Fig. 32: Pressure changes in the gallbladder and bile duct during bile evacuation induced by cholecystokinin (Freely after Grill).

may be interrupted by transitory relaxation immediately inducing a reversal in bile flow. With identical doses of parenteral cholecystokinin the degree of evacuation varies greatly, even in the same subject, and sometimes the gallbladder fails to contract at all.[25] The evaluation of such variable changes and responses as a sign of functional disorder is thus rendered extremely difficult.

Gallbladder evacuation is reduced by the sex hormones in females, in old age, and possibly by changed sensitivity to cholecystokinin, e.g. during virus hepatitis.

Neuroregulation of biliary tract function appears to be of minor importance. Responses to nerve stimulation appear inconstant and possibly variable. Vagus stimulation increases the tonus of gallbladder and Oddi's sphincter. Vagotomy

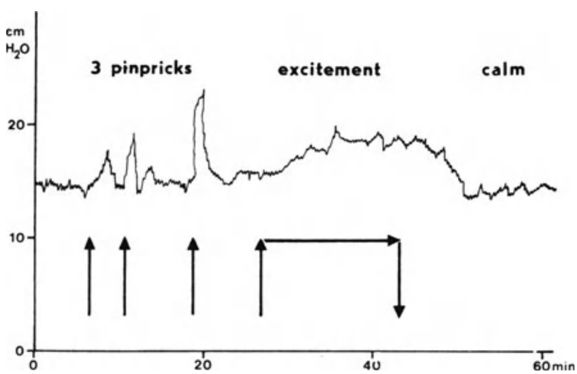

Fig. 33: The effect of pain and excitement on sphincter of Oddi function. (Freely after Doubilet).

produces gallbladder hypotonus, evacuation, however, does not suffer. Stress causes Oddi's sphincter spasm. *Fig. 33.* How the various regulative mechanisms interact is not yet known, but neurohumoral interactions are generally recognised (Necheles, Davenport).

Biliary Pain

Pain is the commonest symptom of biliary tract disorders. It may originate in the gallbladder or ducts; a clinical distinction is not possible. Pain occurs most commonly in attacks, starting as epigastric discomfort, rapidly achieving its localized peak with irradiation, later diminishing gradually. The intensity of an attack often fluctuates, a true colic is an exception, however, though it is usually designated as such.

The cause for an attack is most often biliary lithiasis or an acute inflammation, cholecystitis or cholangitis. In the latter case painful sensation are more intensive, wane more slowly and are protracted. Concurrent reflex limitation of diaphragmatic movement sometimes produces shortness of breath. The pain mechanism in simple biliary attacks is not fully understood. Most probably acute distension of gallbladder and ducts produces the painful sensation. It results from flow obstruction due to calculi or stenosis, particularly if bile secretion or flow has been stimulated intensively. Detection of the causes for pain must concentrate therefore on the narrowest sites of the biliary tract — cystic duct and papilla. Nevertheless, artificially produced pain e.g. by inflation of a balloon in the gallbladder following cholecystostomy, need not simulate spontaneous pain exactly.

Acute cholecystitis produces obvious organ pain. The inflammed gallbladder aches spontaneously and is tender to touch. Parietal peritoneal irritation may be associated. Chronic inflammation is not painful by itself.

Receptors for painful impulses are located in an extensive and communicating network of nerve plexuses in the biliary tract walls. Afferent pathways for pain conduction to the brain stem are set out in the instructive scheme of Kune. *Fig. 34.* Painful sensation, however, is not influenced solely by its cause. It may be modified by the "pain threshold" which is higher in old age and in exhausted subjects. In contrast, it is lower in neurotics, but also in acute inflammation (Walters). The patient's attitude also plays a role, his anxiety, his indifference, selfcontrol etc.

Everyday clinical practice confirms the risks of making erroneous interpretations of pain, which is sometimes without justification suspected as being of biliary origin, or on the contrary underestimated. Chapman found in trials on human subjects that pain caused by the artificial distension of lower oesophagus, duodenum, jejunum and bile duct, frequently cannot be distinguished apart, but may differ from the "spontaneous" pain due to disorders of the same viscera. Doran likewise, in human subjects, found that pain induced by bile duct distension is variously projected and may cause sensations differing from symptoms of biliary tract disease. Distension failed to induce any pain in some subjects. It appears that oversimplification prevails in respect to pain mechanism explanation and that we overlook the effect of simultaneous reactions in neighbouring viscera and variations in nerve supply.

The effect produced by certain drugs may serve to provide a fresh angle

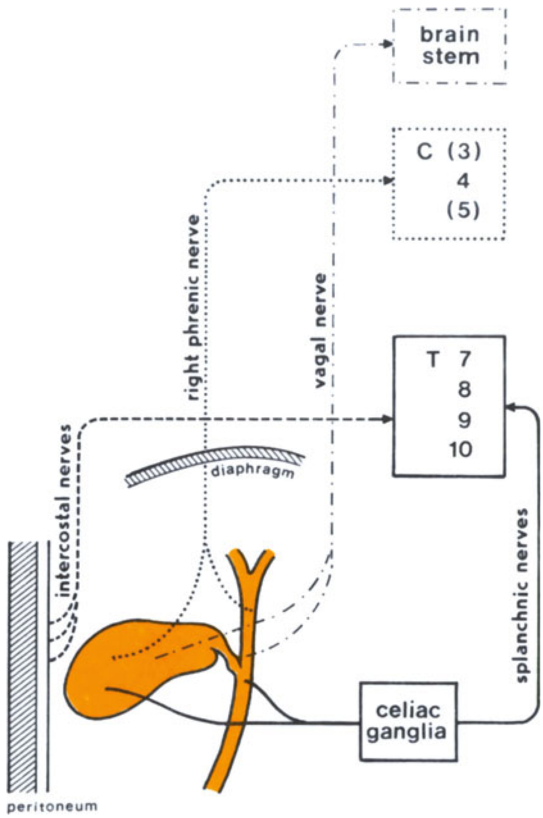

Fig. 34: Afferent nerves of biliary tract. (Freely after Kune). – With permission Little, Brown Publishers Boston.

on the genesis of biliary pain. Experimental results in animals and man lack uniformity and frequently contradict clinical experience. This applies also to the effect of various analgetics, spasmolytics and anticholinergics and other drugs. It is generally known that nitrites reduce Oddi's sphincter tonus, morphine and related drugs increase it.

Biliary pain originates very rarely in an otherwise healthy biliary tract. This was termed biliary tract dysfunction. Formerly this was thought to be at the bottom of a variety of symptoms similar to biliary ones. Complicated schemes were devised for its diagnosis, based mainly on peroperative manometric measurements. It was even a reason for surgical intervention. These views have now been completely abandoned. Nevertheless reports on successful cholecystectomies of non-calculous gallbladders which failed to evacuate correctly before operation and were causing pain keep appearing in the literature. Other writers evade the difficulty caused by the poor reproducibility of function studies by the designation "gallbladder hyperesthesia" denoting a gallbladder with such a low pain threshold that painful sensations arise from awareness of normal activity (Hess, Jacobson). Nevertheless it is an established fact that in patients after cholecystectomy pain may be due to spasm of the sphincter of Oddi.

The correct interpretation of pain simulating biliary disease in the presence of a normal biliary tract at investigation represents one of the most difficult dilemmas in the clinical practice of biliary disorders. Sometimes conditions found at operation correct the preoperative diagnosis of normal ducts, sometimes late postoperative developments disclose an incorrect causal relationship. It cannot be denied, however, that even some anatomically sound or almost normal gallbladders obviously cause pain for reasons unknown to us.

Lithogenesis

Gallstones are generally composed of material which has become separated from the bile fluid. They may be variously sized solitary formations, round or egg-shaped, or multiple polyhedric, closely packed faceted stones, in some cases occupying the entire gall-bladder. Sometimes they are tiny and irregular, or a conglomerate of brittle calculi with biliary slime and sand and may be found occasionally in gallbladder and ducts alike.

Gallstones are composed of normal bile elements i.e. cholesterol, bilirubin and calcium, and minute quantities of other material. These components, however, are present in proportions differing from those in the bile, and calcium salts form various crystals. It is more of an exception if one element predominates to such an extent that we are dealing with "pure" calculi, of either cholesterol, pigment or calcium carbonate. Most often calculi are mixed, cholesterol outweighing the other components by 70% or more, the proportion of pigment being less significant despite their colour. Less common are mixed stones with a lower proportion of cholesterol (25% or less) and with pigment preponderating. The two may be distinguished by their appearance. Mixed cholesterol calculi are smooth or faceted, 2–30 mm in size, light or brownish in colour, and on section laminated or crystalline. Mixed pigment calculi are multiple, 2–5 mm in size, irregular or smooth, black or darkish brown, amorphous or crystalline on section.[53] They are frequently radioopaque. Their frequency varies by regions, in the USA they are about 27% of all calculi, in Central Europe they are less common.

Cholesterol precipitates from so-called lithogenic i.e. cholesterol oversaturated bile. It is quite insoluble in water and can be kept in solution only in mixed micelles. Micellar capacity for dissolving cholesterol is limited, however, and corresponds to the ratio of its concentration to phospholipids and bile acids concentration. As in man under normal conditions micelles are saturated with cholesterol by 70–90%, a relatively minor fluctuation in the ratio between the three elements is sufficient to cause cholesterol to fall out of solution as crystals. This is expressed by the familiar triangular scheme of Admirand and Small, which outlines the relatively small range in the ratio between the three lipidic bile elements in which the monophasic micellar solution is maintained. *Fig. 35.*

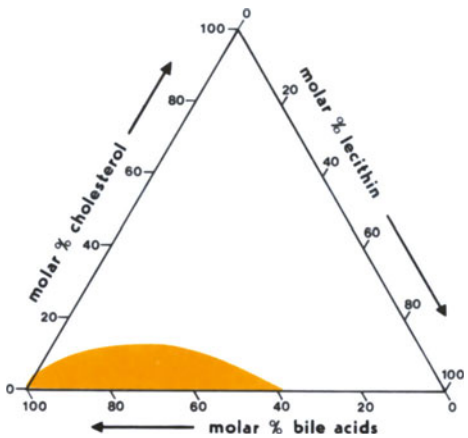

Fig. 35: Admirand's and Small's triangle for the distinction of lithogenic bile. (Yellow area limits region of cholesterol solubility in bile representing region of non-lithogenic bile).

The site where the lithogenic potential of the bile plays a role, however, are not the bile ducts with their rapid rate of bile flow, but the gallbladder. One of the causes is probably the variable duration of bile storage accompanied by irregular and incomplete evacuation. The gallbladder contributes likewise by the provision of precipitation centres (mucous flakes from crypts, pigment granules, bacteria and epithelia) and dissolved mucus which provides the stroma for each stone around which crystals conglomerate into calculi. Lithogenic tendencies may be augmented in cholecystitis by the absorption of bile acids deconjugated by infection (Ostrow), by transformation of lecithin into lysolecithin, and finally, perhaps by physico-chemical bile changes.

This hypothesis is open to objections, and other possible factors are being considered which enhance lithogenesis. Elucidation still awaits the reduced pool of bile acids, a characteristic metabolic deviation of subjects with cholelithiasis. None of the schemes devised so far are capable of reliably distinguishing the bile from subjects with calculi from those without calculi. The term oversaturated bile still lacks exact quantitative definition.[22] It must be assumed that protracted excretion of oversaturated bile is required for the development of stones, in view of the fact that cholesterol concentration fluctuates considerably during the course of the day and crystals might quickly dissolve again during a phase in which normal bile is excreted. Nevertheless the correctness of the hypothesis is borne out by experimental, clinical and statistical facts. The clinical application of the first substance capable of dissolving gallstones, i.e. chenodeoxycholic or chenic acid is also based on studies of lithogenic bile.

The basic metabolic disorder inducing production of lithogenic bile may be in the liver itself or may only manifest itself by a change in liver function, i.e. secretion of lithogenic bile. It appears to be correlated to activity of enzymes which initiate cholesterol and bile acid synthesis (HMG-CoA-reductase and 7-alpha hydroxylase).

Very little is known about the origin of pigment stones. In Western countries they are found chiefly in infected and stagnating bile. They may originate, however, even in the presence of patent bile ducts in hemolytic disorders, in liver cirrhosis with hemolysis and also in patients without overt hemolysis. In the Far East they used to be the most common type of stone, but they are declining with changes in living conditions and diet. The production of these stones is obviously inaugurated by precipitation of deconjugated bilirubin in the presence of an excess of ionized calcium and drop in pH. Maki explains the increased deconjugation of pigment by a rise in beta-glucuronidase. This may upset the balance with its inhibitor, glucarolactone, with a resulting excess of insoluble bilirubin. Japanese authors likewise showed that oral administration of glucaric acid reduced beta-glucuronidase activity in bile.[32] Possibly in the future prevention of calculi formation or their dissolution will be based on such a principle.

However, in Western countries pigment stones are produced differently, as biliary tract infection by E. coli is much less common than in the Far East, where it accompanies parasitic infestations (Boonyapisit et al., 1978). Also, only some patients with hemolytic disorders have a higher bilirubin concentration in the bile. In the Europe mixed pigmented stones are, as a rule, found primarily in the gallbladder, the same as cholesterol calculi, whereas oriental stones originate primarily in the ducts. Calculi found in the ducts in our patients have mostly migrated from the gallbladder, but may enlarge here by apposition. They may, however, originate here primarily as slime and sand, by the aforementioned mechanism, particularly with bile flow retardation (Madden, 1978; Moorehead, 1976). Later they may adjust to duct shape and harden until a proper calculus is produced. Sometimes during an operation it is difficult to distinguish it from a stone of gallbladder origin.

Biliary Tract Obstruction

In obstruction of the biliary passages bile drainage from liver to the intestine is mechanically impeded by blockade, narrowing or compression of the ducts. The course may be stationary (stenosis), intermittent (mobile stone) or progressive (cancer). The resulting flow impairment ranges from nearly normal variations to complete interruption.

Above the obstacle bile flow is more or less slowed down and with increasing intraluminal pressure the ducts dilate, and eventually liver function is affected. Chronic bile shortage in the gut in protracted complete obstruction leads to maldigestion and malabsorption with general deficiency symptoms. In chronic incomplete obstruction, the stagnating bile becomes infected and bacterial cholangitis supervenes.

Pressure increase which together with bacterial cholangitis are the main causes of liver damage, may be compensated, at least temporarily, by some as yet poorly understood mechanisms. One of these is the gallbladder reservoir. If biliary pressure rises gradually, e.g. with pancreatic cancer, the gallbladder becomes passively distended only after its storage capacity has been exceeded (Courvoisier's law). It is well known that in acute biliary obstruction jaundice developes more rapidly in the absence of the gallbladder and also, that sometimes only after cholecystectomy a previously insignificant stenosis of the papilla may manifest itself by duct dilation. — Intrabiliary pressure may also be reduced as a result of volume increase of dilated ducts, possibly capable of resorbing some bile water. During pressure fluctuations hepatic secretion may be temporarily affected and some bile may penetrate from the liver into the lymph[56] or by biliovenous reflux into the bloodstream (Jacobson, 1962).

Established biliary hypertension results in "cholestasis". This nonspecific reaction of the liver may be nevertheless caused by many other, such as toxi-infectious or metabolic noxae, provoking primary damage in identical groups of organelles and their enzymes as well as in the cell membranes and thus producing the so-called primary cholestases. Even though its pathogenesis remains obscure, the disturbance of bile acid transport by hepatocytes appears essential. Its hallmark is an increase of the serum bile acid level concomitant with the decrease in canalicular bile flow. For its further evolution the intracelular accumulation of bile acids is critical, eventually producing hepatocyte necrosis. Probably all mechanisms of bile secretion are affected (Bode et al., 1972).

However, cholestasis in extrahepatic bile ducts disease is reversible, if the cause is removed before the small ducts in the infiltrated periportal connective tissue are destroyed. The longer its duration, the slower is the adjustment of the blood changes, the return to normal of the secretion and composition of the bile as well as the disappearance of clinical symptoms even in successfully performed bile duct decompression.

In surgical conditions obstructive jaundice is clinically the most striking symptom of fully developed cholestasis. It is produced by bilirubin deposits in the tissues. Blood levels of bile acids, conjugated and unconjugated bilirubin and lipids are raised, and lipoprotein X is found. The activity of secretory enzymes rises substantially, a time-honoured example being alkaline phosphatase and its hepatic isoenzyme. Bilirubinemia, even in the presence of complete obstruction, reaches only a certain peak, as a rule exceeding 15 mg%, which is subject to individual variations and does not rise further as jaundice continues. This corresponds to the range of maximal hepatic secretory pressure of 30 cm H_2O known from ductus choledochus measurements. The corresponding pressure at the canalicular level is unknown. Canalicular secretion, however, does not cease completely, as not all liver cells are damaged to the same degree (Schaffner, 1968). In biliary duct impatency, however, any bile produced must regurgitate into the blood stream in the liver.

Hyperbilirubinemia and jaundice are symptoms of advanced cholestasis only, when because of substantial reduction of canalicular bile flow, pigment elimination becomes limited.[5] Its earlier anicteric stages are commonly detected only indirectly by simple sensitive enzymatic tests, since the accurate checking of total blood bile acids level is as yet mostly not accessible in general clinical practice for methodical reasons. In analogy with primary cholestatic syndromes a continuous pattern is also found in the case of secondary cholestasis due to biliary tract disease, ranging from isolated rises of enzymatic activity to fully developed jaundice.

Thus it may be stated that not every obstruction causes cholestasis and every cholestasis need not be accompanied by jaundice. Even fatal and relentless progression of malignant obstruction is characterised by an anicteric period of varied duration before jaundice appears. Most benign bile duct diseases are characterised by clinically latent periods alternating with increased biliary pressure and more or less complete manifestations of cholestasis including jaundice. Its onset only exceptionally coincides with the beginning of obstruction, and its regression need not signify that the obstacle has disappeared.

Sequels of Biliary Surgery

CHOLECYSTECTOMY

Adaptation to the loss of the gallbladder is easy and soon achieved and life runs its course without apparent ill effects following extirpation. It is immaterial whether a gallbladder still functioning before its removal or one whose function had been lost, possibly long ago, has been removed. There is no such thing as a post-cholecystectomy syndrome.

All the liver bile flows through the papilla in the absence of the gallbladder reservoir. This takes place without a rise in intraductal pressure or change in sphincter of Oddi tonus. Evacuation of the bile duct is influenced more by opening pressure, though cholecystokinin sensitivity is preserved. Only, intense intraductal pressure fluctuations such as caused by sphincter spasms following morphine injections may produce pain more easily.

The digestion of fats or other foods is not adversely affected by the elimination of concentrated bile evacuation into the gut. Bile acids whose concentration in the enterohepatic circulation was previously subject to considerable fluctuation, now circulate even more smoothly and a number of authors observed that a previously lithogenic bile returned to normal after cholecystectomy (Simmons et al., 1972).

In some patients, following cholecystectomy, mild nonprogressive dilatation of the main bile duct by 1–2 mm may occur. Marked dilatation, however, never occurs, or is due to some other cause, not uncommonly a sign of an obstruction left in the main duct or papilla.

T - TUBE

Bile duct drainage assures the success of biliary surgery by temporary bile removal. As a rule some bile reaches the intestine and the stools remain coloured. Daily bile loss gradually declines, and may be regulated by tube closure. No clinical method has been devised so far for assaying the proportion of bile or its components out of the total secretion lost by drainage. This is mainly due to the fact that the secretion of bile water and of important organic anions do not run parallel. Protracted major bile loss influences homeostasis, but not nearly so rapidly and profoundly as the loss of other body fluids.

PAPILLOSPHINCTEROTOMY

Complete transection of the sphincter creates an internal anastomosis without valvular closure, resulting in reflux of intestinal contents. — After partial papillosphincterotomy, on the other hand, the remaining intact fibres continue to act as a sphincter. Bile duct pressure may fluctuate after operation, in particular it may rise temporarily due to spasm and oedema. However, within a few weeks as a rule the pressure returns to normal.

The effect of both procedures on pancreatic juice transport varies according to the type of pancreatic duct opening in the papilla.

BILIO-DIGESTIVE ANASTOMOSES

Anastomoses with the gallbladder are performed only exceptionally since severe cholecystitis results from their prolonged presence. In a cholecystogastrostomy even an undesirable bile reflux as far as the oesophagus takes place.

Anastomoses with the bile ducts ensure permanent bile drainage into the intestine and thus interfere with gallbladder function. That is why cholecystectomy must be done simultaneously at operation. The most common anastomosis is with the duodenum or jejunal loop. Peristaltic waves produce irregular, intermittent regurgitation of intestinal contents into the bile duct which dilates and gas is present there permanently (Keclík, 1973). If the jejunal loop is excluded after Roux, reflux does not occur.

Anastomoses may shrink in time, again inducing biliary stasis and cholangitis. In contrast, even a wide stoma with abundant reflux producing the known dramatic radiological images surprisingly fails to produce cholangitis.

With lateral anastomoses a cul-de-sac is produced between the anastomosis and the papilla, which does not evacuate easily, particularly if the papilla is no longer patent.

Pancreatic drainage through Wirsung's duct remains, as a rule, unaffected by anastomoses.

VAGOTOMY

Truncal vagotomy and thus every extensive gastric resection induces gallbladder hypotonia and dilatation. Evacuation and cholecystokinin sensitivity respectively are nevertheless preserved. No convincing evidence was produced showing that the functional changes referred to induced secondary cholecystolithiasis. Selective vagotomy does not produce gallbladder dilatation. The latest trials on dogs show that only parietal cell vagotomy does not affect myoelectric papillary activity (Schumann et al., 1977).

Biliary Tract and Liver

The liver and biliary pathways are so closely interconnected anatomically and functionally that reciprocal influences are self-evident. The significance of the liver was stressed in particular by evidence that hepatic secretion of lithogenic bile is decisive for the origin of pure and mixed cholesterol stones, the most common type in this country. However, it would be premature at this moment to look for their causation solely in an altered hepatic metabolism. A much more complex disturbance in the entire enterohepatic circulation may be concerned, influenced in particular by gallbladder function as such and intestinal absorption.

To what degree liver diseases affect the biliary tract is only poorly understood. Acute viral hepatitis is not one of the causes of cholelithiasis (Demling, 1967). Gallstones are somewhat more common in Gilbert's syndrome and often found after cholestasis of pregnancy. Recently, in contrast to older data, some reports have appeared in the Anglo-American literature about the frequent presence of gallstones in liver cirrhoses. In agreement with the fact that bile from cirrhotics is not lithogenic (Vlahcevic et al., 1973), the difference does not concern cholesterol but pigment calculi. Differences in incidence may be also due to regional or ethnic differences in hemolytic tendencies.

On the other hand, how does biliary tract disease affect the liver? Chronic cholecystitis and cholecystolithiasis by itself does not induce liver damage. Inflammatory exacerbations are frequently accompanied by an acute cholestatic syndrome, which is, however, completely reversible. — The main cause of serious liver diseases is protracted obstruction of the biliary tract, particularly in association with cholangitis. Advanced biliary hypertension is accompanied by cholestasis, which at first is functional and fully reversible. Later, however, degeneration of hepatocytes and liver inflammation occur: "biliary hepatitis". Secondary infection of small hepatic ducts accompanying extrahepatic cholangitis produces purulent inflammation, and hepatic abscesses may originate. Extensive periportal fibrosis develops simultaneously, with interlobular extension, frequently designated as "secondary biliary cirrhosis". Even advanced lesions may still be capable of regression, provided the cause is eliminated. If, however, too many small ducts have been destroyed, true cirrhosis is produced with nodular regeneration and all common sequelae, including portal hypertension. In current practice, fortunately, this is encountered only rarely, and then mainly in surgically incurable high stenosis of bile ducts.

In operative biopsies — possibly due to liver manipulation — monocellular necroses of hepatocytes are common and sometimes blood transaminases may be slightly elevated after operation. This injury is usually not severe enough for clinical symptoms to appear, and subsides rapidly and spontaneously. Following major procedures, however, especially if severe liver damage was present before surgery, or if the operation was performed in the presence of active hepatitis or cirrhosis, hepatic failure and coma may occur.

Biliary Tract and Pancreas

Biliary tract and pancreas may easily affect each other as a result of their close anatomical and functional relationship.

Chronic pancreatic disorders may in the first place compress the bile ducts mechanically and produce obstruction of varying grades. This may be observed particularly in cancer of the head of pancreas, and with some pancreatic pseudocysts. Chronic inflammation of the head with fibrosis may induce tubular or deformative pancreatic stenosis of the terminal bile duct. Loss of elasticity in this portion of the duct may be followed by obstructive jaundice even when the lumen is not fully occluded.

Transient jaundice develops not infrequently also in acute pancreatitis. If it is cholestatic in character, interference with bile transport through the pancreatic portion of the choledochus predominates due to oedema or inflammation. It may, however, be due to direct liver damage by shock and liberated toxic substances entering the circulation. In the latter case the rise in transaminases is characteristic. Analogous changes arise frequently even in the absence of jaundice and are of diagnostic significance.

Pancreatic enzyme activity has been found repeatedly in the human gallbladder, explained by reflux from Wirsung's duct. The findings were obviously often insignificant, but some biliary non-perforating peritonitis cases are thought to be connected with the penetration and activation of pancreatic enzymes in the biliary passages. — Repeated attacks of pancreatitis may possibly give rise to stones in a previously intact biliary tract.

Of great importance, and little understood, is the opposite question: How does biliary disease affect the pancreas? The cumulation of all types of pancreatitis in subjects with lithiasis of the biliary tract is so striking that an etiological connection is assumed to exist. "Gallstone" or "biliary pancreatitis" is a clinical term with which we are familiar.

For pancreatitis to develop simultaneous increased production and stasis of secretion is required, as well as activation of enzymes and loss of defense mechanisms against autodigestion. How can these conditions be affected by the biliary tract?

The cause of impaired drainage of pancreatic juice is mainly sought in organic obstructions in the region of the papilla of Vater since the classical observations of Oppie. Hess laid emphasis on the significance of stenoses which he found in one-third of pancreatitis cases. Stones are important, either merely passing through the papilla (Acosta et al., 1974), lodged firmly in it, or even freely mobile higher in the choledochus. The degree of stenosis or site of the stone, however, are not decisive by themselves, whether the disease displays more typical biliary or pancreatic symptoms. The highly individual ducts arrangement in the papilla is also important and may be altered by inflammation. Impairment of drainage of secretions in the region of the papilla of Vater may facilitate the initiation of pancreatitis, but it cannot be the sole cause.

Even more difficult to understand are cases of biliary pancreatitis accompanying simple cholecystolithiasis with normal bile ducts. A possible explanation is the production of substances toxic for cell membranes in cholecystitis. These might clear the way into the gland for the enzymes with resulting autodigestion of the pancreas. Lysolecithin is one of these substances. Kinins from disintegrated microbial cells which could activate enzymes must also be considered. These noxae might be carried to the pancreas by lymphatic communications or via the ducts.

If these ideas should prove to be correct, pancreatitis could develop by the concerted action of several factors. In all types of pancreatitis investigation of the biliary tract is important. Even though cholecystectomy of a normal gallbladder cannot be expected to protect against pancreatitis, simple cholecystectomy of a lithiatic gallbladder may be successful. It is more of an exception if the attacks of pancreatitis, following cholecystectomy, with thorough revision of the common bile duct lesions remain unaffected. In such cases it must be admitted — ex post — that two concurrent diseases were concerned, but not, however, biliary pancreatitis proper.

Hepatorenal Syndrome

Following biliary surgery unexpected renal failure might occur in subjects who had not been suffering from any renal disease. At risk are patients with advanced obstructive icterus, mostly with a bilirubinemia exceeding 15 mg% and with severe liver damage, particularly elderly patients following major surgery e.g. in the region of the terminal choledochus and papilla.

Failure might resemble terminal uremia in far advanced ascitic cirrhosis, with which it has in common a pathological hepatic metabolism of nitrogenous substances, and a possible decrease in the volume of intravascular fluid.

The cause of this disorder is not known. Bilirubin storage in the kidney, "cholemic nephrosis" is apparently not responsible. The disorder most resembles acute tubular necrosis following hypovolemic shock. It is known from experiments that the kidneys of animals with obstructive jaundice are more sensitive to hypoxia, and that hypotension is produced by smaller blood loss than in control animals (Birstingl, 1965). Of the possible systemic causes the effect of bacterial endotoxins in postoperative septicemia is under discussion.[3] Proposals advocating the suppression of the intestinal flora by antibiotics before surgery appear logical for these reasons.

In view of the fact that therapy of the fully developed condition has little chance of success, it is necessary to take preventive measures under consideration and to react promptly to a postoperative decline in diuresis. The most effective preventive measure is an early operation of the as yet uncomplicated biliary disease.

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PREOPERATIVE DIAGNOSIS

Clinical and Biochemical Examination

The surgeon mostly sees patients with an established diagnosis of biliary disease. However, sometimes the examination has not been complete and the diagnosis is not always certain. A surgeon who takes over responsibility for the operation must be convinced that the diagnosis and the indications for the operation are correct. Even a diagnosis of genuine biliary disease need not always imply operation.

The following questions should be answered:

1. Is this really a case of biliary disease, and of which type?
2. Is it the cause of the patient's complaints?
3. Is operation indicated in the patient, and at what time?

The case history

A well-directed inquiry into the history is often of decisive importance, a fact which cannot be emphasized too much. It shows whether all the symptoms may be explained only by disease of the bile passages or whether more light could be thrown upon the clinical picture by further examinations. Sometimes the biliary disease may be quite wrongly blamed for the complaints. Diverse other diseases may produce similar symptoms and may be overlooked in the presence of an easily diagnosed cholelithiasis. Moreover, it has been reported that approximately half of the organic diseases of the bile passages are permanently asymptomatic.

An analysis of the history also enables the surgeon to anticipate postoperative difficulties from non-biliary causes.

Physical signs

Objectively, the abdominal and general signs are few or absent in the majority of biliary conditions with exception of some diseases of the gallbladder, cases of jaundice and acute conditions.

Biochemical examinations

This is the third group of current routine examinations, on which we base our decisions, even if their main value is only for the differentiation of various types of jaundice and of some acute conditions. However, they also may show that more detailed examination by some special method is necessary. Biochemical data are non-specific and should be appraised only in relation to the total clinical findings and results of other examinations.

In the quiescent stage the laboratory findings are usually normal. But even then it is important to determine the blood levels of alkaline phosphatase, bilirubin, and sometimes also amylase.

High phosphatase blood levels are found in about half the cases of chronic obstruction, sometimes even in those who are permanently anicteric, who would otherwise, prior to operation, remain unrecognized. The determination of gamma-glutamyl-transpeptidase activity is of no essential help in these cases.

When appraising elevated phosphatase levels, the differential diagnosis should consider primary cholestasis or other liver disease with cholestatic features, and focal intrahepatic lesions such as metastases, granulomas etc. High phosphatase blood levels may also be a late sign of abating acute cholecystitis or pancreatitis, especially if jaundice was present. Of other causes, one should consider bone diseases, especially Paget's disease, osteomalacia and tumours. In adolescents they are physiological as a sign of the non-completed skeletal development. In this case the osseous isoenzyme is increased.[46]

Hyperbilirubinemia, even of a moderate degree, is, in the presence of increased alkaline phosphatase activity, a distinct sign of cholestasis. Isolated hyperbilirubinemia itself is, on the other hand, due to a different cause.

Permanently elevated amylase levels may be a sign of a pancreatic pseudocyst, and sometimes also of cancer of the head of the pancreas.

A simple biliary colic produces no biochemical changes.

Acute cholecystitis, on the contrary, does produce in about 1/3 of the cases a slight transient cholestatic jaundice. However, even without this a characteristic complex of biochemical changes is often present. It consists of the current signs of inflammation and of enzymatic changes pointing to a moderate cholestasis: SGOT activity rises acutely and temporarily, that of alkaline phosphatase more slowly and more chronically. Gamma-glutamyl-transpeptidase reacts even more sensitively in acute conditions. A moderate and temporary rise of amylase or lipase is, in these cases, regarded as a sign of "irritation of the pancreas", and is a sign of increased danger for the patient.

An attack of acute cholangitis or that due to obstruction of the papilla is almost always associated with the changes mentioned above, but they are more evident and more persistent. Only if there is a well functioning biliodigestive anastomosis, may the biochemical findings be negative even in attacks of cholangitis.

The biochemical diagnosis of obstructive jaundice is discussed in a special chapter (p. 333).

Biochemical examinations are also of great value for the differential diagnosis of attacks of pain after cholecystectomy, especially if the blood sample is taken immediately after the pain. Positive findings showing even only moderate and transient cholestatic changes may be an important aid to the diagnosis of organic lesions of the biliary tract, in particular if they have been found repeatedly, even in the presence of non-spectacular results from other examinations.

Special Techniques of Examination

Prime place in the diagnosis of biliary disease is taken by radiology. Ultrasound echography and radioactive scan are mainly used as screening methods. All other methods of examination are of only complementary significance, if findings are uncertain or where there is disagreement between the radiological and clinical data. They are mostly used only selectively to find an answer to some special problems. Thus they are, all of them, mutually complementary, but cannot substitute each other. Only in extreme cases is an exploratory laparotomy justified, if the patient's serious complaints cannot be explained by other methods. It is needless to emphasize that the number of such cases is decreasing steadily.

It goes without saying that when examining a patient with biliary disease one also has to make a search for other diseases and complications, but here we are concerned only with a review and the possibilities of auxiliary methods used in the diagnosis of biliary disease.

Duodenal Intubation

This classical method of examination has been practically abandoned nowadays and been replaced by much more reliable methods.

However, it is still sometimes of use for obtaining gallbladder bile for preoperative bacteriological tests of sensitivity to antibiotics, and also currently for the proof, by culture, of the salmonella carrier-state. Further the microscopical examination of the sediment of duodenal secretions in lambliasis and other duodenal parasitic diseases may be more useful than examination of the feces.

Only exceptionally does one still search for cholesterol crystals in the sediment, if lithiasis is uncertain. On the other hand, however, gallbladder bile (which may be labeled with methylene blue) has been used recently for chemical analysis of its lithogenic properties.

Duodenoscopy

Endoscopy is used in biliary diagnosis to differentiate some disorders of the upper part of the digestive tract on the one hand, and for direct assessment of the state of the papilla of Vater and the whole duodenal region in the neighbourhood of the biliary apparatus on the other.

By means of a fiberscope with a prograde optic it is possible to assess the state of the esophagus, the stomach, and the oral part of the duodenum, and to differentiate some disorders with a similar symptomatology at one sitting.

With an instrument fitted with a lateral optic it is almost always possible to identify the papilla in the duodenum, when it has been relaxed by premedication. It is sought at the internal circumference of the descending part of the duodenum, and usually longitudinal folds running out from it can be seen. The normal papilla is pale, flat, and projects into the duodenum as a small protuberance. Sometimes the orifice is reddened, as if stuck together, and the papilla may be swollen or even protrude snoutlike. Such findings are often seen in choledocholithiasis and in papillary stenosis. If there is suspicion of a tumour of the papilla or its neighbourhood, a biopsy sample may be taken. Of course, only a positive result is of any import. Duodenoscopy is at present one of the prime methods in the diagnosis of tumours in the papilla region,[26] but if combined with retrograde cholangiography (p. 303) it is also of help in the difficult diagnosis of tumours of the bile ducts. By introducing a cannula into the papilla it is possible, by suction or with the aid of a small brush, to obtain a sample of material from the main duct for cytological examination.

Endoscopy enables one also to detect or to verify a biliary fistula, whether it originates in a duodenal ulcer, in a tumour, or in the biliary tract. Orifices of diverticula and their relationship to the papilla can be seen too. It is also relatively easy to visualize the orifice of a bilio-digestive anastomosis, to estimate its width and appearance, and to obtain a contrast radiograph by introducing a cannula.

Endoscopy often establishes the diagnosis when a search is made for the source of bleeding into the digestive tract, and may also provide evidence of hemobilia, if blood flows from the bile duct.

Of great advantage is the possibility of performing ascending pancreatico-cholangiography or of showing the anastomosis by contrast radiography.

Duodenoscopy is a great contribution to biliary surgery, but this does not mean that it should be performed prior to every cholecystectomy. When esophago-gastro-duodenoscopy was thus carried out indiscriminately, as a routine measure, there were only 1,7% positive results (Labayle). However, if there are some discrete gastroduodenal signs, it might be more valuable than obligatory peroral radiography.

Duodenoscopy may be also made use of in some therapeutic procedures — e.g. papillotomy, as will be mentioned later (p. 519).

Needle Biopsy

Percutaneous liver biopsy, preferably under laparoscopic control,[18] is a safe diagnostic method in primary cholestasis and other diseases of the liver.[62, 72]

However, if a more advanced obstructive jaundice is suspected, it may be dangerous, as it carries the risk of bleeding or leakage of bile from the puncture. A Quick test of less than 60% and other hemorrhagic conditions are strict contraindications. It should also not be performed in cholangitis. Needle biopsy declined in importance after the introduction of direct cholangiography. We use it now only exceptionally, when we have not succeeded in performing cholangiography, or when this, as well as ultrasonics, has not provided evidence of dilated ducts. It may supplement laparoscopy or minilaparotomy as a last attempt at diagnosis prior to exploratory laparotomy. However, the specimen must be viewed by a pathologist who is familiar with liver biopsy.

Laparoscopy

This is a not very exacting method, which makes it possible to examine visually the anterior part of the liver, and often the gallbladder itself, the adjacent parts of other organs and the peritoneum. Sometimes it objectively supplements one's idea of the nature of a palpable mass in the liver region and, if the picture is distinct, it may sometimes provide evidence of gallbladder cancer. If liver metastases are seen, this may spare the patient an exploratory laparotomy.

Laparoscopy may also be employed as an emergency measure to throw light on an acute abdominal condition including acute cholecystitis. However, its main value is in the differential diagnosis of jaundice of uncertain origin. The best time for laparoscopy is about the end of the second week after onset of the jaundice, when its origin remains uncertain. It enables one to diagnose by simple inspection cases of cirrhosis of the liver, hepatitis, and some tumours which penetrate to the liver surface. A green discoloration is typical in cholestasis, but laparoscopy itself does not always decide whether one has to deal with its intra- or extrahepatic form. Distinction between a gallbladder distended by the stagnating bile, and a hypotonically enlarged one can be made in these cases by palpation with a sound. In liver diseases or hilar obstruction, on the contrary, the gallbladder is lax, even empty. Inflammatory changes in its neighbourhood or its contraction round the stones point rather to a mechanical origin of the jaundice.

Laparoscopy can be used as has been said already combined with the needle biopsy of the liver. Blumgart uses it exclusively if there is suspition of a tumour.

As far as laparoscopic cholecysto-cholangiography by transhepatic puncture of the gallbladder or intrahepatic duct is concerned,[3] this has been supplanted by other safer methods of direct cholangiography and is nowadays only quite exceptionally used (Gilbertini, 1974).

Laparoscopy is contraindicated when there is advanced respiratory failure, serious and, especially, acute cardiovascular disease, and extensive abdominal adhesions, which usually make it impossible to view the liver.

Minilaparotomy

This not very exacting method has been suggested for a quick appraisal of jaundice, liver disease, and also of possible portal hypertension.[43, 75] For both surgeon and patient it may be easier than laparoscopy, and certainly cannot be compared with a real exploratory laparotomy.

As suggested by Strack, the liver is exposed under local anesthesia by a short incision, about 4 cm in length, below the xiphoid. Such an approach may be used, mainly if there is a suspicion of obstructive jaundice, for "open transhepatic cholangiography" under fluoroscopic control, since one may ensure avoidance of leakage from the liver by immediate mattress suture of the puncture site and an omental plastic procedure.

Via the minilaparotomy one can simultaneously obtain tissue for biopsy or a sample of bile or ascitic fluid for culture. It might also be possible to use the omental vein for portography.

Some successes have been reported with this method (Stein), but percutaneous thin needle cholangiography is supplanting it.

Isotopic Examination

This is simple for a well-equipped laboratory, and non-exacting for the patient, but has not become generally adopted. In the diagnosis of biliary disease the various methods are of only limited value.

Examination with ^{131}I labeled bengal red, based on the excretion of the dye by the liver, may be helpful occasionally in diagnosing some incomplete biliary obstruction. — Technetium sulfur colloid (^{99}Tc) is the most commonly used isotope for liver scan if looking for metastases or cystic defects.

Sonography

Ultrasound is a relatively recently introduced method of medical diagnosis. Soon after the first reports of its employment in ophthalmology (Mundt and Hughes, 1956) its value for soft tissue diagnosis of any description was spotted by Oksala and Jehtinen and diagnostic ultrasonics soon gained access to abdominal and biliary surgery in view of its noninvasive property, efficacy, speed and safety of investigation.[28, 29, 39]

Ultrasonic diagnosis is based on the registration of reflected high frequency sound waves emitted into tissues. Waves travel at different speeds through differing media and are partly reflected on the boundaries between structures with varying acoustic impedance. Their depth from the body surface can be determined with an accuracy of ± 2 mm. Capacity of resolution is, however, limited by the size and shape of the reflecting structures. If they are small enough to be approximately the wave length of the sound beam used (i.e. 0.08 mm in a beam of 2.25 MHz frequency, most commonly employed for diagnostic purposes) sound reflected is scattered in all directions making detection of a small echo impossible. The advantage of sound is that no ionization takes place and also that its diagnostic application uses a 100 times less intensity than is required for therapy. It may thus be considered entirely safe.

Echoes can be either observed on the oscilloscope (A-mode, echoscopy) or may be recorded directly as "acoustic maps" of regional sections, into which ultrasonic waves were emitted (B scan, echotomography). By shifting the transducer over the body surface these transverse or longitudinal planes can be selected at optional intervals from each other. The demonstration of small echoes has been greatly improved by the so-called grey scale B scanning system. It produces a better anatomical image and facilitates interpretation.[35, 38, 54, 69]

Investigation technique by the B scan grey scale is simple and requires no specific preparation of the patient. Barium meal examination should not precede B scans, as barium acts as a barrier for the ultrasonic beam. The patient is placed in the supine position and the epigastrium is scanned mostly in 2 cm intervals, first in the transverse, and then in a longitudinal direction.

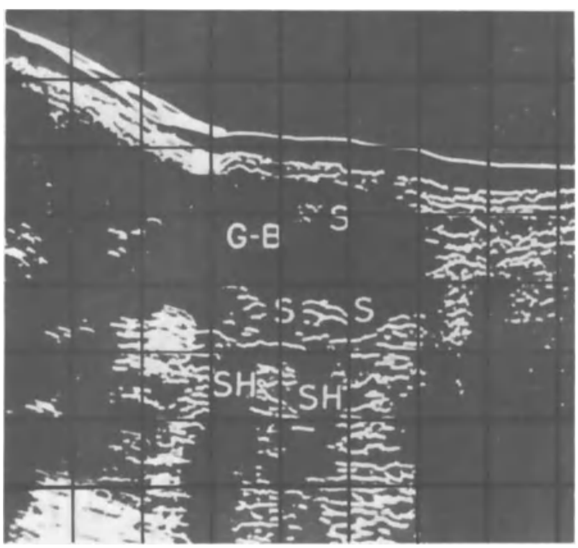


Fig. 36: Ultrasonography: Longitudinal B-scan of the gallbladder (GB) showing cholecystolithiasis (S). Echo free bands – acoustical shadows (SH) are seen posterior to the gallstones. (Ronský.)

Scanning is valuable for preoperative diagnosis of the gallbladder, lithiasis and biliary passages and at the same time assists in the differentiation of some disorders of liver and pancreas. The gallbladder can often be demonstrated by ultrasonics and its size may be assessed.[67] In about 80—90 % of cases stones may be visualized as extra dense structures, provided their size exceeds

0.5 cm, but a stone measuring only 3 mm has been demonstrated. *Fig. 36.* Grey scale B scans are of significant value in cases of jaundice facilitating the diagnosis of obstruction by revealing dilated intrahepatic ducts and allowing conclusions to be reached about the character of the obstacle from gallbladder size.[25, 70] *Fig. 37.*

A cyst of sufficient size or cystic dilatation of ducts as well as localization of some tumours can thus be demonstrated adequately in the liver. The picture of a pancreatic cystoid is likewise typical, whereas differentiation between inflammatory or neoplastic pancreatic diseases is uncertain.

It is true that the interpretation of scans may prove difficult, particularly if experience is limited, or if grey scale equipment is not available. Findings are less explicit and by themselves are usually less definite than radiological evidence. Interposition of gas filled loops sometimes interferes with the investigation of deeper structures, because all the sound waves are thereby reflected. On the other hand its non-invasive nature makes ultrasonics investigation feasible even in patients in poor condition and can be safely repeated as required. It can, therefore, be useful in cholestasis, where intravenous cholangiography fails, but particularly as a screening method in jaundiced patients. In jaundice of uncertain origin the sequence of diagnostic measures will be directed, and the need for more exac-

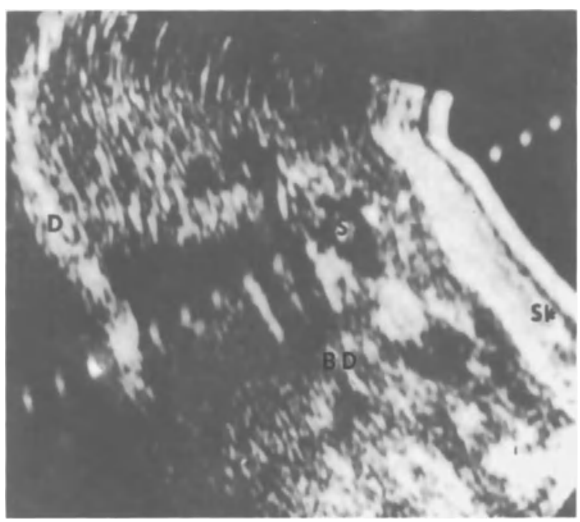


Fig. 37: Ultrasonography: Oblique grey-scale B-scan demonstrates cholecystolithiasis (S) and dilated bile ducts (BD) – sign of "double-barrel gun". (D – diaphragm, Sk – skin). (Vítek).

ting radiological investigations determined by it, such as transhepatic or endoscopic cholangiography or selective angiography.

Sonography is ever more widely used in the diagnosis of biliary disorder, either as supplementary or as screening method, and should be available at every major surgical centre.

Preoperative Radiodiagnosis

Radiological examination is often the decisive method of examination in the diagnosis of surgical biliary disease. According to the situation, different procedures are used.

Basic Radiological Examinations

Plain film

A plain film of the subhepatic region or the abdomen is the simplest and, as a rule, the first radiological examination.

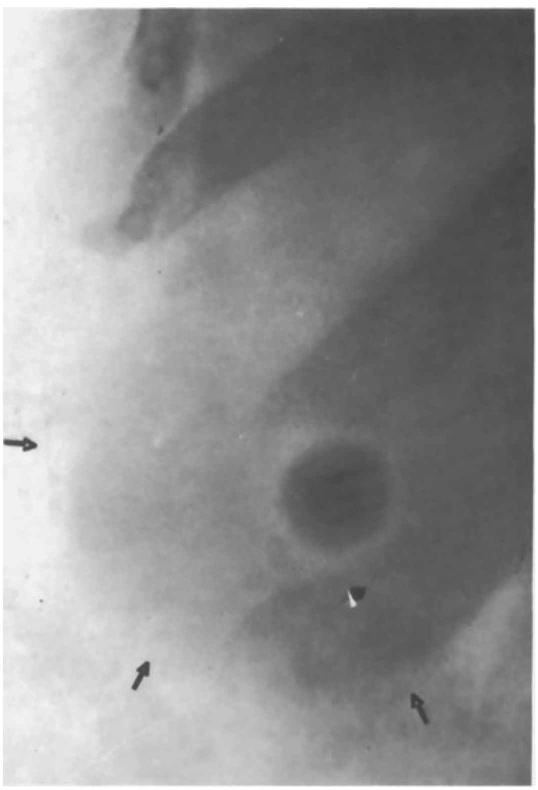


Fig. 38: Hydrops of gallbladder (containing an opaque stone) visible on the plain film.

A film taken in the prone position may provide information on size, shape and position of the liver and its gross structural changes. It may sometimes also show an enlarged or inflamed gallbladder, but this finding should be confronted with the clinical features and varified by cholecystography (Pirk). *Fig. 38.* It is usually possible (with a certain reserve) to locate some mixed calculi which are opaque to X-rays in the gallbladder or the ducts. *Fig. 39.* A typical shadow is also

Fig. 39: Smallish mixed stones in gallbladder and cystic duct on plain film.

cast by "calcareous bile" or by a "porcelain gallbladder". However, its picture may resemble that of a large cholesterol stone with a calcified shell-like surface. *Fig. 40.*

By suitable projections, best with the patient in the vertical position, it is possible to demonstrate gas in the biliary organs if there are fistulas leading into the intestinal tract, either pathological or bilio-digestive anastomoses. A pneumocholedochus may also be found if there is incompetence of the sphincter of

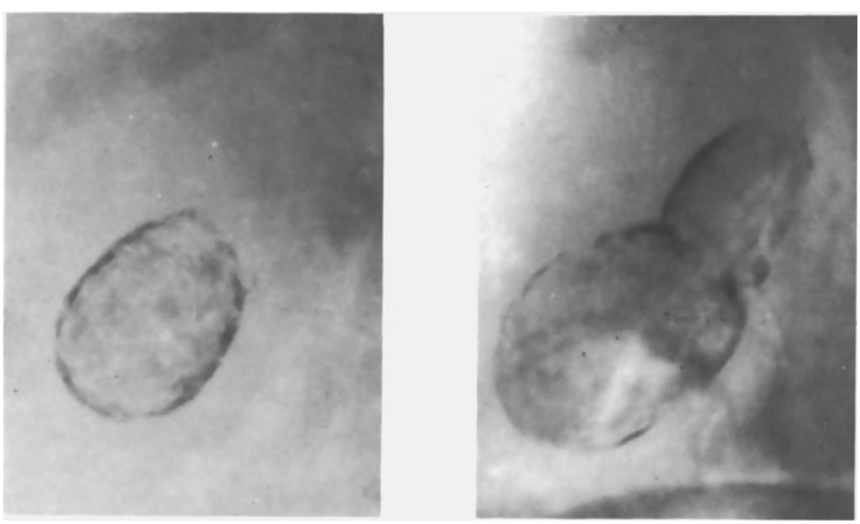


Fig. 40ab: "Porcelain" gallbladder (a). Stones with calcified shell resembling "porcelain" gallbladder (b).

Oddi, especially if the common bile duct joins the duodenum high up and at right angles, and after total sphincterotomy. And gas in the gallbladder may, in isolated cases, be seen if there is acute cholecystitis due to anaerobic infection.[42]

A picture taken with a horizontal ray is useful especially for demonstrating fluid levels in the intestine or the abdominal cavity. If there is a suspicion that ileus is due to obstruction of the intestine by a gallstone, one should always search on the simple film, not only for fluid levels and an opaque calculus in the intestine, but also for gas in the biliary tract. This is a characteristic and more frequently found feature of biliary ileus than a stone, which can only rarely be visualized.

Horizontal rays are also used in cholecystography, if one wishes to demonstrate so-called "floating calculi" or sedimentation of tiny stones. *Fig. 41, 42.*

Fig. 41. "Floating" calculi. Cholecystogram in erect position.

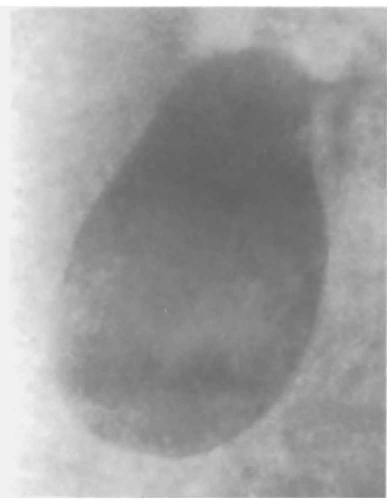


Fig. 42: Layering of opacified bile and sedimentation of tiny stones.

Oral cholecystography

This is a simple morphological and functional examination of the gallbladder. Its success depends on the absorption of the contrast medium in the small gut, its excretion by the liver into the bile, and its passage via a patent cystic duct into the gallbladder, which must concentrate it and void it again into the bile duct and the duodenum.

Therefore, if the gallbladder is not visualized, one should keep in mind that this may be due to a number of causes beside gallbladder disease. Thus e.g. the contrast medium was not fully utilized, did not get into the intestine (vomiting, pyloric stenosis), or its resorption was insufficient (such as in enteritis).

At other times the cause is inhibition of its transport into the liver (e.g. hypo-albuminemia). More frequent causes are liver disorders, stagnation of bile and the more severe degrees of damage to the liver parenchyma (e.g. primary and secondary cholestasis, cirrhosis, metastases, virus hepatitis etc.). Even patients without any manifest jaundice, but with the syndrome of incomplete anicteric obstruction, may have their liver function impaired to such a degree that the gallbladder is not visualized.

Cholecystography is often wrongly indicated when there is still jaundice, but also shortly after a biliary colic, or acute cholecystitis. It is well known that the gallbladder may be visualized in a third of these cases, but it is not possible, under these conditions, to interpret a negative result correctly, the examination puts an unnecessary stress on the patient, and further controls are required. That is why cholecystography should be performed at the earliest about 3 weeks after the abatement of the jaundice or the cholecystitis.

The main and most frequent cause of non-visualization of the gallbladder at cholecystography even in the resting stage are various diseases of the gallbladder and the bile ducts:

- The bile does not enter the gallbladder because the cystic duct is obliterated by a stone, inflammation, a tumour or a kink,
- the gallbladder is shrunk or filled with stones or a tumour, or did not empty prior to the examination, e.g. in a patient starved for a long time,
- the pressure in the bile duct is insufficient for filling the gallbladder because of a fistula, an anastomosis, or incompetence of the sphincter of Oddi,
- the gallbladder concentrates insufficiently because of inflammation or destruction of its wall,
- the gallbladder cannot be seen because it is in an abnormal place, or the patient has had a cholecystectomy.

Thus the so-called "afunctional gallbladder" is found, in a patient without cholestasis, mainly if there is lithiasis, or inflammation, hydrops or a tumour of the gallbladder. Sometimes the gallbladder is only said to show a "bad contrast filling", the causes of which may be similar. There is, however, no objective criterion by which the normal degree of opacity may be assessed, and one should be aware of the fact that even an inflamed gallbladder may retain its full power of concentration.

If the gallbladder is visualized, some of its morphological and topical changes, and also developmental anomalies may be shown. Marginal defects are rare. Sometimes they may point to an incipient tumour, to certain type of cholecystosis, parasites, etc. More often the filling is found to be non-homogenous, which is mainly characteristic for the presence of stones. The films show very diverse pictures as to the size of stones, their shape and number. *Fig. 43.* Some show only in the emptying stage, when the gallbladder has decreased in size. If

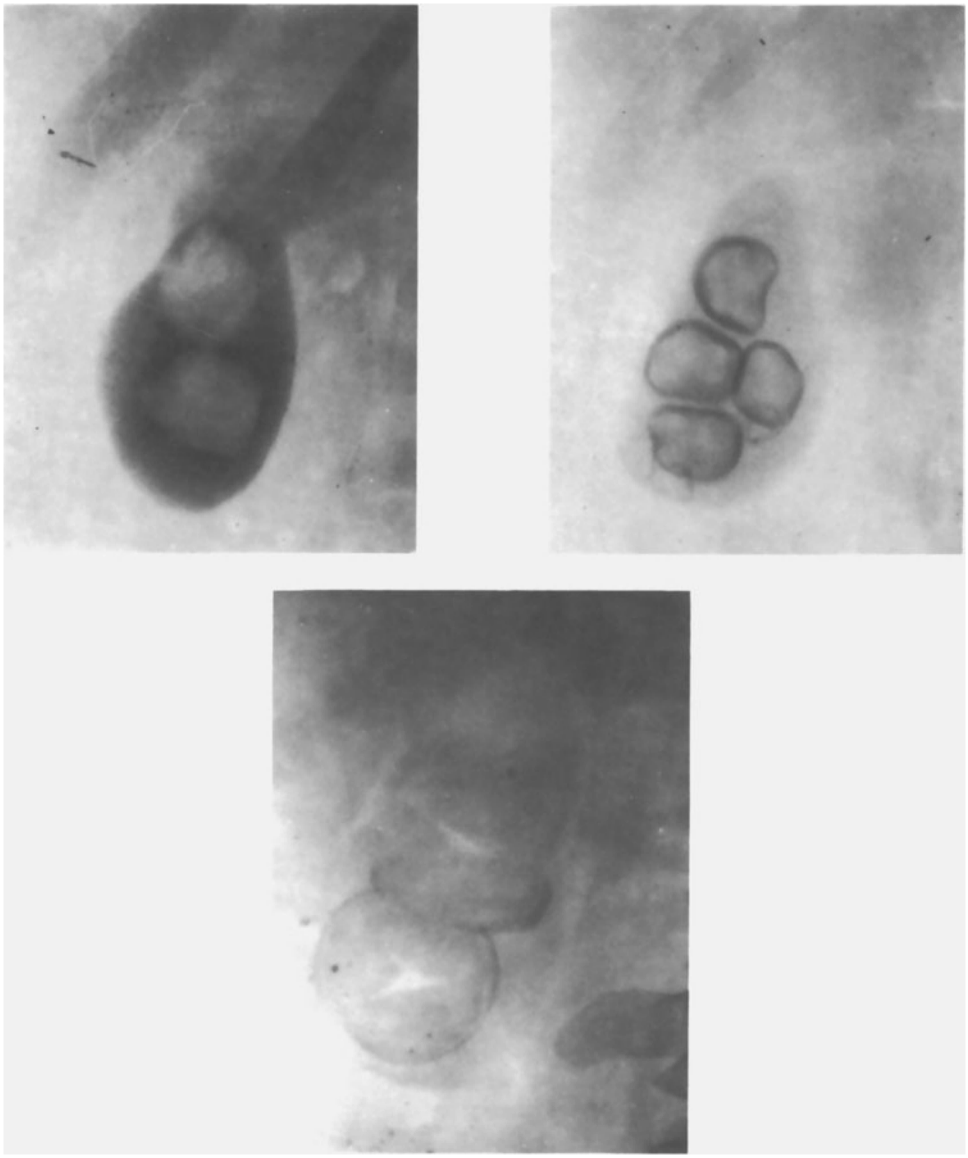


Fig. 43: Cholecystogram with two non-opaque cuboid stones (a), numerous mixed spherical stones of different size (b), faint filling and large cholesterol stones, fellylike translucencies inside the concrements ("Mercedes Benz" sign.) (c).

the moment of exposure and the projection are well chosen it is sometimes also possible to visualize the filling of the common bile duct, when the gallbladder has emptied. *Fig. 44.* Even if the gallbladder cannot be visualized at cholecystography, the biliary duct sometimes shows on the tomogram after a fully saturating dose, and one thus may do without an intravenous biligraphy (Kalisher, 1973).

Impaired emptying of the gallbladder should be judged with caution, especially as far as its interpretation as gallbladder dysfunction is concerned.

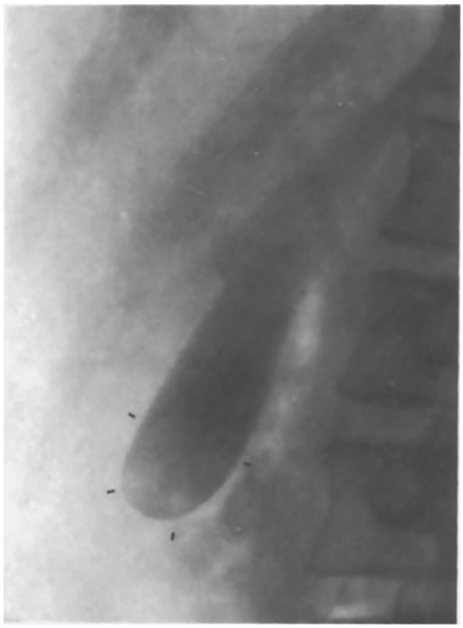


Fig. 44: Cholecystography: Large stone shown only in emptying stage of the gallbladder. Faint filling of the main bile duct visualized at the same time.

Films taken with the patient standing, and tomograms may be added to the cholecystography, if necessary, so as to arrive at the most reliable conclusions possible.

Intravenous cholangio-cholecystography

Since intravenous biligraphy is time-consuming and expensive, it should be reserved for selected cases, even if it may give information on certain changes of the common bile duct, which had not been suspected clinically. It is used mainly in patients after cholecystectomy, and also in certain cases in which the gallbladder could not be visualized by oral cholecystography.

The intravenously injected contrast medium is excreted by the liver in such a concentration as not to require further concentration by the gallbladder: the main bile ducts are visualized, and even the gallbladder is shown more easily, provided, of course, the cystic duct is patent. *Fig. 45.*

A prerequisite of a good biligraphy is adequate liver function. If the bilirubin concentration gives a positive direct reaction of more than 4 mg%, the examination is futile, and if the concentration is between 2–4 mg%, the bile ducts are only rarely visualized. A sufficient lapse of time after the jaundice is, therefore, a condition for a good radiograph. Of equal importance is good radiographic

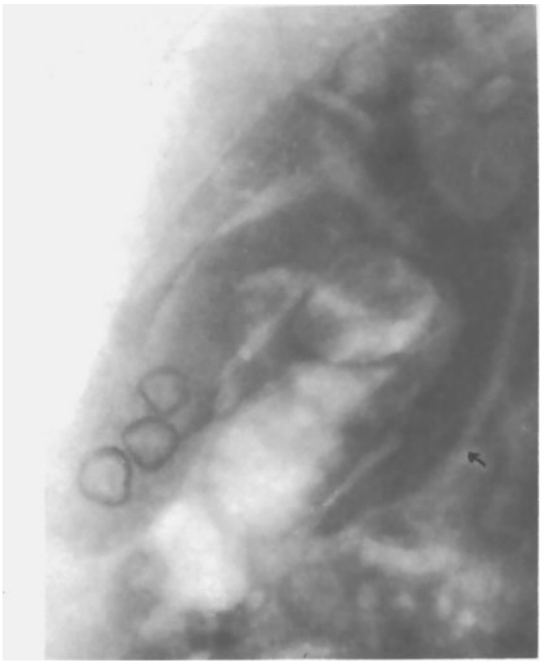


Fig. 45: Cholangio-cholecystography demonstrates mixed facetted stones in the gallbladder and bile duct.

technique, supplemented by tomography. Still, biligraphy gives as much as 15–20% false negative results, and even stones and marked strictures may be missed (Way and Dunphy).

Intravenous cholangiography mainly gives information about the presence of calculi and other changes in the bile ducts. *Fig. 46.* It is to be regretted that it is just the sphincteric portion of the duct which is not, in most cases, reliably shown, since in this portion clinicians are most interested. One may form conclusions, at least as to its impaired patency, from several indirect signs, such as dimension and shape of the ducts and the homogeneity and opaqueness of their filling. One should especially note if the contrast filling remains visible for more than 180—210 minutes and the excretion of the contrast material by the kidneys is delayed. The excretion of the contrast medium by the kidneys simultaneously with the beginning of the biligraphy is not regarded as pathological.

As far as the dimensions of the ducts, converted to actual dimensions from those measured on the films, are concerned, a common bile duct not exceeding 9 mm in width is almost always normal, whereas a width of 9–12 mm may well be a sign of pathological dilatation, e.g. by stagnation. Beyond this limit we are practically always dealing with a pathologically dilated bile duct (Niederle).

In patients after cholecystectomy, a common duct wider than 14 mm is regarded as probably, and more than 17 mm as certainly pathological, this being, as a rule, a sign of an advanced incomplete block (Keclík).

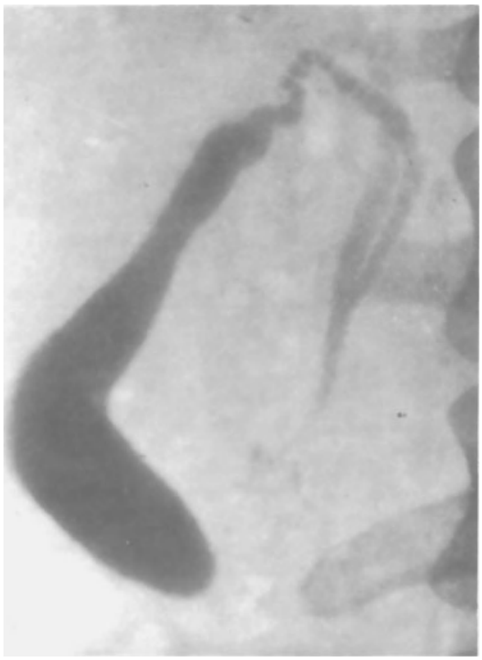


Fig. 46: Cholangio-cholecystogram showing drawn-out cysticus spiralling round the bile duct and entering it retroduodenally.

Prolongation and dilatation of the hepatic ducts may be another sign of impaired patency of the common bile duct.

All indirect signs are interpreted only in the context of the cholangiography as a whole together with the clinical features.

Insufficient opacity may also be caused by a fresh inflammation of the bile ducts, by a bilio-digestive anastomosis, by an incompetent sphincter, etc. This drawback is supposed to be eliminated by infusion cholangiography with a larger quantity of contrast medium.[11] The filling of the ducts is of a higher density, and untoward reactions due to the contrast medium, which otherwise are occasionally encountered, are less frequent. Nevertheless, even in this case all the rules governing the intravenous administration of iodine-containing hepatotropic substances have to be observed, so as to avoid dangerous reactions.

Examination of the digestive tract

Radiological examination of gastrointestinal tract is often necessary for differential diagnosis of biliary diseases. Even direct information about the biliary tract may sometimes be obtained: E.g. biliodigestive fistula may be revealed or valuable information about biliary anastomoses may be provided. *Fig. 47.* Hypotonic duodenography with double contrast is indicated in a patient suspected of tumour

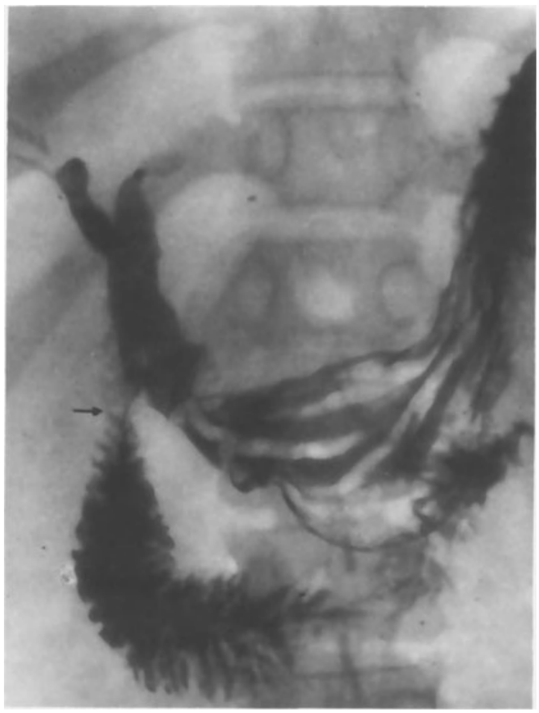


Fig. 47: Choledochoduodenostomy: Barium taken per os fills the bile ducts and freely passes through the anastomosis.

of papilla. It may be advantageous to combine contrast filling of digestive tract with computed tomography, some kind of cholangiography, or fistulography.

Fistulography

The exploitation of every external biliary fistula for the purpose of fistulography should be a matter of course. This applies not only to surgical external drainage of gallbladder or bile duct, but particularly to pathological fistulas, spontaneous and postoperative, due to overlooked bile duct injury.

If a tight fit of the inserted catheter is obtained, the source of the fistula may not uncommonly be identifiable and the biliary tract or a "residual" cavity adjacent to the injured duct, partly filled.

Instrumental Cholangiographies

In patients in whom intravenous cholangiography should not be performed because of jaundice, liver damage, or for other reasons, or when it fails, one may try and visualize the bile duct system preoperatively by direct instrumental cholangiography. The contrast medium is injected either by needling the intrahepatic bile ducts through the liver, or through a catheter passed into the papilla of Vater with a duodenoscope.

Percutaneous transhepatic cholangiography

The puncture needle is passed, under fluoroscopic control, through the body wall into the liver in the direction of the hilum. Several modifications exist, which differ mainly in the site of the puncture and the point at which the needle aims: 1. A lumbar needle may be passed under the xiphoid process at an angle of 60° in

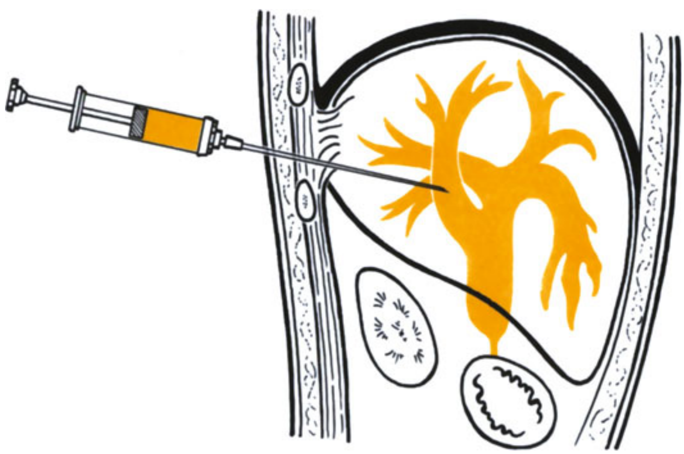


Fig. 48: Schematic drawing of percutaneous cholangiography. The needle is inserted at a site where the liver adheres extraperitoneally.

a cranial direction to a depth of 8–10 cm. 2. Niechel suggests puncturing in the right axillary line in the 9th–11th intercostal space, in an obliquely cranial and slightly ventral direction. 3. Prieton punctures approximately 7 cm to the right of the spine, near the 11th rib, where the liver lies against the body wall without any peritoneal cover. When the bile duct has been entered, the contrast is injected and the film is exposed.[34, 52] *Fig. 48.*

The success of the method depends to a large extent on the degree of dilatation of the intrahepatic ducts. *Fig. 49.* However, if one fails to needle the duct, this does not exclude extrahepatic obstruction.[8, 24, 44, 48]

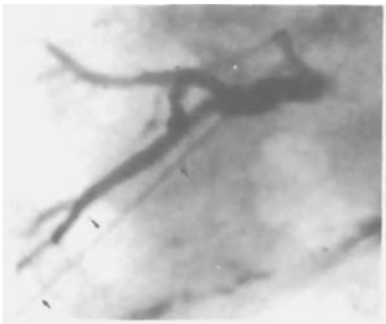
The method is contraindicated if there is a serious coagulation defect, sensitivity to iodine, a hydatid cyst or an abscess, provided of course that this has been

Fig. 49: Transhepatic cholangiography reveals a tumour of the common hepatic duct in a jaundiced patient.

recognized. However, the main danger of percutaneous cholangiography is leakage of bile into the abdomen, and this danger is greater in jaundice due to stagnation and in cirrhosis. Therefore, if one uses the original method, the patient should always be prepared to undergo immediate laparotomy, if necessary, even though the extraperitoneal puncture does not carry such a risk of biliary peritonitis as the transabdominal one. If pressure is high in the intrahepatic ducts, a thin catheter may also be passed into the duct along the needle, which is removed; the catheter is not only used for injecting the contrast medium, but is then left in situ as a decompression drainage.

Thin-needle percutaneous transhepatic cholangiography

In 1969, Tsuchiya described a new, safer method of percutaneous cholangiography developed at Chiba University in Japan. The improved technique involves the use of a thin and very flexible needle inserted into the liver under fluoroscopic control.



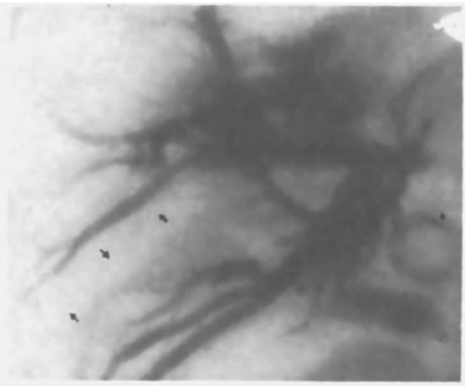


Fig. 50abc: Percutaneous transhepatic thin-needle cholangiography. Papilla blocked by a stone in a 67-year old male patient with obstructive jaundice. PTC with a Chiba needle showed dilated ducts in right liver lobe and stagnation of contrast material in front of papillary stone: (a) beginning of filling, (b) thin canal filled with contrast still visible after removal of needle, (c) 1/2 hour later common bile duct also visualized up to the stone, which allows only little contrast material to pass into duodenum. Contrast material excreted by the kidney.

This fine "Chiba" steel needle is about 16 cm long, its lumen is only 0,7 mm wide, and it is provided with a central stylet. The patient lies supine on the radiographic table, and the needle is introduced in the middle axillary line through the 8th or 9th intercostal space. Its tip is pushed parallel with the table surface, as far as the level of the xiphoid process, which has been marked with a metal tag. During this operation, the patient is allowed to breathe. The needle is provided with a soft connecting piece, which serves for injecting the contrast medium and, at the same time, withdrawing the needle until the contrast medium suddenly enters the bile duct. If these are markedly dilated several tens of ml of bile are first aspirated, and only then is the rest of the contrast medium injected and the films exposed. *Fig. 50.*

Not infrequently a little contrast escapes into the punctured vessel but quickly disappears. If duct puncture fails, several repeated trials in different directions may be attempted. No serious complications have been reported, no major or persistent leakage of bile or blood, which was only occasionally found at operation, and in small amounts, at the liver puncture site (Benjamin et al.). More frequently the patient complains of slight pain in the region.

Cholangiography by fine needle is successful in 100% of cases with dilated ducts, and if the biliary passages do not fill there is a great probability that this by itself is evidence against "surgical" cholestasis. However, it was a surprise to find that this technique is also capable of showing undilated ducts and demonstrating the biliary tree in more than half of the cases.

The Chiba needle is now being widely used because it has proved to be a relatively safe means of simple, rapid, and accurate investigation of jaundice, and more than once has proved equally useful in the non-jaundiced patient, especially in the wake of biliary surgery, when conventional cholangiography is frequently non-contributory and endoscopic cholangiography appears either too onerous or difficult of access. The introduction of the fine needle for performing percutaneous transhepatic cholangiography has contributed to a major renaissance of the method.

Besides this modification of the original method there are two other, rather exclusive, techniques of puncture cholangiography which also reduce the danger of the leakage of bile — the transjugular and transumbilical cholangiography.

Transjugular cholangiography

This unusual method has been developed by Hanafee in 1967. From a cervical skin puncture, a catheter is passed by Seldinger's method through the jugular vein into the liver. The catheter with its guide is passed into the upper vena cava, and through the right ventricle into the lower vena cava. Under fluoroscopic control it is pushed further into one of the hepatic veins, which should be verified by a small quantity of contrast medium. Then a special long cholangiography needle is introduced, which is slightly bent at the end. When its tip has passed beyond the end of the catheter, one tries to make the needle enter some of the dilated intrahepatic ducts. The correct position of the needle is checked by aspiration of the bile, the contrast medium is injected, and a series of cholangiographs is made. *Fig. 51.*

Unlike the common transabdominal methods, this does not lead to peritoneal complications, but to infection of the biliovenous communications, and in a few cases ventricular fibrillation has been observed. The infection manifests itself, as stated by Kadell and Weiner, in about one fifth of the patients by a raised temperature, and sometimes also by signs of sepsis and shock. They registered one death among 120 cases. Therefore this technique is contraindicated in cholangitis, and should be performed under antibiotic protection.

This delicate and rarely used method is mainly indicated for differentiating between obstructive and non-obstructive jaundice and for locating the obstruction in jaundice where other methods of examination have failed.[23, 56, 71]

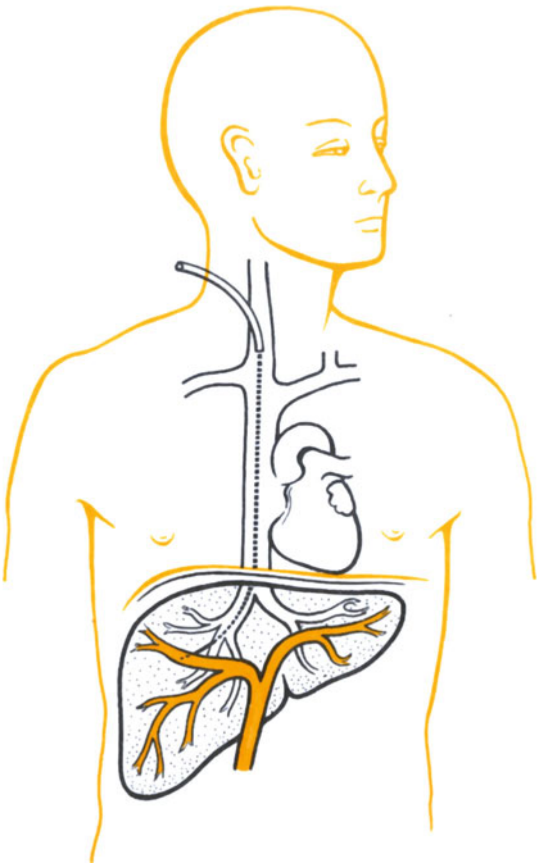


Fig. 51: Schematic drawing of transjugular cholangiography. The special flexible needle traverses a catheter inserted into the jugular vein and through superior and inferior vv. cava into the liver. The protruded needle tip penetrates through the hepatic vein and pierces the dilated bile duct inside the liver.

Transumbilical cholangiography

In 1977, Kalný reported a number of patients in whom recanalization of the umbilical vein (for performing transumbilical hepatoportography, p. —) was attended by a complication, the contrast material getting into the bile duct and leading to visualization of the biliar tree. In a further series of patients this type of cholangiography was carried out intentionally. Neither hemobilia nor bacteremia occurred in any of these first patients.

Transumbilical cholangiography might be, in addition to transumbilical portomanometry and hepatoportography, a further contribution to the differentiation between intra- and extrahepatic cholestasis.

Endoscopic retrograde cholangiography

One of the more recently introduced radiodiagnostic methods is retrograde i.e. ascending cholangiography by means of a catheter inserted in Vater's papilla or the orifice of a biliary anastomosis during duodenoscopy. *Fig. 52.* The substance instilled through the papilla frequently enters the pancreatic duct rather than the bile duct, or both ducts are filled simultaneously and the examination accordingly, is designated ERCP i.e. endoscopic retrograde cholangio-pancreaticography. The

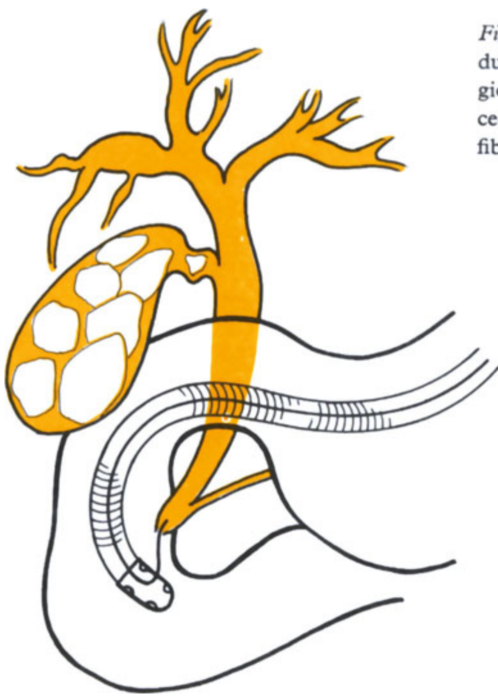


Fig. 52: Schematic drawing of duodenoscopic retrograde cholangiography. The catheter is advanced into the papilla through the fiberscope with a lateral optic.

entire investigation is carried out on the X-ray table equipped with television; the endoscopist and radiologist cooperating. Films are made after preliminary fluoroscopy, some may be made after the duodenoscope and catheter have been withdrawn. The contrast medium remains some time in the biliary tract and not infrequently the gallbladder fills after an interval, provided cholecystectomy has not yet been performed. *Fig. 53.*

ERCP is mainly advisable in complicated cases, before or following cholecystectomy with persisting unexplained complaints, and under certain circumstances.[53] The chief reason is failure of necessary intravenous cholangiography due to hepatobiliary block accompanying jaundice or anicteric obstruction. ERCP, of course, may demonstrate the biliary tract even in the absence of obstruction because dilatation of intrahepatic ducts is not a precondition, as in the case with classical transhepatic percutaneous cholangiography. In contrast to the latter, even with evidence of obstructive jaundice, no danger of peritoneal complications arises.

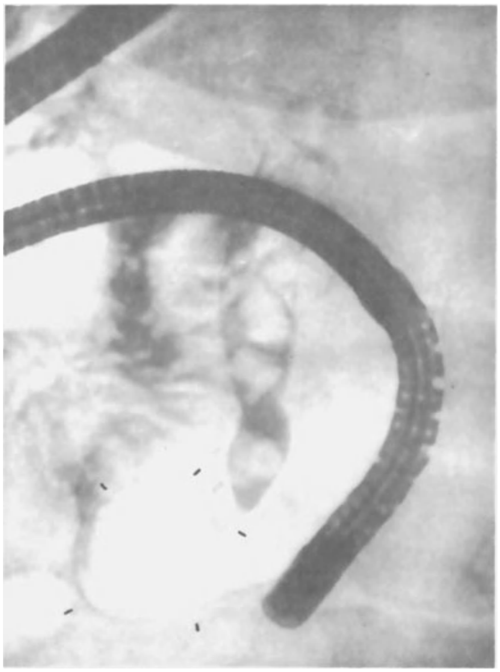


Fig. 53: Retrograde cholangiogram. The catheter passing through the duodenoscope is inserted in the papilla followed by retrograde instillation of contrast medium into the bile duct. In a case of jaundice of uncertain origin "paving" of the duct by stones was revealed by this investigation. (Piťha)

These advantages of ERCP over the original PTC are dwindling nowadays, as the competitive percutaneous puncture of the liver using the fine Chiba needle is increasingly applied.[15] The choice between the two competing methods is decided, apart from availibility, by other considerations:

- ERCP is the obvious method of choice, as against transhepatic cholangiography, in cases of hemorrhagic diathesis or with a large ascites.
- A further advance of ERCP is the simultaneous opportunity for wirsungography, if information about pancreatic disorders is required and a clear picture of anatomical biliopancreatic relations is desirable.
- ERCP can sometims elucidate obscure situations following previous operations or the true cause of symptoms associated with a biliodigestive anastomosis.[7, 64] By the injection of contrast medium directly into the anastomosis under the guidance of the duodenoscope, the biliary tree can be demonstrated even with a narrow orifice which fails to fill by the barium meal technique. Evacuation through the stoma may be judged or stones and food residue revealed in the blind terminal bile duct sac in lateral anastomosis.

- ERCP receives priority before PTC in patients where endoscopic examination of stomach and duodenum is important. Duodenoscopy may also be exploited for collecting material for cytologic or bioptic investigation and ERCP may sometimes be supplemented by some therapeutic surgical measures on the papilla.

The dangers and value of ERCP. Despite all the listed advantages ERCP remains only a selective method of investigation. It requires first class technical equipment, and is time-consuming. The cooperation of the patient is necessary, as well as skilled team cooperation, and success increases with experience. Numerous obstacles are encountered at first: during identification of the papilla and its probing, during filling of bile ducts and interpretation of films. Laurent in his report published in 1974 on the results of 853 ERCP stated that probing of the papilla failed in 5% and injection of the choledochus in 20%. However, with increasing practice, some writers announce successes exceeding 80—90% (Ogoshi, Deyhle, Blumgart a.o.).

ERCP risks are minor. Ihre (1977) mentions 2.6% complications. They are similar to those with any endoscopy, including the rare possibility of virus hepatitis transmission. Transient amylase elevation is frequently observed, apparently correlated to injection technique. A major risk of the method is the initiation — in 0.1–2% of cases — of acute pancreatitis, cholangitis and exceptionally hemorrhage and perforation. Acute pancreatitis and other abdominal emergencies are contraindications, but Safrany (1978) used it successfully just in acute abdominal conditions. — Patients recovered from myocardial infarction require an interval of at least 3 months before investigation.

To sum up, the method, despite its demands, is used on an ever widening scale, because its diagnostic contribution is more selective and definite than that of intravenous cholangiography or angiography.[1, 5, 40, 41]

Selective Angiographies

Hepatic arteriography

This examination consists in selective catheterization of the hepatic, splenic, or superior mesenteric arteries and following the contrast through the liver arteries, capillaries, and hepatic veins. *Fig. 54.* This is useful with uncertain findings in the right epigastrium. Even small secondary liver deposits may be demonstrated, but it was shown that gallbladder cancer may also be detected during the "operable" stage: the cystic artery is dilated with abundant branches, while the arteries are delicate, but their lumen irregular and passing into pathological vascularization. If the tumour has already spread to the vicinity, it is in

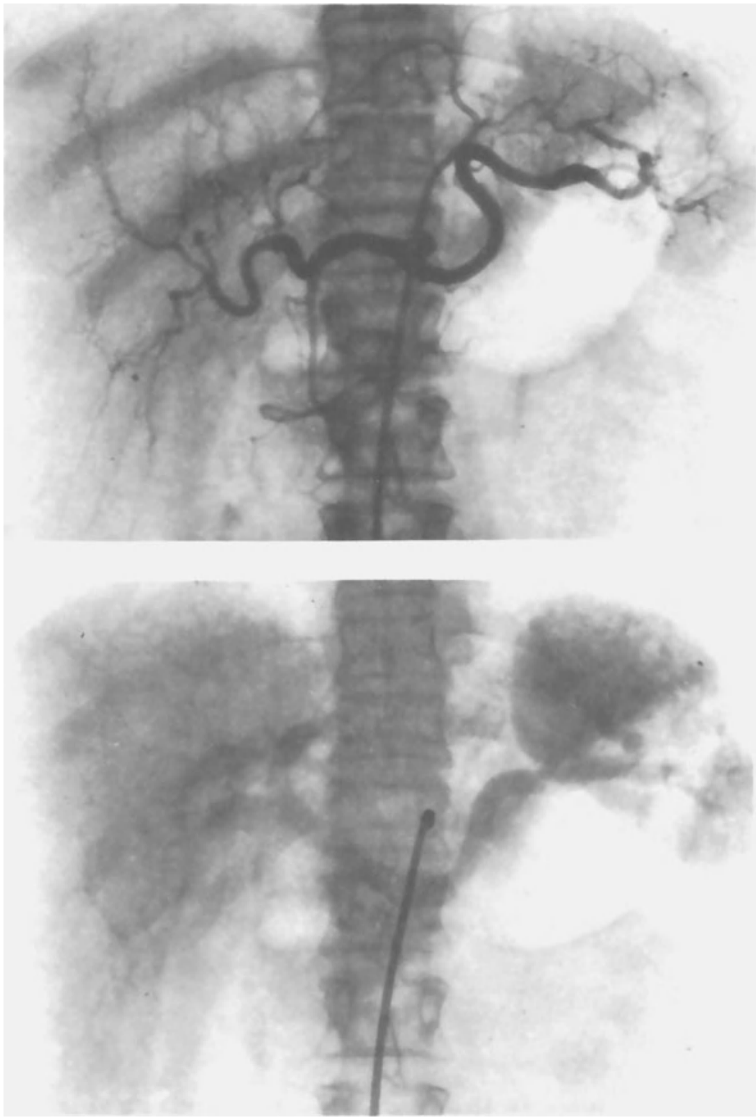


Fig. 54ab: Normal celiacography: The first arterial phase (a), the third venous phase (b). (Indirect splenoportography).

addition supplied by pathological vessels from the adjacent vessels. Shape and size of the gallbladder can be assessed during the parenchymatous phase. As opposed to tumour, vascularization in chronic cholecystitis is poor and pathological vessels are absent in subacute inflammation.

From vascular bed deposition dilatation of the common bile duct may sometimes be deducted and the obstructive origin of jaundice established (Sprayregen). Diffuse cirrhosis of the liver may produce a typical pattern. However, arteriography assumes decisive significance mainly in hemobilia, or the search for the source of hemorrhage, whether intra- or extrahepatic.

If the Seldinger's catheter is inserted into the splenic artery, visualization obtained is similar to that in splenoportography but lacks its risks.

Preoperative arteriograms are also an excellent guide for planned liver resection, as the arterial supply of individual lobes and their anatomical variants are accurately mapped.

The method is not involved and its risk in the hands of a skilled specialist is negligible.

Splenoportography

By this variety of angiography the portal circulation can be excellently visualized. *Fig. 55.* An aqueous contrast medium is injected percutaneously into the spleen,

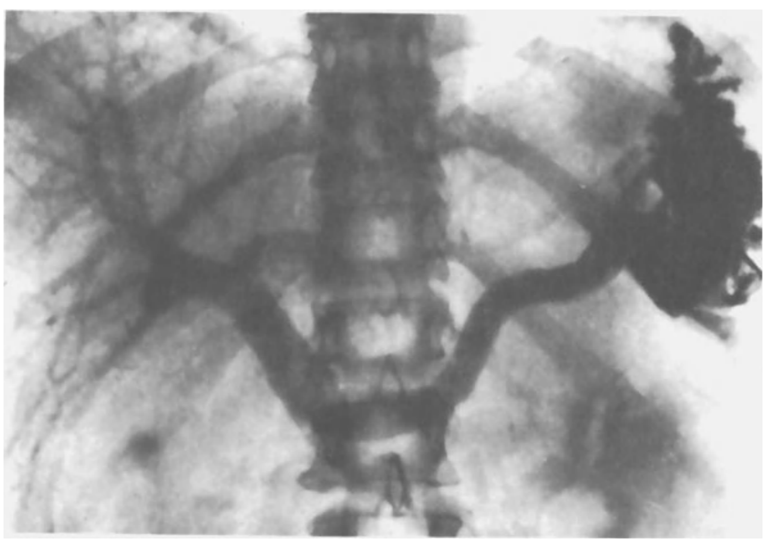


Fig. 55: Normal splenoportography.

preferably under fluoroscopic control, during apnoea practised beforehand. The splenic and portal vein fill immediately, and their hepatic branches afterwards. Splenoportography with simultaneous tensiometry is used in biliary surgery in the presence of portal hypertension, or if malignancy involving the biliary tract and liver is suspected. With propagation of a neoplasm into the liver hilum, deformation, even compression, of the portal vein may be found, indicating inoperability before surgery. During the parenchymatous filling phase, when liver contrast is enhanced, spread of a gallbladder tumour into the liver may show up as an avascular area in this region. Secondaries may similarly appear as rounded avascular liver defects.

The risk of splenoportography and splenomanometry are splenic tears with hemorrhage requiring surgical revision of the abdomen. This danger can be reduced by substituting a plastic catheter for the needle, and by omitting the investigation if hemocoagulation is grossly altered.

Umbilico-portography

This is also termed perumbilical portography. It was Gonzalès in 1959 who first catheterized the fibrotic remnant of the umbilical vein in the round ligament. Following its extraperitoneal dissection and gradual dilatation a plastic catheter is

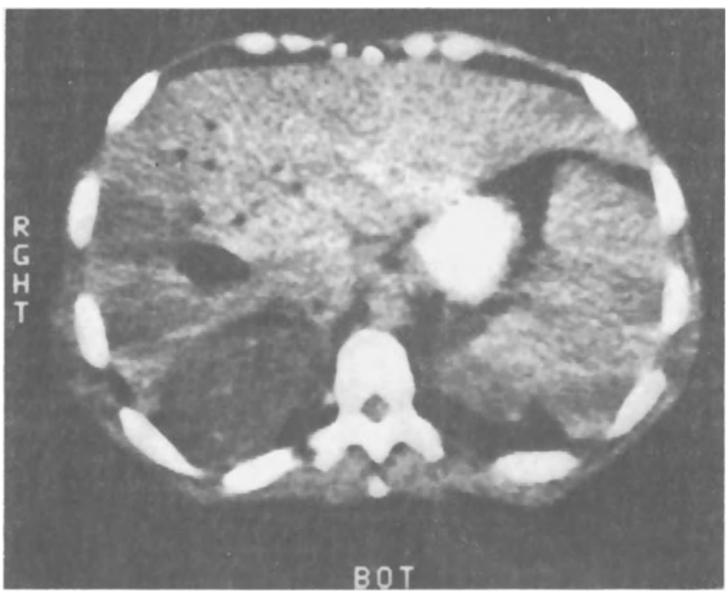


Fig. 56: Computed tomography: Liver scan with cystic dilation of the biliary tree in the right lobe. The stomach contains contrast material. Diagnosis of Caroli's disease confirmed by operation. (Heger.)

inserted into the umbilical vein and an appropriate contrast medium injected. Diagnostic scope resembles that of splenoportography. Gross and coll. even elaborated a selective segmentography (1972) inside the liver which makes localization of tumours less than 1 cm in diameter possible. The risk of splenic damage is absent and it is an advantage that with inoperable growths the catheter may be left for cystostatic perfusion of its vascular bed.

Computed Tomography

This new, revolutionary method of radiodiagnosis has proved useful in view of its high resolving power in soft tissues, this is also applicable to biliary diagnostics. The method is not troublesome to the patient, no contrast media are required, or only in small quantity. Topography of pathological lesions is improved and a more accurate idea obtained about visceral interrelations. For the purpose of biliary surgery non-opaque gallstones may be demonstrated without the use of contrast and the bile ducts may be visualized in patients with cholestasis, where otherwise indispensable contrast medium is not sufficiently excreted by the liver. *Fig. 56.*

Today technical procedure is still being studied and experience with the interpretation of normal and pathological patterns amassed.[4, 13, 58] It seems highly probable, however, that this method will in future assume a position immediately following the plain film in the sequence of investigation. So far this is being prevented by the high cost of the equipment making this progressive method of investigation not readily available.

Choice of Diagnostic Methods

When choosing the diagnostic methods prior to cholecystectomy or other primary biliary operation we are faced with the necessity of gaining the maximal amount of useful information in the shortest possible time and in the least exacting manner. Lack of time makes itself felt especially if the operation is urgent, e.g. in jaundice or if there are frequent attacks, or if a malignant growth is suspected. One has to consider how complete the necessary information must be, which has actually to be obtained prior to the operation, and should attempt to obtain them by simple measures.[50] One should not needlessly accumulate data which give no new information, and sometimes rather obscure than elucidate the problem.

The case history and the physical examination themselves often already indicate the probable diagnosis, and are always a guide for the subsequent examining procedure. They show whether the operation can wait and how the patient may have to be prepared.

In acute biliary conditions, the same as in any acute abdomen, its nature and the urgency of the operation have to be assessed principally by the signs. Of fundamental significance is a quick survey of the internal environment by laboratory tests. Other auxiliary examinations are decided upon not only according to whether they are needed and accessible in the given situation, but also according to the patient's condition.

Among the simplest measures are, in some cases, aspiration of the abdominal contents, plain abdominal radiographs and ultrasonoechography. Angiography and retrograde endoscopic cholangiography may also prove valuable in selected cases. Safrany et al. have used ERCP, after excluding cases of acute pancreatitis, in 12 surgical emergencies with jaundice. The examinations took 15 minutes and were well tolerated. Such examinations are certainly only exceptionally indicated and in selected hospital departments. - The current contrast radiographs of the bile passages, are of use only rarely in acute conditions, and mostly are not even advisable.

The situation is different in patients in whom one has to decide on the indication for an elective planned operation. The auxiliary examination of the first order is peroral cholecystography, whose unambiguous result is, in most cases, regarded as a sufficient basis for surgical action. Intravenous cholangiography is, of course, employed from the beginning in postcholecystectomy cases. We, however, are of the opinion that even in simple cases, where the disease seems to affect only the gallbladder, also a cholecysto-cholangiography should be done and, from among the biochemical methods, at least the alkaline phosphatase activity determined for orientation. Thus the surgeon's attention may be drawn in advance to the possibility that the bile ducts are affected and that a more complicated operation will be necessary.

Naturally, these and, if necessary, other examinations must be carried out if the signs point to an affection of the bile duct, or in patients with attacks of pancreatitis or other complications of the disease. The range of biochemical tests is extended, if necessary, and ultrasonics and special radiological and endoscopic methods are used, but always with a definite aim and selectively, in order to obtain an answer to quite concrete questions. Such examinations are indicated in cases which will bear delay and if they are able to give important information for the preparation for operation. However, it is not always necessary and often not even correct to determine at any cost every detail to establish the anatomical nature of an obstacle in the bile duct. This complete diagnosis is sometimes purposely left until intraoperative examination.

The sequence of investigations in cases of jaundice must also proceed from the simple to the more complicated. The special steps to be taken in jaundice, as well as the analysis and examination of postoperative complaints will be dealt with in the chapters concerned, where the frequent dilemma: early operation or detailed examination will also be discussed.

If there is any uncertainty at all as to the presence of organic biliary disease, it is better to extend the period of observation and repeat the examinations, than to rush into an exploratory laparotomy. Of course, we do not regard non-visualization of the gallbladder as an "uncertain" finding if evident biliary signs are part of the clinical picture.

It should be stated on principle that one must not expect the laboratory and auxiliary examinations alone to establish the diagnosis, even if one directs their selection and the order in which they are done. A conclusion can be reached only by a logical arrangement of all results and by their confrontation with the patient's symptoms and signs. The diagnosis is established, and the indication for operation decided upon, only on the basis of a thorough knowledge of the clinical aspects of biliary disease.

Where these methods fail or provide insufficient information, not infrequently one of the instrumental cholangiographic methods is applied in selected and correctly indicated investigations.

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GENERAL PRINCIPLES OF BILIARY SURGERY AND OPERATIVE DIAGNOSIS

Preoperative Preparation of the Patient

There is no type of biliary surgery which does not require investigation and preparation of the patient, and a suitable time for operation is that which makes it possible. In emergencies we naturally make do with the bare essentials. But just as we must not imperil the patient by delaying an urgent operation, it would also be inexcusable to embark on surgery which can be postponed, without proper investigation and preparation.

Its extent is determined by the disease and the patient's condition.

Simple cases

For simple, uncomplicated cases of gallbladder disease affecting otherwise apparently healthy individuals, no special preparation is required. The necessary radiological and general examinations are done in out-patients, with admission taking place 1–2 days before surgery.

An analysis of the past medical history should ensure that all symptoms can be explained by lithiasis. Cases have been encountered by the author in which cholecystectomy was advised on account of an easily demonstrated lithiasis, but a growth elsewhere in the abdomen was overlooked. History taking also serves to disclose any allergy to antibiotics, some other drugs, surgical tape etc. Lung and cardiovascular function must be tested; auxiliary investigations include the chest film, electrocardiogram, simple urine tests, Wassermann reaction and blood count. Biochemical tests required are blood sugar, bilirubin, alkaline phosphatase and SGPT. It is safer for the patient to have his bleeding and coagulation time checked, and for the people surrounding him, to have the HB Ag test done. Results of all investigations and X-ray films are presented by the patient on admission.

If the patient's condition is satisfactory, no change in his "own diet" need be made. If obesity is a problem, gradual weight reduction should be undertaken, if there is time. Obesity hampers surgery, imperils the firmness of the scar, and exposes the patient to postoperative complications. According to Smith surgical mortality rises significantly with excessive weight. If the patient is 20 kg overweight, risk is increased twofold. — Prompt dental care should also not be neglected, particularly in elderly subjects. No antibiotics are required in uncomplicated cases; only if the course of the disease arises suspicion of infection, needs "umbrella cover" be started immediately before surgery. Information about bacteria in the biliary tract obtained by means of the duodenal tube is considered unreliable.

Prophylactically it is preferable to use an antibiotic with a high level in the serum, rather than in the bile (Keighley, 1977).

The patient should be informed suitably about anaesthesia and operation in advance, including the expected results, and the risk incurred. Anxiety about the loss of the gallbladder which is widespread amongst the lay public, should be dispelled.

Complicated cases

More severe, complicated cases of biliary disease, especially with impaired liver function, require more detailed investigation and preparation (Stone, 1977). Some of the measures may be carried out in the ambulatory patient prior to the planned operation, others only after admission to hospital.

Prevention of new attacks and complications by a stricter regimen is the aim before admission and thus the planned intervention can be accomplished earlier. This applies in a greater degree to recurrent episodes of jaundice, or following pancreatitis. If the patient's nutritional status is reduced, if there is marked negative nitrogen balance, this is amended by adequate substitution as well as by proteo-anabolics. Sometimes preparation requires parenteral nutrition.

If attacks of cholangitis are already a feature of the case, infection can be permanently controlled only by bile duct surgery and never by antibiotics. Nevertheless, the latter are useful in combination with decholin and spasmolytics for immediate preparation. If the patient is afebrile in the preoperative period, broad spectrum antibiotics are started the day before operation and adjusted according to the results of the investigation of bile samples collected at operation.[13]

Patients with a known cholecystocolic fistula are also prepared for large intestine surgery, i.e. with neomycin.

Jaundiced patients require a high protein diet with glycids before surgery. Disturbances of homeostasis must be adjusted, essential vitamins administered. Vitamin K is used even with a normal Quick test, but with a more pronounced coagulopathy fresh frozen plasma is more effective. Antibiotic cover is always useful in the presence of jaundice, and is essential where liver or renal failure is feared. With menacing ammonia intoxication neomycin is useful, otherwise a massive dose of a broad spectrum antibiotics is given on the day of operation. In these patients a urine output chart is kept as a basis for postoperative monitoring. — If refractory pruritus is present, interfering with sleep, cholestyramin is administered and any infected scratch marks carefully treated.

We cannot expect to influence liver function materially in patients suffering from biliary cirrhosis before bile ducts constricted for long periods, mostly by post-operative stricture, have been cleared. If, however, portal hypertension is already present and hemorrhage from oesophageal varices has occurred, the surgical programme must be reversed: a splenorenal bypass must be performed as the first stage and biliary intervention as the second stage, as it would otherwise be hardly feasible on account of operative bleeding (Šerý, 1974).

Cases associated with other disease

Subjects submitted to biliary surgery are mostly middle-aged or elderly. They are frequently affected by disorders of other viscera or systems, whose insufficient function may materially increase surgical risk and postoperative complications, and have an important influence on anesthetic control and surgical strategy. Preparation must sometimes be inaugurated well before surgery, but the basic principle is to advise biliary surgery as soon as possible, in the presence of such associated disorders, if there is a well founded belief that the intervention will be simple and rapid, and that the associated disorder is not too far advanced. We shall allude to the preparations in at least some complications — the most common ones.

Diabetes is a frequent complication, in which the risk of impeded healing must be taken into account, and suppuration and transient deterioration of glucose tolerance after operation are common. Diabetes should be well controlled before admission and patients with moderately severe diabetes, treated with antidiabetic drugs per os should be put on insulin the week preceding surgery. Antibiotics are administered preventively in any case.

Patients suffering from cardiovascular disorders must be prepared by cardiotonic therapy even in cases of minor cardiac insufficiency, and sedatives must be used unsparingly. — Patients with hypertension must also be adequately prepared, but reduction of blood pressure achieved by hypotensive agents must be gradual. — Following a recent myocardial infarction, an interval of at least 3 months before elective surgery should be allowed. Fully compensated patients with an interval of more than 1 year are prepared only by coronary vasodilatory drugs. Data about infarctions in the remote medical history are not as significant for assessing surgical risk as is the permanent persistence of the cardiac angina syndrome and in particular the accumulation of attacks.

Patients suffering from severe bronchitis should be treated in preparation with inhalations, mucolytics and, if required, antibiotics — in such a fashion however, that the expected improvement, which can only be temporary, coincides with admission for surgery.

Similarly, subjects with chronic urinary infections are treated on a long-term basis before admission, and an attempt is made to render the urine sterile.

If disease of the lower limb veins is present, a search must be made for foci of phlebitis, and these must be dealt with before surgery. The blood circulation is supported by exercise, and elastic bandages, if varices are present.

Patients with a history of hepatitis, even recent, require no special preparation, provided that liver function tests are satisfactory. In order to choose epidemiologic measures information about hepatitis B antigen positivity must be obtained. Bleeding time should be verified unfailingly, and opiates and barbiturates omitted even for premedication.

Emergencies

Acute biliary disease, requiring urgent surgical intervention, may by itself quickly induce severe general disturbances even in otherwise healthy subjects. The danger is still greater if the patient in question suffers from another concurrent disease. In such cases investigations proceed hand in hand with preparation for operation in the intensive care unit.

Even though all necessary investigations are available, if this is a genuine emergency, one must partly be guided by guesswork and partly by clinical judgment up to the operation. It is necessary in the first place to deal with pain, acute infection, rapid dehydration and shock. Uncontrolled fluid losses by vomiting, diarrhea or into the third space, participate not only in the decline of diuresis, increased pulse rate and reduced blood pressure, but also on occasions in the development of shock. Dehydration is as a rule isotonic, and the prompt and adequate administration of required drip infusions rapidly relieves the situation. If the time limits imposed prevented the exploitation of findings preoperatively, these will make a welcome starting point for postoperative management.

Anesthesia

General anesthesia is usually preferred for biliary surgery. This may be "tricky" for several reasons. The surgeon requires in the first place perfect relaxation. At the same time the sphincter of Oddi should not be affected by the anesthesia, or premedication respectively, as this would render its assessment, as well as the evaluation of cholangiographic and cholangiometric investigation, impossible during the course of the operation. Patients frequently suffer from liver damage and fairly often are elderly or suffer from concurrent diseases. Preventing harmful effects on the patient is of prime consideration. The surgeon must be provided with the best possible conditions for his task.

Preoperative, internal and anesthesiologic investigations must be painstakingly performed, the medical history must be scrutinized for pre-existing protracted therapy, e.g. corticoids, cardiotonics, hypotensive drugs etc. (Price).

Premedication

Sedatives used the night before are not harmful for the liver parenchyma, the most commonly used is diazepam (Valium) in a dose of 1–1.25 mg per kg body weight. A non-barbituric hypnotic may be added. Barbiturates are not prescribed as most are broken down in the liver.

Premedication proper is started 45—60 minutes before operation by the intramuscular, or if an intravenous cannula is already in use, by the intravenous route. Papaveretum (Pantopone) is used most frequently, as this opiate has the least effect on the sphincter of Oddi and its analgetic action is the most prolonged (Ritsema van Eck). It facilitates deepening (intensification) of anesthesia with pethidine without marked depression of the respiratory centre during the early postoperative phase. Papaveretum is administered in a dose of 0.25 mg/kg. Pethidine may be administered likewise in a dose of 1 mg/kg. However, this drug exerts some effect on the sphincter of Oddi, but this undesirable effect lasts only 45–90 minutes (Fritsch). Thus at the time cholangiometric investigation is done this effect will have waned, provided the timetable for premedication and correct dosage has been adhered to.

The aforementioned drugs are supplemented by atropine in a dose of 0.25 to 0.75 mg according to weight and general condition of the patient, provided other diseases present do not prohibit its use.

Highly advantageous is premedication with thalamonal (Fentanyl with dihydrobenzpyridol) 0.03–0.05 ml/kg body weight. This drug is non-toxic for the liver and does not induce spasms of the sphincter of Oddi.

Particularly weak and cachectic patients are given merely either atropine, or a small dose of diazepam.

Anesthesia

Combined general anesthesia is used in most cases. No special anaesthetic agents or techñiques exist. Every anesthetic may reduce liver perfusion and produce temporary liver damage, but the type of operation and the preoperative condition of the patient are more decisive.[16]

Induction is done with a 2.5% solution of thiopental (Pentotal) 5 mg/kg, or propanidid (Epontol) 10 mg/kg. Poor risk patients receive diazepam 0.2 mg/kg. Scoline 1 mg/kg is administered before intubation and the patient hyperventilated with pure oxygen. After intubation a mixture of $N_2O : O_2$ is administered in a ratio of 2 : 1 by semi-closed circuit; overventilation should be avoided. Anesthesia is deepened by intravenous Thalamonal, or Fentanyl respectively 0.05–0.15 mg. After completion of cholangiometry pethidine 25–100 mg may be administered. If anesthesia needs to be intensified before the performance of cholangiometry, cyclopropane may be used, as this is non-toxic for the liver. The latter may be employed only if reliable facilities for the delivery of expired gases from the theatre exist (explosion hazard).

Halothan was thought to be contraindicated in view of the danger of halothan hepatitis and also because of its hepatotoxic effect in combination with thiopental (Dönike, Christensen). Its hepatotoxicity, however, has not been confirmed (Cooperman et al., 1977).

Muscle relaxants like pancuronium (Pavulone) 0.1 mg/kg or alcuronium (Alloferine) are administered only after signs of muscular activity have appeared. As a result of liver damage in jaundiced patients particularly, the pseudocholinesterase level may be lowered, slowing down scoline break-down. Scoline relaxation after a single dose administered before intubation sometimes lasts 30 minutes or more in such patients.

A motionless abdominal cavity required for operative cholangiography is achieved thus: the adequately relaxed patient is three times hyperventilated with an increased volume. During this period the contrast medium is injected into the choledochus by the surgeon. After the third expiration ventilation is arrested and the films taken. Normal ventilation is resumed immediately after the exposure. If additional films have to be made the procedure is repeated.

The entire surgical team, including nursing staff, must be protected from radiation during exposure according to regulations.

10% glucose is administered during anesthesia. — Arterial or as the case may be venous blood pressure must be continually watched in order to promptly restore any blood losses. For minor blood losses substitution therapy is preferable (Gelifundol, Macrodex), any major blood loss is compensated by transfusion. In the presence of severe liver damage, however, transfusions have to be used with greater caution in view of the possibility of serum hepatitis and on account of the greater liver cell hazard due to erythrocyte disintegration (Wunsch, 1972).

Vitamin K is required for patients with obstructive jaundice. Other drug therapy during the operation, such as antibiotic, Trasylol, hydrocortisone etc., are administered as directed by the surgeon or anesthetist.

To avoid hypoxemia by N_2O excretion into the lung alveoli, the patient should inhale pure oxygen for 3–5 minutes after termination of the operation. Other medication does not differ from routine anaesthesiologic procedure.

Less extensive interventions may be performed under partial infiltration anesthesia if no clotting disturbances are present. Successive layers are anesthetised with 0.5–1% procain or 0.25% bupivacain (Marcain). Using this anesthesia urgent cholecystectomy may for instance be performed in patients in poor general condition.

Regional anesthesia, such as epidural block, is non-toxic but at that level reduces pulmonary ventilation and may also undesirably reduce oxygenation of a damaged liver.

Laparotomy and Abdominal Exploration

Surgical instruments and apparatus

Biliary surgery ranges over a wide scale of surgical interventions from a simple operation to the most complicated procedures taking several hours. The time taken for the operation must not be shortened at the expense of painstaking care, but even if modern methods of anesthesia and resuscitation are available the time factor is not negligible. Though biliary surgery may be performed with simple instruments, a shortage of special tools for performing the operation more rapidly and sparingly should not cause unnecessary delay. Even during the performance of the most simple operation unforeseen situations may arise, thus for each operation everything must be prepared as if a complicated procedure was contemplated.

The basic tray for abdominal surgery must be supplemented by some additions, modified by the centre's preferences. In particular the inclusion of the following is advisable:

For cholangiography and cholangiometry:
appropriate cannulas and catheters,
fine plastic catheter for duct of Wirsung,
balloon catheter for selective cholangiography,
possibly simple manodebimeter,
thin Shiba needle for transhepatic cholangiography.

For liver biopsy:
needle for biopsy (e.g. Menghini or Roholm-Iversen needle).

For removal of stones from ducts:
suitable forceps and scoops,
Dormia's biliary loop,
Fogarty's balloon tipped biliary catheter.

For papillosphincterotomy:
soft catheters and cannulas,
flexible probes measuring 3–8 mm in diameter,
suitable instruments for approximation and division of papilla (e.g. modified Bakeš probes, instrument of Solar-Roig).

For delicate procedures:
vascular scissors,
atraumatic sutures,
operation magnifying glass or spectacles.

For drainage of bile ducts and abdomen:
T- and Y- tubes with 2–8 mm lumen,
transhepatic drains made from plastic material and appropriate introducers,
Redon's suction tubes.

As regards apparatus, apart from an electric scalpel, suction pump and x-ray unit, it appears advisable also to have a choledochoscope ready, at least for re-operations.

Position of patient and of operating team

The patient lies on a straight operating table with his 12th thoracic vertebra overlying the centre of the x-ray cassete container. On the film the common bile duct should be projected away from the spine. For this reason the body of the

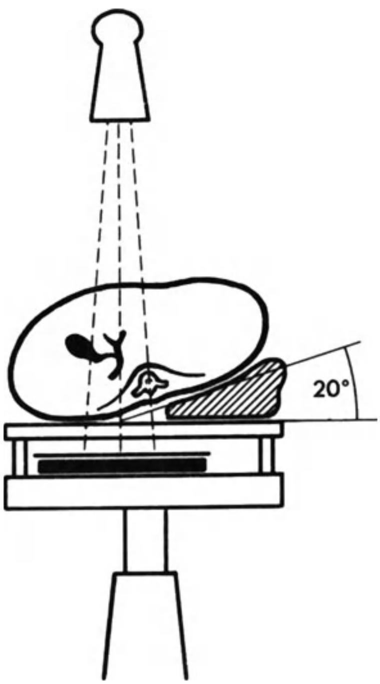


Fig. 57: Inclined position of patient for operative cholangiography. Projection of common bile duct clear of the spine.

patient is always inclined 20° towards the right: either by insertion of a cushion under the lower portion of the left chest or by tilting the entire operating table with the patient. In this case the Bucky screen grid must be at right angles to the table axis so as not to interfere with the vertical projection of the x-ray beam. *Fig. 57.*

The patient has an in-dwelling stomach tube even if intubation anaesthesia is used, to prevent stomach distension.

The surgeon stands as a rule to the right of the patient, the second assistant at the surgeon's left, and the first opposite. During some phases intervention from the left is preferable.

Laparotomy

The entire abdomen is prepared and towels in the region for roentgenography are sutured to the skin, instead of using metal clips, or the operation field is covered by adhesive foil.

No universal abdominal incision for biliary surgery exists. It is selected according to the type of intervention, patient's physique, and any scars already present from previous operations. *Fig. 58.*

The midline incision is the simplest and quickest. It provides sufficient, though not direct, access to the gallbladder and bile ducts, particularly in persons

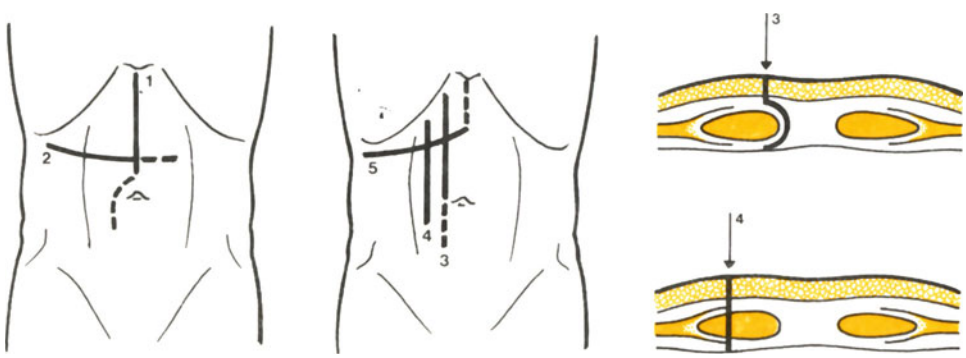


Fig. 58: Laparotomic incisions. Longitudinal median (1), transverse (2), paramedian (3), longitudinal transrectal (4), subcostal-hockey stick (5). Paramedian incision (3) and longitudinal transrectal (4) in cross section of abdominal wall.

with a narrow chest aperture. If possible the teres hepatis ligament is spared by pushing it to the left as the peritoneum is opened. The incision is also suitable for duodenotomy if extended to the right of the umbilicus. One objection is the possible development of incisional hernia, but this is more a question of surgical technique.

Right paramedian rectus retracting incision is more complicated, but the approach to the biliary tract is more direct. It is suitable for obese patients with a wide chest. The scar remains firm as a rule.

Transrectal longitudinal incision is done through the muscle directly towards the palpable mass. It is used in some high risk cases, mostly for drainage of a suppurating gallbladder.

Subcostal oblique incision widely exposes the subhepatic region and many surgeons employ it as a matter of principle. It should not be made too close to the costal arch, but parallel with the liver edge. Even so access to the duodenotomy is not so good. The incision bleeds more freely, does not spare the nerves, and is more time consuming, but if carefully sutured no hernias ensue.

The transverse, or rather oblique, incision runs from the arch above the umbilicus, sometimes crossing the midline. It is more physiological than the preceding one, as it avoids the nerve supply and, in addition, does not interfere with the approach to the papilla of Vater. One condition for it is a wide thoracic aperture. Closure is laborious, but firm.

Hockey-stick incision is intended to extend the oblique incision by a longitudinal median incision. It is not required as a rule, extension of the original incision across the midline is preferable.

In first operations a longitudinal incision is preferred, the midline incision is used most often at our clinic. Oblique incisions are reserved for reoperations, in preference to subcostal incisions.

Exploration of abdomen and inspection of biliary tract

The abdomen is explored nearly in the same order at each operation. However, this proceeding differs slightly from the surgical tactics employed in reoperations which will be described later (p. 510).

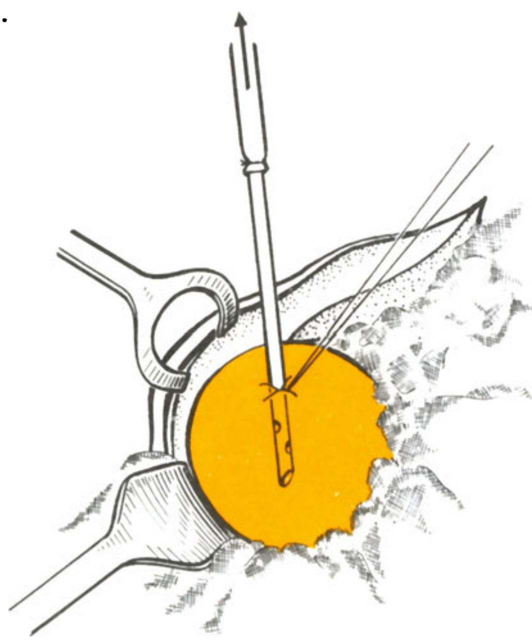


Fig. 59: Puncture aspiration of gallbladder.

After entering the abdomen a check is made of the subhepatic region and surroundings by inspection and palpation. The appearance of liver and gallbladder is assessed, and information obtained about neighbouring organs. Each laparotomy should be exploited for a check of more distant viscera, at least if any doubt exists, but the incision does not always facilitate this. Therefore the extent of exploration should always be stated in the surgical protocol.

As a next step the fundus of the gallbladder is carefully grasped with the proper clamp and pulled up into the wound. Sometimes the gallbladder must be freed all round from its immediate adhesions. If it is distended, aspiration is done before clamping it and to facilitate examination. *Fig. 59.* Abdominal viscera are protected by moist pads and retracted. A large right-angled retractor is placed under the liver laterally from the gallbladder and the hepatic flexure of the colon, covered by a pad, is retracted downwards. The second pad covers stomach and duodenum, which are retracted upwards and medially, the third is used as a padding for the liver retractor placed immediately to the left of the gallbladder.

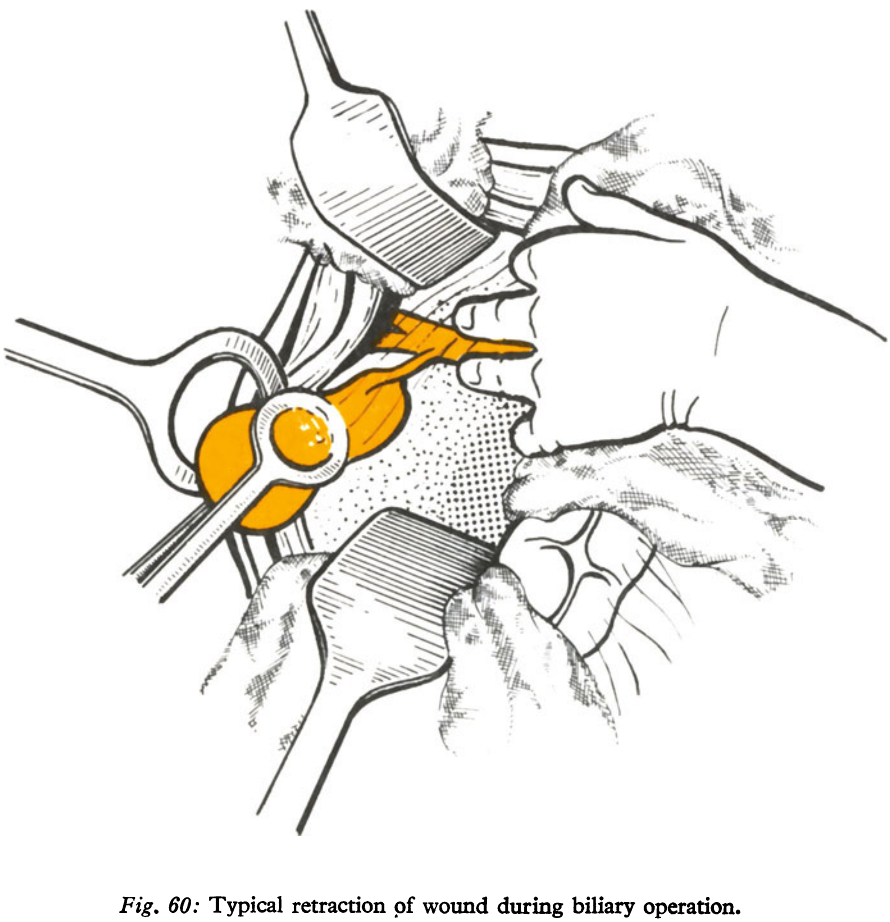


Fig. 60: Typical retraction of wound during biliary operation.

Manual retraction of stomach and traction on the duodenum is more circumspect, as a deep retractor might prove dangerous; it can slip, causing injury to duodenum, pancreas or vessels and may even compress the inferior vena cava without our knowledge. As the hand of the assistent cautiously pulls on the duodenum and the operator applies gentle traction on the gallbladder the liver root is stretched. Letting the common bile duct with adjoining cysticus run between his extended fingers the assistant provides valuable information for the surgeon on their position and course. *Fig. 60.* The pancreas and choledochus are assessed by palpation from in front and through the epiploic foramen. If necessary examination of the terminal portion of the common bile duct from behind by Kocher's manoeuvre is also done, but preferably following cholangiography and in connection with probing.

Only after this preliminary investigation of the biliary tract and other viscera, and after confrontation with preoperative findings can further procedure be considered: a decision is made about cholecystectomy, about the need and mode of instrumental exploration of the bile duct, or some other procedure.

Methods of Operative Instrumental Exploration

Radiology and Manodebimetry

The organic integration of radiological examinations of the biliary tract with the operation itself had, in its beginning (Mirizzi, 1932) to contend with a number of technical difficulties, mainly the imperfection of radiological apparatus, the low sensitivity of films, and the disadvantages of oil contrast media. Nevertheless, even then this method proved superior to the conventional surgical exploration of the bile ducts. Results became more exact when measurement of pressure and flow was introduced (Doubilet and Colp, 1937, Mallet-Guy, 1943, Porcher and Caroli, 1948). In recent years, new mobile x-ray equipment with fluoroscopic monitoring, which facilitates the intraoperative examination, has contributed to the more extensive use of operative cholangiography. However, opinion is still divided on the utilization of the different modifications of the two basic types of radiological examination, which differ in their timing in relation to the operation: "primary" (precholedochotomy, preexplorative) cholangiography, which precedes the operation on the common bile duct or the hepatic bile ducts, and "secondary" (postcholedochotomy, control) cholangiography, which provides the current or terminal control of the operation.

General technical considerations

The fundamental technical condition for operative cholangiography is an operating theatre equipped with a mobile x-ray apparatus. A current one-pulse radiographic apparatus will be helpful, but because of its low efficiency, the exposure is too long and the pictures are often of poor quality. More efficient is a mobile apparatus with intensifier and fluoroscopic monitor, which provides the facility of an easy fluoroscopic control of the contrast filling of the bile ducts. Fluoroscopy requires the patient to be placed on a radiolucent support with which new types of operating tables are routinely equipped.

The instrument equipment for the cholangiography itself and for the measurement or graphic recording of the pressure and flow conditions in the bile ducts may range from very simple to extremely complex. The requirements of sterility are best served by the simplest aids. The most suitable instruments to be introduced into the cystic duct are fashioned contrast catheters (e.g. Oedman's green one). With a very narrow cystic duct it is sometimes impossible to introduce anything but a very fine metal cannula. Puncture of the hepatocholedochus or of the hepatic bile ducts is performed with a long thin needle. In secondary cholangiography, the contrast material is mostly injected through a rubber T-tube, a simple straight tube, or a balloon catheter. — The simplest device for measuring pressure and flow is a graduated 20- or 50 ml syringe connected to a transparent tube. An L-shaped glass tube, 40 cm long, connected by a tube with the introducing catheter will serve as a simple water manometer. An interposed three-way cock enables the use of alternative physiological saline solution and contrast material administered with a 20 ml syringe. The height of the column is checked with a metal measure. *Fig. 61.*

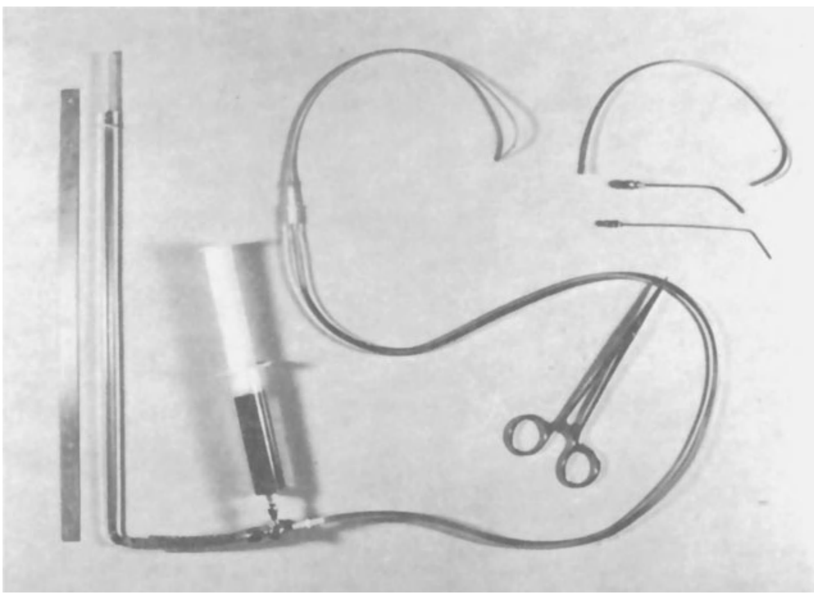


Fig. 61: Simple instrumentarium for radiomanometry.

For direct contrast filling of the biliary tract aqueous solutions of tri-iodated organic compounds (Verografin, Urografin etc.) in 20–35% concentration, warmed to body heat, are currently being used.

Pharmacodiagnostic is used comparatively seldom. Spasmolytics of the atropine-type are given to eliminate spasm of the sphincter of Oddi (usually 0.25–0.5 mg atropine sulphate intravenously). During the operation there occur a number of unphysiological stimuli, which may affect the pressure in the bile ducts; however, if one proceeds gently and observes uniform conditions in all the examinations, interpretable results can be obtained with current practice.

Anti-radiation precautions concern not only the radiological staff, but the entire operation team. One should be aware that even the doses of fluoroscopic monitoring are not negligible (one minute of fluoroscopy approximately equals the dosage of one radiograph). Therefore, the anesthetist, who is sitting nearest to the radiation source and is most exposed to the radiation, must wear a protective apron during the fluoroscopy. Before the radiograph is taken, he hyperventilates manually and then disconnects the breathing apparatus. During exposure, only the x-ray assistant and, if necessary, the surgeon provided with a protective apron remain near the operating table. All others leave the room.

Primary and secondary operative cholangiography may be performed in several different ways, the selection of which depends on the apparatus and instruments available, on the one hand, and on the anatomical conditions and pathological changes, on the other. This sometimes restricts the possible choice of the instrument to be introduced and the route of administration. The basis and main component of all methods is cholangiography, i.e. radiography of the bile ducts filled with contrast material, and this may be combined with other supplementary methods — fluoroscopy, manometry and debitometry.

Simple cholangiography

More radiographs of the contrast filling of the bile ducts can be made, in an improvised manner, with the current mobile x-ray apparatus. Films 24×30 cm in size are used, with a tube-film distance of 70 cm in the ventro-dorsal view. When a fine Lysholm grid, 75–80 kV and 15–20 mA are used, the exposure time

Fig. 62: Primary operative cholangiogram via needle puncture of hepatic duct. Film taken during injection showing papilla in phase of relaxation. (Previous cholecystectomy, separate orifice of right lobe segmental branch. Appearance of bile ducts otherwise normal.)

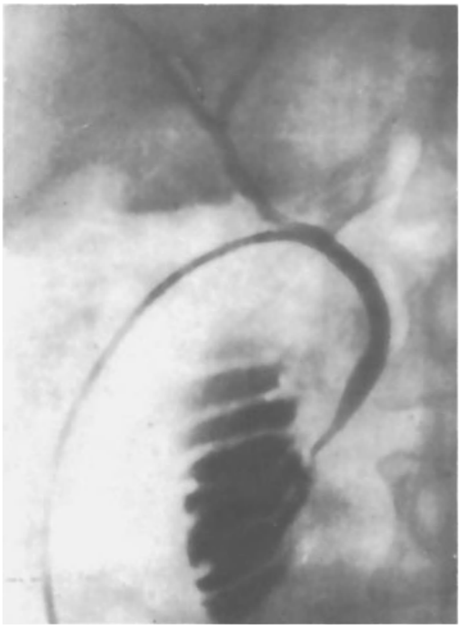


Fig. 63: Primary operative cholangiogram by means of catheter inserted into cystic duct. The sphincteric segment is relaxed during instillation.

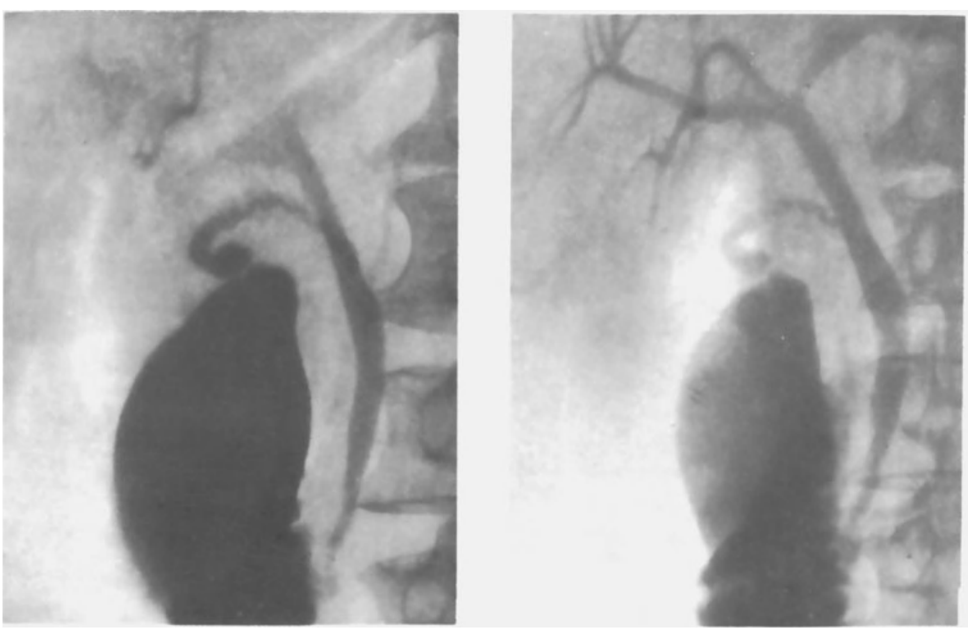


Fig. 64ab: Primary operative cholangiogram by the transvesical route. (a) Defective filling of ducts, (b) manual compression was required to achieve complete filling. (Papillary flow is unimpeded, minor reflux into pancreatic duct.)

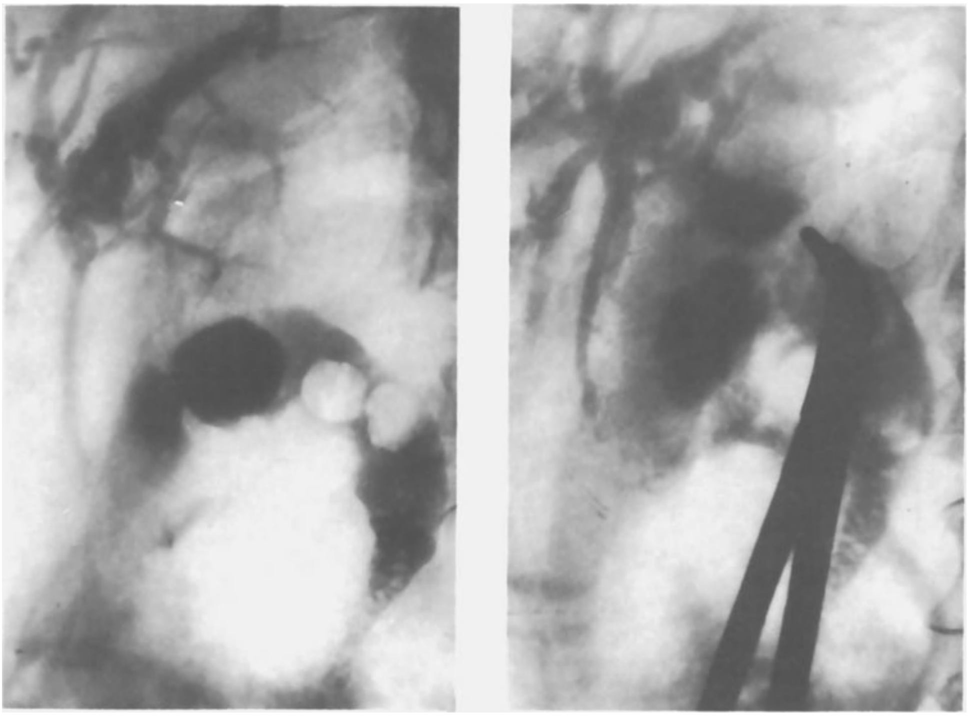


Fig. 65ab: Primary operative cholangiogram by puncture of contracted gallbladder. (a) Due to layering with non-opaque bile the common hepatic duct is not visible at first, (b) adequate filling is achieved following compression of the more distal portion by a swab. (Multiple cholecysto-hepatico-choledocholithiasis.)

mostly exceeds 5 seconds. Modern mobile high-power radiographic apparatus makes it possible to reduce the exposure time to 1–2 seconds.

Since the contrast filling and the radiography are performed without visual control, the warm 30% contrast medium is injected in fractionated doses of 5–10 ml, to avoid producing too high a pressure in the bile ducts. Usually 2–3 pictures with different degrees of contrast filling are made. One is exposed during the injection to visualize the expanded terminal portion of the choledochus. *Fig. 62, 63.*

When the transvesical route is exceptionally used, 40 ml of 30% contrast are injected into the emptied gallbladder. After exposure of the first radiograph, the surgeon gently compresses the gallbladder manually, which improves the otherwise usually weak contrast filling of the bile ducts. *Fig. 64, 65.*

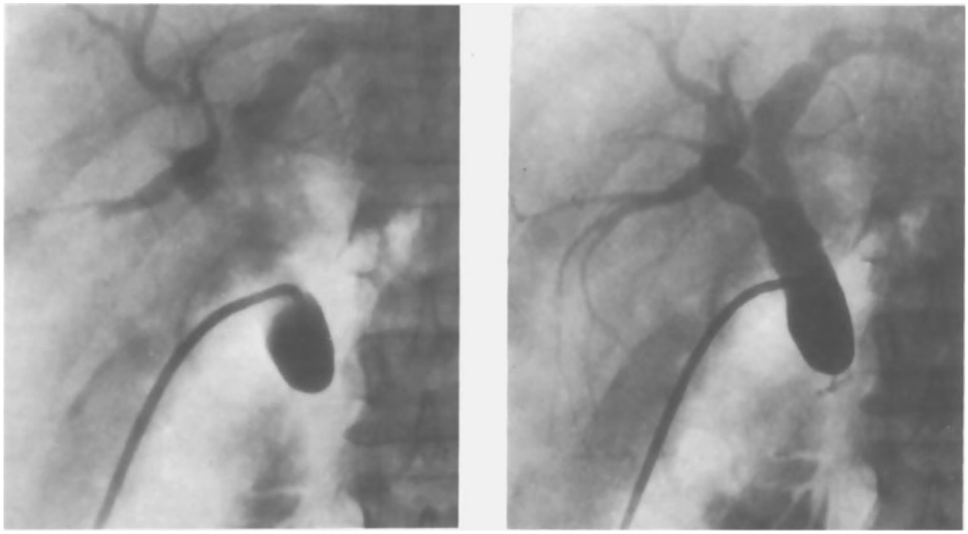


Fig. 66ab: Primary operative cholangiogram. (a) Dilatation of biliary tree, drainage into duodenum impeded, (b) massive filling of the common bile duct is required to demonstrate its stenotic terminal segment.

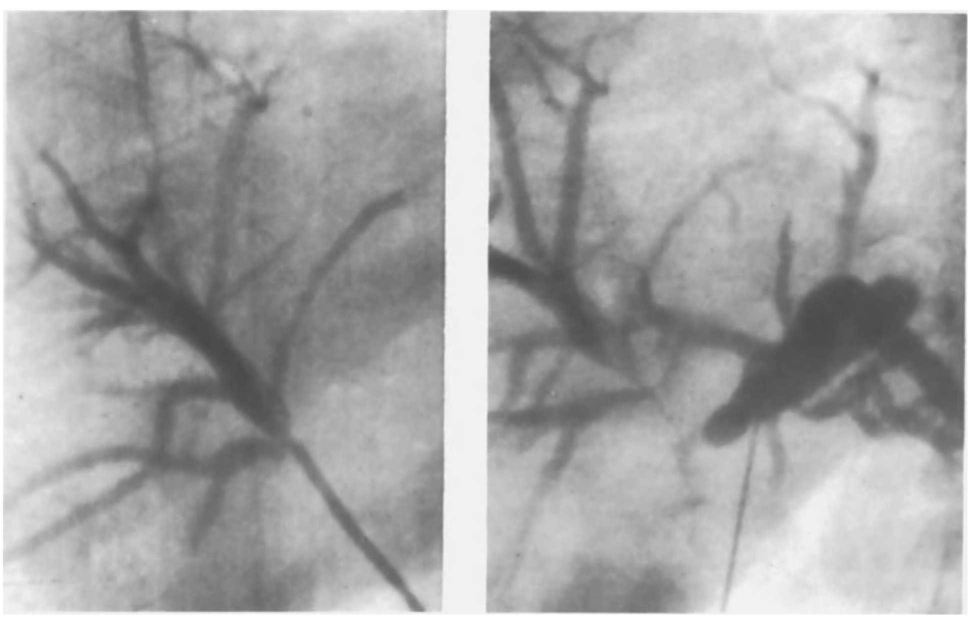


Fig. 67ab: Obstructive jaundice following repeated surgery of the biliary passages. The right hepatic duct was dissected proximally to the narrowed hepatico-duodenal anastomosis and 30% verografin injected. Only the slightly dilated branches of the right hepatic duct are filled (a). The dilated branches of the left hepaticus were filled only after its transhepatic puncture under fluoroscopic control (b).

Cholangiography with fluoroscopy

Modern mobile x-ray sets with intensifier and monitor allow for contrast filling of the bile ducts under fluoroscopic control in the fully lit operating theatre. Fluoroscopic control mainly helps to choose the proper projection and to obtain the optimal contrast filling with, if necessary, application of overpressure. *Fig. 66.* It also gives orientation of the anatomical and dynamic conditions in the bile ducts

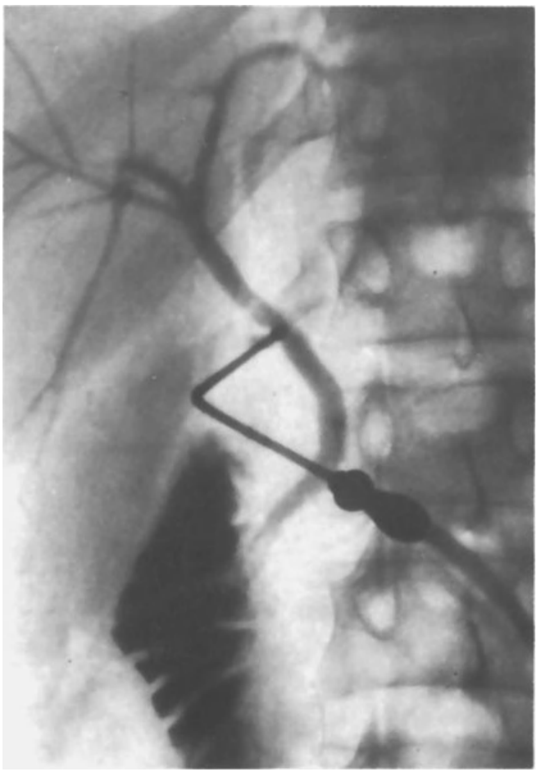


Fig. 68: Primary operative cholangiogram by means of cannula. Fluoroscopy showed free flow into the duodenum, the choledochus was not dilated. The film, however, reveals the presence of about seven small stones above the papilla.

and their emptying into the duodenum. In complicated and anatomically obscure situations, which are not rare in re-operations, they permit a quick individualized decision on how best to proceed. *Fig. 67.*

The distinction of details, however, is inferior to that on a radiograph and the fluoroscopy findings may therefore be only regarded as a valuable supplement of intraoperative cholangiography. That is why full size films are taken even in those cases where the fluoroscopic picture seems quite normal. *Fig. 68.*

Cholangiography with manometry

The different modifications of operative cholangiography combined with measurement of the pressure in the bile ducts are derived from two basic forms.

Manometry by Mallet-Guy's method uses warm physiological saline for the measurement, and is carried out prior to or after the injection of the contrast material. The original set of instruments consisted of a simple water manometer, a puncture cannula, a 50-ml syringe, and connecting tubes. Later, an appliance for graphical recording was added. With this, the residual pressure is measured, and the measurements are repeated several times, always after injection of a small amount of physiological saline solution, by which the pressure is raised by aproximately 10 cm H_2O above the basic level.

Radiomanometry by Caroli's method is carried out directly during the injection of the contrast material and while taking the radiographs. The set of

Fig. 69: Primary operative cholangiogram and cholangiometry by means of Oedmann's catheter passed through the cysticus. A flow of 18 ml/min. at 30 cm H_2O; residual pressure 10 cm H_2O. The cholangiographic pattern is likewise normal.

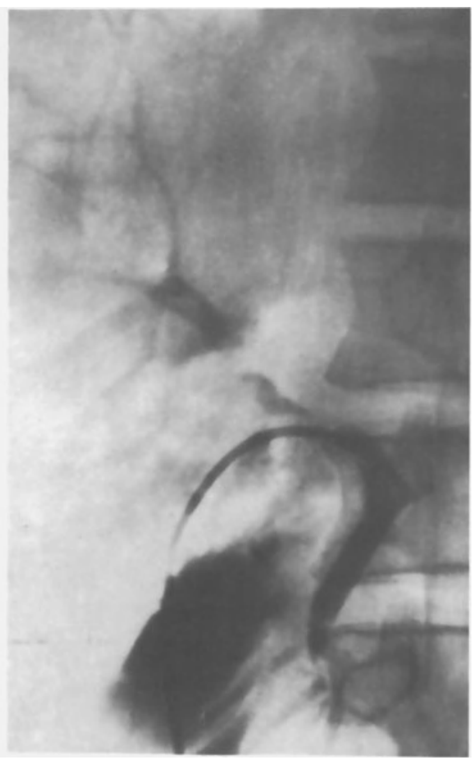


Fig. 70: Primary operative cholangiogram and cholangiometry by ureteric catheter inserted through cysticus. The catheter got embedded in the choledochal wall, thus flow fluctuated. Residual pressure and cholangiographic pattern were normal.

instruments is similar to that used for the preceding method, and the contrast solution is delivered from a reservoir. To this set an appliance for the graphical recording of the measurements may also be added.

Caroli, apart from the residual pressure, also measures the so-called opening pressure (which usually exceeds the former by about 5 cm H_2O), at which the contrast material passes through the open sphincter into the duodenum. Radiomanometry is somewhat simpler and quicker than measuring the pressure separately with the aid of physiological saline, and, therefore, it has gained more favour, although it is said to carry a greater possibility of artifacts due to irritation of the bile ducts by the contrast medium.

Cholangiography with debimetry

The speed of evacuation from the bile ducts into the duodenum can be assessed only approximately by cholangiography, even if this is combined with fluoroscopy. Therefore, measuring the flow at a certain constant overpressure has, in recent years, been gradually gaining ground. To this end, various complicated flowmeters have been constructed. However, it is quite possible to manage with

Fig. 71: Primary operative cholangiography and cholangiometry following acute pancreatitis in a patient aged 16 years with cholecystolithiasis. The catheter is inserted merely into the cystic duct which opened into the segmental hepatic duct, but values measured were normal. The film taken during injection reveals rather pronounced pancreatic reflux, but the pattern is otherwise normal.

a simple set of instruments for manometry, supplemented by a time-measuring device which enables one to determine or calculate the flow in milliliters per minute. The controversies between the supporters of measurement with the aid of physiological saline or of water-soluble contrast medium itself are similar to those for manometry. Since low perfusion pressures lead to uncertain results as far as the differentiation of normal and pathological conditions is concerned, the flow is now mostly measured at constant overpressure of 30 cm H_2O, which corresponds to the so-called secretory pressure of the liver. Our practice is to measure the flow together with measuring the residual pressure. For this debimanometry or "cholangiometry", we use a very simple set of instruments. *Fig. 61.*

Since debitometry is a hydrodynamic method, it reacts to different artifical factors even more sensitively than manometry. First of all, the lumen must nowhere in the whole measuring system be narrower than in the normal terminal portion of the choledochus. It is not possible to determine the flow through the papilla with a thin cannula, catheter or needle. The thinnest applicable lumen is that of a catheter with an internal diameter of 2 mm. *Fig. 69.* If, however, its opening comes to lie tightly against the wall of the choledochus, it falsely measures a reduced flow. *Fig. 70.* An intermittent reduction of flow may, however, also be caused by a mobile calculus. Therefore, the results of flow and pressure measurements have always to be confronted with the results of the cholangiography, which follows the debimanometry (Blažek, 1972). *Fig. 71.*

EVALUATION OF THE RESULTS OF OPERATIVE CHOLANGIOGRAPHY

Primary operative cholangiography saves the surgeon's time by sometimes, if the picture shows normal conditions, making primary exploration by probing superfluous. What is appreciated most is that it reduces to a minimum the probability of overlooking choledocholithiasis. With regard to its diagnostic reliability, as far as pathological changes of the hepatocholedochus are concerned, cholangiography has been reported to give, on an average, 78 % correct results, which increases to as much as 95% if a good technique is used. Our own experience is here also very good. We have been able to achieve, in 84.6% of the cases, full agreement with the findings at operation. There were no instances of fundamental disagreement, but in 15.4% the cholangiographic findings were uncertain or incomplete. This was mostly due to insufficient contrast filling of some part of the biliary tract.

The value of secondary cholangiography is, in different degrees, impaired by the presence of gas bubbles, by the greater difficulty of obtaining a complete filling of the entire biliary tree, and by the consequences of instrumental injuries of the terminal choledochus and the papilla.

The highest degree of reliability can be achieved, in exploratory spot filling of the bile ducts, after gently removing an obstructing stone or stenosis.

We also had similar results in control fillings of the bile ducts with a balloon catheter. *Fig. 72, 73.* When it is passed into the choledochus in a caudal direction, evacuation through the terminal portion into the duodenum can be visualized even

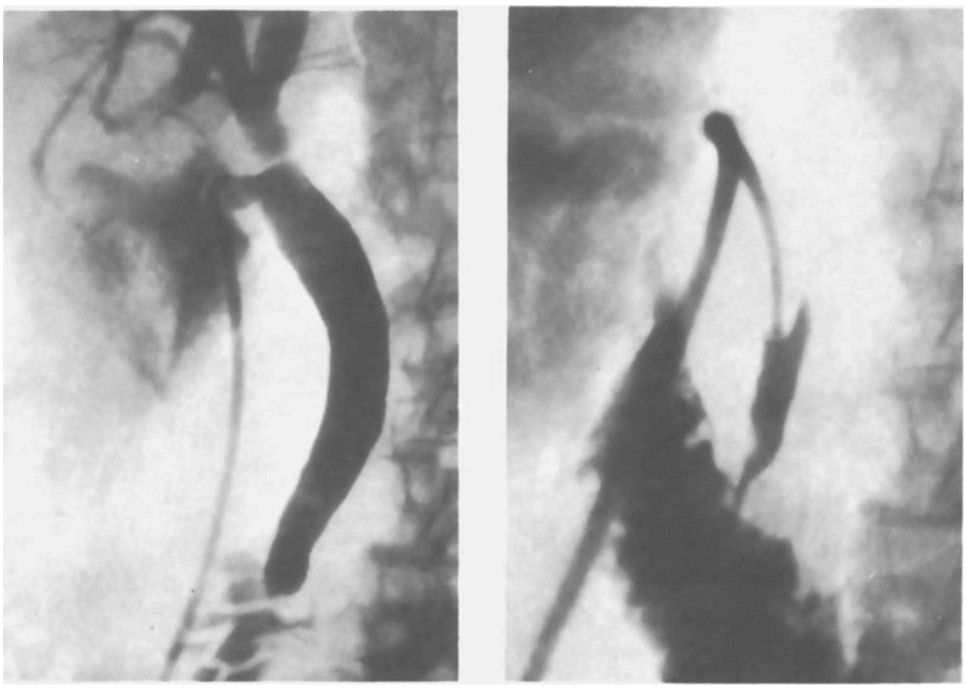


Fig. 72ab: Primary operative cholangiography with blockade of papilla by a small stone (a). As some doubt persisted whether the stone has been pushed through into the duodenum by probe, selective secondary cholangiography of the terminal segment was performed by balloon catheter and it was shown to be free (b).

when there is marked oedema of the papilla. When the catheter is passed in a cranial direction into the common hepatic duct, a continuous contrast filling of both hepatic ducts and their hepatic branches is obtained.

In controls of anastomoses or of inserted drains, it usually is not a matter of excluding residual lithiasis, so that a radiograph that demonstrates the position of drains and patency of the stoma is sufficiently satisfactory for the surgeon even if there is a marked admixture of air bubbles.

The reliability of the final intraoperative cholangiography through the T-tube varies according to the extent and type of operation on the bile ducts and the papilla. It is easiest to give an opinion on the course and width of the bile ducts after operations dealing with limited stenoses, with external compression or

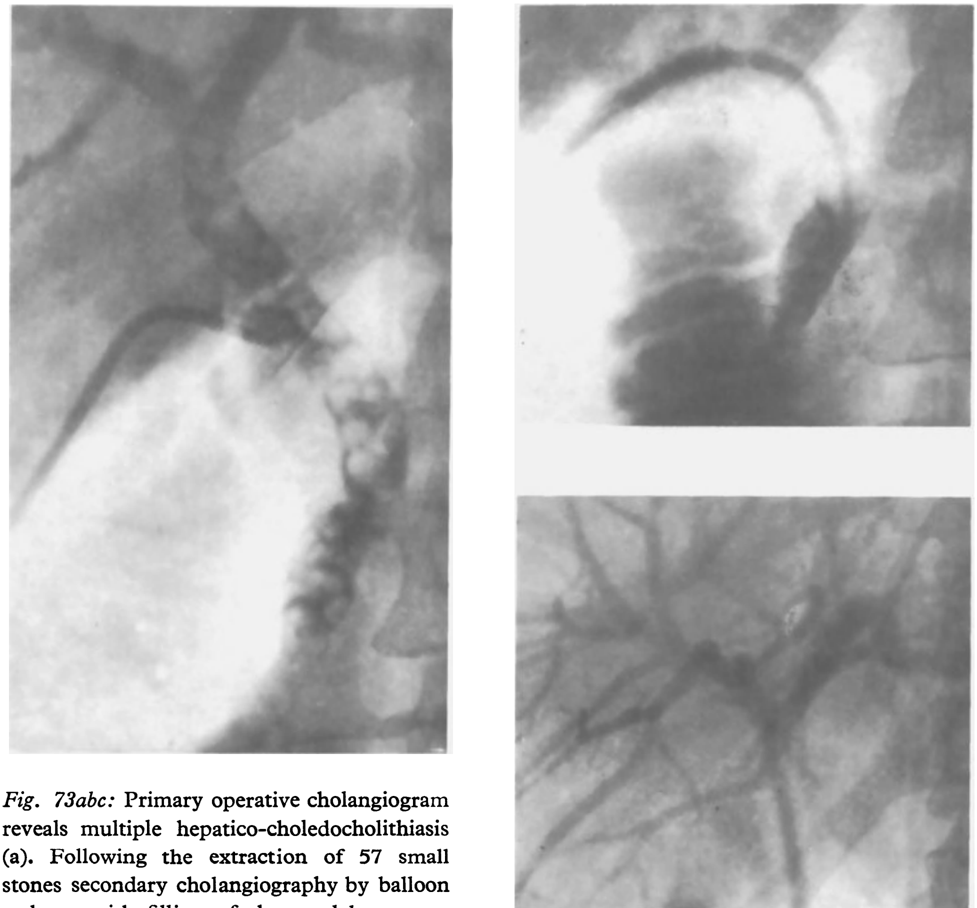


Fig. 73abc: Primary operative cholangiogram reveals multiple hepatico-choledocholithiasis (a). Following the extraction of 57 small stones secondary cholangiography by balloon catheter with filling of the caudal segment was performed (b), later followed by filling of the cranial portion of the biliary tree (c). Residual stones could not be demonstrated.

traction, etc. It is more difficult to provide evidence of, or to exclude, a residual cholangiolithiasis, because a continuous contrast filling without gas bubbles can be achieved in only about half the examinations. To distinguish between bubbles and non-opaque calculi by their shape and transparency is rather difficult. *Fig. 74.* The use of positioning manoeuvre, such as are currently used for this purpose in postoperative cholangiography, is possible only to a limited extent, even if modern inclinable operating tables are used.

An equally important source of difficulties and uncertainties, when performing the final cholangiography through the T-tube, are changes of the terminal choledochus and the papilla produced by surgical injuries. These traumatic changes are most frequent and most marked after forcible dilatation of a stenotic papilla, where we have found a completely normalized x-ray picture in only 1/6 of the cases.

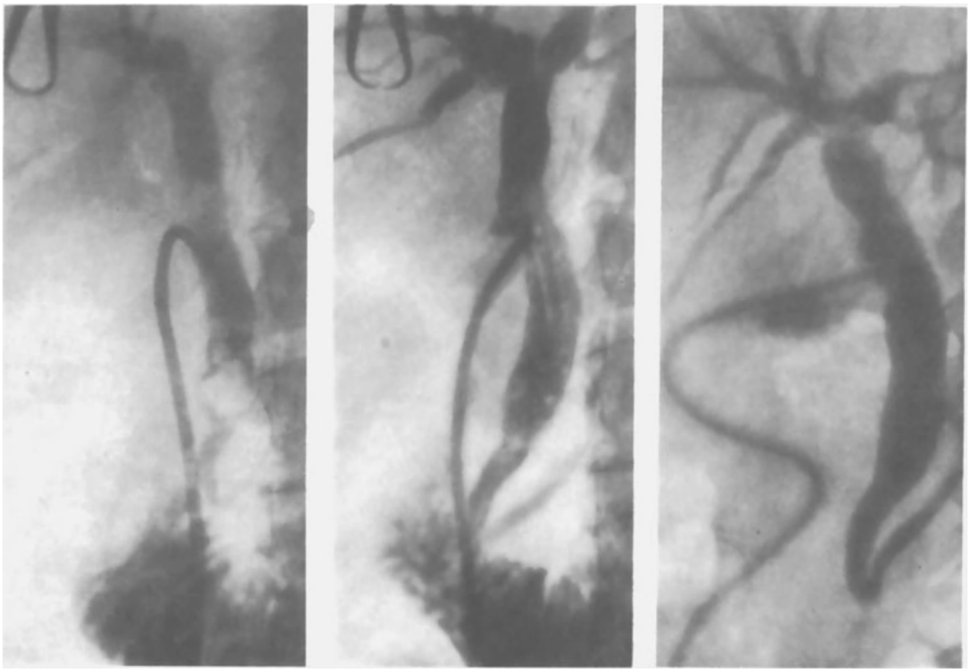


Fig. 74abc: Primary operative cholangiography showed one large and a number of smaller stones in the suprapapillary region (a). Secondary cholangiography demonstrates adequate drainage into the duodenum, minor pancreatic reflux and a series of tiny translucencies in the common bile duct, some of polygonal outline and resembling fragments (b). One of the latter causes almost complete occlusion of the papilla as seen on the postoperative cholangiogram (c).

Neither a reduced flow nor an increased residual pressure is always proportionate to the extent of the changes shown by the radiograph and cholangiometry has not the same significance as in primary cholangiography.

RADIOLOGIC FEATURES

The radiological findings resemble those of other cholangiographic methods. Though the technical standard of operative cholangiographs is usually lower, the majority of details can be discerned more easily than e.g. in an intravenous cholangiograph. This is mainly due to the higher concentration of the contrast medium in the bile ducts. A higher contrast makes especially the direct radiological signs of pathological changes more evident — the non-homogeneous filling and circumscript changes of the lumen.

A non-homogeneous contrast filling is a reliable sign of abnormal contents (mostly stones), if it has been possible reliably to prevent troublesome air bubbles from getting into the bile ducts during the filling. This we manage to achieve currently in primary operative cholangiography, at which we have missed only 0.5% of cholangiolithiasis cases. Even so, one is usually less successful when trying to visualize distinctly all stones so as to be able to count them. If the filling is massive, even larger stones may not be visible. *Fig. 75.*

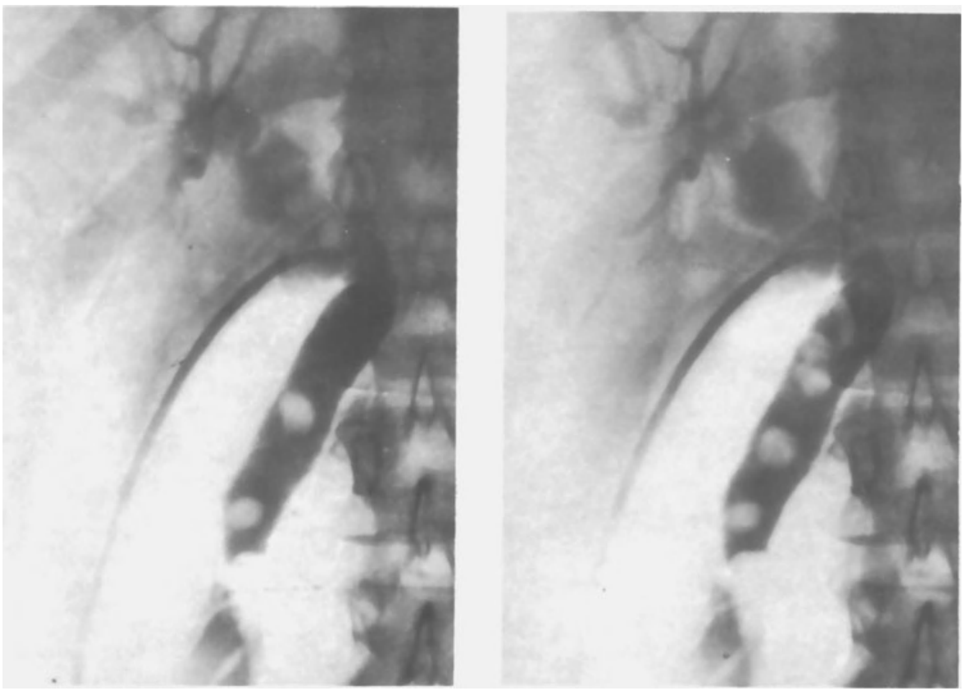


Fig. 75ab: Obstructive jaundice accompanying cholecysto-choledocholithiasis. Papilla intermittently occluded by stone. Depending on the volume of contrast medium a variable number of translucencies is shown (a), (b). A total of 17 stones was eventually removed from the hepatocholedochus.

A circumscript narrowing or deformation of the bile ducts is also an easily demonstrable radiological sign. Only the terminal portion of the choledochus is an exception, as its lumen is normally thin. Besides, if the number of separate pictures is limited, one does not always succeed in visualizing the sphincter with a sufficient contrast filling, especially if there is associated choledocholithiasis. In secondary cholangiography, there may also be spasm or oedema after instrumental injury.

Dilatation of the bile ducts is the most frequent indirect sign of a pathological process associated with overpressure in the bile ducts. We regard 8 mm as the upper limit of normal for the width of the hepatocholedochus, after correction of the projectional enlargement on the films (without correction, this corresponds to an average of 12 mm in intraoperative cholangiographs). Values of 8—10 mm are not certain to be pathological and are often found in cases without verified obstruction. Values above 10 mm should be regarded as manifestly pathological.

Impaired evacuation into the duodenum can be assessed only with uncertainty from a small number of x-ray pictures. Slightly more certain is the appraisal of the concomitant fluoroscopy, which may, together with dilatation of the bile ducts, draw attention to an obstruction in the region of the papilla.

MANOMETRICAL AND DEBIMETRICAL DATA

Cholangiometry may sometimes contribute to the assessment of the morphology and function of the choledochoduodenal junction. In 80% of verified papillar stenoses did we find manometrical overpressure, which, however, was also found in 10% where subsequent surgical exploration failed to discover any obstruction. Other authors report similar experience[1, 62] and they therefore have come to prefer debimetry. The extent of information provided by manometry alone, when compared with cholangiography, is much more limited, but when the results of both methods are correlated, one may very well complement and correct the other.

On debimetry, we have found a reduced flow in 93% of organic, surgically verified papillary stenoses. In choledocholithiasis without concomitant papillary stenosis, the contribution of debitometry was less evident. We found a reduced flow in only 60% of the cases.

A certain disagreement was presented by 2.5% of the cases with patent bile ducts and a reduced flow, whose cause we were not able to explain even by correlation with cholangiography. Despite these false positive results we regard debimetry, or preferably combined debimanometry as the most useful method for giving more precision to the data on the state of the papilla in primary operative cholangiography.

In secondary operative cholangiography we do not measure flow and pressure, because the values so obtained are very much influenced by the functional and morphological changes subsequent to the surgical traumatization of the choledochus and the papilla.

INDICATIONS FOR AND EMPLOYMENT OF OPERATIVE CHOLANGIOGRAPHY

There are practically no absolute contraindications for direct operative cholangiography. It may be relatively contraindicated in individual cases because of the patient's serious condition, which does not permit a more complicated operation, and in whom prolongation of the operation would markedly increase the risk. Pancreatic reflux is seen on the radiographs in about half the operative examinations, when the injection of the contrast material is more rapid. There is no evidence that this may lead to the development of acute postoperative pancreatitis.

There are great differences in the employment of primary operative cholangiography. Some authors use it routinely in all gallbladder or bile duct operations. They do so on the basis of statistical data, mainly of the comparatively high incidence of choledocholithiasis (25%) in their own surgical material, which is in agreement with reports from pathological departments. On the other hand, in the surgical material from departments, where operative cholangiography is not practised, or indicated only in selected cases, the incidence of choledocholithiasis is substantially lower (5–15%). The restriction of indications mainly concerns patients operated on for the first time, whereas in repeat operations operative cholangiography is considered useful and even indispensable. The selection is made mostly on the basis of an evaluation of the case history, the preoperative clinical and laboratory data, the situation found at operation and the patient's age. Since we have found out from our own experience, that all data on which such a selection is based are not sufficiently reliable and that any restriction of indications is associated with a certain risk of leaving behind some unrecognized obstruction in the bile ducts, we use primary operative cholangiography almost routinely not only in repeat operations, but also in patients operated on for the first time.

During bile duct operations, filling of some part of the biliary system after removal of its obstruction gives reliable results, and therefore we use it whereever it can be expected to give important information.

Current control during bile duct surgery entirely depends on the surgeon's requirements of the moment. Mostly it is expected only to provide a general orientation and usually this is all that this examination is capable of giving.

In the majority of cases after the extraction of stones we perform the final cholangiography through the T-tube despite its unrealiability. In recent years we have instead sometimes used control cholangiography with the aid of a balloon catheter prior to inserting the T-tube and have found this more reliable. This is mostly the case in multiple hepato-choledocholithiasis and in those cases where primary cholangiography has not led to visualization of the entire biliary tree.

Probing

Originally probing was the only instrumental method used for examining the bile passages. When post-operative x-ray controls with a T-drain showed how unreliable the probe is in demonstrating concrements in the ducts, and that a large number of stones which formerly, on re-operation, had been thought to be newly formed, actually were overlooked stones, surgeons made increasing use of intraoperative cholangiography until this practise became routine. But there also was another consequence. Surgeons who saw for themselves how many stones had escaped their own, seemingly infallible probing and palpation, learned to use the probe much more delicately and critically.

Such thorough probing combined with palpation still remains the most important method of searching for gallstones after cholangiography and is definitely more effective in identifying stenosis of the papilla. Certainly, probing will not reveal the functional efficiency of the papilla nor the reversibility of its stenosis, which sometimes can be shown by flowmetry, but is the best aid to determining its patency and width.

Probing of the bile ducts is usually done after cholangiography in those cases, where the films are equivocal or where the radiological findings have to be verified or supplemented, especially in suspected stenosis of the papilla or pancreatic portion. Naturally, probing will be used primarily whenever intraoperative cholangiography cannot be performed.

Probing of the common bile duct is first attempted with a soft urological catheter and, if this fails, a flexible metal cannula or probe is used. The instrument is introduced through the cystic duct or via a choledochotomy.

Transcytic probing

The stump of the cystic duct is isolated as far as the common duct, caught with two stay sutures and, if necessary, the tight opening is widened with a mosquito-clamp. Then the rinsed and well moistened catheter is gently slid into the duct in a distal direction. If one fails to introduce a catheter or a probe of required thickness into the cystic duct, even when it has been widely cut open, and if probing is essential, we open the choledochus.

Probing via choledochotomy

It is generally easy to find the common bile duct, but a mistake may be so unpleasant, even catastrophic, that the choledochus must be identified safely before being opened.

Common bile duct can be recognised

- by exposing the entrance of the cystic duct into it,
- by a probe introduced through the cystic duct,
- by palpating a stone in the duct,
- by denuding choledochus from its peritoneal covering in the hepatoduodenal ligament, where it usually lies more superficially and externally than the hepatic artery and is conspicuous by the network of fine vessels on its wall,
- by puncturing it with a thin needle, if one is not sure.

Technique of the choledochotomy

The common bile duct is opened by a short, usually longitudinal incision. A curved mosquito-clamp is introduced into the choledochus through the cystic duct and the wall is incised between the slightly opened jaws. If the clamp cannot be introduced, the wall of the choledochus is lifted with fine tissue forceps or with atraumatic sutures, and the incision is made between them, not longer than

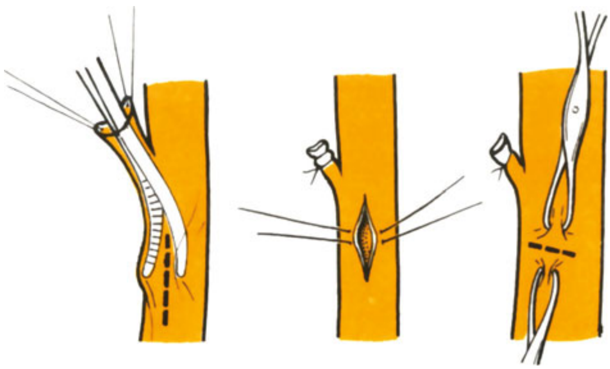


Fig. 76: **Longitudinal choledochotomy over hemostat inserted through cystic duct or by means of stay sutures; transverse choledochotomy by means of small forceps.**

absolutely necessary for introducing the instrument. Blood vessels should be avoided, (with the help of the duct transillumination in some cases),[19, 24] —and every bleeding point should be secured. *Fig. 76.*

Technique of probing

Whether the common bile duct is probed from the cystic duct or through a choledochotomy, the entire common duct should be palpated simultaneously, its terminal portion even from the back by the so-called Kocher's manoeuvre: Peritoneum is incised for 3–4 cm parallel to the outer edge of the descending duodenum, 1–2 fingers of the left hand are carefully inserted and the head of the pancreas together with duodenum freed. For mere assessment these viscera need not be exposed to any great extent. — Such a manoeuvre was described by Kocher in 1903. However, it was proposed earlier by Jourdan and Vautrin. In England it is called Moynihan's rotational manoeuvre and in France Wiart's method.

The catheter is first introduced in a peripheral direction, and only after that, if necessary, also into the hepatic ducts. We prefer to use Tiemann catheters or flexible cannulas with a diameter of 3–4 mm, and first test whether they will pass the papilla. It is true that stones may be identified with a thinner probe, but this would not furnish evidence of sufficient papillar patency. The catheter or probe is introduced with the right hand without any use of force while the fingers of the left hand, pushed behind the duodenum and the pancreas through the Kocher's peritoneal incision, follow its progress. This makes for easier guidance of the instrument, for a better assessment of papillar patency and for better identification of stones, which can thus be differentiated from changes in the neighbouring pancreas. *Fig. 77.*

Sometimes it will be found necessary to verify the results of the probing and

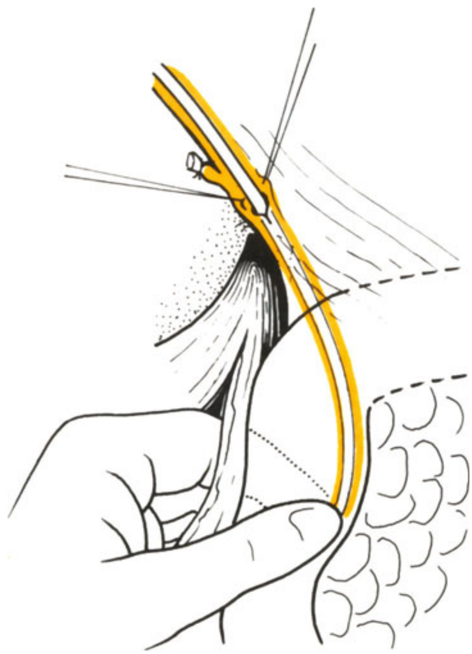


Fig. 77: **Palpation of terminal choledochus after Kocher.**

to examine the papilla by duodenotomy. This is also the case when one cannot be certain whether a sufficiently wide catheter has really passed into the duodenum. An error is possible if the catheter point appears to be outlined visibly through the anterior intestinal wall, when in reality the obstructed papilla is merely pushed forward by it. Such a wrong impression may especially be caused with a low opening of the bile duct into the intestine.

Evidence that the probe really has passed the papilla is

- a sensation of overcoming a certain resistance when penetrating the orifice of the papilla (but beware of "false passage"),
- the papilla strung on the probe may be felt as a cuff,
- the metallic shine of the probe point through the duodenal wall which may be confirmed by a microincision,
- a soft catheter can be pushed far down the duodenum,

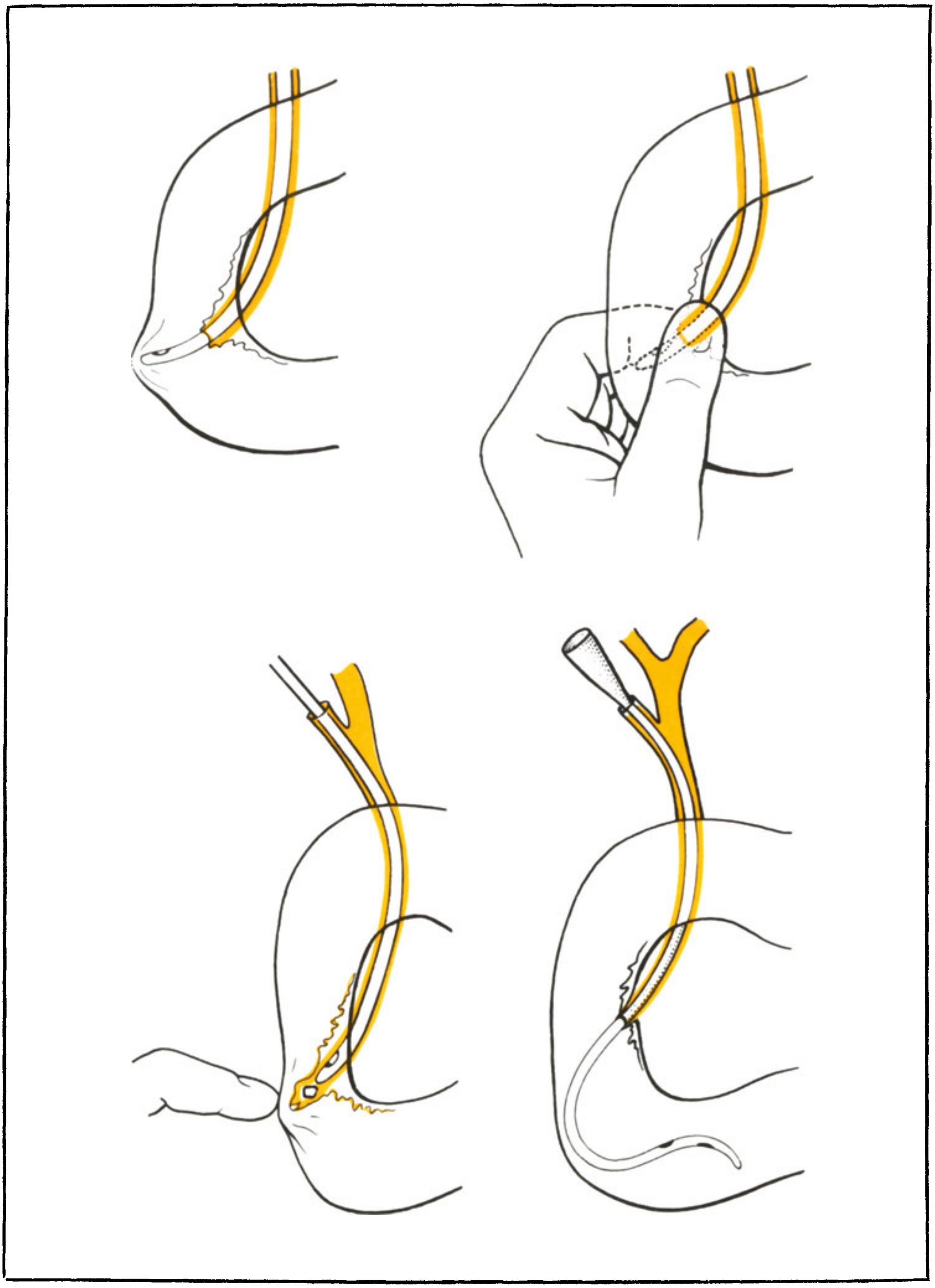


Fig. 78a–d: Tip of probe raising duodenal wall and "shining" through it (a), mistaken impression that the probe has passed the papilla (b), papilla can be palpated as forming a "collar" on the catheter passed through it (c), the catheter may be inserted deeply into the duodenum after the papilla has been traversed (d).

- saline solution injected through the catheter does not return and its flow into the duodenum can be felt,
- the catheter directly examined through the intestine. — *Fig. 78.*

Technique of duodenotomy

Probing is not followed up by duodenotomy light-heartedly. Like any opening of the intestine, it carries some risk. Even though it can provide better direct information than any other method on the state of the papilla, it is indicated only when changes in this region cannot otherwise by exactly determined, or when it is necessary for direct therapeutic surgery of the papilla.

In itself, duodenotomy is not a serious operation if it is carried out gently and carefully. First the insertion of the mesotransversum is pushed downwards on the descendings part, which, together with the pancreas, can be partly mobilized by Kocher's manoeuvre. The laparotomy is enlarged in time, if necessary. With the surroundings well covered, the intestine is opened by a longitudinal or transverse incision between two stay sutures. *Fig. 79.* Our experience has led us to prefer a longitudinal incision near the internal circumference, only about 2–3 cm in length. If possible, we prefer 2/3 of the incision to be above the papilla and 1/3 below it. The site of the papilla is estimated from the cholangiography or with the aid of the inserted probe. Bleeding from the intestinal wall is dealt with carefully. To bring the papilla into sight, it is better to use small swabs caught in long

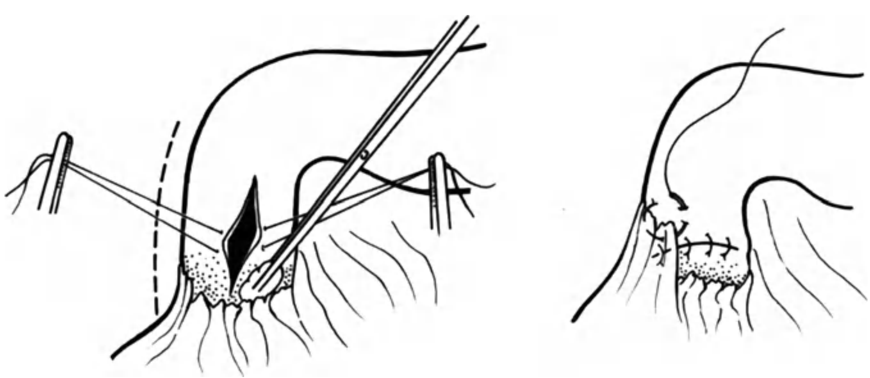


Fig. 79: Longitudinal duodenotomy following sliding down of the mesotransversum and splitting of peritoneum to mobilize the duodenum; transverse duodenal suture which is covered by mesentery.

curved clamps than hooks. Rather than to draw it with forceps or sutures, we try to bring the papilla nearer to the intestinal incision with a suitable catheter or a special instrument inserted from above[30].

After examination of, or operation on the papilla we make sure that there are no bleeding points and close the duodenotomy. A transverse incision is closed in one layer, whereas a longitudinal one is sutured transversely, in this case in two layers. If the intestine is wide, the longitudinal incision may be closed longitudinally. The suture is covered with the edge of the pushed-down mesentery. Using this method of closing the duodenotomy we have had no occurrence of duodenal fistula in 800 duodenotomies.

Choledochoscopy

This old method of distinct value for intraoperative exploration of the bile ducts is still not a widely accepted procedure.

The earliest report on intraoperative endoscopy of the bile duct was in 1923 by the Czech surgeon Bakeš.[3] In 1937, Babcock and Bartlett examined the gallbladder with a cystoscope, but it was only in 1941 that McIver again wrote on endoscopy of the bile ducts. An improved type was demonstrated and made popular in 1953 by Wildegans, the first flexible fiberoptic choledochoscope was introduced by Shore a. Shore (1970).

Modern choledochoscopes are either firm, made of metal, or flexible, or combinations of both types. Their external diameter is not more than 4–7 mm. They may be fitted with devices for extracting stones or taking biopsy specimens, but their main object is diagnosis. A disadvantage of the choledochoscope is the still rather long time needed for sterilization.

The instrument is inserted usually through the choledochotomy and only rarely through the wide lumen of the cystic duct. The bile duct must be sufficiently wide and easily accessible. The rigid, right-angled choledochoscope is preferable as it is easier to guide than the flexible type. The latter, however, adapts itself to the course of the bile passages and with the newer type the movements of the tip are remote-controlled from the handle.

Technique of examination

The field of operation is isolated with pads and the irrigation fluid is removed by continuous suction. The bile ducts are viewed on inserting and on extracting the choledochoscope, and usually we start with examining the hepatic duct and its branches. The spur ("carina") dividing their junction serves as a guide. In the majority of cases, one can see further directly into the ventro-cranial branch of the right hepatic duct. Its dorso-caudal branch is usually less accessible and visibility of the third-order branches differs according to their course and dilatation. The left hepatic duct can often be examined to a greater depth. *Fig. 80.*

Normally the ducts are pale, light yellow-red in colour, with a fine vascular network. The mucous membrane is smooth and uncoated, and only at some sites are there scattered pin-point openings of glands. Sporadic flakes of mucus represent the normal secretion and are not signs of inflammation.

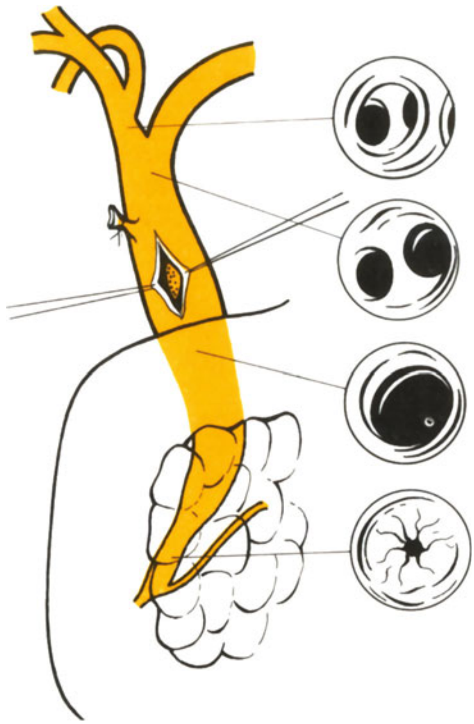


Fig. 80: Choledochoscopic appearance of hepatocholedochus segments.

After examination of the upper tract, the instrument is pulled out and re-inserted into the bile duct in a distal direction. It is slid in gently, and the bent and inflexible course of the duct through the pancreas is followed carefully. On approaching the papilla, the sphincteric portion of the duct gets narrower and its wall has longitudinal folds. It is usually necessary to increase the rate of irrigation to obtain a better view. The opening of the normal papilla is usually star-shaped or irregular with coarse folds, which may even occlude it completely. In other cases, the dark duodenal lumen may be seen through the opening, or one may even enter the duodenum without noticing it and recognize it by the wide intestinal plicae.

Indications and contraindications

Well mastered choledochoscopy lasts about 5–8 minutes and its risk is slight. Choledochoscopy can usefully supplement a thorough exploration of the hepatic ducts, if they are sufficiently accessible and wide. It is for this reason that choledochoscopy is of most use during reoperations, when the ducts are usually dilated and when the operation can be speeded by primary endoscopy instead of other more usual methods. In first operations, on the other hand, choledochoscopy is, as a rule, used as a final step, mainly to check for remaining concretions in the hepatic ducts, whereas examination of the papilla is not rewarding. Mättig, 1977, recommends choledochoscopy as an additional measure after any exploration of the ducts. It is more reliable than secondary cholangiography and is more easily repeated, even several times.

Choledochoscopy is contra-indicated if the instrument is difficult to insert, and whereever it would unnecessarily increase the risk of the operation, e.g. in acute pancreatitis.

Results

Choledochoscopy is a safe procedure. If the technique has been properly mastered, it gives good results and can reduce the number of residual stones.[47, 56] Shore (1970) overlooked concretions only twice in 100 cases of choledochoscopy whereas in the series of 88 cases of Finnis and Rowntree (1977) no undetected calculus remained. Berci (1978) states that choledochoscopy reduced in a recent series of 120 consecutive choledochotomies the incidence of retained stones to 2 %. We have used the fibroscope in 74 bile duct stones operations: concretions escaped our notice twice in the second-order hepatic branches. However, we discovered a coexisting incipient carcinoma of the choledochus and a congenital stenosis of the left hepatic duct.

Puncture and Biopsy

The puncture needle we use mostly when, during operation, we are searching for the common duct or its remains or for dilated intrahepatic ducts. We also use puncture to differentiate certain, in particular cystic, structures, in the pancreas or liver, or to obtain material for cytology.

Biopsy is mostly peformed on the liver. It should be carried out at the beginning of the operation when this has not yet caused any changes in the liver parenchyma. The specimen is usually taken from the liver margin, even though this is not the most suitable site from a structural point of view. However, it is easily sutured and covered with adjacent ligament. Menghini et al. (1977), recommend needle biopsy even in the open abdomen instead of excision as a more simple and quicker procedure.

Biopsy of the pancreas or of sections of the bile ducts is used mainly if tumorous growth is suspected, and in the case of the liver it often serves to differentiate the type of jaundice, if no obstacle has been found. Intraoperative biopsy, however, is not too reliable. It sometimes gives not only false negative, but even false positive results, and therefore one should preferably wait for a full histological report.

Choice of Diagnostic Methods

Nowadays, the most frequent, almost routine kind of surgical examination of the bile ducts is operative cholangiography and probing, whereas cholangiometry or choledochoscopy have their special indications.

Assessment of the gallbladder is quite feasible by mere inspection or puncture. Cholecystography is hardly ever used. The removed gallbladder should always be cut open during the operation, and bacteriological and histological examination requested.

On the contrary it is not possible to make sure of the state of the bile ducts by inspection and palpation only, and different instrumental methods help to discover stones and other changes, which had not been suspected:

- Primary intraoperative cholangiography may be used in every operation, if it can be performed through the cystic duct, otherwise in selected cases.
- Cholangiometry can give valid conclusions only in combination with primary cholangiography.
- Probing of the ducts is used after cholangiography which has not given sufficient information or if this intraoperative radiography cannot be carried out. If a probe of at least 3 mm thickness cannot be introduced through the cystic duct, choledochotomy is used for this purpose.
- Duodenotomy is used in combination with the probe whenever direct inspection of the papilla is called for.
- Checking for stones accidentally left in the ducts should be carried out, if possible, by choledochoscopy rather than by secondary cholangiography. As far as cholangiometry is concerned, this is of no value at all at the end of the operation.
- As far as intraoperative biopsy is concerned, one should keep in mind that only the final histological report is reliable.

Basic Surgical Procedures

The final decision on surgery is made only after operative examination of the biliary tract and after reconsideration of the history and of all findings. The operation should be safe and its result permanent. Whichever type of procedure is chosen, it is performed gently and cautiously, and every piece of tissue is checked carefully prior to its ligation or division.

The different types of biliary operations are described in the clinical chapters. Here we shall deal only with the general principles of suturing the bile ducts, of draining them and of draining and closing the abdominal cavity.

Suturing of Bile Ducts

In operations on the bile passages it is advisable to use, as much as possible, atraumatic sutures. Fine nonabsorbable material such as silk, nylon etc. is used for sutures tied externally. For sutures tied inside the bile duct lumen absorbable material is preferable, it must be reliable, however. New plastic fibres, Dexon and Vinycryl, are superior to chromic catgut as their strength is maintained longer, and there is much less tissue reaction around the sutures in a biliary environment. In addition, suturing and knotting is also easier as twisting is absent (Sugimachi et al., 1978).

The use of adhesive plastic material instead of sutures for joining visceral

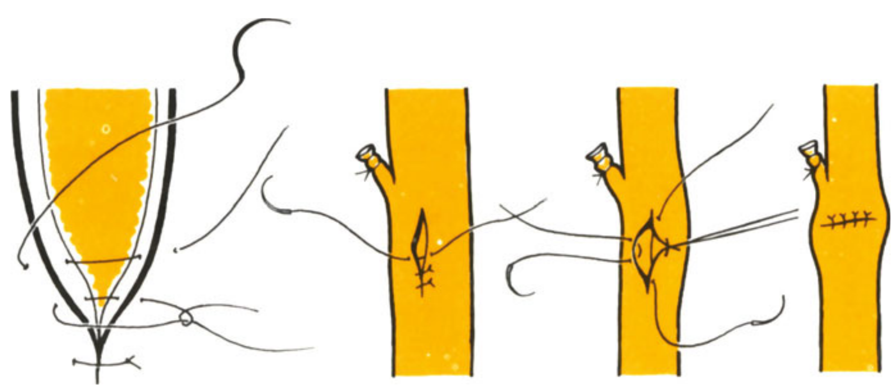


Fig. 81: Longitudinal choledochotomy suture for wide choledochus; transverse suture of the longitudinal incision for narrow choledochus.

organs, including the bile ducts, is still in an experimental stage (Vinogradov, 1974, — Théodoridès, 1974, and others).

Primary suture of the choledochotomy may be safely done only if the necessary conditions are fulfilled: completely free flow of the bile, a sufficiently wide bile duct with reliable walls, and a non-infected environment. We use atraumatic, interrupted silk, or Dexon sutures, tied externally. The interval between the single sutures is approximately 3 mm, and we try to achieve correct appositions of the edges, without inversion or eversion. The suture is peritonealized, provided that this does not compress the duct, and a tube is always placed next to it as a safe guard.

Whatever incision was used, with a dilated choledochus it is closed in its own direction. However, if the duct is narrow, we always open it longitudinally and suture it transversely, we first place sutures at the mid-points of the incision edges, then with their aid we pull them apart transversely and finish suturing in this direction. *Fig. 81.*

A divided choledochus is sutured by inverting its posterior wall and using fine chromic-catgut or Dexon. All sutures are placed first and only then knotted inside. On the contrary the anterior wall is sutured edge-to-edge with silk or other non-resorbable atraumatic sutures, which we knot outside. *Fig. 82.*

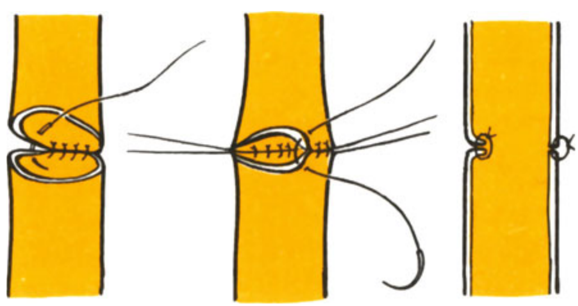


Fig. 82: End-to-end suture of the duct. Absorbable sutures on posterior circumference are tied internally, non-absorbable sutures on anterior circumference are tied externally; cross section of sutured duct.

A bilio-digestive anastomosis is closed, according to circumstances, in 1—2 layers, using a similar technique as described for the duct. For the posterior circumference non-resorbable sutures may be used, since in an anastomosis they will be eliminated through the bowel. However, even here we prefer fine plain or chromic catgut, or Dexon sutures to prevent their becoming encrusted and irritating the stoma.

Drainage of the Gallbladder – Cholecystostomy

The direct incision of the purulent gallbladder adhering to the abdominal wall is apparently the oldest operation on the biliary tract and has been carried out sporadically for many centuries. In the initial period of genuine biliary surgery cholecystostomy via laparotomy was also among the first operations. As early as 1879 Tait succeeded in performing the first cholecystostomy exposing the gallbladder through a laparotomy.

Nowadays cholecystostomy is used seldom and mainly as a palliative operation only. According to Welch and Malt (1972), it accounts for approximately 5% of all biliary operations. Among our 295 emergency operations we have used it in 18% of the cases, but of all our more than 7000 biliary interventions cholecystostomy accounted for only 0.2%.

Cholecystostomy, though a simple intervention in itself, is not without risk in the critical situations in which it is used. The writer agrees with Moorehead that "cholecystostomy may be as dangerous and unsuitable for the patient, as it is comfortable and easy for the surgeon", but it may also be lifesaving in cases where even simple cholecystectomy would exceed the patient's power of endurance.

It is usually an emergency or preparatory operation enforced by the patient's serious condition, and makes it possible to prepare him for the final operation.

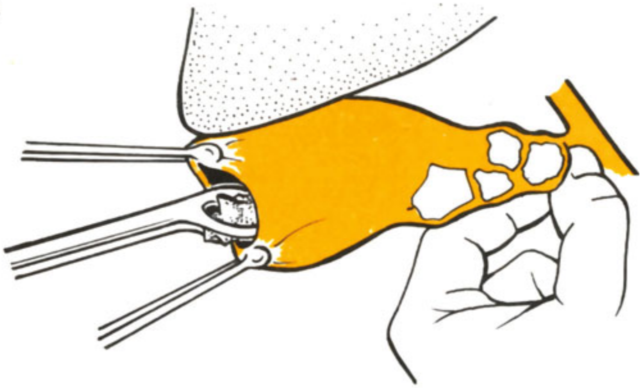
Indications

- Emergency drainage of a purulent or necrotizing gallbladder which threatens to perforate, but only if acute cholecystectomy would be extraordinarily risky.[72]
- Drainage of a sclerotic gallbladder remnant, which cannot be removed without risk.
- To drain off bile in advanced jaundice in a very ill patient, if drainage of the choledochus is difficult.
- As a preparation for pancreato-duodenectomy in patients with severe jaundice.

Technique of cholecystostomy

If the gallbladder is on the point of perforating, a longitudinal incision is made directly over the distended gallbladder. Adhesions are not separated. The gallbladder is punctured with a trocar or a very widebore needle, the opening enlarged and all contents, including stones, removed by suction, under digital control if necessary. *Fig. 83.* One should not lose time by extracting impacted stones in the cystic duct. The gallbladder with the remaining stones will be removed at a second-stage operation. A sample of bile is sent for culture and a tube inserted into the gallbladder, which has been rinsed with an antibiotic solution. We prefer to use a Pezzer catheter 6—8 mm in diameter after having cut off part of its cap. The edges of the gallbladder are inverted around the tube by 1–2 circular chromic-catgut sutures, which should also include the parietal peritoneum. If the gallbladder

Fig. 83ab: Cholecystostomy. (a) Gallbladder puncture aspiration, (b) extraction of stones.



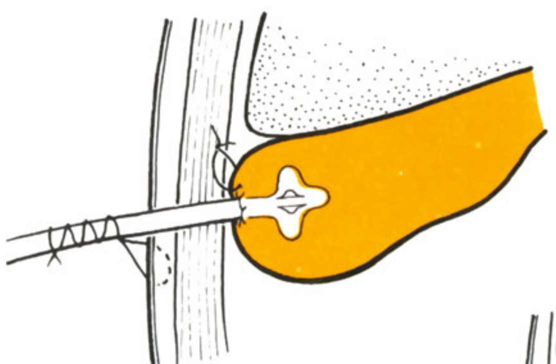
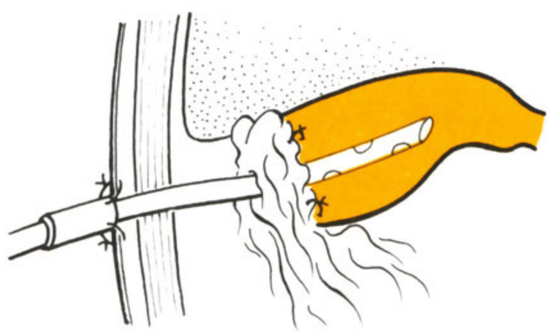


Fig. 84ab: Cholecystostomy. (a) Insertion of Malecot catheter and gallbladder suture to abdominal wall; (b) gallbladder covered by omentum.



does not adhere to it closely, we cover it with omentum perforated by the drain. The peritoneum together with the fascia is then closed round the tube with a few stitches and the anterior fascia together with the skin is secured with widely placed sutures as a second layer. The tube is fixed with a cuff and anchored in the suture. *Fig. 84.* The operation can sometimes be performed entirely under local anaesthesia.

If cholecystostomy is decided upon as a first preparatory step for later second stage pancreato-duodenectomy, the tube is brought out by the shortest route through a separate incision in the abdominal wall.

Management and closure of the cholecystostomy are dealt with on p. 151.

Drainage of Bile Ducts – Choledochostomy

External drainage of a bile duct is practically always temporary, whether done for decompression, drainage, intubation or other purpose. Only exceptionally it is permanent providing relief to some jaundiced patients with inoperable tumours until death supervenes.

The tube is passed into the main bile duct through the cystic duct stump or through a supraduodenal choledochotomy and rarely through the hepatic duct. In some special cases of obstructive jaundice transhepatic insertion into the biliary tree may be done following percutaneous puncture cholangiography. — Usually a T-tube is inserted into the common duct, but sometimes a straight or special tube is used. As a rule the tube is brought out by the shortest route, through a separate incision or through the laparotomy incision. If it passes transhepatically, an ancillary abdominal incision is used.

There are great differences between surgeons as far as drainage of the bile ducts, most frequently choledochostomy, is concerned. Some use it to conclude almost any operation on the common bile duct and the papilla, others favour primary suture and drain the duct only if this is unavoidable. Much depends on the operating surgeon's personal experience and on the profile of patients with which he has to deal. No exact and generally valid indications can be given.

Drainage of the choledochus is usually only a supplement and a safety measure in some biliary operations:

- We use it always in patients with advanced jaundice, or for quick decompression and draining bile in septic cholangitis or in acute duct obstruction associated with shock.

- Drainage is likewise useful after complicated manipulations in the region of the sphincter of Oddi for the prevention of transient hypertension.

- Drainage is also advised in acute biliary pancreatitis or if the choledochus is compressed by the chronically inflamed pancreas.

- Drainage plays an important role in cholangitis, where it may be utilized for therapeutic lavage.
- Sometimes it is used to protect the suture line or damaged bile duct against leakage of bile.
- A tube is also left in the choledochus if one is not sure whether all stones have been removed from the bile passages, and it then may be used for their extraction.
- An evident advantage of the drain is the possibility of direct postoperative radiological check-up.
- Finally, there are special and indisputable indications for intubation drainage for inoperable tumour stenoses or for recurrent benign strictures of biliary anastomoses in the porta hepatis.

T - tube drainage

The classical method of drainage consists of the insertion of a Kehr's T-tube into the common bile duct through a choledochotomy or a cysticus stump.

If the choledochus has not yet been opened during the operation, its peritoneal covering is carefully incised and stripped a little from the site of the proposed

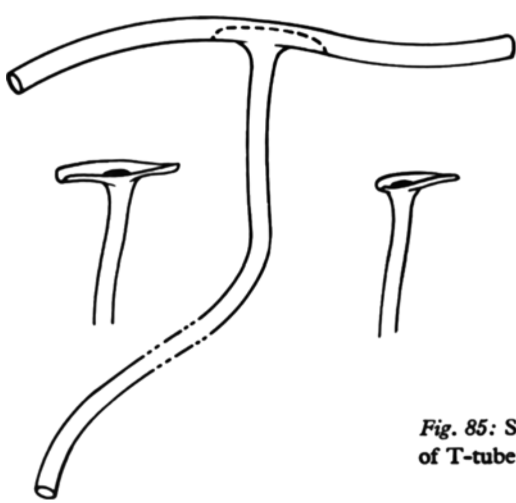


Fig. 85: **Shallow groove adaptation of T-tube or L-pattern.**

choledochotomy. The duct may be aspirated with a fine needle to confirm its identity and to lower the bile pressure if necessary. The longitudinal incision of the duct is performed in the fashion as has been already described (p. 128) and the escaping bile is continually aspirated.

The thickness of the tube is chosen to fit the bile duct loosely and preserve the patency of the duct. The lumen of the tube is usually about 3–4 mm. Its transverse branch is usually cut open to form a shallow groove with short wings, only about 5–10 mm in length. These closely trimmed intraductal limbs are simple to introduce, prevent the tube from sliding out and do not encroach upon the lumen of the duct, and later facilitate the removal of the tube. *Fig. 85.* If the incision is short, the T-tube is inserted by lifting the edges of the incision and passing first the lower, then the upper wing. Sometimes we give it the correct direction by introducing a curved, slightly opened haemostat, to obviate penetration of the tube falsely underneath the thickened peritoneal covering of the duct. Finally, we always palpate to make sure that both wings of the tube are correctly placed and are not bent. *Fig. 86.*

The T-tube is well fastened in the incision with atraumatic sutures. The suture which is nearest to the tube should be of catgut, so that the tube may later be pulled out without any difficulty. By injecting physiological saline with antibiotics

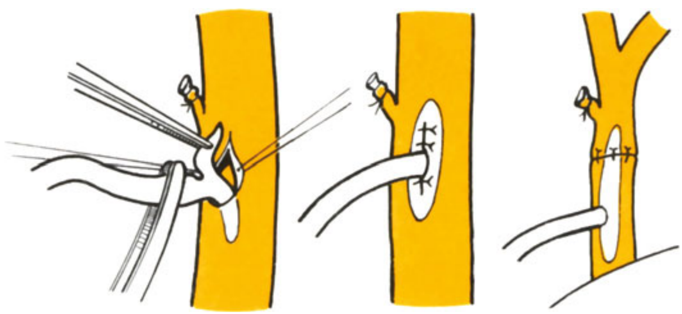


Fig. 86: Insertion of T-tube into choledochotomy; its longitudinal suture; its transverse suture if the duct is narrow; T-tube positioned in the duct at a distance from its suture.

one can check the tightness of the suture which may also be covered with peritoneum, as long as this does not compress the duct. The T-tube should emerge from the bile duct at right angles and pass to the abdominal wall unbent, loosely, so that it is not strained by respiratory movements. It is tied securely into the skin suture, but some free play is permitted.

The T-tube is sometimes used to protect the suture line of the bile duct or its anastomosis. In this case it is always inserted through a separate stab incision. Its wing can pass along the suture, but quite loosely. The point of such a drainage is not to "model" the anastomosis, but to protect the sutures from possible bile pressure.

Through a wide cystic duct stump the T-tube can be introduced in a similar way as through the choledochotomy. We have found it preferable to cut it into an L-shape, since it is thus easier to introduce, and one short wing is enough to prevent it from sliding out. *Fig. 87.*

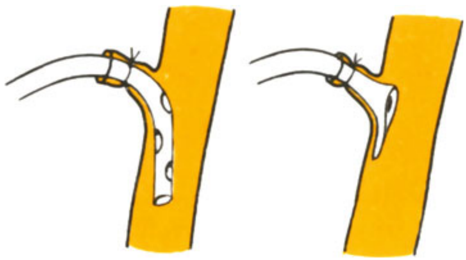


Fig. 87: Common bile duct drainage via cysticus; by means of L-drain.

If the cystic duct is narrow, only a straight soft tube is passed as a safety drain into which holes have been cut near the end and at the sides. Its internal diameter should be at least 3 mm, and it should reach deeper into the choledochus but not as far as the papilla. Mallet-Guy, 1977, recommends for such a transcystic drainage "à minima" a child-size Nélaton catheter. It should be well tied into the stump of the cystic duct, so that it does not come out prematurely.

When a high anastomosis is carried out, a decompressing tube may be passed

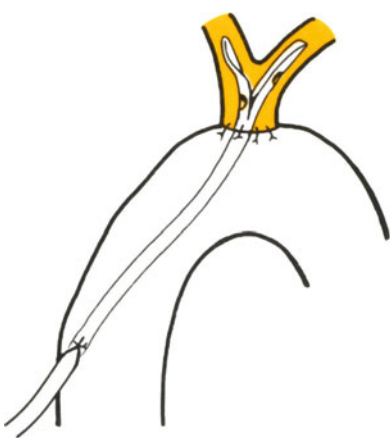


Fig. 88: Tube introduced through the anastomosis into the hepatic ducts, its lower end brought outside through the intestine.

through the intestine so as to reach the hepatic duct through the stoma. Usually a straight tube is used, which is brought out from the intestine by Witzel's method. *Fig. 88.* Only exceptionally do we leave it as a buried tube fixed with catgut to the intestine so that after a short time it is eliminated spontaneously. One

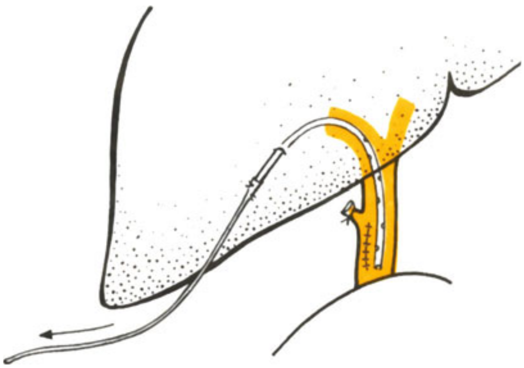
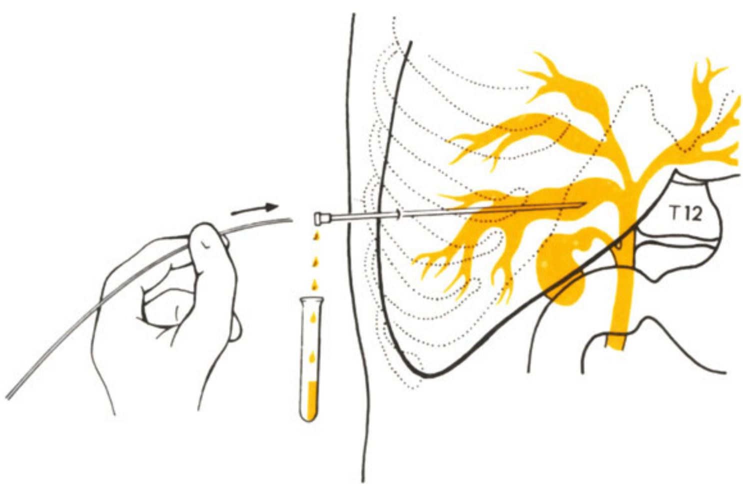


Fig. 89: Transhepatic drainage of the main bile duct.

also may insert a long transverse arm of a T-tube into the anastomosis, the other arm being cut short and the main tube brought out through the intestine. All these drainage tubes are removed early, after 7–10 days, but if the anastomosis is wide and well sutured they are quite unnecessary. — It is sometimes beneficial or even necessary when draining the main bile duct to bring out the tube through the



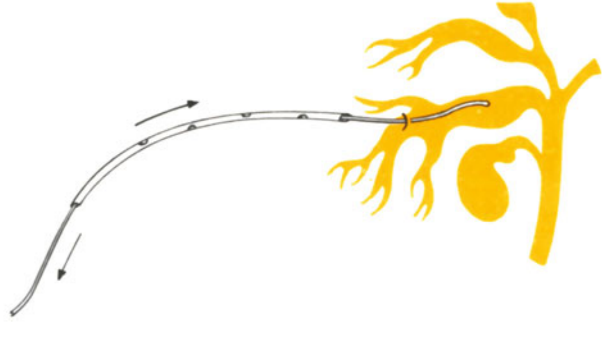


Fig. 90ab: Percutaneous cholangiography followed by drainage for decompression of obstructive jaundice. (a) Percutaneous transhepatic needling of the dilated bile tree, (b) plastic catheter introduced over a guide-wire.

liver. The tube is pushed through the liver parenchyma and brought out of the abdomen via an auxiliary stab incision. Its other, lower end reaches into the common bile duct or through the anastomosis, into the connected part of the intestine and, as a rule, is brought through its wall out of the abdomen (Milonov, 1973). *Fig.89.*— In some cases of obstructive jaundice submitted to percutaneous transhepatic cholangiography a polyethylene catheter, 1,5 mm internal diameter, may be slipped over the needle or a flexible guide-wire into the dilated intrahepatic ducts and left for decompression of jaundice, preparatory to surgery.[11, 65, 69] *Fig. 90.*

Transpapillary drainage

This safeguards the patency of the papilla after its dilatation or after sphincterotomy, and its protagonists leave it in position for 1–2 weeks. One transverse arm of the T-tube is left long and passed through the papilla into the duodenum. Since there is sometimes considerable loss of fluid, the tube ought to pass beyond Ochsner's sphincter as suggested by Lahey, i.e. beyond the crossing of mesenterical blood vessels with the intestine. *Fig. 91.*

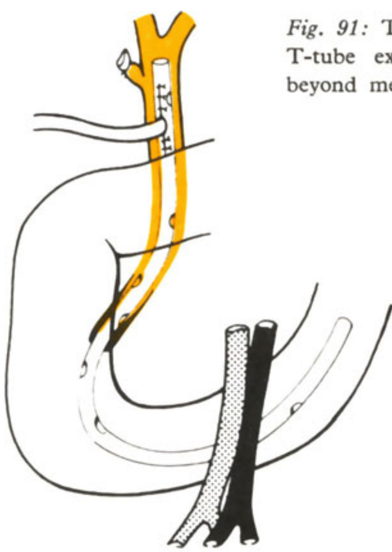


Fig. 91: Transpapillary drainage: T-tube extends into duodenum beyond mesenteric vessels.

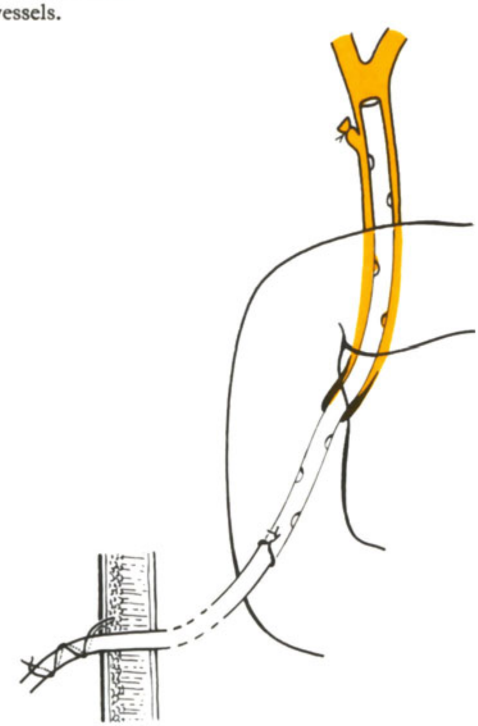


Fig. 92: Transpapillary tube is embedded in the duct and is brought out through the duodenum.

One also may, as suggested by Voelcker, pass a straight tube through the papilla, bring it out through the duodenum by Witzel's method, and then close the choledochotomy. The tube should have holes both in the choledochus and in its intestinal portion. *Fig. 92.* This transpapillary drainage ought to protect against transient blockage of the papilla and against recurrence of stenosis, but may itself cause acute pancreatitis. Therefore it is rejected by many surgeons, and we ourselves, regard it as unnecessary and often harmful.

Intubation drainage

The object of intubation is the dilatation of an inoperable neoplastic or sclerotic bile duct stenosis and to provide bile drainage from the dilated intrahepatic ducts. The stenosis is penetrated with a semi-rigid catheter, or a suitable hemostat, and gradually dilated. A rigid non-corroding tube is inserted reaching beyond the stenosis. Its lower end is brought out through the common duct or through the anastomosis and its adjoining intestinal loop out of the abdomen. This facilitates lavage as well as radiological control, and it may be removed whenever desired, though never replaced by a new one.

Long-term intubation is now increasingly used in reoperation for cicatrical stricture of entero-biliary anastomosis in the porta hepatis. The indwelling drain must be left in situ for many months or even years in cases of old recurrent strictures. In view of the fact that drains become blocked in all long-term intubations, a special type of endless transhepatic U-tube must be used, which can not only be irrigated easily, but can also be replaced without risk at any time (Galperin a. Kuzovlev, Saypol a. Courian, Smith, Ströcker, Niederle ao.). It is passed through the stricture so that both ends are brought out of the abdomen — the upper one through the liver, the lower via the anastomosis and intestine. Its, quite negligible, drawback is that it damages some of the parenchyma and at the point wheıe it leaves the liver adhesions are caused which can be sometimes painful.

Technique of U-drainage

The narrow, or even obliterated stoma, is penetrated with a slim hemostat and cautiously dilated with probes to a diameter of approximately 7 mm. It is then intubated with a tube made of plastic, non-corroding material, which neither hardens or softens in the bile duct.

From the cholangiogram and by probing a duct is chosen through which one can penetrate as near as possible to the surface of the liver in its accessible anterior part. A suitably curved pointed haemostat, a semi-rigid catheter, probe or cannula is inserted through the stenosis into the chosen dilated intrahepatic duct. After introduction the instrument is pushed through the liver parenchyma, as a rule

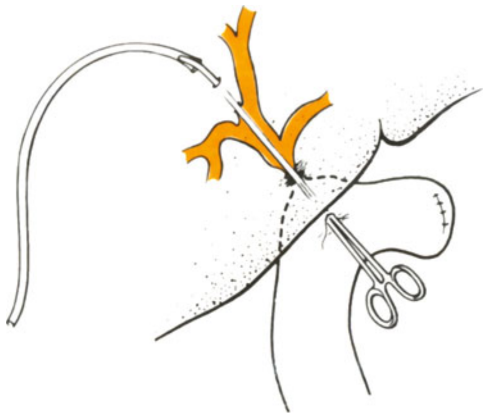


Fig. 93: Transhepatic drain pulled through the hilar stricture by means of a long pointed hemostat.

on the superior surface of the right or left lobe. The parenchymatous layer is usually thin since the dilated duct is near the surface. The prepared modelling tube or, what is even better, first an auxiliary thin catheter or drainage tube is then pulled through either from below or from above; with the aid of the latter the intubating tube is pulled through the liver. *Fig. 93, 94.*

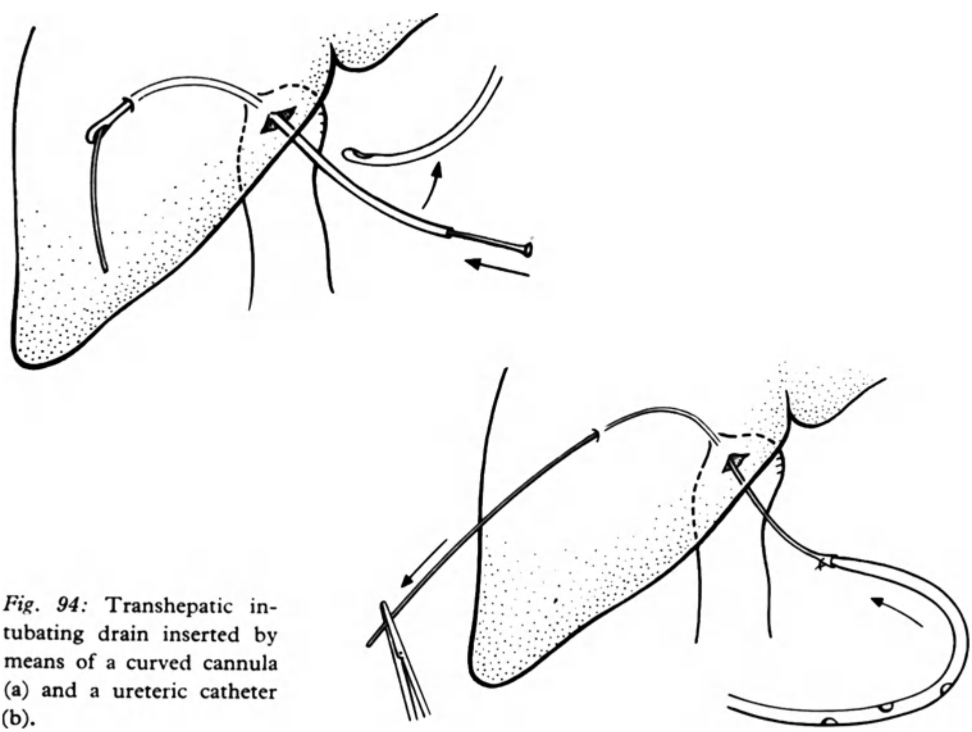


Fig. 94: Transhepatic intubating drain inserted by means of a curved cannula (a) and a ureteric catheter (b).

Prior to its insertion the tube is provided with a number of holes at 10—15 mm intervals, which come to lie above and below the stenotic stoma. They should not be so large or at such a distance from each other as to lead to kinking of the tube. Both ends of the endless tube are brought out through the abdominal wall via separate stab incisions, secured against displacement by cuffs sutured to the skin and drained into a plastic bag. *Fig. 95.*

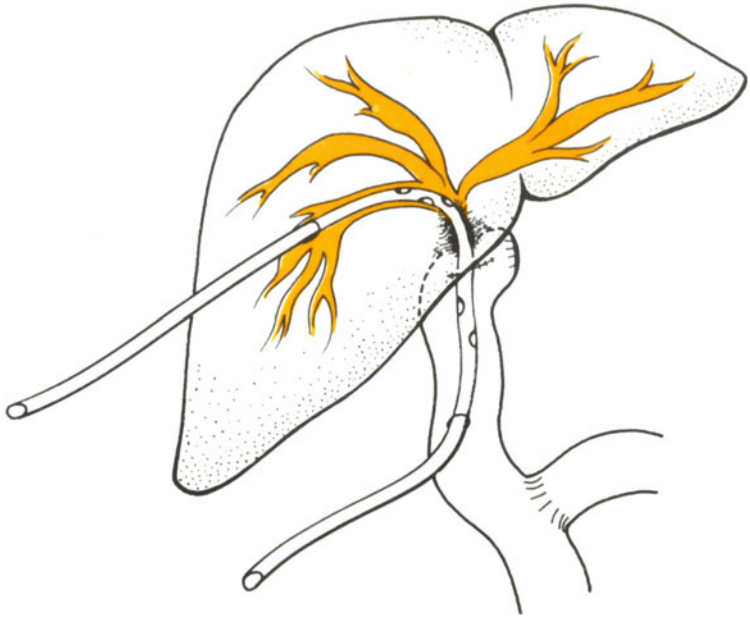


Fig. 95: Transhepatic drain intubating tight anastomosis and brought out through liver as well as gut as endless U-drain.

One also may drain the bile separately from both liver lobes with two tubes if both narrowed branches of the hepatic duct have to be intubated (Praderi, 1974).

Naturally, such U-drains can also be used for intubating tumorous stenoses. On the other hand, a primary anastomosis for a benign lesion would thus only be needlessly complicated (Aust, Lindenauer).

Endoprosthesis

Buried prostheses, which at one time were recommended for substituting a defect of the bile duct, have been abandoned. New alloplastic and biological grafts are under trial, but none have so far been found satisfactory.[28] The prostheses migrate or are expelled, some corrode, and all obstruct. Sooner or later, even after many years, they cause intermittent obstruction and cholangitis requiring re-operation.

Buried drains, especially if made of rubber, should not be left in the bile ducts unnecessarily, even temporarily. If such a tube soon loosens, it is usually unnecessary and if it remains in place, it becomes blocked or incrusted, and may even disintegrate.

Drainage and Closure of the Abdomen

In operations on the biliary tract it is always safer to drain the abdominal cavity. There are sometimes septic conditions and blood may ooze, but mainly one cannot be sure if bile leakage will not occur. The advantage of a safety drain exceeds its drawbacks; nevertheless, one may refrain from using it in certain well chosen cases, where justified by experience.[25, 37] This is mainly the case after simple cholecystectomy for uncomplicated disease of the gallbladder, where drainage really is not particularly important (Borgström, 1977, Carpenter et al., 1978). We refrained from it in 1/4 of simple cholecystectomies, and Ross and Quinlan, 1975, left 70% of such cases without drainage. However, in general, we would not dare advise closing the abdomen without drainage after every simple cholecystectomy. Even after such an operation there is increased secretion in approximately 2–6%, and these patients, without a drain, might be in some danger.[40, 52, 70] Even after an apparently simple operation we drain without exception, if there is acute inflammation, if the common bile duct has been entered, or even if satisfactory closure of the gallbladder bed could not be accomplished.

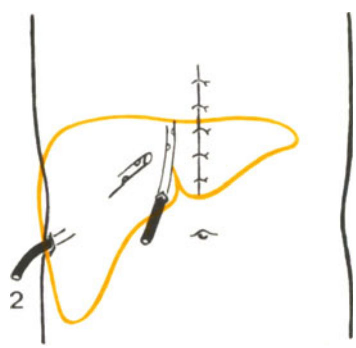


Fig. 96: Subhepatic drain brought out through a stab incision or dependently.

The subhepatic drain is placed, after cholecystectomy close to the gallbladder bed and lies, as a rule, in the notch for the ligamentum teres in the liver edge. In other cases, of course, we choose the mode of intubation according to situation and purpose. We use only tube drains, mostly of silicone or polystyrene.[40, 54] Rubber drains irritate much more and readily produce adhesions; however, this may sometimes be desirable. The drain should be brought out of the abdomen by the shortest route, either through a separate incision or through the laparotomy, or as a lowest point drainage after Morrison. *Fig. 96.*

A separate drainage does not irritate or weaken the laparotomy wound, but its course through the wall sometimes becomes kinked, and it cannot be replaced as easily as the tube through the wound, where the secretions also tend to break through spontaneously (Champeau, Pineau and Léger). We counter the drawbacks of Morrison's and of direct drainage by the regular use of the abdominal types of Redon's suction drains.[26, 49] We try to obtain an impression of their position and course in the abdominal cavity after closure of the wound, so that they will not be displaced or compressed by the abdominal wall. The drainage tubes are tied securely into the skin suture.

Closure of the abdominal cavity: The abdominal wall is sutured in layers and the fascia adapted as meticulously as the skin. This is especially necessary in the case of a midline incision, where many a diastasis or hernia has resulted

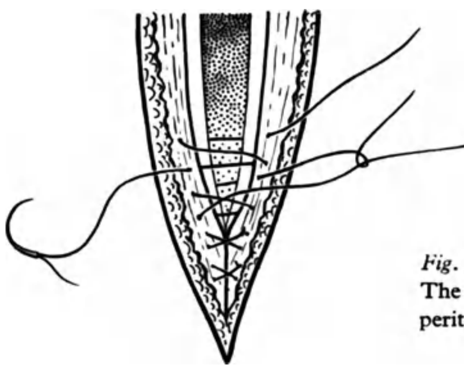


Fig. 97: Cross stitch of wound. The first loop includes fascia and peritoneum, the second only fascia.

from inaccurate suture of the linea alba. If the wound is under much tension, the fascia may be sutured by Smed-Jones cross stitches. The first stitch takes in the fascia and peritoneum, the second the fascia only. *Fig. 97.*

Healing of the wound may be endangered by extravasation or infection, which may be partly countered by subcutaneous Redon suction drains, but mainly by a good operative technique. One should not rely on antibiotics.

Postoperative Management

Hospital Care and Control Radiology

All patients should be treated in the intensive care ward for the first postoperative days. This measure produces a material reduction of biliary surgery hazard, particularly in elderly persons.[18, 31, 46] Treatment there can be prolonged as required, especially in cases whose condition was already serious before operation, or following exacting interventions or in the presence of complications, particularly if failure of vitally important organs threatens.

Operation cases must not only be continuously observed after operation, but an active lookout must be kept for the possible first signs of postoperative complications. As with all abdominal operations, adequate respiration must be ensured, oral hygiene attended to and intestinal peristalsis observed. Limb exercises are encouraged from the very beginning. Early rising has its known advantages, but the speed of resuming activity depends on the patient's general condition and the type of surgery he has undergone.

The duration of parenteral nutrition is shortened to the essential period and right from the first days a light, individually adjusted diet is introduced for most patients. Infusions are only continued in complicated cases, according to requirements for several days, but overdosage and too rapid infusions must be avoided, as these are particularly dangerous in the aged. Major losses of bile are assessed as identical amounts of plasma without proteins, and they are made up by 2/3 physiological saline and 1/3 molar lactate solution, with the addition of calcium according to values estimated. In cases in which excessive bile loss cannot be controlled by adjustment of drainage and is continued for a prolonged period, bile can be collected under sterile conditions and returned to the gut by a nasogastric tube.

Antibiotics are not administered routinely, but treatment is continued where for valid reasons it was already started before surgery, or where its necessity for it was revealed at operation. They are also started if complications threaten which require this therapy.

Management and closure of the cholecystostomy

The management of the cholecystostomy is simple: the surrounding skin is covered with a protective ointment and the tube is allowed to drain into a sterile bag with disinfectant solution. After an emergency operation it first drains pus or turbid bile, which is repeatedly sent for bacteriological examination.

The drain is never removed without having been utilized for fistulography, i.e. cholecysto-cholangiography. This can usually be carried out soon after the inflammation has abated and the patient has recovered. Sometimes only the gall-

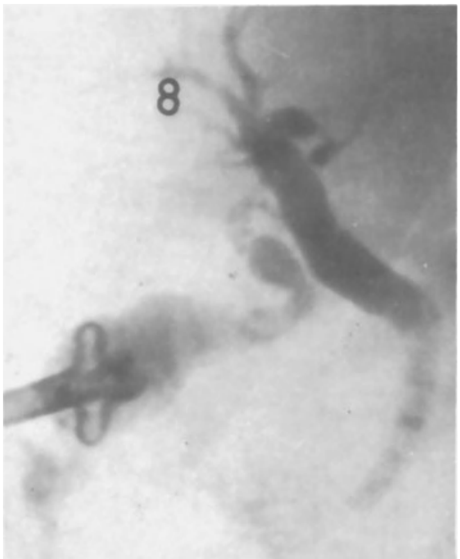


Fig. 98: Fistulography after cholecystostomy reveals multiple cholecysto- and choledocholithiasis.

bladder fills while in other cases the ducts are also visualized, or there may be evidence of stones or a stenosis. *Fig. 98.*

Cholecystectomy, supplemented, if necessary, by an operation on the main bile duct or the papilla, is usually carried out 2–4 weeks after the cholecystostomy. When there is an obstruction in the ducts, the drain is left till the second operation, otherwise, if the bile duct is patent, it may be removed unless it is expelled spontaneously. The fistula usually closes of its own accord and if one waits until the tissue reaction has subsided, the operation will be clean and easier. Even if radiological control shows the gallbladder to be without stones and the bile duct patent, subsequent cholecystectomy is indicated. However, it may sometimes be dispensed with, especially in old debilitated people if the fistula does not reopen and if there are no symptoms after its closure.

Closure of the cholecystostomy and cholecystectomy is performed by circumcising the scar or the fistula with the drainage tube to permit entry to the free abdominal cavity. For disengaging the gallbladder from adhesions, digital control is sometimes advisable; one must not overlook stones which might have migrated into the vicinity. If preoperative films indicate this, the operation is extended to the ducts and the wound is, of course, always drained.

If only a gallbladder remnant has been drained, it is sufficient to reduce the tube size gradually as secretion diminishes. The fistula will close spontaneously but naturally only if the bile can flow freely into the intestine.

If the cholecystostomy was performed as a preparatory step prior to duodeno-pancreatic resection one should wait for the jaundice to subside

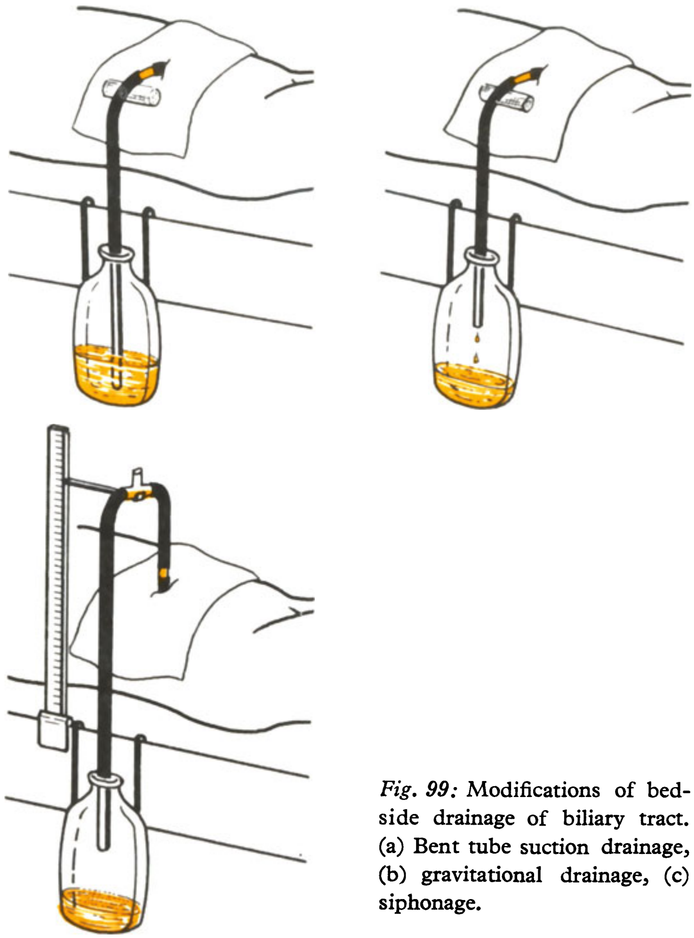


Fig. 99: Modifications of bed-side drainage of biliary tract. (a) Bent tube suction drainage, (b) gravitational drainage, (c) siphonage.

and the patient to recover. The interval is used for a thorough check-up and for intensive preparation. The radical operation is performed after 1–2 weeks, cholecystectomy included.

Management of drainage of the bile ducst

At the bedside, the drainage tube may be arranged in different ways. *Fig. 99.*

1) If the choledochus tube is made to drain into a sterile bag beneath the

level of the disinfectant solution, it acts by siphonage and the force of suction depends on the level at which the collecting bag is suspended. It equals the distance, in centimeters of water, between the water level in the bag and the height of the choledochus, which is in the middle of the side of the patient as he lies.
2) If the tube hangs freely in the bag above the fluid level, air may enter and the bile will flow only every now and then by the force of gravity according to the pressure in the bile duct.
3) The drainage can also be arranged as a siphon in which the bile flows only when its pressure in the duct reaches the desired level. It is adjusted by elevating a bend of the tube above the level of the choledochus. When the bile reaches the height of the bend, it overflows into the container, but there is no suction, because air can enter through a side opening at the top of the bend. This is usually placed 15 cm above the level of the choledochus, so that the bile overflows only when it exceeds the "opening" pressure (Bekier, 1972).
4) In exceptional cases the tube may be connected to a lowpressure suction pump.

The quantity of drained bile should be measured daily and, if necessary, examined bacteriologically and biochemically. For the first few days, the bile flows beneath the fluid level or by the force of gravity, later, after approximately one week, the container is elevated or the tube intermittently closed during the day. At that time the changes which impede the flow of bile, and also the sequelae of stagnation should have subsided. This is determined not only by what the patient feels, but the flow of bile can be checked exactly by cholangiometry.

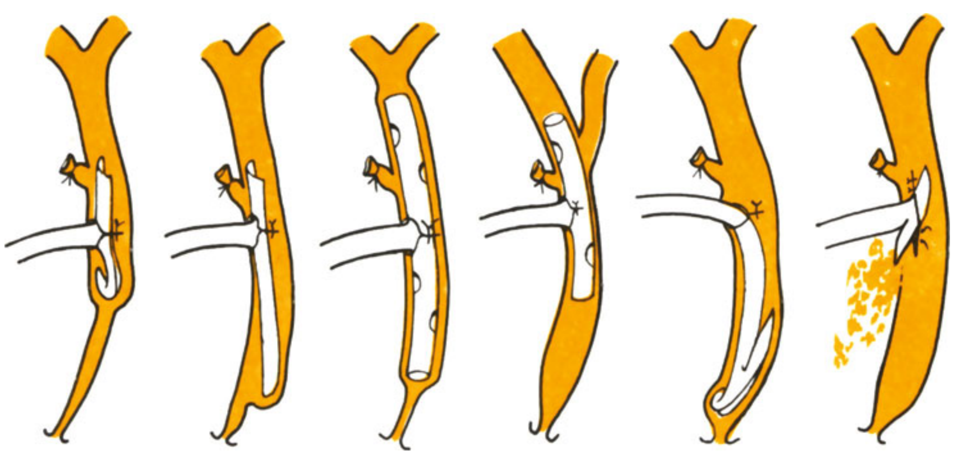


Fig. 100: Interference with choledochus drainage. (a) The tube is bent over, (b) wedged, (c) cramped in the duct, (d) blocking one hepatic duct, (e) inserted too far, (f) slipped out of the choledochotomy.

Disorders of drainage: Sometimes it may be happen that the tube also drains pancreatic or duodenal juice which occurs especially in the case of transpapillary drainage. Suspicion is aroused if the amount of fluid exceeds half a litre, and if it is of light colour or turbid. Such losses are not indifferent and the suction force of the tube should be reduced immediately, or the tube should be closed or removed if further drainage of bile is no longer necessary.

In other cases on the contrary the tube drains insufficiently because it is blocked, pressed against the wall, or bent within the duct. Sometimes the sutures securing it in the duct loosen, or the T-tube or its arm slides out of the duct and bile starts to flow from the subhepatic drain or to soak through the bandages. Less frequently the bile may also leak into the abdominal cavity. One should immediately make sure whether the tube is patent by washing it through, and increase suction force. At the same time the subhepatic drain should also be connected to suction to keep the bandage dry. If the bile escapes only round the loosened tube, this will cease within a few days and the T-tube will again drain all the bile. *Fig. 100.*

If it is not certain where the fault is, this can be ascertained by injecting a small amount of radioopaque material through the drainage tube. If the tube is found to have come out of the choledochus, it is removed immediately and replaced by an ordinary suction tube.

If, after closing the tube, everything is found in order and the bile flows is unimpeded, the tube may be removed usually on the 9th postoperative day. However, before removal it should in any case be used for postoperative cholangiographic control.

Postoperative cholangiography and cholangiometry

A temporary external drainage of the main bile duct was used for contrast filling and radiological examination for the first time as early as 1930 (Gabriel). After the place of iodized oils was taken by aqueous contrast media, postoperative cholangiography became the decisive method for controlling the results of operations on the bile ducts.[35] The examination, which is not very exacting for the patient, is carried out in the X-ray department with the use of powerful apparatus and further technical devices, such as intensifier, fluoroscopic monitoring, videorecording, radiocinematography and rapid seriography. Since the concomitant manometry and debimetry are also easy to perform, postoperative cholangiography has nowadays, from a radiodiagnostic point of view, the best technical conditions of all the methods using direct contrast filling of the bile ducts, and has recently also come to be used for the nonsurgical removal of residual stones.

For cholangiography combined with manodebimetry the patient is placed in the supine position on an inclinable table. The draining arm of the T-tube is connected to a simple water manometer with a three-way cock and the residual pressure measured from the level of the middle portion of the choledochus. *Fig. 101.* With the aid of the three-way cock the warm contrast material (30% Verografin) is

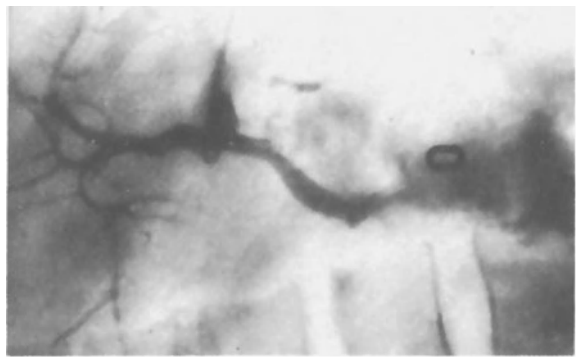


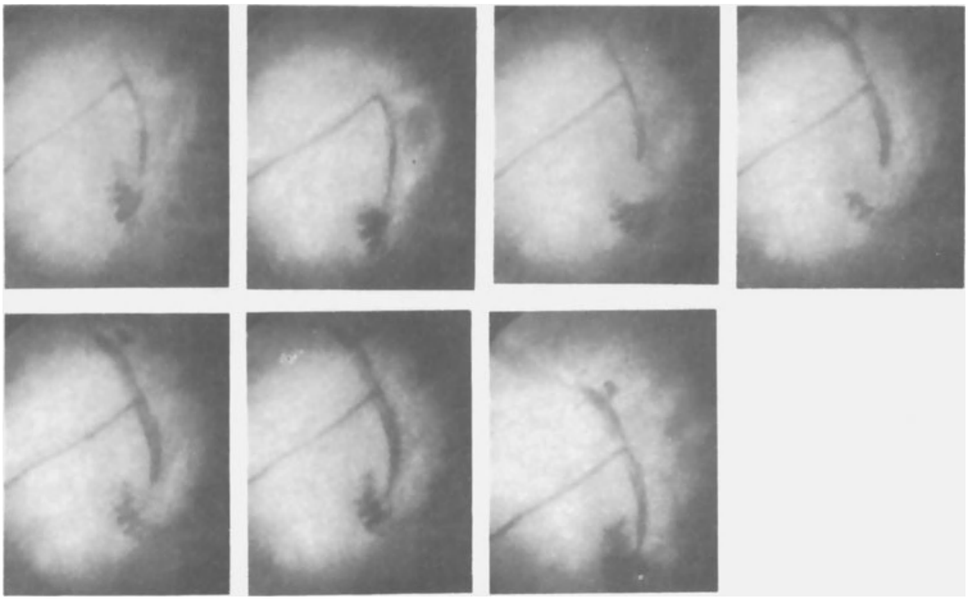
Fig. 101 ab: Postoperative cholangiography: (a) Anterior-posterior projection, (b) lateral projection in patient in the supine position. The film shows the normal arching of the common bile duct ventrally; the left hepatic duct and its branches also are directed forward.

injected slowly in fractions, and spot radiographs are taken at suitable moments under fluoroscopic control, using a television monitor. Towards the end of the examination, pictures are also taken routinely with the patient in the vertical position. The patient is then turned back into the horizontal position and the flow measured three times with warm physiological saline at a pressure of 30 cm H_2O, and subsequently the residual pressure is also measured.

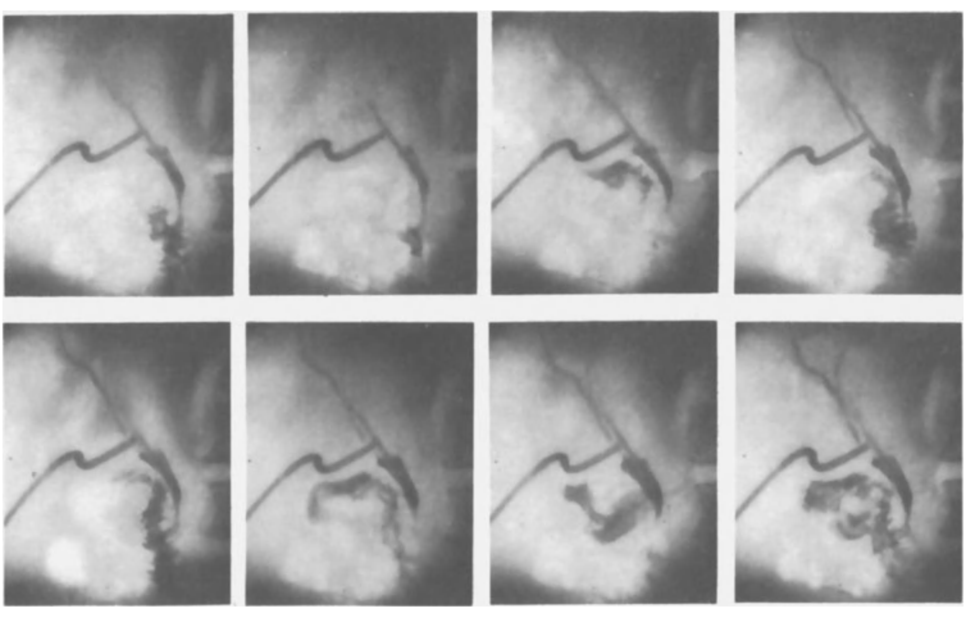
For a more detailed documentation of the bile duct dynamics, especially the region of the terminal choledochus it is quickest, from an operational point of view, and best, with a view to the requirements of radiation hygiene, to use magnetic television recording (videorecording). The stationary phase is easier to evaluate from cinecholangiographic stills on a 35 mm film taken at a rate of 16–24 shots per second. An even better evaluation of the anatomical details of the different dynamic phases is possible with rapid seriocholangiography with a spotcamera on a 70 mm or 100 mm film. Details become distinguishable so that in cholangiography the usual large-size films can be dispensed with. *Fig. 102.*

At present, the combination of indirect radiography and small-size seriography with fluoroscopic monitoring and magnetic videorecording may be regarded as most satisfactory from all angles of view.

Fig. 102: Cyclical alternation of contraction and relaxation phases of sphincter of Oddi documented cinematographically (a), and seriographically (b).



(a) Films selected at 1 second intervals. (Taken during the postoperative period following cholecystectomy and revision of biliary tract.)



(b) Amplified seriograms taken at intervals of 1 to 1.5 seconds.

Evaluation of the results of postoperative cholangiography

Simple postoperative cholangiography with concomitant fluoroscopic monitoring will, in most cases, suffice to fulfil the main requirements: verification of the anatomical situation in the biliary system and exclusion of the presence of retained stones, strictures or other pathological changes, which might have developed in the meantime.

Fig. 103ab: Postoperative cholangiography (following CHE and the extraction of 16 calculi from the bile ducts) reveals 2 residual stones. They are shown at the junction of the hepatic ducts on the film taken in the supine position (a); on the film taken in the erect position they have dropped to the level of the upper T-tube wing (b).

Good-quality radiographs taken in different projections allow for a satisfactory assessment of the course, outlines and width of the contrast-filled bile ducts. In order to distinguish gas bubbles from non-contrasting stones, positional manoeuvres will be found useful and in particular radiographs taken in the vertical position after partial elimination of the contrast material. *Fig. 103.* However, it should be kept in mind that, despite all technical advantages, even postoperative cholangiography is not entirely protective against the possibility that retained stones may be overlooked in a too massive filling or if they are hidden in the intrahepatic branches or in the stump of the cystic duct. Therefore, if there is the slightest suspicion of residual lithiasis, cholangiographic control, directed at the suspected area, should be repeated.

Assessment of papillary function and radiographic recording of the relaxing phase

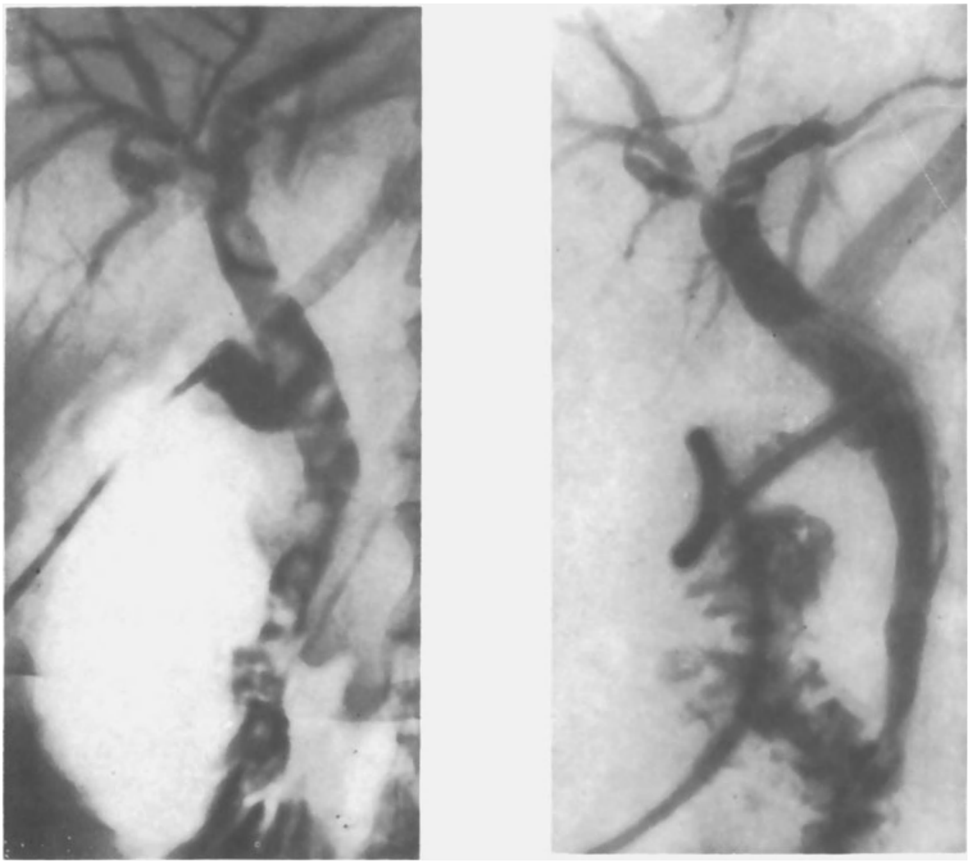


Fig. 104ab: Primary operative cholangiogram (a) shows the main bile duct packed with stones. Postoperative check cholangiogram (b) a fortnight later reveals no residual stones; the duct dilatation persists.

of the sphincter is facilitated by fluoroscopic monitoring. The various dynamic phases of the terminal choledochus can be registered quite reliably by radiocinematography or rapid seriography alone, but in current practice these methods can, in most cases, be dispensed with. The function of the sphincter can be assessed more exactly by manodebimetry, whereby the pressure and flow conditions in the bile ducts during the postoperative stage can be examined in a gentle and simple way at the bedside.

Persisting dilatation of the hepatocholedochus need not always be a sign of a residual obstruction and of overpressure in the bile ducts. What will solve the problem in these cases, is a confrontation of the cholangiogram with the results of manodebimetry. We have found complete normalization of the width of the common bile duct in half the choledocholithiasis cases and in two thirds of the cases of papillary stenosis without choledocholithiasis. In the remaining cases the

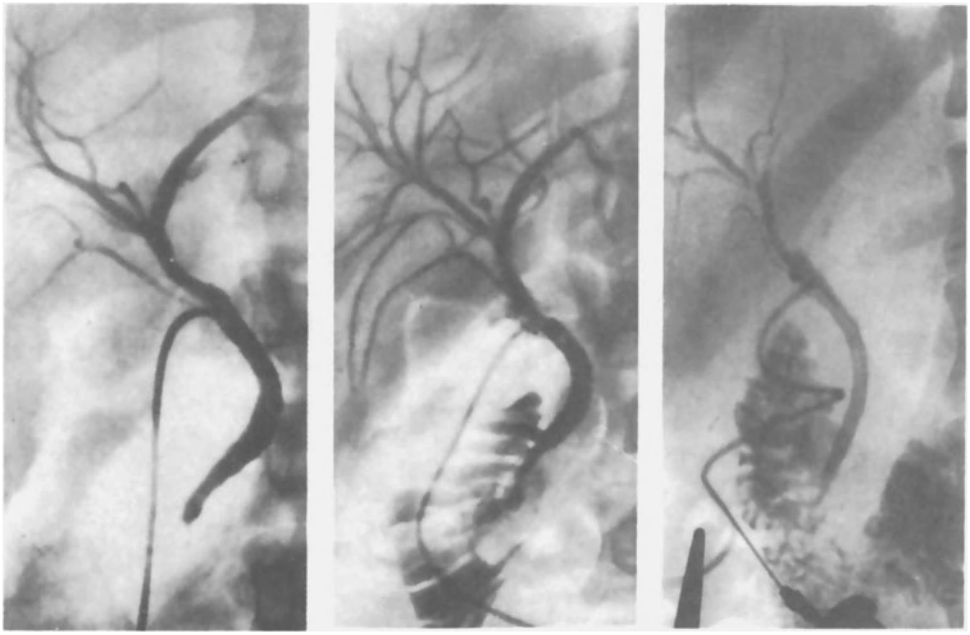


Fig. 105abc: Primary operative cholangiogram with cholangiometry reveals complete occlusion of the papilla by a small calculus (a). – Secondary cholangiography via T-tube shows pronounced papillar edema following stone extraction and instrumental exploration of the papilla; a few gas bubbles can be seen at the lower wing of the T-tube (b). – Postoperative check cholangiography a fortnight later shows a series of small gas bubbles, but an otherwise normal appearance of the junction (c).

dilatation receded only partly, in one tenth of the choledocholithiasis cases the dilatation persisted even to the same extent as during operation, although even in these cases pressure and flow became normal. *Fig. 104, 105, 106.*

Indications for, and use of postoperative cholangiography

Cholangiographic control prior to discontinuing the external drainage of the bile passages is nowadays generally regarded as a matter of course and we have not, so far, met with any contraindications. The indications for early cholangiographic controls during the first postoperative days are, to a certain extent, limited by the patient's serious general condition and the advisability of protecting him from uncalled-for transport to the X-ray department. It is performed mainly if a technical fault in the drainage of the biliary tract or any other pathological condition is suspected, which might require active surgical interference.

If radiological control shows that a stone has been left behind, or if the flow of the contrast material into the duodenum seems to be retarded, the T-tube

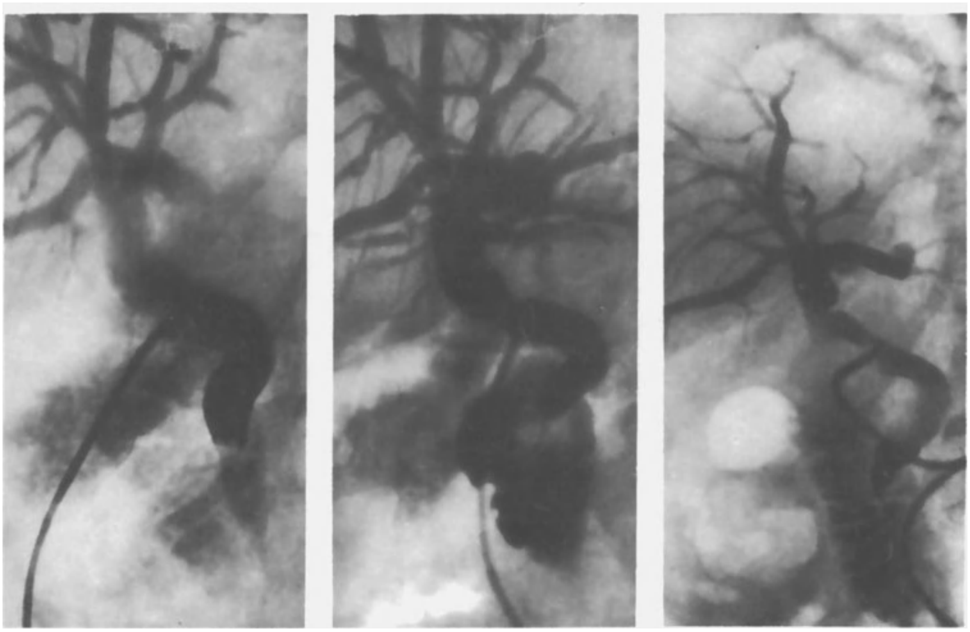


Fig. 106abc: The primary operative cholangiogram with cholangiometry shows intermittent blockage of the papilla by a smallish stone (a). – After its extraction and the forcible dilatation of the stenotic papilla by Bakeš probes secondary T-tube cholangiography shows persistent dilatation of the biliary tree and papillary edema in the shape of a circular translucency in the contrast filled duodenum surrounding the choledochus orifice (b). – Postoperative check reveals that duct dilatation has largely subsided and papillar edema is no longer visible (c).

should be left in situ, and may be used for lavage or for the removal of any residual stones. The cholangiography is repeated after a few days.

If the first or subsequent cholangiography shows normal conditions, the tube is washed through and left open till the following day, when it is removed. Its removal is usually followed by the secretion of only a few ml of bile, and if the patient keeps lying down, the wound will be dry on the following day and the patient may be discharged.

Management and replacement of the U-tube

During the first days both ends of the tube are left open, and it is washed through daily with sterile physiological saline containing neomycin. The washing-through is always performed through the upper, hepatic end. After approximately one week one starts to close the upper, and then also the lower end of the tube, and if the patient learns to wash it through himself, he may continue as an out-patient.

Sometimes signs of cholangitis appear suddenly, and in this case both ends of the tube are left open, the bile is examined bacteriologically and suitable antibiotics are added to the lavage fluid or given systemically. The attack of cholangitis usually passes quickly and the original management may be resumed.

Every drainage tube becomes choked after some time. This can be determined clinically, biochemically (bilirubin levels) and also radiologically. So far no solution is available which can dissolve the pigment deposits. Usually after 2–3 months the obstructed tube has to be replaced. Replacement is easy and the same kind of tube is used. It is first fixed to the upper, hepatic end of the U-tube, and under aseptic conditions pulled into the place of the original tube, which is removed by pulling at its lower end. The holes of the new tube should again lie at the same required level. The tube is removed definitively according to the clinical situation. The results of such a modelling drainage seem to improve the longer the tube is left in situ — for many months or years.

Management of peritoneal drains

It is preferable to draw up the subhepatic drain to lie outside the abdominal wound dressing and, even if secretion is minimal, to connect it to very slight suction. It may thus reveal any hemorrhage, extravasation of bile, pancreatic secretion, exudation, or intestinal fistula, but is not always a reliable indicator. It sometimes remains dry because it is thin, plugged, constricted or misplaced. In a suspicious case it is rinsed through, moved a little, or the adjacent suture is cut. If no secretion is present and the abdomen is quiet, the drain can usually be removed on the second or third day.

If the bile duct or the pancreas have been operated on, it is advisable to reduce the peritoneal drainage slowly and to remove the tubes later. If bile starts to be discharged through them, it is suctioned off and, what is most important, at the same time the suction effect of the T-tube is increased. Only after a few days, if one succeeds in getting all the bile to flow again permanently only through the T-tube, may the subhepatic drain be disconnected from the suction, but it is removed completely only after the T-tube has been drawn out.

Management of dressings and the wound

Dressings are changed as soon as they become saturated, otherwise on the second or third day when, as a rule, the subhepatic drain is withdrawn. Some of the skin sutures can be taken out at the same time. The rest are removed on the seventh day and the last, fixing the choledochostomy tube, are taken out at the time of its removal.

Wound healing may be interfered with by hematoma or infection whose incidence may seldom be reduced by antibiotics which, however, are always advisable in diabetics, in jaundiced patients, in cases of septic cholangitis (bile duct infection), and preferably also in elderly patients (Stone, 1977, Cox et al., 1978). Disruption of the operative wound is most likely in cachectic patients, usually after one week, when the dressing must be checked for oozing. Disruption thus may be revealed at a time when the skin suture still appears to be holding. Rapid and secure healing is assisted by adjustment of metabolic disorders, abundant caloric supply, the administration of proteins, amino-acids and ascorbic acid. Even so, it would be a mistake to assume that a scar in the absence of any complication is sufficiently firm after a fortnight. Though it is permissible to perform exercises and to submit the abdominal musculature to some work load, its definitive consolidation takes one year by all counts.

Long-term Patient Follow-up

Patients after simple cholecystectomy may, in the writer's experience, be discharged from hospital on the seventh day as a rule. Otherwise the duration of hospital stay is determined by the type of operation and the patient's condition.

After simple operations patients are kept resting at home for a fortnight, and for the first few days a somewhat stricter regimen is adhered to than was the case in hospital before discharge. Dietary restraints are gradually ralaxed during the first month. Food with a choleretic action and with excess protein should be subdivided into several daily doses. Various individual intolerances prevent the transition to a completely free diet in some patients, but many may be plagued rather by problems of excessive weight gain.

Patients after straightforward cholecystectomy do not require any medicines in this connection, and an operation wound healed by first intention does not require any abdominal belt. Systematic training of abdominal muscles can be started within a month. Work is resumed by these patients 4–6 weeks after their return home. Only if great physical effort is required or nervous strain is excessive, may this period be prolonged.

Some patients experience at first a variety of dyspeptic symptoms, and temporarily even painful episodes may occur, particularly following heavy or voluminous meals or following excitement. Sometimes a "final colic" is registered after operation, explained by the expulsion of coagula or other remnants from the bile duct. Such symptoms should not be overestimated, provided investigation reveals normal conditions in the biliary tract. There is no point in certifying such patients as unfit for work, as they have only simple mainly functional symptoms and it would tend to confirm any belief they had that a serious disorder is present or that the operation has failed. On the other hand such symptoms should not be a smoke screen for genuine organic disease of the bile duct. The latter, however, produces clinical manifestations rather from a feeling of complete health, frequently after a prolonged interval lasting for months or even years.

The after care of patients with severe forms of the primary disease, following complicated surgery and reoperations, or with complications of an internal or surgical character, particularly after pancreatitis, has to be much more cautious and differentiated. Such cases require prolonged rest, and so leave their bed later. Functional adaptation is slower in these cases and requires an individually devised dietary regime, frequently with medication. Aftertreatment at a sanatorium or spa is advisable. A yardstick for the improvement made is a gain on weight and restoration of strength.

Incapacity for work may extend to a number of months. Any complaints require careful check-up and they are taken seriously even in the absence of laboratory evidence. The emergence of hepatitis between the second and sixth month following biliary surgery must be taken into account.

A specific problem is the management of patients after surgery for neoplasm. The efficacy of cystostatics in these cases is still in doubt. A number of patients are at first improved by surgery, regardless of whether this was radical or served only to relieve jaundice. They are treated with all the required caution, but principally the same as cases of surgery for nonmalignant disorders. Return to work is permitted even after palliative operations, if the patient expresses the wish and his condition allows it.

It is not customary in our country to inform the patient about the malignant nature of his disease. If symptoms persist or reappear and the disease progresses, a common interpretation of symptoms is arranged with his family, and the most favourable conditions for what remains of his life are created.

At discharge from hospital after biliary surgery, even after simple operations, a detailed report is sent to the community physician containing information about the operation, postoperative course, and results of investigation, particularly those made before discharge. Patients submitted to complex surgery are also followed-up by the surgeon. The latter is self-evident in cases with long-term intubation, where a two stage operation is planned, or where a retained stone is known to be present. Particular attention should be devoted and checks made at suitable intervals following biliary ileus, after operative bile duct injuries, sphincterotomy or anastomoses and in patients with preceding pancreatic attacks, operations for neoplasm, etc. Participation of the surgeon both in clinical, and radiological controls benefits not only the patient, but the surgeon receives excellent instruction about the results of his work.

Some surgical cases need to be permanently followed-up. This clinic surveillance is required in cases of congenital atresia and other rare anomalies and diseases, "radically" removed neoplasms, and, of course, all cases of operated iatrogenic duct strictures and stenoses of anastomoses, which are so frequently imperilled by recurrences. If the need for reoperation arises, the right time should not be missed, and an attempt made, even at the price of repeated interventions, to reverse the fatal evolution of biliary cirrhosis.

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GALLBLADDER DISEASES AND CHOLECYSTECTOMY

Cholecystolithiasis and cholecystitis are the most common biliary tract diseases encountered in surgical practice. Despite historical evidence that the disease is a very ancient one, gallstones are more frequent in countries with an advanced civilization where their incidence in adults is estimated to amount to 20–30% (Peskin 1973). But only about one-third to one-half of cases manifest themselves by clinical symptoms.

The gallbladder is the decisive primary site for the origin of most stones and occupies a key position for the origin of chronic diseases affecting the biliary system. Cholecystolithiasis is so frequently accompanied by cholecystitis that for clinical practice gallstones and inflammation fuse into one disorder. If we sometimes find one without the other, the reason might simply be that the disease has not yet progressed in the usual fashion.

Cholecystolithiasis

Etiology and pathology

Stones of diverse types and numbers may be present in the gallbladder. Sometimes a large solitary or a few big stones are present, in other cases a group of faceted stones or a large number of concrements varying in shape and size are found, possibly also accompanied by biliary slime. Frequently only a few small stones are present, floating in the bile or lying on the gallbladder wall, these may be palpated only with difficulty.

Stones containing chiefly cholesterol develop by conglomeration of crystals precipitated from oversaturated bile (p. 49), whereas pigment stones develop after deconjugation of bilirubin. However, mixed gallstones are most common. These are radio-opaque if containing a larger amount of calcium salts. It is not clear why their composition differs and they need not be identical even in the selfsame gallbladder. Sometimes several "generations" of stones are found obviously formed under differing conditions. Likewise we ignore the reason why sometimes a solitary cholesterol stone is formed, sometimes multiple mixed stones.

Lithiasis in children may be connected with some hemolytic disease as congenital hemolytic jaundice or spherocytosis.

Some hormonal influences and age undoubtedly play a significant role in the etiology of cholecystolithiasis. Throughout the world the incidence of stones in females exceeds that in males two to three times.[66] Amongst lithogenic drugs some hormonal preparations probably including anti-conception pills are known.

Cholecystolithiasis increases with age, decade by decade, but recently the disease has appeared with increasing frequency even in adolescents and children especially if overfeeded. In any case, the high number of cholycystectomies in surgical statistics for the 4–6th decade is not entirely due only to higher lithiasis incidence in this period, but also to its more frequent clinical manifestations.[1]

Epidemiological studies of the causes of cholecystolithiasis also stress genetic influences and nutrition.[27, 35] The white race is affected most severely, as are some tribes of North American Indians. Lithogenic bile is excreted by them apparently for several years before the development of stones. Probably only the polygenic liability to stone formation is inherited because migration changes the incidence of stones.[21]

The true incidence of cholelithiasis in various parts of the world is not accurately known on account of the many asymptomatic forms and due to errors caused by selection in surgical and necropsy statistics. It appears, however, that cholelithiasis is on the increase everywhere in connection with changing habits of life. The well-known association of cholelithiasis with obesity is rather a consequence of excessive intake of calories (Sarles) than fats, as was supposed earlier. As regards nutrition the ingestion of refined sugars may be significant in the genesis of stones, as well as a shortage of fibrous foods, both characteristic for regions with a high degree of civilization, heavily affected by lithiasis.[21]

Clinical pattern

Cholecystolithiasis remains clinically silent throughout life in more than half the cases.[49] If silent stones are detected incidentally, we are never able to foresee whether they might not cause symptoms in the future and even produce serious complications.

Clinical manifestations of cholecystolithiasis are due either to the disease itself or to its complications. An intermittent symptomatology is characteristic: painful attacks and cholecystitis alternate with intervals when the patient remains symptom free, or suffers only from dyspepsia.

Attacks of pain termed "biliary colic" is a characteristic symptom of cholecystolithiasis, although it may be induced also by other biliary tract disorders. As a rule it is due to transient obstruction of the gallbladder by a stone. The onset is acute and it ceases gradually within minutes or hours. Attacks vary in frequency, even with intervals of several years duration; in other cases they develop into a permanent torment and are of almost daily occurrence.

Recognition is possible by the localization of pain, its irradiation and severity and from the absence of rigidity, which would rather favour an inflammatory condition. Pain is accompanied by nausea and vomiting, terminating in the violent ejection of bile or retching. The patient awakes in the morning following the dramatic, as a rule nocturnal incident, feeling tired, but without major complaints.

"Biliary dyspepsia" a frequent accompaniment of gallbladder disease is not always caused by it and frequently persists even after cholecystectomy.[28] Sometimes indistinct painful spasms may be evaluated in this connection as "rudimentary colics", which, though not reaching the intensity of a true attack, might be its equivalent.

The complication of cholecystolithiasis which is typical for it and, at the same time, represents another chief manifestation, is chronic and acute cholecystitis. Inflammation, however, may on the contrary represent the stimulus for stone formation.

Other complications are mainly caused by the migration of stones. A stone lodged in the cystic duct causes its obstruction: sometimes incomplete and valve-like with impairment of gallbladder filling, sometimes permanent, producing hydrops or empyema. Stones which pass into the choledochus remain there or pass through the papilla to reach the gut. Stones may leave the gallbladder even through a spontaneous biliodigestive or bilio-biliary fistula, produced by decubital necrosis. These stones too are commonly passed in the stools, but may sometimes cause biliary ileus.

Diagnosis of cholecystolithiasis. A typical colic is convincing, but a reliable diagnosis of stones is established only by radiology. In some cases the plain film alone demonstrates the stones; if they are non-opaque a cholecystogram is required. If the gallbladder is not visualized after several weeks interval since the attack, this is taken as a rule as evidence of cholecystolithiasis; this is the most common reason for non-visualization of the gallbladder.

Pathological symptoms may not infrequently be ascribed without justification to stones found and some other serious disorder may be overlooked on this account. Penetrating peptic ulcers are amongst causes to be considered, as well as acute gastritis, hiatus hernia, pancreatitis, hepatitis or subhepatic appendicitis. An intermediate coronary syndrome must also be exluded. It has been stated in the past that ischemic cardiac disease is adversely influenced by cholecystolithiasis,[16] but that is mainly a problem of differential diagnosis.

Radicular pains may also be mistaken for biliary colic alongwith renal colic, abdominal pains associated with migraine, irritable colon and even abdominal attacks of porphyria. In some cases the incidental finding of gallstones may delay the recognition of a neoplasm affecting liver, stomach or hepatic flexure of the colon.

Therapy

CONSERVATIVE TREATMENT

Expectant treatment assists in relieving the colic but, it cannot prevent further attacks or remove the lithiasis. Even if some stones leave the gallbladder, this remains pathologically altered.

In uncomplicated cases of cholelithiasis, clinically silent or with minor symptoms, however, nowadays an attempt may be made to dissolve the stones by chenodeoxycholic (chenic) acid. This is so far the first substance with such a confirmed effect.[67] The drug abolishes the lithogenic properties of the bile by a reduction of cholesterol secretion. It is effective only with small non-opaque cholesterol calculi and with a patent cystic duct. It is applied in a daily dosage of 10–15 mg/kg for periods of 1–2 years, with success in 50–70% of cases treated.[5] It appears to be a safe method of treatment, laboratory checks of liver function and reliable patient cooperation are required, however. The main disadvantage lies in the fact that stones are formed again after discontinuation of the drug. A definitive method of treatment has not yet been devised and other substances with a similar action are being searched for.[22, 42, 43, 47] The treatment is no substitute for surgery, but may be used in cases where patients refuse operation, or where this carries a high risk.

SURGICAL TREAMENT

The statement made by W. Mayo in the year 1911 is still valid: Harmless gallstones are a myth and cholecystolithiasis can be cured only by operation.

The conviction about the efficacy of surgical treatment for cholecystolithiasis and about the usefulness of preventive cholecystectomy before the emergence of complications has spread so much that it might be easier to talk about cases where cholecystectomy is contraindicated.

If operation is advised one must be aware beforehand what is to be achieved by it: removal of the affected gallbladder on account of symptoms caused by it, or in order to forestall their emergence, i. e. preventive operation. We disagree with the most radical demand for surgery in every case as soon as stones are found, and believe that not even signs and symptoms due cholecystolithiasis make surgery always advisable with the same urgency.[14]

Symptomatic cholecystolithiasis

Cholecystectomy is indicated in the vast majority of patients with symptoms. However, an individual decision should be made and account taken in particular of the patient's age, the character of the disease, its complications and associated diseases.

Indisputable indications are complications directly threatening life, or tormenting the patient to such a degree that his consent to the operation can be obtained without trouble.

Such an emergency requiring immediate operation, for example, is threatening perforation in acute cholecystitis, or already present biliary peritonitis.

Urgent indications include: febrile gallbladder empyema, frequent colics, presence of stones in the ducts and all types of main bile duct obstruction, and also relapses of acute pancreatitis associated with confirmed cholelithiasis.

Operations is emphatically advised as a rule even in cases where the disorder fails to cause dramatic symptoms but where little hope exists that the patient will remain permanently free of symptoms, particularly after acute cholecystitis or following a series of biliary colics.

If only minor and sporadic attacks occur or only dyspeptic symptoms are complained of, or if we are unable to promise relief from all complaints after the operation, the patient understandably consents to operation with reluctance. If we advise it nevertheless, no pressure is exerted and intervention may as a rule be delayed for weeks, or even months to a date advantageous for the patient. In weakly patients operation may have to be permanently deferred as long as the benign course of the disease permits. It is pointed out, however, that complication may arise at any time.

Asymptomatic cholecystolithiasis

The problem of cholecystectomy for silent stones is still a subject under discussion.[46, 51, 55]

Several reasons favour preventive gallbladder removal:

- The patient should undergo surgery whilst still relatively young and otherwise healthy. At such a time cholecystectomy is easy and surgical risk is minimal.
- With the duration of cholecystolithiasis and with increasing age the number of complications and the surgical risk increase. Mortality from uncomplicated cholecystectomy according to Hess in younger age groups amounts to 0.1–0.2%, whereas it rises in higher age groups and in the presence of complications increases some 50 times. In our own patients with associated choledocholithiasis surgical mortality after the 65th year rose threefold, and after the 80th year as much as tenfold.
- The risk of carcinoma originating in a gallbladder filled with stones cannot be entirely excluded, even though it has not been accurately verified, and some consider it negligible.[55]

The following important objections may be raised against preventive cholecystectomy:

- About one-third to one-half of stone bearers remain free of complications to the end of their lives.
- The risk of simple cholecystectomy though low – it has dropped below 1% – nevertheless exists. For a young person who is asymptomatic this is an immediate and unexpected risk, in contrast to the risk in complicated disease, which causes symptoms and represents a threat in itself for the older person.

After carefully weighing the pros and cons we may offer or agree to operation for silent stones in some carefully considered cases:

1. In patients suffering from an other disease with a progressive character and which would substantially enhance the risk of a later unavoidable operation. This applies e. g. to essential hypertension, cirrhosis, some renal disorders and in particular to diabetes mellitus. If acute cholecystitis occurs in a diabetic, its complicated course endangers the life of the operated patients in 10–15%.
2. In patients aged 45 to 60 years, for whom the possibility of lithiasis complications and possibly of cancer has a rising trend, and who at that age are well able to support a simple operation. We are more likely to adopt surgicel intervention in the presence of smaller stones.
3. If calculi are incidentaly discovered in the gallbladder during another operation its removal may be undertaken even though no symptoms have so far been caused.

Principles of surgical procedure

The basic operation for cholecystolithiasis is cholecystectomy. A warning not to underestimate this operation cannot be overstressed. In particular a seemingly entirely simple case may be most treacherous, not infrequently endangering the patient by injuries to vessels or duct, these pitfalls must be known and operation performed with great care in every situation.

In each gallbladder operation confirmation must be sought whether operation need not be extended to include the bile ducts. For this reason primary cholangiography is as a rule performed, and possibly other instrumental exploration of the bile duct included in suspicious cases.

We are never satisfied with mere cholecystolithotomy for stones, even if only a solitary stone or stones on a hemolytic basis are present, and the gallbladder appears to be healthy. From time to time some surgeon "studies" anew this alternative, before he becomes convinced himself that such an operation is inadequate. An exception would be enforced by a case where the gallbladder cannot be removed without risk and we must be satisfied with the extraction of stones and drainage of the remainder. A similar situation also exists in emergency cholecystotomy.

If during operation the expected stones are not found and no other lesions of the gallbladder are present, it may be left. But if operation was advised for a well grounded suspicion of lithiasis, even such a gallbladder may be removed. The findings by palpation need not be correct and not until the gallbladder has been opened may a few soft stones resembling peppercorns sometimes be found.

If we operate on a cholelithiatic patient for another disorder in the neighbourhood of the gallbladder, simultaneous simple cholecystectomy is recommended, provided the combined intervention can be well supported by the patient. This should not be done, however, if a difficult operation on the main bile duct would also be necessary, or if the original operation is done for a peptic ulcer penetrating into the pancreas, or for a malignancy.

Splenectomy for a hemolytic disease may preceed CHE, if it is indicated.

Tactics and technique of cholecystectomy are described at the end of the chapter (p. 188).

Cholecystitis

Inflammation commonly involves a gallbladder with stones (calculous cholecystitis), whereas its development in a gallbladder without stones is a rare event indeed (acalculous cholecystitis). It may be acute or chronic, the latter often being associated with acute exacerbations.

Etiology

Etiology of cholecystitis hat not been studied exhaustively, the role played by stones is, however, obvious and vice versa, cholecystitis itself probably modifies the conditions for their origin. Stones act apparently by mechanical irritation and by impairing gallbladder evacuation. Secondary changes occur in stagnant bile and may cause toxic damage to the mucosa. However, none of these factors has yet been clearly defined.[64] Bacterial infection in our regions is only rarely the primary cause for cholecystitis, but may be a serious complication.[11, 61] Specific infection, e. g. tuberculosis of gallbladder is an exceptional finding. Cholecystitis develops also sporadically on the basis of parasitic infestation (echinococcal, lambliasis, bilharziosis).[26] Further possible factors for gallbladder inflammation are allergy, autoimmunity[24] and ischemia.[58]

Acute Cholecystitis

Acute cholecystitis may be the initial manifestation and cause of biliary tract disease, but much more commonly it affects a gallbladder already altered by chronic inflammation.

In the overwhelming majority of cases, approximately in 95%, it develops in association with cholecystolithiasis, most frequently as a result of neck obstruction by stone.[7] The role of bacteria is secondary, but is suggested by the therapeutic effect of antibiotics. Aerobic and anaerobic intestinal bacteria are usually cultured, but staphylococci and others sometimes appear. Bacteria multiply chiefly during the few days following the onset of inflammation.

Acute cholecystitis without gallstones is rare. It may occur in malformations of the neck and possibly also by closure of the cystic duct by oedema and lymphadenitis. Primary, purely bacterial cholecystitis also exists, the best known is typhoid cholecystitis. Likewise severe acute cholecystitis with a tendency to perforation may sometimes occur in cachectic subjects, or following severe operations.[4] Sporadically acute cholecystitis may also be the initial sign of cancer of the gallbladder.

Pathology

The intensity of inflammation may exhibit all graduations, from edematous swelling to gangrene. The acutely inflamed gallbladder is distended, initially reddened, firm, later almost cyanotic, gangrenous. The bile is usually opaque, sometimes even purulent. Inflammation may be arrested or regress already in the first days, but the tissues remain soggy and friable, and if the cystic duct remains blocked, chronic empyema might ensue.

The omentum frequently becomes adherent to the inflamed gallbladder, effusion forms in the neighbourhood, lymph nodes swell and inflammation spreads to neighbouring structures. A relatively firm pericholecystic infiltrate is produced by adhesions with the neighbourhood, the so-called "plastron". Perforation occurs only rarely, but is possible even at the commencement of acute inflammation. It occurs more often into the adhesions surrounding the gallbladder or into its fossa, than into the open abdominal cavity, thus peritonitis does not develop so readily, but rather a smaller or larger pericholecystic abscess is formed. Fundus and neck are the most common perforation sites. Even severe cases of cholecystitis and such closed perforative inflammations settle and regress as a rule, but sometimes very slowly, taking weeks to subside. They leave a fibrotic gallbladder with adhesions, sometimes with abscess residues or fistula into a neighbouring viscus.

Clinical pattern

Acute cholecystitis is one of the common abdominal emergencies. It most often affects a subject in previously perfect health, sometimes it is preceded by a period of dull pain or even colic in the right hypochondrium, which culminates in acute inflammation and then, for a time, disappears.

Basic signs of acute cholecystitis are pain, fever and tenderness of the gallbladder region on palpation.

Pain at first resembles that of simple biliary colic, but fails to subside or even intensifies. It is aggravated by jolting, pressure on the abdomen and deep respiration, and the patient avoids these. Vomiting, if it occurs, provides no relief.

Fever rises sharply at the onset, frequently after an initial rigor. It sometimes appears later, behaves according to the course of the inflammation, and gradually decreases in the course of several days.

There is marked tenderness on palpation in the right hypochondrium and we can sense or distinctly palpate the acutely painful, distended gallbladder.

If inflammation spreads to the neighbourhood, muscular rigidity is present and Rovsing's rebound sign may be suggested. If a plastron develops, a fairly extensive, not sharply defined mass may be palpated, which is sensitive and not easily distinguished from rigidity. The remaining abdomen, however, remains soft, without tenderness and per rectum findings are negative, provided that inflammation has not spread to the free abdominal cavity.

In about one-third of patients transient mild cholestatic jaundice appears. If it is marked and lasts for several days, coexisting involvement of the bile duct is the rule.[29] Not infrequently the presence of accompanying pancreatitis is entertained, in particular if tenderness is also found on the left side.

Ancillary investigations. Leukocytosis or at least neutrophilia in the blood count accompanies acute cholecystitis, Ehrlich's reaction in the urine is positive and traces of bilirubin might be found. Serum and urine investigations for amylase should be made immediately on admission, an ECG tracing obtained, as well as plain films of abdomen and chest. Other necessary investigations are done as soon as possible.

The course of cholecystitis varies, but most often it is mild to medium severe. This is not only a question of treatment, but of the character of the inflammation and the patient's resistance. Inflammation may subside spontaneously, or exacerbate or progress despite adequate treatment, and sporadically perforation may occur during the first days. Inflammation may arrest and subside in every phase, even with complications present – apart from biliary peritonitis. The patients must be observed continuously, particularly if treated on conservative lines, to prevent perforation and biliary peritonitis by timely surgery. The danger for elderly patients is greater and the risks of acute cholecystitis are intensified by cardiac disorders, bronchitis, renal disease, cerebral sclerosis and particularly by diabetes.[65]

The diagnosis of acute cholecystitis is as a rule easy and if serious doubts exist, investigation may be supplemented by diagnostic aspiration of the abdomen, emergency laparoscopy or intravenous cholangiography: if the gallbladder is visualized no inflammation is present.

From the differential diagnostic angle acute pancreatitis must be chiefly considered, some types of appendicitis and perforated peptic ulcer – but also some acute non-surgical diseases: right-sided pyelitis, basal pleuropneumonia, myocardial infarction, painful forms of acute alcoholic hepatitis, etc.

Acute cholecystitis is mistaken for appendicitis particularly in children, first because we do not ever think of it and secondly because its clinical features differ from its adult form. In children, we find no enlarged gallbladder and concrements are generally absent, infection plays the main role whereas in adults acute cholecystitis is commonly due to the cystic duct obstruction.[68]

Diagnosis of acute cholecystitis may be difficult in old and exhausted subjects, as its manifestations may be uncharacteristic, and its course, accordingly, treacherous. Pain is atypical or absent, abdominal findings equivocal, the picture may be dominated by protracted fever which is hard to explain. If ancillary tests fail to elucidate the character of the disease, the patient may deteriorate without proper therapy and sometimes only autopsy discloses the true nature of the disease.

Therapy

CONSERVATIVE TREATMENT

Usually conservative treatment is first commenced, but patients with acute cholecystitis should be admitted to the surgical department, as the need for urgent operation can never be excluded.[32, 34, 47, 48, 56, 58] Fundamental elements of conservative treatment, apart from other measures, include rest in bed and initially only parenteral nutrition. Wide spectrum antibiotics are indicated with acute inflammation accompanied by high fever and particularly in the elderly and diabetics. Necessary investigations and observations of the patients are done simultaneously with the treatment of other associated disorders.

SURGICAL TREATMENT

This may be required during various stages of cholecystitis. Its object is always a definitive cure, if possible, with minimal morbidity and mortality.

Emergency operations

The decision is usually already made during the first hours, but sporadically later, with threatening deterioration of inflammation. Indications are diagnostic uncertainty with progression of peritoneal signs, threatening perforation of the gallbladder or existing biliary peritonitis, rarely fulminating pneumocholecystitis.

Even at an emergency operation gallbladder removal is always attempted, cholecystostomy is an expedient only.[39]

Early operation

In most cases of acute cholecystitis operation is advisable even without progressive inflammation, but it is usually preferable only during the first three days from the onset of symptoms.

The discussion between partisans of conservative and surgical treatment during the acute stage of cholecystitis is still in progress. The following advantages of early cholecystectomy are advanced:

– Cholecystectomy is easy in recent inflammation. Its morbidity and mortality are not higher than with delayed operation "à froid", when it is made more difficult by fibrotic adhesions and possibly even fistulas.

- Conditions for surgery are similar to those of elective surgery, because intervention is not necessary immediately in the first few hours, thus leaving sufficient time for the investigation and preparation of the patient.
- The patient more willingly consents to the operation during the painful phase. Timely intervention forestalls possible complications and continued illness.[10] Besides, perhaps an early stage gallbladder cancer may sometimes be discovered.
- Total morbidity is shortened, and unfitness for work during the interval between acute inflammation and delayed operation is eliminated, thus giving an economic advantage[47]

The following disadvantages and dangers of early cholecystectomy are put forward:

- Technical and staffing facilities for urgent operation are usually not as good as with elective operation.
- Investigation and shorter preparation are not as thorough, which matters particularly in old people with their concurrent diseases. Fatal mistakes with myocardial infarction are also on record.
- If operation is actually done on the third day or later, as a rule intervention gets increasingly difficult on account of tissue fragility and adhesions, and sometimes by abscess formation.
- Incorrect selection of patients regardless of the necessary investigations and preparation, also makes early operation mortality and morbidity higher than elective operation.
- The great majority of acute inflammations subside with expectant treatment.

Long experience of some surgeons, our own included, confirms, however, the great advantages of early cholecystectomy. The danger of acute inflammation is eliminated in one stroke, it is eliminated rapidly, and a definitive cure including associated lithiasis is achieved. This operation during the early phase of inflammation is valuable not only as preventive therapy, but also from the social aspect. Operation is safe if we heed all critical points referred to: Operation is done after confirmation of the diagnosis only, selection of patients is correct, account is taken in particular of associated diseases, and preferably, only performed in the first few days. As also reported by Ram (1977), in carefully indicated cases no difference in operation results was found between the first 3 days and later, and some (Linden 1973) disregard the duration of inflammation and operate at any time. However, despite this, the inflammatory milieu during the period between the 4th–8th day appears to us the least suitable for performing "acute" cholecystectomy in most cases.

It is important, if the time factor does not limit us unduly, that investigation and preparation of the patient is done reliably. The operation should not differ substantially from an "elective" one, neither in the skill of the surgeon, nor in the opportunity for proper investigation, and if required, for operation on the common bile duct. Its exploration is not contraindicated during "acute" operation and is highly desirable. Carlsen, 1977, thus found in almost 20% of his cases stones in the main bile duct not signalized by raised alkaline phosphatase or bilirubin.

Delayed operation

Sometimes preconditions for reliable early cholecystectomy cannot be satisfied and many surgeons also treat acute cholecystitis at first conservatively as a matter of principle. Accordingly, operation is frequently done after the acute phase has passed. This is after nine days at the earliest, but most often in 2–3 weeks. The sub-hepatic field of operation should be quiescent, "matured" for surgical intervention and general symptoms of inflammation should have disappeared. The date of delayed operation should be determined cautiously to exclude premature intervention. It depends on how rapidly the inflammation subsided initially, how the sedimentation rate and leukocyte count are returning to normal values, and in particular on the abdominal findings. The interval provides time for proper investigation and preparation of the patient and, similarly, the condition is resolved during a single hospital stay. Otherwise, if patients are first discharged home improved, they frequently fail to return for surgery and appear again only with a new attack or some other complication.[30]

Late operation

In some cases operation is delayed for 1–2 months, and this usually requires readmission. One reason is patient refusal, another is slow regression of inflammation with remissions. Sometimes more detailed radiological investigation or prolonged preparation is required.

PERSONAL CURRENT PRINCIPLES OF ACUTE CHOLECYSTITIS MANAGEMENT

If an emergency operation is not necessary, early operation is performed, but as part of a normal operating session. Intervention is usually timed to fall within 3–4 days from the onset of inflammation, following rapid but proper investigation and preparation of the patient. Early operation is not done where preconditions are not met, and also if inflammation has already disappeared on the first day, so that diagnosis is not reliable, or, on the contrary, if inflammation is already advanced on admission and lasts as a rule more than 3 days. In such a case operation is performed soon after the inflammation has settled, most commonly after 2–3 weeks. If cholecystectomy has been postponed to a later date, the operation is performed 6 weeks later on readmission.[62] Of course any progression of inflammation compels us to operate urgently at any time.

Chronic Cholecystitis

Chronic cholecystitis is so frequently present in cholecystolithiasis and its more advanced non-calculous forms are so rare, that both disorders are in the surgeon's mind merged into a single nosological entity.

Chronic cholecystitis originates gradually ab initio or subsequent to acute cholecystitis. It is usually associated with stones generally already present before the inflammation. If in rare instances pronounced non-calculous cholecystitis is encountered, then the question remains, whether stones have not left such a gallbladder earlier. A small contracted gallbladder favours this concept. On the other hand discreet histological lesions sometimes providing a supplementary justification for the removal of an otherwise healthy gallbladder, cannot be considered evidence of chronic cholecystitis in the clinical sense.

Pathology

Chronic cholecystitis is a productive inflammation involving first as a rule, the mucosa, and later the entire wall. Initially the gallbladder loses its translucency, the mucosa thickens, infiltrates and inflammatory pseudopolypi or ulcers are formed. Later the entire mucosa may undergo destruction, and the entire gallbladder wall changes into scar tissue. Such a gallbladder with a thickened firm wall and necrotizing mucosa may be a source of embarassment at operation, masquerading as possible carcinoma. Only histological examination makes a reliable distinction possible. In some far advanced cases, the gallbladder may change into a small fibrotic remnant containing stones or residues of biliary slime.

Obliteration of the cystic duct may cause chronic hydrops or empyema. Light coloured mucous bile may be found in far advanced cholecystitis even without cystic duct blockage, from a loss in concentrating ability. If lime salts are deposited in greater amounts, a milky radioopaque cloudy "limey bile" results. Extensive calcifications in the gallbladder wall produce the so-called "porcelain gallbladder".

Most chronic cholecystitis cases are accompanied by delicate membranous or firm and hard adhesions. Sometimes they only represent the residual effects of an inflammation whose course was clinically silent.

Clinical pattern and diagnosis

Chronic cholecystitis probably does not possess a clinical pattern of its own, complaints due to cholelithiasis dominate the picture. Most complications, as biliary fistula, pancreatitis, subphrenic abscess etc., are also common to both.

Independent manifestations of chronic cholecystitis are only acute exacerbation of the inflammatory process, clinically indistinguishable from acute cholecystitis.[29] During the intervals "biliary" dyspepsia is sometimes ascribed to it, but this does not differ, however, from other functional dyspepsias and is mostly unconnected with gallbladder disease. Likewise a diagnosis of acalculous cholecystitis is frequently only a means of escape from explanation of a variety of noncolicky painful sensations in the right hypochodrium.

A reliable diagnosis of acalculous cholecystitis can probably be made only in inflammations due to reflux into the gallbladder which has been incorrectly utilized for a biliodigestive anastomosis. A special clinical type of bacterial chronic cholecystitis is the permanent salmonella carrier state.

Therapy

Chronic acalculous cholecystitis only rarely requires operation as such. Cholecystolithiasis is the decisive factor, the simultaneous existence of cholecystitis in various stages of evolution being more or less assumed (Višněvskij). It may happen, on the contrary, that we mistakenly expect stones in every gallbladder which fails to fill with contrast medium, even though the reason is chronic inflammation.

Regardless of the presence or absence of stones, operation for chronic cholecystitis is indicated particularly:

- in exacerbations of acute inflammation and its complications,
- in chronic hydrops or empyema of the gallbladder,
- in biliodigestive fistula,
- in reflux cholecystitis,
- if salmonella is found permanently in the gallbladder bile.

Surgical treatment of chronic cholecystitis, as with lithiasis, consists of cholecystectomy and management of complications. It cannot usually be foreseen how exacting the operation will turn out to be. Tactics and technique of operation are determined by the local conditions found (p. 202). In some exceptional cases cholecystectomy might be so hazardous that we are forced to abandon radical operation.

In salmonella carriers surgical treatment should be combined with antibiotics, the latter being administered systemically and locally. Cholecystectomy is the basic operation. If, however, choledochus changes are present, simultaneous choledochotomy is performed, any stones present are removed and a T-tube inserted, through which antibiotics are instilled for a number of days (Pánek). Some writers, such as Brühl, undertake choledochus drainage as a matter of principle, even in the absence of lesions.

After operation patients have their stools, urine and bile regularly checked bacteriologically, but later follow-up is a public health matter. The combined surgical and antibiotic treatment is successful in about 96% of cases. If lithiasis is present a solely conservative approach is out of place.

Cholecystoses

Cholecystosis is the designation given to some pathological lesions of the gallbladder degenerative and proliferative in character, thus neither inflammatory nor neoplastic. The term "cholecystosis" was employed first by Colesson (1957).

A variety of disorders was assigned to them, independent clinical and radiological patterns were ascribed to them (Arianoff, 1966). Currently only two disorders are counted to this category: cholesterolosis and intramural diverticulosis which corresponds with thesaurismosic and hyperplastic forms (Varola, 1977).

Cholesterolosis

This originates through abnormal deposition of cholesterol in the epithelium and stroma of the gallbladder mucosa, producing thickening of the latter and even polypoid structures.

If involvement is diffuse the inner gallbladder lining has a strawberry appearance, being accordingly called "strawberry gallbladder". In localized types one or several polypoid structures are found, so-called cholesterol polyps.

Intramural diverticulosis

This is incorrectly termed "adenomyomatosis". In the diffuse type intramural mucosal diverticula are created with glandular structures which penetrate into the thickened musculature as so-called Rokitansky-Aschoff sinuses. In the localized type the dilated diverticulum is surrounded by hypertrophic muscle bundles and forms a solitary nodule in the gallbladder fundus.

Although cholecystoses are doubtlessly pathological conditions, they do not represent clinical entities. Gallbladder dysfunction and pains were ascribed to them mistakenly in the presence of cholelithiasis and cholecystitis (Lubera et al., 1967).

Only exceptionally may some cases of cholecystosis be detected before operation by radiology. Cholesterol polyps and localized nodules with intramural diverticles may as a matter of fact show up as small defined defects in a gallbladder opacified by contrast medium, and may be a reason for cholecystectomy from uncertainty about their character.

Gallbladder Dysfunction

From time to time the surgeon is requested to treat a patient whose symptoms are evaluated as biliary, but in whom no pathological lesion of the biliary tract could be demonstrated to exist. The assumed cause is gallbladder dysfunction.

Symptoms, as a rule attacks of pain or various painful sensations in the right hypochondrium are felt by the patients so forcefully and severely that they consent to an operation, and even demand it.

In surgical practice dysfunctions are important mainly from the differential diagnosis angle.[11] The greatest danger lies in the fact that an easy diagnosis of dysfunction provides an escape route from the exacting and responsible search for organic disease, particularly if the surgeon is unwilling to undertake an operation.

Three categories of cases are found amongst these patients:

1. Patients in whom symptoms had been incorrectly ascribed to the biliary tract from the very beginning, although they were in reality suffering from any other organic or functional complaint, such as irritable colon, abdominal pain accompanying migraine or various somatic manifestations of neuroses. Frequently the cholecystographic finding of common place congenital deformities is overestimated, such as the phrygian hood, small septa and narrowing, which by themselves cause no symptoms.
2. Patients in whom organic biliary disease was not recognized due to shortcomings of diagnostic methods or clinical observation. It is generally known that in about 5% of lithiasis cholecystography is falsely negative. The so-called infundibulocolic syndrome accompanying various anomalies of the outgoing portion of the gallbladder may be demonstrated with difficulty even at operation (Hess 1967). Clinically it is characterized by attacks of pain, even mild cholecystitis, in which a tender enlarged gallbladder is palpable, which quickly disappears and subsequent cholecystography is normal. Rare primary stenoses of the papilla are demonstrated with difficulty without operation. In favour of their presence are incidents with a mild cholestatic reaction and, with intravenous cholangiocystography, an enlarged, poorly emptying gallbladder with a slightly dilated bile duct.
3. Finally patients in whom cholecystectomy of a normal gallbladder has actually brought relief, thus pain was really emanating from it. Verification of the correct diagnosis rests, however, on long-term follow-up. In view of the exceptional nature of such purely functional disorders far from all patients on whom we allowed ourselves to be persuaded to operate, achieve this.

The operation to be considered is cholecystectomy. The basic attitude vis-a-vis operation on patients with unconfirmed biliary disease, however, should be extremely reserved. We agree with Fahrländer who advises that the diagnosis of dysfunction should be discarded altogether at first, to be returned to only after everything else has been excluded.

Amongst the auxiliary diagnostic methods recommended for this group of patients is measurement of the gallbladder size during cholecystokinin cholecystography (e. g. after Siffert) – or to provoke the spontaneously experienced pain. Such findings in our opinion should be assessed highly critically. The true cause of symptoms, however, is unmasked in due course, provided it is organic, or dissolves if brought about by difficult personal problems.

Therapy

Operation is undertaken only if we have convinced ourselves that the symptoms are biliary and that they are of such intensity that they cannot be managed otherwise. The diagnosis may be revised during the course of the operation following careful exploration of the biliary tract and the organs in its neighbourhood. In some carefully selected cases surgery will relieve the patients of their symptoms, but, however, if the surgeon is overhasty in operating inadequately elucidated cases, the patient's condition may deteriorate. An operation accepted only out of embarassment results in the patient's consequent loss of trust in his doctors. Thus the "postcholecystectomy syndrome" is created, with little hope of relief.

Gallbladder Operations

Palliative Operations

Cholecystolithotomy i. e. mere removal of stones from the gallbladder which, by the laparotomic route was first performed by Bobbs in 1867, is no longer undertaken as an independent intervention. It may be considered only if preservation of the gallbladder is required for an anastomosis or drainage.

Cholecystendesis is likewise only part of surgery designed to drain the remainder of the gallbladder. Its scarring is facilitated, to with, if the mucosa is stripped from it mechanically or by cauterization.

Cholecystostomy is usually an exigency or preparatory intervention. The indications, technique and management have already been dealt with (p. 137).

Biliary anastomoses are dealt with later in the appropriate chapter (p. 379).

Cholecystectomy

This was first performed in the year 1882 by Langenbuch in Berlin, in Prague in 1891 by Maydl.

Cholecystectomy is often thought to be a simple operation, but in reality it possesses a number of pitfalls, one amongst others being the variability in the course of the blood vessels, cystic duct and biliary ducts.

It is most commonly performed for cholelithiasis as an elective intervention, less often as a so-called acute cholecystectomy in cholecystitis, and sporadically as an emergency for gallbladder perforation or hyperacute, threatening inflammation. There are some differences in technique between these operations. First we shall present the procedure used in elective cholecystectomy, the special features of acute and emergency operations will be presented later (p. 204).

Elective cholecystectomy

Abdominal incisions and preliminary exploration were described in the general chapter on technique (p. 107).

Examination of the gallbladder. This is cautiously freed from adhesions and if the gallbladder is distended, it is evacuated first by aspiration. This facilitates its dissection and investigation, and reduces the danger of expressing small stones through the cystic duct into the choledochus during manipulation of the gallbladder. Fig. 107. This is safer than applying a clamp to the cystic duct which, particularly with a distended gallbladder, is not easily accessible.

Aspiration of gallbladder. The region of the gallbladder fundus is packed and a suture placed surrounding the proposed puncture site. The gallbladder is aspirated with a wide bore needle connected to the syringe by a short length of tubing, the latter being clamped each time the syringe is emptied. The contents

Fig. 107: Firm grasping of a full gallbladder may produce expulsion of its contents including stones into the bile duct.

may be either dark or lightly coloured "white bile", sometimes hemorrhagic bile, cloudy bile or purulent matter. In the latter case a few ml of 1% neomycine solution may be instilled into the gallbladder and gloves changed. The purse string suture is tied after withdrawal of the needle, the amount of fluid withdrawn measured and a sample sent for bacteriological investigation. Fig. 108.

After evacuation of the gallbladder dissection is continued further in the direction of cystic duct. Neighbouring structures are pushed aside with a moist swab on a long artery forceps or manually. Any incidental injuries of the duodenum, colon or some other viscus are immediately repaired, the opening of any fistula into the gut is circumcised and sutured. If the liver is ptotic, access may be facilitated by an assistant grasping its border gently with a warm wet towel or linen glove and withdrawing it from the wound. Bruising must of course be avoided and it must not be flexed over the wound edge.

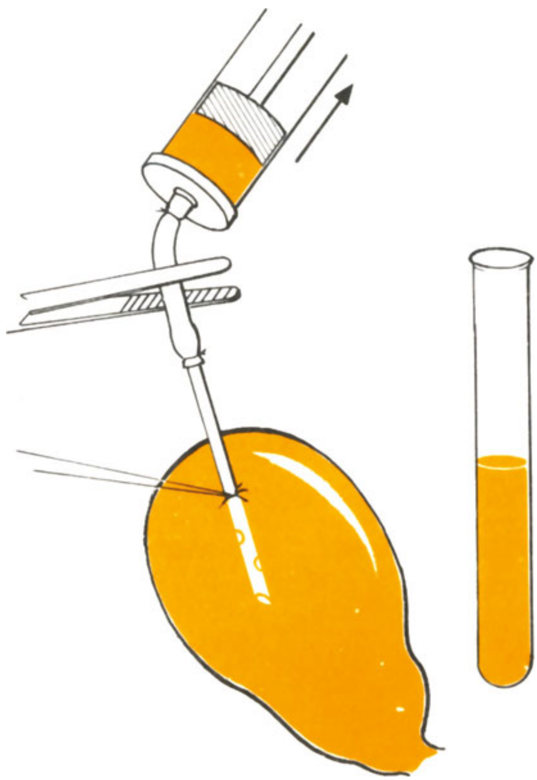


Fig. 108: Evacuation of bile by aspiration and collection of sample for bacteriological investigation.

After adequate exposure has been obtained the presence of stones in the gallbladder is again verified by palpation and the lodgment of any in the cystic duct ascertained. The position of choledochus, hilus and pancreas is checked and a definite decision about cholecystectomy made.

According to the condition and also, up to a point, according to custom, operation may be continued by various methods. The procedure as described by Lahey[33] some years ago, has not changed substantially.

Two basic procedures exist from cholecystectomy:

- orthograde, "fundus down" cholecystectomy, where dissection of the gallbladder is started from the fundus downward and cystic artery and duct ligated last,

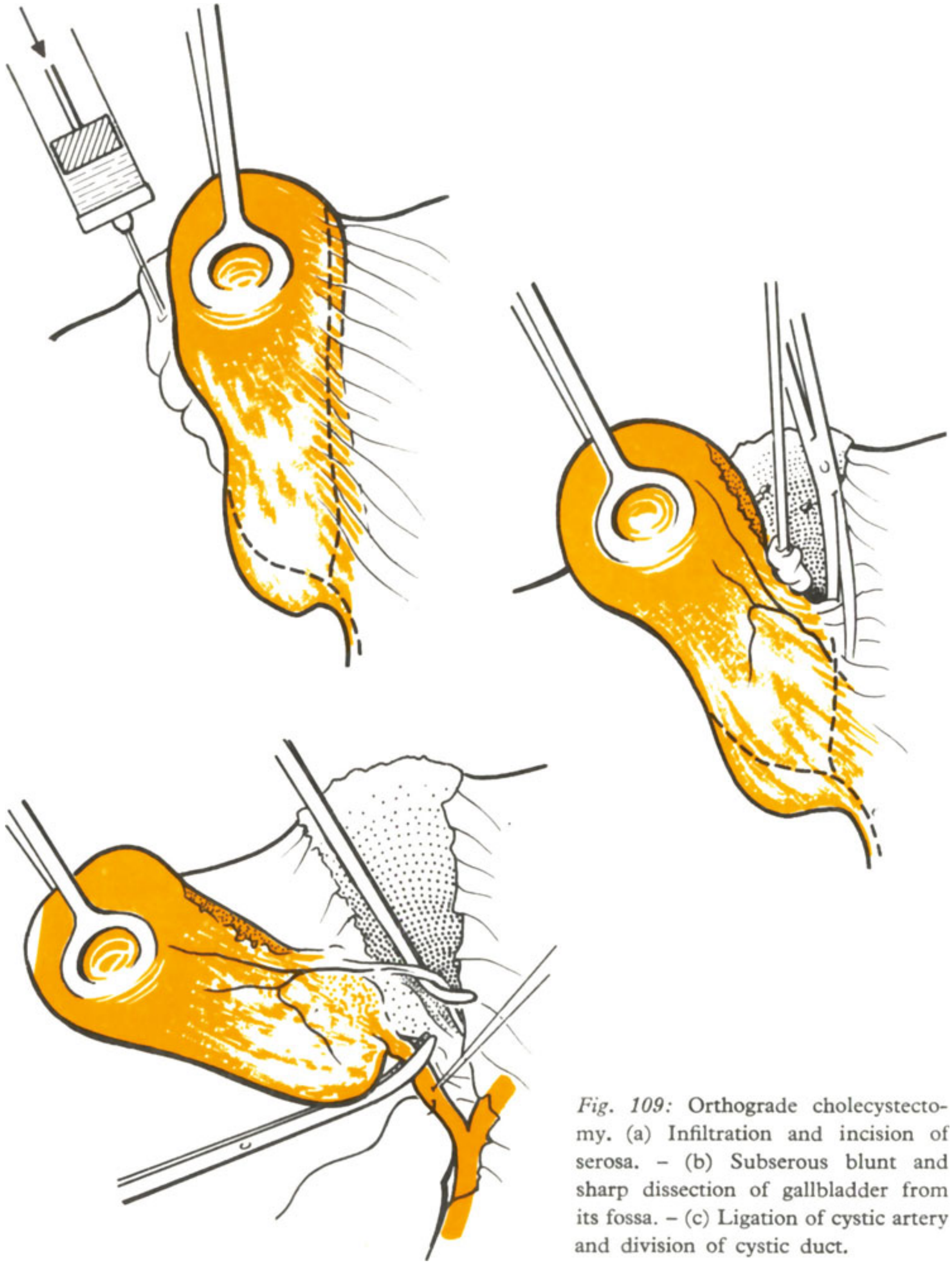


Fig. 109: Orthograde cholecystectomy. (a) Infiltration and incision of serosa. – (b) Subserous blunt and sharp dissection of gallbladder from its fossa. – (c) Ligation of cystic artery and division of cystic duct.

- retrograde, "duct to fundus" cholecystectomy where, on the contrary, artery and cystic duct are first ligated and the gallbladder dissected from the duct upward towards the fundus.

The gallbladder surroundings are protected by pads, its fundus is grasped by fenestrated forceps and subserous dissection from its fossa is attempted. The peritoneal covering of the gallbladder is accordingly incised about 1 cm from the border with the liver, and the gallbladder separated from its bed in such a manner that the dense Glisson's capsule remains in place. Dissection might be assisted by the subserous injection of physiological saline solution. The serosa incisions are carried down on both sides of the gallbladder towards the cystic duct and its junction with the main bile duct. Fig. 109.

The gallbladder is separated from its bed by means of a gauze pledget held by clamps or dissected with the aid of a finger and blunt-bladed pair of scissors. Firmer bands with vessels are ligated and divided. Exceptionally, a small bile channel is encountered between liver and gallbladder, or traversing its bed towards the hepatic duct. This is closed by suture-ligation, otherwise oozing of bile might occur postoperatively.

Modifications. If it is found that dissection of the gallbladder from the fundus would prove difficult on account of fibrotic changes tight to the gallbladder summit, the peritoneum on both sides of the gallbladder body is incised first. The gallbladder is mobilized in the correct layer, first back towards its fundus and thereafter towards the neck and cystic duct. Fig. 110.

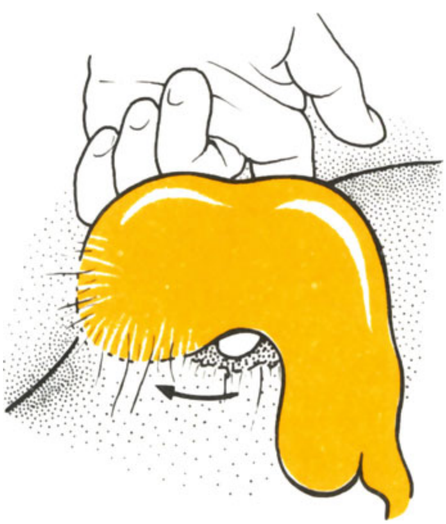


Fig. 110: **Modification of orthograde gallbladder dissection by starting freeing it from the fossa in its middle.**

Dissection may be hampered by tears in the gallbladder, particularly of its delicate wall in the fossa, which is not covered by serosa, or by tears and hemorrhage from the bed. Small tears of the bladder are closed with forceps or sutures and any escaped bile or stones are carefully removed. Torn liver tissue is replaced and temporarily compressed together with the oozing bed by a swab or pack soaked in warm normal saline or thrombin solution placing a rectangular retractor over the fossa in the liver. Hemorrhage and oozing of bile is definitively stopped by parenchymatous suture and by peritonealization of the fossa at the end of operation.

Ligation of the cystic artery follows the mobilization of the gallbladder. During dissection of the gallbladder its branches are successively ligated as they approach the gallbladder wall. This usually means from above, on the surface facing the liver. The cystic artery should be divided before the cystic duct because it is as a rule shorter. Should the cystic duct be divided first, traction on the

Fig. 111: Pringle's manoeuvre for compressing arteries in the biliary "stalk" during hemorrhage in the triangle of Calot area.

gallbladder could easily tear it apart, or even rip it from the hepatic artery. If in such a case injury or slipping of the ligature should produce torrential hemorrhage, it would be a fatal mistake to try and control it blindly by the application of artery forceps or suture-ligation. The hepatic artery is compressed in the hepatoduodenal ligament between thumb and forefinger of the left hand (so-called Pringle's manoeuvre) and blood sucked up. Fig. 111. After hemorrhage has been controlled the cystica stump is identified and ligated without hurry. If a larger artery has been torn, closure with atraumatic sutures is attempted and if we are forced to ligate it, preventive measures against liver ischemia are then inaugurated during operation (p. 475).

The cystic artery and its branches are best identified as vessels which pass into the gallbladder wall and ligated as close to it as possible. A whole series of **congenital variants** exists regarding number and course of the cystic artery, which has been referred to already in the chapter on anatomy (p. 31):

- The presence of two or more cystic arteries is the most common variant. These vessels may pass towards the gallbladder from opposite sides, and at different angles. One of them may be very short thus threatening injury to the hepatic artery during its ligation. Another risk connected with this variant is due to the fact that after ligation of one artery, the other, unrecognized one, may be torn off by cysticus traction.
- An anomalous course of the cystic artery is also encountered frequently. Instead of lying behind the common or cystic duct, it crosses in front of them.

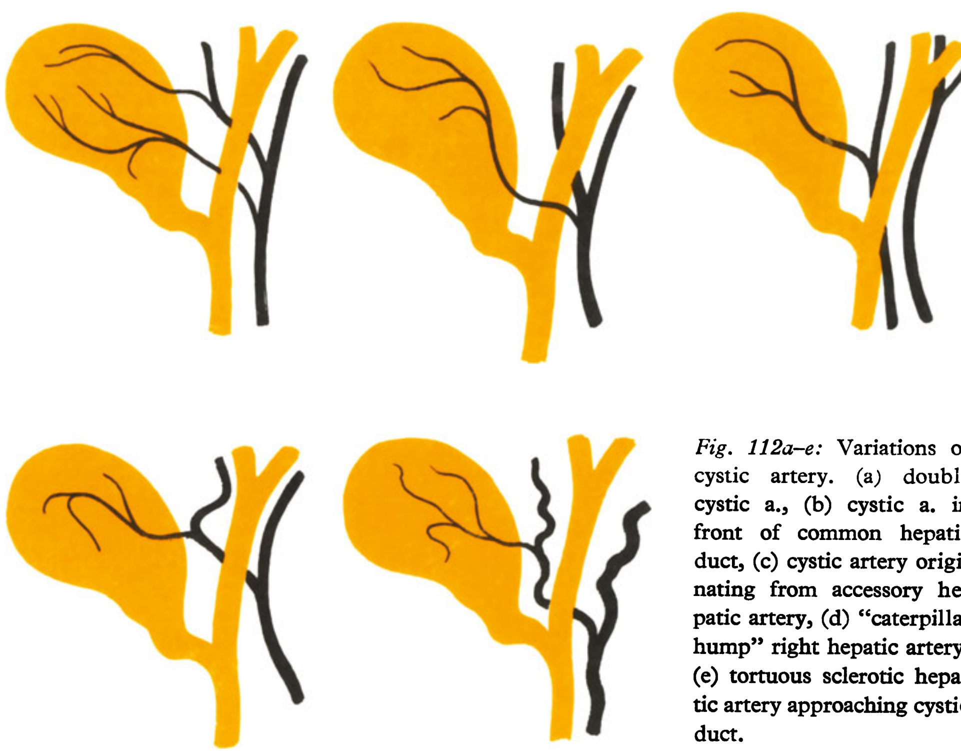


Fig. 112a–e: Variations of cystic artery. (a) double cystic a., (b) cystic a. in front of common hepatic duct, (c) cystic artery originating from accessory hepatic artery, (d) "caterpillar hump" right hepatic artery, (e) tortuous sclerotic hepatic artery approaching cystic duct.

- Another important variant is an accessory hepatic artery giving off the cystic artery with which it may be confused.
- A rare but dangerous abnormality is the so-called "caterpillar hump" right hepatic artery, the loop closely adjacent to the cystic duct and thus exposed to inadvertent ligation.

– A similar anomalous right hepatic artery course might also be due to pathological lesions, the sclerotic tortuous artery approaching close to the cystic duct, giving the impression of being the cystic artery. Fig. 112.

The isolation and ligation of the cystic duct follows on that of the cystic artery. An attempt is made to expose its whole length up to the junction with the main bile duct.

During cystic duct dissection it must be borne in mind that its length and mode

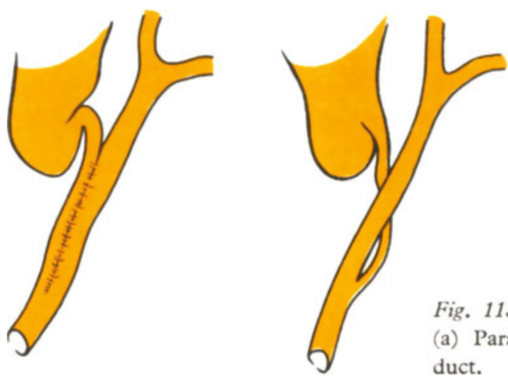


Fig. 113: Variations in cysticus course: (a) Parallel, (b) spiral behind common duct.

of union with the common hepatic duct is variable. The three main types, angular, parallel and spiral, have already been described in the chapter on anatomy (p. —, fig. —). – Most often the cystic duct measures 2–5 cm in length and passes towards the common duct obliquely from the right and from in front. However, sometimes it is extremely short or, on the contrary, runs for a certain distance parallel and adhering to the hepatic duct. In such a case there is danger of tearing the hepatic duct during excessively zealous dissection of common connective tissue fibres, even though such a tear might be minute. Not uncommonly a long cystic duct crosses the hepatic duct in front or behind and enters it more deeply from the left. Fig. 113.

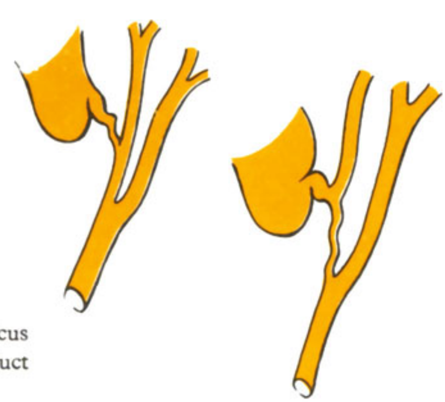


Fig. 114 ab: Anomalies in cysticus course: (a) cysticus joining segmental hepatic branch, (b) segmental duct opening into cysticus.

Only exceptionally does the cystic duct extend behind the duodenum and a curiosity is its independent course into the duodenum or its doubling. Not quite so rare, and a very dangerous anomaly is union of cystic duct with the segmental hepatic duct, or on the contrary, opening of a hepatic branch into the cystic duct, or sporadically, directly into the gallbladder. If the situation is not correctly interpreted a mistaken ligature may be placed. Fig. 114.

Apart from anomalies, some deviations may be of pathological origin. A special case is the so-called "confluence stone". A stone wedged in the cystic duct may widen it considerably and so occupy the space that it lodges directly in the junction of the cystic and common duct. The choledochus may be confused with the cystic duct. Fig. 115.

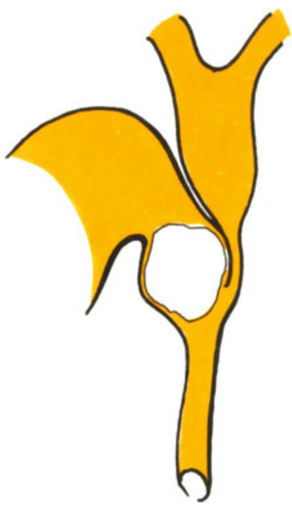
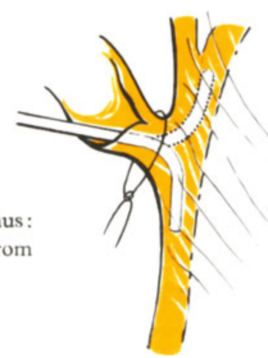


Fig. 115: Wedged junction stone. Choledochus may be confused with the cystic duct.

If we wish to prevent injury to the main bile duct vis-à-vis such variability in cysticus union, prior identification of the common bile duct by some simple method should always be tried (p. 127). *Fig. 116.*

Fig. 116: Verification of choledochus: (a) By puncture, (b) by probing from the gallbladder.



After its meticulous dissection the cystic duct is tied, close to the gallbladder and partially cut with scissors under the ligature. Its contents are expressed manually, or by means of a small artery forceps to prevent any calculus being left behind. *Fig. 117.* Note is taken of the appearance of the choledochus bile and the pressure under which it flows.

Now the cystic duct is clamped and divided and the gallbladder re-

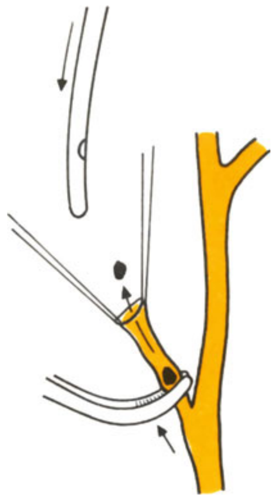


Fig. 117: Massaging out the cysticus contents before probing or ligation to avoid leaving a small calculus behind.

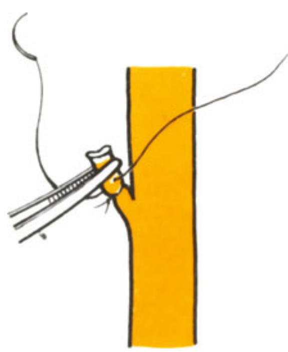


Fig. 118: Ligation and through-suture of cysticus stump.

moved. The latter is immediately cut open and its contents examined, a step which sometimes influences our decision about cholangiography or choledochus probing. The entire gallbladder is always sent for histological investigation, in view of the possibility of carcinoma. Peroperative biopsy from a suspicious site need not be reliable.

The cysticus stump is employed, as a rule, for cholangiography, debimetry or choledochus exploration prior to its ligation and according to the results obtained the operation is terminated.

The cystic stump held by long slender forceps or sutures is doubly ligated – ligation should be performed close to the choledochus, but must not draw its wall into the ligature. Particular care is exercised with a wide cysticus which must not be tied flush at its junction with the common duct. In a long stump, on the other hand, inflammation might persist and a stone be formed. The first ligature, usually silk, is applied in the groove left in the cystic duct by artery-forceps compression about 0.5 cm from the choledochus, the second peripherally from the first – usually a silk suture – ligation. Catgut is sometimes recommended, but so far we have failed to observe the elimination of non-absorbed ligatures or their migration into the common bile duct. *Fig. 118.*

Peritonealization of gallbladder fossa

This step is best taken after gallbladder removal, preferably during the time required for the development of films that may have been taken. Borders of the serosa left on the liver are closed with fine stitches or a continuous suture. The latter is preferable with slight bleeding from the peritoneal borders or from the fossa. If the serous flaps are absent, or the fossa lacerated, closure is made with strong catgut sutures inserted with a large blunt or round-bodied needle. If the

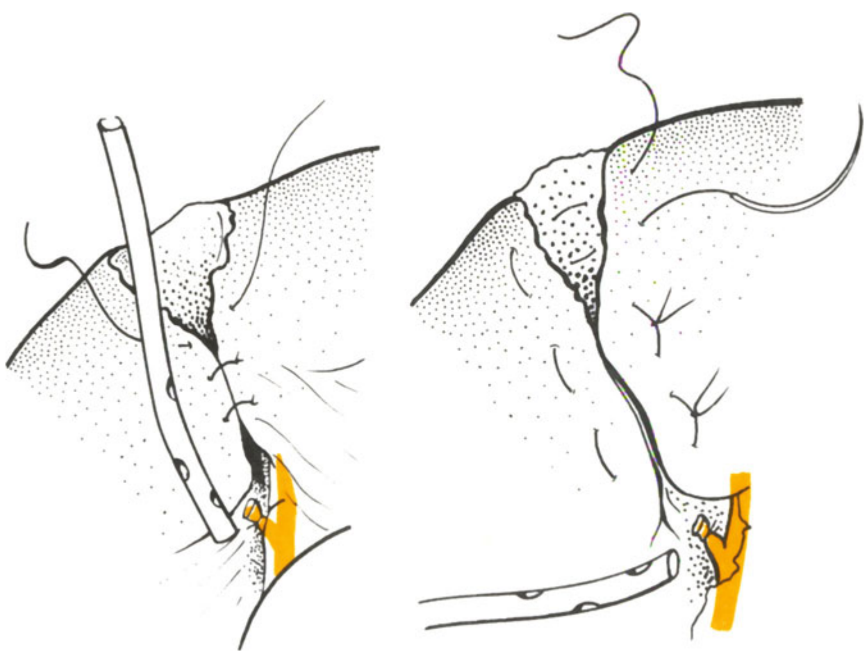


Fig. 119: Peritonealization of gallbladder fossa and subhepatic drainage. (a) Suture of serosal border and placement of drain brought out through the wound, (b) parenchymatous suture of fossa and lowest point drainage after Morrison.

fossa is thus firmly closed by deep mattress liver sutures or carefully covered with peritoneum, adhesions to neighbouring organs are less likely. *Fig. 119.*

The peritoneal cover above the cystic stump and the denuded portion of the main bile duct is sutured only partially and loosely, preventing damming up of leaking blood or bile and compression of the choledochus. If the hepatic duct was lacerated during cysticus dissection, the stump of the latter may be applied over its suture.

Drainage

Drainage is necessary even after simple cholecystectomy by a thin suction drain, preferably Redon drain, and this is omitted only in selected cases. Some writers object to systematic drainage, but such a course is more hazardous (p. 149).

The drain is applied to the gallbladder fossa, but should not press on the ligated cystic duct. It is brought out directly through the operation wound or separately through a stab incision, according to the position of liver and incision. It is usually connected to a suction flask or low pressure suction pump. If there is no secretion the safety drain is removed on the 2nd–3rd day.

Advantages of orthograde cholecystectomy:

- It may be employed in all situations, even with an enlarged gallbladder or one with adhesions.
- Ligation of vessels close to the gallbladder, as they are encountered, step by step, protects against variants of the cystic artery and against mistaking them for other arteries.
- Primary dissection of the gallbladder from its fossa facilitates isolation of the cystic duct and dissection in Calot's triangle.

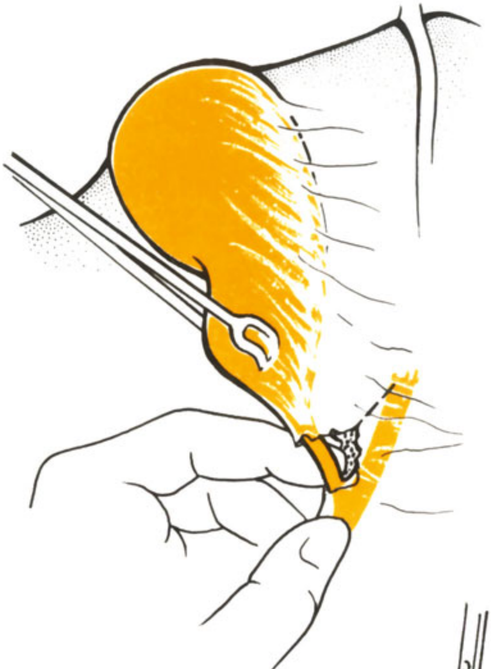
Disadvantages:

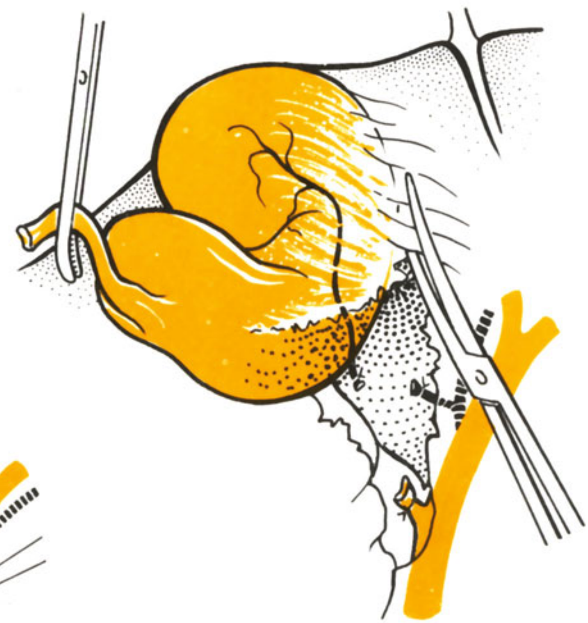
- During manipulation of the gallbladder before ligation of the cystic duct a small stone might escape into the choledochus.
- Dissection of the gallbladder from its fossa may cause some hemorrhage.
- Excessive traction on the gallbladder might tear its artery or the cystic duct.

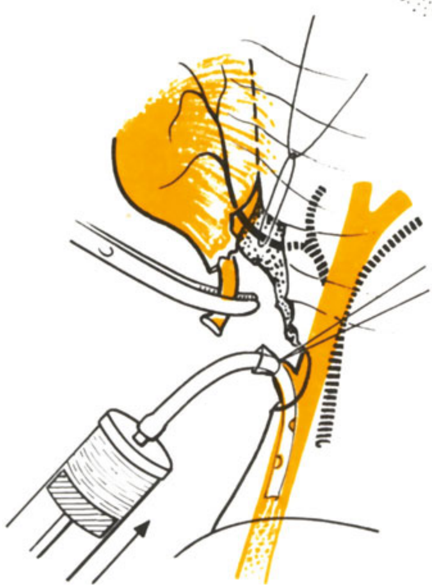
RETROGRADE CHOLECYSTECTOMY

This commences with the identification and ligation of the cystic duct and artery and the gallbladder is mobilized in the direction from choledochus towards fundus.

Fig. 120abc: Retrograde cholecystectomy. (a) Dissection of cysticus, (b) division of cystic duct and cholangiography, (c) ligation of cystic artery and subserous dissection of gallbladder from its fossa towards fundus.







Isolation of cystic duct. Dissection is facilitated by traction on the gallbladder and retraction of the duodenum. The peritoneal covering above the border of the hepatoduodenal ligament is incised and separated, and the cystic duct exposed by cautious blunt dissection. It is sometimes preferable to identify it at its origin from the gallbladder, but its entire length is then exposed to its union with the common bile duct. Its previously described variants are in any case respected. As soon as feasible the cystic duct is ligated or caught in a small right-angled clamp close under the gallbladder and divided under the ligature. Cholangiography, if required, may be performed at once or following removal of the gallbladder. *Fig. 120.*

Dissection and ligation of cystic artery. During the retrograde procedure the frequent above mentioned arterial variations must be kept constantly in mind. The most common mistake is inadvertent ligation and division of the right hepatic instead of the cystic artery. With the retrograde procedure particularly, there is a temptation to ligate the cystic artery further away from the gallbladder and this might cause faulty ligation or injury to another vessel.

No artery must be ligated before making sure that it enters the gallbladder wall. The cystic artery is usually thinner, with a diameter of 1–2 mm, whereas hepatic arteries are 3–5 mm in thickness. If the arteries cannot be adequately identified in Calot's triangle, the orthograde procedure should be adopted in preference.

After division of the gallbladder pedicle subserous mobilization of the gallbladder is undertaken, holding it by the cystic duct and turning it upwards. Dissection is made easier because arterial hemorrhage is less, venous hemorrhage from the fossa is, however, possible.

In a modification of retrograde cholecystectomy the cystic artery and duct are ligated at the start, but the gallbladder is then mobilized in "fundus down" fashion.

Advantages of retrograde cholecystectomy are as follows:

- The operation produces less hemorrhage.
- Cholangiography and manodebimetry can be perfomed at the beginning of the operation without great influence on its result.
- The time taken for developing X-rays may be exploited for completing cholecystectomy.

Its disadvantages are as follows:

- An enlarged or fixed gallbladder impedes access to Calot's triangle.
- The risk of injury to vessels and ducts if variants are present is greater.
- Most accidents and threatening sequelae of cholecystectomy have their source in the retrograde procedure tempting the surgeon to proceed precipitately.

Comparison of both methods reveals that orthograde cholecystectomy can always be used und carries less risk. Frequently, however, it is immaterial which of the two methods is used. It may be a question of custom, but the conclusion of the operation must be the same in both cases: a perfect view of the operation field and its painstaking final revision in order not to overlook any error or injury (Moynihan).

ATYPICAL MODES OF CHOLECYSTECTOMY

In some special cases accurate adherence to any of the presented modes is not possible. This is the case particularly in the following:

Gallbladder distended with stones practically without bile whose wall tears. Puncture is useless. The gallbladder is opened and most of the stones removed, then dissection is done over an inserted finger or a gauze swab introduced into the gallbladder to make its manipulation easier.

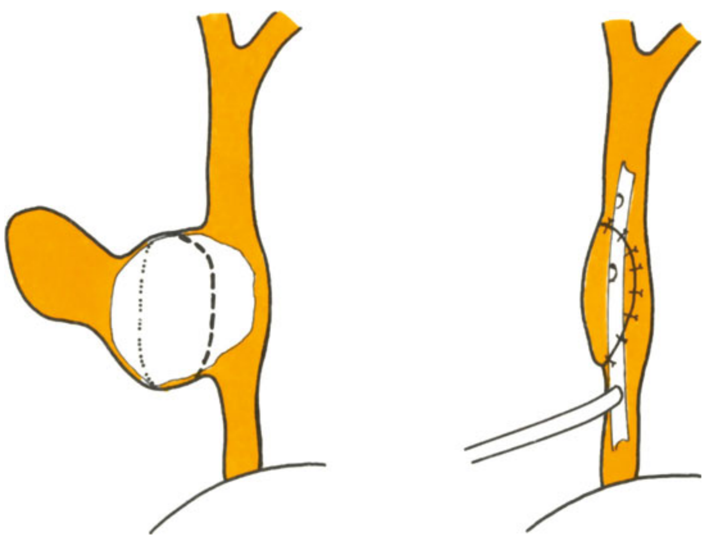


Fig. 121: Junction stone. Its extraction and removal of gallbladder with preservation of part of its wall; plastic cover of wide opening in the bile duct left by the expended cystic duct; T-tube inserted separately.

Gallbladder with a "confluence stone". If such a wedged junction calculus is suspected the gallbladder should be incised over it, the stone removed and the positions of choledochus and hepatic duct ascertained by probe. Otherwise the choledochus, erroneously taken as part of the gallbladder may be divided by mistake, or even resected. – The wide opening in the common bile duct is covered by means of the remaining gallbladder wall and a thin T-drain introduced into the reconstructed choledochus by a separate incision. *Fig. 121.*

Contracted gallbladder. Subserous dissection cannot usually be done, the shrunken gallbladder and liver bed tear and bleed. If the gallbladder is very small, empty and embedded deeply in the liver, it may, exceptionally, be left in position, but the bile duct is treated. It is itself the source of symptoms in such cases.

If we attempt the removal of a contracted gallbladder, it is mobilized very gingerly over an inserted finger. If the region is obscured, it may be preferable to verify the course of the hepatic duct by a probe, introduced if necessary through a separate bile duct incision. *Fig. 122.*

If dissection of neck and cystic duct in firm adhesions is dangerous, or even impossible, the remainder of the gallbladder or its neck are left behind.

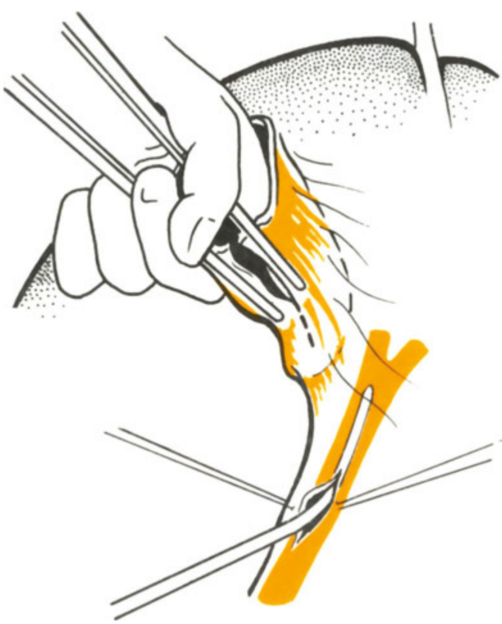


Fig. 122: Dissection of gallbladder embedded in adhesions over inserted finger. Information about the position of choledochus is obtained by probe introduced into it through a separate incision.

The mucosa is cauterized or scraped off and a drain inserted, even though the cystic duct appears obliterated. If bile flows from the cystic duct a T-tube is inserted into the choledochus by separate incision and left for as long as bile continues to drain from the cysticus.

Biliary fistula may be encountered unexpectedly during elective cholecystectomy. It is most commonly situated between gallbladder and duodenum, more rarely between the former and colon or stomach. It is usually narrow, even after the passage of largish stones. The gallbladder is separated from the appropriate viscus in such a fashion as to preserve the wall of the latter as much as possible, the fibrotic borders of the fistula are excised and reliable suture performed. It is essential to explore the choledochus in case the fistula was compensating its obliteration, ensuring free bile flow into the gut.

If the gallbladder has perforated into the choledochus producing a biliobiliary fistula, an attempt is made to preserve part of the gallbladder wall at the fistula border. This is used to cover up the choledochus defect. Procedure in the presence of a "confluence stone" has already been described.

Acute and urgent cholecystectomy

These are characterized by some special features, although no basic difference exists from "elective" cholecystectomy. Tissues are very sodden and edematous, a fact which facilitates the shelling out of the gallbladder from its fossa. On the other hand its wall is fragile, even gangrenous and vessels, cystic duct and choledochus may be injured more easily, as they may be adherent and tear readily. The swollen gallbladder impedes a clear view and the orthograde procedure is preferable. It is particularly advisable to evacuate the gallbladder by aspiration and to instil antibiotics, such as neomycin. A fragile or already perforated gallbladder, is held in a surgical pack and exudate as well as bile from its neighbourhood is gradually removed by suction, and dried off.

Even in cases of acute cholecystitis operative cholangiography may be performed, the common bile duct must be investigated reliably and any stones removed. (Carlsen, 1977, Pantsyrev, 1978). The choledochus and the pancreaticoduodenal region are treated circumspectly and awkward interventions on the papilla are not undertaken unnecessarily. If accompanied by pancreatitis, and in other risky situations when urgent operation cannot be prolonged, we must provisorily be satisfied with a T-tube. Cholecystectomy is deferred only exceptionally, however, but in such cases temporary cholecystostomy is preferable to partial excision of the gallbladder.

A difficult situation might be encountered if a large abscess in the gallbladder neighbourhood is entered. The radical excision of omentum and other severely inflamed infiltrated tissues is not always useful and may be dangerous. We must, however, search for stones which have penetrated into the adjacent abdominal cavity and must remove them to prevent continued suppuration.

At the end of the operation antibiotics are applied to the operation field, and these are also administered generally according to susceptibility test results. The subhepatic region of the liver undersurface is drained, according to circumstances, by one or several suction drains.

The procedures in some other biliary emergencies are dealt with later (p. 442).

Associated operations with cholecystectomy

During cholecystectomy pathological lesions of other abdominal viscera may be encountered. The question then arises whether they should be treated simultaneously.

The following guide lines are adhered to:

- Operations for malignancy have priority over cholecystectomy.
- Appendectomy is performed simultaneously only if lesions after previous inflammations are found. A healthy appendix is not systematically removed.
- Operations for peptic ulcer: the decision is subject to considerations about their urgency and patient tolerance for both operations; if the combined operation can be tolerated a chronic ulcer is always submitted to suigery, even though the patient reported no symptoms. If both operations cannot be supported, operation of a gastric ulcer usually takes precedence, particularly if malignancy is suspected. In duodenal ulcer the biliary operation may have priority, if the choledochus is involved to such a degree that its operation is essential. Otherwise both: cholecystectomy and selective vagotomy combined by antrectomy or pyloroplasty with excision of ulcer are performed.
- Pancreas operations take precedence if a growth is present, in chronic pancreatitis on the other hand cholecystectomy is primarily indicated.
- In paraoesophageal hiatus hernia operation is always added, but in sliding hernia only if symptoms are pronounced. Both simultaneous operations must be supportable.

Prognosis and results of cholecystectomy

Cholecystectomy for lithiasis is currently one of the commonest abdominal operations and its surgical mortality has almost generally declined steeply to below 1%. Statistical data from the Charles University Surgical Department in Prague Motol comprising 4 119 elective cholecystectomies undertaken for non-malignant disorders confined to the gallbladder for the 1950–1974 period is as follows:

Inflammation was present but no stones were found in 128 cases (3.1%). 2 patients were operated on for dysfunction and 9 for cholecystosis. The gallbladders of all the remaining patients contained stones associated with inflammation (96.6%). – Surgical mortality in this series declined from the original value of 1.2 to 0.4 per cent. On the contrary, even for simple operations on the bile ducts mortality still stands at 1.6%.

The causes of death in the 26 patients following simple cholecystectomy were as follows: cardiovascular or pulmonary complications in 10 cases, cerebral vascular incidents in 2, diabetic complications likewise 2, and one case each of acute pancreatitis, renal failure and leukaemia. As generally stated, the author's series also displayed an obvious correlation to advanced age (17 cases were over 60 years), all the more striking, as simple cholecystectomy concerns patients whose bile ducts have not yet been involved. Cholecystectomy, if indicated, should thus not be deferred after the age of 50 years.

The present author's attitude towards so-called "acute cholecystectomy" has been positive during the past 7 years. The 298 early procedures did not differ as regards mortality from the elective operations, provided the necessary conditions were adhered to. This does not apply, of course, to the emergencies not included in this review, emergencies which every surgeon must tackle, even the partisans of conservative management who otherwise prefer to wait for acute cholecystitis to subside. These emergencies are frequently accompanied by biliary peritonitis and thus carry a high mortality.

Morbidity following simple elective cholecystectomy has not been accurately determined, but is not great. Apart from complications in common with other abdominal surgical procedures, interference with wound healing is most frequently encountered. Evidence of the much-feared surgical injuries to bile ducts or vessels was recorded in about 0.2% of cases.

Late results of correctly indicated cholecystectomies are excellent, and the loss of the gallbladder per se causes no difficulties. A post-cholecystectomy syndrome sensu strictiori does not exist. Persistent, or fresh postoperative symptoms are due to disorders of different origin, or due to a new, or overlooked biliary complication which has to be searched for.

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BILE DUCTS DISEASES AND THEIR SURGERY

Choledocholithiasis

Choledocholithiasis signifies not only calculi in the choledochus, but frequently, albeit inaccurately, calculi located in any of the ducts. This is due to the fact that their exact location in the ducts may not be known, and if mobile, they may change their position.

Of the 5 490 primary operations for benign biliary diseases performed at the Charles University Department of Surgery in Prague-Motol over the years 1949 to 1974 choledocholithiasis occurred in 20% of patients. Stones were found in 85% of 1 371 primary duct operations and in 54% of 538 reoperations. This makes gallstones the most common finding in duct operations and their important role in diseases involving the ducts is therefore self-explanatory.

Etiology and morphology

Such stones have mostly originated in the gallbladder and choledocholithiasis is the most common complication of cholecystolithiasis. Even a contracted, "burned out" and empty gallbladder bears the mark of their departure. Small and medium sized stones may traverse the cysticus, large ones are extruded into the duct through a wide fistula. Their shape and number varies; at operation sometimes only a few small stones or grit are flushed out, in others, the choledochus is literally paved with them. Even in post-cholecystectomy patients, overlooked gallbladder stones as borne out by their cholesterol content are as a rule involved.[63]

Amorphous pigment material with mucus, so-called biliary debris, precipitates directly in the ducts only from stagnating bile, particularly in the presence of infection. New stones may form from it, initially smeary and crumbly, but later firm. Exceptionally they may be polyhedric, and as a rule rounded large solitary stones take the shape of a duct cast or prepapillary plug. Pigment salts are deposited mainly in front of an obstacle, but also on sutures, parasites, and particularly on gallbladder stones already present: enlarging them, softening their surface and changing their shape. Only stone section reveals how it was altered and how it grew by accretion.

It may prove difficult or even impossible to decide at operation whether a stone originated in the gallbladder or whether it was formed primarily in the duct. In the era before postoperative check cholangiography shook the self-confidence of the surgeon that his operation carried the guarantee of complete removal of all stones, he was always inclined to consider stones found at reoperation as newly formed, although the majority were in fact overlooked stones. If stones are identical with those in the removed gallbladder this is strong evidence for residual stones. Ortherwise, according to Troturan 1977, the distinction between pigment and cholesterol mixed concretions can be made more advantageously by qualitative infrared spectroscopy, than by chemical or radiological methods.

Incidence and seat of stones

The incidence of choledocholithiasis is difficult to estimate. It is important for the surgeon to know at least how often he must reckon with their presence at operation for cholecystolithiasis. The finding of choledocholithiasis at operation increased with the practice of systematic and accurate bile duct exploration, but decreases with the wider indications for early cholecystectomy.[38, 118, 126] The presence of stones in the biliary tract at cholecystectomy is stated to amount to 5–20% and more. Their incidence is higher with a long medical history and in elderly subjects. In our own operation series they were encountered during the last ten year period in 14% of cases, but after the age of 65 however, the incidence was 23 %.

Stones are most often found in the common bile duct, but in about 10% of these operation cases they are also present in the hepatic ducts (Hess 16%, Kune 8%), particularly in multiple choledocholithiasis. Stones arising inside the liver in congenitally dilated segments of the bile ducts occupy a special position. "Intrahepatic lithiasis" is a unique, in most cases exotic oriental disease. It is characterized by the formation and accumulation of large numbers of small stones in part of, or even in the entire biliary tract for reasons not yet clearly understood, in cases of infestation cholangitis or even where this is absent.[6]

Fate and sequelae of choledochotithiasis

Stones may merely pass through the common duct into the gut, and sometimes they remain in the duct. They move about freely, or they accumulate, or one stone becomes temporarily or permanently arrested in the sphincteric portion or proximal to it, and may thus obturate the duct. The presence of stones in the biliary tract is not irrelevant even if they happen to be mobile and "silent". Only smaller stones can pass into the intestine without damaging the duct, and this happens more often than is commonly thought. The main bile duct may remain slender at first. Later, however, it becomes dilated and thickened as a rule, losing its elasticity, particularly if it becomes obstructed or packed with stones.

If they repeatedly pass through the papilla or are arrested in the sphincteric portion, not only transient spasm and edema of the papilla are caused, but after a time fibrotic changes and stenosis set in. This is found much more often than with simple cholecystolithiasis and the etiological connection is here quite obvious. If on rare occasions a large wedged stone passes through, the papilla, on the contrary, gapes widely, even though it may likewise be somewhat rigid.

In some cases induration of the pancreas close to the common bile duct also occurs; this was designated as "pancreatitis paracholedochica" by the author. In certain situations even minute stones impacting or only passing through the papilla may provoke attacks of acute pancreatitis with transient or permanent lesions in the pancreas and its neighbourhood. Chronic fibrocystic lesions in the head of the pancreas sometimes compress and deform the terminal bile duct and may lead to the so-called "tubular" stenosis of its pancreatic segment.

Plugging of the duct by a stone even of large size is, as a rule, even typically incomplete and frequently transitory, but each instance of impeded bile flow creates favourable conditions for infection, which in its turn intensifies any mechanical damage. Complete obstruction and permanent jaundice, as in cases of neoplasm, is a rare event. It is characteristic of lithiasis that it produces dilatation of the ducts, but not as with tumours of the gallbladder. The reason is that the gallbladder in lithiasis has lost its elasticity, may be fibrotic and the cysticus may sometimes be blocked. In any case, the ducts in most cases do not attain such a degree of dilatation as in neoplastic obstruction, as they have lost their elasticity as a result of inflammation.

The liver remains unharmed for long periods in choledocholithiasis, but suffers through repeated bile stasis and cholangitis spreading into hepatic branches. If stones are not removed from the duct in time, and flow restarted, protracted choledocholithiasis may induce biliary hepatic fibrosis and, rarely, even genuine secondary biliary cirrhosis.

Clinical pattern

The course and sequelae of lithiasis as described is naturally reflected by clinical symptoms, but no systematic parallel exists between the two. Urgency and character of complaints does not depend so much on the size and number of calculi in the ducts, but more on their mobility and position, mainly in relation to the papilla. A single smallish wedged stone may even produce complete obstruction or severe pancreatitis, whereas "paving" by large multiple calculi may long remain clinically silent.

The main symptoms of choledocholithiasis comprise: pain, fever and jaundice, its main complications are stenosis of papilla, tubular stenosis, biliary pancreatitis and secondary liver damage.

Pain is of biliary colic character and cannot be distinguished from pain arising in the gallbladder. More often, however, than with cholecystolithiasis, it is felt high up in the epigastrium. One of its rare and malignant variants is excruciating pain following sudden obturation of the orifice, the so-called "papillary ileus".

Fever is due to bacterial cholangitis and is of septic character, typical for choledocholithiasis. Less typical are lower spikes of fever, accompanying attacks of colic. They may be distinguished from fever accompanying cholecystitis by its shorter duration.

Jaundice is always cholestatic in character. Closure is incomplete as a rule and its intensity, manifested chiefly by bilirubinemia level, fluctuates. Complete obstruction of insidious development, without colic, cannot clinically be differentiated from tumour.

The patient submits to operation either in the presence of jaundice, or jaundice forms an important item of the past medical history in about one half of cases. Suspicion is aroused not only by every instance of transient jaundice, but also by fleeting subicterus, particularly if often repeated. Choledocholithiasis however, by no means always manifests itself by jaundice. Cases have been reported where, despite an accumulation of stones, "bile flowed freely over the stones like a mountain brook" (Kehr). Even severe forms may run an anicteric course, particularly if lithiasis is associated with internal biliodigestive fistula.

Episodes of cholestatic jaundice may also at first be fully reversible, and fluctuating increases in blood enzyme activity are more significant for establishing a diagnosis of choledocholithiasis, than as a sign of liver damage. They may be detected in at least 50% of cases at least transiently following attacks of colic, and constantly following episodes of cholangitis. However, only permanently raised levels of these biological values may signalize the danger of liver damage, even before clinical manifestations of cholestasis by jaundice. The evolution of biliary fibrosis of the liver possesses no clinical pattern of its own and can be detected only by morphological investigation and by laboratory evidence of chronic cholestasis. In some patients, however, liver damage accompanying choledocholithiasis may manifest itself, even in the absence of jaundice, by troublesome pruritus escaping pathogenetic recognition for a long time. Thus the surgical risk in choledocholithiasis cannot always be correctly assessed by merely judging the duration and depth of jaundice, but may also be influenced by liver damage due to subclinical cholestasis present for an undefined period.

One of the most common complications of choledocholithiasis is stenosis in the sphincter of Oddi region, in particular affecting the papilla. It can hardly be distinguished clinically from choledocholithiasis as such, but it presents such special problems that an independent chapter is devoted to it.

Similar considerations apply to the slender tubular stenosis of the pancreatic bile duct segment including attacks of acute or relapsing pancreatitis, which will be dealt with independently. They usually represent indirect clinical manifestations of choledocholithiasis, sometimes silent up to that time. Suspicion as to their biliary origin, however, is aroused if signs of lithiasis are also present.

COURSE AND PROGNOSIS

The course of choledocholithiasis proper is highly variable, with intermittent symptoms and asymptomatic intervals of variable duration. These symptoms sometimes differ only quantitatively from cholecystolithiasis, thus the pattern of both diseases may merge. It is as a rule not possible to establish when stones have penetrated into the bile duct, and they may surprise us there during operation, possibly even after the first colic. We likewise fail to recognise the onset of some of the complications such as developing stenosis of the papilla.

Symptoms of choledocholithiasis may be variously combined, but also may be present entirely separately, such as e.g. jaundice or chronic sepsis. Their completeness and the incidence of complications is correlated mainly to the duration of the disease. Choledocholithiasis is usually a chronic complaint and only intermittently does the character of its symptoms create the impression of its acute origin. Sometimes, it may become manifest even after years of latency, when its first biliary manifestations have already been forgotten, but only quite exceptionally do the stones remain permanently silent.[117] Once the patient has suffered his first attacks of cholangitis these tend to be repeated and fail to disappear as a rule.

The prognosis of choledocholithiasis is thus uncertain, but as a rule serious. Stones in the choledochus produce symptoms more frequently and also mainly more severely than is the case with simple cholecystolithiasis. But even during the latent phase they are by no means negligible and may be insidious: a stone lying silently in the duct for a long time may surprise an elderly patient by causing jaundice or fatal pancreatitis. Even a "stone paved" duct may remain symptomless for long periods and be accompanied by the insidious development of secondary biliary cirrhosis, which manifests itself by hemorrhage from varices and hepatic insufficiency. It is true, on the other hand, that some stones, even large ones, may pass through the papilla spontaneously. They sometimes slip through silently, sometimes symptoms disappear after a dramatic interlude. We have also observed patients with proven stones in the duct who refused operation and have remained symptom free. Such instances, however, cannot affect the principle that every stone shown to be present in the bile duct should be removed in time. Their recognition before the operation, however, may prove difficult.

DIAGNOSIS

Diagnostic procedure in choledocholithiasis differs according to whether we are dealing with an anicteric, not yet operated patient, or whether we entertain surgery in a patient with jaundice or a reoperation for suspected residual or newly formed stones. Problems of obstructive jaundice and reoperations are treated in their respective chapters.

Here we are dealing with differential diagnosis in the most common situation, i.e. in anicteric patients with cholelithiasis. A suspicion of the presence of concrements in the common bile duct is aroused here in the first place by an analysis of the clinical pattern, the most specific feature being cholangitic manifestations. Transient jaundice may occur even in disease limited to the gallbladder, but intermittent and protracted obstruction in the absence of a palpable acutely inflamed gallbladder is usually in favour of stones present in the duct.

Likewise the finding of raised enzymatic activities justifies a diagnosis even in cases where the bile duct fails to be shown by cholecystography – this occurs in 10–20% of choledocholithiasis cases. Otherwise, however, direct evidence of stones may sometimes be provided only by intravenous cholangiography. Stones may be hidden, however, in the opacity of the dilated duct, and thus escape recognition in up to 50%, this applies particularly to little calculi in the distal choledochus. Though every choledochus wider than 10 mm must be suspect, not even a dilated duct is always a reliable guide; it may be present even without obstruction, and on the contrary in not very advanced disease stones may be present in a normal or only slightly widened duct. Endoscopic cholangiography, a far more reliable method of detection, would be probably entertained only exceptionally preceding a first operation in an anicteric patient.

Not infrequently, therefore, stones are an unanticipated finding at cholecystectomy, particularly in acute interventions, or our "preliminary diagnosis" is corrected and rendered more accurate only following surgical exploration of the bile duct.

The syndrome of incomplete choledochus obstruction

The clinical pattern of choledocholithiasis is nonspecific, and, in addition, stones may be frequently combined with obstructions of another type, particularly stenosis of the papilla or, more rarely, with choledochus compression accompanying pancreatic lesions. Symptoms produced by the various types of obstructions are similar, biochemical results uncharacteristic, and the basic diagnostic method, intravenous cholangiography is not sufficiently reliable as a rule for their distinction – according to Blumgart (1978) it provides sufficient information in hardly 40% of anicteric patients. An accurate picture of the true state is thus difficult to obtain even in the absence of obstructive jaundice.

Prior to cholecystectomy a simpler situation exists, in view of the fact that cholecystolithiasis by itself may make intervention advisable. It is advantageous, however, if the surgeon is aware in advance of lesions to be expected in the bile ducts. Accordingly, if there is evidence of their involvement, but demonstration of calculi has failed, we make do with at least a comprehensive diagnosis of the "incomplete bile duct obstruction syndrome" prior to intervention on an anicteric patient. The anatomical character of the obstruction, e.g. choledocholithiasis, may be suspected from clinical evidence, but a precise diagnosis is deliberately left until surgical exploration has been made. Such a comprehensive diagnosis could be confirmed in almost 90% of the writer's surgical series, calculi were usually at the root of the matter, either alone or with stenosis of the papilla and sporadically with tubular stenosis.

Treatment of choledocholithiasis

PREVENTION

The passage of calculi from the gallbladder into choledochus can only be prevented by timely cholecystectomy and the formation of new stones in the ductal system only by the attempted removal of all obstructions, foreign bodies, stones and inflammation included, and by maintaining an unobstructed bile flow into the gut.

NONSURGICAL TREATMENT

Stones lodged in the ducts cannot yet be disolved reliably, nor can their passage be effectively facilitated. The latter may only be attempted in cases of stones left behind after operation with the drain still inserted in the choledochus. In some suitable cases the drain may be utilized for their instrumental removal. In recent years another method has been devised: small, overlooked stones may be removed by means of duodenoscopic papillotomy. All these techniques which are only used after surgery will be discussed in detail in the chapter on "overlooked" stones (p. 498).

Lately duodenoscopic papillotomy is being performed in cases of choledocholithiasis not yet submitted to surgery in view of an excessive surgical risk. Endoscopic intervention dispenses with the stress of the operation and postoperative immobilization of the patient. According to Manegold (1976) this method, without prior cholecystectomy, is justified chiefly in aged, debilitated persons with hyperbilirubinaemia in the region of 20 mg %, or those threatened by renal failure. It is contraindicated in the presence of coagulation disorders, pancreatitic attacks and apparently also in cases with parapapillary diverticulum.

Duodenoscopic papillotomy can succeed only with stones of small size, up to a diameter of 1 cm (p. 519). It relieves papillary stenosis as well, but not, however, the slender tubular stenosis of the pancreatic segment of the choledochus.

Surgeons are usually reserved vis-à-vis technique where direct surgical control is not feasible, but immediate serious complications have so far been recorded less often than following surgical papillosphincterotomy (Safrany, 1977). Likewise surgical mortality – 1.3% – from a series of 472 endoscopic papillotomy results performed at 9 centres in Germany appears favourable.[12] The number of restenoses will be known when late results become available and these will also provide an opportunity for final assessment of the new technique after a suitable interval. It must also be taken into account that the patient is protected from surgical stress only during the danger period, and that elective cholecystectomy should be performed at a later date.

SURGICAL TREATMENT

The new endoscopic method of treatment of choledocholithiasis is too exclusive to alter the fact that genuine therapy, i.e. removal of stones from the duct, continues to be mainly surgical.

Indications and timing of operations

Surgical treatment, as a matter of principle, is still necessary in every instance of choledocholithiasis, or even in cases of well founded suspicion of bile duct stones, some non-surgical procedures may sometimes be applied only in overlooked stones. Surgery is indicated as a preventive measure even in symptomless cases and if stones are found unexpectedly, either before, or during surgical intervention.

In all cases in which surgery is advised on account of choledocholithiasis or more comprehensively for the "obstructive syndrome", the urgency of the operation must be considered simultaneously:

Surgery is performed, if possible, without long delay in order to prevent complications, but at a time suitable for the patient, and unfailingly only after proper investigation and preparation.

Situations may arise, however, when operation becomes urgent and cannot be delayed, others, when an expectant attitude is possible, or when surgery may have to be abandoned:

Operation is acutely imperative

- in acute septic obstructive cholangitis,
- in sudden papillary blockade with shock,
- with imminent attacks of acute biliary pancreatitis,
- with biliary peritonitis.

Operation is urgent

- in verified obstructive jaundice or with colic accompanied by icterus which fails to subside in a few days, or only fluctuates in intensity,

- with jaundice of obscure origin, if subhepatic obstruction cannot be excluded within three weeks,
- in incomplete choledochus obstruction with evidence of cholangitis,
- in cholelithiasis with chronic cholestasis and danger of hepatic fibrosis.

It is advisable to delay operation

- if proper preparation of the patient for surgery requires it: even an urgent operation may usually be delayed for several days, an acute emergency for a few hours,
- in cases of colic accompanied by jaundice, if there is a persistent tendency to regression: operation is performed after its disappearance, otherwise surgery is not deferred,
- in residual stones known to be present since the operation, surgery should be undertaken after a suitable interval to allow the patient to recuperate, and the operation field to settle (p. 514). Small stones may sometimes be passed spontaneously. However, acute blockage of the papilla would make immediate postoperative revision unavoidable.

Surgery must be abandoned

- as long as the patient refuses consent
- during the period when the patient's condition does not permit it, or the patient is directly threatened by other disease. However, even a daring immediate operation is not contraindicated, if life is in jeopardy from some biliary disorder itself, such as papillary obstruction accompanied by shock;
- it is likewise advisable to defer surgery if the hazard far ecxeeds the danger and complaints due to the stones. It is this last group which apparently will provide most of the candidates for primary endoscopic papillotomy.

STRATEGY

Surgery for choledocholithiasis or "obstructive syndrome" respectively should be performed so as to provide a definitive solution. Its object, in the first place, is to ascertain the presence of stones, stenoses and any other pathological lesions in the ducts. In the second place, all lesions must be dealt with completely and free bile drainage into the gut guaranteed. Cholecystectomy is an integral part of the intervention. During preparation of the patient with duct involvement due consideration must be paid to any liver damage present (p. 99), and also to the greater incidence of bacteriological contamination in the bile (Cox and al., 1978). Particularly with evidence of cholangitis the preventive administration of antibiotics is advisable, ampicillin and gentamycin in combination for 1 or more days prior to surgery.

Surgical procedures differ according to whether this is the first biliary operation in a patient still with a gallbladder, or a reoperation, whether elective or urgent surgery is done, or finally whether the patient is still jaundiced. In this chapter only the procedure used for a first biliary duct operation in an anicteric patient will be presented.

Abdominal incision, exploration and gallbladder removal have already been described (p. 107).

Bile duct operation proper is performed in two phases: explorative and curative. Basic bile duct exploration is identical for choledocholithiasis and the entire loosely defined group of incomplete obstructions, and will be dealt with jointly. The curative phase of the operation will already differ according to the type of disorder found, and will be treated individually in the appropriate chapters.

EXPLORATION OF BILE DUCTS

The bile duct used to be explored previously only if the presence of lesions was suspected. Current practice in many centres is now to explore the ducts systematically in cholecystectomies by means of operative cholangiography, even in the absence of suspected duct involvement. The risk of such routine cholangiography, if it can be performed using the cystic duct, is negligible and sometimes is unexpectedly rewarding, particularly if stones are found. According to personal experience this is the case in 5% of such investigations. Similar systematic debimetry or probing requires larger catheters and does not provide as extensive or reliable information about stones.

If x-rays are not available or cholangiography cannot be performed through the cysticus and would require puncture or incision of the choledochus, preferably only selective exploration should be done, i.e. in cases where stones or other lesions may be encountered with a certain degree of probability. Thus some superfluous routine investigations may be avoided, which would already increase the surgical risk by opening the choledochus with relatively little gain. However, indications for selective exploration should be made as wide as possible (Marks, 1976, Niederle, 1977).

What are these criteria which make exploration of the common bile duct desirable or even necessary?

Pre-operative signs include in particular:

- the known presence of stones in the ducts before surgery,
- subicterus or icterus in the past or recent jaundice persisting at the time of surgery,

- biochemical evidence of anicteric obstruction, typical attacks of pain or cholangitis,
- episodes of pancreatic attacks or recent pancreatitis,
- dilatation or other duct lesions found by radiology or sonography,
- biliary fistula, internal or external,
- protracted, at least 4-years biliary history.

Characteristic intraoperative findings necessitating duct exploration are the following:

- palpable calculi or other suspicious palpable lesions in the ducts,
- a thickened or dilated common duct with a diameter exceeding 10 mm,
- bile under tension in the duct, sometimes cloudy or containing debris and strings of mucus,
- small shrunken gallbladder without stones,
- wide cystic duct or at least wide enough to permit passage of small stones present in the gallbladder,
- a single faceted stone in the gallbladder,
- biliary fistula,
- an anomalous course or arrangement of extrahepatic ducts
- pronounced pancreatic lesions in the vicinity.

This also includes an unexpected positive result obtained by routine operative cholangiography: filling defects, a bile duct wider than 10 mm (Marks and Kelvin, 1976), narrowing or deformation of its terminal segment, impeded contrast medium drainage into the gut (Le Quesne).

Investigation of bile duct: any one of the criteria listed is sufficient to be followed by exploration of the bile duct, even at the price of choledochotomy. A variety of methods is used in combination: cholangiography, cholangiometry, probing with palpation, duodenotomy and choledochoscopy. None of these should be added unnecessarily or omitted. A particular search is made for stones which, however, in at least one-third of cases, are combined with stenosis of the terminal segment, but not infrequently may disclose a practically significant duct anomaly. Investigation, accordingly, must be systematic and complete.

Two extreme views still exist on the question whether bile duct examination should be commenced with probing or cholangiography. Some consider radiology in cholelithiasis to be so superior and gentle, that probing can be omitted altogether, and only cholangiometry is added for the better assessment of papillary patency. Others, e.g. Olivier, Bismuth and Hepp (1976) in contrast, initiate selective investigation solely by probing. Greater weight is attributed to this method even for the demonstration of stones and cholangiography is only added in uncertain situations.

No doubt the particular case is important, but much depends also on the habitual usage of the centre and the skill with which any method is practised.[22, 54, 96, 97, 135] Each one has its advantages and disadvantages:

Cholangiography opacifies the entire ductal system and best demonstrates any stones present, but shows stenoses less accurately even if screening and seriography is used. Some false negative or even false positive results are obtained. Modern technical equipment and the team work of experienced personnel are necessary.

Probing gives good information about impeded patency of sphincteric and pancreatic segments of the main bile ducts, and may sometimes be utilized for clearing the papilla. It is simple and least time consuming, but some stones might escape even an experienced surgeon exercising delicate palpation on the probe. Others, in the hepatic branches, are not accessible at all.

Cholangiometry has lost its former credit. It can only signalize a peripheral obstacle, without, however, distinguishing between stenosis or stones. It can be performed without special apparatus, but should not constitute a formal adornment of investigation, and should be used prior to instrumental intervention in the sphincter of Oddi region.

Duodenotomy and choledochoscopy are likewise only supplementary

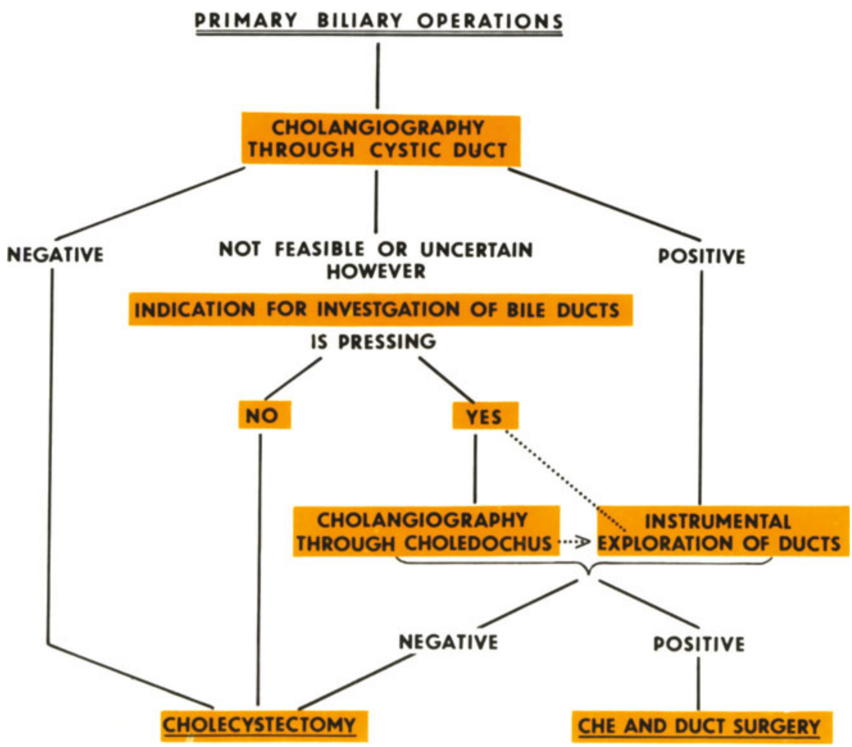


Fig. 123: Sequence of investigations for first biliary operation.

methods. The first is essential, if the papilla must be inspected or surgically treated. Dilated hepatic branches can be adequately checked by choledochoscopy in order not to leave any stones behind.

Order of investigations

Cholangiography as the first step for biliary duct investigation has proved most useful at the author's centre, not without exceptions however. *Fig. 123.*

As set out in the schematic table, surgical cases may be subdivided into three groups:

One comprises patients for whom cholecystectomy is advised, but no grounds for bile duct exploration are present. Nevertheless routine cholangiography via cysticus is always attempted in them. *Fig. 124.* If unexpected stones or other

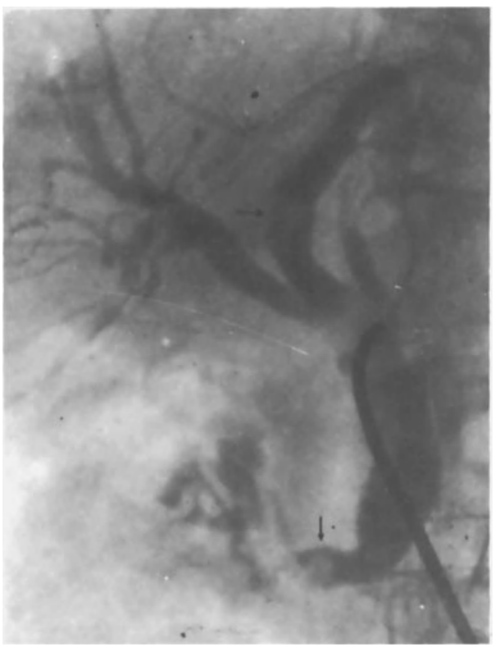


Fig. 124: Routine operative cholangiography revealed stones in the left hepaticus and proximal to papilla in a patient lacking other evidence for duct involvement.

lesions are discovered, investigation is supplemented and cholecystectomy followed by any necessary intervention on the bile duct. If, however, cholangiography via the cystic duct is unsuccessful or findings are normal, any further bile duct exploration is omitted.

The second group comprises cases in whom, according to selection criteria, exploration of the bile duct is planned. If in such cases cholangiography using the cysticus fails, it is performed by direct puncture or incision of the common bile duct and findings checked by probing or some other method. *Fig. 125.*

The third group comprises patients in whom investigation is initiated by immediate probing of the bile duct, either because x-rays are not feasible or films are not adequate, or because in the case in question primary cholangiography

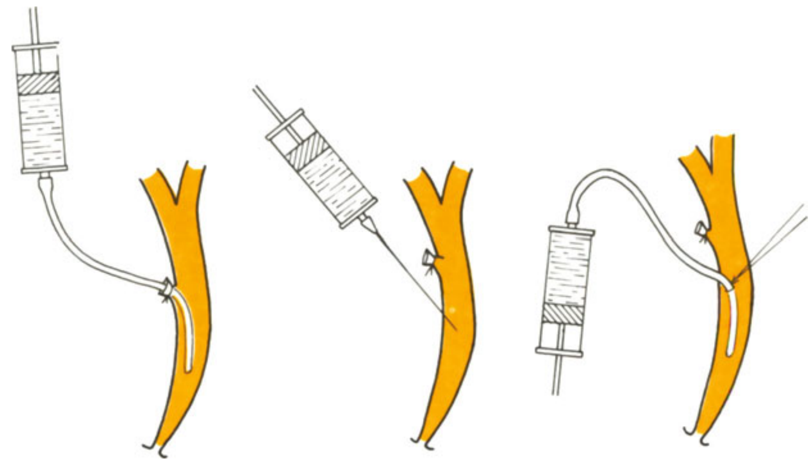


Fig. 125: Primary operative cholangiography: Via cysticus, via choledochus puncture, through catheter inserted by stab incision.

is unnecessary or even unsuitable: for instance in cases of stone packed choledochus or with a large wedged stone. In such cases cholangiography may not be useful until at the time of final revision.

Technique of exploration

Primary cholangiography may precede cholecystectomy or may follow it. In the second case, preferable in the author's view, the gallbladder is removed first and an assessment of the stones ability to pass through the cystic duct is made. The pressure under which the bile flows from it and its appearance are also studied. A sample is sent for bacteriological investigation, a smear may be Gram-stained immediately (Keighley).

A catheter is inserted through the cysticus stump containing no stones, but only for a distance short of the terminal choledochus and tightened by temporary ligature round the cysticus. For cholangiography the smallest calibre catheter suffices, but if debimetry is also to be carried out, or it is to be utilized for probing the papilla, a semi-rigid and at least 3 mm wide one has to be used. *Fig. 126.*

Before taking films any air bubbles present are aspirated from the catheter and the contrast medium e.g. Hipaque in a concentration of 25% is injected manually. Injection is done slowly, at a rate of about 2 ml/sec., more rapidly only if drainage into the gut is unduly sudden (p. 115). Opacification of the ducts is monitored on the x-ray or television screen, registering the rate of flow and taking films at the required intervals. If such control is not available, 2, 4 and 8 ml contrast medium are injected gradually and films taken blindly every time, or seriography performed. The injected volume is adapted to the width, i.e. capacity of the ducts. As a rule an amount of 6–15 ml is sufficient for their opacification,

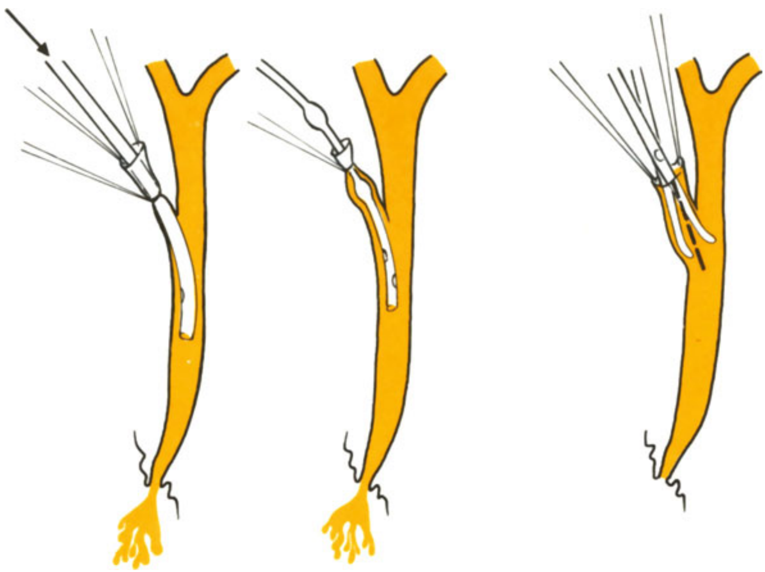


Fig. 126: Operative cholangiography via cystic duct: (a) Fixation of drain or (b) special catheter; (c) splitting of narrow cysticus prior to probing.

in greatly dilated ducts a maximum of 20 ml of contrast medium may be required. Caroli's method of radiomanometry is used by us only exceptionally and we can also make do without the intraabdominal films of the terminal choledochus on small films inserted behind the duodenum below the head of pancreas.

Before film processing is finished the gallbladder fossa is repaired and sometimes debimetry performed by an extremely simple method using normal saline solution. *Fig. 127.* It may be indicated, for instance if there is disagreement between a past history of bile duct obstruction and its slender appearance. Attention is drawn to the presence of an obstacle by a flow of less than 20 ml/min. with a tension of 30 cmH_2O, but stones are not excluded by normal values. This applies also to the original pressure, if it is higher than a 15 cm column of water. Values are not affected by preceding cholangiography, if performed carefully.

This is followed by a scrutiny of films and consultation with the radiologist is useful in this respect. Only technically adequate films that can be easily interpreted are evaluated. A particular search for filling defects and stenoses or deformations in the terminal choledochus and the papilla is made, but also for obstruction of some smaller hepatic branch by stones. Duct width is assessed, its course and the pattern of the biliary tree and pancreatic reflux, and an attempt made to estimate contrast flow into the duodenum (p. 123).

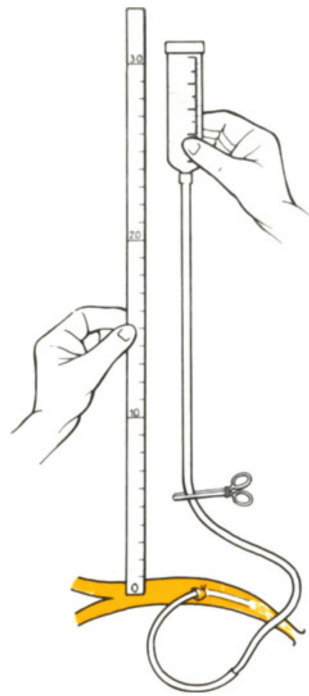


Fig. 127: Operative cholangiometry. The syringe barrel is filled with physiological saline and connected to the catheter inserted in the choledochus, the metal measure held at that level for zero point. – Manometry: The hemostat on the catheter is released and the barrel gradually raised; at the exact moment when the fluid level starts to drop it is read on the meter establishing the "opening pressure". By lowering the barrel "basic, or residual pressure" is established in a similar fashion at the moment when the fluid stops flowing out. Both values are close together. – Flowmetry: The filled barrel is raised till the level reaches 30 cm and the catheter hemostat is released; the fluid level is maintained at a constant height of 30 cm whilst outflow continues by continual elevation of the barrel, to maintain a constant fluid pressure. The amount of physiological saline flowing out per minute represents the "debit", i. e. the flow rate during a constant water pressure of 30 cm.

As a rule sufficient data are obtained for a decision whether exploration should be extended by probing and other methods or whether therapeutic intervention on the duct can be undertaken immediately or can be omitted altogether.

As mentioned, it is sometimes necessary or preferable to initiate exploration by immediate *probing* which must be done very cautiously (p. 126). It is first attempted via the cysticus, but the catheter must pass freely through it, to distinguish any hitch or snag in the pancreatic segment or the papilla. For the detection of small stones even a small calibre catheter is adequate, for an assessment of papillary patency it must be 3—4 mm in diameter. Many surgeons perform instrumental exploration for this reason mainly through choledochotomy. We prefer using a semi-rigid Tiemann catheter or a flexible cannula which is introduced without force under constant control of left hand palpation. Even so, assessment of the papilla makes direct inspection by duodenotomy frequently indispensable. (p. 131)

Evaluation of the various *findings* must take into account the possibility of error with all methods of investigation. One must be aware of the fact that only some findings are diagnostically explicit, such as palpation or radiological image of stones, presence of purulent bile, rigid stenosis of the papilla. On the other hand, various signs of obstruction, impeded passage or dilated choledochus remain nonspecific even at operation. It is clear that operative data must be assessed in their mutual relationship and within the framework of the complete disease history.

Sometimes duct exploration passes into therapeutic intervention, with which it gets intertwined, a final diagnosis not being established until surgery is completed. Nevertheless, investigation as a rule steers the course of surgery earlier, according to the main lesion.

Recent trends in therapeutic procedures

Surgery for choledocholithiasis is the most common primary duct operation. It makes up 86% out of the writer's 1431 elective operations on the bile duct performed for benign diseases. Choledocholithiasis has been complicated by other disorders, mainly stenosis of the papilla in one third of these cases.

Surgical procedure is continuously changing according to recent experience and diagnostic advance, in principle, however, one ought to use the simplest and least traumatic methods available, comprehensive and definitive as far as possible.

Thus recently the question of effective choledochus drainage and access to stones in the ducts has been revised again, and a discussion started on the best way to finish the operation in order to achieve a permanent result.

Kehr's drainage used to be an integral component of common bile duct surgery, choledochotomy being employed to open the latter. At present primary closure is in many cases not only tolerated but even recommended.

If the cystic duct is wide enough to allow the passage of small forceps, use may be made of it not only for exploration, but also for the removal of small-sized stones, and for clearing the papilla. Intervention is simple, almost on the same level as cholecystectomy proper, it can be terminated by cystic ligation without drainage of the choledochus.

If access to larger stones present in the ducts is difficult or they are impacted, there is no point in first removing a few small stones via the cystic duct, but choledochotomy is undertaken at once. This should not be avoided with the idea that thereby the operation is made more complicated. Easier access, on the contrary, may speed up the intervention. Even then primary suture, provided conditions are suitable, is not infrequently possible.

Access to the stones from below, by papillotomy, is used nowadays only from necessity, if they are wedged there or inaccessible, or if fibrotic papillary stenosis is encountered (papillotomie de nécessité). The number of sphincteromies for ensuring passage of remaining stones (papillotomie de sécurité), or to facilitate surgery (papillotomie de facilité) has declined. Following papillosphincterotomy (PST) choledochus drainage is done in most cases, but primary closure may be attempted, if operation was simple. Even in such cases, however, at least a thin transcystic drain is inserted for security (drainage à minima Mallet-Guy).

Primary suture is attractive by its elegance, cleanliness and by shortening hospitalization. It robs us, however, of the opportunity of postoperative cholangiographic checks and exposes to twin dangers: bile leakage and stenosis. Both can be prevented by adequate suture technique and a selective drain protects from bile leakage. Such a complication occurs in as much as 20%, but secretion is usually transient. Fatal dehiscence has an incidence of less than 1% of cases.

As far as the question of ensuring a permanent result following choledocholithiasis operations is concerned, the prevention of the most common causes of late failure is mainly required. These include retained stones and obstructed bile flow. The incidence of missed stones has declined thanks to operative cholangiography and more delicate probing combined with palpation. Some are also discovered in time by selective cholangiography or choledochoscopy by checks in the concluding phase of surgery. Nevertheless a certain percentage does escape, and similarly stenosis of the papilla is sometimes overlooked.

Hopes entertained in connection with papillosphincterotomy for guaranteed success were exaggerated. The passage of retained stones, with the exception of very small ones, was not ensured, renewed stenosis was shown to occur. PST is also unable to clear a duct compressed by the pancreas and cannot counteract bile stagnation in a widely dilated, flaccid main bile duct.

As anastomosis mostly lacks the disadvantages set out, no wonder that many surgeons recommend it as a matter of principle for choledocholithiasis surgery, even in primary interventions, particularly if the duct is dilated. (Schein et coll., 1978, Engin and coll. 1978, Pomyet and coll. 1973, Blumgart, 1978). The relative proportion of operations used in choledocholithiasis is undergoing changes: though choledocholithotomy still occupies the first place, the number of anastomoses approximates, or with some surgeons even exceeds, the number of sphincterotomies, while papillary dilatations are becoming less frequent or even disappearing.

Both contemporary trends, directed towards limitation of choledochus drainage, as well as to asserting anastomoses, should not become "the fashion": in the first instance, in order that excessive use of "the ideal choledochotomy" without drainage does not endanger the safety of operation, in the second instance, in order that a palliative anastomosis does not serve as a substitute for carefully performed radical interventions. All stones present must be removed, and fibrotic stenosis relieved by sphincterotomy even if an anastomosis is carried out. This operation also carries its hazard, the disadvantage of reflux and a possible late stricture of the stoma. It is certainly correct to utilize anastomoses more often in choledocholithiasis than has been the custom at some centres, but it would be a mistake to complicate every, even faultlessly performed, lithotomy and sphincterotomy by using a by-pass.

SURGICAL TECHNIQUE IN CHOLEDOCHOLITHIASIS

Tactical approach will differ mainly according to the localization of stones, their number, size and as to whether they are mobile or impacted. Cases exist which require more complex procedures, in particular stones in the sphincteric portion, as they are frequently complicated by stenosis of papilla or terminal bile duct. Procedure must sometimes be adapted to an urgent situation or the poor conditions of the patient.

A. Mobile and accessible stones

The hepatic duct is checked first by palpation and if some stones are found there, we may succeed in pushing them down or remove them directly with forceps. Stones located higher up cannot be palpated and methods used for their removal will be described later.

Stone extraction from the supraduodenal portion of the common bile duct

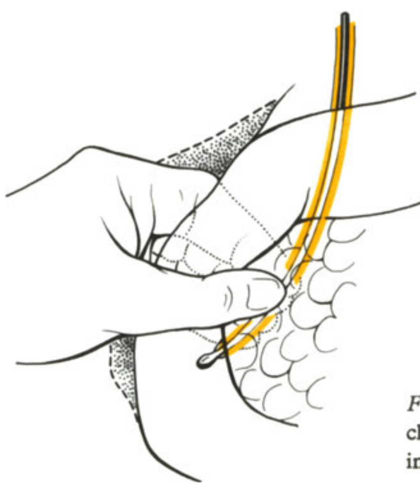


Fig. 128: Exploration of terminal choledochus by palpation over a probe inserted in it.

is simple and from its terminal portion will be facilitated by Kocher's manoeuvre. An eminent role is played by the left hand in this respect. *Fig. 128.* With its help we may sometimes succeed in finding even smaller calculi and to

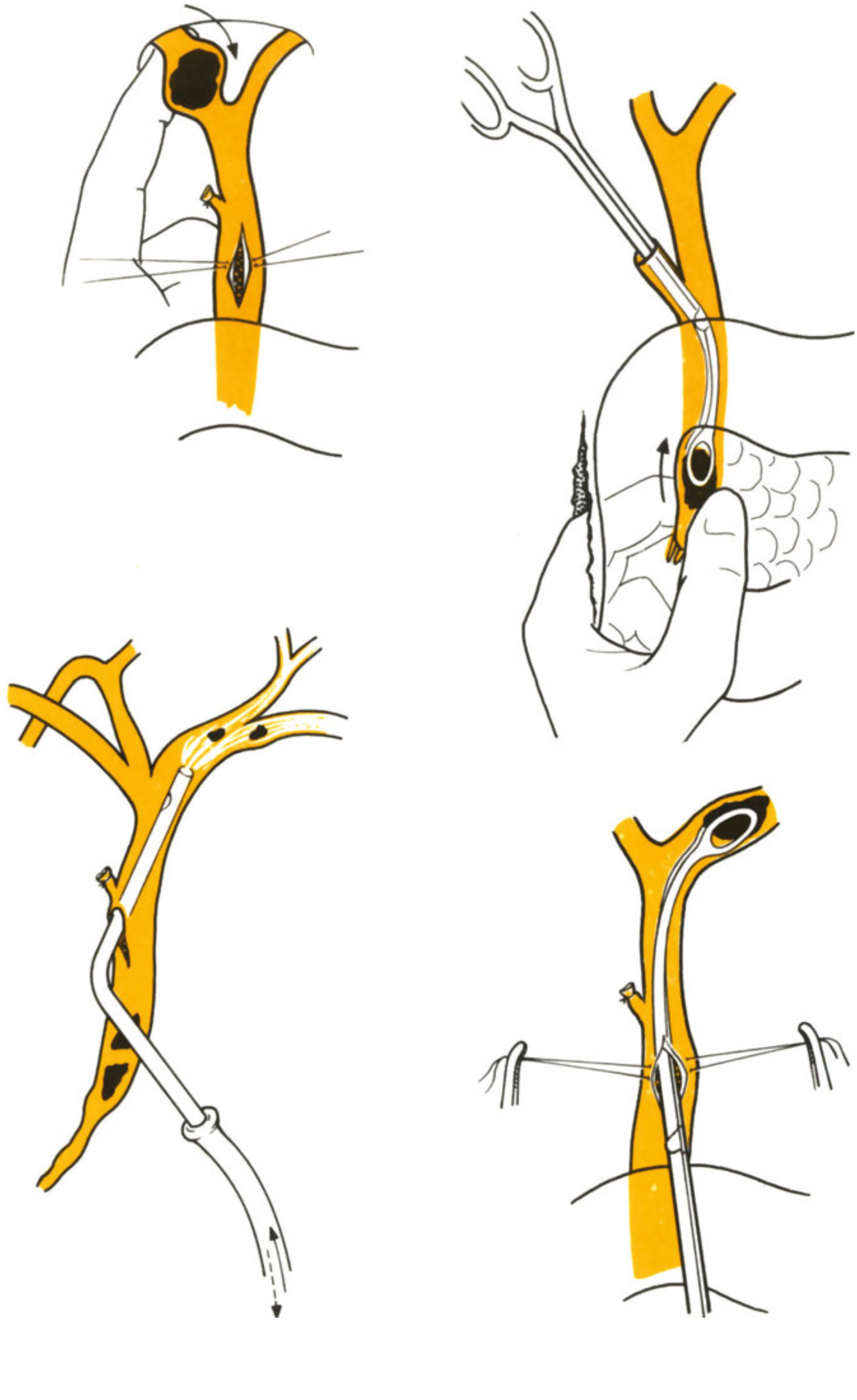


Fig. 129 abcd: Removal of accessible small stones from extrahepatic ducts. (a) Milking, (b) extraction, (c) lavage, (d) small forceps.

shift them supraduodenally or to grasp them with forceps. Crushing of stones should be avoided, as this would leave debris and slime on the walls. Gentle lavage may be helpful and some calculi can easily be shifted into the gut. *Fit. 129.*

Surprisingly, even a largish stone measuring up to 1 or even 2 cm in diameter may sometimes escape probing in the terminal choledochus. This applies particularly to smooth, facetted stones, the probe sliding past them without apparent

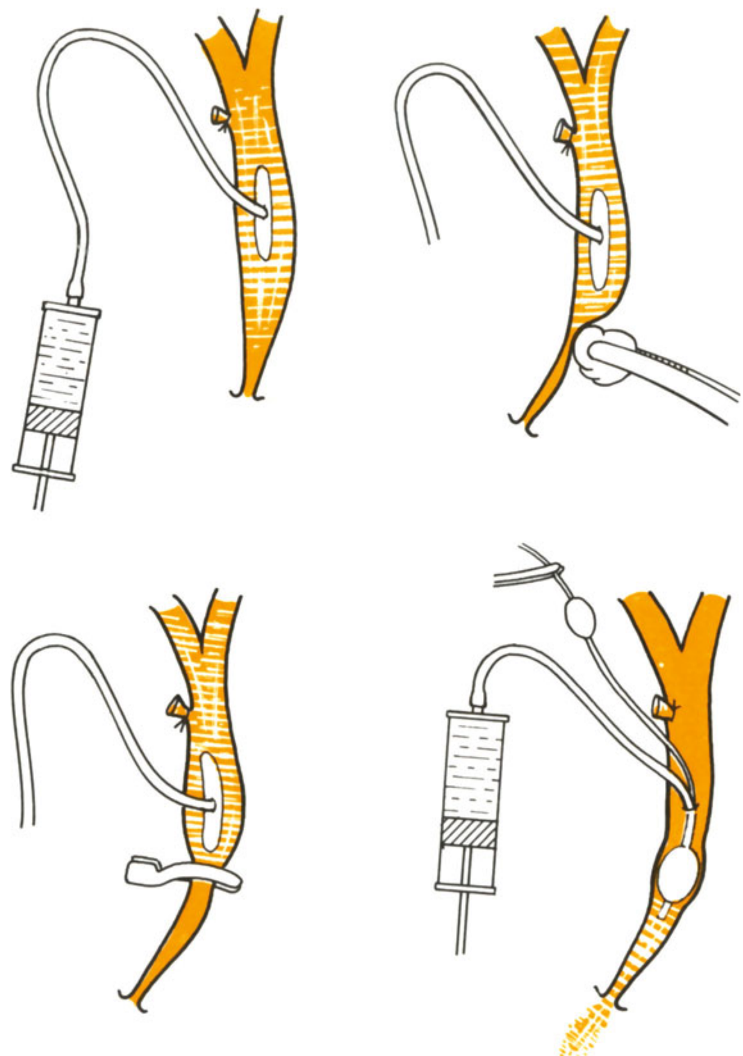


Fig. 130 abcd: Secondary operative cholangiography: Via T tube (a), selective check-up on hepatic branches by swab compression of choledochus (b), or by soft clamp (c); selective check on terminal choledochus segment by occlusion of duct with balloon tipped catheter (d).

resistence, particularly if the stone is thus shifted into an excentrically located pouch in the dilated choledochus short of the sphincteric segment. In this location the distinction between calculi and indurate lobules or inflammatory chronic lesions in the pancreas may prove difficult. Futile attempts at grasping the supposed stone with forceps only lead to bruising of duct and pancreas. If no "stone" is visible on the films and it cannot be shifted, attempts at extraction are abandoned. Naturally, the opposite case of erroneous interpretation would be still more disastrous, i.e. failure to remove a stone supposed to be pancreatic tissue. A doubtful obstacle could be assessed by papillotomy and probing from below.

After removal of stones from the common bile duct, lavage with warm normal saline is carried out and, provided the papilla is patent, it is closed.

Even though operative cholangiography and all other methods of exploration are used, stones may still be overlooked in the bile ducts – according to Glenn (1977) in about 7—10% of choledocholithiasis operations. If in doubt, therefore, secondary cholangiography is attempted as a check, even though it is not as reliable as primary investigation and in the writer's clinic it is being employed three times less frequently. It is sometimes difficult to expel the air from the duct and to fill them adequately without special selective methods *Fig. 130.* Furthermore, a check on the terminal part of the choledochus is not uncommonly made impossible by a stop, spasm or papillary swelling preventing contrast filling. This occurs often after major manipulation in the sphincteric portion.[132] Lavage is repeated and even though no further stone is demonstrated, a thin drain is preferably left in the choledochus in such cases, against possible excess tension and for postoperative radiological checks.

If lithiasis is associated with papillary stenosis, the catheter becomes jammed even after removal of all stones. If the papilla is compliant, gentle dilatation can be done, up to 6 mm diameter. If marked stenosis is present, investigation via the duodenum is preferred and if necessary PST added.

If during stone extraction pancreatic lesions are detected which deform and narrow the choledochus, an anastomosis is added. If, however, the bile duct is not yet dilated in front of a tubular stenosis, this may be taken as a sign that the pancreatic lesions are still capable of regression following simple choledochus drainage.

B. Hepaticolithiasis

Stones from the choledochus may travel into the dilated hepaticus and its branches either singly, or may eventually congregate there filling the entire common duct. Sporadically stones may be formed in front of a congenital stenosis, or an acquired hilar stenosis, or they may descend from the liver in rare cases of primary intrahepatic lithiasis. Sometimes, however, the surgeon himself may push a stone into some distant hepatic branch either with an instrument or by lavage, or it may slide or even "shoot up" in the attempt to grasp it.[105, 131]

Stones in the hepatic branches pose problems if they become impacted there, or if access from the choledochus is difficult. Operative cholangiography and in dilated ducts the choledochoscope may produce evidence of them while incidental detection is also common. Suspicion is roused by the presence of dilated ducts reaching into the liver.

Finger massage assisted by small forceps is used first for removing accessible stones. If this fails, the following possibilities are open:

1. First, with great patience, a variety of instruments, lavage and suction are used alternatively. Forceps, scoops, Dormia's basket and even Fogarty's biliary balloon catheter are not without risk (Henzel and de Weese). Injury to the ducts is possible and stones may be pushed up, or attempts with them fail because the stones cannot be reached by instruments. Most commonly even in such cases, lavage or suction eventually succeeds in removing or at least mobilizing the stones and bringing them nearer. Lavage and suction are the outstanding methods for inaccessible stones. A very thin semi-rigid catheter is inserted high up (or a cannula with lateral holes only) and 5–10 ml of warm normal saline solution with neomycin are injected vigorously. The danger of sudden excess tension is averted by the immediate return flow of the fluid round the thin cannula, the latter is also rapidly withdrawn during the final phase of injection. Small stones are washed away by the current of the returning fluid. *Fig. 131.*
   Lavage is alternated with suction, where in contrast a suction tube or catheter with a terminal opening is required. This opening may be smaller than the stone as it is sufficient if it adheres to it and can be then withdrawn.

2. Lipton (1971) recommended the removal of small calculi by plasmatic coagulum. Plasma and Thrombin are instillated into the duct and the coagulum created with stones attached is withdrawn as a duct cast. The present writer has no personal experience with this method.

3. Sometimes incision of the common hepatic is required to gain access to the stones and facilitate instrumentation. After clearance of the duct is completed, the hepaticotomy is sutured and, if necessary, the choledochus drained by a separate incision, or via the cystic duct.

4. Another possibility is the direct incision over a stone impacted in the hepatic duct or in an accessible branch. This is cautiously dissected from in front, divided longitudinally where no vessels are present, and resutured after stone extraction. A choledochus drain is inserted separately.

5. If stones are encountered accompanying stenoses and dilatations, or in diffuse primary hepatolithiasis, only descended stones and accessible obstacles can be removed. Otherwise these diseases require liver surgery which will be described later (p. 433).

Following the removal of stones from the hepatic duct selective check-up

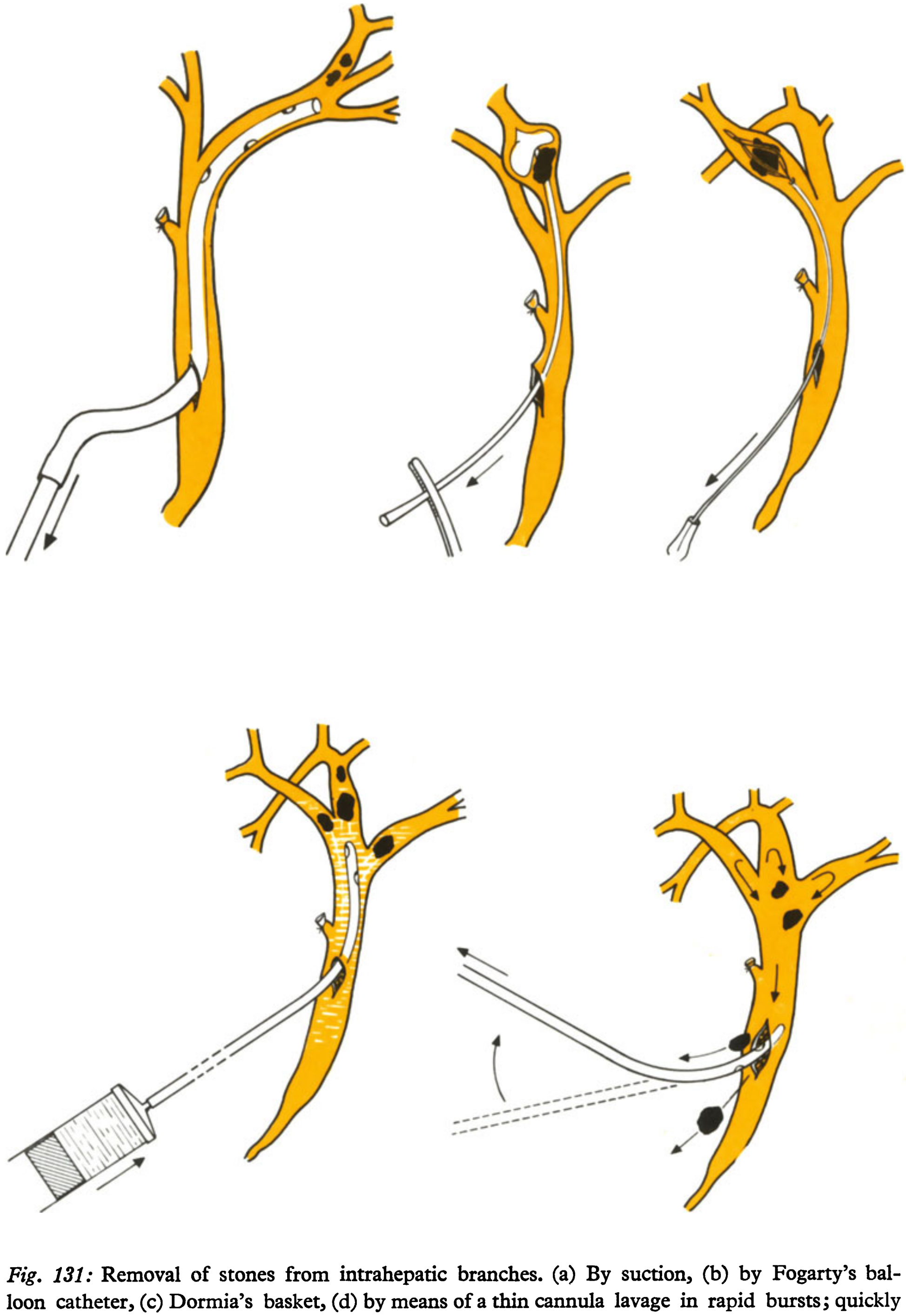


Fig. 131: Removal of stones from intrahepatic branches. (a) By suction, (b) by Fogarty's balloon catheter, (c) Dormia's basket, (d) by means of a thin cannula lavage in rapid bursts; quickly withdrawing the cannula in order to pry loose and wash out the small stones by the returning fluid (e).

cholangiography is always attempted and is best performed by means of the balloon catheter which plugs the hepaticus. *Fig. 132.* Choledochoscopic control may also be applied in these cases, though it is still not a widely accepted procedure (Finnis-Rowntree, 1977). If required, and permitted by the patient's condition, clearing of the ducts is resumed until no further calculi are recovered. Naturally the choledochus must also be cleared of stones and free bile flow into the gut ensured in order to complete the operation without drainage.

If we suspect or know that some calculi have been retained, anastomosis is performed. Their spontaneous passage cannot be relied upon even after

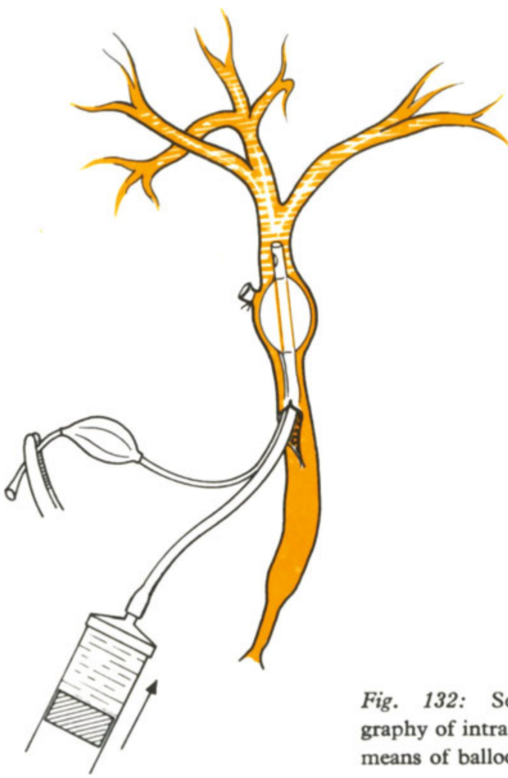


Fig. 132: Selective cholangiography of intrahepatic branches by means of balloon catheter.

a wide PST if their diameter exceeds 5 mm (Niederle 1972, Mayhoff 1975, Bismuth and Hepp 1976). Should the duct not be sufficiently wide for anastomosis, or the operation has to be quickly terminated, choledochus drainage only is done. This facilitates postoperative checks and attempts at non-surgical removal of retained calculi.

C. "Stone paved" common bile duct

If palpation has already disclosed the fact that the main bile duct is packed with stones, extraction may be commenced immediately. Primary cholangiography is irrelevant: as thereby neither the number nor location of all stones can be interpreted as these are heaped on top of one another and adherent with slime, and not infrequently extend into hepatic branches. These are situations where some stone might easily be missed, even if an experienced surgeon is in charge. *Fig. 133.*

Fig. 133: Operative cholangiogram showing a common duct packed with stones.

Abdominal pads are placed in the vicinity of the choledochus which is opened and the bile with escaping stones sucked up. Attempts are made to shift more stones towards the opening and all accessible ones are removed, mainly with biliary forceps. Hepatic branches are afterwards systematically cleared by lavage and exploration and clearance of the distal choledochus follows. In order to prevent any stones again escaping towards the liver, the hepatic duct is plugged with a tagged swab or is lightly compressed. *Fig. 134.* After removing the bulk of the stones papillary patency is checked. Sometimes it is already clear but mostly it appears swollen or rigid, is not easily penetrated, and a residue of small stones or debris cannot be excluded. It is often necessary to explore it by way of the duodenum and to enlarge it by sphincterotomy.

Exploration and clearance of the upper and lower passages is resumed there-

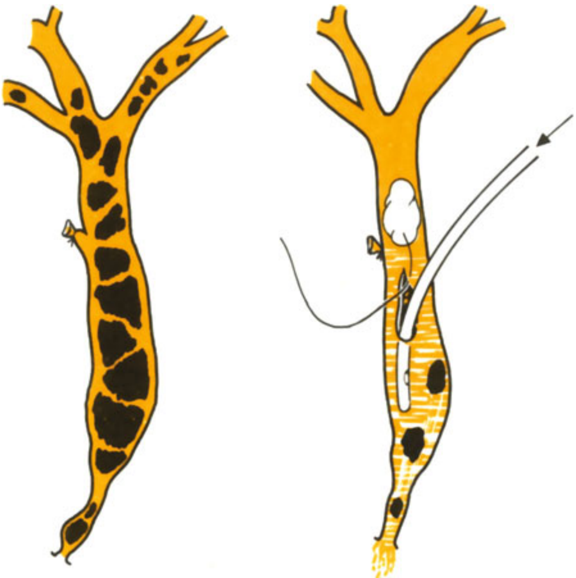


Fig. 134: Packed choledochus (a). A swab in the cleared hepaticus prevents stones from again penetrating into it during lavage of the distal choledochus (b).

after, until we are convinced that they are clear and the lavage fluid remains clean. After suture of duodenum and revision cholangiography or choledochoscopy, the bile duct must be drained or an anastomosis performed. *Fig. 135.* The latter is preferred if the bile duct is markedly dilated and its mucosa damaged or plastered with biliary slime or if we are not sure that all calculi have been removed. Lateral anastomosis between choledochus and duodenum is commonly

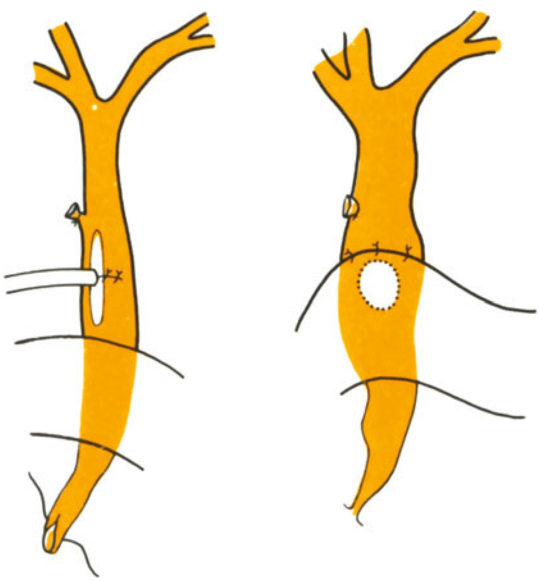


Fig. 135ab: Conclusion of intervention following removal of numerous stones from the ducts. (a) T-tube is useful even with simultaneous sphincterotomy. (b) anastomosis is indicated for a wide, flabby choledochus.

done. If, however, previous duodenotomy presents an obstacle or the duct is not sufficiently wide, anastomosis with the jejunum after Roux is preferable.

D. Large impacted stones

A stone which has migrated from the gallbladder is sometimes so large that it becomes lodged in the bile duct at the site of entry. The cystic duct may have been "swallowed" by it, the stone still apparently lying entirely in the gallbladder. Dissection may result in the inadvertent division of the bile duct which is mistaken for the cystic duct. The gallbladder must be opened up first, the stone extracted then and there, and the bile duct reliably identified by probing. The

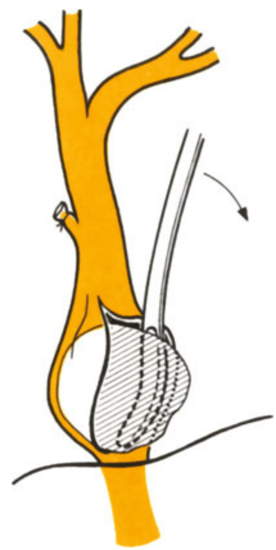


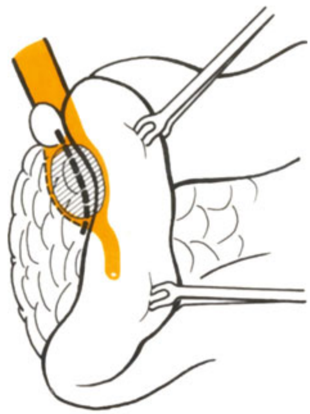
Fig. 136: Large stone impacted supraduodenally is removed by direct lithotomy.

part of the wall near the orifice is preserved during excision of the gallbladder, and this is used for cover or a T-tube is inserted there (p. 202).

A stone lodged more distally near the duodenum can usually be extracted easily by a longitudinal incision. It is made no longer than strictly necessary, and the stone is cautiously dislodged with a flat scoop, to avoid crushing it or lacerating the duct wall. *Fig. 136.*

A large stone wedged as far as the pancreatic segment and sometimes extending into the sphincteric portion may masquerade as a neoplasm or inflammatory pseudo-neoplasm of the pancreas. Sometimes not even the x-ray film will provide a satisfactory answer and stone is suspected by shape and definition, sometimes by slight mobility, or the way forceps strikes against it and may scrape a little off its surface. If the stone cannot be dislodged it must be removed by direct incision from behind through the pancreas, or from below through the duodenum if it bulges into the gut.

The first route carries the higher risk: duodenum and pancreas are displaced adequately by the Kocher manoeuvre and the depth at which duct and stone lie embedded in the pancreas is ascertained. Glandular tissue above the stone



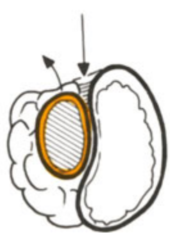


Fig. 137: A stone wedged in the pancreatic segment may be removed from behind by pulling the duodenum away (a) and shifting the gland border (b).

may be thinned to such a degree that a direct approach can be risked. As a rule, however, small vessels between pancreas and duodenum are ligated and divided close to the gut and the border of the separated glandular tissue cautiously shifted. *Fig. 137.* Even if the duct runs at depth, an anatomical approach can be created without division of the gland (p. 23). The stone is extracted by a longitudinal incision in the duct wall, this is closed again and covered by the replaced layer of pancreatic tissue. The duct is drained via the cystic duct, a suction drain placed retroduodenally, and preventative measures against pancreatitis commenced (p. 264).

If the stone occupies an intramural position and bulges into the gut, the overlying duodenum is incised. The stone is steadied firmly by the finger tips and the overlying stretched mucosa with the separated gut musculature and duct wall are cut through. An electric scalpel is useful for this step. The borders of the divided duct and duodenum are, after dislodgement of the stone, sutured through

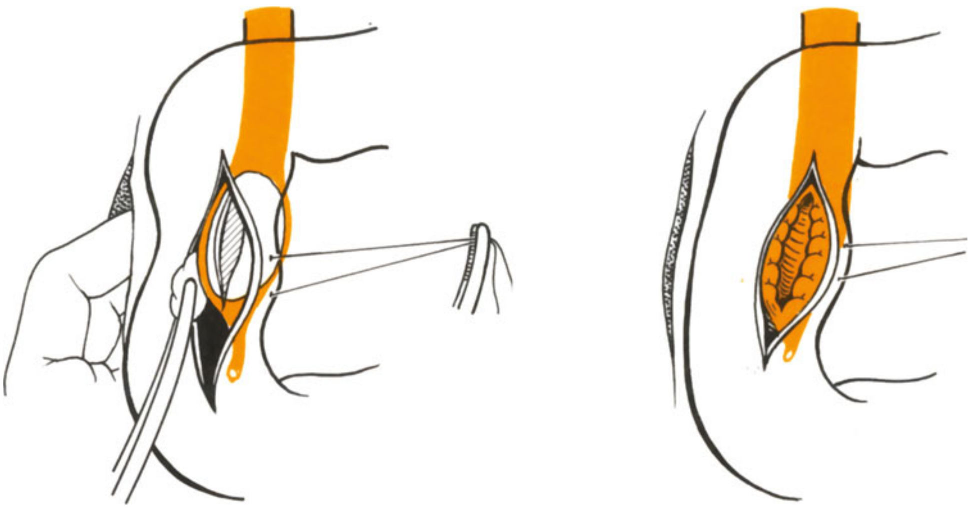


Fig. 138: Intramurally impacted large stone in sphincteric segment of choledochus. Incision over the stone from the duodenum and suture of the incisional margin similar as in internal choledochoduodenostomy.

Fig. 139: Operative cholangiogram demonstrates a small stone in the papilla; minor pancreatic reflux.

to prevent oozing of blood, bile, or intestinal contents into the retroperitoneum. *Fig. 138*. Thus in reality an internal choledochoduodenal anastomosis is created, used earlier by Kocher for similar reasons in the last century. The peripheral duct portion and papilla are not sectioned, unless a stone is also lodged there. There is no need to drain the bile duct, the wide internal anastomosis completely cancels the function of the sphincter of Oddi. A peritoneal drain, however, is essential for the vicinity.

E. Calculi in the sphincteric segment and papilla

The choledochoduodenal junction is frequently the site for calculi, and also for stenosing lesions. Access to this site is difficult and risky, and any rough manipulation may easily irritate the pancreas. *Fig. 139, 140*.

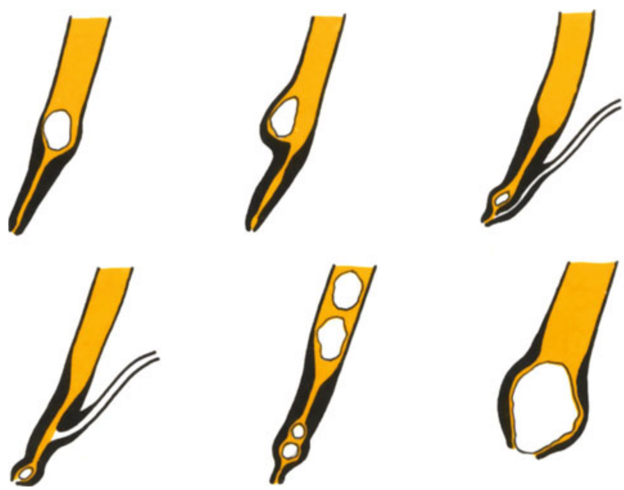


Fig. 140a–f: Small calculi of sphincteric segment. (a) Valvular stone fitting sphincter of Oddi, (b) stone in a pouch in front of sphincter escaping probing, (c) small stone in sphincteric segment in front of Wirsung's duct orifice, (d) small stone in the papilla blocking "common channel", (e) stones associated with stenosis of papilla, (f) large stone protruding from papilla; following its "birth" the sphincter remains damaged occasionally and the papilla gapes (so-called "wide stenosis" of papilla).

Exploration in this region, and if possible surgery also, is always started from above by way of the choledochus, and only if this approach proves inadequate is revision carried out from below, i.e. from the duodenum. Choice of operation is not only determined by the lesion present, but also by the experience with which the reversibility of detected lesions is assessed.

1. X-rays and probing show normal conditions – a catheter with 3–4 mm diameter passes free and suspected stones are absent. Exploration is terminated by lavage and the bile duct closed.
2. If stones are found which can be removed from above and the papilla is then patent, surgery is completed similarly by lavage and without choledochus drainage.
3. The catheter passes the papilla jerkily or at first catches in the orifice, but stones are absent: In such a case the catheter might only have caught on a mucosal fold, "tenting" of the papilla or a "phimotic" jammed orifice, or an unsuspected calculus was pushed through; edema of the papilla, "soft stenosis" which can be dilated without force also cannot be excluded. In such a situation perseverance and intensification of probing is continued – up to a diameter of 6 mm at most however, or the duct is merely washed through and closed. Following dilatation a thin safety T-drain should be inserted into the choledochus.
4. If stones or other lesions of the papilla cannot be reliably diagnosed or removed from above and the 3 mm probe cannot be passed readily into the duodenum without undue pressure duodenotomy is advisable. The duodenum is entered by a short, well placed incision (p. 131), the sphincteric portion including the papilla assessed and as a rule, the latter is divided to the required extent to ensure a permanently free bile flow, but without overshooting the mark. Mere papillotomy sometimes fits the case by freeing a soft swollen papilla and clearing small lodged stones and debris.[47] Sometimes a "rigid surgical stenosis" must be divided by an extensive sphincterotomy, until the normal channel is reached (p. 261). Naturally, if the papilla shows suspicious lesions a specimen is sent for histological examination. *Fig. 141.*

An indication for duodenal revision and papillosphincterotomy PST is also provided by preceding attacks of pancreatitis, in particular with concurrent cholelithiasis. On the other hand, total sphincterotomy is not indicated for tubular stenosis of the pancreatic section.

Any surgery of the papilla should be carefully indicated and exceptionally non-traumatic to prevent as far as possible postoperative pancreatitis. Before the duodenum is sutured probing and lavage are done as a check; secondary cholangiography and more so cholangiometry is unreliable following interference with the sphincteric portion.

Several modifications for terminating the operation are available:

In some cases of simple dilatation or PST the insertion of a thin tube is sufficient, or primary choledochus suture is undertaken. Most often, however, following surgery dealing with the choledochoduodenal junction, adequate bile duct drainage is ensured, never, however, transpapillary. If the risk of postoperative pancreatitis is considerable, preventive measures are carried out at once (p. 264).

A peritoneal drainage tube is always placed near the carefully sutured duodenotomy.

If the patient's choledochus was excessively dilated, or tubular stenosis was found at the same time, surgery is terminated by anastomosis and the duct is not drained.

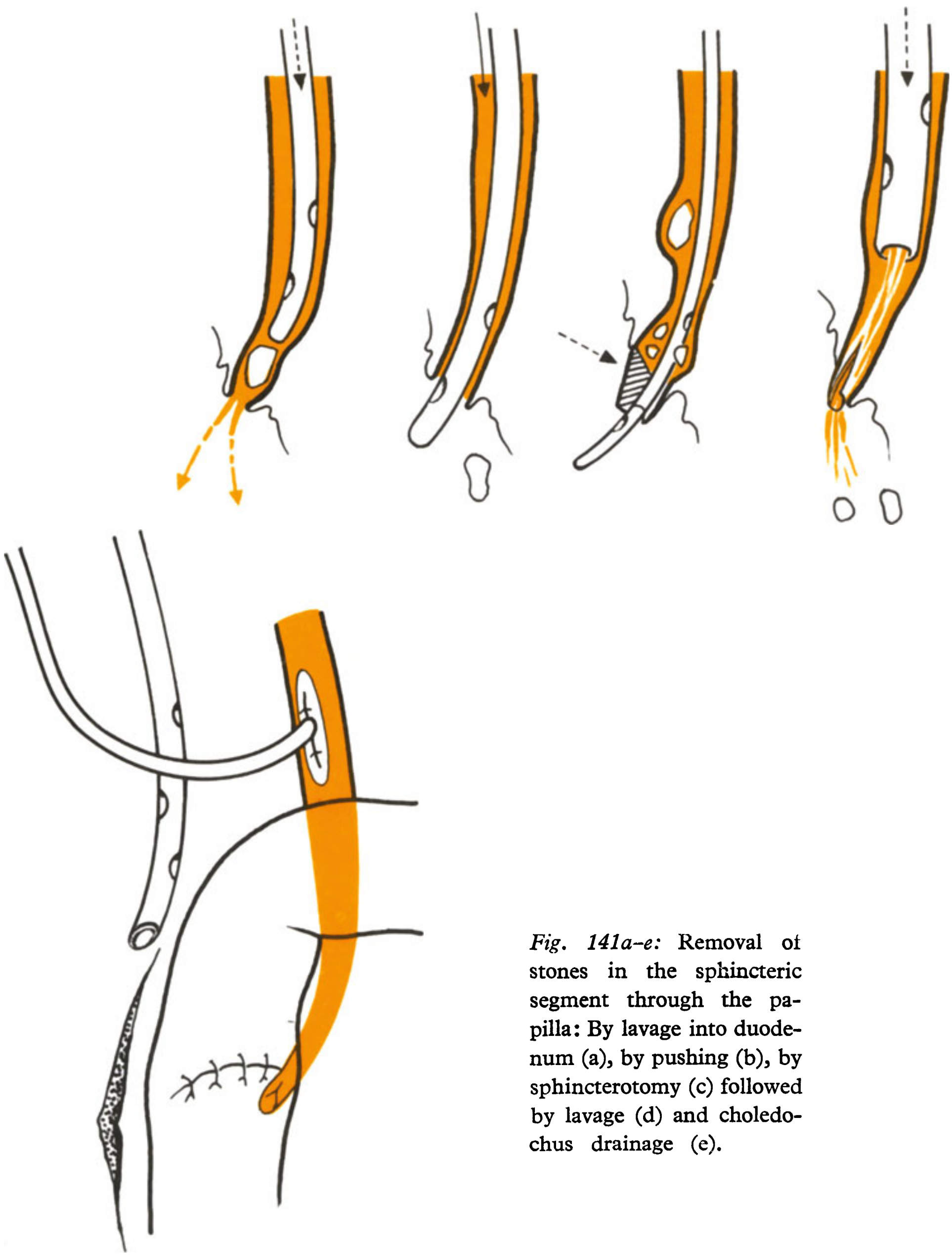


Fig. 141a–e: Removal of stones in the sphincteric segment through the papilla: By lavage into duodenum (a), by pushing (b), by sphincterotomy (c) followed by lavage (d) and choledochus drainage (e).

Schein in 1977 also recommended a combination of choledocholithotomy with "neurogenic sphincterotomy", the latter permanently facilitating bile flow into the gut. Division of hepatic vagus branches in the gastrohepatic ligament should produce relaxation of the sphincter of Oddi and reduce by 40% the pressure required for the evacuation of this sector into the duodenum without the risk of PST. Discarding or inducing „incontinence" of the sphincter is also supposed to facilitate the spontaneous passage of even medium sized calculi retained in the ducts. Neurotomy has not been verified in the writer's centre, but it might assist conservative procedure in such lesions which hamper free passage in the sphincter of Oddi region and papilla, and are considered reversible.

PROGNOSIS IN SURGICALLY MANAGED CHOLEDOCHOLITHIASIS

Only 50 years ago about half of the patients operated for choledocholithiasis were not expected by Lecène to survive. Current surgical mortality in this disorder is estimated to amount to a mere 2–5%.

Surgical risk in choledocholithiasis is not always the same and depends on a number of circumstances. Simple choledocholithotomy is least dangerous, but even this exposes the patient to a risk about twice as high as that carried by simple cholecystectomy, for which surgical mortality has generally dropped below 1%. A higher risk is incurred with icteric cases, or with protracted latent obstruction, i.e. in cases of stone packed choledochus and with small stone blockage, where in addition the duct requires drainage, anastomosis, or even sphincterotomy must be performed. In such complicated cases mortality rises especially after the age of 65, to reach as much as 9% and even as much as 30% in patients over the age of 80 years.

About one-third to one-half of fatalities after choledocholithiasis operations are connected with the primary biliary disease or directly with surgery. They are most commonly due to acute pancreatitis, particularly if PST was employed. Biliary peritonitis or leakage from the duodenal stump are other common causes, in some instances renal or hepatic failure. Only sporadically is hemorrhage of various origin at the root of a fatality.

In our patients with choledocholithiasis the mean surgical mortality during 25 years amounted to 3.7%. During their hospital stay 50 patients out of this series of 1371 cases of primary choledocholithiasis operations died. Amongst causes of death cardiovascular complications occupied the first place – 27 instances; amongst the 20 deaths connected with the surgery, purulent biliary peritonitis was first – 6 cases, postoperative pancreatitis the second – 5 cases (four of which after PST).

Postoperative morbidity is not, as a rule, studied so closely as mortality, but it attains probably 10% with choledocholithiasis. As regards complications of a general character, pulmonary diseases occupy the first place, in lesser numbers cases of deep thrombosis and various cardiovascular disorders. The remaining half of the complications are linked directly to surgery: some patients suffer from postoperative pancreatitis following papillosphincterotomy, it is said as many as 15%. Slightly raised amylase activity on the first postoperative day was found in up to 25% of our series. With a considerable interval after irritation and inflammation of the pancreas we encounter patients with biliary or duodenal fistula, leakage or serious infection of the wound, or in the subhepatic region, sporadically with hemorrhage into the gut from a sectioned papilla. The major abdominal complications are not infrequently combined with evidence of renal or hepatic failure, signs of cholangitis or transient icterus.

Late results. Following removal of stones from the ducts in a large majority of cases patients remain permanently symptomfree. Late results are decidedly affected by retained stones, overlooked papillary stenoses or restenoses. To a much lesser degree symptoms may be caused by other sequelae of surgery, the most feared being the sequelae of bile duct injuries. The number of overlooked stones and stenoses is less and even fewer when the various methods of duct exploration are combined, and the greater the patience and efficiency with which stones and other obstacles are cleared from the choledochus. By such procedure the number of retained stones can be reduced from the previously recorded 15% to 5%, and to only 2% or less (Stefanini) following choledocholithiasis operations. Comparison of results obtained by various methods utilized for choledocholithiasis operations is not really possible, as with correct procedure these methods are not alternatives. If, however, a mean from several tens of statistics by various surgeons, who after all prefer one or the other method, is taken, the conclusion reached is that in choledocholithiasis immediate mortality and morbidity is lower after anastomosis compared with papillosphincterotomy. Late results after PST are, however, by about 10% better, at least in our personal series.

Intrahepatic lithiasis

Intrahepatic lithiasis occurs under three conditions:

- Secondary stones may be present in the intrahepatic ducts, having migrated there from the extrahepatic ducts. This is a kind of choledocholithiasis or rather hepaticolithiasis, where stones originally coming from the gallbladder have been displaced as far as the segmental branches of the hepatic ducts in some instances.
- Secondly, stones may be encountered which originated in the intrahepatic ducts primarily, due to stagnation and infection proximal to a hilar anastomosis stricture, or a high, as a rule congenital, stenosis of some hepatic duct branch. Similarly multiple nests of primary stones originate in congenital segmental dilatations in the entire hepatic tree, or in one of its regions in cases of Caroli's disease.
- An entirely specific, pathogenetically obviously different disease is the third type of intrahepatic lithiasis on the basis of infectious or parasitic cholangitis, or even in noninfested ducts, from unknown causes.

The clinical pattern and treatment of the various types of intrahepatic lithiasis are dealt with in the appropriate chapters devoted to hepaticolithiasis (p. 233), congenital duct anomalies (p. 429), cholangitis and parasitic disorders (p. 279).

Primary Diffuse Hepatolithiasis

In this chapter we shall mention exlusively the primary hepatolithiasis whose etiology has so far remained obscure. Multiple stones composed of bile pigment and poor in calcium are precipated directly in the intrahepatic ducts in this disease, affecting their large and small branches and filling them with gravel, sand or masses of slimy debris. Only one duct may be affected with its catchment area; this involves most often the left lobe of the liver, but both ducts, and thus the entire liver may be involved. This type differs from other forms of lithiasis by the fact that the gallbladder either escapes, or is involved only secondarily. The formation of stones is neither due to hemolysis nor to the results of primary stagnation.

Clinical pattern

As long as the stones remain in the hepatic portion of the biliary tract, no clinical signs need appear, as they do not cause any by themselves. It is not until they descend into the extrahepatic ducts that severe attacks of colic ensue, as well as cholangitis and intermittent jaundice. Choledochus and chiefly the hepatic duct are greatly dilated, even secondary stenoses may develop and the biliary tree becomes massively infected. The liver tissue contracts round the cavities filled with stones and biliary cirrhosis evolves.

First symptoms sometimes make their appearance in adolescence, or even during childhood and boys are more often the victims. Sometimes, however, symptoms are absent altogether and the lesions found at necropsy are a surprise.

The disease is usually not diagnosed until operative cholangiography. Preoperative biligraphy either fails to opacify the ducts, or only a dilated hepatocholedochus is shown. Information in similar cases might perhaps be provided by ascending duodenoscopic cholangiography.

Treatment

In the first place all those stones are removed at operation which have already migrated to the extrahepatic passages and an attempt is made by means of lavage and suction to empty as much as possible the primarily affected intrahepatic ducts. In practice one never succeeds in clearing the latter completely and it is advisable, therefore, to perform an anastomosis, in order to facilitate the passage of further stones descending from the hepatic system.

Some nests of stones sited in the intrahepatic ducts can also be opened directly by liver discision, or the most involved liver lobe removed by lobectomy (Maki). Surgery under antibiotic umbrella is mandatory and the latter is also employed for lavage of tubes inserted into the bile ducts or liver.

Prognosis is uncertain, recurrences and reoperations common, and associated with mortality due mainly to liver failure.

BENIGN BILIARY STENOSES

Stenoses of the extrahepatic ducts are mainly of inflammatory or fibrotic character. They are designated as benign, as those due to neoplasma are not included, but some strictures, particularly postoperative ones, run a no less "malignant" course and may be fatal, even if treated with great surgical effort and skill. They may be subdivided into several groups:

- congenital stenoses,
- traumatic strictures following accidents,
- iatrogenic strictures following operative injuries,
- stenoses of biliary anastomoses,
- stenoses of papilla and sphincteric segment of common bile ducts,
- stenoses of pancreatic section of common bile duct,
- cholangitis stenoses.

The most common biliary stenoses are those of the papilla, strictures of biliary anastomoses or due to operative injury are less common, and the rest are even rare.

In our above mentioned series of 1 371 primary duct operations we found one of the types of stenosis in about a half of the operated patients, mostly associated with calculi. A frequently observed combination were stones with papillary stenosis, whereas this stenosis alone was found in less than 9%. On the other hand different types of stenosis not combined with lithiasis was a frequent finding in our series of reoperations.

The following is the percentage of the above types of stenosis in all our duct operations and reoperations: Stenosis of papilla – 76%, pancreatic segment of the common bile duct – 8%, biliary anastomosis – 6%, iatrogenic stricture – 3,9%, inflammatory stenosis – 3.8%, congenital stenosis – 2%, and traumatic stricture 0.25%.

Papillary, terminal bile duct, and cholangitic stenoses will be dealt with first, in sequence to bile duct lithiasis. The remaining types of stenosis, where stones are not its cause but only its occasional sequela, will receive attention later in the appropriate chapters.

Stenosis of Papilla and Sphincteric Part of the Common Bile Duct

In the year 1926 Del Valle described stenosis of the papilla as "choledochitis sclérorétractile chronique" and proposed papillosphincterotomy (PST) for it. The existence of a new clinical and pathological entity and its method of treatment was gradually recognised the world over. However, it was found that "primary" independent stenoses are uncommon (6.5% Hess) and that "secondary" stenoses, accompanying cholelithiasis form the vast majority.

Definition

Despite the mass of experience available, discussion has not been terminated, stenosis of the papilla still remains a term full of contradictions. There is no agreement on the character of pathological changes, the causes of origin, about incidence and clinical symptoms, nor about the method for its diagnosis and treatment. A number of different terms are also being used – papillitis, odditis or sphincter of Oddi stricture, mucous stricture of the orifice, phimosis of papilla. None of these terms, however, reflect the substance and extent of lesions with consistent accuracy. No uniform anatomical definition for stenosis of the papilla which at the same time also serves clinical and surgical requirements, exists.

In the wider sense any narrowing of the sphincteric portion of the main bile duct and papilla can be designated as stenosis, whether it is congenital, inflammatory or neoplastic in origin, or temporarily induced by edema or blood extravasation. The object of surgical therapy, apart from neoplasm, however, is confined only to a stenosis due to persistent organic lesions of inflammatory or sclerotic character and as a rule, irreversible. This also represents the definition of "surgical stenosis" of the papilla.

The surgeon must be able at operation to distinguish it from stenosing lesions of transient or neoplastic character, but at the same time must rely strictly on clinical and operative findings, excluding biopsy: for the latter, papillotomy is required, – the very operation for which histological investigation was intended to demonstrate the necessity. The anatomical substance of lesions found and their prospective evolution is thus a matter for assessment: an attempt must be made to differentiate between spasm and edema, to exclude neoplasm and to recognise whether inflammatory lesions are still reversible and do not require sphincterotomy – the latter being the most difficult task.

Morphology

Lesions of the papilla are frequently more striking at operation than in the specimen or at necropsy. As a rule the papilla is found to bulge, is swollen, soft or hardened and narrowed. Sometimes it projects snout-like into the duodenum. Rigidity of the papilla may be only illusory, due to an impacted stone. Relatively seldom do lesions involve the upper sphincteric segment or the pancreatic duct.[48] More often only an adherent or rigid orifice is encountered, occasionally congenital narrowing without pathological lesions cannot be excluded with certainty.[86] "Wide stenosis" also exists, the orifice being rigid and gaping, apparently following the passage of a largish stone, but where nevertheless flow is impeded; the impairment evidently is not mechanical but functional from damage to the sphincter of Oddi.

In contrast to necropsy or histological findings, the appearance and consistency of the papilla is also affected by alterations in blood supply, edema and, apparently, by sphincter spasm. Thus it is not surprising that biopsy evidence does not tally with the operation protocol. As many as 60% of stenoses, it is said, lack histological lesions (Grage 1960). This discrepancy – if sampling error is discounted – is also due to the fact that the histology of a longitudinally sectioned specimen cannot, with the exception of far advanced lesions, show adequately how the duct was narrowed.[95]

Biopsy of the stenotic papilla, however, frequently is instrumental in revealing variously pronounced patterns, long established or of recent origin, of inflammatory edema and infiltration, sometimes with metaplasia or hyperplasia of the lining – up to severe fibrotic transformation of subepithelial tissue accompanied by loss of musculature and epithelial atrophy.[33] Gradual transitions are known from mild, obviously insignificant inflammatory lesions, commonly found in about half the adult population. Interpretation of specimen must also subtract manifestation of senile involution of the papilla and its fibrotic transformation and glandular hyperplasia. Adenomyomatosis is a common finding and need not be at the root of stenosis. Pronounced, chronic, nonspecific inflammation is the most characteristic finding in the latter.

Incidence

The incidence of papillary stenosis according to older sources in particular differed greatly. Numbers ranging from 2–30 and more percent were mentioned, according to criteria used by various surgeons for diagnosis, and also according to patient selection (Arianoff, Baumann, Kune, Madden, Niederle, Yvergneaux). The era of over-diagnosing by misguided use of radiomanometry is past. In recent years diagnosis has relied more on probing and direct inspection of the papilla, flowmetry by itself is considered only significant as a warning signal. As a result scatter has declined and newer statistics correspond more closely to reality. If our definition of "surgical stenosis" is adhered to, it is found at 5 to at most 10% of operations for benign biliary disorders, in a majority of instances with concurrent lithiasis. It is, as a rule, encountered in cases with a prolonged history of lithiasis, mostly in older patients and at reoperations.

Etiology

The functional hypothesis was the first to be proposed (Del Valle, Mallet Guy), stenosis was thought to be due to protracted spasms, which however, was never confirmed.

The hypothesis of an inflammatory origin assumed spread of inflammation from duodenum to papilla. This would explain superficial inflammatory lesions, sometimes making the orifice "stick", or inducing glands infection, and some rare "primary" stenoses of the papilla.

Probably most valid is the hypothesis of its traumatic origin due to damage from stones and, occasionally, surgical instruments. Fibrotic stenosis is accompanied by lithiasis so often (40–90%), that their etiological relationship appears highly probable, and stenosis is one of the most frequent complications of choledocholithiasis. Yvergneaux found only one case in seven of stenosis not associated with stones. The present author did not find any coexisting stones in 1/6 of cases among 600 stenoses of papilla revealed at primary bile duct operations. Stones traumatize the epithelium and also damage the deeper layers in the sphincteric segment, cause mechanical irritation and facilitate contamination, either if lodged or only passing through.

The papilla and sphincter of Oddi may also be damaged in the course of forcible exploration and stone extraction and in particular by rough divulsion. The process of repair terminates sometimes in iatrogenic fibrotic stricture. PST likewise may sometimes end in restenosis by fusion of the incision, particularly with bruising and inflammation of the papilla.

Stenosis of the papilla has thus no uniform etiology and various insults, inflammations and dystrophic disorders present initially may lead to similar results; their future evolution cannot be assessed accurately from findings at operation.

Clinical pattern

Stenosis of the papilla is the second most common nonmalignant cause of choledochus symptomatology. This is nonspecific, often equivocal and represents a major challenge for preoparative diagnostics. It merges with cholelithiasis manifestations; stenosis of the papilla is suspected mainly with recurrent episodes of jaundice, pancreatitis and cholangitic attacks, if no stone can be demonstrated in the bile duct. Compared with choledocholithiasis, symptomatology as a whole is milder, though the difference is one of degree only.

Understandably, the purest pattern caused by stenosis follows cholecystectomy, if it is the only abnormality which originated, or was overlooked during a previous biliary operation. In this chapter, however, we deal chiefly with diagnosis in a patient not previously submitted to surgery.

If a functioning gallbladder is present stenosis may sometimes cause no symptoms, biochemical tests reveal a discrete cholestatic syndrome. Intravenous cholangiography may contribute to its diagnosis only indirectly, if a slightly dilated bile duct lacking stones is found. A slender duct does not exclude its presence, however. It is suspicious, according to Wise-O'Brian, if uniform density of duct opacification persists after 2 hours. However, this applies chiefly after cholecystectomy. Stones in the ducts practically preclude a cholangiographic diagnosis of stenosis and alas not even a homogeneous broader opacity exludes their presence.

Duodenoscopy, however, may contribute to diagnosis if an enlarged, bulging papilla is observed. Neoplasm has to be differentiated at the outset, but if this is scirrhus it may resemble a small indurated papilla. Ascending cholangiography reveals slower evacuation of contrast medium, but it has greater reliability only with pronounced narrowing.

Definitive recognition of papilla stenosis is gained by inspection at operation. As stenosis cannot be distinguished with certainty from other obstructions in the ducts before operation, patients are submitted to surgery under the wider diagnosis of incomplete bile duct obstruction, as in many cases of not accurately verified choledocholithiasis.

Treatment

PREVENTION

The best prevention of stenosis of the papilla is prompt treatment of lithiasis, and in the course of biliary surgery gentle handling in the region of the papilla. In order to avoid restenosis following sphincterotomy tissues must not be bruised. Suturing the divided margin has no marked preventive significance.

NONOPERATIVE TREATMENT

Endoscopic papillotomy is a nonsurgical method of treatment recently introduced. It could be applied chiefly in persons exhibiting excessive surgical risk and some cases of restenosis of the papilla. The technique and results will be dealt with later (p. 519).

SURGICAL TREATMENT

Stenosis of the papilla is indicated for surgical therapy usually under the wider diagnosis of incomplete obstruction as mentioned earlier. Thus what has been discussed generally for choledocholithiasis applies here also. Preparation of the patient and the initial phase of operation i.e. its exploratory stage, are identical (p. 220). We cannot be sure up to this time to what extent the findings at operation will confirm our suspicions.

Operative diagnosis of sphincteric stenosis

In most cases signs of an obstruction are found, a dilated duct and sometimes bile under increased pressure. Operative cholangiography does not give realiable

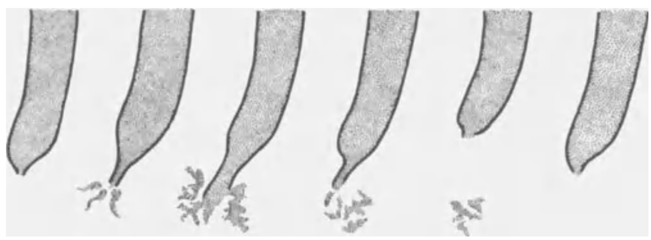


Fig. 142: The changing play of the papilla during cholangiography according to the phase of sphincter of Oddi activity.

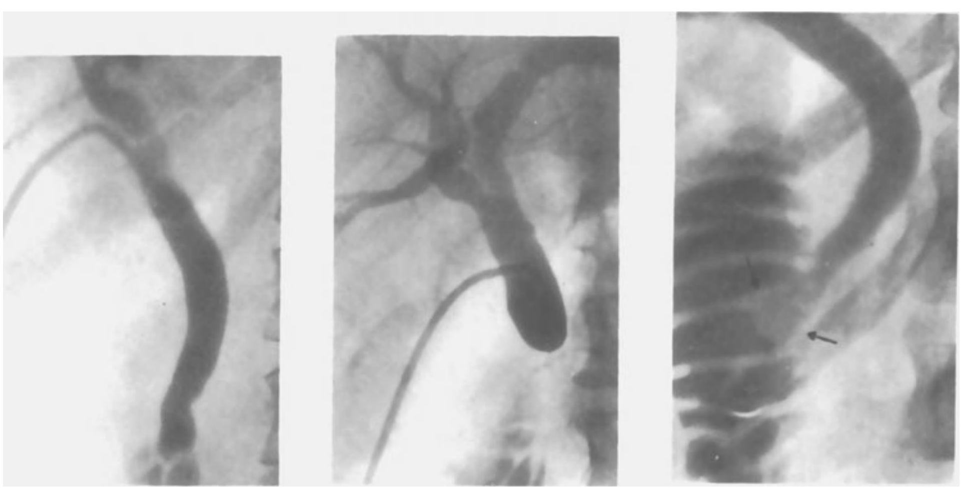


Fig. 143 abc: Operative cholangiography: (a) Fibrostenosis of the papilla, prooved by operation; no stones. (b) Almost complete fibrotic occlusion of the terminal part of the duct. (c) An edematous papilla revealed in the contrast filled duodenum. Two translucencies in the sphincteric segment correspond to small calculi.

information about the papilla, individual films may picture the sphincteric segment in the phases of contraction or incomplete relaxation creating a false impression of stenosis. *Fig 142.* Suspicion is aroused, however, by permanent narrowing or poor flow of contrast medium into the gut visible on serial films, and particularly on screening. Pharmacological tests have been abandoned on account of their unreliability. An indirect sign of stenosis is dilatation of the homogeneous opacity of the bile duct to over 10 mm or a sometimes visible translucency in the opacified duodenum corresponding to the swollen papilla. Contrast reflux in the duct of Wirsung by itself is not a sign of papillary stenosis, but with a dilated pancreatic duct this is usually due to organic lesions (Lataste and Albou, 1977). *Fig. 143.*

A higher opening pressure on manometry draws attention to an obstruction (over 15 cm water column), it rises even more with repeated measurement. This information is unreliable (Arianoff), as the scatter of normal values has a range between 2–20 cm H_2O! Flowmetry is more reliable, though its significance has been reduced to a "signe d'alarme" at the commencement of surgery. Slowing of flow through the papilla below 20 ml per minute with a constant pressure of 30 cm H_2O favours an obstruction, however, about 3.5% false negative, and about 1% false positive results may be expected (White, 1972). The type of obstruction has a considerable effect on error percentages (Blažek).

The presence of stones in the terminal choledochus reduces the diagnostic value of radiological and cholangiometric investigations for stenosis. Following their removal and handling of the sphincteric region, no reliance can be placed on these methods for the evaluation of patency of the papilla.

Probing performed cautiously provides information more safely, particularly if evaluated in connection with other results. Stenosis of the papilla is suggested if a probe with 3-4 mm diameter snags in a papilla after removal of stones, or fails to pass. Probe diameter has been selected empirically (Catell) and does not apply in all instances. Probe passage may be hampered not only with fibrostenotic surgical lesions, ("rigid stenosis"), but also with spasm, edema, bruising or inflammatory swelling ("soft stenosis"), the latter being reversible.

The probe may catch in a narrow cystic duct, in the pancreatic segment or before entry into the sphincteric segment. *Fig. 144.*

Finally it must be pointed out that it is not width alone, and accordingly patency of the sphincteric segment for the probe, which decide on stagnation in the patient, but sometimes excessive dilatation and flacidity of the main duct, or injury to the sphincter of Oddi caused by the passage of a large stone: In such cases bile flow may be impeded even though a probe wider than 5 mm can be passed through the papilla. Stenosis is not exclusively an anatomical, but also a functional term and in this sense the term "wide stenosis" must be understood.

Probing is sometimes inadequate for assessment of the papilla and has to be supplemented by direct exploration from the duodenum. After duodenotomy stenosis is suggested by the following findings:

- A thin catheter 3 mm in diameter fails to pass the papilla or only its tip emerges from the orifice.
- The papilla is swollen, pulpy or indurated, sometimes bulging into the gut. Biopsy during operation may provide preliminary distinction from neoplasm, otherwise such an investigation is valueless for nonmalignant lesions.

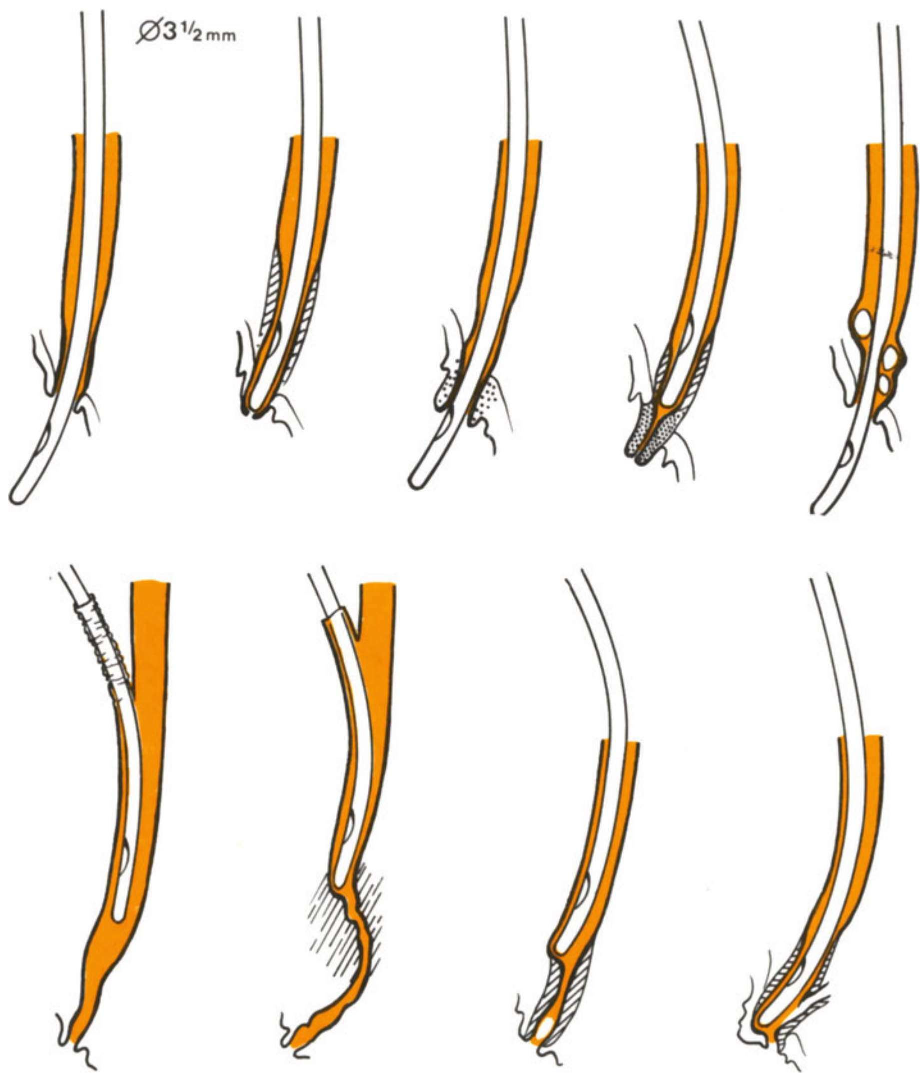


Fig. 144: Probing of papilla. (a) Normally patent papilla, (b) stuck or narrowed orifice, so-called "phimosis", (c) "soft" stenosis, (d) "rigid" stenosis, (e) calculi acting as snag to catheter in the sphincteric segment, (f) catheter catching in a narrow cysticus, (g) catheter stuck in the pancreatic segment, (h) catheter halted proximal to a sphincter positioned excentrically, (i) catheter caught on mucosal roof of papilla.

- The orifice even of a small papilla may be rigid, narrowed or extinct.
- Induration of the papilla is a fairly reliable sign of fibrotic irreversible stenosis requiring transection. Doubts may arise with a soft papilla and many a time the character of lesions cannot be accurately evaluated until papillotomy is performed and the upward extent of lesions disclosed.

Operations for stenosis of papilla and sphincteric segment of common bile duct

The object of surgery is relief of stenosis and a guarantee of free bile-flow by removal of stones, dilatation of the papilla, sphincterotomy or anastomosis. The method of operation is selected according to the grade of stenosis and from an assessment of its reversibility.

However, this is not only a matter of findigs, but also of experience: – We are not entitled to make the decision easier and to treat every uncertain situation by immediate sphincterotomy and thus expose the patient to a sometimes unnecessary risk.

Clearance and the provision of rest for the sphincteric segment.

It is sometimes sufficient to remove impacted stones from the terminal bile duct and the papilla is adequately patent on probing alone. Simultaneous cholecystectomy and drainage of derivation avoids disturbance and protects from fresh insults. Papillary edema regresses rapidly and trauma caused by calculi and their extraction heals without stenosis.

Dilatation of the papilla

Gentle dilatation or rather graded probing is admissible only in soft, compliant stenosis after removal of calculi. Its technique is simple: under control of the left hand gradually thicker probes are inserted without force. A diameter of 6 mm is not exceeded as a rule, to prevent tears and restenosis. This could not be reliably prevented even by massive divulsion, which could easily induce pancreatitis. Dilatation is terminated by tepid lavage and bile duct drainage, but not however by transpapillary tube.

Dilatation of the papilla is not as reliable as PST, as intervention is blind, and unexpected trauma might be inflicted and some reject it altogether. Cautious dilatation, however, does not usually induce fibrosis,[4] and the writer has found it useful, particularly with obese or aged patients where the risk of duodenotomy and sphincterotomy had to be avoided.

Papillosphincterotomy

PST ist the sovereign method for fibrostenosis and for the reliable clearance of stones adhering to the sphincteric segment. This method has been known for 75 years, and the first to divide the sphincter of Oddi transduodenally was apparently McBurney (1903).

The writer's personal series comprises 617 patients over a period of 20 years. The most frequent reason for PST in this series was removal of impacted or from above inaccessible calculi, even in cases without pronounced papillary stenosis. Cases where papillary lesions were also found predominated, however, including the most severe "surgical" stenoses. Such fibrotic narrowing of the papilla in the absence of choledocholithiasis has rarely been encountered with primary operations, only in about 7% of the series, and as a rule only in patients whose calculi had apparently passed through the papilla earlier. The same applies to large surveys (Arianoff, Fegiz, Koriolov, Pi-Figueras, Šerý).

A recognized and relatively common indication for PST even in low grade stenosis are repeated attacks of biliary pancreatitis.

In some countries indications for PST are justified in a variety of parasitic disorders of the bile ducts.

PST is also an essential supplement of lateral anastomosis to avoid the creation of a "blind sac" with calculi.

In contrast, PST alone is not indicated and serves no purpose in bile duct compression by a pathological pancreas. Neither is it a reliable protection against missed stones, as it facilitates the passage of only the smallest calculi. It is no protection either against recurring pancreatitis of other origin than biliary. It is hard to perform in obese subjects, and carries a higher risk in acute pancreatitis, where some surgeons consider it contraindicated.

Technique of transduodenal sphincterotomy. Access to the descending part of the duodenum must be excellent and if necessary the laparotomic incision is extended in time. A log swab is inserted under the mobilized duodenum and pancreas, and the duodenum incised in the usual manner (p. 131). The papilla is identified by a catheter passed through it or is at least directed towards it. If identification is not possible a search is made by finger, or methylene blue may be instilled into the bile duct. If at least the tip of a thin Tiemann catheter can be passed, this is grasped with artery forceps and the papilla divided over it. Sometimes the whole thin catheter can be smoothly pulled through until it becomes caught in the papilla by its wider end. The papilla is gently drawn up by the catheter, a small retractor held in the superior angle of the minimal duodenal breach, and the papilla divided. An electric scalpel is useful, a fine needle and very weak current, or a very sharp scalpel. Instead of a Tiemann catheter the tip of a Fogarty's catheter can be drawn through, its balloon slightly inflated to let it catch in the papilla. The catheter can be used only once, as the balloon is usually destroyed by the incision (Henzel).

If a soft catheter cannot be inserted a semirigid catheter is tried, or a flexible metal cannula, very gently. (With a metal cannula, however, electric scalpel must not be used.) The incision is made, if possible in situ over its opening, situated before its tip on the concave side of the instrument. Without fail we must avoid raising the papilla and terminal bile duct by the catheter, both ends of which are held in artery forceps, nor must this segment be levered upwards by the metal instrument. Otherwise the pancreas would almost unavoidably be bruised. In order to prevent slipping of the papilla during incision, it is wedged by small swabs held in long hemostats, which thus simultaneously stretch the breach in the gut. It may also be steadied by catching the lips of its orifice in two atrau-

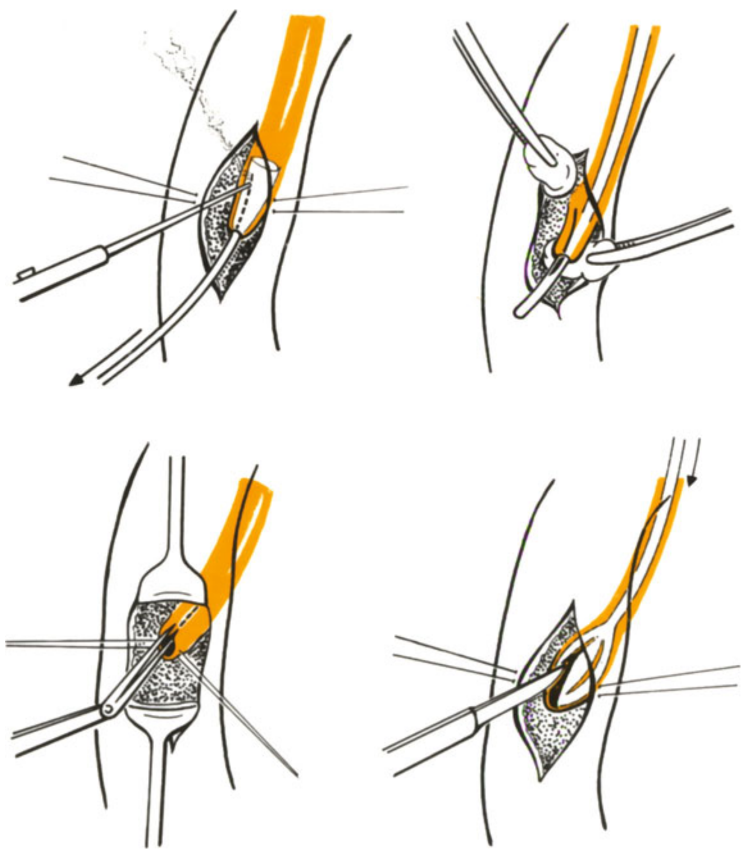


Fig. 145 a–d: Papillosphincterotomy. (a) Lifting and division of papilla with electric scalpel over widened tip of Tiemann catheter, (b) division of papilla in situ over opening in metal cannula, (c) splitting of papilla between sutures, (d) displacement and division of papilla over notch of Bakeš probe olive.

matic sutures or Allis' clips, guiding the incision between them, or inserting fine scissors for cutting the papilla.

For performing a limited PST (made "to measure") special instruments for improving access to the papilla are advantageous, such as Solar Roig's probe with a set of conuses varying in width, or the Bakeš sound adapted for this purpose. It bears at one end a slim olive which passes the papilla, the other bears an olive 4–6 mm in diameter which hitches on the papilla and draws it closer. It bears a number of longitudinal notches to that the correct site for division on the papillar circumference can be selected. An electric scalpel must not be used with a metal instrument in position. *Fig. 145.*

In cases where neither the tip of some instrument or an ureteric catheter can be passed through the papilla, three possibilities arise:

- The papilla can be cautiously projected forward by a fairly rigid catheter or other instrument inserted from above. It is advanced towards the breach in the gut and the orifice transected with fine scissors.
- If the instrument cannot be pushed to the orifice, the duct is incised over it transduodenally. The tip of a curved fine hemostat is inserted in a distal direction into this small opening until the orifice is passed. The remaining bridge of stenosed papilla is divided between its slightly distended branches.
- If the papillary orifice is visible in the gut it may sometimes prove more advantageous to insert the hemostat tip into the small orifice from below and commence division of the papilla from there.

Amongst the modalities set out the least traumatic is always chosen. The papilla is always approximated strictly in the direction of the terminal bile duct axis, without forcibly raising or levering it. Projection of the papilla as far as the gut opening for its division, though convenient, may easily bruise the pancreas.

Incision or cutting of the papilla should always be done in its outer anterior sector, at 11 o'clock on the circumference. At this site injury to the pancreatic duct is least likely to occur as this joins the bile duct from below and to the left. For the same reason the papilla or its edge is held by stay sutures or small forceps only at the site in question, between 10 and 12 o'clock. The relative positions of the bile duct orifice and pancreatic duct may change somewhat according to the position of the papilla. If it is situated deeply in D 3–4 Wirsung's duct lies completely to the left and the papilla may be safely split at 9 o'clock (Pedinielli).

The incision should be done as smoothly as possible without bruising, and the whole procedure must be extremely gentle. If a specimen is to be collected simultaneously for histological investigation, a small wedge is excised from the edge with an ordinary knife or scissors. Investigation is more of documentary or research value, if neoplasm does not have to be excluded. It alters nothing as regards surgical intervention in papilla stenosis and is better not done routinely.

Three procedures are distinguished by the length of incision: papillotomy, papillosphincterotomy — partial or total. *Fig. 146, 147.*

As a rule partial papillosphincterotomy is performed, and if nothing is added to the abbreviation PST, this always applies to the partial incision. — Mere papillotomy is frequently considered inadequate and total papillosphincterotomy in most cases excessive.

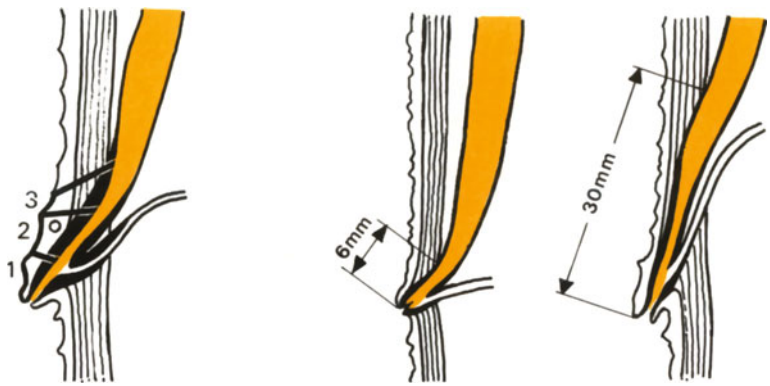


Fig. 146: Papillotomy (1), partial papillosphincterotomy (2), total papillosphincterotomy (3). Under mucosa a cross section of a small artery crossing here in front of the choledochus.
Fig. 147: Short and long sphincteric segment of choledochus.

Partial papillosphincterotomy—
"To divide such a differentiated, delicate sphincter without producing damage is surprising" (Soupault). This is true, at least as far as partial papillosphincterotomy is concerned. It has to be long enough to divide the entire narrowed segment until the patent duct is reached. No other general rule on incision length can be given, if only because of the considerable individual fluctuations in the length of the sphincteric segment. The statement that PST length should equal choledochus width is entirely misleading. It is thus irrelevant to mention incision length in mm in the operation protocol, but to record the extent of stenosis, whether the entire sphincter has not been cut, and what gauge instrument could pass into the gut.

Stenosis in most cases merely involves the orifice or papilla. Partial PST preserving the upper portion of the sphincter of Oddi needs an incision of 5–12 mm and a probe measuring 5–8 mm or more can then be passed. If the cut exceeds 12–15 mm the entire sphincter may have been divided. A small artery in the intestinal wall crossing obliquely in front of the duct may frequently be divided in extensive sphincterotomy, for which a fine transfixed catgut ligature is required. *Fig. 148.*

Practice revealed that it is immaterial whether an electric or ordinary scalpel is used for the incision, or whether the divided edges are sutured or not, though theoretically this "sphincteroplasty" should prevent restenosis more efficiently than edges left unsutured, or divided only by an ordinary scalpel. At the writer's clinic PST edges were sutured only if hemorrhage occured. Despite this restenosis took place only sporadically, in about 5%. It is prevented mainly by the yawning

Fig. 148ab: Papillosphincterotomy: (a) Partial, (b) long one with suture of edges, so-called "sphinctero-plasty". The lumen of the divided small artery is visible in the incisional margin.

circular sphincter fibres produced by cutting. This may sometimes be so marked after operation that postoperative cholangiography arouses suspicion of a stone, as the cleft and swollen papilla transiently assumes the shape of a claw. *Fig. 149.* Duodenal reflux is not induced by partial PST as only the stenosis is relieved and sphincter of Oddi activity not completely abolished.

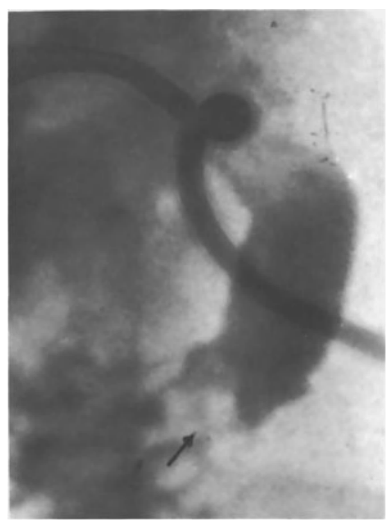


Fig. 149: Postoperative cholangiography one week after partial papillosphincterotomy. Divided papilla is claw-shaped simulating stone.

Total sphincterotomy is usually accompanied by division of the entire intestinal wall, with the danger of leakage into the retroperitoneum. In most cases, however, terminal choledochus already lies closely to the duodenum before the commencement of the sphincteric segment, thus its division need not always create a communication between the gut and its surrounding. Nevertheless, the additional performance of plasty is recommended with long incisions, the intestinal mucosa being sutured to the duct margin.[50] As this measure is generally accepted, some authors use the terms total papillo-sphincterotomy and sphincteroplasty indiscriminately. Such an operation permanently abolishes sphincter of Oddi activity and produces duodenal reflux, as in internal choledochoduodenal anastomosis. However, even such an extended discision fails to relieve biliary stasis in cases of tubular pancreatic segment stenosis, or with a duct rendered toneless by chronic dilatation. It only facilitates the passage of some stones and possibly prevents restenosis. Total PST carries a higher risk due to posterior duodenal wall damage (Danilov and Vishnevsky), but Partington who uses it reports a postoperative mortality of only 2.9%. The present writer performs total section only if forced by a large impacted stone, or by stenosis of the entire sphincteric region.

Transampullary septotomy. Transduodenal approach to the papilla can be utilized during operation also for wirsungography, if this is indicated for pancreatic symptoms. The pancreatic duct orifice can usually be visualized at the bottom of the cleft papilla and can be identified from the flow of clear secretion.

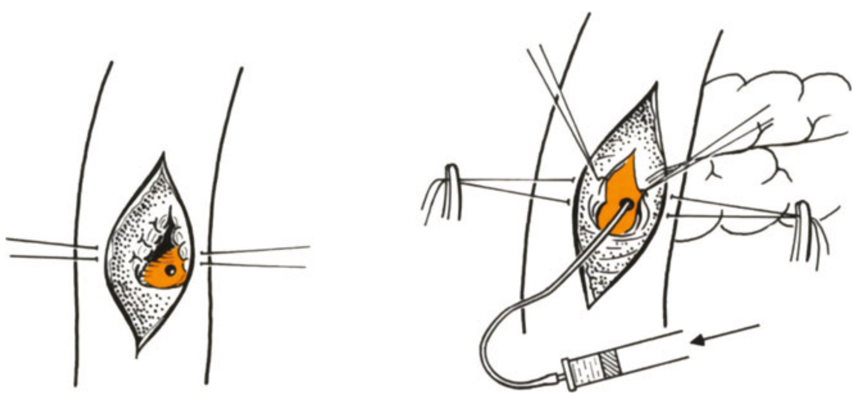


Fig. 150: Wirsungography. (a) Pancreatic duct orifice exposed by papillotomy, (b) injection of small quantity of contrast medium through fine catheter.

Contrast medium, however, is preferably instilled prior to papillotomy, in an amount of just less than 1 ml. *Fig. 150.* Papillotomy may be combined with the so-called transampullary septotomy. This signifies division of the pancreatic orifice, if its limited narrowing is present.

Final surgical phase

Operation is terminated — following PST — in the manner described already in operation for wedged calculi (p. 243). A peritoneal drain is always placed against the carefully sutured duodenum.

Operation is completed by duct drainage or closure. Ideally choledochotomy is possible even after PST, under favourable local and general conditions however (p. 137). A majority of surgeons still consider bile duct drainage safer and it may certainly be recommended following difficult interventions and pancreatic bruising. The tube protects against transient hypertension, facilitates radiological checks, and sometimes bile duct after-care. Transpapillary drainage, however, is not recommended in any of its modifications. It is unnecessary and may be harmful. In the writer's view, shared by other surgeons (Welz 1968, Bohmig 1968, Meyhoff 1975) this may sometimes participate in the origin of pancreatitis. — With equal resolution the preventive insertion of an indwelling catheter into Wirsung's duct is contraindicated.

If acute postoperative pancreatitis is feared, some measures can be commenced during operation: tetracycline is prescribed and 1–2 million units Trasylol or Antilysin given by drip. Their preventive value, if administered early, has not yet been refuted. Venalot (combination of coumarin and rutin) and Mercurascan (mercury derivative of fluorescein) may also be opportune. These medicaments have been efficacious in the prevention of experimental pancreatitis arising with the pancreas transplantation. (Málek, Bartoš et al., 1979) and seem more promising than the application of glucagon. A nasogastric tube is left in position and nutrition is exclusively parenteral. Gastric contents are continuously aspirated, and bile left to drain freely through the T-tube — until the danger of pancreatitis has subsided as shown by clinical checks and monitoring of amylase levels, and secretion from the peritoneal drains.

Anastomosis for stenosis of the sphincter of Oddi region

Anastomosis, linking bile duct with duodenum or jejunum is not by itself such a correct measure for sphincteric stenosis, but sometimes a suitable or essential supplement. It is essential with a greatly dilated, damaged main bile duct, and in advanced compression by the pancreas. — It may also be advisable if retained stones are feared, or following clearance of papilla solely by dilatation if we cannot be certain that the stenosing lesions will regress.

Choledochoduodenostomy and choledochojejunostomy will be described elsewhere (p. 382). If anastomosis supplements papillosphincterotomy, the original incisions of choledochus and duodenum are made in sites that can be utilized for anastomosis or at least do not hinder it. Sometimes jejunum is preferable. The bile duct used must be sufficiently wide to create an adequate stoma and the papilla must be free to avoid difficulty due to a "cul-de-sac".

Palliative, exigency management of terminal choledochus stenosis

In cases of excessive immediate risk with direct operations for sphincteric stenosis, e.i. in the aged, debilitated subjects, in septic cholangitis or other manacing situations, only a provisional drain is placed in the choledochus, and surgery proper deferred to a more convenient time. The mere performance of an anastomosis without radical clearance of the papilla could only exceptionally be justified in this respect.

Prognosis of surgical treatment for stenosis of papilla

Surgery of the papilla and sphincter of Oddi is delicate, and not infrequently under the threat of pancreatitis. Immediate results are also affected by the general condition of the patient, often impaired by protracted latent cholestasis. Late results then depend not only on the skilful performance of surgery, but also on correct indication and selection of intervention.

The author agrees with Hepp that "to leave a small sphincteric lesion unrecognized may be, everything balanced, less risky than to perform a sphincterotomy abusive".

Surgery in the region of choledocho-duodeno-pancreatic junction, in particular PST, increasingly exposes patients to a variety of typical complications and in particular the following:

- Acute postoperative pancreatitis which may arise after mere dilatation of the papilla. Frequently it remains undiagnosed, but nevertheless it may account for a half of the mortality.
- Renal failure, quite common after surgery in this region.
- Intestinal hemorrhage from the sectioned edges of the papilla presenting as transient melaena. Found twice in our series.
- Duodenal fistula from dehiscence of sutures or after total sphincterotomy — not encountered by present author.
- Infection of subhepatic region with formation of subhepatic abscess.
- Stagnation of gastroduodenal contents of several days-standing apparently linked to interference with the duodenum and perhaps sometimes to latent pancreatitis.

Surgical mortality in nonmalignant stenosis of the papilla fluctuates much according to the type of disorder, operation and resistance of patients, but should not exceed 5% following the most frequently used partial papillosphincterotomy. Olivier reports 6.3% mortality in 1965, Roux in 1974 reports 4.5% fatalities, Manegold in 1976 a mean mortality of 4.2%, Šerý in the same year 4.5%, and Stefanini in his review of 770 PST had as little as 1% mortality. The author's latest statistics compiled in 1975 shows 3.9% mortality in 617 PST.

The continuous decline in surgical mortality may chiefly be explained by the fact that the risk of pancreatitis and some failures of PST resulted in limiting its indications to the rational and essential, that operations are less traumatizing, that systematic prevention of pancreatitis is performed, and that patients menaced by it are carefully managed from the time of operation.

Successes and failures in operations for stenosis of the papilla are hard to assess as choledocholithiasis is almost always also surgically involved. Most statistics compare papillosphincterotomy, dilatation of papilla and anastomoses from the standpoint of operations more than from indications. Definitive results of all three operations are mostly obtained after 1–2 years. They are better after PST than after simple dilatation. In our patients they were excellent in 65 to 85% discissions of the papilla, even with severe fibrosis, whereas dilatations produced a permanent good result in only 50–60%, although the latter have been performed only in less pronounced stenoses and sometimes even in reversible ones.

As far as PST goes, its results may largely be identified with the evaluation of operations for stenosis as such; this applies to anastomoses only with reservations. The latter are usually supplementary to surgical clearance of the papilla and only participate in its result: doubtlessly significantly in patients with a widely dilated choledochus. Otherwise our check-ups following anastomoses would reveal worse results than after sphincterotomy; excellent permanent results were found in 60–75% of cases.

If symptoms recur after PST or after dilatation, recurrence of stenosis must always be considered. This is encountered by surgeons in 2–6% of their operation cases. The author's series comprises 5% known restenoses. Reflux is more likely to cause symptoms after total sphincterotomy, stenosis of the stoma after anastomosis.

Biliary Pancreatitis and Pancreatic Choledochus Stenosis

Biliary tract and pancreas, closely linked anatomically and functionally, affect each other by their diseases as well. The surgeon is interested mainly in those which can be treated by operation. These are on the one hand cases of pancreatitis provoked by cholelithiasis, and on the other choledochus compression caused by lesions of the head of pancreas.

Biliary Pancreatitis

More than half of all attacks of acute pancreatitis in this country and in the whole of Central Europe originate with concurrent biliary disease. Its incidence in patients with cholelithiasis is so common, that an etiological connection is assumed in a majority, thus the designation "gallstone pancreatitis".

No exact criteria exist for distinguishing it from pancreatitis originating independently of stones, and only incidentally associated with them, although our prospective study and a ten-year follow-up of 179 patients (with evidence of both diseases either in the medical history or at operation) revealed relatively pronounced differences.[85] Attacks of relapsing gallstone pancreatitis were four times more frequent, and differed not only in frequency, but also in their pattern, findings on biliary passages and pancreas, age and sex of patients. Characteristics, even statistically significantly diverse, are, however, represented in both groups. For practical purposes this means that attacks of gallstone pancreatitis are almost regularly preceded by biliary symptoms, whereas other attacks lack this overture. Even this rule does not apply without exception.

Etiology

Commentaries about the origin of biliary pancreatitis are so far speculative. This analysis also supports the current belief that pancreatitic irritation and even its severe inflammations are caused by calculi and microliths passing through or lodging in the sphincteric segment or papilla. Kelly states that stones in the stools may be found in attacks based on cholelithiasis in 84% of cases, but in only 11% in cholelithiasis without pancreatitis.

Repeated insults as well as a certain type of junction are probably required suddenly to raise the intraductal bile tension, even to produce reflux, or impede the flow of pancreatic secretion as a result of an obturating stone, spasmus and induced swelling and possibly stenosis of the papilla. If other essential factors are associated, particularly if glandular secretion is stimulated, and the enzymes activated, acute pancreatitis may be induced. Sole blockage of papilla by stone, in the sense of Opie's common channel closure, only rarely causes hemorrhagic necrosis and, as a matter of fact, the finding of such a stone during emergency operation is a rarity.

It is even more problematical to explain pathogenetic correlations in "cholecystopancreatitis" as such, where experience is purely empirical. If stone migration can be excluded, spread of inflammation from gallbladder to gland via lymphatics, activation of pancreatic enzymes by kinins from disintegrated bacteria or by toxic impairment of cell membranes due to lysolecithine can be considered, but evidence, however, is missing (p. 57).

Clinical pattern

The clinical pattern of relapsing biliary pancreatitis is variegated. Usually attacks can be directly ascribed to symptoms of complicated choledocholithiasis and only rarely does pancreatic necrosis cause surprise or even kill a patient with so far latent lithiasis. Necropsy then discloses the presence of some small calculi in the gallbladder or papilla which escaped radiological investigation, but may have been causally related.

As a rule, as already stated, biliary complaints precede such attacks of pancreatitis, in some cases for many years. Perhaps this is one reason why these patients are usually over 50 years of age. Females are affected twice as often following the typical ratio for lithiasis. Symptoms are at first biliary in character, but later also choledochal, with intermittent obstruction of the papilla. Involvement of the pancreas occurs frequently at this juncture: it may manifest itself immediately by acute pancreatitis, or only by suspicious pains and laboratory evidence of "pancreatic irritation", which is added to an ordinary colic. The attacks of inflammation usually run a mild course, in contrast to primary pancreatitis, but usually force the patient who up to now has refused operation, to agree to it.

There exists, however, biliary pancreatitis which is painless and whose sequelae are surprise findings at operation. They may sometimes be suggested by pronounced temporary rises of amylase and lipase blood levels. ERCP may provide additional information in some cases.[114]

As far as findings at operation are concerned, numerous stones of small size are present in the gallbladder and in at least one-third of cases also in the bile duct. A typical finding is one of small calculi impacted in the papilla (12.3% after Streichenberger and Pelissier). The numerous cases of stenosis of the papilla, even in the absence of calculi, are evidence that stones at least have been passing through.[4]

At operation undertaken in the interval between attacks of pancreatitis findings are not parallel with the clinical or laboratory pattern. It must be borne in mind that anatomical lesions may regress in time and may disappear. Sometimes severe lesions were found by the present writer even with a negative pancreatic history, in contrast, the pancreas appeared normal even following repeated pronounced attacks. Most commonly lesions were found on palpation alone, in particular of the head and in the vicinity of the terminal bile duct and in 7% there was evidence of tubular stenosis. No signs of pancreatitis need to be found some two weeks after an acute attack, while swelling of the head regresses as a rule within a few weeks, as do Balser's necroses. The latter were found after an interval of several months at the latest. Even pseudotumorous lesions may gradually regress in the course of months.

Findings made at urgent operation, i.e. in the acute phase of pancreatitis, have been described in the chapter on urgent biliary surgery.

Treatment

Urgent surgery in biliary pancreatitis is indicated in the face of a menacing inflammatory explosion, and preventive, elective surgery during a period of quiescence.

In the first case, with the acute onset of severe pancreatitis, when surgery is undertaken for an acute abdominal emergency of obscure character, or after the failure of intensive conservative therapy; the biliary etiology of pancreatitis forms the third main indication for urgent surgery in progressive inflammation, as will be shown later.

In the second instance surgery is indicated for biliary tract disease, but the associated manifestations of recurring pancreatitis increase its urgency. Operation also controls the pancreatitis, but is in the first place a preventive measure. It consists of cholecystectomy, clearance of any stones in the ducts, and frequently includes sphincterotomy in order to clear the papilla. Septotomy might rarely be advisable, i.e. transpapillary division of the stenotic orifice of Wirsung's duct. Choledochus anastomosis is required only in tubular stenosis with dilatation of the main bile duct.

The increased danger of postoperative acute pancreatitis is stressed with all these operations in patients already disposed to pancreatitis. In the author's series of 143 such cases 5 patients died, but none of them from pancreatitis. Clinical or merely laboratory evidence of pancreatitis during the postoperative period was found only three times after 76 papillosphincterotomies.

Late results are said usually to be good. Pancreatic symptoms in this series disappeared in 82% for periods of 6–10 years, in 11.7% dyspeptic symptoms persisted and dieting was required, in only 6.3% did pancreatitis recur.

Clinical experience is of practical value,[114] namely that surgical treatment of biliary disorders can have a favourable effect even on recurrent pancreatitis not directly related to existing lithiasis. 36 patients in this category were submitted to operation by similar methods; however, there were fewer sphincterotomies, only 7 being required. Results were satisfactory, though less excellent, pancreatic attacks recurred in a quarter of cases. Preventive clearance of the biliary passages may thus also be indicated in these "primary" pancreatitis cases, even if only latent cholelithiasis is present.

Pancreatic Stenoses of the Bile Duct

Interrelations between disease of biliary tract and pancreas may be the reverse of biliary pancreatitis: pancreatic lesions, neoplastic or inflammatory in character may press on the bile duct and interfere with bile flow.

Neoplastic *pancreatic stenoses of the bile duct* originate as constriction of its terminal portion by cancer of the head and are the most common cause of total obstruction. The diagnosis of rapidly developing and progressive jaundice and about its surgical treatment will be dealt with elsewhere (p. 299), as this chapter deals only with nonmalignant involvement of the bile duct.

Inflammatory *pancreatic stenoses and deformations of terminal choledochus* are a typical complication of acute and, in particular, chronic recurrent pancreatitis of any type, biliary or non-biliary. Compression may be transient, as a rule diffuse, caused by acute edema and inflammation of the gland, or more persistent, of irregular shape, caused by chronic fibrocystic lesions in the head of pancreas. In compression of the duct during the acute phase of pancreatitis symptoms of the latter predominate, and only if in addition subicterus or jaundice appear, a suspicion of sudden constriction of choledochus by the swollen pancreas is roused. Jaundice may, however, be due also to primary obstruction of the duct by small stones or to cholecystitis or to hemorrhagic necrosis of the pancreas itself. If urgent surgery is resorted to and bile under pressure is found in the duct, decompression drainage is always indicated and only postoperative radiological checks through the tube may decide whether there has actually been duct compression.

Chronic stenoses develop gradually, when the pancreatic segment is only partially, but permanently deformed and narrowed by previous inflammation, particularly if the latter was repeated and produced fibrotic lesions. Such stenoses are of varying grades.

Typical are elongated "tubular" stenoses, but lately we have become increasingly aware of the high incidence and significance of quite short deformations. According to their site bile and pancreatic ducts may be cramped, either separately or both (Hess).

Clinical pattern

Pancreatic stenoses are not easily diagnosed.

The author has found a "tubular" pancreatic stenosis of the common duct at 1 461 primary bile duct operations in 49 patients only, — in 19 of them without coexisting gallstones.

Distinction from calculi or stenosis of the papilla is not easy and laboratory data are consistent with the general syndrome of incomplete obstruction, occasionally with a bias for biliary symptomatology, and sometimes pancreatic or mixed. The presence of such a stenosis may be suggested by duct dilatation shown on cholangiography, if there is a past history of attacks of pancreatitis and pancreatic insufficiency is disclosed by the secretin-pancreozymine test. Retrograde endoscopic cholangiography done before operation throws light on the matter, if both ducts can be opacified. Appearance are characteristic for several types of their simultaneous or isolated involvement and provide a guideline for definitive management.

At operation suspicion is aroused by the dilated choledochus and concurrent evidence of subsiding pancreatitis, or by chronic lesions in the head of pancreas. The latter may be enlarged, indurated or of uneven consistence (nodular). Induration is sometimes felt only along the bile duct. *Fig. 151.*

Operative cholangiography sustains suspicion by disclosing choledochus dilata-

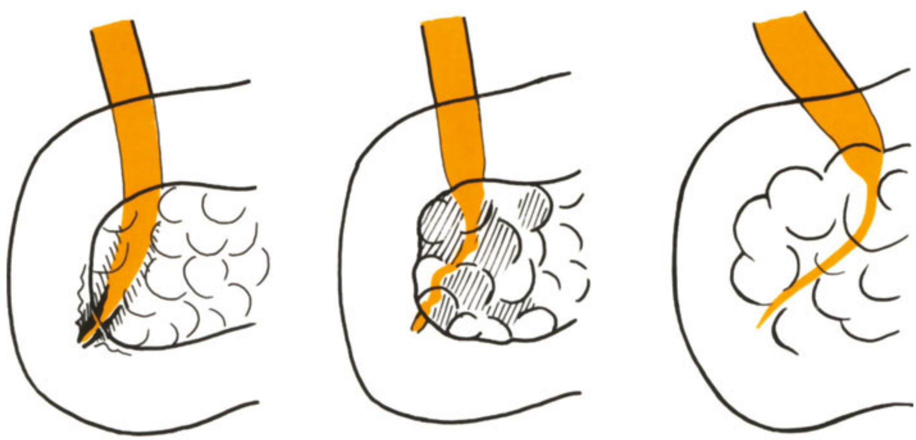


Fig. 151: Lesions of pancreatic segment of choledochus. (a) Pancreatitis paracholedochica, (b) duct deformation, (c) extended tubular stenosis.

tion falling short of the sphincteric segment, but terminating at the pancreas. In that region the picture of so-called tubular stenosis may be seen, with the choledochus transformed into a narrow long channel, forming a wide arch or angle curving to the left. A distorted duct irregularly narrowed, or with asymmetrical outline is found at times. According to Arianoff serial cholangiography performed under debimetric control is also capable of distinguishing various phases and types of pancreatitis. Undoubtedly, the idea that only one typical pattern of pancreatic stenosis exists is incorrect, and without a series of films and confirmation by probing interpretation of films may often be erroneous. *Fig. 152.*

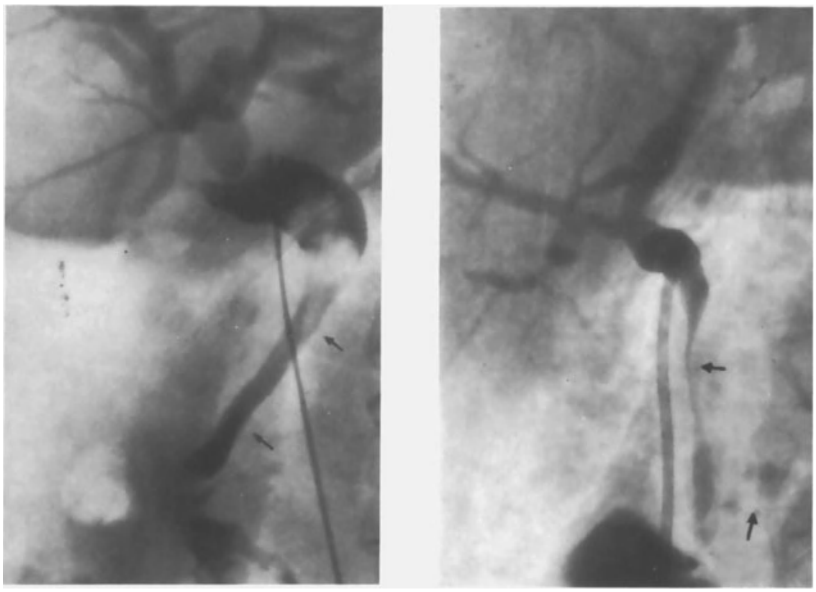


Fig. 152 abc: Operative cholangiography: (a) Dilatation of the common bile duct proximal to its narrowed pancreatic segment; (b) a distorted and stenotic pancreatic part of the common bile duct and calcifications in the pancreas; (c) extensive tubular stenosis of pancreatic part of the bile duct in chronic pancreatitis with calcifications.

Carefully performed probing sometimes reveals that passage is already impaired in the pancreatic region and not at the level of the papilla. It fails to give information, however, regarding the extent and character of the narrowing and cannot be decisive as regards concurrent stenosis of the papilla. The latter can be demonstrated only by means of duodenotomy in such cases. Not even delicate palpation by probe can always distinguish between induration due to fibrotic nodes in the glands or stones.

Surprisingly even severe lesions of the pancreas are not associated with obstruction and jaundice in contrast to neoplastic infiltration of similar extent. This is one of the clues for their distinction otherwise beset with difficulties if inflammatory stenosis is, after all, accompanied by jaundice. Appearance and feel of the gland proper are quite misleading. Lesions in the vicinity are of greater assistance, as congestion, Balser's necroses or adhesions. The presence of secondaries would naturally indicate neoplasm. Operative biopsy was marred in the author's series by false results in a third of cases and cholangiographic pictures, even "stop" of contrast medium have sometimes been similar in shape in cases of neoplasm, stone or inflammatory stenosis.

It is altogether most difficult to distinguish between pancreatic stenosis and stenosing choledochitis or carcinoma, if these very rare lesions do not spread beyond the pancreas region. Histology often fails to provide a reliable clue in these cases too.

Treatment

Stenosis of the pancreatic segment of choledochus may be encountered in the course of urgent surgery during an attack of acute pancreatitis, but also in planned biliary surgery undertaken for the incomplete obstruction syndrome.

In the first instance, the sudden compression of the choledochus as such requires its drainage, apart from other measures against pancreatitis. Postoperative checks will show whether compression has subsided and whether the T-tube can be withdrawn.

In elective surgery temporary choledochus drainage is likewise sufficient, if compression is recent and compliant. Minor pancreatic stenoses and deformations which may sometimes escape recognition if combined with lithiasis and stenosis of the papilla may regress spontaneously, possibly after the removal of stones and papillotomy, the latter preventing further exacerbations of pancreatitis.

If, however, fibrotic tubular stenosis with a dilated choledochus is encountered, biliary intervention must be supplemented by an anastomosis with the duodenum. Dilatation or protracted intubation of a pancreatic stenosis is incorrect and it would be quite illogical to imagine that tubular stenosis can be relieved by total PST.

Papillotomy may, however, be justified if stenosis of the papilla is also present, i.e. a second "distal" stenosis which could prevent evacuation of the trunk even with an enterobiliary anastomosis.

In rare instances when apart from choledochal compression marked signs of obstruction and dilatation of the pancreatic duct are also found, determining possibly the clinical features of the case, division of the stenotic orifice of the duct of Wirsung is justified;[77] if the duct in the body of the pancreas is dilated, it may be anastomosed to a jejunal loop after Puestow. In multiple severe fibro-cystic lesions of the head of pancreas and persistent pains from chronic pancreatitis Whipple's operation may be in order. This operation, according to Guillemin, Kümmerle and two personal cases, is justified, particularly if the neoplastic origin of pancreatic lesions is suspected.

Cholangitis and Inflammatory Stenoses

Cholangitis is an inflammation which may involve either only the hepatic ductules and fine intrahepatic bile ducts or, on the contrary, the large, chiefly extrahepatic ducts. From here inflammation sometimes spreads ascending into the smaller branches inside the liver, resulting in diffuse cholangitis.

Cholangitis and pericholangitis of the first type are classified as liver diseases and usually belong to the primary cholestasis category.[113] Large bile ducts are not involved, the clinical pattern is typical and is merely of differential diagnostic importance for the surgeon.

The second group of inflammations, much more common, is of great surgical significance. These cases of cholangitis originate as a rule by bile infection accompanying obstruction of the main ducts and only rarely without apparent obstruction. An unusual type are some, mainly hepatic, purulent cases of cholangitis occurring chiefly in the Pacific Ocean region and often associated with parasitic duct infestations. Finally a disease sui generis, the so-called primary sclerosing cholangitis is assigned to this group.

Bacterial Cholangitis in Biliary Stasis

This secondary obstructive cholangitis is the most common in this country, representing the "second disease" with lithiasis, strictures, tight anastomoses and stenoses of the bile ducts and papilla. Cholangitis is their clinical symptom, and serious sometimes life threatening complication. It may originate in the absence of an obstruction, but rarely, — merely due to retarded bile flow as occurs in a dilated, flabby bile duct, or with a congenital bile duct cyst. Intestinal bacteria are the usual source, such as E. coli, enterococcus, aerobacter proteus, pseudomonas — less often strepto- or staphylococci. These bacteria reach the ducts apparently mainly from the gut, portal circulation or via the lymphatics, or by contamination of the ducts during surgery or drainage. Bacteria may, however, pass there also from the systemic blood circulation.[52, 87, 110] Their presence in the bile — "bacteriocholia" is not synonymous with cholangitis. Biliary stasis is the decisive factor for infection becoming established, even reflux of intestinal contents into the anastomosis is not sufficient, provided adequate bile drainage is maintained. The type of obstruction is also of importance: infection arises more easily in nonmalignant, incomplete or intermittent obstruction,[34] and more particularly in lithiatic, rather than in neoplastic. Apparently bile infection precedes the inflammatory lesions and clinical pattern of cholangitis for some time. *Fig. 153.*

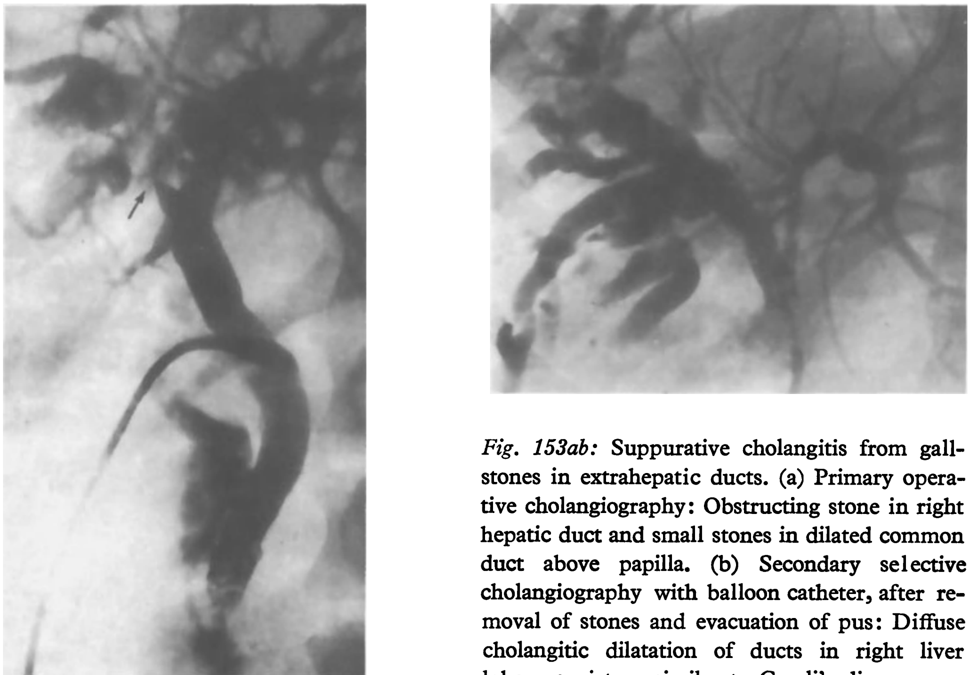


Fig. 153ab: Suppurative cholangitis from gallstones in extrahepatic ducts. (a) Primary operative cholangiography: Obstructing stone in right hepatic duct and small stones in dilated common duct above papilla. (b) Secondary selective cholangiography with balloon catheter, after removal of stones and evacuation of pus: Diffuse cholangitic dilatation of ducts in right liver lobe – a picture similar to Caroli's disease.

Pathology

The appearance of the bile and, at first, the lesions of the bile duct depend on the current status of microbial activity. Signs of inflammation range from flakes of mucus to purulent turbidity, congestion, edema and inflammatory infiltration in the duct walls. Fibrosis and loss of tissue elasticity occur later, and the bile duct, as a result of inflammation and concurrent biliary hypertension becomes progressively, and later irreversibly dilated.[108] Superficial ulcers and decubital lithiatic lesions with subsequent stenoses may be produced at some sites. Various lesions pass into each other or exist concurrently. In protracted or highly active cholangitis spread of infection from the large into the fine intrahepatic ducts takes place, with purulent material accumulating there. Necrosis of epithelium sets in, and purulent infiltrates in the neighbouring portal tissue heal by circular scars, or lead to abscess formation.

Findings at operation, surprisingly, sometimes fail to tally with clinical manifestations of cholangitis, such as typical attacks of bacteremia with septic temperatures. These symptoms are transient, due to biliovenous reflux accompanying rapid rises in intrabiliary pressure or the multiplication and increased virulence of microbes following stress or weaking of the organism. This discrepancy between clinical impression and operative findings occurs in particular if surgery is delayed until infection has been brought under control by antibiotics.

Trials to classify surgical cholangitis according to route of infection, site of obstruction and seat of inflammation and its anatomical character appear artificial to the clinician. It is only necessary in actual practice to distinguish certain clinical patterns differing in etiology, evolution and requiring specific treatment.

Clinical pattern

The clinical picture of cholangitis blends largely with manifestations of the primary disorder, i.e. with signs of chronic bile duct obstruction. The onset of cholangitis is, however, heralded by the addition of septic steep rises of temperature associated with rigors. These acute spikes of fever, 39° to 40°C, are superimposed on the basic fever in acute cholangitis, in chronic cases they arise from normal temperature values.

Charcot's trias of symptoms remains the classical pattern, i.e. fever, jaundice and pain.

Acute cholangitis is always a serious life endangering disease, or complication. It may start with an attack of pain similar to acute cholecystitis, but differs from it by its septic course. It may also be only an exacerbation of chronic infection accompanying a chronic obstructive disorder of the ducts. The patient is sometimes very ill, menaced by sepsis and liver failure. Laboratory data include a considerable leucocytosis and pronounced biochemical signs of inflammation and cholestasis. Hemocultures obtained during rigors are frequently positive.

A malignant variety of acute cholangitis is acute shock producing bile duct obstruction by impacted stone with the duct crammed with pus. The patient who may be delirious and in hepatic failure can sometimes be saved only by emergency surgery, as described later (p. 448). — Another dangerous type is acute cholangitis with renal failure. This announces itself by a drop in diuresis and rise in urea nitrogen and creatinin blood levels. It is often accompanied by jaundice and gastrointestinal hemorrhage. The cause of uremia is usually acute tubular nephrosis.[45]

A special group is formed by cases of necrotising cholangitis, sometimes of non-obstructive origin. Decubital necroses due to stones which may lead to perforation have been mentioned. Bile duct necrosis, however, may be caused by autodigestion in acute pancreatitis. Recently necroses have been recorded following liver transplantation if the cystic artery was divided too high. — A quite exceptional case of diffuse necrosis of the main bile duct has been described by Mellière (1974). Apparently this was a case of primary colibacillary infection.

Chronic cholangitis is really a clinical diagnosis used for intermittent septic episodes accompanying chronic biliary tract infection, and otherwise running an uncharacteristic or subclinical course in anicteric obstruction. Septic fever and chills complicating the primary bile duct involvement occur sometimes after lengthier intervals. Some cases may be temporarily nonsymptomatic, the patient being surprisingly well in the intervals. The pattern of chronic sepsis may even be overlooked, or not appreciated amongst manifestations of the primary biliary disorder, but it always signifies an advanced stage of the disease. Physical findings are modest, liver and spleen not usually being enlarged. Emerging biliary liver fibrosis frequently shows no laboratory evidence.

The diagnosis of chronic cholangitis is based on recognition of the septic character of the fever, its biliary origin and the causes of bile stagnation. Intravenous cholangiography may reveal a dilated bile duct as a sign of obstruction, sometimes its cause. As indirect evidence of cholangitis — in the presence of clinical symptoms — non-opacification of ducts after repeated examinations, is the more likely event. Biochemical evidence of cholestasis is of great assistance in this connection, even if hyperbilirubinemia is absent or appears regularly at least with attacks.

Some patients may develop the rare stenosing type of infectious cholangitis. Chronic inflammation induces thickening of the wall, usually of limited extent, and not always visible externally, but instead of the usual duct dilatation, segmental stenosis is found. Terminal bile duct, common hepatic duct at cystic duct origin level, and the bifurcation region are the sites commonly involved. In other instances a number of narrow sectors develop, which alternate irregularly with the wider. Suprastenotic dilatation need not even occur in extensive periductal fibrosis. Diagnosis is possible only at operation, when such stenoses are found, as a rule as a complication of the primary lithiasis, or following cholecystectomy. Clinically they confer a pronounced cholestatic character to the disease.

Some stenoses of infectious origin are hard to distinguish from "primary" sclerosing cholangitis and from scirrhus degeneration of the bile duct, not only clinically and radiologically, but also histologically. Distinction from neoplasm is particularly difficult in cases where the relatively inaccessible bifurcation region is involved. This occurred in two personal cases, the epithelium showing proliferation and even mitoses.

Treatment

As regards therapy of cholangitis, acute and chronic, it is not so important to diagnose duct inflammation, but to detect its cause — obstruction, and if possible the character and site of the obstruction. Treatment is directed not merely to the inflammation, but always concurrently to biliary stasis. This second object is also more significant and decisive for a permanent cure of inflammation. For this reason surgery is indicated in the first place, at least in all instances where a mechanical duct obstruction has been discovered. Surgery must remove or by-pass any obstruction and guarantee free bile flow, antibiotic treatment being supportive and significant mainly for the preparation of the patient for surgery.

Operation should not be unduly delayed even in mild, common forms of acute cholangitis. Suitable antibiotics are administered for a few days, such as ampicillin, gentamycin, chloramphenicol and cephaloridin — and if required transfusion and infusion. We must not be led astray by the temporary improvement and dispense with surgery, a common enough mistake. On the contrary, the improvement should be exploited for the operation. It may also be necessary, as correct diagnosis is thereby provided. Utilization of operative cholangiography should not be feared in this respect, even in cholangitis.

Two-stage procedures are not suitable as regards surgical tactics. It is frequently preferable to solve even an emergency by definitive intervention, if that can be tolerated. This includes removal of calculi, papillosphincterotomy, anastomosis, plasty or resection of stricture etc. If the gallbladder has not yet been removed, cholecystectomy is always indicated. Only if the patient's condition is very poor must be satisfied with external bile duct drainage or limit surgery to cholecystectomy if the cystic duct is widely patent. Still less hazardous sometimes, is percutaneous transhepatic cholangial drainage or even endoscopic papillotomy. Every patient menaced directly by toxi-infectious shock accompanying sudden bile duct obstruction, or sometimes also renal failure, must be submitted to surgery without delay. Antibiotics must be started immediately and frequently in the latter hemodialysis is also used. Emergency surgery must be risked if essential.[34]

Each operation done for biliary obstruction accompanied by cholangitis, even if bile flow has been restored fully by radical surgery, should be completed by bile duct drainage. T-tube accelerates drainage of infected bile, and makes lavage of ducts and collection of bile samples for bacteriologic checks possible. The patient receives selective antibiotics after operation and is afterwards a suitable candidate for spa after-care.

Surgical revision is always advisable in stenosing cholangitis, even if in this case the character of the stenosis cannot always thereby be assessed. In segmental peripheral stenosis an anastomosis can be attempted, if the duct is dilated proximally, or an anastomosis between gallbladder and gut can be performed. If the stenosis is high in the hilum or inside the liver, or in long stenosis, even hepatodigestive anastomosis is useless and intubation by in-dwelling external drainage tube is preferred. Choleretics and antibiotics are administered through it and it can be also used for lavage. The writer cured two patients with inflammatory stenosis in the bifurcation region by intubation transhepatic drainage maintained for periods of 4 and 8 months.

Pyogenic Parasitic Cholangitis

This is a special type of chronic recurrent cholangitis, where infection, mostly E. coli, is not due to main duct obstruction, but to infestation of ducts by some parasites. Their presence causes irritation and in conjunction with secondary bacterial intestinal infection produces inflammation of the walls. Limited stenoses develop with proximal dilatation of intrahepatic ducts which are filled with mucus, pus, biliary mud and multiple pigment stones. In their vicinity inflammation supervenes, leading to abscess formation and local liver tissue atrophy.

Such parasitic infestations mainly by Clonorchis sinensis and Ascaris occur particularly in some Far Eastern regions and these inflammations are called, accordingly, oriental cholangiohepatitis. Exceptionally the disease may affect people who have emigrated from these regions. Malnourished subjects in the low socio-economic classes are the chief sufferers.

In the Pearl river basin, Korea, Taiwan, Malaysia infestation by Clonorchis sinensis is prevalent. The source is chiefly from fish and secondary hosts are domestic animals. It has been described particularly in the inhabitants of Hongkong and termed Hongkong disease. The parasite enters the biliary tract from the duodenum through the papilla. There it matures, lives and produces eggs around which bile stones are formed. At present doubts have been raised about the specific significance of the parasite, similar cases of cholangitis also occur in regions where it is absent (Warren). The disease has been observed in regions where Ascaris is common, particularly in the Near and Far East, especially in Japan, but also elsewhere in the world.

The bile ducts may also be affected by other parasites which inundate them suddenly or settle there permanently. These include hydatid cysts, trichostrongulus and distomiasis — their prevalence fluctuating in various countries. As a rule inflammatory and obstructive symptoms are caused, sometimes with similar, sometimes with a different clinical patterns.

Clinical picture

Typical pyogenic cholangitis due to parasites is characterized by recurrent attacks of excruciating, even shock producing, biliary colic accompanied by fever and chills, and frequently by transient jaundice. Patients are toxic during this stage, the liver is enlarged and tender, and the gallbladder frequently palpable. Males and females, and even young people, are affected. The severe, sometimes fulminating clinical signs are usually the result of recurrent secondary infection by E. coli, which may terminate in the formation of liver abscesses.

Laboratory data are consistent with inflammation, and the success of intravenous cholangiography depends on the condition of the liver. Preoperative diagnosis is possible only if the patient's origin is taken into account, furthermore by evidence of multiple stones in the intrahepatic ducts, and primarily by the finding of parasite eggs in the stools and bile.

Exploration reveals an enlarged liver and distended bile duct. The gallbladder may be distended in an acute attack, because its walls are not pathologically altered. Stone and purulent bile is present in the ducts, but the papilla is at first patent. The earlier mentioned stenoses and cavities are found in the liver, sometimes abscesses, and in stenosis of a larger branch the entire hepatic segment may be dilated and filled with pathological contents.

Treatment

Large doses of broad spectrum antibiotics are administered in the acute febrile attack. Otherwise, however, treatment is surgical with the object of clearing the ducts as far as possible and ensuring permanent free bile flow.

If acute infection induces septic shock and the patient is in a desperate condition, urgent decompression by T-tube introduced into the bile duct is the minimum required.

Surgery outside the period of fulminant infection is the rule, cholecystectomy is followed by patient clearance of dilated ducts. If the disease is not of long standing, their return to a normal width is possible after the extraction of stones and removal of obstructions. The removal of intrahepatic calculi is often almost impossible and requires various manoeuvres. It is better rather to perform a wide anastomosis proximal to the stenosis, if the dilated duct is accessible extra- or intrahepatically. Sporadically a successful resection of a destroyed liver segment has been accomplished.

If clearance of ducts proves infeasible, stones cannot be removed and infection and parasitosis controlled, recurrent attacks continue, and patients are endangered by sepsis, abscess formation and later cirrhosis.

Primary Sclerosing Cholangitis

This is a rare disease, originating without obvious cause, characterized by a diffuse chronic inflammation and fibrotic thickening of bile duct walls, terminating in their stenosis and obliteration. It differs from the earlier cited stenoses sometimes produced in infectious cholangitis. As early as 1899 Lancereaux described such a case of sclerosing cholangitis without stones,[106] but its origin has remained obscure to the present day, diagnosis, even at operation, is difficult and treatment so far only empirical. From the time of Delbet, who in 1924 pronounced it to be an independent entity, only a few tens of cases have been reported.[31, 81, 89, 109, 115, 125]

Etiology

Sclerosing cholangitis has the appearance of a "primary" disease: it is not preceded by trauma or operation, or accompanied by lithiasis or infection. An autoimmune origin is being discussed, similar to that in cases of ulcerative colitis, Crohn's disease, or Riedel's thyroiditis diseases, with which it is sometimes associated. It is known that about 30% of cases were associated with ulcerative colitis,[121] whereas, in contrast, only about 1% of colitis cases simultaneously suffer from it. Classification as one of the collagenoses is also under consideration, as it has been recorded in retroperitoneal and mediastinal fibrosis.[106] Its origin is also being sought in connection with a mild, insidious bacterial infection, or in analogy with primary biliary cirrhosis (Fee 1977).

Clinical pattern

Sclerosing cholangitis more frequently affects middle-aged males and presents as a slowly developing cholestatic jaundice without pain and lacking the symptoms of an acute inflammation. The condition terminates in biliary cirrhosis. Laboratory

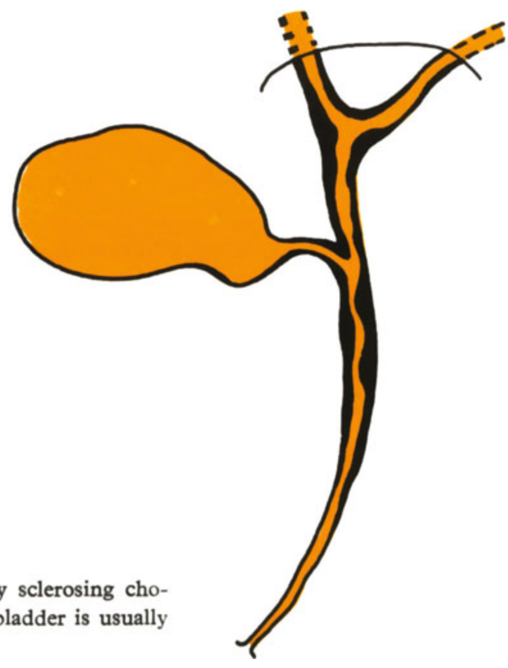


Fig. 154: Primary sclerosing cholangitis. The gallbladder is usually spared.

data are also consistent with cholestasis, but not, however, with inflammation due to infection. Intravenous as well as percutaneous cholangiography fails to demonstrate the biliary tract. Suspicion is aroused only by retrograde endoscopic cholangiography which reveals markedly narrowed irregular bile ducts, with amputation of some of the branches — dead tree image — (Suzanne and coll.). Liver biopsy shows bile stasis and periportal fibrosis.

Diagnosis is established at exploration by the finding of marked ductal lesions.

The latter resemble rigid cords and sometimes are irregularly beaded and thickened. Their lumen is so narrow that incision is difficult and even the finest catheter is difficult to insert. The gallbladder is intact, sometimes distended, but stones are absent. *Fig. 154.* All ducts may be involved, or mainly the extrahepatic or intrahepatic system segmental forms have also been reported (Grodsinsky 1974). Operative cholangiography provides the best information. Histology discloses inflammation and avascular fibrosis in the subepithelial and subserosal layers, the mucus being spared. This contraindicates canalicular infection and damage due to reflux of pancreatic secretion.

Diagnostic criteria, apart from the quoted signs and types of lesions, also include the absence of cholecystolithiasis, no previous operations and the opportunity for excluding primary cirrhosis, infectious cholangitis and biliary tract malignancy. In particular the similarity with extensive scirrhous duct carcinoma may be so striking, that not only the gross appearance of lesions and the radiological image of stenosis, but even microscopic findings need not be explicit.[2] Thus only the further evolution after operation, or even necropsy, may decide between sclerosing cholangitis and malignancy (Glenn).

Treatment

Surgical revision is mandatory, if only in view of diagnostic uncertainty about the character of obstructive jaundice. If suspicious lesions causing diffuse stenosis of ducts are found and verified by cholangiography, it is always advisable to obtain in addition a biopsy specimen by curetting the duct interior and for bile samples to be tested bacteriologically and cytologically to exclude neoplasm. A drain is introduced in the common bile duct with a diameter selected to fit the narrow lumen. T-tube from plastic material is best. This is left in position even for a number of months, and radiological checks sometimes show that the duct lumen has widened. It sometimes happens that mere laparotomy and external drainage bring about an improvement in which jaundice regresses and pruritus disappears; most often, however, after operation these patients also receive choleretics, cholestyramin, and broad spectrum antibiotics against possible cholangitis. In particular long-term corticoid therapy is recommended, administered locally and chiefly orally. The best results have been obtained with prednisone in a daily dose of 10 to 40 mg orally. Potassium levels are monitored and if necessary potassium is supplemented. This therapy is continued for months and the dose gradually reduced. Other immunosuppressive drugs, apart from steroids, are under trial, but no wider experience is as yet available.

The outlook for patients with sclerosing cholangitis frequently treated for palliation only, is uncertain. In some, treatment is followed by prolonged remissions, but in most, however, even after corticoids, the disease terminates in cirrhosis and the patient succumbs in a few years to hepatic failure.

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BILIARY TUMOURS

Among biliary tumours, carcinoma is of prime importance. Cancer of the gallbladder and the extrahepatic bile passages is about fifth in frequency among gastrointestinal tract tumours. The diagnosis and surgical treatment of these malignant tumours is still one of the unsatisfactory chapters of abdominal surgery. Early diagnosis is difficult, and the possibilities of operative treatment are limited by the anatomical conditions.

In recent years the interest in biliary tumours has been stimulated by the important knowledge that some of these tumours grow slowly and for a long time without forming metastases, and that the long-term results after operations for carcinoma of the lower part of the choledochus are relatively good. Treatment has also been influenced by chemotherapy, mainly by the method of selective perfusion.

Tumours of the Gallbladder

Benign Tumours

Benign tumours of the gallbladder are rare. They are encountered in less than 1‰ of all cholecystectomies. Apart from the isolated instances of fibromas, lipomas and neurinomas reported in the literature, it is papillomas and adenomas which are most frequently met with. They grow as solitary flat or pedunculated tumours covered by the nonulcerated mucous membrane. Sometimes it is very difficult to distinguish them from hypertrophic inflammatory reactions which may occur in the gallbladder fundus and which are called by pathologists "glandular proliferating cholecystitis".

No reliable evidence has been produced as to whether benign tumours of the gallbladder may undergo malignant degeneration. Cellular metaplasia might be due to the irritating effect of concentrated bile, stones, or of chronic inflammation, with which they are often associated.

Benign gallbladder tumours are usually an incidental finding at cholecystectomy performed for other reasons. They have no characteristic clinical signs of their own, and cholecystectomy is a sufficiently radical operation for them.

Malignant Tumours

Cancer of the gallbladder is a rare, insidious disease, which frequently is discovered only when it is well advanced.[32, 35] According to data from the literature, the number of deaths due to cancer of the gallbladder accounts for approximately

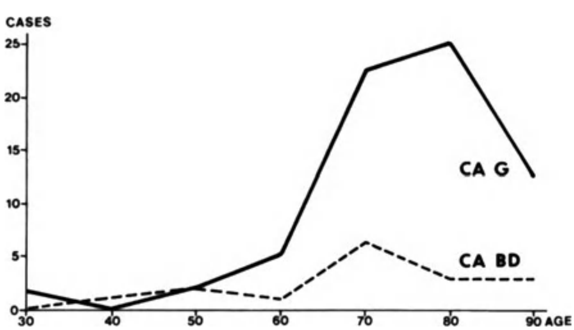

Fig. 155: Incidence of cancer of the gallbladder and extra-hepatic ducts by age decades (Hradec Králové, 1964–1973).

1–4% of all cancer deaths. It is found in about 0.33–0.43% of all necropsies, and stones are reported to occur in 72–90% of these cases. Females are more often affected than males, the relation being approximately 3 : 1, as may be expected considering the connection with lithiasis, and there is a sharp rise of incidence after the 60th year.

An evaluation of necropsy findings from 7283 adults at Hradec Králové during the years 1964–1973 showed cancer of the gallbladder in 0.9%. Cholelithiasis, which occured in 24% of all necropsies, was found in more than 90% of patients with gallbladder cancer. *Fig. 155.*

During the same period, 3164 patients were admitted to the surgical clinic at Hradec Králové for disease of the gallbladder and the bile ducts, 2.7% of them for cancer. Benign adenoma of the gallbladder was found only once.

Pathology

Most malignant gallbladder tumours are adenocarcinomas with infiltrating growth, which quickly spread through all layers of the gallbladder wall, penetrate into the liver hilus, and produce metastases in the liver and lungs. Histologically, they are papillary carcinomas, which often ulcerate,sometimes obliterate the cystic duct, and therefore are associated with infection, for which occasionally operation as for subacute cholecystitis may be indicated. In other cases a scirrhous adenocarcinoma may be found, or a mucus-producing tumour, or, finally, the polypoid type, which also grows into the lumen; it is less invasive and may resemble glandular proliferating cholecystitis. Of very rare occurrence are leiomyosarcomas, melanomas and carcinoid tumours.

The fact that gallstones are found in a high percentage of cases should not be taken as evidence that the stones themselves are the cause of gallbladder carcinoma. One should not forget that these gallbladders are always the site of severe chronic inflammation. Possibly the stones have a subsidiary effect, or contain a specific carcinogenic component, which belongs to the same group as methylcholanthrene or other polycyclic hydrocarbons. Carcinoma develops mainly in patients over 60 who have gallstones. Thus it cannot be ruled out that in sensitive individuals products of a disordered metabolism of bile acids, cholesterol or of other steroids occurring naturally in the bile may participate in producing carcinoma. — From a theoretical point of view it is also possible to consider a noncalculous etiology of gallbladder carcinoma, which admits malignant transformation of polypoid or adenomatous foci.

Carcinoma of the gallbladder spreads, in about half the cases, via the lymphatic pathways, and in the other half by the blood-stream, via neural spaces, intraductally and by direct invasion. From the outset, the carcinoma spreads in all directions, infiltrates the walls of the gallbladder, invades the lymph-vessels and surrounds the gallbladder with tumorous masses. The cystic node is usually first affected when the carcinoma spreads via the lymphatics. The tumour gradually involves the peripancreatic and para-aortic nodes. In the liver hilus there are no nodes, and the tumour directly invades the hepatic lymph-vessels (Adson, Marchal). *Fig. 33.* At the time of operation, lymph node metastases are usually present in 25% of the cases. Adjacent hepatic metastases, however, are mostly due to direct invasion.

A less frequent mode of spread is invasion of the blood vessels: directly from the gallbladder bed into the liver, or via the venous network surrounding the choledochus. Distant metastases in the lungs or other organs are met with less often at the time of surgical treatment. Dissemination of distant metastases in advanced disease usually follows the invasion of the portal system by the tumour.

Neural spread is, in the majority of cases, limited to the gallbladder wall and the intraductal route of spread is found especially in papillary carcinoma.

The appearance of a gallbladder which is the seat of a tumour may differ according to the type of growth. Sometimes only a small incipient tumour is found in the fundus or neck of the gallbladder, less often in its middle portion. When the less usual polypoid carcinoma grows into the gallbladder lumen, it may, by occluding the cystic duct, lead to hydrops or empyema of the gallbladder and transform the gallbladder into a rigid pouch. Very often, on the contrary, the carcinomatous gallbladder looks like a thickwalled structure, filled with pus or mucin and, as a rule, containing stones. In other cases, again, it looks like a small shrunken gallbladder, and is most likely to be due to a scirrhous type of cancer, which may easily be mistaken for local reactive thickening caused by past cholecystitis and lithiasis. On the other hand, chronic inflammation of the gallbladder with a fibrous reaction of the surrounding tissues may be mistaken for a tumour. Such a finding at operation often requires histological examination to ascertain the malignant nature of the disease.

An example of such diagnostic difficulties is the case of a 52-year old patient with a "biliary" history of several years' duration, who was operated on for obstructive jaundice. The entire gallbladder wall was infiltrated by whitish tissue suggesting a tumour. A solid infiltration of the same appearance involved the gallbladder bed and extended into the liver hilus. It also involved the hepato-duodenal ligament and the adjacent lymph nodes, which were enlarged and hard. There were no metastases in the liver. Intraoperative histological examination did not provide evidence of malignant growth, but the macroscopic appearance at operation suggested an inoperable carcinoma of the gallbladder. However, postoperatively the jaundice gradually disappeared, the patient gained weight, and has been well for 3 years since the operation. This was evidently a case of extensive inflammatory reaction and not of tumour.

When the tumour spreads beyond the gallbladder, it is sometimes difficult to determine the site of its origin. This difficulty is especially marked if there is a gangrenous gallbladder, which perforates and forms an abscess limited by the surrounding organs, which are bound together by the tumorous growth. In such cases it is not rare to find fistulas between gallbladder and choledochus, duodenum or large intestine, and even generalized peritonitis or hemorrhage may develop.

Clinical features and diagnosis

Cancer of the gallbladder has no early specific clinical symptoms or signs which distinguish it from benign disease. Operable tumours are usually found accidentally on histological examination of the extirpated gallbladder. In other cases, cancer is discovered late, when the possibilities of even palliative surgery are limited. In these cases, the most frequent symptoms are pain in the right upper quadrant of the abdomen, anorexia, jaundice and loss of weight.

The really early symptoms are indistinguishable from those of cholecystitis and cholelithiasis, with which the disease is associated in a high percentage of cases, and the discovery of a carcinoma at operation is then an unpleasant surprise. Suspicion is aroused in every case of calcified bladder, especially in old patients, if permanent right subcostal pain is present. — One should also take into account that, in rare cases, an attack of acute cholecystitis without any biliary past history may be the first symptom of a tumour. This occurs when the tumour occludes the cystic duct, and the clinical features of such a case are indistinguishable from simple inflammation. — The most frequent but usually late sign of cancer is a hard, sometimes strikingly irregular mass underneath the liver. — Other patients make their first attendance when jaundiced and with signs of cholangitis, and biochemical examinations provide evidence of its obstructive nature. Such a jaundice may be due to the tumour spreading to the bile duct or to compression of the bile passages by the tumorous lymph nodes, but if there is lithiasis the bile duct may be blocked by a stone only, even if a tumour is also present.

Jaundice is mostly a late and ominous sign, and the same holds true of a marked loss of weight. Less frequent are concomitant disorders of intestinal passage, and exceptionally there may be massive abdominal hemorrhage from a corroded artery in the neighbourhood of the tumour.

Radiological examination may sometimes discover a calcified gallbladder which often harbours a cancer, in 25 per cent of instances (Moorehead). This is a valuable clue to its early diagnosis. — Preoperative cholangiography shows, as a rule, only a "non-functioning" gallbladder, but nothing that is specific for gallbladder carcinoma. Only quite accidentally may a papillary tumour show up as a filling defect of the gallbladder. Not even percutaneous cholangiography is, in jaundice, of any help, apart from showing the level and the type of the obstruction. — Radiological examination of the gastrointestinal tract may sometimes, in advanced cases show infiltration of the neighbouring organs. If a gallbladder carcinoma is suspected, splenoportography or celiacography may be of help in demonstrating the spread of the tumour and thus deciding on radical treatment.[59] — The possibilities of laparoscopy are limited, it is more likely to prove useful in advanced cases, where the discovery of metastases may spare the patient an exploratory laparotomy.

Treatment

The only way known so far of preventing the development of cancer of the gallbladder would be its removal in any case of lithiasis, whether it gives rise to complaints or not.[32] However, when indicating such a preventive cholecystectomy in practice, the age and the operative risk have also to be considered. Early cholecystectomy for manifest lithiasis might, however, reduce the incidence at least of inoperable carcinomas.

The choice of the operation for gallbladder carcinoma depends on the extent of the growth, on the patient's power of resistance and on the surgeon's experience.

Simple cholecystectomy may be regarded as a sufficiently radical operation for a carcinoma, which is found accidentally on postoperative histological examination, especially a carcinoma "in situ". When the tumour is evident macroscopically, even if the gallbladder has been operated on for inflammation or stones only, simple cholecystectomy should not be regarded as a radical measure. In such a case, if the patient's general condition is good, one should remove the whole gallbladder bed together with the regional lymph nodes along the entire hepato-biliary pedicle.[61]

If the tumour penetrates already through the serose of gallbladder, but there are no visible metastases present, and the hilus is not involved, an extensive wedge-shaped excision of the liver tissue in the neighbourhood of the gallbladder, or even rightsided lobectomy, might be considered. Such an operation is exacting for both patient and surgeon, and apparently would not lead to a permanent cure, but perhaps to a longer survival.[51]

If the tumour spreads towards the liver hilus, one should not only abandon its removal by wedge resection, but any attempt at lobectomy should be firmly rejected. The unsatisfactory postoperative result cannot outweigh the risk of the operation.

A gallbladder carcinoma, however, which, by infiltration of the hilus, causes obstructive jaundice, requires at least a palliative operation. If it is feasible to intubate the tumorous stenosis, one should content oneself with simple internal drainage of the common duct with a stiff plastic tube. Its end is usually brought out via the choledochus or through the liver. One might also consider peripheral hepato-jejunostomy or cholangio-jejunostomy, which, however, is unnecessarily exacting.

The technique of the surgical operations which are in use for gallbladder cancer is described in the concluding section of this chapter.

Prognosis

The prognosis of gallbladder cancer is bad. Many surgeons are enthusiastic about wedge resection of the liver and exstirpation of the lymph nodes, simple cholecystectomy, however, has proved the highest survival rate (Moorehead, 1975). Even in these tumours discovered only by histology, the results of cholecystectomy are permanent only in one third of "carcinomas in situ" and in a small percentage of the other cases.[19] But approximately 60% of patients present themselves when the tumour has spread beyond the gallbladder. Of the patients whose operation is considered to have been radical, even if only histologically confirmed cases are counted, only approximately one third survive for 5 years, and less than half for one year.

Radical and palliative surgery is also associated with a comparatively high early mortality rate, which, for radical operations, is in the range of 10–40%. Nevertheless, if conditions are favourable, one should attempt an active approach, perhaps with the use of cryosurgery, or at least deal with the jaundice by a palliative operation, which not only will alleviate the patient's suffering, but may also prolong his life. Survival after palliative operations fluctuates between 6 months and as much as 2 years according to the stage of the disease and the type of tumour.

A total of 470 patients suffering from biliary tract tumours were operated on at the University Department of Surgery in Prague-Motol, 468 of these were malignancies.[48] (Cancer of the gallbladder was present in 278 cases, the growth originated from the bile ducts and papilla in 145 cases, the precise site of origin was uncertain in 45 cases.) Out of the 39 patients who underwent "radical" operation for gallbladder carcinoma only 11 survived for 5 years; nine of them had carcinoma in situ, in 2 penetration into the immediate neighbourhood through the serosa was present.

Tumours of the Extrahepatic Bile Ducts and the Papilla

Benign Tumours

Benign tumours of the extrahepatic bile passages are exceptional (Reifferscheid, Dowdy). Papillomas, adenomas, fibromas, lipomas, polypi and granulomas may be found. Also benign cystic changes of the choledochus wall causing intermittent obstructive jaundice have been reported in isolated cases. Benign tumours are mostly small and produce no clinical signs. Only some of them cause obstructive jaundice.[31] The most frequently found type is adenoma of the papilla of Vater. Most benign tumours can be removed by simple resection. Radical removal is called for in the case of papillomatosis of part of a duct, since this is considered a precancerous lesion. Malignant degeneration of bile duct papillomatosis has been observed (Huguet, 1978).

Malignant Tumours

Statistical data show that cancer of the extrahepatic ducts occurs less frequently than that of the gallbladder. But apparently it is sometimes mistaken for a tumour of pancreatic or intestinal origin. It is met with more often in those regions where there is chronic cholangitis with stones in the ducts. Cancer of the bile ducts, with the exception of that of the ampullary region, unlike gallbladder carcinoma, affects males and females equally. The simultaneous occurrence of gallstones has been reported in only 21–57%. The patients' mean age is most often above 50 years.

Vortel, at Hradec Králové, found, in 10 years necropsy material cancer of the extrahepatic duct in 0.2% of all dead adults. Cancer originating undoubtedly in the papilla of Vater was found in 0.1%, and cancer originating in the intrahepatic ducts in 0.08%.

Pathology

The most frequent malignant tumours of the extrahepatic ducts are medullary adenocarcinomas in different stages of differentiation. Some of them are of a scirrhous nature. Carcinomas with infiltrative growth predominate in the region of the bile ducts, and the papillary forms in the region of papilla of Vater. The involved duct is either narrowed by a circular malignant stricture or occluded by the protruding tumour. Strictures of a cicatricial appearance are caused by the so-called sclerosing carcinoma, which is accompanied by marked reactive cicatrization of the adjacent tissue. It grows slowly and metastasizes late. Sometimes it is very difficult to distinguish it macroscopically from benign sclerosing cholangitis.

The most frequent site of tumours is the junction of both hepatic ducts (70%), the union of the cystic with common hepatic ducts (20%), and the lower end of the choledochus. However, carcinomas of the terminal choledochus and the region of the papilla of Vater are less frequent than carcinoma of the head of the pancreas. Some tumours found at the origin of the cystic duct may originally be primary carcinomas of the gallbladder neck.

Carcinomas of the extrahepatic ducts grow by infiltrating their walls mainly in a proximal direction, transforming the bile duct into a rigid tube. They spread also via lymphatics and involve the liver only later by metastases. Carcinomas of the terminal choledochus may also spread to the head of the pancreas, but rather opposite is the case.

Tumorous occlusion of the bile passages soon leads to jaundice and cholestatic changes in the liver. The contents of the dilated bile ducts above the obstacle may become infected, although this occurs less frequently than in the case of stones.

In late stages of the disease it is sometimes difficult to ascertain the exact site of origin, especially if the distal third of the choledochus is affected. Tumours of the region of the papilla of Vater are therefore collectively, and not quite exactly, called "ampullary" tumours, for often even histology cannot decide whether the tumour originated in the duodenal mucosa, the choledochus, the papilla, the pancreatic duct, the parapancreatic tissue or in Brunner's glands.[22, 40] They occur in about 1–2% of all necropsied cancer deaths, and Arianoff states (1977) that genuine ampullary carcinoma was present in only 0.4% of all his biliary operations. Carcinomas of this region are of comparatively low biological activity. They are regarded as the second most frequent cause of obstructive jaundice. This develops very early with this tumour site, so that at operation the tumour may often be small and difficult to see, but may be resected (Dencker). When the duodenum has been mobilized, the tumour can usually be palpated as a submucous node, whereas tumours originating in the duodenal mucosa are more often papillary and ulcerated. Tumour may also cause dilatation of the pancreatic duct, hard induration of the pancreas, or sometimes focal fatty necroses, which are associated with acute pancreatitis.

Clinical features and diagnosis

Usually it is not difficult to arrive at a diagnosis of obstructive jaundice, but its malignant etiology and the level of the obstruction are determined with great difficulty, and often only at operation. Courvoisier's sign points to a malignant tumour below the level of the cystic duct. In other cases, it is perhaps sometimes possible to establish the diagnosis preoperatively by percutaneous cholangiography or preferably by duodenoscopy with ascending cholangiography. The latter may, in some cases, show tumorous changes of the duct prior to the development of jaundice.

„Silent jaundice", i.e. jaundice developing without pain and gradually increasing, is the most often mentioned characteristic feature of bile duct cancer. However, it is not exceptional to meet with patients in whom this type of jaundice is caused by a stone lying near the papilla, and, on the contrary, with patients who have pain and even colic as the first symptom of carcinoma. Usually the progressively increasing jaundice is associated with only slight epigastric pressure, lack of appetite, digestive disorders, eructations, flatulence, pruritus, loss of weight and apathy. The faeces are acholic, and the urine is dark.

Laboratory tests show evidence of obstructive jaundice. Since the jaundice aggravates rapidly, liver function tests usually do not show signs of parenchymatous damage. Serum bilirubin levels are raised even when the jaundice has not yet become manifest clinically. There may also be signs pointing to recurrent cholangitis with attacks of fever.

Courvoisier's sign is present in less than half of malignant growths leading to

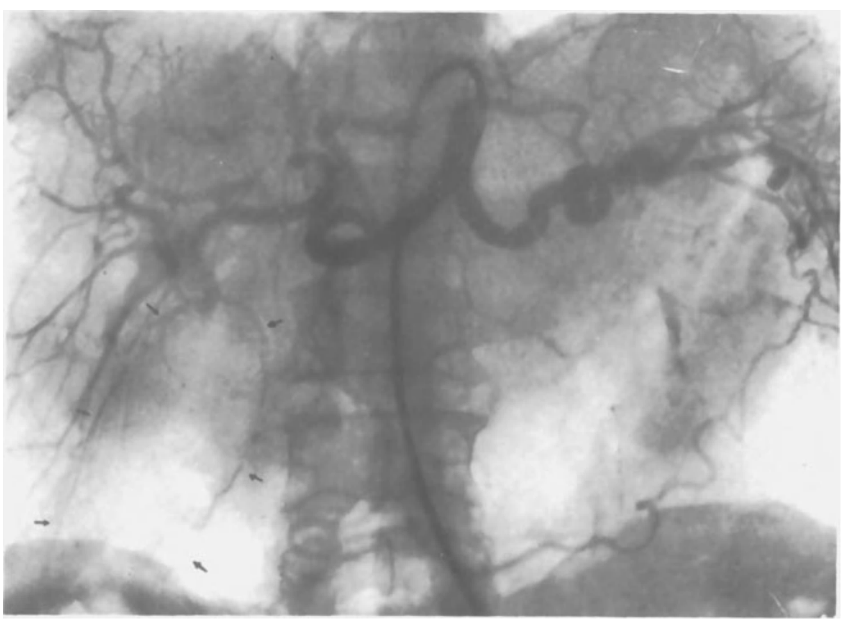

Fig. 156: Cancer of head of pancreas in patient with obstructive jaundice and an epigastric mass. Celiacography shows a dilated gallbladder (Courvoisier's sign), displacement of the gastroduodenal artery and atypical vascularization around the pancreaticoduodenal artery. The tumour was inoperable.

obstructive jaundice. If the tumour site is above the level of the cystic duct, Courvoisier's sign cannot develop. At other times, stones and thickening of the gallbladder wall after past inflammation can prevent the development of this sign as well, or the distended gallbladder may be hidden under the liver edge and is, therefore, inaccessible to palpation; it might, however, be seen in angiogram or with the laparoscope. *Fig. 156.*

In exceptional cases, Courvoisier's sign may be produced by a stone obstructing the papilla of Vater, especially if the cystic duct is wide and the gallbladder wall still sufficiently elastic. On the contrary, if the malignant tumour involves the choledochus, pain of a colicky nature may sometimes lead to a mistaken diagnosis of lithiasis, as has previously been pointed out. If the site of the cancer is in the "ampullary" region, there is more often fever, rigor and a jaundice which, in a third of the patients, is intermittent.[6]

To distinguish ampullary carcinoma from cancer of the head of the pancreas is of importance for deciding the mode of treatment and for assessing the prognosis. For the "ampullary" carcinoma a more radical surgical approach is generally recommended. Fluctuations in the intensity of the jaundice or a rapid rise of the serum bilirubin are signs which may assist in this differentiation. Cancer of the head of the pancreas has a more marked tendency to infiltrate neighbouring tissues and to spread beyond the limits of organs. It is more often associated with pain, and if the pancreatic duct is occluded, also with malabsorption

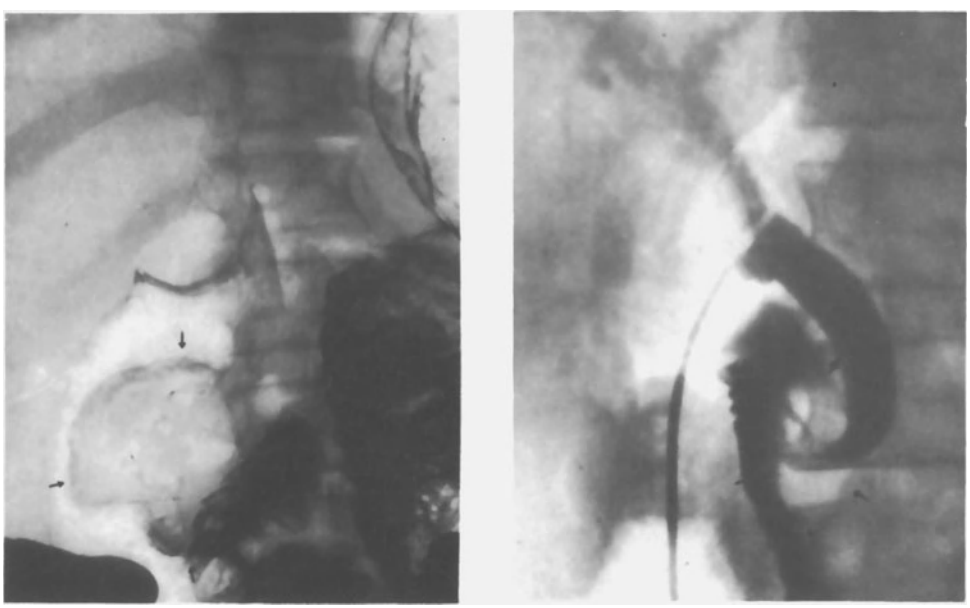

Fig. 157 ab: Carcinoma of papilla in a 57year old male patient. (a) Tumour protruding into intestine as shown by hypotonic duodenography, (b) tumour as shown by operative cholangiography. The tumour was removed by hemipancreato-duodenectomy (Balaš).

syndrome and associated diarrhoea. Patients with "ampullary" cancer usually remain in a comparatively good condition for some time, whereas the condition of patients with cancer of the head of the pancreas usually rapidly deteriorates, once jaundice has developed. If the tumour originates from the papilla of Vater, secondary anemia is frequent, cytology of the duodenal contents and radiological examination of the duodenum may contribute to the correct diagnosis. *Fig. 157.* Duodenoscopy, however, is the most important and decisive method for the diagnosis.[11, 30]

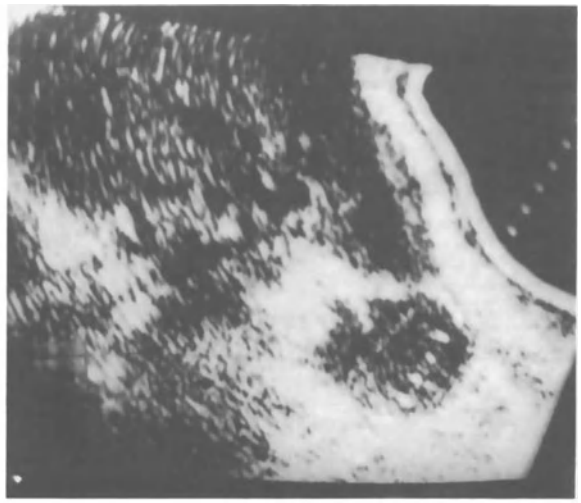

Fig. 158: Tumour of liver hilus in a patient with obscure jaundice discovered by grey-scale sonography. Echogram shows dilated intrahepatic bile ducts and anechogenic subhepatic area corresponding to the tumour.

To distinguish periampullary tumours from chronic pancreatitis may be still more difficult. A past history of attacks of pancreatitis, the presence of old foci of Balser's necrosis, edema of the adjacent tissues, and the absence of metastases point to inflammation. Intraoperative biopsy with a biopsy needle passed from the duodenum settles the diagnosis only if it produces evidence of carcinoma.

Oral cholecystography and intravenous cholangiography are useless if there is advanced jaundice. In such a case sonography helps to recognize its obstructive character and percutaneous cholangiography to determine the site of the obstruction. *Fig. 158, 159.* Endoscopic ascending cholangiography, however, may be of greater value if this method of examination is available.[10, 11, 21]

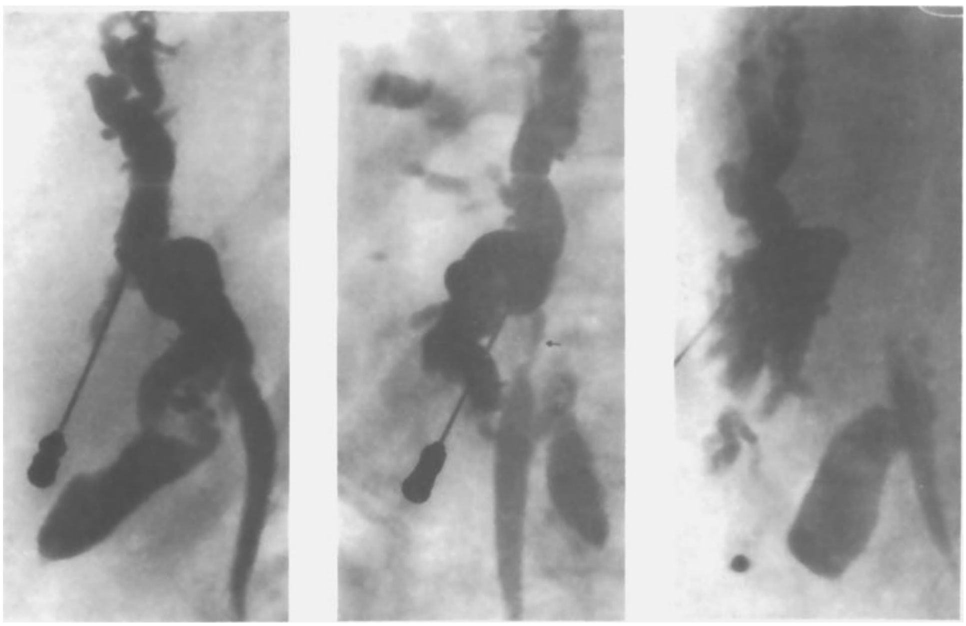

Fig. 159: Tumour of hepatic duct bifurcation in a 67-year old female patient. Only the second of three stages of percutaneous cholangiography, with patient slightly turned as required, and contrast material injected under increased pressure, shows narrowing of the duct by the tumour.

ERCP, however, is not suitable for the early diagnosis of malignancy of the biliary tree, since it is too combersome to be used as a survey method (Manegold, 1974). Sometimes one is forced to perform transhepatic cholangiography during operation, if the cause and site of the obstruction cannot be found even by the usual operative cholangiography or with the choledochoscope. Sometimes the real cause of the jaundice remains obscure even after laparotomy, especially if the obstruction is high in the hilus. In particular, tumorous infiltration of the duct is not reliably distinguished from sclerosing cholangitis. Suspected tissue can be obtained for biopsy by scraping the inside of the duct with a curette introduced through choledochotomy. However, even the pathologist may confuse the tumour with the fibrotic reaction around it and only the further progress settles the matter.[5, 47]

Treatment

Interest in tumours of the bile ducts is increasing, and their early diagnosis and operability are mentioned more and more often, and a more active approach to surgical treatment is recommended. Radical operations for carcinoma of the ducts are still connected with a comparatively high postoperative mortality rate, nevertheless radical resections offer the only chance of cure. A mean 5-years' survival after radical surgery for cancer of the extrahepatic bile ducts of all types, irrespective of site, is reported to be in the range of 14—32%.

If radical removal of the tumour is impossible, the patient's life may often be at least prolonged and alleviated by different types of bilio-digestive anastomosis, which deal with the jaundice and its sequelae. After palliative operations, survival fluctuates between 6—15 months according to stage and type of carcinoma. The number of mere leg exploratory laparotomies should be decreasing.

When deciding on the type of operation the site and extent of the tumour, the patient's age and general condition, the risk of the operation, and the possibility of further prolonging life should be taken into consideration. The histological type of the tumour should also be taken into account, for some tumours grow slowly, so that there is hope that life may be prolonged for several months after a palliative operation, and even for years after a successful radical operation.

THE PROXIMAL PORTION OF THE EXTRAHEPATIC BILE PASAGES

The region of the hepatic ducts confluence is most often involved. In carcinoma of the right or left hepatic duct, resection of the corresponding liver lobe might be indicated. However, involvement of the hepatic artery or the portal vein by the tumour, the patient's bad condition, or also unpreparedness of the surgeon very often make lobectomy impossible. When the tumour site is high up, with involvement of both hepatic ducts, a radical operation is often out of the question, but also the possibilities of a palliative operation, which would only deal with the jaundice, are limited and reoperations are often necessary. One might consider a bilateral hepato-jejunostomy, or sometimes it is feasible to anastomose one of the peripheral intrahepatic bile ducts with a jejunal loop. Exceptionally it might be found possible to perform the difficult intrahepatic cholangio-jejunostomy,[9, 12, 53] however, with a high, even 35 per cent mortality (Chigot, 1978). A much more practicable palliative solution is internal intubation drainage or external transhepatic drainage of one of the dilated ducts. If a neoplastic stenosis has been intubated the indwelling drain is left permanently in position to relieve the patient at least from the harassing jaundice.[60]

THE MIDDLE PORTION OF THE EXTRAHEPATIC BILE PASSAGES

With a tumour in the middle portion of the hepato-choledochus, this portion might be amenable to resection. Even if the tumour is far above the margin of duodenum the operation will only rarely be radical, since the adjacent hepatic artery and portal vein are generally also involved. — In these cases, the most suitable palliative operation is an anastomosis of the proximal portion of the common duct with a jejunal loop. Gallbladder anastomoses are not suitable, because their result depends on the patency of the cystic duct, and they also easily lead to severe cholecystitis. — Sometimes it is of advantage simply to intubate the bile duct constricted by the tumour. Simultaneous intraoperative radiotherapy has been proposed in the last years (Abe 1975, Iwasaki 1977).

THE DISTAL PORTION OF THE EXTRAHEPATIC BILE PASSAGES

Cancer of the lower part of the choledochus is, of all the tumours of the extrahepatic bile passages, most amenable to radical extirpation. It can sometimes be diagnosed very early by duodenoscopy. An early duodeno-pancreatectomy may even give the patient a chance of complete cure.[26, 39, 45] Even ampullectomy may be successful, with a mean survival rate of 7 years (Arianoff), but only for beginning cancer of papilla. If the tumour is inoperable, the jaundice may be dealt with by different types of operation by-passing the obstacle.[25]

The technique of the different surgical operations is described in the concluding section of this chapter.

Prognosis

In current clinical practice, the views on the results of surgery of cancer of the bile ducts and the papilla are still pessimistic. However, surgeons who occupy themselves with these problems in detail, definitely advocate and recommend a more active attitude. Too often one contents oneself with merely stating that the tumour cannot be removed, without attempting at least a palliative operation. Naturally, a surgeon caught by surprise by an unexpected situation and not perfectly familiar with the difficult technique must not embark on an exacting lobectomy or other complicated operation; the less, since he has to deal with a patient weakened by malignant disease. The pessimistic attitude, however, is wrongly transferred to the approach to certain simple palliative operations, the reason being an exaggerated fear of the surgical risks. If one considers, however, the inescapable hopelessness that is the consequence of such an attitude, then one may also become reconciled to the immediate risk attending the more active approach.

Untreated patients survive for only a few months from the onset of symptoms or from the time of discovery of the tumour.

The long-term results of the radical treatment of malignant duct tumours are still unsatisfactory. Hardly 20% of the patients present themselves at a stage where the tumour may still be removed. The prognosis becomes worse, the nearer to the hilus the tumour grows, since there its radical extirpation is, for anatomical reasons, difficult and often impossible. If it can possibly be removed, then even here there is hope that the patient's life may be prolonged. After palliative operations in this regions, about 50% of the patients operated on may hope to survive for 6 months, 10% for no more than one year, and only isolated cases for several years, depending mainly on the type of tumour and its rate of growth.

The prognosis is better for carcinomas of the lower choledochus and the ampullary region, because they soon lead to jaundice. The prognosis of "ampullary" carcinoma seems to be determined more by the type of the tumour than by the kind of surgery. A papillary or polypoid tumour grows more slowly and can more often be removed surgically. Five-years' survival has been reported even after simple resection of the tumour.

The immediate operative mortality rate after duodeno-pancreatectomy is given as 10–20% and below 10% with specialized technique, irrespective of whether the tumour was of the papillary or infiltrative type. Five-years' survival after radical treatment is given as 3–7% for infiltrating, and as much as 20% for non-infiltrating tumours. However, surgeons who occupy themselves with these problems systematically, are able to report steadily decreasing percentages of operative mortality rates after radical surgery[6, 7, 13]. — After palliative operations, reported operative mortality rates are as much as 10%, and the mean survival time is 5–6 months.

Out of our above mentioned series of 190 malignant tumours of the bile ducts (p. 297) only 30 patients underwent "radical" operation (duct resection, amputation of ampulla, duodenopancreatectomy, lobectomy) with 33% surgical mortality. Palliative or explorative surgery in the remaining 160 patients was accompanied by 13% mortality.[49]

Surgery for Tumours

Operations for cancer of the gallbladder

Cholecystectomy: with or without regional lymphadenectomy
with wedge resection of the liver
with lobectomy of the liver

Anastomoses
Drainage operations

Operations for cancer in the hepatic duct region

Lobectomy of the liver
Anastomoses
Drainage operations
Regional perfusion with cytostatics

Operations for cancer of the middle portion of the hepato-choledochus

Resection of the duct
Anastomoses
Drainage operations

Operations for cancer of the terminal choledochus and of the papilla

Duodenopancreatectomy
Amputation of the papilla
Anastomoses
Drainage operations

Radical operations

CHOLECYSTECTOMY WITH LYMPHADENECTOMY

Simple cholecystectomy is indicated in precarcinomatous lesions, i.e. polypi and papillomatosis of the gallbladder. This is also sufficient if the tumour is found only at postoperative histological examination, and is often a "carcinoma in situ". The technique of excising the gallbladder does not differ from that of cholecystectomy for benign lesions, and a description has already been given (p. 188).

If the presence of the tumour is ascertained or suspected at operation and seems to be limited to the gallbladder only, antegrade cholecystectomy is performed and an attempt is made at removing the regional lymph nodes, in particular the cystic nodule and the nodes lying along the bile duct and the blood vessels in the hepato-biliary fascicle and, if necessary, also the pancreato-duodenal nodes. Thus in most cases at least the enlarged nodes are removed together with the embedding connective tissue, and are subjected to histological examination.

CHOLECYSTECTOMY WITH WEDGE RESECTION OF THE LIVER

This is used for gallbladder carcinoma which has begun to spread to the gall-bladder bed but not to the hilus, and if no metastases can be discovered.

The necessary access should be secured by a sufficiently large laparotomy. The cystic artery and the cystic duct are ligated and cut. The gallbladder neck with the stump of the divided cystic duct is dissected free from the surrounding tissue. On either side of the tumour, and at sufficient distance from it, hemostatic compressing U-sutures are placed in the liver parenchyma. It is useful to pass them through square pieces of teflon, which prevent the sutures from cutting out when being tied. The liver tissue together with the gallbladder tumour is cut away, preferably with an electric knife, leading the incision internally along the passed sutures. This is not a segmental resection, but the liver is cut into by making a wedge-shaped excision in the direction of the interlobar cleft, and the superficial portion of both lobes is removed without any risk of damage to the biliary pedicle. When the tumour together with the adjacent healthy tissue has been removed, the rough surface of the liver is checked. Hemorrhage may be reduced by temporarily compressing the artery in the hepatoduodenal ligament between two fingers. Bleeding points and areas of bile leakage are secured by single transfixing ligatures. The wound surfaces having thus been dealt with, are partly approximated by single U-sutures and, if necessary, oversewn with omentum.

Cryosurgery may preferably be utilized for gallbladder excision: areas of neoplastic infiltration in the adjacent liver are destroyed by deep-freezing to $-190°C$, exposure lasting 2—4 minutes.[61]

The wedge excision of the liver is supplemented by removal of the lymph nodes draining the gallbladder region. Cutting the peritoneum along the right side of the duodenum gives access from behind to the upper and lower pancreatoduodenal nodes, and those which are enlarged are excised together with the adjacent retroperitoneal tissue. Redon drains connected to suction are placed into the subhepatic region and the abdomen is closed.

HEPATIC LOBECTOMY FOR GALLBLADDER CANCER OR FOR TUMOUR OF THE RIGHT OR LEFT HEPATIC DUCTS

In quite exceptional cases of gallbladder cancer spreading to the liver one might consider resection of the right liver lobe, which only a very experienced surgeon should attempt. One case of 5-years' survival after rightsided lobectomy for carcinoma of the gallbladder has been reported (Barsfield, 1961), but nevertheless there is still justifiable scepticism as far as such an operation is concerned.

Hemilobectomy, however, might be indicated in suitable cases of circumscribed tumours of the right or left hepatic duct, where it is more likely to lead to permanent results. Perfect knowledge of hepatic anatomy as well as of the techniques is a necessary prerequisite.[3, 4, 18, 37]

The best approach in resection of the right liver lobe is through the 8th intercostal space by a rightsided thoraco-phreno-laparotomy. For a leftsided lobectomy, the approach through a bilateral subcostal laparotomy will be sufficient.

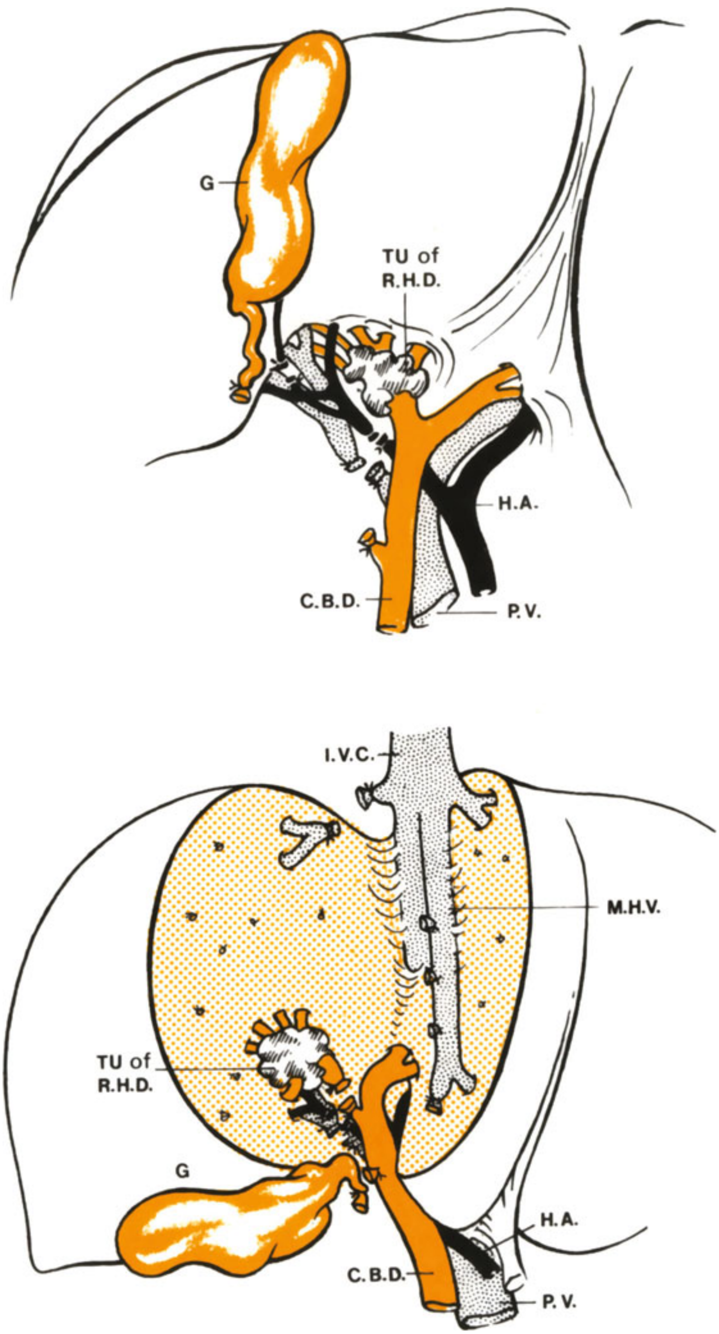

Fig. 160ab: Resection of right liver lobe for cancer of right hepaticus. (a) Ligations of rightsided hilar structures; (b) access by interlobar plane preserving the middle hepatic vein.

The interlobar fissure between the right and left liver lobe lies between the inferior vena cava and the left margin of the gallbladder bed. Resection is made possible by the segmental arrangement of the supplying vessels and the biliary system, whereas the hepatic veins lie in the intersegmental and interlobar fissures (p. 16).

For the resection itself it is best to use blunt preparation. We have no personal experience with cryosurgery. We proceed by cutting the liver capsule with a scalpel or with an electric knife in a line corresponding with the anticipated plane of resection, and then dividing the liver tissue by crushing it carefully with a hemostat, or better between the fingers, i.e. by "finger fracture" whereby the firmer blood vessels and biliary channels are not damaged but exposed, and then more easily tied. For control of hemorrhage suture-ligatures, mosquito forceps, special hemostatic clips, coagulating current or plasma scalpel may be used. Application of a non-crushing clamp across the major vessels in hepatoduodenal ligament or their preligation may be of importance. Resection can then be completed without any great loss of blood.

Using this technique, we cautiously proceed as far as the hilus. When dissecting, the hepatic vein, which lies in the hepatic fissure, must be effectively preserved. When reaching the vena cava, a few veins are exposed, which join the vena cava directly from the posterior portion of that part of the liver which is to be removed, and these are ligated. The structures in the liver hilus are tied at a level which makes it possible to remove the entire right hepatic duct, which is infiltrated by the tumour, together with its surroundings. It is useful to ligate these structures one by one and as early as possible, especially the arteries and the branch of the portal vein supplying the right lobe, since the tissue deprived of its blood supply is visibly demarcated, which helps in selecting the plane of resection.[29] *Fig. 160.*

When resecting the left lobe for cancer of the left hepatic duct, the procedure for penetrating through the interlobar fissure is the same, but it is the structures supplying the right lobe which are to be spared, and the interlobar hepatic vein is to be left on the lateral wound surface of the parenchyma which is not removed, i.e. on the right lobe. On reaching the hilus, the left lobe is pushed downwards, which exposes the left and middle hepatic veins. Only the left vein is tied. Some smaller and poorly visible hepatic veins may be tied near the vena cava. The fragile interlobar vein may be protected in both types of resection, i.e of the right or left lobe, by choosing the resection plane approximately 1 cm further away from the part to be resected, so that there remains a 1 cm layer of parenchyma covering the vein.[3]

After removal of the liver lobe the wound surface is checked and all bleeding points secured by transfixing ligatures. The wound surface is covered with omentum, and Redon's suction drains are placed near the under surface of the liver, and in the Morrison's pouch.

RESECTION OF A TUMOUR OF THE HEPATOCHOLEDOCHUS

In only a very few cases it is possible to resect a circumscribed tumour of the hepatic duct or the supraduodenal part of the choledochus. In such a case cholecystectomy is performed, and the entire portion of the hepatocholedochus involved is removed as radically as possible together with the lymph nodes. The ramaining

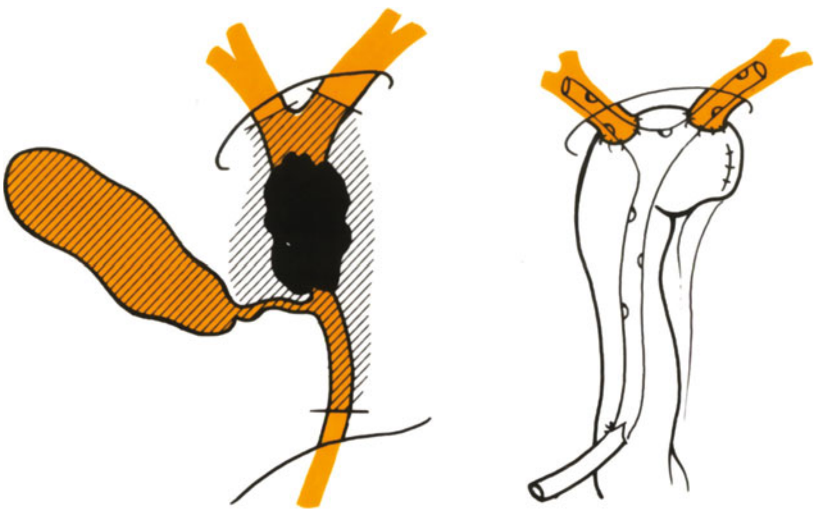

Fig. 161: Resection of hepatic duct tumour and anastomosis of both hepatic branches with the jejunum.

upper hepatic duct or its branches are then connected to the jejunum, either to a loop isolated as suggested by Roux, or to a loop shaped Ω as shown in *Fig. 161.* A suture of both ends of the duct after its radical resection is usually impossible, and would not be correct.

If occasionally resection of a tumour involving the hepaticus bifurcation can be accomplished, the operation is completed by high level hilar hepatojejunostomy. The divided segmental ducts are intubated and, with the entire defect in the liver, sutured to an antimesenteric opening in the gut.[36, 55]

AMPUTATION OF THE PAPILLA OF VATER WHICH IS THE SEAT OF A TUMOUR

Local excision of a tumour of the papilla is justified only in cases of small circumscribed tumours. In practice, this is possible only rarely, and mostly only in the case of a benign tumour.

The laparotomy must permit a perfect approach to the duodenum. Through a longitudinal duodenotomy the papilla and its surroundings are thoroughly examined from within the intestine. After the peritoneum along the outer border of the duodenum has been incised, its descending part is freed by blunt dissection, according to Kocher, so that one may work one's way to the region of the papilla from the posterior aspect of the duodenum.

If the tumour is small and mobile, and involves only the papilla, it is pushed into the intestine with a probe of medium strength introduced from above through the choledochotomy, and circumcised together with a sufficiently large disc of healthy mucous membrane and of the deeper inner layers of the surrounding intestinal wall. The bile duct and the neighbouring pancreatic duct are divided on the probe at a sufficient distance 1–2 cm above the tumour. One should endeavour to do as little damage as possible to the pancreatic tissue and meticulously stop even the smallest hemorrhage. After removal of the tumour, there remain, in the depths of the wound, the visible openings of the divided dilated choledochus and pancreatic duct. First, the bile duct is fixed to the edges of the intestinal mucosa by 4 mattress sutures placed in a quatrefoil pattern so as not to compress the pancreatic duct, but also not to allow bile to leak into the retroperitoneum. The pancreatic duct is fixed to the duodenal mucosa just firmly enough to prevent its slipping back. The best material are thin atraumatic sutures of chromicized catgut or Dexon. *Fig. 162.*

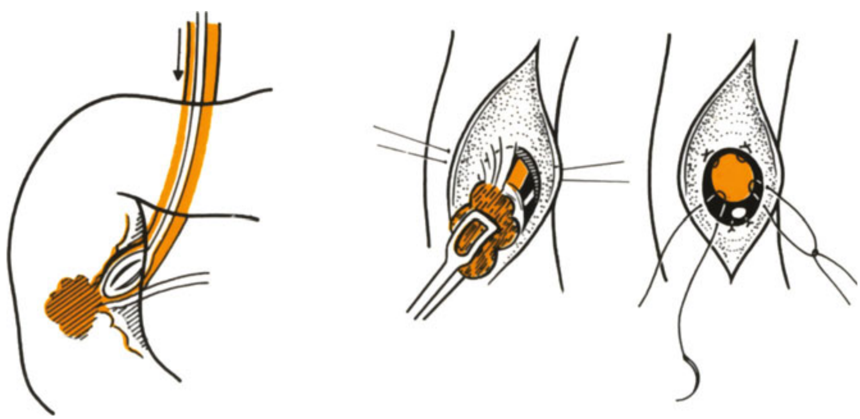

Fig. 162: Amputation of papilla of Vater with tumour. – Elevation of papilla by means of Bakeš probe, circumcision of papilla with growth and exposure of choledochus and pancreatic duct. Suture of divided choledochus to border of intestinal excision taking care not to compromise the pancreatic duct.

A T-tube is inserted into the bile duct supraduodenally, but we recommend not to pass its transverse limb as far as into the intestine. The duodenotomy is sutured transversely in two layers and covered with the pulled-down base of the transverse mesocolon. One to two peritoneal suction drains are inserted, and all measures necessary for the prevention of pancreatitis are initiated during the operation (p. 264).

HEMIPANCREATO-DUODENECTOMY

This operation carries the name of Whipple, who, in 1935, was the first to perform it successfully for ampullary carcinoma. Its main indications, as malignancies are concerned, are local cancer of the papilla, the terminal choledochus, the parapapillar region of the pancreas, or the duodenum.

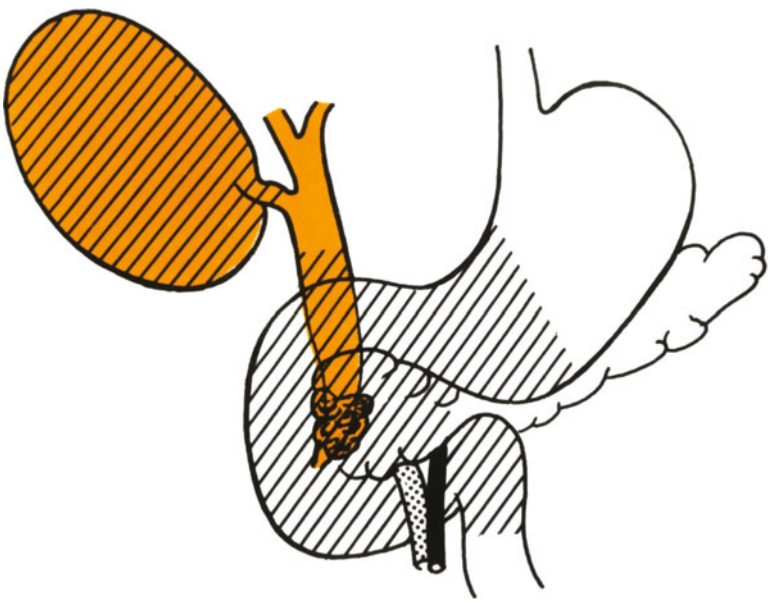

Fig. 163: Duodeno-pancreatectomy for cancer originating from the papilla or the surrounding tissues.

By this operation, one removes cephalic part of the pancreas, the whole duodenum, as a rule together with the duodeno-jejunal flexure, the gallbladder, almost the entire choledochus and at least one half of the stomach. *Fig. 163.* The operation is mostly performed in one stage, because a two-stage operation reduces the risk only very little.[14] However, a two-stage operation is indicated in patients with severe jaundice and liver damage, which calls for biliary decompression as a first step. It is best to perform only a cholecystostomy and to bring out the drainage tube by a separate stab incision. If the cystic duct is not patent, a T-tube may be inserted into the bile duct close to the duodenum or a low choledocho-duodenostomy may be established.

For the radical operation a perfect surgical approach is obtained by a transverse epigastric incision, at first only on the right side, and extended to the left epigastrium when the tumour has been found operable. The examination is started by palpating the root of the mesentery, which usually is the site of metastases. The region of the hepatobiliary pedicle is scrutinized thoroughly. By incising the peritoneum along the entire right and inferior border of the duodenum its descending part and the head of the pancreas are freed by blunt dissection from the retroperitoneum. Thus the region of the papilla of Vater is made easily accessible for palpation, and the relationship of the pancreas to the mesenteric blood vessels and the portal vein is made clear. *Fig. 164.* — Valuable information regarding the

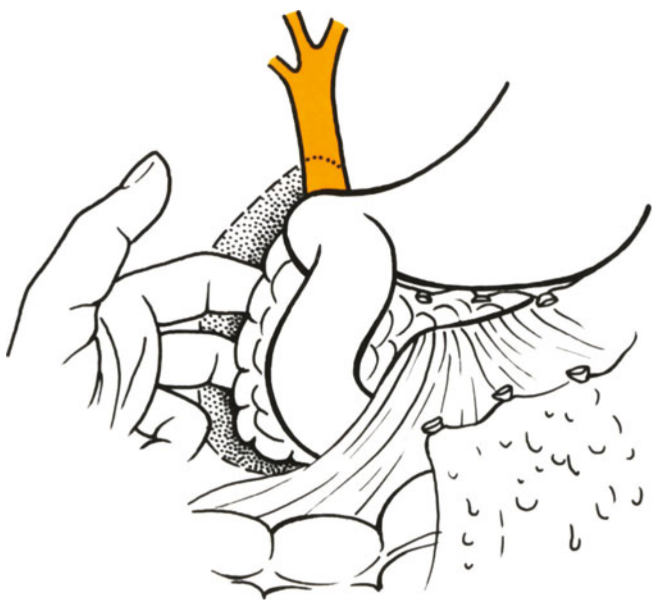

Fig. 164: **Exploration of tumour following retraction of the duodenum with pancreas.**

operability is obtained by trying to penetrate with the index fingers of both hands towards each other behind the pancreas along, and to the left of the mesenteric blood vessels. *Fig. 165.* If it is possible to penetrate quite freely, the operation is usually feasible. The anterior surface of the entire pancreas is exposed by incising the gastrocolic ligament, and the medial colic artery is pushed towards the lower border of the pancreas.

Before deciding on how to proceed further, it is advisable to take a sample of tissue for biopsy, preferably with a special needle through duodenotomy. Enlarged lymph nodes should also be examined histologically. A further step is the dissection of the choledochus and the removal of the gallbladder. One should make sure that the right hepatic artery, which runs parallel to the choledochus, does not arise from the cranial mesenteric artery, as it might easily be damaged or tied, leading to necrosis of the corresponding region of the liver. The gastroduodenal

Fig. 165: Mobilization of the mesenteric vessel region behind the pancreas and division of stomach and choledochus.

artery is isolated and divided beyond the origin of the common hepatic artery. As much of the gastrocolic ligament is divided as is necessary for resection of two thirds of the stomach. The small curvature is also skeletonized for the same distance.

The mesocolon is dissected free from the lower border of the pancreas far enough to expose the mesenteric blood vessels underneath the uncinate process of the pancreas. The index finger of the right hand penetrates in the direction of the axis of the mesenteric blood vessels underneath the pancreas cranially from its inferior border, and by blunt dissection separates the head of the pancreas from these vessels. Care should be taken not to damage their pancreatic branches. If there is any slight hemorrhage due to injury of the small veins leading from the pancreas into the mesenteric veins, this is, for the time being, arrested by plugging. The index finger of the left hand works its way from the spot where the gastroduodenal artery has been divided, from above behind the head of the pancreas, and finishes the separation of the neck of the pancreas from the mesenteric blood vessels. Here a piece of tape or a rubber tube is then pulled through, and the freed tissue is lifted up with it. If any resistance is encountered on operating, the

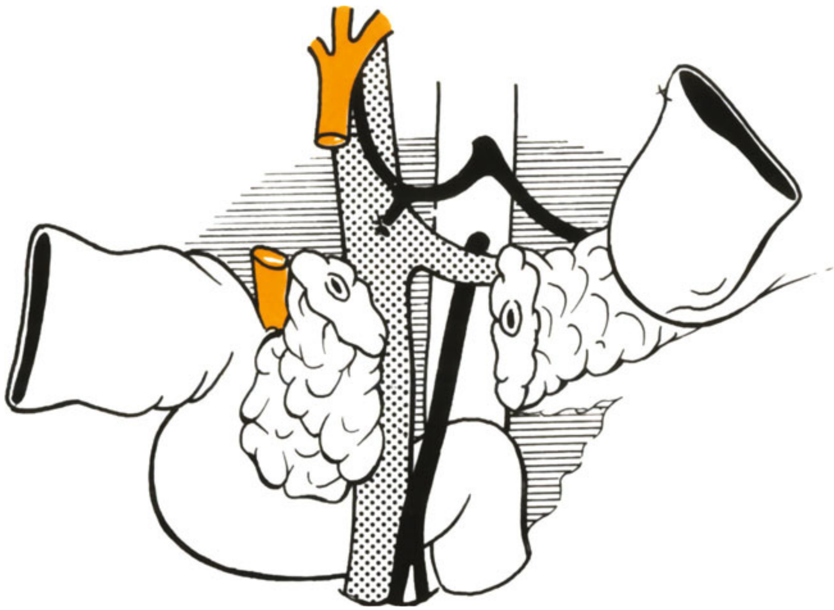

Fig. 166: Division of the mobilized pancreas.

dissection has to be discontinued, because there may be an aberrant vessel, which has to be divided under visual control.

The stomach is divided at the level fixed previously, and its aboral part is pulled to the right. The isolated choledochus is divided at a sufficiently high level. Then the pancreas is divided where it has been freed, and hemorrhage is arrested by

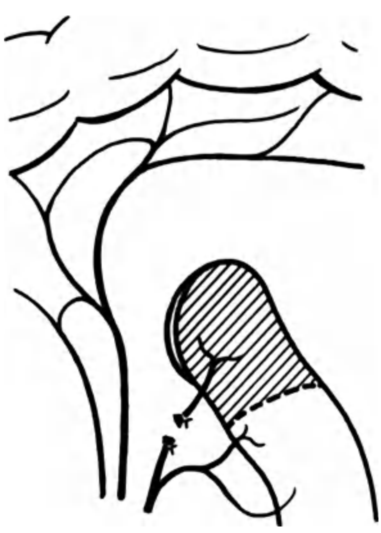

Fig. 167: Division of jejunum below mesocolon.

transfixing sutures. The pancreas is cut in such a manner as to leave its duct, which need not be dilated, slightly protruding from the cut surface of the remainder of the pancreas. Into the pancreatic duct a polyethylene tube is inserted, while the head of the pancreas is pulled to the right, by this means a number of veins passing into the mesenteric veins are exposed, and these are now ligated one by one. Thus the pancreas is freed from the retroperitoneum, and remains in connection only with the lower part of the duodenum. *Fig. 166.* — Underneath it remains the exposed inferior vena cava. The duodeno-jejunal flexure is found, and the jejunum is divided approximately 10 cm below it between two clamps. The short mesentery of the oral part is detached as far as the flexure, and Treitz ligament is divided. *Fig. 167.* — The lower part of the duodenum underneath the root of the mesentery can now be digitally pushed under the mesenteric blood vessels and pulled, together with the initial part of the duodenum, into the right epigastrium. Thus the whole mass containing the head of the pancreas with the duodenum, bile duct, gallbladder and lower stomach is freed.

After the block of organs together with the tumour has been removed, the stomach has to be rejoined to the intestine, and the bile duct and pancreas connected with the jejunum. We start, as a rule, with the anastomosis of the pancreas.

Anastomosis of the pancreas with the jejunum.

A loop of jejunum is pulled through a wide hole in the mesocolon into the right epigastrium, and one should see to it that the mesentery be sufficiently long to permit the pulling of an approximately 20 cm long section without any tension as far as the liver hilus.

The pancreas may be joined to the jejunum in two ways: either end-to-end or end-to-side. Both have their advantages and disadvantages.

For an end-to-end anastomosis between pancreas and jejunum, the open end of the pulled-out jejunal loop is approximated to the divided pancreas. The

Fig. 168: Pancreato-jejunostomy end-to-end. (a) Suture of pancreatic edge to end of gut. (b) Pancreas stump inverted into gut by second layer of sero-serosal stitches, (c) cross section of anastomosis.

drainage tube which has been placed in the pancreatic duct is passed into the intestinal lumen for about 5 cm and left there as a free internal drainage. Then the circumference of the end of the intestine is fixed with single seromuscular sutures to the edges of the cut surface of the pancreatic capsule, and after that the pancreas is pushed into the jejunal lumen. By so doing, the jejunal wall is inverted, and its serous surface comes to lie against the surface of the pancreas. In this position the jejunal wall is again sutured to the pancreatic capsule with a second layer of stitches. It may be found useful first to place the single silk sutures at a distance from the first row of sutures corresponding to the assumed site of inversion caused by the pancreatic stump. Then the pancreas is pushed in and, at the same time, the sutures are tied. The suture is completed and secured with additional stitches. *Fig. 168.*

For an end-to-side pancreato-jejunostomy, first the free end of the intestinal loop is closed and placed sideways against the cut surface of the pancreas so as to allow the blind end of the intestine to reach the liver hilum without any tension, when the bilio-digestive anastomosis can be formed. The end-to-side

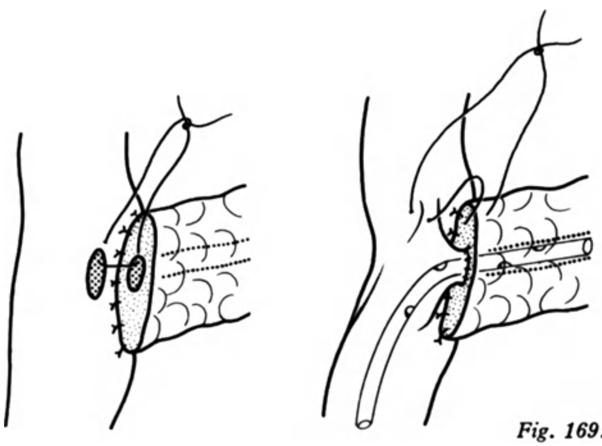

Fig. 169: Pancreato-jejunostomy end-to-side.

pancreatic anastomosis is then begun by suturing the serous coat of the posterior wall of the intestinal loop to the pancreatic capsule. The seromuscular layer only of the intestine is then incised for a distance corresponding to the width of the pancreas, and its edges sutured with thin stitches to the posterior border of the outer surface of the pancreas. In the centre of this incision, exactly facing the pancreatic duct, a small opening is cut into the exposed mucosa, and the pancreatic duct stitched with 5 to 6 chrome-catgut sutures to the edge of the mucosa. Finally, the other free edge of the seromuscular incision is sutured to the anterior border of the pancreas. Thus the entire cut surface of the pancreas is covered by intestinal mucosa, and only the pancreatic duct empties into the lumen of the small intestine. The anastomosis is completed by a row of fine sutures joining the serous coat of the intestine to the pancreatic capsule on its anterior surface. *Fig. 169.*

This end-to-side anastomosis may be modified by making the incision in the jejunal wall only as large as the diameter of the pancreatic duct. Then a muco-mucous anastomosis is made on the inserted drainage tube. The intestine around the anastomosis is sutured to the pancreas and its capsule so that no dead space is left.

Anastomosis of the pancreas with the stomach.

The resected pancreas may also be made to empty into the digestive canal through an anastomosis with the stomach.[42] After resection of the pancreas its cut surface is transfixed with single sutures so as to leave the pancreatic duct intact. The sutures are left long, and are used later to pull the pancreas into the stomach. The pancreas is isolated for a distance of 3 cm from the cut surface. The basis of

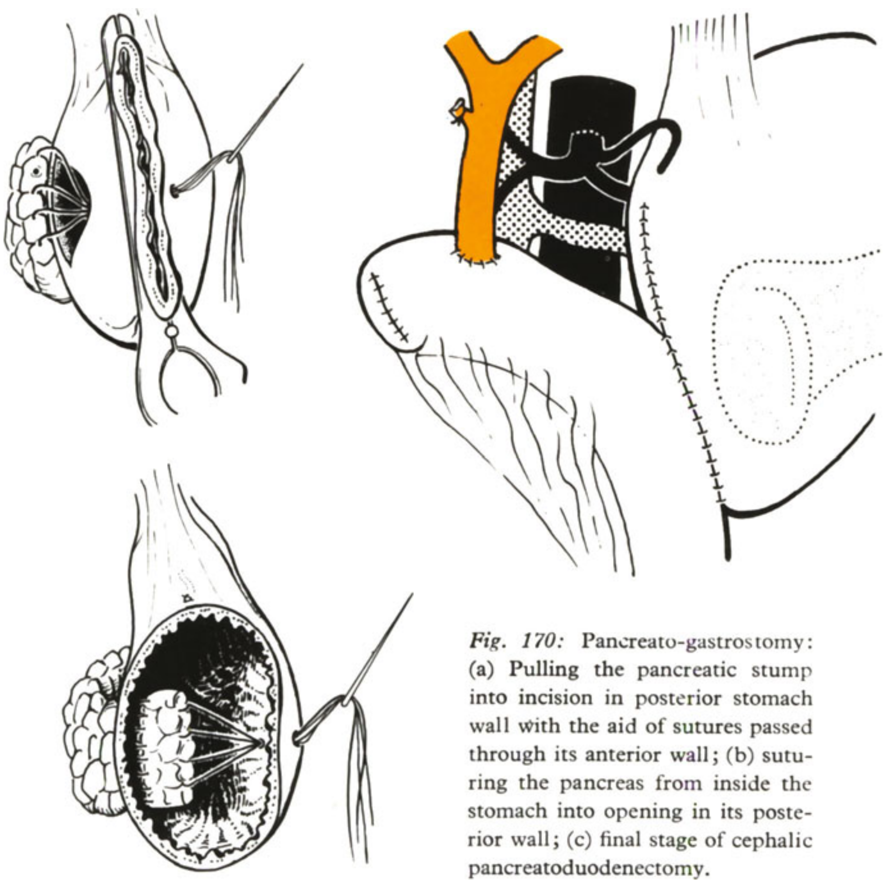

Fig. 170: Pancreato-gastrostomy: (a) Pulling the pancreatic stump into incision in posterior stomach wall with the aid of sutures passed through its anterior wall; (b) suturing the pancreas from inside the stomach into opening in its posterior wall; (c) final stage of cephalic pancreatoduodenectomy.

the anterior surface of the freed part of the pancreas is fixed with single sutures to the posterior wall of the stomach. A transverse gastrotomy about 3 cm in length (according to the width of the pancreas) is made in the posterior wall of the stomach at a distance of at least 4 cm proximally from the planned gastroentero-anastomosis. The sutures left in the pancreas are pulled through this gastrotomy into the stomach, and, with a needle, into its anterior surface. The pulling at these sutures guarantee that the pancreas will remain in the stomach during the anastomosis. The fixation of the base of the freed pancreas to the stomach is finished with the aid of stitches between the posterior pancreatic surface and the posterior gastric wall. In the open stomach, the second layer of the anastomosis is established by suturing the buried pancreas to the gastric mucosa with chromic-catgut sutures. When the stitches used for traction have been cut, at least 1,5 cm of the pancreas will protrude into the gastric lumen. *Fig. 170.*

A gastro-jejunostomy is performed, suction drainage tubes are placed at both sides of the implanted pancreas, and a catheter is passed into the stomach to prevent gastric dilatation.

Anastomosis of the bile duct with the jejunum.

The end of the bile duct is sutured to the side of the intestine regardless of which method of connection with the pancreas has been used. The jejunal loop is approximated sideways to the liver hilus; it should be quite mobile and without any sharp bend. The divided duct is joined to the apex of the bend. The serous coat of the intestine is sutured to the posterior duct wall, the intestine is incised for a length of approximately 1 cm and fixed with single chromic-catgut stitches passed through all intestinal layers to the posterior circumference of the bile duct. A tube is passed into one or both hepatic ducts, and is brought out through the intestinal wall as in the Witzel's mode at a distance of about 10–12 cm. The anastomosis is then finished by connecting the anterior edges of the bile duct and the jejunum with single chromic-catgut stitches. A second layer of these stitches may be put between the intestinal serosa and the anterior wall of the hepatocholedochus. Under suitable conditions one layer of sutures will be sufficient. The intestinal loop is then suspended by a few stitches to the tissue in the region of the porta hepatis and is also fixed with a few sutures at the point where it passes through the mesocolon. The drainage tube is brought out through a stab incision in the abdominal wall, and the intestinal wall is sutured at this site to the peritoneum.

Gastrojejunal anastomosis.

The gastric stump can be joined to the intestine in different ways. So, for instance, it can be sutured with its end to the side of the selected loop of intestine underneath the mesocolon, or the subsequent longer jejunal loop is pulled up in front of the colon and joined with the stomach in a similar manner. In this case, the two limbs of the loop used for the anastomosis are joined together by a Braun entero-entero-anastomosis. *Fig. 171.*

The field of the operation is controlled carefully for hemostasis and drained thoroughly by a number of Redon's suction tubes, especially near the pancreatic and biliary anastomosis and in the area of the Morrison's pouch.

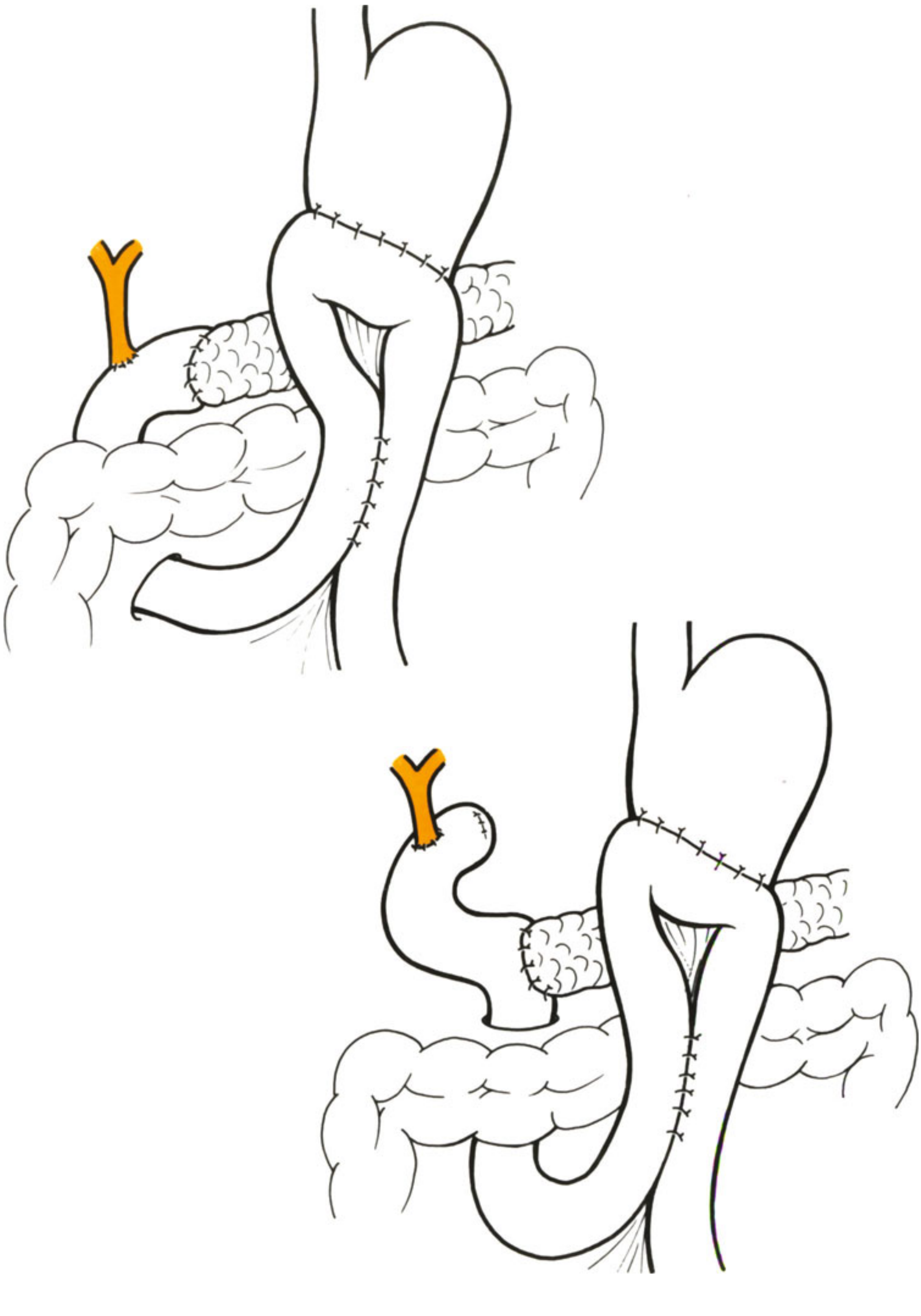

Fig. 171 ab: Pancreatico-duodenectomy with gastric resection and antecolic anastomosis. Pancreas anastomosis end-to-end (a), end-to-side (b).

There exist several modifications of duodeno-pancreatectomy. The differences between the various procedures are in the different arrangement of the anastomoses and the different techniques used. Any modification of the operation always makes great demands on the surgeon, and appears simple and easy only on diagrams. It requires a thorough preoperative preparation, exact execution, extensive drainage, and perfect postoperative care.

Postoperative care and complications of duodeno-pancreatectomy. For a few days after duodeno-pancreatectomy, the gastric contents are aspirated, if necessary. The tube draining the bile is kept patent permanently for five to six days, and only after this it is closed. The re-establishment of peristalsis is very often delayed until the fifth day, so that the patient is entirely dependent on parenteral feeding. A check is kept on the electrolyte and fluid metabolism, and elderly patients are given cardiotonic drugs. When intestinal peristalsis has been re-established, oral feeding may be started. It is advisable to keep a check on the central venous pressure, so that hypovolemia, which occurs frequently during the first days, may be detected early. If the blood volume is normal, and the hourly urine excretion falls below 60 ml, about 30 ml of 20 % mannitol is given during 30 minutes.

Palliative operations

Their main aim, whether of anastomosis or of drainage, is to suppress or at least to mitigate the patient's complaints due to the jaundice. They are therefore indicated in jaundiced patients, when a radical operation is not feasible and when

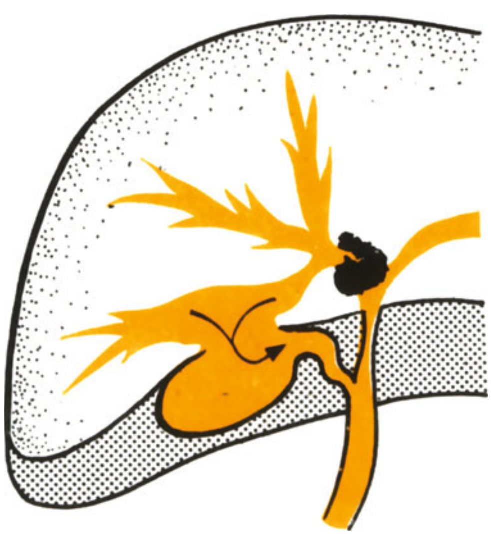

Fig. 172: Anastomosis between gallbladder and dilated intrahepatic duct in hilar tumour.

the jaundice is caused by obstruction of the common bile duct. They are, however, out of place in jaundice due to liver metastases, or if the tumour has become generalized.

If the jaundice is suppressed by the palliative operation, a few patients survive with an inoperable tumour for more than two years, so that one sometimes comes to doubt whether one's original diagnosis and bad prognosis were correct.

CHOLECYSTOCHOLANGIOSTOMY

This is an unusual operation, in which a dilated intrahepatic duct is anastomosed with the gallbladder. The anastomosis by-passes a tumour of the right hepatic duct or of the bifurcation. Its effectiveness depends on the patency of the cystic duct, and in case it is not patent, the jejunum should also be joined to the opposite side of the gallbladder. *Fig. 172.* — The operation is described in the chapter on anastomoses (p. 404).

CHOLANGIOJEJUNOSTOMY OR HEPATOJEJUNOSTOMY

They make it possible to drain the bile through the digestive canal by joining dilated intrahepatic bile ducts, exposed by dissection or blindly by resection of liver tissue, to a jejunal loop. They are applicable in jaundiced patients with tumour

Fig. 173: Cholangiojejunostomy or hepatojejunostomy in neoplastic hilar obstruction.

infiltrating the hilus, where the gallbladder cannot be used for the anastomosis, and where there are no metastases, either in the liver nor in the abdominal cavity. Generally the left lobe of the liver is used for the anastomosis, but also the right lobe or both may be used.

The mode of anastomosis should be determined by cholangiography. Sometimes one has to dispense with this, and then the peripheral portion of the liver lobe has to be resected blindly. *Fig. 173.*

The operation is not too difficult technically, since the intrahepatic ducts are dilated, hemorrhage is checked easily, and there is no risk of injuring the portal vein or the hepatic artery. Nevertheless, it does require some experience, for the patients' resistance is very low.[20] In the sclerotizing and comparatively slowly growing carcinoma of the hepatic duct, long-term mitigation of complaints due to jaundice can thus be achieved (Seigert). When branches of both hepatic ducts or their junction are occluded, drainage even of only one lobe is considered to be sufficient for mitigating the jaundice.

The technique of these various anastomoses is described in the appropriate chapter (p. 403).

HEPATICOJEJUNOSTOMY

This anastomosis forms the terminal stage of radical resection of the duct, but as a palliative operation it may also re-establish the flow of bile in inoperable tumours of the middle or inferior part of the bile duct. It places much heavier demands on surgeon and patient than the above mentioned hepato-jejunostomy. The hepatic duct, or even the intrahepatic portions of its branches, which are usually dilated above the tumour, are dissected and divided.

The lower divided end is ligated, and the upper end is anastomosed with a jejunal loop. A Redon drain is invariably placed in the subhepatic region (p. 388).

ANASTOMOSES OF THE GALLBLADDER WITH THE STOMACH OR DUODENUM AND OF THE CHOLEDOCHUS WITH THE DUODENUM OR JEJUNUM

These are appropriate for inoperable tumours of the terminal choledochus, the papilla or the pancreas associated with jaundice. Anastomoses of the gallbladder are easier to suture, but require a patent cystic duct, and should be used only in patients who are not expected to survive for long. *Fig. 174.* Otherwise, there will always be heavy inflammation of the gallbladder after some time. In not very advanced tumours it is, therefore, preferable to use the bile duct and immediate gastroenterostomy may be added with advantage (Arianoff, Omanik).

The technique of both anastomoses is described on p. 379.

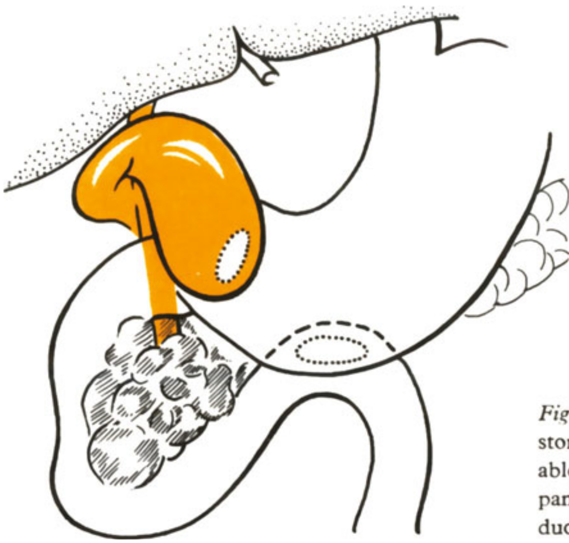

Fig. 174: Cholecystogastrostomy and GEA for inoperable tumour of head of the pancreas pressing on the duodenum.

INTERNAL DRAINAGE OR INTUBATION OF HEPATIC DUCTS WHICH ARE THE SEAT OF A TUMOUR

Permanent intubation with a firm catheter or a drainage tube may be used as a palliative operation for jaundice due to obstruction in the hilus. The bile duct is incised below the inoperable tumour mass, and a probe is made to pass upward through the stenosis. This is gradually dilated until it allows a semirigid drainage

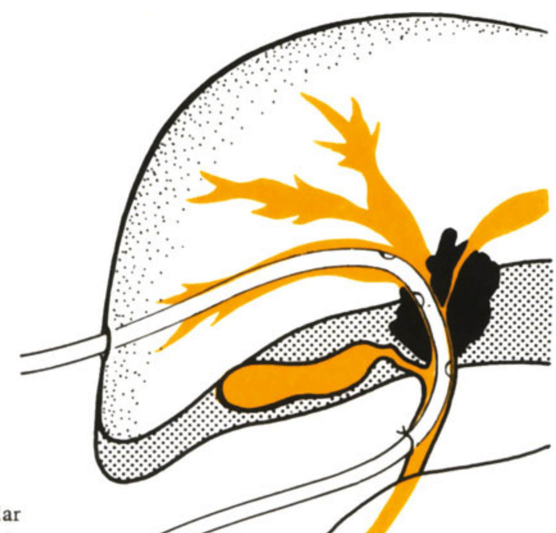

Fig. 175: Intubation through hilar tumour by means of transhepatic U-tube.

tube to be passed as far as to some of the dilated branches of the hepatic duct within the liver. The lower end of the drainage tube is usually brought out through the bile duct. The tube must always be provided with several holes in the part lying above and below the tumour, and should be washed through at regular intervals. As long as it remains patent, the jaundice will disappear and the patient's condition will improve.

For such long-term drainage the transhepatic U-drainage proves useful.[60] It is easier to wash through and to exchange if it becomes obstructed. Its construction and after-care are described in the general chapter (p. 146, 161). *Fig. 175.*

EXTERNAL DRAINAGE

In advanced, inoperable tumours of the bile duct or the head of the pancreas, when neither anastomosis nor intubation is applicable, one should try to alleviate the jaundiced patient's complaints at least by external drainage of the bile. Drainage is applied to the gallbladder, if the cystic duct is patent, or to the common duct if it is dilated above the tumour, and accessible. A thin catheter may also be introduced percutaneously into a dilated intrahepatic duct. Cholecystostomy is especially justified in those cases where the first manifestation of the cancer is an acute suppurative cholecystitis, if cholecystectomy is no longer possible. The technique of all these procedures has been described in the general chapter.

EXPLORATORY OPERATIONS

Even if the current trend is to alleviate, at least temporarily, the jaundice of patients with inoperable bile duct tumours and thus also give them mental support, there are still enough advanced cases where even a palliative operation is impracticable and to no purpose. In exploratory laparotomies, one should never commit the error of mistaking severe inflammatory changes of the gallbladder or the hilum, or a chronic pancreatitis, for a tumour (p. 301). Biopsy, and at least some interim palliative operation should always be tried to avoid fatal mistakes. This holds good also for cases of primary sclerotizing cholangitis, which so closely resembles primary cancer of the duct. In such cases one should always act as if the disease was benign in character.

Regional perfusion of the tumour with cytostatic drugs

For advanced neoplastic disease of the bile passages also involving the liver, arterial or venous perfusion with cytostatic drugs has been mentioned as a method of treatment.[16, 27, 63] Its practical application is limited, the method is relatively exacting, requires special perfusion apparatus, and the results are difficult to assess.

The cytostatic drug is infused under pressure with a special pump into the supplying artery. In this way one achieves the highest effective dose of the cytostatic in the tumour tissue with a minimum of exposure of the remaining vital organs. As for cytostatics used, 5-fluorouracil, 5-fluoro-deoxy-uridine and methotrexate have been mentioned. The whole course of action has to be decided in co-operation with an oncologist and on the basis of pharmacological tests.

The infusion is given to selected patients who are incurable by surgical methods, and for whom radiation treatment is not suitable. The treatment should be started as soon as possible, and is continued for several days or even weeks. The catheter is introduced by Selinger's method following surgery or may be inserted at operation, during which the blood supply of the tumour is verified by injecting a 5% solution of fluorescein into the assumed supplying artery. Mostly it is inserted into the gastroduodenal artery and passed upstream until its end reaches the hepatic artery. Its "nonhepatic" branches are ligated so as to ensure the infusion reaching only the tumour in the liver. The other end of the catheter is brought out of the abdomen and is kept patent between the cytostatic infusions by physiological saline and, if need be, an addition of heparin. After treatment has been concluded, at least after a week, the catheter may be pulled out, if the prothrombin time is normal. The slight hemorrhage from the wound can be arrested by compression.

For selective perfusion of a tumour in the liver the portal vein may also be used. The cytostatic drug is applicated via the upper mesenteric or splenic vein. Sometimes catheterization of the teres ligament i.e. the occluded umbilical vein can be used. It is dissected extraperitoneally and gradually dilated as in angiography.

As complications of cytostatic perfusion treatment have been mentioned: liver damage, obstruction of the catheter, wound infection, hemorrhage and delayed thrombosis.

Contraindications are hepatic failure and peritoneal dissemination of the tumour.

The prospects of perfusion treatment are uncertain. According to data from the literature, one may, with regional cytostatic perfusion, achieve temporary remission and prolong life by some months. Partial local regression of the tumour is said to occur in as many as 60% of cases.

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SURGERY OF JAUNDICE

The urgent and alarming symptom of jaundice has always been a genuine challenge to medical acumen and skill, and is still so today. Apart from pathogenetic considerations, the basic diagnostic and therapeutic problem remains: is jaundice due to a mechanical obstruction of the bile ducts and thus constitutes "surgical jaundice", or is the cause different, an internal disease. There has never been any argument about the fact that delay of surgery in obstruction may be harmful for the patient, and the same applies to an ill considered intervention in jaundice of other origin. This is also true of neonatal jaundice, which will be dealt with in another chapter (p. 412).

Jaundice is a clinical symptom and marked jaundice is obvious at a glance. Staining of tissues is due to excessive bile pigment deposits. All pathological conditions producing jaundice may also occur as anicteric forms or accompanied by subclinical hyperbilirubinemia, and these may gradually merge into each other. Skin and mucous membranes do not usually stain yellow until bilirubinemia has risen to over 2 mg %. Slight and transient jaundice, subicterus, may escape attention, but recognition of all grades of jaundice is facilitated by the appearance and analysis of urine and stool specimens and blood tests. Recognition of its cause, on the contrary, may be difficult.

Classification and Diagnosis

Current subdivision of jaundice into microsomal, pre- and post-microsomal, according to the site of bilirubin transfer disturbance in the hepatocyte organelles — reflects the complexity of the disorder — for clinical practice, however, classification according to the prevailing mechanism is still most useful: into prehepatic (hemolytic) jaundice, hepatic (parenchymatous) and post-hepatic (obstructive). A special group has been added, the so-called functional hyperbilirubinemias on the basis of congenital enzymopathies with an inborn error of metabolism; its most common representative is Gilbert's and Dubin-Johnson's syndrome.

A surgical disease is mechanical obstructive jaundice due to obturation, stenosis or compression of ducts, either benign or malignant.

The main causes of mechanical jaundice may be:

Gallstones in the ducts.

Tumours: of the papilla, bile ducts, gallbladder, liver, pancreas, duodenum, or metastases.

Benign stenosis: of the papilla and sphincter Oddi, pancreatic segment of the common bile duct, stenosis of cholangitic, iatrogenic, or traumatic origin, stenosis of biliary anastomosis.

Non-tumorous compression: by an inflamed gallbladder, acute or chronic pancreatitis, echinococcus cyst, adhesions, or enlarged lymph nodes.

Non-lithiatic obturation: by inspissated bile, parasites, coagula, indwelling drain.

Congenital anomalies: biliary atresia, stenosis, cysts and dilatations of the bile ducts, diverticulum Vateri.

A malignant tumour is by far the most frequent cause of surgical jaundice. Out of the author's series of 7 338 biliary operations (Prague-Motol 1949–1974) every fifth operation was performed for jaundice. However, this concerned only 10% of patients with benign disease (6314 : 631), whereas 78% of patients operated on for tumour (985 : 768).

The mechanical jaundice in all above mentioned causes of obstruction is a sign of advanced cholestasis from biliary hypertension, but is not a necessary manifestation in incomplete biliary obstruction; and the majority of decompressions are performed in anicteric patients. The causes of obstruction and the principles of surgical treatment are the same in both instances, it would thus be more accurate to speak of "surgery of biliary obstruction" than of surgery of jaundice. In patients suffering from jaundice, however, diagnostic and surgical problems are more pressing and investigation is more difficult; during preoperative preparation and postoperative management the time factor assumes greater importance, as well as sepsis, impaired function of liver and kidneys. Surgical risk in a jaundiced patient is always greater. Vinogradov states rightly "jaundice is a symptom only at the onset, but afterwards its significance may outgrow its cause and become the leading factor in the 'illness'."

Diagnosis of surgical jaundice

The object of diagnostics is the reliable distinction between surgical and nonsurgical jaundice, to avoid as far as possible abdominal explorations and doubtful laparotomies.

Distinction between surgical and nonsurgical jaundice is easy in most patients already undergoing clinical and biochemical investigation. The significance of careful history taking cannot be overstressed, particularly as regards the distinction of liver diseases with cholestatic syndromes, which biochemically frequently closely resemble obstruction.

Primary cholestasis and hepatic jaundice with possible cholestatic syndrome causing most difficulties in differential diagnosis of "medical" and "surgical" jaundice:

- Acute or chronic hepatitis: viral, bacterial, alcoholic, drug-induced, toxic, granulomatous.
- Liver steatosis.
- Periportal liver cirrhosis.
- Primary biliary cirrhosis.
- Cholestatic jaundice of pregnancy.
- Postoperative cholestatic jaundice.
- Syndrome of Summerskill-Walsh.

Changes in bilirubin metabolism apparent in the blood, urine and stools assist in the exclusion of hemolytic jaundice and of most enzymopathies; they are, however, useless for the differentiation of hepatic jaundice cases. *Fig. 176.*

	Blood:	Urine:		Stool:	
	Direct-reacting bilirubin	Bilirubin	Urobilinogen	Acholic	Normal or light-coloured
Jaundice:					
hepatic	+	+	+	−	+
obstructive					
complete	+	+	−	+	−
incomplete	+	+	+	−	+
hemolytic	−	−	+	−	+
Gilbert	−	−	−	−	+
Dubin-Johnson	+	+	−	−	+

Fig. 176

Here biochemical blood investigations are particularly valuable. The fully fledged cholestatic syndrome is characteristic for obstruction, i.e. high activity of alkaline phosphatase and gamma-glutyl transpeptidase, accompanied by slightly or transiently raised transaminase activity and with a negative thymol turbidity test. Cholesterol is likewise raised in obstruction and lipoprotein is present. HBsAG makes viral hepatitis B probable, but its absence does not exclude hepatitis of other origin. A pathological Quick test, found in longstanding complete obstruction also occurs in liver disease with advanced insufficiency. Some instrumental methods, however, which might endanger the patient by hemorrhage, require always preliminary hemocoagulation screening: clotting time, bleeding time and Quick test.

The evolution of jaundice may sometimes be also characteristic: rapid development and complete and permanent obstruction is usual in neoplasm, fluctuations in its intensity in stones, sudden and transient icterus in choledocholithiasis or acute cholecystitis or pancreatitis. *Fig. 177.* In hepatic disease its course is more or less stationary and waning gradually.

Each case of jaundice ought to be assessed comprehensively, biochemistry

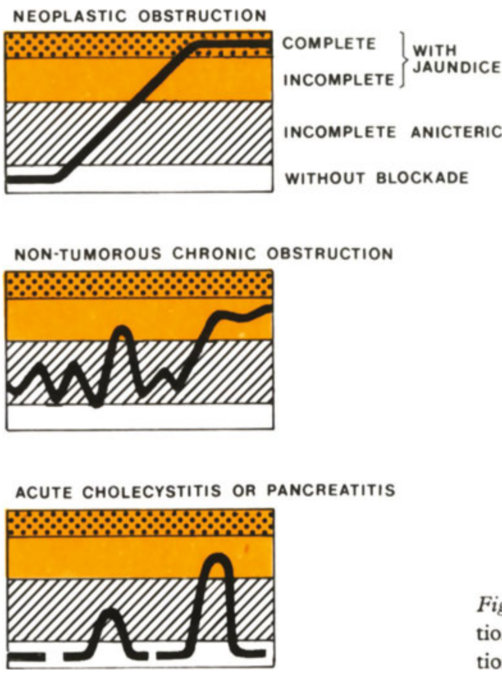

Fig. 177: Types of clinical evolution in common bile duct obstruction.

reveals cholestasis, while history taking and physical examination determine its cause with reasonable certainty.

If obstructive jaundice has been recognised, many surgeons, even currently, are satisfied with this syndromologic diagnosis and accurate determination of its anatomical character is deferred until operation.

However, contemporary trend in general favours the determination and localization of the obstacle prior to intervention, particularly in complicated cases.

Moreover in many cases the obstructive nature of the jaundice remains uncertain, the pattern is atypical. Embarassment arises obviously more often in diseases with various grades of cholestasis than without it. The combinations of diseases are particularly treacherous, such as viral hepatitis in subjects with cholelithiasis, neoplastic obstruction in alcoholics etc. Such cases have been managed previously by observation of various duration and by repetition and supplementation of the spectrum by expensive biochemical tests, and finally by laparotomy.

Concurrently, preoperative procedure is much more aggressive.

The object is to establish not only a highly accurate diagnosis but to do this speedily, within a matter of days. This is facilitated at present mainly by three new or improved methods: Percutaneous transhepatic cholangiography by fine needle (PTC), endoscopic retrograde cholangio-pancreaticography (ERCP) and by additional screening grey-scale ultrasonography. It is no longer required to render basic investigations more accurate in uncertain cases by protracted observation of patients or to attempt i.v. cholangiography, a method which fails even in most anicteric obstructions and is contraindicated in jaundice, where it is necessary to introduce the contrast medium directly into the biliary tree. However, the original

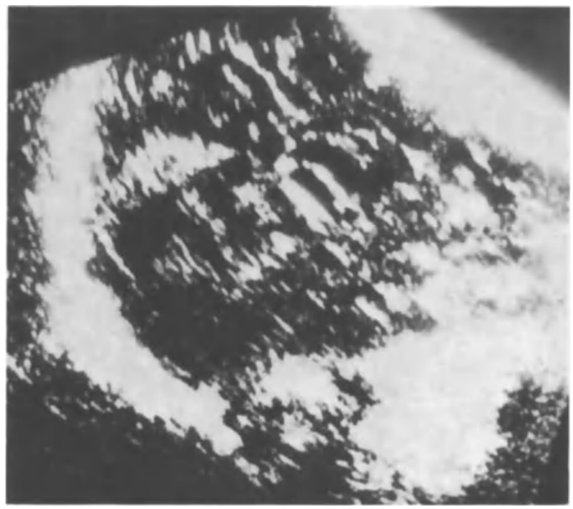

Fig. 178: Grey-scale sonography in a patient with jaundice of uncertain origin: Dilatation of intrahepatic bile ducts with the typical "star" sign was found and obstruction of the common bile duct by pancreatic tumour evidenced by surgery and biopsy. (Heger).

technique of PTC by wide bore needle is obsolete and transjugular and laparoscopic cholangiography has been abandoned; only for limited indications, or if more suitable methods are not available, is needle biopsy, laparoscopy and minilaparotomy still used.

In many centres, if there is uncertainty, sonography by the grey scale technique (p. 67) is employed right at the beginning for screening. *Fig. 178.* It reveals a high percentage of correct results whether intrahepatic bile ducts are dilated or not, and so facilitates the selection of suitable more invasive methods of investigation. An added advantage is the demonstration of some tumours, stones in the gallbladder and fluid accumulation in the biliopancreatic region.[28, 35] — Its disadvantage is the occasional confusion of ducts with venous structures, and also that some cases of obstructive jaundice are not accompanied by intrahepatic duct dilatation.

Biliary scanning by means of isotopes could also be utilized for screening, usually 99^{m} Tc. — It is not impossible that computer assisted whole body tomography will play a role in the future, but the author has here no personal experience. It is necessary to be able to dispense with these screening methods and to be guided in the selection of investigations for uncertain cases by the evaluation of the basic investigation.

If a mechanical obstruction has not been excluded by initial investigation and sonography has shown dilated ducts, percutaneous transhepatic cholangiography (PTC) is the logical further step. *Fig. 179, 180.* It is assumed that this is done by fine needle technique.[1, 2, 11] This is necessary because not until the introduction of the fine Chiba needle, and under an antibiotic umbrella, has the risk diminished, and recognition of obstruction and dilated ducts respectively improved to almost 100%. It has replaced endoscopic cholangiography as the first method in the sequence of investigation, as also advocated by Blumgart and others. The level of obstruction can be determined, and sometimes also its anatomical cause, neither does laparotomy have to follow immediately for fear

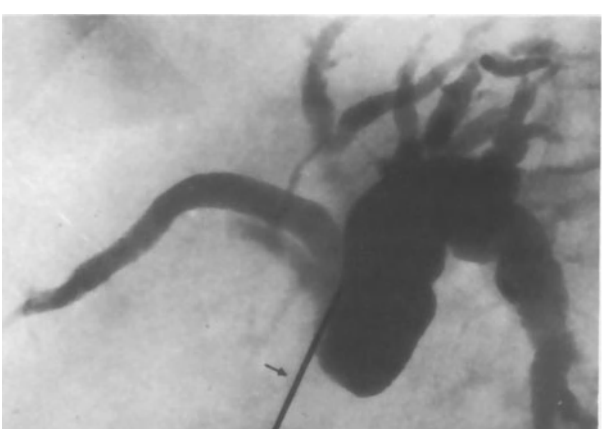

Fig.179: Percutaneous transhepatic cholangiography in a patient whose jaundice developed 3 month after cholecystectomy.
Dilatation of the intrahepatic bile tree and occlusion of the hepatic duct were found. Surgical revision revealed tumorous infiltration of the hilus.

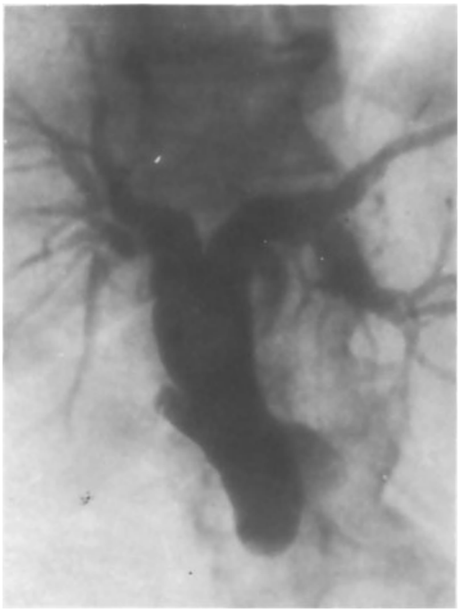

Fig. 180: **Percutaneous cholangiography in a patient whose jaundice developed "silently", lacking a lithiatic past history. Investigation revealed a large stone in the hepatic duct, several less voluminous ones, one of the latter occluding the terminal choledochus, and a tiny stone blocking the cystic duct. (Kašpar.)**

of bile leakage through the puncture in obstruction, as was previously the case when wide bore rigid needles were used.

The intrahepatic ducts may be successfully entered and filled with the fine

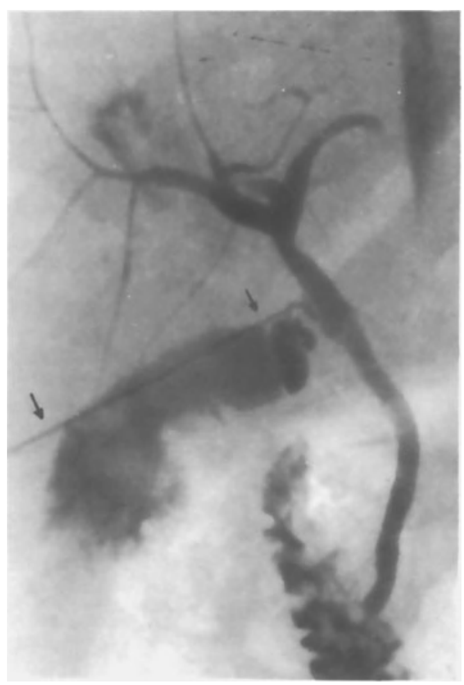

Fig. 181: Percutaneous cholangiography by means of the thin Chiba needle in a patient with intermittent jaundice of obstructive character. No dilated bile ducts were found and surgery with biopsy revealed cholecystolithiasis and chronic hepatitis.

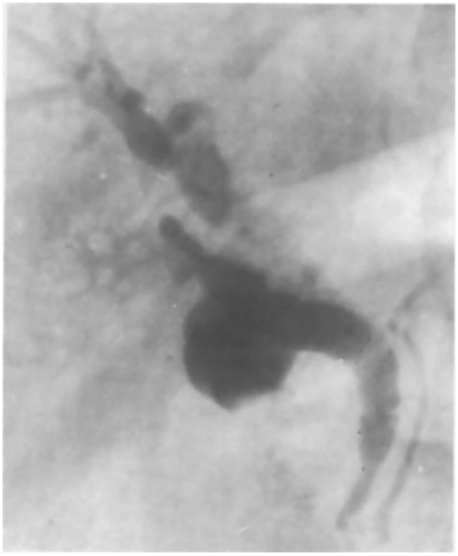

Fig. 182: Retrograde cholangiography in a patient with jaundice of obscure origin. Only duodenoscopic cholangiography demonstrated cholecystolithiasis with a dilated cystic duct and a stone "packed" choledochus. (Following duodenoscope withdrawal contrast persists in the bulbus duodeni and the pancreatic duct which enters the intestine separately above the common bile duct.) (Horáček.)

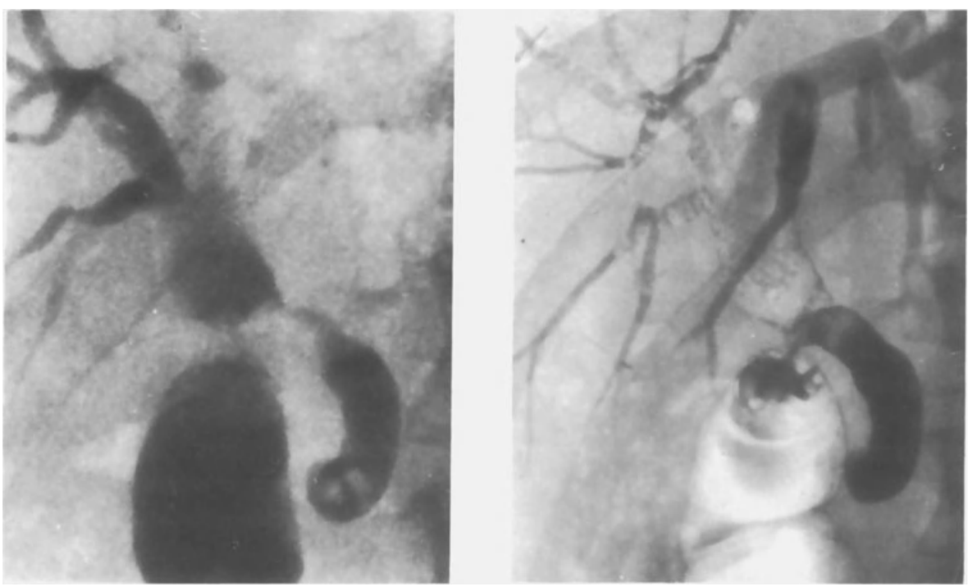

Fig. 183 ab: Endoscopic retrograde cholangiography in patient aged 40 years suffering from intermittent biliary obstruction. In the past gastric resection, cholecystectomy and choledochoduodenostomy were performed. A cannula was inserted through the duodenoscope into the anastomosis and contrast medium instilled. Dilatation of the common hepatic duct and small stones in the terminal choledochus cul-de-sac were found (a); after withdrawal of the endoscope foamy contrast medium flows back through the anastomosis, but the papilla remains blocked and pooling in the cul-de-sac occurs. Surgery confirmed these findings and revealed an advanced stenosis of the anastomosis. (b). (Skála-Pirk).

needle in 25 to as much as 85%, even in the absence of dilatation. *Fig. 181.* If dilated ducts are not demonstrated by sonography, or aspiration fails, or PTC reveals ducts of normal calibre, obstruction is unlikely, but not entirely excluded. Further tests are selected according to the probable character of jaundice—whether that accompanying hepatic disease, or if there is still a greater likelihood of its mechanical origin.

If suspicion of obstruction persists, endoscopic retrograde cholangio-pancreaticography (ERCP) is now indicated, as this does not depend on duct calibre (p. 84).[3] We may also begin with it, without preceding PTC, in hemorrhagic diathesis or if not equipped with a suitable PTC fine needle. Advantages of endoscopic cholangiography are the possibility of simultaneous pancreaticography, the opportunity for inspecting the upper division of the digestive tract, and investigating secretion and brushings from the ducts for malignant cells. *Fig. 182, 183, 184.*

Fig. 184: ERCP in patient after cholecystectomy and choledocholithotomy revealed residual and recurrent common duct stones as the cause of obstructive jaundice. The whole biliary tree and the pancreatic duct were dilated. Stenosis of the papilla of Vater has been found at reoperation.

A disadvantage is the technical exaction of ERCP and the occasional failure to demonstrate both ducts, in particular the choledochus. Recent reports, however, cite successful biliary tract filling in 80% of investigations, and in the principal endoscopic centre in Prague even 86.4% (Frič et al., 1977). The method has its contraindications and there is a slight risk of cholangitis and pancreatitis, but, nevertheless this is one of the recent major advances in jaundice diagnostics. According to Elias et al., the combination of this investigation with percutaneous cholangiography was successful in establishing a correct diagnosis in 90% of diverse cholestatic jaundice cases. *Fig. 185.*

If ducts fail to opacity with PTC or are of normal calibre and hepatic jaundice appears more probable than mechanical obstruction, further procedure depends on which of the primary hepatic diseases is considered to be probably present: if

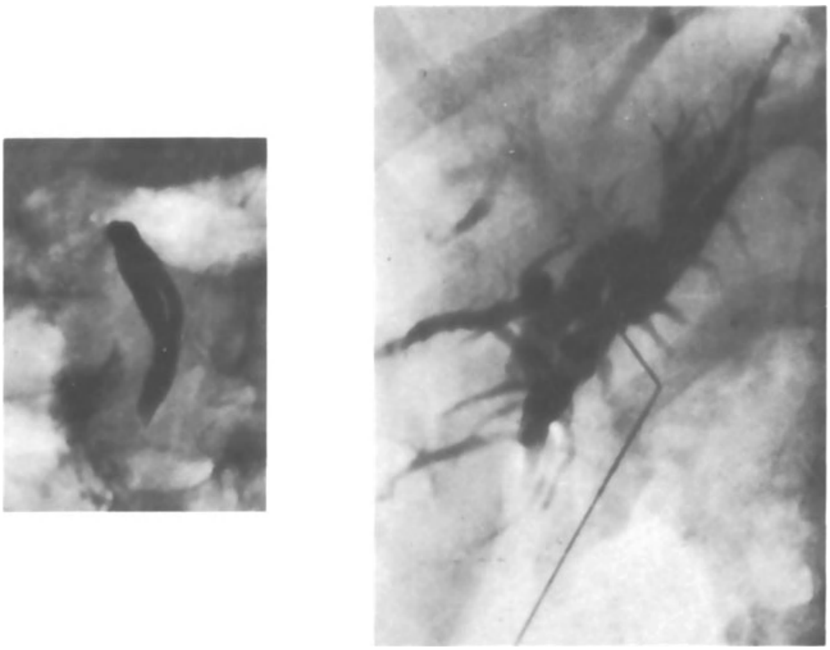

Fig. 185ab: Combined investigation by ERCP (a) and transhepatic cholangiography (b) in a jaundiced patient following cholecystectomy. The films demontrate the seat and size of a iatrogenic stricture of the common hepatic duct verified by surgery. An excessive long remnant of the cystic duct is also shown entering the common bile duct from the left.

primary biliary cirrhosis is suspected, immunological tests are done in the first place, in hepatic cirrhosis and Dubin-Johnson's syndrome, or if metastatic involvement is suspected, laparoscopy is performed, and in acute and chronic hepatitis needle biopsy. The latter can, however, be considered only if hemocoagulation allows it and a mechanical origin of cholestatic jaundice has been definitely excluded.

Puncture biopsy has lost its value in the diagnosis of mechanical, obstructive jaundice; not only because of the risk involved (which is small), but because its results are frequently doubtful. It is employed, the same as laparoscopy, only if a more suitable method is not available and if it is not contraindicated.[6, 10, 18] —

Similarly minilaparotomy has not been abandoned as a rapid diagnostic approach to unexplained jaundice.[20, 33, 38] However, this method, integrating open transhepatic cholangiography, liver biopsy and omentoportography is mainly used if suspicion of portal hypertension is entertained in a case of jaundice.

Diagnostic procedure in surgical jaundice has changed and is changing as better diagnostic methods are being evolved, but must be adapted to their availability and cost. Blumgart's scheme is considered currently the most satisfactory and has been adapted to the author's practice. *Fig. 186.*

Despite the results obtained by contemporary methods — which have genuinely revolutionized jaundice diagnostics — it must be stated that behind their selection

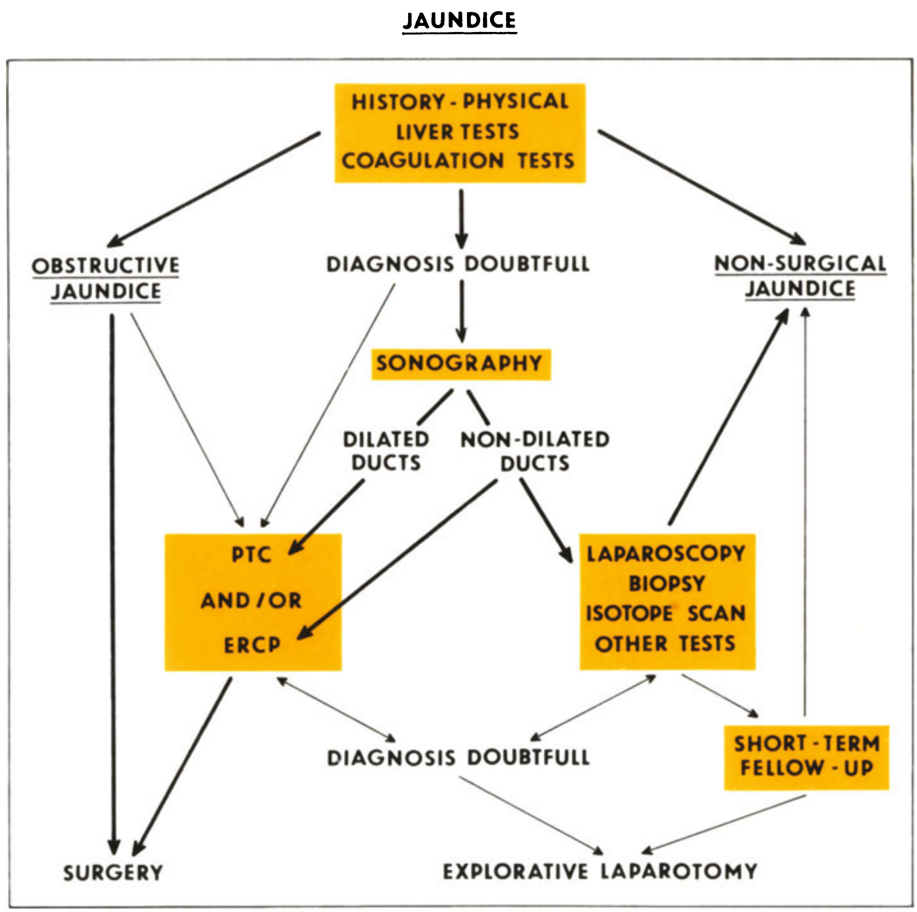

Fig. 186: Diagnostic procedure in jaundice.

and interpretation stands the physician with his clinical judgment, prudence and responsibility. Investigation is based on the clinical condition and returns to it, after all findings have been arranged. We do not expect that a decision about surgery will be arrived at by some auxiliary method instead of by ourselves.

Indications for Surgery and Surgical Interventions

Timing of operations

In every biliary obstruction and the more so if accompanied by jaundice, timely surgery is essential. Investigation can, as a rule, be completed within a week, and some of the time required for it can be utilized for intensive preparation, as surgery must be investigated without unnecessary delay. Only if jaundice is resolving rapidly and permanently, intervention is delayed until it has subsided, but is undertaken before relapse occurs.

On the other hand, emergency surgery is exceptional with jaundice, e.g. in acute purulent cholangitis with sepsis and in acute block of the papilla with shock inducing pain or with pancreatitis. Complete obstruction by a small stone is the usual cause and its removal, or at least choledochus decompression by tube, can avert a fatal outcome. Surgery should also immediately follow percutaneous cholangiography, if the fine needle technique has not been used. If obstruction was found and attempts to substitute a flexible decompression tube e.g. teflon catheter for the needle have failed, bile which is under pressure, might leak through the hepatic puncture.

Contemporary literature sometimes states that exploratory laparotomy is obsolete in the surgery of jaundice. Though the need for it is undoubtedly diminishing, it is the author's view that this statement is too optimistic and that the measure cannot altogether be dispended with in large scale surgical practice. Not every patient is lucky enough to be included in the high percentage of diagnostic results achieved by any one of the methods used, and not all of them are always available. Laparotomy may be intentionally diagnostic in cases of uncertainty[4] that cannot be resolved by other means and may, of course, also constitute a diagnostic error as "there is no living... infallible in the diagnosis of jaundice" (Moynihan).

Laparotomy should only be resorted to after the failure of other diagnostic methods and observation of the patient. However, surgeons demand that intervention should be undertaken after three weeks duration of jaundice at the latest. Longer delay is usually unnecessary and harmful, as the risk of operation rises sharply after this period. Particularly if we know that jaundice was preceded for some time by anicteric obstruction, the observation period should be reduced to the shortest permissible limit. Exploration in hepatic disease accompanied by jaundice is not free of risk either (Turner, Niederle). The danger is not identical in all cases of hepatic cholestasis and one should take into account, before surgery, which kind of cholestasis is likely, if the suspected obstruction cannot be confirmed. Cholestasis of pregnancy, familial cholestasis, and cholestasis due to drugs do not carry an excessive risk, provided evolution of liver damage is not highly acute. Biliary cirrhosis cases also tolerate cautious exploration quite well. A mistaken laparotomy in subacute dystrophy, in liver cirrhosis, in icteric exacerbation, and in acute alcoholic hepatitis or in viral hepatitis in a cholestatic phase is highly dangerous.

Every fifth operation from the author's series of 7 338 biliary operations was performed in jaundiced patient. These icteric patients represent 10% of the group operated on for benign disease, and 78% of the group with malignant tumours. Etiology of jaundice remained unrecognized in 19 patients, and came out not to be of surgical type in 21 cases: Infectious hepatitis 4, liver cirrhosis 10, hepatic cholestasis 6, and hemolytic jaundice 1 case. Thus the diagnosis of an obstructive surgical jaundice has shown erroneous in 1.4% of cases.

We are sometimes entitled to refuse surgery in some cases of neoplastic jaundice. Such a decision must be carefully considered: first of all, we may be mistaken as behind silent jaundice in a cachectic old man a stone which can be removed may be hidden. Secondly, jaundice itself may sometimes cause such distress that, even in malignancy, palliative anastomosis or mere external drainage may improve the quality of the patient's last days. On the other hand no operation relieves the excruciating pains of secondary deposits, and it is also correct to refuse operation in confirmed painless metastases, with ascites.

In some instances jaundice disappears with expectant treatment, its cause not having been exactly established. If such a patient is discharged, these uncertainties should be mentioned in the case report, and suitable investigations suggested.

Surgical strategy

The object of surgery is relief of biliary stasis in the first place. Its cause must be established and the obstacle, if possible, either removed or by-passed. Icteric patients always run a greater risk: not only are they usually older, but they also suffer from nutritional impairment, from hypoalbuminemia, have disturbed renal and hepatic function, hemorrhage due to hemocoagulation defect is an ever present danger and exposure to infection is greater. Surgical mortality in the author's series, with nonmalignant obstruction, was threefold, compared with similar biliary tract operations in non-jaundiced patients.[24]

Preparation for surgery must be intensive and must effectively and rapidly adjust homeostasis. The required fluids are administered, electrolytes and acido-basis equilibrium restored by infusions, blood volume and, in particular, plasma protein deficit supplemented. Patients are given vitamins C, B and always vitamin K even with a normal prothrombin level. In cases where the effect of vitamin K on prothrombin time is inadequate, an unfavourable prognostic indicator, blood transfusion should also be given preoperatively on this account. — Pruritus is controlled by drugs to prevent insomnia and skin damage by scratching: cholestyramin is effective only in the absence of complete obstruction, however. — Broad spectrum antibiotics are preventively prescribed as a routine in jaundice and not only with cholangitis. Treatment is started the day before operation as a rule and continued afterwards. Bile per os is useful according to Williams as the anerobic intestinal flora is checked by it. — Renal function is carefully watched even before operation, and oliguria associated with severe jaundice prevented by prompt mannitol administration.

Hepatotoxic substances should be avoided for anesthesia (p. 102), and hypoxia and hypercapnia prevented during its administration. Even transient hypotension should not occur, blood losses must be compensated immediately by whole blood transfusion, using fresh blood as far as possible. A careful watch must be kept on the patient even after minor surgery.

Surgical intervention for obstructive jaundice should be rapid and careful, but adequately detailed. A wide approach is chosen and hemostasis painstakingly performed. The nature of jaundice and probable cause of obstruction are ascertained first, even in cases where preoperative investigation has provided a definite answer. It is true that this facilitates more rapid progress and confers a sense of security, but it does not relieve us from the responsibility of checking systematically, as though we were searching for the obstruction for the first time. We must not rely solely on our conceptions and succumb to the first impression, because several causes of obstruction or at least lesions may be simultaneously present in the biliary tract.

The appearance of the bile ducts and their vicinity at operation are frequently so characteristic for a certain type of obstructive jaundice that it may serve as a guide for instrumental exploration and surgical intervention, sometimes correcting erroneous preoperative diagnostic conclusions. Some such examples of typical operative findings will be presented briefly as well as of the strategic perplexities encoutered in icteric patients. A detailed description of the etiology of obstruction and of operations for stones, tumour, stenoses etc. appears in the appropriate chapters.

First pointers during exploration in jaundice cases are usually provided by the gallbladder, the comon bile duct is the second guide. It is not good practice to start immediately with bile duct exploration in which the obstacle "must" be found somewhere. It is the appearance of the gallbladder which might on occasion resolve our perplexities, if obstruction cannot be discovered or if its cause or nature appears uncertain.

A. Greatly distended gallbladder and main bile duct, thin-walled and transparent, containing colourless "white" bile is the classical Courvoisier sign of malignant tumour in the terminal choledochus region. Puncture aspiration of bile is done, and by palpation, sometimes by cholangiography or duodenotomy, the site of origin is ascertained and its resectability examined. Most often malignancy arises from head of pancreas or papilla and its neighbourhood, more rarely from choledochus itself or duodenum. *Fig. 187.*

In all these cases the neoplasm can sometimes be removed by cephalic pancreato-

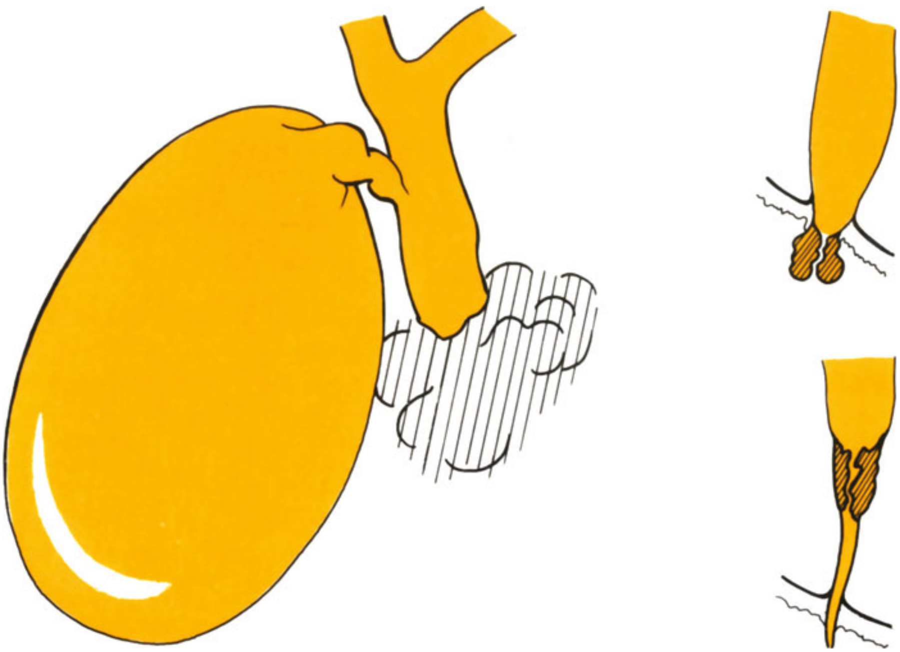

Fig. 187: Dilated bile duct and distended thinwalled gallbladder (Courvoisier's sign) in neoplasstic obstruction: (a) Pancreatic, (b) ampullar, (c) choledochal growth.

duodenotomy. In advanced jaundice only gallbladder drainage is performed, as a rule, suspicious lymph nodes removed for histology and radical surgery attempted after subsidence of jaundice. External drainage through a separate incision is less troublesome during the second stage, than the performance of an anastomosis. Only rarely can such an exacting procedure be done whilst jaundice is present, and then only if it does not overtax the patient's strength and the surgeon's experience.

In benign tumours of the papilla, or in unrecognized early cancer, papillectomy is adequate.

If the malignancy is obviously inoperable, it is by-passed by an anastomosis, or in excessive risk cases decompression is done to alleviate the suffering of the patient whose days are in any case numbered. Anastomosis is performed most easily between gallbladder and stomach, which is acceptable considering the limited life expectancy. Choledochoduodenostomy would not improve matters. If duodenal obstruction threatens, gastroenteroanastomosis is performed immediately (Omanik).

B. If an enlarged gallbladder and dilated choledochus are found, whose walls are thickened, opaque, and sometimes filled with palpable stones, and the main feature is an enlarged and indurated head of pancreas, such a situation favours obstruction by stone and chronic pancreatitis. *Fig. 188.* If the tumour palpated in the head of pancreas is discovered to be a large stone impacted in the

Fig. 188: Dilated bile duct and distended thickened gallbladder: (a) Due to compression of duct by chronic pancreatitis, (b) due to its obturation by stone.

pancreatic choledochus segment, this must not be left or by-passed by an anastomosis, even though removal may be difficult. The former procedure would be wrong, patients experience pains, attacks of pancreatitis and cholangitis. Least traumatizing is removal of the stone by transduodenal incision (p. 239), followed by management of the patient as a candidate for acute postoperative pancreatitis.

To distinguish separate chronic lesions of the head from tumour is usually even more difficult. The author operated 276 carcinomas of head of pancreas during jaundice, but in 36 cases it was found later that lesions were of an inflammatory character. On the contrary, out of 632 benign cases of jaundice, the opposite error was committed in 13 cases, malignant tumour of pancreas not being recognised at operation. Impressions conveyed by palpation cannot be relied upon, appearance of the vicinity must be noted, history taken into consideration as well as radiology, and peroperative biopsy utilized. If dissemination of tumour or ascites are present, diagnosis of cancer is established, but in the absence of propagation even the experienced surgeon may be deceived.

Previous biliary or pancreatic episodes favour chronic pancreatitis, so do lower age, sometimes pains at the onset of jaundice and its fluctuations, as well as the presence of stones and inflammation in the ducts. Palpation of the pancreas in inflammation usually shows greater variety, and sometimes cysts and calcifications are suggested. Diffuse browniness or thickening of the peritoneum may be particularly characteristic, spreading continuously from the head of pancreas into the surrounding tissues and particularly traces after Balser's necroses. — Other findings and ancillary methods do not contribute decisively and may even lead astray. Cholangiography may reveal that duct dilatation proximal to benign tubular pancreatic stenosis does not commence suddenly and does not attain the same width as in growth. This is apparently due to the reduced compliance of duct walls and its vicinity resulting from previous inflammation.

Peroperative biopsy is not always reliable. Negative biopsy of node or pancreatic specimen obtained by ordinary or bioptic needle or by excision cannot

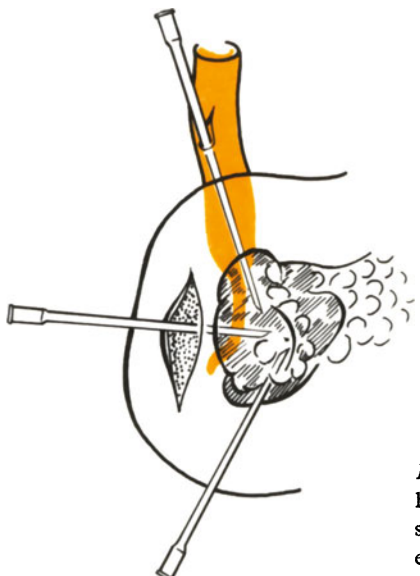

Fig. 189: Operative biopsy from head of pancreas by a needle inserted into the suspected tissue either directly or via duodenotomy or via the common bile duct.

exclude tumour and in one instance we were deceived by a false positive result from a quick-frozen section. Biopsy likewise is not entirely without risk, and the routine procedure with a wide needle or by excision is frequently hazardous *Fig. 189*. It is, therefore, best to perform puncture through the posterior wall of the opened duodenum, and to use a fine needle (as recently recommended by Kline, 1977). In a series of 36 carcinomas accuracy was attained in 94%, and there were no false positive results.

In pancreatic stenosis in which inflammatory lesions of pancreas are believed to be recent and are still reversible, merely a T-tube may sometimes be introduced. However, in most chronic lesions affecting jaundiced patients the performance of an anastomosis is preferable, though never of cholecystogastrostomy, even if tumour was suspected. — Radical duodenopancreatectomy for chronic pancreatitis of the head with chronic complaints and excruciating pains is never undertaken during jaundice, only after the patient has recovered following biliary drainage.

C. The most common finding in obstructive jaundice is a stone filled gallbladder chronically inflamed or a contracted gallbladder, not infrequently empty. Both suggest that the cause of jaundice are s t o n e s i n t h e p a s s a g e s. *Fig. 190.* The choledochus is usually dilated, its walls thickened and the bile cloudy. Pancreas in

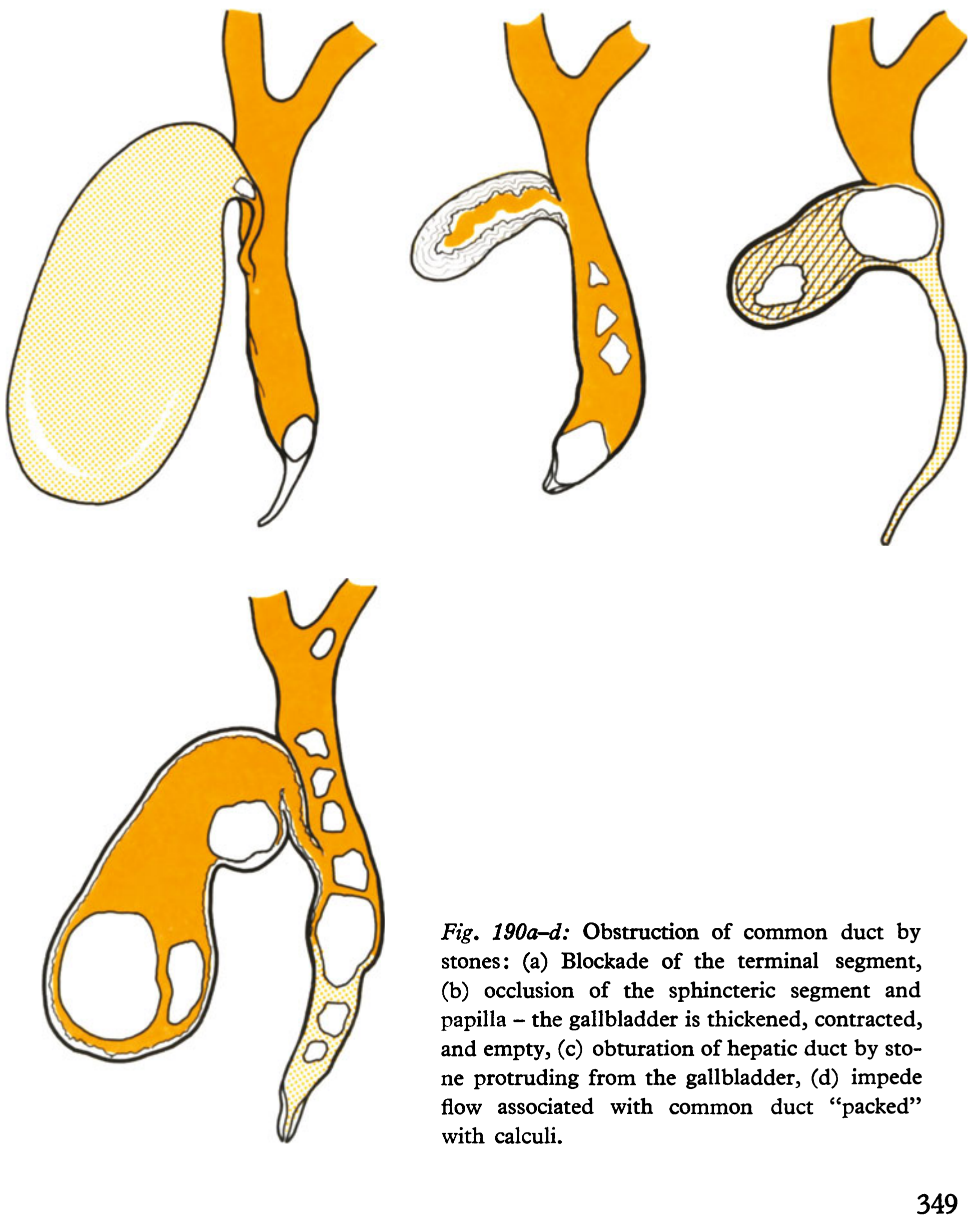

Fig. 190a–d: Obstruction of common duct by stones: (a) Blockade of the terminal segment, (b) occlusion of the sphincteric segment and papilla – the gallbladder is thickened, contracted, and empty, (c) obturation of hepatic duct by stone protruding from the gallbladder, (d) impede flow associated with common duct "packed" with calculi.

its immediate neighbourhood may be firmer, but is not grossly pathological. The stone causes jaundice most often by blocking the terminal choledochus or papilla, as frequently the latter is also stenosed. *Fig. 191.* It may, however, be plugged by a large stone even supraduodenally, or "paved" with calculi right up to the hepatic

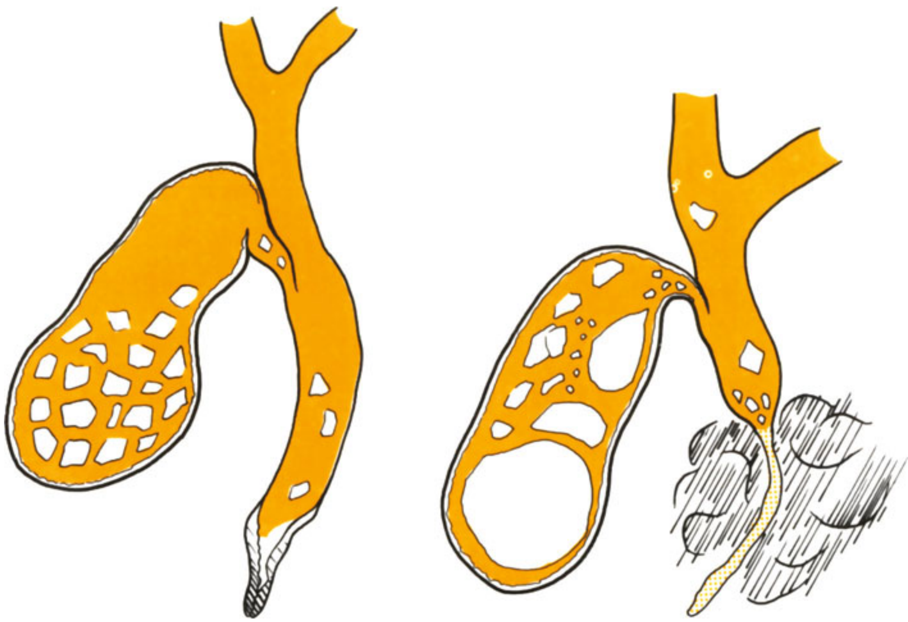

Fig. 191ab: Combined main bile duct obstruction: (a) By stones and stenosis of the papilla, (b) stones and pancreatic stenosis.

ducts. In such cases, however, obstruction is mostly incomplete. Operative radiology as well as palpation and probing provide the best information about the situation.

Operations for jaundice due to stones do not differ materially from the procedures described in the chapter on choledocholithiasis. They consist of cholecystectomy, perfect clearance of the ducts, possibly with PST or anastomosis. The latter is advisable for major dilation of the duct and in reoperation.

D. Sometimes jaundice occurs in acute cholecystitis. The gallbladder is found to be distended, but bile does not stagnate distally from the cystic duct, and the common bile duct and papilla are patent.[25] Compression of the main bile duct or cholestasis induced by toxi-infectious action on the liver may be concerned. In the first case, in the writer's view, the inflamed gallbladder or its neck containing a stone — because its short mesentery and adhesions prevent any shift — not only press on the hepatic duct, but also induce swelling, resulting in closure. *Fig. 192.* In the second eventuality no genuine, surgical obstruction is present. Similar cases still await an explanation. It is a fact, that here and there, protracted jaundice with obstructive features and acute cholecystitis without duct dilatation is relieved by cholecystectomy with rapid regression of the jaundice.

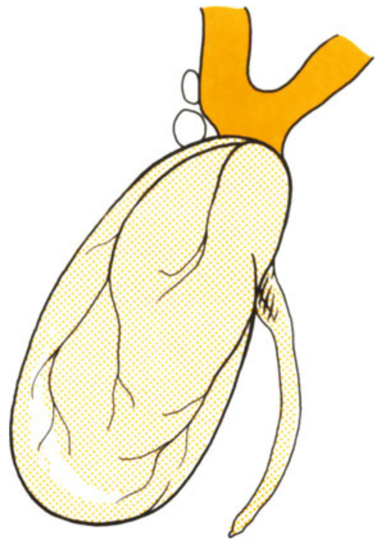

Fig. 192: Compression of hepatic duct by an acutely inflamed gallbladder and an inflammatory paraductal infiltrate.

Cholecystectomy is indicated in any case on account of the acute inflammation, in addition a thin drain is inserted via the cystic duct into the bile duct for post-operative checks, liver biopsy and bacteriological investigation of bile not being forgotten.

E. A hard gallbladder with whitish infiltration may be encountered in obstructive jaundice, and signifies neoplastic involvement. Jaundice is caused by its spread along the cystic duct into lymph nodes, invasion of hepatic duct and hilus, and metastases in the liver may also participate. In some cases of gallbladder carcinoma, usually associated with lithiasis, jaundice may actually be due to simultaneous obstruction by stone. Otherwise, however, if caused by spread of cancer, relief may only be provided by intubation of the neoplastic stenosis.

F. In operations for obstructive jaundice the surgeon occasionally encounters a limp or chronically inflamed gallbladder and simultaneously with a bile duct which is not dilated and is empty. This means that the obstacle must be higher up in the hilus. If this is really a case of mechanical jaundice, the common hepatic duct or its bifurcation must be involved, obturation of one branch is not enough as a rule. To ascertain the character of the obstacle high up in the hilus is often difficult even during dissection. Cholangiography is most informative, provided contrast medium penetrates beyond the obstacle, or this may be injected transhepatically into a dilated intrahepatic branch. It is of the greatest advantage if this investigation has been done already before operation. Tumour located at high level may be concerned, less often stone with inflammation, and quite rarely — in primary operations — a congenital or inflammatory stenosis, compression by hydatid cyst etc. In reoperations one has to consider postoperative stricture. *Fig. 193.*

The hilus may be packed with firm masses resembling cancer. Later it may transpire, however, that these were really inflammatory infiltrates of large extent,

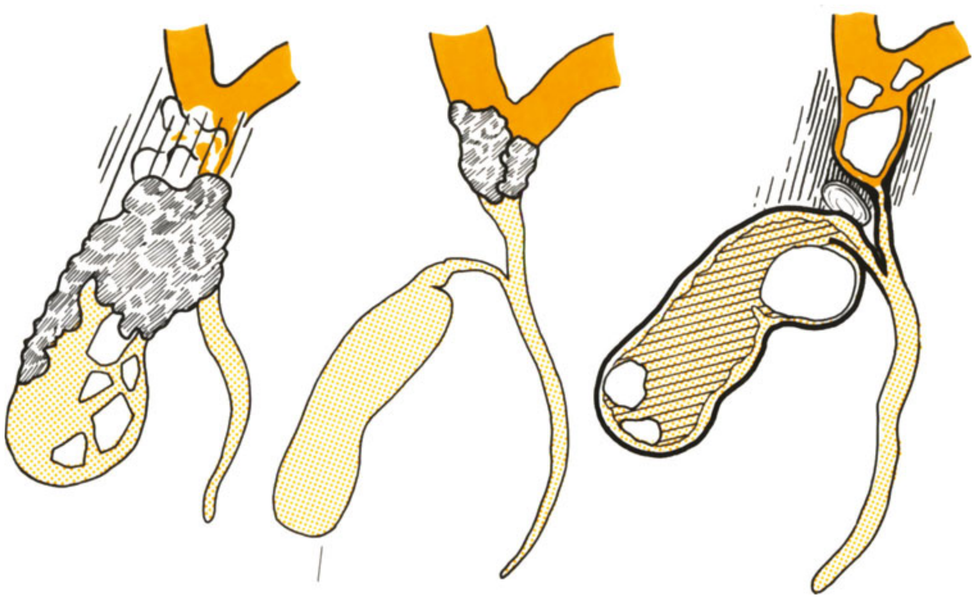

Fig. 193 abc: Obstruction in hilar region: By gallbladder tumour (a), by hepaticus tumour (b), by stones, inflammation, and adhesions (c).

with fibrous tough adhesions in the vicinity of a stone impacted in one of the hepatic branches. Three such patients have been operated by the author, no other alternative being open than intubation drainage. Histology failed to disclose cancer, and only postoperative radiology revealed stones in the hepatic ducts, not demonstrated by operative cholangiography. Reoperations 4–6 weeks later showed marked regression of inflammatory lesions, and the stones could be removed. Similarly, certainly exceptional cases prompt us to consider, in the presence of obstruction by a "neoplastic" mass in the hilus, also the possibility of infiltrates surrounding stones in the hepatic ducts.

Still more difficult is the differentiation between congenital and inflammatory stenosis, and in particular, the distinction between sclerosing cholangitis and scirrhous tumour of the hepatic duct. Sometimes even histology fails us and only the further course provides the answer. It is these hilar obstructions which emphasize the value of detailed preoperative investigation, which determine the site of the obstacle and its character. Thus not only the patient, but also the surgeon is better prepared for an exacting intervention.

Such a stenosis or hepatic duct tumour, if resectable, may require a hilar or even intrahepatic anastomosis of ducts with jejunum, in cases of postoperative stricture one of the plastic operations or long-term transhepatic intubation.

G. Amongst parasitic diseases oriental icteric cholangitis is encountered only exceptionally, but obstruction by ascaris may be met. This is a sporadic event, clearance of ducts must be performed, further management of the case is left to the internist.

Jaundice due to echinococcus is also a possibility. It is caused by cyst pressure on ducts in the porta hepatis, but may also be induced by their sudden flooding with the contents of a ruptured cyst.[16, 30, 40]

Jaundice due to duct compression occurs in only about 5–9%, because cysts are located mostly in the right lobe. If they happen to be in the central portion of the liver, compression of ducts is a possibility, and so is compression of hilar vessels producing posthepatic portal hypertension.

Jaundice due to cyst rupture, according to literary data, is somewhat more common, up to 18% of cases. The tear may be largish, but may also measure only a few millimetres and the cyst ruptures because the internal pressure is much higher — up to 120 cm H_2O — than intraductal pressure. Its contents are completely or only partially evacuated and cause obstruction by hydatids, as well as by oedema or spasm of the sphincter of Oddi (Kourias). Sudden rupture is heralded by colic, jaundice and fever, the latter being allergic or due to infection of stagnant bile. As pressure in the cyst declines and rises in the blocked duct, infection may spread into the original cavity and a hepatic abscess created.

The cause of jaundice may be suspected before operation when hydatid disease is known to exist; however, some such patients have no liver enlargement, no eosinophilia, negative tests — the true nature of the obstruction is detected only at operation. The hydatic cyst must be excised, or it must be reduced in size and drained. Simultaneously the flooded ducts are cleared and free bile flow restored. Tagliacozzo (1974) recommends sphincterotomy as a supplement to prevent biliary fistula which might develop after cyst removal.

H. Urgent surgery in jaundice cases must be mentioned too. This is not motivated by its acute emergence, but by the fact that a sudden blockade is accompanied by septic cholangitis, acute pancreatic necrosis or shock producing "papillary" ileus. The grave condition forces us to forsake some of the investigations, orientation at operation must be rapid, and sometimes temporary T-tube decompression must suffice.

I. A different matter are reoperations during jaundice, where there is time for proper preparation and an endeavour is made to perform definitive surgery. The appearance of the main bile duct provides no reliable guidance, as it may be altered, in particular dilated, since the first operation, or enclosed in adhesions. Diagnosis is decided mainly by palpation, radiology and instrumental exploration. Causes of jaundice are similar as in first operations: stones, stenosis, tumours, — but tumours recede in order of frequency and new types of

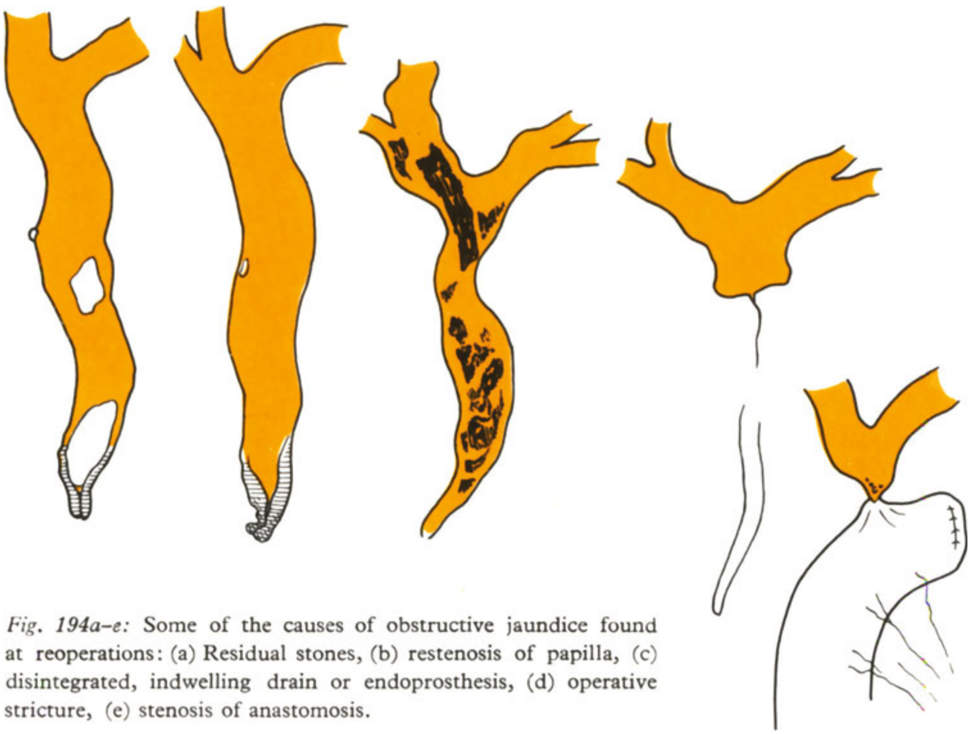

Fig. 194a–e: Some of the causes of obstructive jaundice found at reoperations: (a) Residual stones, (b) restenosis of papilla, (c) disintegrated, indwelling drain or endoprosthesis, (d) operative stricture, (e) stenosis of anastomosis.

obstructions appear, particularly operative strictures and stenoses of biliary anastomoses. To-day it is quite exceptional to find — as a cause of jaundice — a disintegrated indwelling drain or endoprosthesis. *Fig. 194.*

K. In some operations, particularly those embarked upon from uncertainty about the obstructive character of jaundice, it happens that no particular lesions are found in the biliary tract, or slight dilatation but with tonus maintained lacking signs of stagnation. *Fig. 195.* If even cholangiography fails to disclose an obstruction hidden in the liver, nonsurgical jaundice must be assumed. Liver appearance sometimes suggests its presence and biopsy is performed. In the case of the 20 erroneous laparotomies (1.3% of cases in the author's series of 1 463 biliary operations for jaundice) biopsy most often showed infectious hepatitis and cirrhosis.

It is no mistake, if in such a case a tube is placed in the choledochus for draining off all bile and for postoperative checks. Views differ about the therapeutic value of periarterial sympathectomy of hepatic artery. The author has not used it.

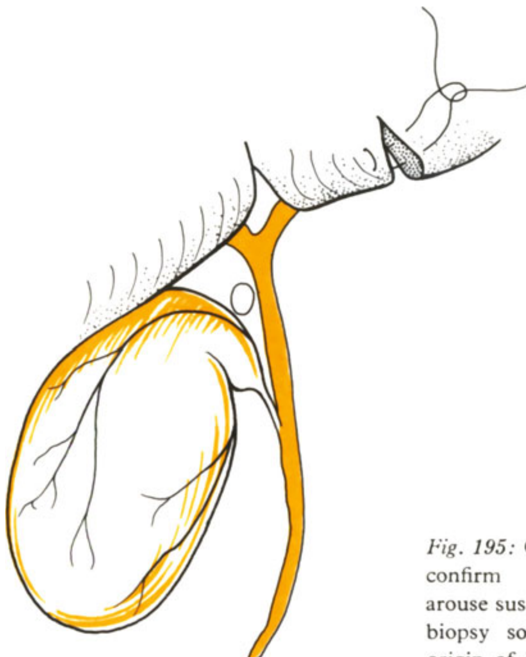

Fig. 195: Operative findings fail to confirm surgical jaundice and arouse suspicion of hepatitis. Liver biopsy sometimes elucidates the origin of jaundice.

L. Rarely it happens that at operation during pronounced jaundice of an obstructive character no mechanical obstacle is found in the ducts despite detailed exploration. This occured in 19 cases out of the author's series (1.3%). Ducts appeared dilated but patent and the cause of obstruction remained obscure. Gallbladder findings varied and calculi were not always present. Papilla or pancreas may show minor signs of inflammation, in other cases markedly enlarged lymph nodes may be found along the main bile duct, some of which may show up as impressions on the contrast filled duct. This may tempt us to think that jaundice is due to inflammatory stenosis or common duct compression. The possibility of congenital dilatation of the main bile duct, either fusiform or diffuse, has also to be considered. But as a rule we believed that before or during operation a stone was mobilized and passed, the jaundice being a sign of slow recovery of liver cells following protracted cholestasis of mechanical origin.

In such a situation all methods of exploration have to be exhausted, including duodenotomy and choledochoscopy, and if negative, a final conclusion should not be reached until after biopsy and the result of postoperative cholangiography via T-tube.

If the cause of jaundice remains obscure even then, explanation causes embarassment. In some cases spontaneous passage of stones might apply, some remain unexplained, and the author, wishes to underline the need for obtaining a cholangiographic image of the obstacle already before operation.

Tactics and technique of surgery during jaundice

This does not differ materially from operations and reoperations of patients without jaundice, and it is sufficient to make only some general comment on matters of principle.

As far as the gallbladder is concerned, the principle applies in jaundice cases that its removal should not be undertaken, even if it is pathological, before it cannot be excluded that it may have to be used for cholecystostomy or for an anastomosis. — If a small, shrunken and empty gallbladder is found, and operation during jaundice must be speedily completed, the gallbladder can be left and operation limited to the ducts. In 19 cases of the author's series no harm resulted from this. — If in acute cholecystitis jaundice is believed to be due to duct compression by the distended gallbladder, or is not of a mechanical character, exploration of the duct, nevertheless, must not be omitted.

Stone removal in icteric patients must be painstaking and should not be limited merely to the relief of obstruction. Operation should not be unnecessarily prolonged, however, by unsuccessful attempts to clear poorly accessible calculi from the sphincteric region, papillotomy is undertaken in due course. Similarly attempts at the exacting extraction of calculi from subsidiary proximal hepatic branches are abandoned, and their passage ensured by a wide anastomosis. The latter is also frequently used to terminate intervention in the presence of a grossly dilated choledochus, or in stenosis of the papilla, which though not necessitating PST is not reliably reversible. — The condition of the icteric patient may be so serious that even performance of an anastomosis appears too daring. Decompression by external drainage is done in such a fashion as not to interfere with the second stage of definitive surgery.

Choledochus drainage, either direct or via the cystic duct, forms the last step of all finished interventions excepting anastomosis. Primary choledochus closure after operations for obstructive jaundice is not advisable. Drainage is an excellent aid in protracted cholestasis and is harmless even in nonsurgical cholestasis.

In reoperations loss of time for mobilization of adhesions and dissection of choledochus must be taken into account. This, though partly outweighed by the fact that cholecystectomy has already been done, is still significant in the event of high level hilar stricture, fistula or stoma stenosis. Time saving procedures are used for hilar obstruction in icteric patients, and some ingenious but complicated plastic operations are best avoided. However, despite this, the patient must be completely rid, if possible permanently, of his obstruction. Half-measures directly endanger the patient's survival. The approach to the hilus may be so laborious that a suggestion to interrupt operation and finish it during a second stage is tempting. However, dissection is hardly likely to succeed a second time, and, if already accomplished, it might be less risky for the patient not to temporize even if the operation is highly exacting.

Matters are different if after entering the abdomen, threatening hemorrhage from venous plexus is encountered due to advanced portal hypertension: intervention is abandoned, but this is done right at the start. Only bile drainage measures are feasible, and a return to reoperation of bile duct will follow surgical treatment of portal hypertension (p. 99).[31]

It is clear from the foregoing that icteric patients for whom operation is expected to be exacting should be admitted to specialized centres.

Surgery in jaundice requires rapid decision and gentle procedures, but this does not signify undue hurry or fear of complicated dissection and radical intervention in every case. Sometimes the patient may be saved by selfrestraint, sometimes by deliberate and systematic, even daring operation in the face of far advanced jaundice and threatening hepatic and renal failure.

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BILIARY FISTULAS AND ANASTOMOSES

Biliary fistulas arise from a variety of reasons and are of two types: – external, when the fistula from the biliary tract opens externally through the skin, – internal, connecting the biliary passages with some part of the digestive system, more rarely with another bile passage, and exceptionally with another viscus or body cavity.

Both types of fistula are subdivided according to their origin into three main groups:

- Spontaneous, arising on a pathological basis or following a trauma,
- postoperative, persisting after drainage or originating through some surgical error,
- artifical i.e. surgical, created deliberately by operation (stomata, anastomoses).

External Fistulas

Spontaneous Fistulas

These biliary fistulas, originating through inflammation, growth or traumatization are very uncommon.[28]

An inflammatory fistula may arise from the direct perforation of a far advanced gallbladder empyema through the abdominal wall, or indirectly by abscess perforation associated with suppurative calculous cholecystitis. Spontaneous perforation through the abdominal wall should be prevented by incision and drainage, or by emergency cholecystostomy. Inflammation is relieved by drainage, suction and antibiotic lavage. Fistulography is attempted later and, according to its result, cholecystectomy is performed with appropriate treatment of the bile ducts.

Neoplastic fistula may be produced by penetration of the abdominal wall by gallbladder cancer, usually with inflammatory participation. In such fistulas the growth is, as a rule, far advanced and its removal is unlikely. It cannot, however,

Fig. 196: Recurring external biliary fistula after penetrating gunshut wound of liver and after surgical explorations in 21-year old male patient. Fistulography: The fistula leads into the right lobe and fills the biliary tree including hepatic duct. Common bile duct compressed by adhesions, with stones in front of stenosis. Visible gallbladder shadow and subcutaneous deposit of contrast material near the fistula.

be a priori excluded, though such an operation could scarcely be sufficiently radical. Mostly, however, the fistula surroundings are protected by ointment, fistular contents suctioned off, deodorized and antibiotics instilled into the opening. Analgesics are used unstintingly, as the condition is usually painful.

Traumatic fistula represents more of a theoretical possibility. It could be caused by open abdominal injury or by a closed injury which had to be treated surgically. The source and mode of repair of the fistula could be decided by fistulography. *Fig. 196.*

Postoperative Fistulas

Postoperative fistulas are not a common occurrence, either following injury to the biliary passages during operation, or due to some error of technique or tactics, most frequently if we have failed to ensure free bile flow into the gut by the operation. The fistula appears usually immediately after operation, rarely within a few days.

Following cholecystectomy biliary secretion may sometimes be observed from the subhepatic drain, due to several reasons:

- Bile oozes from a lacerated liver bed, particularly if not covered by peritoneum or if a small aberrant bile duct was torn there. Secretion stops after a few days and usually the term "fistula" is not even used.
- More copious secretion arises from a remaining portion of the gallbladder which could not be removed completely. If proper drainage has been maintained, the fistula closes spontaneously provided, of course, that bile flow into the gut is unimpeded.
- Bile flow can be due to a slipped cystic duct ligature. With ligation and through suture of the stump such an event has not been experienced by us. Bile would commence to drain soon after operation and abundantly, and probable bile leakage into the abdomen makes surgical revision an urgent matter (p. 490).
- Finally, even simple cholecystectomy might be accompanied by injury to the main bile duct, this will be discussed later (p. 476).

Following choledochotomy, papillotomy or creation of an anastomosis fistula sometimes develops, because of dehiscence or oozing through sutures of the bile duct or intestine, or due to postoperative pancreatitis. One must make sure whether it is only bile that flows or whether duodenal contents, possibly pancreatic secretions are present. Each case must be managed on its individual merits.

Where perforation has occurred soon after operation peritonitis is a real danger, and the patient will more likely be saved by immediate reoperation than by expectant treatment (p. 490). If this is a late complication when adhesions have already formed, a cure can better be achieved by permanent suction drainage and aspiration of stomach contents. Such a type of fistula requires painstaking care of the skin surrounding the fistula and drains and in particular if pancreatic secretions are present.[43] Prevention and treatment of skin lesions accompanying pancreatic fistula or with an admixture of pancreatic secretion consists in its permanent removal by suction connected with irrigation of the wound and surroundings with a lactic acid solution (4.5 g lactic acid per 1 litre saline solution, with the addition of isotonic bicarbonate solution, adjusting pH to 4.5–5). This sterile solution is applied by drip infusion to the fistula or its orifice by a thin plastic drain and simultaneously suction under a slight negative pressure is applied through a second tube in order to remove secretion and irrigation fluid. Protective ointment is applied to the wound edges and a canopy erected over the fistula which is covered by a sterile pack to allow for ventilation. An excellent protection of damaged skin may provide wafers of Stomahesive (gelatin, pectin, sodium-carboxymethylcellulose, and polyisobutylene) which are not allergenic.[22] It is necessary to measure the amount of fluid supplied and drawn off by suction so as to know the losses due to secretion, and to follow continually any disturbances of homeostasis and its adjustment by parenteral nutrition.

Sometimes an external bile leakage persists after removal or slipping out of the tube from the bile duct, — should bile flow into the gut remain obstructed.

Likewise bile secretion may persist from a subhepatic drain which was used as an emergency measure in biliary peritonitis. In all these instances further management is guided by fistulography or some other radiological investigation.

True post-operative biliary fistulas

As such are designated iatrogenic fistulas originating through damage or real injury to the common duct during the operation. They are amongst the most dreaded. There are only few complications following biliary surgery with which surgical experience is so limited, as is the case with these fistulas.[32] If they are incomplete there is always a tendency to spontaneous cure, but as a rule even complete fistulas close at least intermittently. This does not signify that the patient has been effectively cured. On the contrary, he is usually permanently affected by an emerging stricture which, sooner or later, draws attention to itself by symptoms, usually due to common duct obstruction or cholangitis, and necessitates surgical revision (p. 522). Serious surgical problems are posed by external fistulas soon after operation in case they are permanent or recurrent. This is true particularly if they are associated with duct obstruction or in complete fistulas which can be cured only by a second, frequently difficult operation. They are rare however.

Reoperation had to be done in 14 of our patients with persisting external fistula following surgical injury. This corresponds to 0.25% of biliary operations for non-tumorous disorders and to 3% of all elective reoperations.[27]

What injuries produce such permanent biliary fistulas?

According to our personal experience and that of other authors, this is usually either ligation or complete division of the common bile duct or right hepatic duct, either by their strangling or through sewing.

Damage arises mainly in two situations:

- Inadequate exposure of the operation area, when the severely altered gallbladder adheres to the main duct or opens into it widely, the duct being mistaken for the cystic duct.
- Hemostasis in the neighbourhood of hepatic duct, particularly in blind application of suture-ligation in which the duct becomes entrapped.

If an injury is recognized during operation, the damage must be repaired at once, flawlessly (p. 480).

It happens not infrequently that the surgeon is not aware that the duct has been damaged. Such an injury, even though a minor one may, by its consequences, be more significant than a major one which is recognized immediately. Unrepaired damage announces itself by dramatic symptoms, which usually lead to early reoperation. Compared with the first intervention, however, conditions may be much more difficult. The question must be considered whether duct injury can be safely repaired by definitive surgery at once or whether tiding over the danger by preliminary drainage is to be preferred, reoperation being undertaken later when the tissues are no longer fragile and brawny.

Evidence of the failure of such early surgical revisions is a series of 21 patients in whom repair was attempted elsewhere during the early period after trauma but later proved ineffective. Most often stenosis of the anastomosis or of the reconstructed duct occurred, sometimes fistula recurred, and some patients were submitted to repeated reoperations. They were admitted already stigmatized by the first surgical traumatic experience. In such cases operation is not merely performed for external fistula, but for the failure of attempted repairs. As a rule only a high hepatico-jejunal anastomosis brought relief.

If a fistula forms after biliary surgery, two questions must be answered. It is necessary in the first place to investigate the anatomy and type of fistula by fistulography, and secondly the surgeon must make a decision on when to reoperate.

Protracted large biliary fistulas not only damage, but even endanger the patient, often not only by massive bile loss and its shortage in the intestine, but sometimes also by concurrent intermittent obstruction. The stools may be almost acholic, calcium and lipid metabolism may be impaired, erythrocytes or even blood as a whole may be reduced. The patient is weak, weight loss is common. Continual oozing of bile keeping the patient in bed and requiring constant adjustment of drains and dressings leads to depression. Sometimes signs of biliary infection and cholestasis are added and produce liver damage.

It may thus appear advantageous to eliminate the fistula as soon as possible. However, if repair of the damaged ducts has not occurred after the intervention, reoperation for fistula should preferably be undertaken only after its "maturation". We were able to confirm that an interval of a fortnight, frequently due to nervousness, is inadequate, but that it paid us to delay reoperation for several months.

Treatment

In acute stage of fistula bile loss must at first be compensated by water and electrolytes. The composition of the bile resembles that of plasma without proteins. — In chronic fistula adaptation of the organism to these losses is surprisingly good and compensation for bile acids liposoluble vitamins is more important. It is highly problematical whether ox bile should be administered, or the collected bile refunded by stomach tube. If reoperation has to be delayed for many months, returning the bile by external enterobiliary anastomosis should be considered (p. 406). Recovery following such an extracorporeal anastomosis is striking, but despite all this the patient must be well prepared for operation with proteins, glycids, vitamins and antibiotics, a watch being kept for possible anemia and transfusions given if required.

Reoperation should be performed by a higly experienced and patient surgeon. Even with the assistance of fistulography and after instillation of coloured solutions into the fistula it sometimes proves extremely difficult to find it at operation and to get a clear view of the course of the biliary tract as a whole. Even though bile has been previously draining freely through the fistula, in consequence of the intervention no bile may flow during the operation. Its secretion during operation may be increased by an injection of Decholin^{R} (cca 10 ml) and bile may also be stained to advantage by an intravenous injection of indocyanine green. An attempt has also been made to delineate the ducts by the intravenous injection of patent blue, but the result was not impressive.

The operation proper depends on the circumstances encountered. The main duct stump can sometimes be mobilized and divided above the fistula orifice, which is always carefully resected. As a rule a high hepatico-jejunal anastomosis has to be done, sometimes even in the porta hepatis. In other instances the left hepatic duct has to be exposed transhepatically. Priority must always be given to the most accurate repair even at the price of prolonging the operation, otherwise the patient will return with a stenosis. Such operations are delicate and may last as long as 5 hours.

Prognosis

Results of operations for chronic fistulas following surgical injury are not hopeless. Out of a personal series of 14 cases 2 died from pulmonary complications. A definitive cure of the fistula was achieved in 10 patients by the first operation. In the remaining 2 cases a second operation was required. Eleven patients from this series were followed-up for 4–23 years. In all of them the fistula had completely healed, one had occasional symptoms of cholangitis, apparently due to stenosis, while the remaining ten patients had remained asymptomatic.[27]

Apart from these patients a follow-up is being done on another 21 cases reoperated after previous repair of fistulas performed elsewhere. Their complications most commonly displayed the features of intermittent obstruction from stricture of the stoma. Repair of such a stenosis is no less exacting than repair of a persisting fistula and 4 out of the 21 patients had already undergone 5 reoperations. This shows how patients with an external biliary fistula originating from surgical injury are stigmatized for long periods and how great is the surgeon's responsibility in the prevention or treatment of this grave complication from the very start.

Artifical External Surgical Fistulas

Cholecystostomy and choledochostomy or hepaticostomy have already been dealt with (p. 137).

Internal Fistulas

Internal fistulas, according to their origin, are subdivided similarly to external fistulas, into three groups. In contrast to external fistulas, internal fistulas due to operation injury are negligible in number.

Spontaneous Fistulas

We designate as a spontaneous internal biliary fistula any unusual, pathological communication between the bile ducts and some part of the intestinal tract, more rarely between bile ducts or most rarely with another viscus or body cavity. *Fig. 197.*

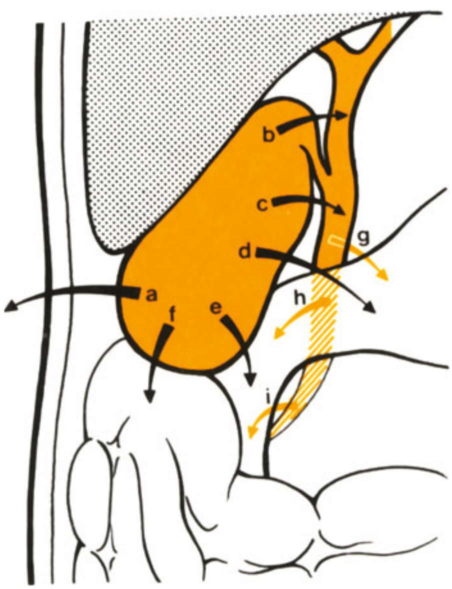


Fig. 197: Spontaneous biliary fistulas. External gallbladder fistula (a). – Internal fistula: cholecysto-hepatic (b), cholecysto-choledochal (c), cholecysto-gastric (d), cholecysto-duodenal (e), cholecysto-colic (f), choledocho-gastric (g), choledocho-duodenal (h), (i).

Lithiasis is at the root of most, about 87% of cases, a small percentage is due to peptic ulcer penetration or disintegration of a malignant growth, and exceptionally to other diseases such as pancreatitis, regional enteritis or accidental trauma.

A majority of authors publish similar figures regarding the relative incidence of the different causes of fistula formation[4, 15, 29, 30, 31]

Cause of fistula	Noskin	Lapeyr	Charvát	Niederle
Lithiasis	90%	66%	83%	87%
Peptic ulcer	6%	23%	7%	5%
Tumour	4%	8%	9%	6%

Internal spontaneous fistulas are decidedly uncommon, but not, however, rare. Most frequently they are detected at operation on the biliary tract and they were encountered by the author in 111 cases out of a series of 6 150 operations undertaken for non-tumorous biliary disease. Fistulas thus amounted to 1.8% in this material, a rate corresponding to literature data. Internal biliary fistulas due to lithiasis are on the increase, apparently because of the increasing number of lithiasis cases and together with a lengthening of the patients' life-span.

Fistulas originate most often in the gallbladder. In the author's series gallbladder fistulas represent a full 94%, common bile duct participating in 5%, and hepatic duct 1%. Amongst multiple fistulas cholecysto-duodeno-colic ones are more common, and cholecysto-gastro-duodeno-colic less frequent.

Corresponding to topographic relations of the subhepatic regions, biliodigestive fistulas opening into the duodenum predominate — 70%, followed by colon — 13.5% and stomach in 11%. Bilio-biliary fistulas between gallbladder and bile duct were recorded in only 5.5% (Kazda and Niederle). Data of other surgeons do not differ substantially as regards types and numbers of fistulas. Some kinds of fistula occur quite sporadically, and for this reason alone they might be serious, as their existence is not taken into account. Such fistulas were described with the esophagus, small intestine, appendix, sigma, fistulas communicating with the pleural cavity, bronchus, pericardium, pancreatic duct or pseudocyst, hepatic artery, portal vein, renal pelvis, urinary bladder, vagina and uterus.

Biliary fistulas caused by stones

As early as 1556 the Spanish surgeon Ricardo was aware of the existence of unusual communications between viscera of the subhepatic region in cases of cholelithiasis.

Origin and evolution of fistulas

Biliodigestive lithiatic fistulas almost always originate from the gallbladder and their emergence is preceded usually by chronic calculous cholecystitis with pericholecystitis. A stone, usually a large one, erodes the wall by pressure combined with inflammation, and its penetration is often assisted by biliary stasis and by gallbladder contraction. Adhesions to neighbouring viscera prevent free perforation and the concretion escapes into the gut followed by the evacuation of part or the entire gallbladder contents. Smaller stones pass into the gut without special symptoms and the patient usually fails to note their presence in the stool. The intestinal passage of a large stone is troublesome and may produce intestinal obstruction, called "biliary" or gallstone ileus.

Fistula formation may bring relief to the patient, even though only part of the gallbladder contents was evacuated, and the fistula displays an immediate tendency to closure. The author's observed in 3 patients in whom a large stone was expelled into the bulbus duodeni, how the fistula closed even during a period when the stone was still passing through the adhesions and the intestinal wall. If the fistula remains open further stones might be evacuated through it, and on the other hand, regurgitation of intestinal contents may occur and produce inflammation. Even a completely evacuated gallbladder may become a source of repeated attacks of cholecystitis and a spontaneous lithiatic fistula needs thus not always terminate symptoms, but may complicate a case of cholelithiasis still further. This applies in particular to colic fistulas.

Clinical pattern and diagnosis

Recognition of fistula without operation is difficult and was successfully accomplished in only one-fifth of our cases. Frequently the presence of fistula is not even suspected, as biliary fistulas do not present specific symptoms. The clinical picture is always that of the basic disease, i.e. biliary lithiasis. It may, however, in addition, be complicated by some manifestations of the fistula during its inception or if it remains open.

Manifestations of incipient fistula

The development of fistula may be overshadowed by uncharacteristic symptoms; more frequently, however, a fistula originates during one of the exacerbations of the basic disorder, or may manifest itself by the dramatic pattern of an acute abdominal emergency. Understandably enough, a possibility of fistula is considered as more likely in an elderly female with many years' history of severe lithiasis. In half the cases, accordingly, we find stones in the ducts and stenosis of the papilla in association with the fistula, while episodes of obstructive icterus often precede it. For this reason it is in elderly patients that fistulas are common, most of them occur in the seventh decade of life, and four times more frequently in females. Exceptions are possible: a fistula was found in a male aged 45 years, and sometimes preceding symptoms are short, possibly only six months.

As the fistula originates its borders may bleed,[9] such hematemesis accompanied by melena was only encountered in 4 cases out of 100 fistulas in question and its significance was understood only subsequently. — The same applies to a case of acute pancreatitis with which a fistula announced itself due to a stone impacted at Treitz's ligament. Exceptional was the case of a diabetic patient aged

50 years. His acute gallbladder empyema perforated into the duodenum which was followed by repeated attacks of massive melena. Urgent surgical revision disclosed the source of hemorrhage in aroded cystic artery bleeding into the cholecystoduodenal fistula.

The possibility of a fistula is certainly entertained in patients with protracted biliary symptoms who discover, following an acute colic, stones in the feces. — A reliable sign of fistula is biliary ileus, as a stone which obstructs the gut could hardly pass the papilla. Stones with a diameter of 2–3 cm are much discussed in this connection, as the smallest which may become wedged in the gut, and at the same time the largest which in sporadic, but verified cases managed to pass through the papilla. In the author's series of 41 cases of biliary ileus the diameter of the smallest obstructing stone was 3.2 cm, the others were larger and thus evidence for the simultaneous fistula.

Matters are different if obstruction in the pyloric region occurs, where the presence of biliary disease is not suspected. If in such a case the fistula is directed towards bulbus or stomach proper, a large sized stone or adhesions by themselves impede the passage to such a degree that typical signs of pyloro-duodenal stenosis make their appearance, and their biliary origin is not even disclosed by radiological investigation. The patient keeps vomiting, wasting sets in and he must soon be submitted to operation for impaired evacuation of the stomach (p. 373).

If formation of the fistula is followed neither by intestinal obstruction nor by pyloro-duodenal stenosis, further symptomatology depends on the fistula site and its continued patency, and naturally also on the evolution of the primary biliary tract disease.

Manifestations and fate of established fistula

Its presence will be suggested in cases where after a violent attack the character of complaints alters suddenly, either for the better or the worse.

Passage of the stones may alleviate pain or may lead to temporary cessation of painful attacks. If the event concerns a patient with persistently blocked bile duct, an open "functioning" fistula may constitute a desirable safety valve and the patient's previous symptoms are alleviated, and icterus generally disappears if the cystic duct is patent. Pains and icterus return, however, as soon as the fistula closes.

In other rare cases where the gallbladder has completely emptied itself, the fistula closes, the patient loses his symptoms and a spontaneous clinical "cure" results.

If the fistula remains open, reflux may cause attacks of acute cholangitis. This occurs particularly in colic fistulas, where acute infections arise. In these patients bile flows directly into the colon, and patients thus suffer in addition from diarrhea and malabsorption.

Ancillary investigations

Neither cholecystography nor biligraphy are capable of demonstrating a fistula conclusively, and as a rule not even the ducts are visible. On the other hand air

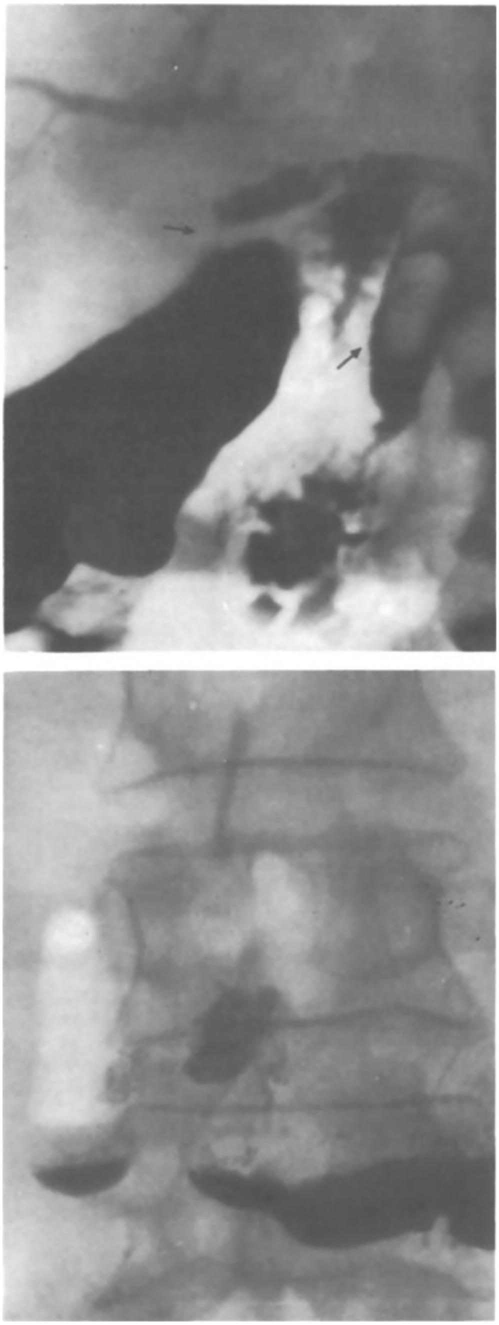


Fig. 198: Cholecysto-duodenal fistula (a): The gallbladder contains gas and a barium layer mixed with bile. Cholecysto-colic fistula (b): Retrograde endoscopic cholangiography revealed large stone in the common bile duct, contrast filling of cystic duct and gallbladder neck and, from there, via the internal fistula, massive filling of colon. No gallbladder shadow present.

in the biliary tract, visible even on the plain roentgenogram is a frequent and significant finding in biliodigestive fistula. It is present in about 6–10% of cases, but may be demonstrated more frequently if selective roentgenograms are made with the patient in the erect position.

Barium reflux through the fistula is direct, more accurate evidence of fistula, and may be achieved in as much as 70% of cases (Stull). A barium meal may thus succeed in revealing fistulas into the upper portions of the digestive tract, while colic fistulas are revealed by barium enema. *Fig. 198.* Neither barium nor air, however, need always penetrate into the fistula even in the course of selective investigations and negative results thus do not exclude fistula.

Endoscopic proof may be forthcoming with duodenal fistulas, and contrast medium can be instilled.[11, 16] In 2 personal cases with a cholecysto-duodenal fistula this was revealed during duodenoscopy by outflowing bile.

Treatment

Biliodigestive fistulas originating in lithiasis may heal spontaneously. This is the case if all stones have been passed, bile flow through the papilla is free and the gallbladder has shrunk to an insignificant remnant. In most cases, however, the primary biliary disease continues and the fistula still intensifies infection or causes the malabsorption syndrome, providing an indication for surgery.

Two types of surgery for fistula exist: urgent and elective. Emergency operation is done chiefly for biliary ileus (p. 454). Immediate removal of fistula, however, would be added only to operations for obstruction of pylorus or duodenum. Otherwise in more distal intestinal obstruction, the author does not advocate the immediate surgical revision of fistula during the present intestinal obstruction. Biliary surgery is indicated in these cases later, usually after two or more months, but only if the fistula persists, produces reflux and infection, or where symptoms are due to biliary lesions (remaining stones, intermittent or permanent duct obstruction etc.).

Elective surgery for fistulas is mostly advisable for the primary biliary disease itself, not exactly for fistula, which is frequently not even suspected before operation. This may make it seems almost superfluous to expend much effort in its diagnosis. The prior diagnosis of fistula, however, is of practical value: its presence makes the indication for operation stronger, patients can be better prepared, in particular in cases of colic fistula —, and finally, surgical procedure is more rapid and more assured.

Biliogastric fistulas. As a rule a communication between gallbladder and the pyloric region is present, and the reason for surgery is more usually impairment of stomach emptying rather than lithiasis. The fistula is discovered in most cases at operation and before this is undertaken ulcerogenic stenosis or tumour are suspected in a majority of cases.

Operation consists of removal of stones from the stomach and of cholecystectomy and fistula closure. Free outflow of bile into the duodenum is ensured, as well as adequate stomach evacuation. It is necessary for this purpose to perform additional pyloroplasty or a small eliminating resection in about 50% of cases. In an aged, cachectic patient a small gallbladder with fistula may be left and a GEA performed only.

Bilioduodenal fistulas. These are much more common and as a rule start off from the gallbladder, exceptionally from the bile duct. Stones passing through them produce intestinal obstruction in about 50% of cases. Lacking this complication fistula is diagnosed mostly at operation and in only 10% prior to it.

Intervention for cholecystoduodenal fistula is often hampered by adhesions and severe gallbladder lesions. We must also take into account that a fistula between gallbladder and colon or even with the stomach may coexist. Elimination of the fistula must proceed with caution, sharp dissection being carried out rather in the gallbladder wall than in the duodenum in order to preserve as much of the intestinal wall as possible. Operation is prolonged and complicated also by lesions of the papilla and stones in the ducts which have to be removed. The papilla is usually accessible from the duodenal defect and this is accordingly not closed before the former has been explored. Drainage by T-tube is always advisable.

If duodenal suture is awkward or narrows the intestine, the latter ought to be excluded by a limited gastric resection.

It has been stated already that in emergency operations for biliary ileus exploration and operation of the biliary fistula should not be performed simultaneously. — A different approach is, however, required in cases where the gallbladder stone penetrates the bulbus duodeni, becoming wedged, and rather passing into the stomach than advancing through the duodenum, which is usually compressed by the stone lodged in the gallbladder. In reality this is a special type of pyloroduodenal blockade and operation is performed for a pattern of pylorostenosis. This was the radiological diagnosis made in 4 of our patients. We believed that it was due to an ulcer, and in one case due to a large polyp, but this turned out to be a large non-opaque concretion, only once was bulbus obstruction by an opaque stone recognized. In contrast to biliary ileus, in pyloric obstruction the stone must not only be removed but also the problem of fistula solved, as this lies directly in the operation field. It is not always advisable to force oneself to eliminate it and to remove a contracted, empty gallbladder at any price. Reconstruction of a deformed and damaged bulbus may even be risky. In our patients it sufficed to remove the stone by pylorotomy, leave the fistula and exclude the duodenum by gastric resection, to produce a permanent cure.

No large personal experience has been obtained with operations for the sporadic choledochoduodenal fistulas due to lithiasis. The communication as such need not be harmful, but it appears that not always do all the stones pass through the fistula, that some remain in the gallbladder and in the duct, and may even become wedged there. In such a case their removal, followed by cholecystectomy and clearance of the papilla is sufficient to produce spontaneous fistula closure.

Biliocolic fistulas. According to various series these occupy the second or third place in frequency. As a rule a communication exists between gallbladder and hepatic flexure or the adjoining portion of transverse colon. Intestinal obstruction almost never occurs and only exceptionally have cases been reported where a large stone has lodged in the sigma or ampulla recti above the sphincters, as was the case in one of our patients. This stone was the size of an egg, and was removed manually.

Colic fistulas draw attention to themselves by attacks of acute cholangitis, diarrhea, and sometimes even by a malabsorption syndrome. Frequently the diagnosis is also established by radiology, thus they are amongst the fistulas most often recognized before operation. Evidence of colic fistula is sufficient to indicate surgical intervention, even though symptoms may not be marked at the time.

If the fistula is known, the colon is prepared for surgery and fistula is eliminated solely by its excision. The gallbladder is always removed simultaneously and the common duct explored and treated.

In cases where the fistula is detected at operation and the colon has not been prepared one-stage operation carries a considerable risk. Likewise the extent of reactive lesions in the neighbourhood of an unprepared fistula is usually large, and the untreated process is active. For this reason mere disconnection, or excision of fistula may not always be sufficient. Despite this, if necessary, radical intestinal resection under antibiotic cover can be ventured, with adequate drainage. One-stage surgery is desirable particularly in elderly subjects, and only in cases where the immediate risk would be prohibitive and the surgeon would not be familiar with a similar situation may the operation be temporarily deferred, a preliminary ileostomy only being performed in the first stage. Surgery in the second stage is done under much better conditions following proper preparation.

Biliobiliary fistulas. Pathological communications between gallbladder and biliary tract pose problems differing from those of biliodigestive fistulas. Some statistics fail to mention this type of fistula. Apparently this is due to the fact that they are commonly recorded only in operation protocols, but not, however, in the diagnosis.

Biliobiliary fistulas are hardly ever recognized on preoperative biliography films. They could be discovered by retrograde endoscopic cholangiography, but as a rule they are not detected until surgery is undertaken. Now and there detection occurs at a time when the stone thrusts itself through the fistula from gallbladder into the bile duct or hepatic duct, causing their occlusion and jaundice. Such a fistula may confuse and there is danger of main bile duct injury (p. 203). The gallbladder is not immediately removed in toto, its remnant can sometimes be utilized as a plastic covering for a large defect in the duct after the fistula has been separated. Free passage through the duct must be guaranteed, and drainage is performed through a separate incision. When extensive duct damage is present or a danger of stricture exists, a satisfactory anastomosis is preferred.

Prognosis of surgical therapy

Surgery for biliary fistula due to stones is a serious matter. Patients tend to be elderly and fistula still further complicates an already severe type of lithiasis. Surgical mortality, morbidity and late results are not solely determined by the presence of fistula, but by the complexity of the disease as a whole and the necessary surgical interventions. Decisive is not only how a "bad risk" patient has proceeded to difficult impasse, but also how experienced a surgeon is unexpectedly confronted by it. In 75% of cases, apart from cholecystectomy and fistula closure, small stones have also to be removed from the common duct, the papilla operated, or an anastomosis performed. In 10% of our personal series operation for impeded stomach evacuation was also added, and in some cases part of the colon had to be resected. Surgical mortality is given as high as 20% and causes of death include hepatic insufficiency, renal failure, acute pancreatic necrosis, shock, bronchopneumonia, embolism, asystole, encephalomalacia. Our own surgical mortality amounted to 6%, and all fatalities were over 70 years of age. Late prognosis is surprisingly favourable. Only 3% of our series had to undergo reoperation on account of stenosis of papilla or anastomosis. Follow-up of 85% of operation cases for periods from 2—16 years revealed that patients had no significant complaints.

The surgeon should not encounter this late complication of lithiasis, the opportunity of timely surgical therapy having been missed. Prevention of fistula depends on the timely surgical treatment of the underlying disease before complications appear.

Ulcerogenic biliary fistulas

Experience with these is scanty. They represent less than 10% of all internal spontaneous fistulas.

Fistulas due to peptic ulcer originate most often from a duodenal ulcer penetrating into the gallbladder, if the ulcer is situated on the anterior aspect of the intestine, or into the retroduodenal segment of the common bile duct if an ulcer on the posterior duodenal wall is concerned. Such a fistula is not called biliodigestive but more accurately designated as enterobiliary. More rarely peptic gastric ulcers have also been recorded which perforated into the gallbladder.

Despite the fact that duodenal ulcers affect younger subjects, these enterobiliary fistulas develop relatively often in older subjects. It is the peptic ulcer which in these cases determines symptomatology, less so the concurrent fistula as such. This communication is recognized sometimes prior to operation by contrast medium reflux during radiological investigation of stomach and duodenum. Such deep duodenal ulcers are not uncommonly accompanied by signs of duodenal stenosis and fistula also announces itself at times by marked hemorrhage, cholangitis or icterus associated with an ulcer symptomatology. It seems likely that the increasingly wide scale application of duodenoscopy will detect more ulcerogenic biliary fistulas prior to operation, though the presence of intestinal stenosis hampers the introduction of the fiberscope.

With coexisting lithiasis a decision may have to be made whether the prime cause of fistula is the ulcer or a stone, sometimes during surgery itself. The medical history usually favours the ulcer, as do callous fistula borders in the gut, and certainly also the site as far as fistula in the retroduodenal bile duct segment is concerned. A lithiatic origin from the gallbladder may be assumed, on the contrary, in the presence of extensive adhesions following pericholecystitis and from the type of old established lithiasis.

Treatment

A peptic ulcer at the root of a fistula is usually by itself an indication for surgery and operation must in the first place also deal with the ulcer. Biliary reflux is likewise not immaterial, and therefore the fistula is as a rule also eliminated. Should the fistula open into the gallbladder, fistula closure is combined with cholecystectomy and radical gastric resection.

If an ulcer penetrating from the posterior duodenal wall into the bile duct is concerned, the problem is still more complicated. Frequently a pronounced inflammatory and fibrotic reaction is present in the neighbourhood of a chronic ulcer. This makes radical removal dangerous, or even impossible. It may be more advantageous to leave the fistula and to exclude the duodenum by antrectomy with simultaneous vagotomy. The gallbladder is removed and the patency of the duct must be checked; fibrosis surrounding the ulcer may also have caused main bile duct stricture. In a similar situation a jejunal Roux-anastomosis should be performed. In each operation for ulcer in the neighbourhood of common bile duct or papilla a catheter is previously inserted into the bile duct to provide information on its exact position.

Surgical results are satisfactory, particularly if we dispense with radical operations on poorly accessible and deep-seated retroduodenal ulcerogenic fistulas.

Hemorrhage accompanying fistula would require acute revision and management similar to that with massive hemorrhage anywhere in the upper digestive tract. If a radical operation would be too risky the site of hemorrhage should at least be sewn over and vagotomy performed.

Neoplastic biliary fistulas

Such fistulas are likewise uncommon. They concern malignancies originating as a rule from the gallbladder or the head of pancreas. A primary stomach cancer may also be concerned, as well as one from neighbouring viscera, which cause necrosis or directly invade the biliary tract with resulting fistula. Frequently a fistula originates from a growth with concurrent lithiasis and inflammation. Symptoms are determined, accordingly, sometimes more by the growth, or by the stones, but in both cases preoperative diagnosis of the fistula by radiology is purely fortuitous. Either gas or contrast medium enter the biliary tract from the intestine, or the fistula may be demonstrated by cholangiography.

Operation depends on the resectability or palliative therapy for the tumour. Gallstones are sometimes removed, but the problem of the fistula proper remains a secondary one. It is always necessary in some way to ensure bile drainage.

Post-traumatic internal biliary fistulas

Fistula due to actual abdominal injury is a rarity. Post-traumatic broncho-biliary fistula has been described, for instance.[5, 6] Symptomatology and surgical treatment of such unusual fistula depend on the special features of individual cases.

Postoperative Internal Fistulas

A iatrogenic internal fistula to the neighbouring viscus caused by some damage to the bile ducts during surgical intervention is quite exceptional. It is more likely that surgical injury might lead to biliary peritonitis, or produce an external fistula. In thirty years the author has encountered only a single case of choledocho-duodenal fistula which arose from injury to the common bile duct and the adjacent duodenal wall by a suture and which was later an incidental finding during another abdominal operation. Surgical treatment of such a rare postoperative internal fistula must be adapted to the given situation and no general guide lines can be laid down.

Artifical Internal Fistulas or Biliodigestive Anastomoses

Various types of biliodigestive anastomoses are performed between gallbladder or ducts and stomach, duodenum or jejunum. They usually serve the purpose of guaranteeing permanent free bile drainage into the gut in duct obstruction or merely of diverting biliary flow, if the bile duct is damaged and threatened. Anastomoses have been discussed already in connection with the therapy of some biliary diseases. However, they must also be viewed from the opposite aspect, as a group of operations sometimes having similar consequences, thus representing a certain clinical entity.

Gallbladder anastomoses

The gallbladder is mostly unsuited for communication, as here reflux would induce troublesome inflammation. Nevertheless cholecysto-duodenal or cholecysto-gastric anastomosis is admissible especially as a temporary expedient in bile duct obstruction for a patient in poor condition or in cases of inoperable malignancy. An obvious requirement for using the gallbladder is patency of the cystic duct.

Indications for gallbladder anastomoses

- Injury or destruction of the supraduodenal portion of the bile duct or atresia, stricture or neoplasm of this segment render anastomosis utilizing the gallbladder necessary but only in cases where thė hepatic duct cannot be satisfactorily joined to the gut.
- Bile duct obstruction by unresectable neoplasm of pancreas or papilla is the commonest indication for a gallbladder anastomosis. It is easy to perform and satisfactory in view of the short survival prospects.
- It is used seldom in obstructive jaundice preparatory to radical operation of a tumour, if we wish the jaundice to subside before the second stage of operation is undertaken. It may serve later instead of definitive choledochoenterostomy following duodenopancreatectomy.
- In sporadic cases an extensive bile duct defect could be bridged by the gall-bladder (even with an obstructed cystic duct). On one side an anastomosis between gallbladder and hepatic duct, and on the other between gallbladder and duodenum or jejunum have been devised (Juvara 1971, Wadell 1973).
- Similarly the gallbladder can be exploited in obstructive jaundice due to porta hepatis neoplasm. If intubation of the neoplasm fails, the dilated intrahepatic duct may be joined through gallbladder to the gut.

Surgical technique

The gallbladder may be joined to the stomach, duodenum, or exceptionally, even jejunum. To avoid tension of the anastomosis, the gallbladder must sometimes be mobilized at least partly from its fossa. Evacuation by puncture is done at the future anastomosis site. If stones are present, these are removed after opening. If dark or "white" bile can be seen to flow from the bile duct into the gallbladder this is evidence of cystic duct patency.

The anastomosis should be at least 2.5 cm wide. It is sutured by interrupted atraumatic sutures which are tied inside on the posterior, and outside on the anterior aspect of the anastomosis. Only if required a few serosa sutures are placed in a second layer. A peritoneal drain is inserted as a safeguard.

a) Cholecystogastrostomy: This anastomosis is performed transverse to their longitudinal axis on both gallbladder and stomach. *Fig. 199.* It is very easy, but sometimes causes unpleasant bilioesophageal reflux. Despite this it is comparatively often used in jaundice from inoperable neoplasm in the sphincteric region of the main bile duct. An immediate supplementation by preventive GEA is useful if duodenal patency is endangered.

b) Cholecystoduodenostomy: This is considered more physiological, but is unsuitable where the neoplasm spreads to the duodenum. The gallbladder is usually opened by transverse, the duodenum by longitudinal incision. *Fig. 200.*

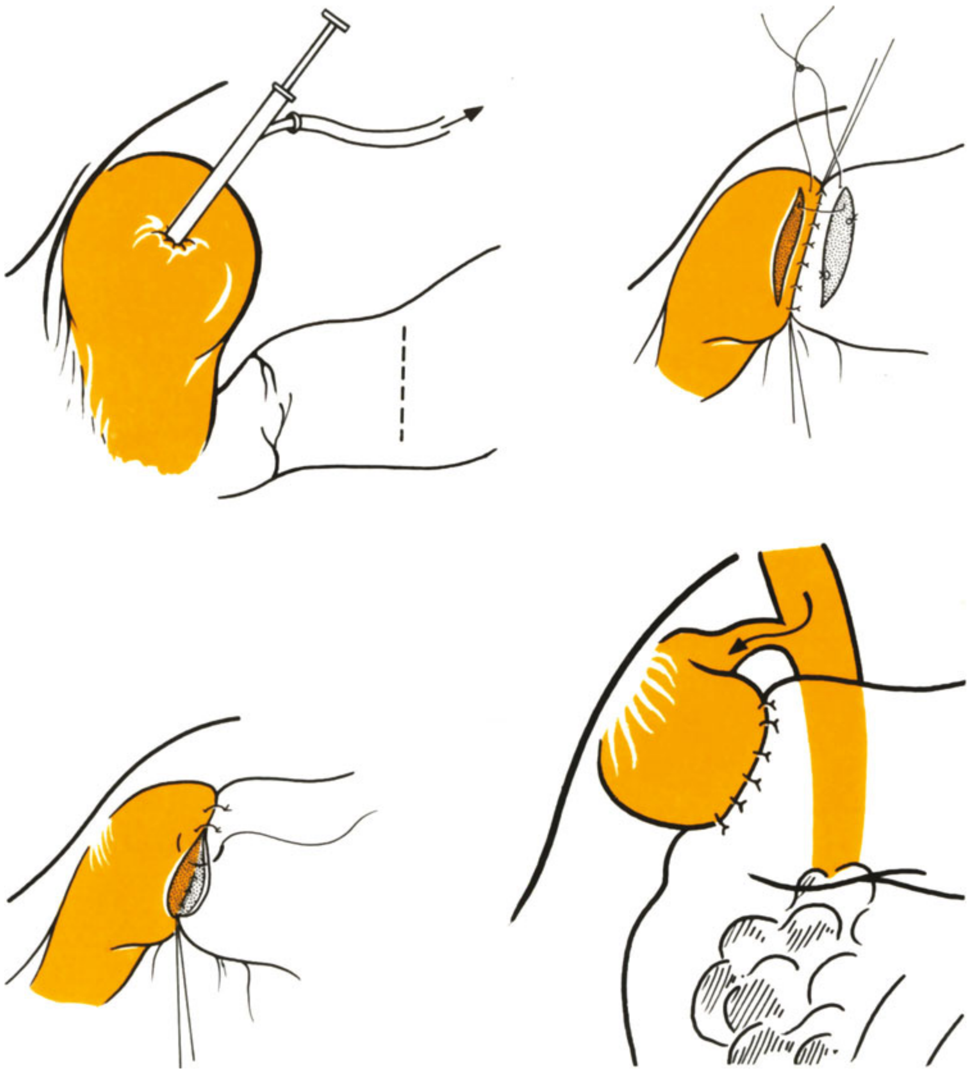


Fig. 199: Cholecystogastrostomy in pancreas tumour: Aspiration of gallbladder and two layers suture of anastomosis.

Fig. 200: Cholecystoduodenostomy.

Fig. 201: Cholecystojejunostomy.

c) Cholecystojejunostomy: This is indicated quite exceptionally. An antecolic, side-to-side anastomosis with an undivided jejunal loop (anastomosis Ω shape) or with an excluded loop after Roux (Roux-en-Y) is performed (p. 389). *Fig. 201.*

Prognosis in gallbladder anastomoses

These operations are safe, and suture leakage is rare. Reflux from the digestive tract is the rule, but only rarely do stenoses of the stoma occur. However, severe gallbladder inflammations even with a wide stoma are not infrequently observed and if the infection penetrates as far as the ducts, violent attacks of cholangitis result. Thus the gallbladder may be utilized for anastomoses mainly if life expectancy is limited.

Main bile duct anastomoses

Anastomoses of the common bile duct are performed with the duodenum or jejunum. A sufficiently wide duct is a precondition. If this is not the case, some other mode of operation must be tried. Cholecystectomy is always necessary, as gallbladder is affected by permanent bile drainage due to the anastomosis. Anastomoses with the duodenum are mostly simple to perform, do not divert the bile from the duodenum, but are exposed to intestinal reflux. Anastomoses with the jejunum are technically more exacting, may exclude reflux, but convey bile to the gut at a considerable distance from the pylorus, thus facilitating the induction of duodenal ulcer. Selection of the anastomosis must be governed in the first place by the level of obstruction or duct damage.

ANASTOMOSES WITH DUODENUM

a) Internal choledochoduodenostomy resembles total sphincteroplasty, but in some cases papillotomy need not to be added.

Indications:
- As a rule transduodenal choledocholithotomy is performed for a large stone wedged in the terminal choledochus. Kocher first successfully performed such an operation at the end of the last century.
- A more theoretical indication is also choledochocele (p. 428).

Surgical technique of internal choledochoduodenostomy has been dealt with beforehand (p. 240).

b) External choledochoduodenostomy: is one of the most commonly employed anastomoses. First reported by Riedel in 1892.

Indications:

- A widely dilated, flabby bile duct undoubtedly represents an indication for anastomosis, even if the obstructing stone or stenosis are dealt with.
- Choledocholithiasis would require a drainage operation only if there was a high risk of residual or newly formed stones. These are chiefly cases of "paved" bile duct or of hepaticolithiasis and cases of a wide duct with primary stones. Anastomosis may sometimes be performed — also preventively — if the terminal duct is damaged by impacted small stones, or if their extraction is difficult. It would be a mistake, however, to leave a stone wedged in the papilla, and merely add the anastomosis. Anastomosis is no substitute for clearance of the bile duct, and should not be added routinely to every operation for choledocholithiasis.
- Stenosis of the papilla demands an anastomosis only if sphincterotomy cannot be done, e.g. in acute pancreatitis. It would be erroneous, however, to expect any help from the shunt in mere "dysfunction" of the sphincter of Oddi or in obscure symptoms following cholecystectomy. The condition of such patients can only be aggravated by the unwelcome sequels of the anastomosis — reflux which may even make desanastomosis necessary.
- One of the main indications for anastomosis is extensive stenosis of the pancreatic segment of the bile duct. Some surgeons also recommend anastomosis for attacks if "biliary pancreatitis", but decidedly we prefer papillosphincterotomy.
- Congenital atresia, injuries or strictures of the terminal bile duct belong to the more unusual indications for anastomosis.
- Obstruction of the terminal bile duct by malignant growth which is unresectable but does not involve the duodenum. A number of authors recommends palliative anastomosis even in operable cancer if the head of the pancreas is the primary site.

Surgical technique:

External choledochoduodenostomy may be performed as lateral or as terminal. The decision and selection of procedure is not made until surgery.

For side-to-side anastomosis the bile duct is incised either longitudinally or transversally.

If the longitudinal incision is used, it must be at least 2 cm in length, the incision being extended behind the retracted duodenal border. The latter is incised longitudinally in its axis close to it, the incisions thus being at right angles.

The centre of the intestinal incision is anchored by the first suture to the lower pole of the choledochotomy. The second suture is prepared between the distal end of the duodenotomy and the centre of the lateral border of the bile duct incision. One or two further sutures are placed in the gap between the first and second, and only then are all sutures tied. In similar fashion also the second half of the posterior circumference of the anastomosis is sewn. A row of fine atraumatic chromic catgut stitches is knotted inside.

On the anterior border of the anastomosis a suture is first placed between the upper pole of the choledochotomy and the centre of the anterior enterotomy border,

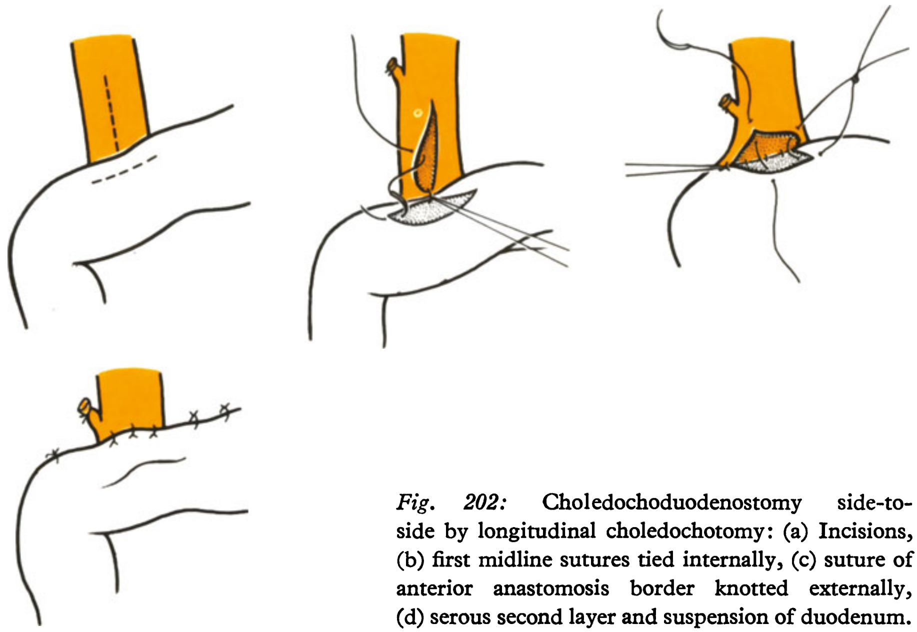


Fig. 202: Choledochoduodenostomy side-to-side by longitudinal choledochotomy: (a) Incisions, (b) first midline sutures tied internally, (c) suture of anterior anastomosis border knotted externally, (d) serous second layer and suspension of duodenum.

thereby dividing the anterior circumference into two sections. Suture is performed with non-resorbable atraumatic sutures, tied externally; as far as possible only the sero-muscular bowel wall is included. Tension is relieved by a few serosal stitches, which turn the anterior duodenal wall over the bile duct. A subhepatic drain is inserted avoiding contact with the suture line. *Fig. 202.*

The other modification with transverse choledochotomy is performed thus: the bile duct is stripped close to the duodenum and its entire anterior border

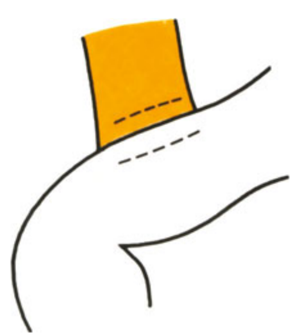


Fig. 203: Choledochoduodenostomy side-to-side by transverse choledochotomy in a greatly dilated duct.

divided transversely. The adjoining gut is opened by a parallel incision. *Fig. 203.* The anastomosis is sutured in one layer, to avoid narrowing. Sutures, spaced equally, take up the whole posterior wall. The anterior borders are approximated by extramucosal sutures as far as this is possible, as accurate apposition is essential to prevent mucosal prolapse. If the suture is unreliable, further protection is provided by several serosa stitches and by bile drainage by a tube inserted into the duct through the cystic duct or through a separate incision.

Both modifications of bile duct incision have their advantages and disadvantages: a transverse incision accelerates intervention and does not expose the sutures to so much tension as a longitudinal. It can only be used, however, with a bile duct at least 15 mm in width, otherwise stenosis is more likely. A longitudinal incision can, in contrast, be joined even to a bile duct which is only slightly dilated.

The end-to-side choledochoduodenostomy is used if exclusion of the terminal duct is required. This is a more exacting intervention than lateral anastomosis, but some surgeons prefer it because no undesirable cul-de-sac is created. In any case, no stones must be left even in a completely excluded sphincteric segment.

At the site where the bile duct is to be divided a narrow circular section is freed. If it adheres to the portal vein, Beyret's modification is safer: only the anterior aspect of the bile duct is stripped to a length of 3/4 cm and divided transversely.

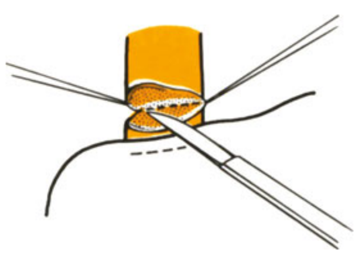
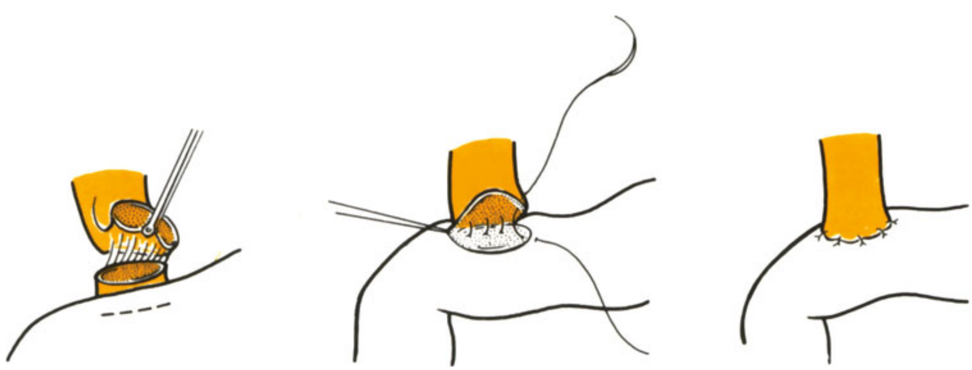


Fig. 204: Choledochoduodenostomy end-to-side: (a) Transsection of the posterior choledochus wall from in front, (b) limited mobilization of the proximal end of the divided duct, (c) suture of the posterior border of the anastomosis tied internally, (d) suture of anterior circumference knotted externally.



The borders of the incision are drawn apart and both angles grasped with fine forceps. By raising the latter the posterior wall is drawn taut, and this is now cautiously transected from front to back. The divided posterior wall is now carefully dissected from its surroundings for a distance of 0.5 cm. The lower remnant of the duct needs not be ligated.

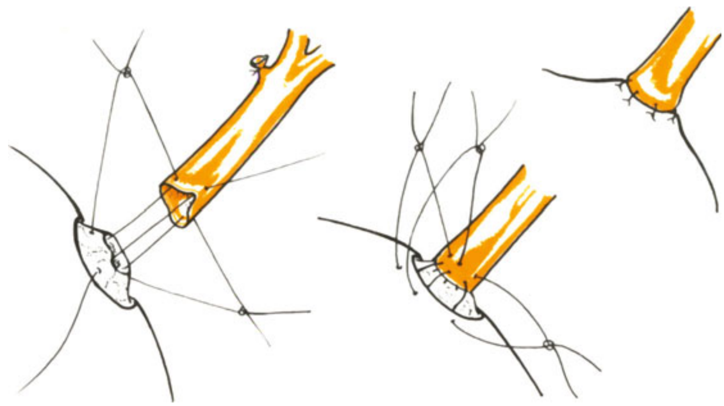


Fig. 205: A mode of terminal choledochoduodenostomy in non-dilated duct: Three stay sutures are placed; the first layer of interrupted catgut sutures joins all-coats of the bile duct with duodenal mucosa; this layer is now buried by a sero-muscular layer of interrupted silk sutures.

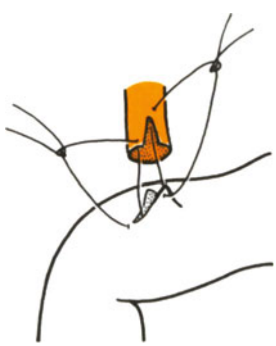


Fig. 206: Creation of a wider stoma by splitting the anterior wall of a narrow duct prior to joining to a V-shaped duodenal incision.

The adjoining duodenal flexure is now mobilized and longitudinally incised or a circular opening made as close to the divided duct as possible. The anastomosis is sutured in one layer and tension is relieved by lateral supporting sutures. A tube may be inserted separately into the duct. *Fig. 204.*

If we are forced to implant an undilated duct, another mode of suture may be used (Barnes, 1977) or its calibre may be widened by longitudinal splitting. Fig. 205, 206. Narrowing of the anastomosis may also be prevented by eversion of the incised border creating the shape of a "papilla", but this appears unnecessarily elaborate.

c) Hepaticoduodenostomy: In trauma or stricture of the supraduodenal bile duct portion the common hepatic duct must be joined end-to-side to the duodenum. It is not a very satisfactory type of anastomosis in most cases, as the duodenum is drawn out excessively, sutures are under tension and there is a greater tendency for stenosis of the stoma. Despite this, it is used occasionally, in particular if operation has to be speed up, because it is simpler than anastomosis with the jejunum.

Surgical technique does not differ materially from terminal choledocho-duodenostomy (p. 385). The duodenum must be adequately mobilized by Kocher's method and by sliding the mesocolon downwards. Sutures at the posterior border of the anastomosis are drawn tight and knotted after all have been inserted in advance. In order to prevent tenting of the duodenum by the stoma, the gut in its neighbourhood is widely attached to the hilar peritoneum, or even as far as Glisson's capsule at the porta hepatis. Internal drainage of the anastomosis is not done, but tube drains are always placed close by as a safeguard.

Prognosis of common duct anastomoses with duodenum

Internal anastomoses are so sporadic that data for their evaluation are not available. Such an anastomosis was used only three times by the author for intramural wedged large stones, and the patients remained symptomfree.

External anastomoses are safe operations, with a low, less than 2% mortality, which mostly is not directly connected with surgery. Immediate complications are rarely encountered: transient oozing of bile, quite sporadically duodenal fistula, and exceptionally postoperative pancreatitis.

Late disadvantages and complications are more frequent:

- Reflux. All duodenal anastomoses facilitate unwelcome reflux of intestinal contents, with the exception of patients whose duodenum has been excluded by gastric resection. Reflux as such is not troublesome as a rule, provided the contents return quickly through a patent stoma. Raised temperatures after operation ascribed to reflux are usually transient, afebrile intervals become prolonged and manifestations of infection disappear usually after six months to one year. In cases where, in contrast, cholangitis attacks start to appear after months or years and become successively worse, impaired patency of the stoma is heralded. Incidence of biliary infection after anastomoses is estimated at 10–15%. There exist, however, particularly sensitive subjects, for whom reflux of intestinal contents into the biliary tract, even in the presence of a wide stoma, is associated with severe pains, a condition designated as "reflux intolerance syndrome". If this should not disappear in due course the anastomosis has to be discontinued.
- Cul-de-sac. Lateral anastomosis may occasionally be exposed to yet another

unwelcome sequel, trouble due to the cul-de-sac. Residues of regurgitated food may cling to the terminal bile duct, or even small stones may form there, causing inflammation and pain, and sometimes even obstruction of the stoma.
- Stenosis of anastomosis. This occurs particularly in cases where the stoma created was too narrow and under tension, a significant role being played in this respect by the peristaltic tugging motions of the duodenum. Inflammatory scarring may even close the stoma.

Stenosis of duodenal anastomoses occurs in about 4–5% of cases (Capper 1961, Johnson and Stevens 1969, Keclík 1973). Their number is apparently higher if the hepatic duct has been joined to the duodenum. If patency and activity of the terminal bile duct is restored after the performance of lateral anastomosis, loss of the stoma needs cause no clinical symptoms. Otherwise its stenosis is heralded by cholangitis episodes, laboratory evidence of anicteric obstruction and finally by jaundice.

Such a stage should not be allowed to develop. In adequately followed-up patients reoperation must be undertaken much earlier.[2]

Late-results of duodenal anastomoses are, however, satisfactory as a whole, particularly if an already dilated main bile duct has been utilized. Failures do not exceed 7% in choledochoduodenal anastomoses while in hepatic duct anastomoses they are more frequent.[13]

ANASTOMOSES WITH JEJUNUM

a) Choledochojejunostomy: The common bile duct is sutured to jejunum end-to-side. Anastomosis is more time-consuming than with the duodenum, and is rarely used.[11] It is constructed similarly to a hepaticojejunostomy, where procedure will be described.

Indications:
- No satisfactory conditions for duodenal anastomosis exist.
- Duodenal anastomosis has failed.
- Usually part of duodeno-pancreatectomy procedure.

b) Hepaticojejunostomy: The anastomosis is performed in the lower part of the hilus and the jejunum can be brought up easily and joined without tension. Preparation of the intestinal loop, however, is time-consuming.

Indications:
- Injury, defect or stricture of the main bile duct defying reconstruction. Injury during surgery occurs commonly in the area of confluence between cystic duct and hepatic bile duct, and its repair is the chief domain of hepaticojejunal anastomosis.

- Congenital stenosis or atresia of the common bile duct, in particular if the cystic duct is not patent, represents another undisputed indication.
- Final step during resection of congenital cystic dilatation of the common bile duct.
- Reoperation for unsuccessful duodenal anastomosis.

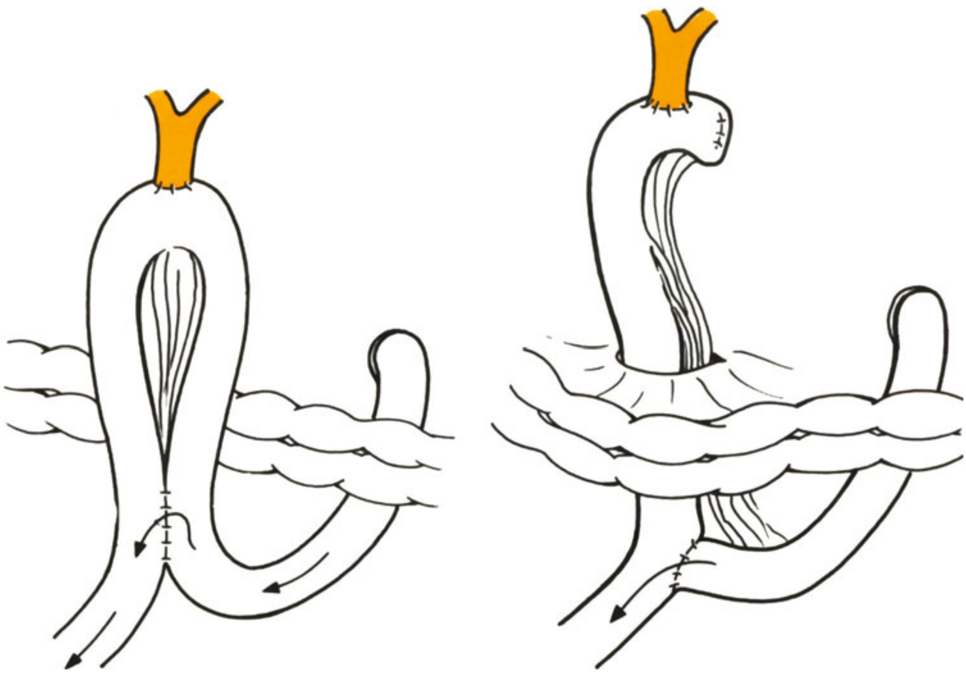


Fig. 207: Hepaticojejunostomy end-to-side: (a) With an omega shaped loop in antecolic position; (b) with excluded loop after Roux, pulled through an opening in the mesocolon.

Technique:

The higher healthy portion of the bile duct is dissected free and divided. Variations of hepatic arteries must be taken into account (p. 29). Ligation of the peripheral stump of the duct is not necessary as a rule.

The highest jejunal loop is now selected, junction may be effected in various ways: in the simplest the gut is not divided, the loop is placed in front of the colon and the prepared terminal portion of the bile duct implanted at a distance of about 30 cm distal to Treitz ligament. In order to divert the flow of food from the stoma both limbs must be interconnected by a wide EEA, about 25 cm proximally. The loop is Ω shaped. In addition the afferent limb may be closed by suture. *Fig. 207.*

If the jejunal mesentery is short, antecolic positioning is not possible, it must be drawn through an opening in the mesocolon. In such an event the EEA must always lie below the colonic mesentery.

The second method, which is better and always used by ourselves if the time factor is not pressing, consists of joining the duct to an excluded jejunal loop after Roux. It can be drawn easily under the liver and is more efficient in diverting intestinal contents from the anastomosis. The loop is Y-shaped.

Jejunum with mesentery is divided about 20 cm distal to Treitz ligament at a suitable site according to the disposition of vascular arcades. As a rule 1–2 arterial communicating branches in the arcade need to be divided to approximate the aboral end of jejunum to the hepatic duct without tension. The closed stump of the gut is drawn through the mesocolic opening and placed externally along the duodenum with the jejunal mesentery facing to the left. The hepatic duct is implanted at the peak of this loop, at a site which can be approximated easily. Only exceptionally is end-to-end anastomosis of duct and loop more advantageous.

Suture of the biliary anastomosis is undertaken similarly to that in duodenal anastomoses (p. 382). The peak of the loop is opened on the side opposite

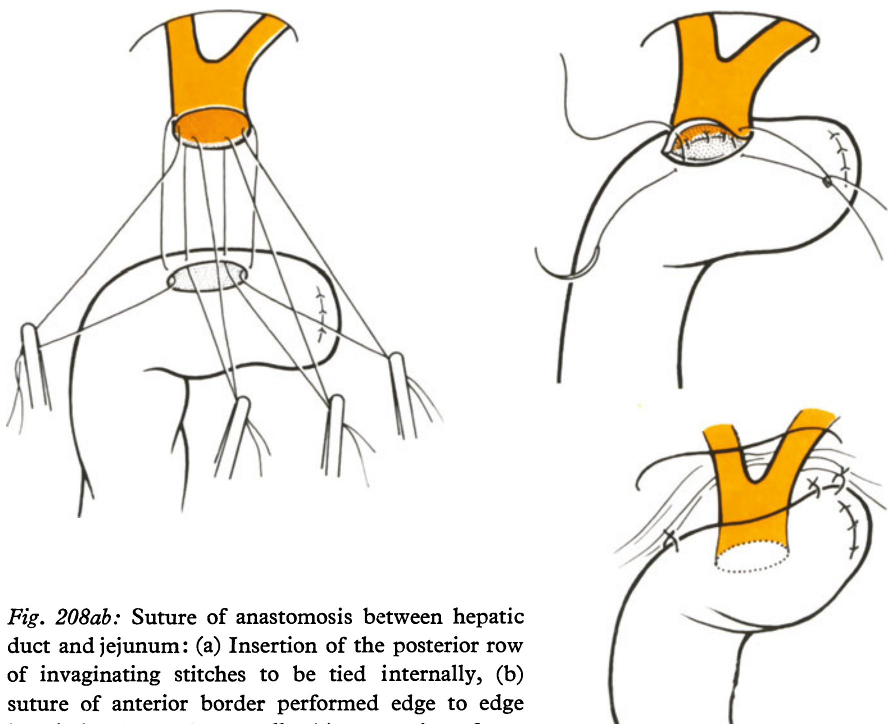


Fig. 208ab: Suture of anastomosis between hepatic duct and jejunum: (a) Insertion of the posterior row of invaginating stitches to be tied internally, (b) suture of anterior border performed edge to edge by stitches knotted externally, (c) suspension of gut.

to the mesentery by a small incision. Small submucosal hemorrhage is stopped by about 4 chromic catgut sutures accurately spaced on the posterior stoma border. All layers are included by fine atraumatic sutures which are left untied at first. The jejunum is then brought close to the duct and the sutures tightened and knotted internally one by one. Likewise on the anterior border all sutures are placed beforehand at regular intervals of about 4 mm. Atraumatic nonresorbable sutures are used, excluding the mucosa as far as possible, and knotting externally. One layer of sutures for the stoma is used, but tension is relieved by suspension peritoneal sutures of the gut with Glisson's capsule near the hilus. *Fig. 208.*

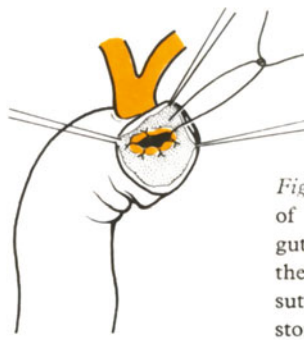


Fig. 209: "Telescopic" suture of anastomosis from interior of gut: (a) Hepaticus drawn into the Roux loop by means of stay sutures, (b) accurate suture of stoma in the interior of the jejunum whose blind end is closed afterwards.

A long hepatic duct stump may also be sutured "telescopically", but this modification is more likely to complicate the intervention. *Fig. 209.*

If bile leakage through the suture line is feared, a thin catheter is inserted into the anastomosis through the jejunum for several days decompression. It is provided

Fig. 210: Internal drainage of the anastomosis for decompression by Y shaped tube brought outside through the intestine after Witzel.

with openings above the anastomosis and below it, and brought out through the intestine or through the liver to facilitate its removal as desired (p. 144). *Fig. 210.* This drainage has no splinting significance and if the stoma is wide and well sutured it is completely unnecessary. Safeguarding by placing of peritoneal Redon's drains close by, however, is always done.

Continuity of the gut is restored about 30 cm from the biliary anastomosis. The divided end of the distal jejunum is joined to the side of the excluded upper loop, invariably below the mesocolon. The opening in the transected jejunal mesentery is closed near the intestinal anastomosis which is, in addition, loosely sutured to the opening in the mesentery of the transverse colon. Before closing the abdominal cavity the positions of excluded loop and tube drain are checked.

Prognosis of common duct anastomoses with jejunum

Anastomoses with jejunum, particularly Roux's modification are more exacting and carry a higher surgical mortality (about 4%) than with duodenum. Prognosis is still more unfavourable if surgery is done for iatrogenic stricture.

Postoperative complications, however, are infrequent. In contrast to duodenal anastomoses, reflux problems do not arise, though this is not entirely avoided even by Roux-en-Y anastomosis. On the other hand, there is the unwelcome diversion of bile from the duodenum, and if pain and hemorrhage occur in such a patient, the possibility of a peptic ulcer situated in the duodenum must be taken into account. Its incidence amounts to 22% according to Anst, 13% McCarthy and Longmire, 8% Ay and Dunphy, and to only 2% after Lindenauer. A lower incidence of about 4% conforms with our personal experience.

It is mainly stenosis of the stoma which causes more distant serious symptoms. Its presence is announced by cholangitis, pains and jaundice. Development chiefly depends on whether surgery was done on a still healthy duct — where it has an incidence of only 1–2% — or if operation was done for fibrotic stenosis, when recurrence of stenosis is up to ten-times more common. With recurring cholangitis surgical revision must be entertained early.

Disorders due to intestinal obstruction or from a long blind-loop are hardly ever encountered.

THE CHOICE BETWEEN ANASTOMOSES

with duodenum or jejunum is governed mainly by indications. Some of these permit only one type of anastomosis. In situations where a choice is feasible, account is taken of the age and general condition of the patient. Our object is to preserve as much of the duct as possible and to perform simple surgery. Both methods have their partisans and successes accordingly, and depend also on our skill and familiarity with the operation concerned.[1, 7, 34, 38]

Hilar anastomoses

Biliodigestive anastomoses in the hilus are forced upon us if the hepatic duct or its branches can be used for anastomosis only at a higher level in the hilus or as they enter the liver. They are always connected to the jejunum, and preferentially to an excluded loop after Roux.

Indications:

- Immediate repair of extensive surgical injury of hepatic duct.
- High level congenital stenosis or atresia of biliary tract (p. 415).
- Resection of tumour of hepatic duct or cystic duct region.

The hilar approach is mainly indicated with reoperations, for two conditions:

- Surgical strictures on external fistulas of hepatic duct.
- Stenosis of high level anastomosis of hepatic duct.

Surgical technique

Operations in the hilus have two equally important difficult components — dissection of hepatic duct or its residuum respectively, and creation of a satisfactory anastomosis.

Access to the hepatic duct and its branches is either from in front and below, by dissection in the liver hilus, or from in front and above, by the hilar roof into the porta hepatis.

Firstly an attempt is made to identify or dissect the hepatic duct or its bifurcation inside the hilus from in front. It lies foremost and the main danger is the proximity of the hepatic artery and its right branch crossing the bifurcation from behind, but which in exceptional cases may also run in front of it.

Fig. 211: High hilar approach to junction of hepatic ducts and to hilar vessels from in front.

The left hepatic artery situated more medially is not usually endangered, neither is the portal vein and its branches, which are at a greater depth. Only the left portal vein branch sometimes curves in front of the left hepatic duct. The right vascular pedicle with the corresponding right hepatic duct enters the liver vertically in the hilar axis, whereas the left pedicle with the left hepatic duct bends to the left and continues extrahepatically before entering the liver, and thus becomes surgically significant. *Fig. 211*. However, variations concerning the junction of hepatic branches and vascular courses must be taken into account as described earlier.

Dissection in the hilus is still more difficult in reoperations, as described in the chapter on postoperative strictures under which heading they belong (p. 523).

If identification and access to the hepatic ducts by the classical route fails, an attempt at d i s s e c t i o n f r o m a b o v e is made t h r o u g h t h e r o o f o f t h e h i l u s.

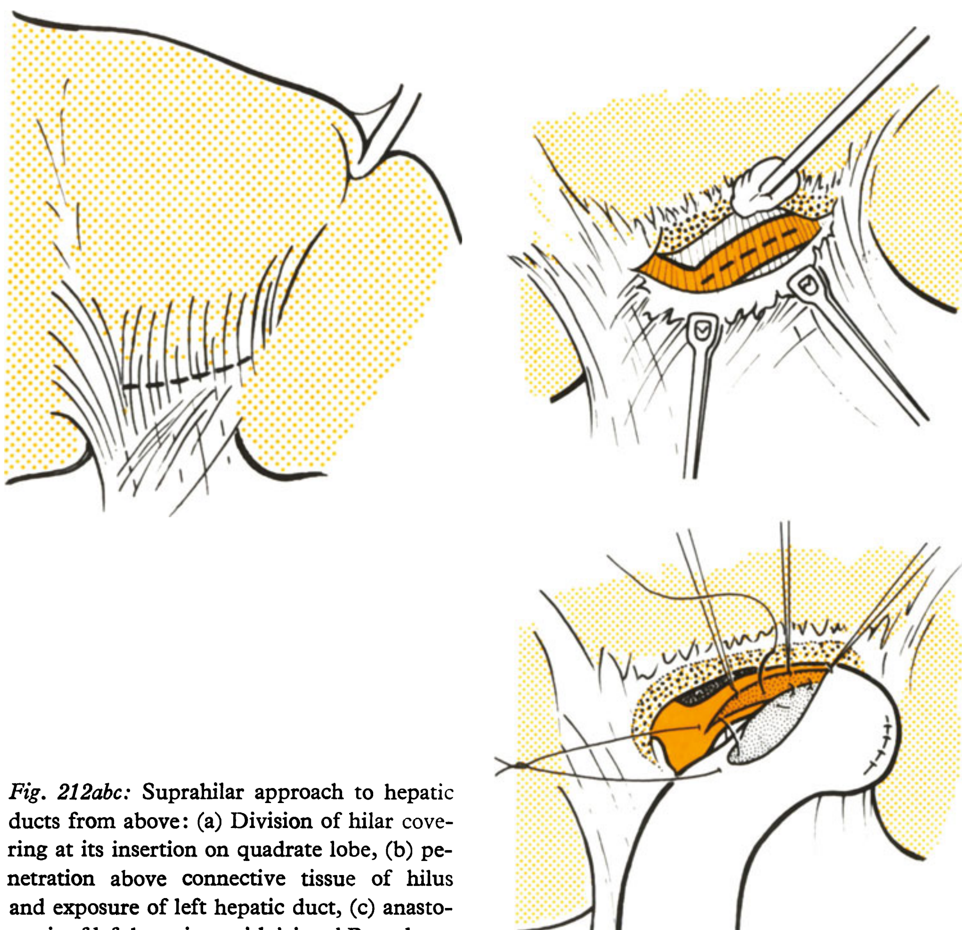


Fig. 212abc: Suprahilar approach to hepatic ducts from above: (a) Division of hilar covering at its insertion on quadrate lobe, (b) penetration above connective tissue of hilus and exposure of left hepatic duct, (c) anastomosis of left hepaticus with jejunal Roux loop.

This course is forced on us particularly in reoperations where an altered hilus transformed into a mass of sclerotic connective tissue is found. *Fig. 212.*

Glisson's capsule with the insertion of the hilar sheath is divided transversely close to the quadrate lobe. The lower, thickened and fibrotic boundary of the divided peritoneal covering is held by forceps and the exposed liver gradually stripped by swabbing from the fibrous disc forming a kind of hilar roof. This is exposed for the entire width of the quadrate lobe. Its lateral borders, where segmental pedicles already enter the liver, however, are not crossed. Minor hemorrhage from the liver parenchyma is stopped by slight pressure and the liver gradually separated from the hilar disc until a whitish, more compliant connective tissue layer makes its appearance covering the left hepatic duct, or the bifurcation from above. This cover is divided and duct position verified by puncture. The duct is always situated closely underneath and is usually dilated. It is sometimes quite surprising how little its neighbourhood is altered here, even though we may have encountered, during its dissection from the hilus, almost unpenetrable adhesions. If access is impeded by an enlarged and hardened liver, this may be "chiselled off" a little above the hilar disc. Considerable hemorrhage is the usual result and it may be preferable to enlarge the access to the left hepatic duct, instead by incising the liver, as will be described later (p. 402).

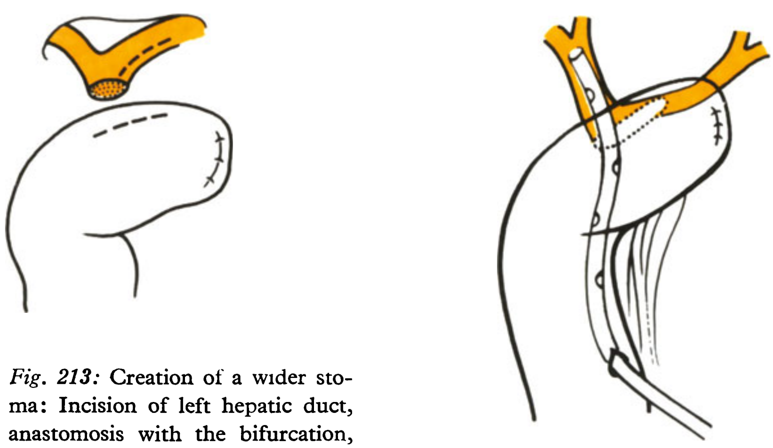


Fig. 213: Creation of a wider stoma: Incision of left hepatic duct, anastomosis with the bifurcation, drainage for decompression after Witzel.

Hilar hepaticojejunostomy: If we succeed in dissecting, either from in front of or from above the hilus, the hepatic duct or its left branch, removing any granulation tissue until a satisfactorily mobilized, healthy portion is available, anastomosis with the jejunum is performed in typical fashion, as already described (p. 389).

If only the bifurcation is available for anastomosis, a wider stoma may be achieved by extending the incision in the left hepatic duct. If only stumps of both hepatic branches are left, these may be joined by lateral suture and the spur created transected with scissors or artery forceps, to produce a larger common orifice. If this should fail, both ends must be joined to the jejunum separately, a disadvantage, as stomata are primarily narrow and their patency threatened. *Fig. 213, 214.* If only access to the left hepatic duct is possible, open communication with the right branch in the junction is verified by probe or radiology, thus the entire liver will be drained by the anastomosis. Otherwise drainage of the other liver half must be attempted by some other method (p. 403) to avoid not only destruction of its parenchyma, but the likelihood of cholangitic abscesses.

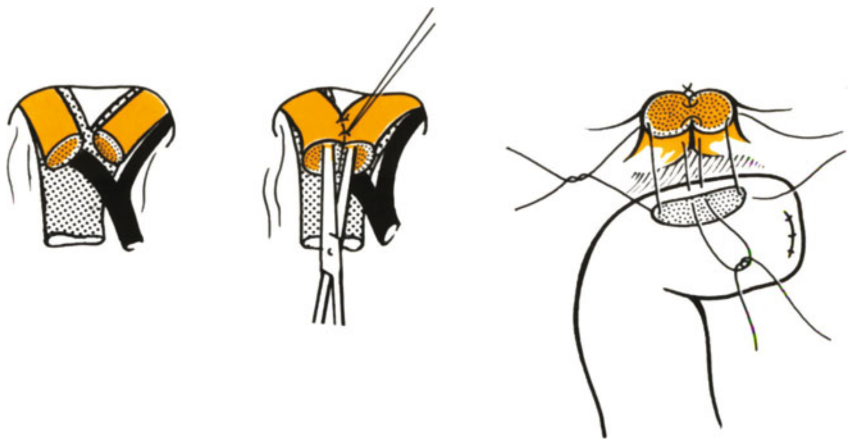


Fig. 214: **Interconnection of both hepatic ducts and creation of common orifice for the anastomosis.**

The creation of a reliable anastomosis in tough scar tissue during reoperations for stricture or high level fistula is usually difficult and operations have to be completed by some compromise. A description of such interventions is left to a later chapter on postoperative strictures (p. 525). Only some of the principles will be stated, which occasionally might prove useful even in primary operations:

- Line a damaged duct with intestinal mucosa if possible.
- Suture the freed borders of the duct to the surrounding liver bed and cover the entire area with the jejunal orifice.
- Dilate the scarred channel and splint it with a drain.

Prognosis of hilar anastomoses

Surgical mortality and immediate morbidity is understandably higher with hilar anastomoses as compared with more distal drainage operations; this depends not only on the more exacting intervention, but to a large degree on the patient's general condition before surgery. There is a greater risk of cardiopulmonary complications, renal or hepatic failure. Directly linked to the operation is bile leakage and its consequences, intra-abdominal hemorrhage, wound infection, and possibly signs of insufficient patency of the stoma. The greatest immediate risk is incurred by those patients in whom free bile flow into the intestine could not be satisfactorily accomplished. On the other hand, patients are sometimes able to weather even prolonged, but carefully and rationally performed operations surprisingly well.

Late prospects of hilar anastomoses are determined chiefly by the continued patency of the anastomosis. Early stenosis manifests itself most often by cholangitic attacks and other signs of intermittent obstruction but consequences of impaired drainage may accompany the patient throughout his life as a result. Hematologic disorders, the formation of liver abscesses, the development of biliary cirrhosis and portal hypertension, threatening through hemorrhage from varices, mental disturbances and drug addiction may occur.

According to large scale statistics success is definite within two years of operation, as a rule. If cholangitis, subicterus and other signs of threatened obstruction have not appeared by this time, permanent patency of the stoma may be predicted with great probability. In patients free from symptoms for 3–4 years following performance of hilar anastomosis, a satisfactory permanent result can be counted on in 95%.

Hepatic anastomoses

These are operations within or at the liver periphery, undertaken only exceptionally, if the simpler subhepatic mode for performing an anastomosis or drainage cannot be employed.

Indications:

- Congenital stenoses, dilatations and cysts of the intrahepatic biliary tract.
- Intrahepatic primary and secondary lithiasis.
- Recurrent stenoses of hilar anastomoses.
- Jaundice due to neoplastic obstruction of extrahepatic ducts without evidence of metastases, not amenable to any subhepatic operation.

a) Interlobar hepaticojejunostomy: Access via the liver to hepatic duct branches and their junction in the porta hepatis facilitates a more satisfactory approach than the hilar route, but liver parenchyma has to be divided.[36, 40]

Surgical technique: A subcostal incision is made or the incision used is extended in the costal arch direction. The latter may be divided in the 8th interspace. The liver is mobilized from adhesions as near to the hilus as possible. Hepatic cholangiography is useful for obtaining information on biliary tree anatomy and for identification of the plane dividing the two liver lobes: this runs from the gallbladder fossa to the left border of the inferior vena cava above the liver and on the liver undersurface from fossa to hilus. The falciform ligament is incised in front close to the diaphragm and the liver thus further mobilized.

The liver incision is commenced on its anterior edge at the gallbladder fossa notch and carried gradually from front to back, keeping a little to the left from the assumed interlobar plane, to preserve the middle hepatic vein lying there and which may serve as a landmark. Only its left tributaries are divided and ligated. The electric scalpel is sometimes used for commencing the incision, which is continued

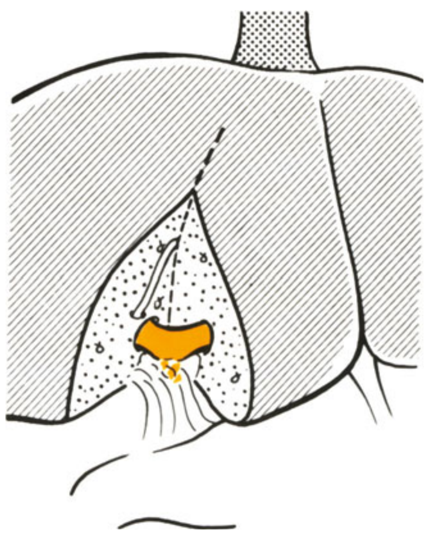


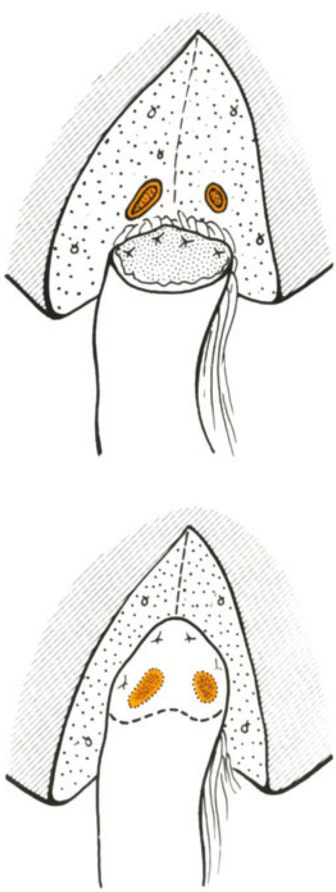
Fig. 215: Interlobar approach to union of hepatic ducts.

using an ordinary scalpel or preferably by digitoclasia which is associated with less hemorrhage. No personal experience with cryosurgery is available. Each little vessel is tied or transfixed in such a fashion that the convexity is cut a little in advance of the undersurface. Nowadays special fine clips are used instead of ligatures for small hepatic vessels.

Deeper down above the hilus a whitish firm structure appears which is exposed still further from above and in front, and using this as a guide the liver undersurface is divided up to the edge of the porta hepatic. The hepatic duct junction lies most superficially directly in the exposed fold of Glisson's capsule. This is verified by aspiration and/or by radiology if required. If the junction of both lobes is preserved, a longitudinal incision is made in the bifurcation, the greater in extent the smaller the duct calibre, and the more they are hidden by the cirrhotic liver. *Fig. 215.*

An excluded jejunal loop is prepared and sutured accurately in typical fashion to the bifurcation borders. One layer suture is used, side-to-end, or side-to-side of the gut, as the jejunal mesentery permits. If anastomosis is adequate no internal drainage is required, otherwise a derivation tube is brought out through the intestine or the liver.

If the duct junction is found to be constricted or completely interrupted, or if radiology shows that a segmental duct from the right side does not join the bifurcation, separate dissection of terminal duct portions on the right and of the origin of the left hepatic duct is done, the latter being exposed still



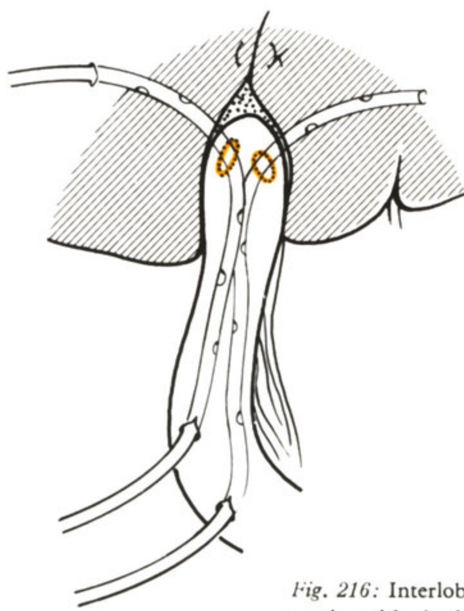


Fig. 216: Interlobar anastomosis with both separate hepatic ducts: Suture of open end of gut to the liver covering both hepatic duct orifices; approximation of liver incision and terminal or transhepatic drainage.

further by withdrawal of the quadrate lobe. Sclerotic connective tissue is removed and a surface area prepared into which all the lobar and segmental ducts respectively from right to left open. The excluded intestinal loop is sutured to the firm connective tissue on the circumference of this area, sufficiently far from the orifices of the ducts in question. Their lining is not in actual contact with the intestinal mucosa, but contraction of the anastomosis is prevented by the wide suturing of the intestine to the vicinity and to the sides of the transected liver edge. The upper part of the liver section is closed by U-stitches. Hemostasis is completed very carefully and tube drains placed above and below the liver. *Fig. 216.*

b) Intersegmental left cholangiojejunostomy: If communication between both lobes has been maintained and the bifurcation is inaccessible from under the liver, it may be more useful to connect jejunum with the hepatic duct of the left lobe third segment, than to attempt interlobar exposure of the bifurcation as just described. The left intersegmental procedure is more simple.

Surgical technique: We advance along the lig. teres hepatis to the anterior corner of the so-called recessus of Rex, where as a rule the third segmental duct can

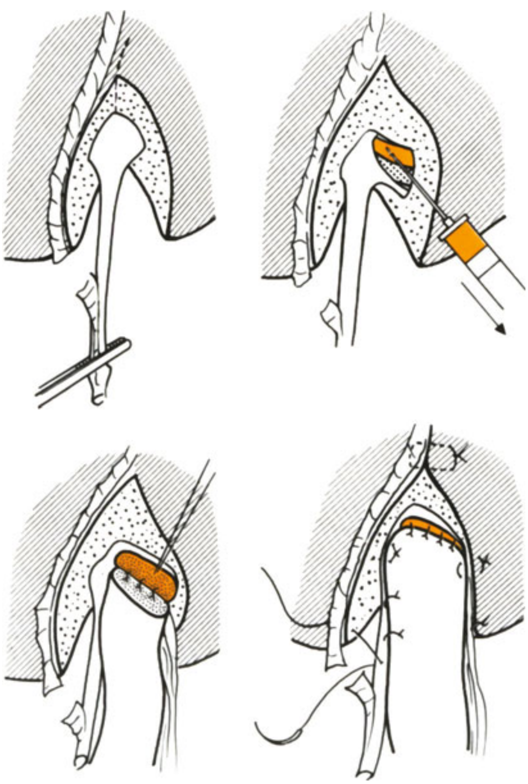


Fig. 217: Intersegmental leftsided cholangio-jejunostomy: (a) Approach to the recessus of Rex alongside teres hepatic ligament, (b) exposure and puncture of 3rd segmental duct, (c) suture of posterior jejunal border to duct edge, (d) completion of anastomosis and approximation of incised liver.

be exposed as it curves to the left. The best access is obtained by an arching subcostal incision, or the original incision extended towards the arch. The divided round ligament is stretched by artery forceps, the anterior portion of the falciform ligament cut through above the liver, and the liver penetrated closely along the glistening ligament sheath: we always hold on the liver convexity to the left of the falciform ligament insertion remnant. Blunt dissection with scissors is carried out and the liver opened up to the point where the glistening sheath of the ligament suddenly widens terminating in the anterior corner of the recessus of Rex at great depth. This connective tissue covering of the third segment hilus is cautiously opened. The portal vein runs in front, behind and above the bile duct and underneath is the artery, completely hidden behind the vein. We keep above the vein, identifying the duct behind it by aspiration. A longitudinal incision measuring several millimetres is made in the duct, and if it is dilated, it is sutured with fine atraumatic stitches to the excluded loop. According to the situation found an omega or Roux shaped loop is used and sutured laterally or terminally. In addition the gut is fastened to the borders of the intersegmental cleft and simultaneously to the oval ligament. The liver is closed with a few U-sutures in the upper end of the incision. *Fig. 217.*

If the segmental duct is not dilated or the third segment vessels have been damaged during dissection, the liver fissure is extended by resection of the third segment. Its hilar vessels are ligated and the segment resected at approximately right angles to the original incision. The limits for the resection required are sometimes suggested by a colour change following hilar vessel ligation. Bleeding points in the cut or contused surface are ligated and the liver transfixed with U-sutures. As much as possible of the segmental duct is preserved in the process.

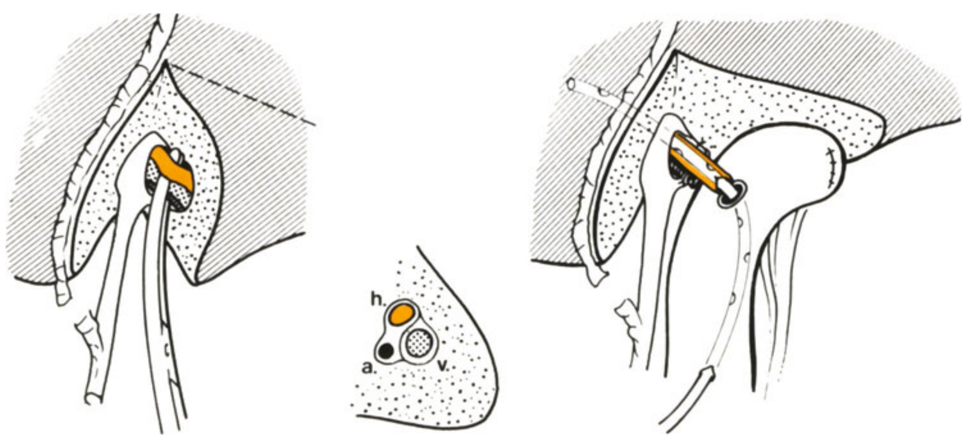


Fig. 218: Left-sided cholangiojejunostomy with resection of the 3rd liver segment: (a) Intersegmental access and exposure of bile duct, its mobilization with the resection incision outlined; (b) relative position of bile duct, artery, and portal vein in the recessus of Rex; (c) appearance after the resection of the 3rd hepatic segment and division of its angiobiliary bundle; the bile duct is connected by tube to an excluded loop.

It is incised longitudinally to enlarge its orifice into the connecting jejunal loop. Intestinal anastomosis is sutured routinely and the loop stitched to the resected liver borders. It is also fastened to the round ligament in order to cover the maximum of exposed parenchyma. A tube is inserted through the anastomosis, and brought out through the gut. Tube drains are placed against leakage of bile and blood from the liver into the surroundings. *Fig. 218.*

If the segmental duct is found to be narrow, but the accompanying vessels have remained undamaged, probing by catheter in a hilar direction may be tried, and with its assistance the hepatic duct in the hilus identified and exposed, if its identification by subhepatic dissection has failed previously. *Fig. 219.*

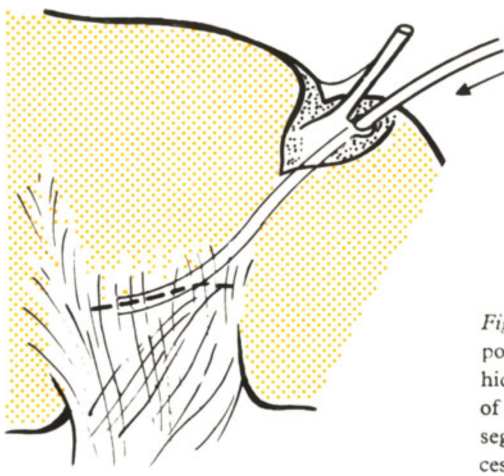


Fig. 219: Determination of the position of the left hepatic duct hidden by adhesions by means of a probe introduced into the segmental branch from Rex recessus.

c) Left-sided hepaticojejunostomy by combined suprahilar and transhepatic route: If wide anastomosis of the left hepatic duct exposed through the roof of the hilus is not feasible (p. 395) because fibrotic liver prevents access or the duct is narrow, access can be widened by incision of the liver tissue in the direction of the umbilical notch.

Surgical approach: Advance towards the left hepatic duct is made through the hilar roof disc (p. 394). If approach is narrow, the duct cannot be followed adequately to the left beyond the quadrate lobe border without endangering its vessels. For this reason the liver edge to the right of the ligament teres is incised first, and by a fresh intersegmental plane dissection is advanced from above downwards along the right border of the ligament to the recess of Rex, and the whitish hilar cover of the 4th segment. A catheter introduced from the hilus into the left hepatic duct serves as a guide. Only a bridge of liver tissue is dissected bluntly above it, whereas the biliary hilus sheath must not be opened. This is the only way to prevent its injury. In the space gained the left hepatic duct incision from the hilus is extended to a distance of about 1 cm in front of the recess of Rex axis.

Further extension would endanger the 4th segment blood supply. The intestinal loop is connected in the usual fashion. We have no personal experience with this operation, as described by Champeau and Pineau as early as 1964.

PERIPHERAL HEPATIC ANASTOMOSES

The classical operations of Longmire and Dogliotti preceded anatomical knowledge of the segmental anatomy of the liver and have since been substituted by a selective search for suitable dilated segmental branches. They have, however, not lost their significance even to-day if access to such a branch is not simple and the condition of the patient suffering from jaundice due to an inoperable cancer does not permit more than a short, simple intervention.

A unilateral operation is possible if radiology has demonstrated free communication at the confluence of bile from both lobes, otherwise a bilateral anastomosis would be required.

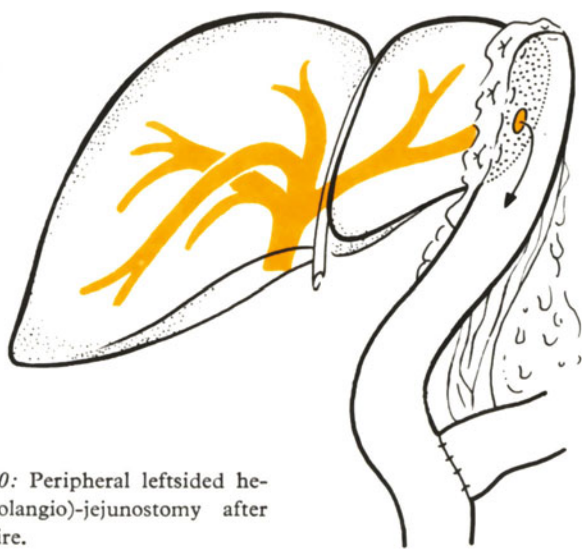


Fig. 220: Peripheral leftsided hepato(cholangio)-jejunostomy after Longmire.

a) Peripheral left-sided cholangiojejunostomy after Longmire: The left liver lobe is mobilized by incision of the terminal coronary and falciform ligaments. The end of the left lobe is resected until dilated bile duct is encountered in the cut surface. Liver hemorrhage is controlled by U-sutures shielded by teflon pads. The Roux-en-Y loop is sutured to the lower border of the cut surface and if the bile duct is wide, it is sutured to the mucosal opening in the gut. Otherwise a polyethylene tube provided with holes is inserted in the duct and brought out through the intestine. The exposed liver parenchyma ist then covered by the intestinal loop, which is sewn to the upper border of the cut surface together with omentum. *Fig. 220.*

b) Peripheral left-sided cholangiogastrostomy after Dogliotti: This differs from Longmire's operation by connecting the anterior stomach wall covered by omentum, instead of jejunum, to the resected liver surface, using it for suturing to the amputation area. Provided a tube has been inserted into the channel, this traverses the stomach on its way out.

Anastomosis with the stomach is exposed to reflux and the tube becomes dislocated more easily than is the case with Longmire's operation. The stomach instead of jejunum is used in those cases where a hilar anastomosis with the gut has already been performed and which has ceased to function. It would be time-consuming and unnecessary to discontinue it.

c) Peripheral right-sided anastomosis, cholangio- or hepatojejunostomy: These have not been so well elaborated and utilized as the left-sided versions.[37] Hepatography may be used for information about the position of a dilated bile duct and its selective exposure attempted, either with or without a resection of liver tissue. Sometimes such greatly dilated bile ducts are found closely under Glisson's capsule that a tube can be introduced into them by a simple direct incision. A jejunal loop is used for the anastomosis; support by omentum into which the necessary opening has been made is provided before suturing. *Fig. 221.*

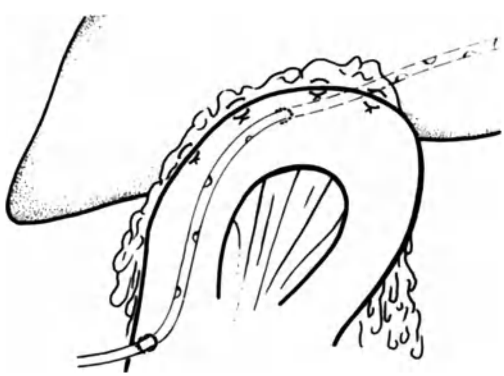


Fig. 221: Rightsided hepato(cholangio)-jejunostomy with a tube inserted into a dilated hepatic branch. The loop is sutured over an underlay of omentum.

d) Cholangio-vesico jejunostomy after Kolsky: This is an operation which should be tried only exceptionally, if a healthy gallbladder is available and the right liver lobe must be drained, in view of the fact that right hepatic duct blockage cannot be overcome in the hilus.

The gallbladder is partly mobilized from its fossa and needle exploration to the left and right for the assumed interlobar plane is carried out. If bile is aspirated the dilated bile duct is exposed alongside the needle track and this is sutured together with the liver to an opening made in the adjoining gallbladder wall. If evacuation of the gallbladder through the cystic duct is unreliable, its fundus is connected on the opposite side to the gut.

e) Bilateral anastomoses: In cases where drainage of both liver lobes is required and their biliary union in the hilus is interrupted and inaccessible, va-

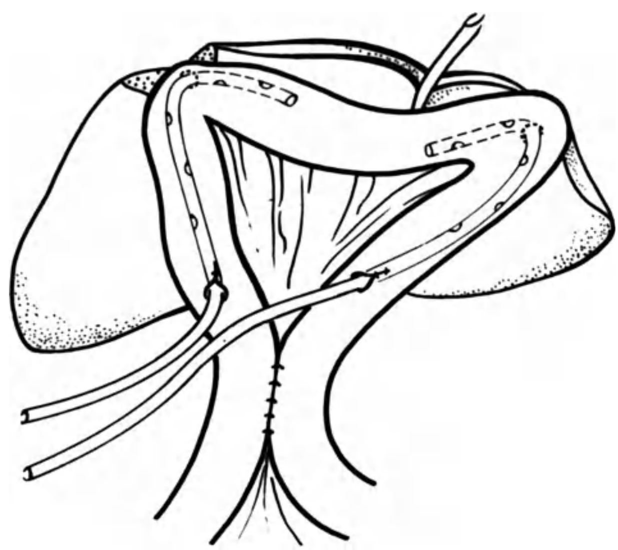


Fig. 222: Bilateral cholangiojejunostomy (on right with wedge excision of liver, on left without). Tubes from the hepatic branches are brought out through the gut.

rious combinations of the interventions quoted for the right and left lobe can be used according to the given situation, and thus double, bilateral anastomosis performed. *Fig. 222.*

Prognosis of hepatic anastomoses

The future of the patient is determined more by the character of the underlying disease, than merely by the satisfactory function of the anastomosis. It may be stated in general that peripheral anastomoses are less exacting but also less effective. They may, however, provide sufficient transient relief in jaundice due to malignant obstruction.

Central intrahepatic operations are delicate, even exacting, with frequent complications and failures. This is in part due to the fact that indications for them are rare and that they are approached without wide personal experience.

Extra-abdominal “anastomosis”

This in substance is the connection of a tube draining bile from the duct or from an external fistula of long duration to a tube introduced into the abdominal cavity and into the gut at a different site. Indications for such a procedure are exceptional indeed, if we want to supply the patient’s own bile into the gut.

Surgical technique: The abdomen is entered through a fresh incision, at adequate distance from previous scars and drain. The highest jejunal loop is selected and a thin tube after Witzel sutured into it. This is brought out and secured by a stitch. Both drains, biliary and Witzel’s, are joined with a transparent inter-connection. This is armed with a three-way valve, thus a bile sample can be collected and investigated at any time and drains washed through. *Fig. 223.*

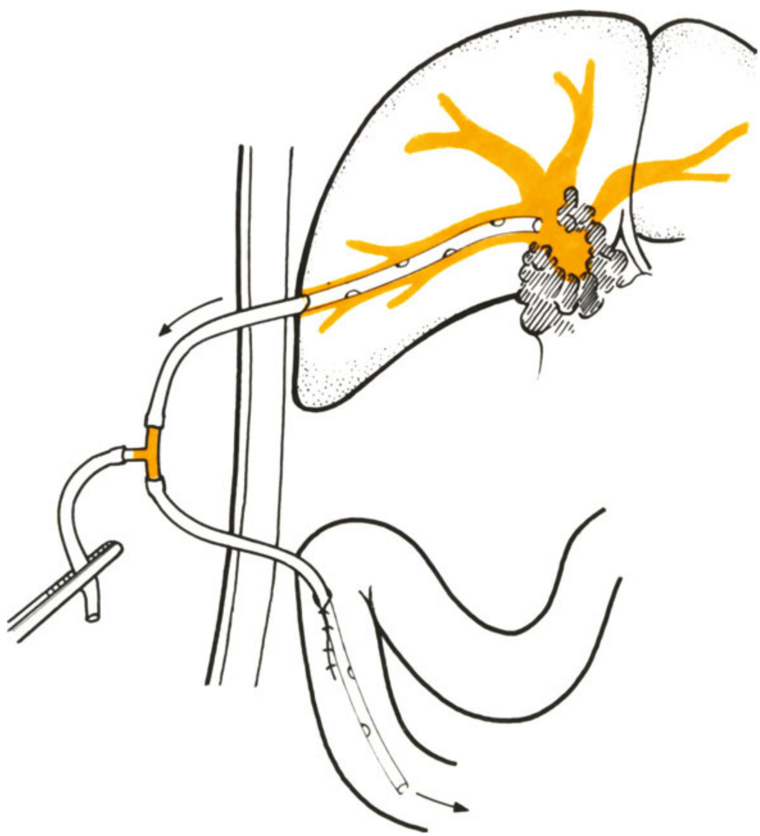


Fig. 223: Extraabdominal “anastomosis”. Transhepatic tube from hepatic branch is linked in front of abdominal wall to tube inserted separately into the abdomen into an upper jejunal loop.

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BILIARY ANOMALIES

Congenital abnormalities of the biliary tract may be subdivided into two groups: anomalies without clinical manifestations and abnormalities with clinical symptoms.

Anomalies without Clinical Manifestations and Sequelae

Congenital anomalies of this type are common. The so-called normal anatomical pattern and disposition of the biliary tract and its vessels is in actual practice encountered in only about one-third of patients. These deviations, listed in the chapter on surgical anatomy (p. 33), are really mere anatomical variants. They produce no signs or symptoms but are found routinely at operation by the surgeon. For this reason they must be known just as well as the "normal" anatomy — failure to recognize them is at the root of many mistakes and operative injuries resulting in grave consequences.

Anomalies with Clinical Manifestations and Symptoms

Congenital malformations causing clinical symptoms and complications and sometimes not even compatible with survival, include:

Atresias and stenoses of the biliary passages
Agenesis and hypoplasia of the biliary tract
Cysts and dilatations of the ducts
Congenital common duct perforation
Duodenal diverticula in the papilla region

Congenital Atresias and Stenoses

As a rule, evidence of these makes it appearance soon after birth or in early infancy, a time at which the further fate of the child is decided. It depends on the extent of lesions, whether surgery is feasible at all — no other treatment exists. These operations are amongst the most exacting in the field of pediatric surgery, they are risky and their outcome uncertain.[3, 26, 38]

The first surgeons to attempt surgical treatment of atresia are supposed to be Witzel (1895) and subsequently Holmes (1916). But is was only in 1927 that Ladd could register the first success. A number of surgeons then attempted to treat this disorder, but with no marked success. In scarcely 5–10% of the cases could a suitable anastomosis be established, but even most of these finally died of cirrhosis. Moreover, an exploratory laparotomy performed in cases of hepatitis might probably lead to deterioration of the disease. As far as intrahepatic atresia is concerned, its prognosis was practically completely lethal, it was regarded as inoperable, and a number of attempts at its surgical treatment resulted in failure. The situation started to change after 1959, when Morio Kasai introduced his hepatic portoenterostomy, which was afterwards modified. In Kasai's opinion successful surgical treatment is, at present, possible in 80% even of "inoperable" atresia cases, if one operates at the latest within the first 10 weeks of life. Only few children can be saved as late as after 3 months.

Etiology and pathology

The cause of congenital atresia has not been determined so far. The theory that it occurs — in a similar way to intestinal atresia — if the development is arrested in the so-called "solid stage" and no lumen is formed, has been more or less abandoned. At present it is thought that it is due to inflammation; one can therefore understand the difficulties encountered by pathologists when interpreting histological inflammations.

Atresia may be extra- or intrahepatic. Both may be only partial and various combinations are possible. Rarely the atresia involves the entire internal and external biliary tree. *Fig. 224.* Since Kasai's epoch-making work we no longer speak of corrigible and incorrigible atresia.

It is important to know that if the disease lasts for some time — i.e. mostly as

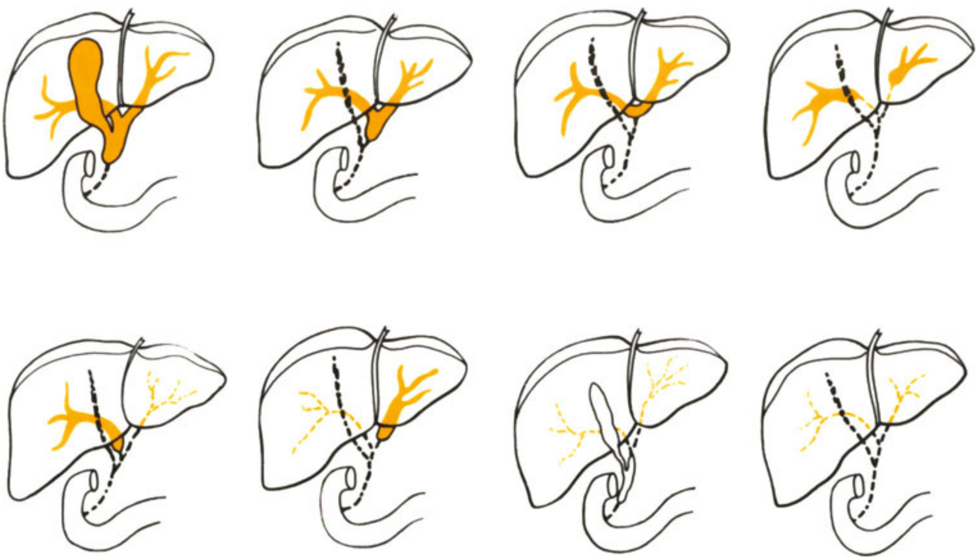

Fig. 224: Types of congenital biliary atresia. – Extrahepatic atresia: (a) of distal choledochus, (b) gallbladder and choledochus, (c) gallbladder and the whole extrahepatic duct sparing the bifurcation, (d) of extrahepatic duct including the union of hepatic ducts. – Atresia partly extrahepatic and intrahepatic: (e) of extrahepatic common duct and left intrahepatic ducts, (f) extrahepatic common duct and right intrahepatic ducts. – Intrahepatic atresia: (g) of intrahepatic bile ducts sparing the external ducts, filled with mucus. – Extrahepatic and intrahepatic atresia: (h) involving all bile ducts system.

early as in the 12th week of life — biliary cirrhosis and sometimes also portal hypertension starts to develop.

Clinical features

The most marked sign is jaundice of an obstructive character. It need not be evident at birth and immediately after. It is only later that it becomes conspicuous. After birth the meconium may even be coloured by the bile, since most of the colouring is from bile which passes by the hematogenous route. However, when the jaundice has once made its appearance, it does not subsequently disappear, even temporarily, but progresses steadily. The stools are pale and the urine is dark. Surprisingly enough, these children remain for a comparatively long time in a good condition. The abdomen is enlarged by the liver, which has a hard edge and extends far below the costal margin. The spleen is also enlarged.

Laboratory results. The blood count is usually anemic. Bleeding time and coagulation time are usually not prolonged from the outset. Blood cholesterol levels and the thymol reaction are normal. Alkaline phosphatase levels are raised, and a high blood bilirubin level with a positive van-den-Bergh reaction is the rule. There is bilirubin, but no urobilinogen in the urine.

Differential diagnosis. In most cases it is not difficult to exclude, in the newborn, physiological jaundice, the nowadays very rare syphilitic jaundice, and septic jaundice. Similarly, it is mostly possible to differentiate jaundice due to enzymatico-metabolic and hematological disorders. Erythroblastosis on the base of blood incompability could also be a cause of very severe jaundice in the neonatal period. Coomb's reaction makes the diagnosis sure. Inspissation of bile may develop which only exceptionally needs surgery. — Inspissation of bile exists, however, even without erythroblastosis. The correct diagnosis is most often done only during the operation.

The greatest difficulties are presented by acute hepatitis of the newborn.[5, 31] In these cases, weekly assay of total bilirubin has proved of value: in atresia it slightly increases, in hepatitis, on the contrary, it gradually decreases. The determination of serum leucine aminopeptidase activity (LAP), needle biopsy of the liver, the determination of the presence of bile in the aspirated duodenal contents, and also the ^{131}I Rose Bengal excreting test with liver scintigraphy have proved useful.

Treatment

Children with atresia usually have hypoprothrombinemia. It is therefore, necessary to administer vitamin K_1 daily for about one week prior to operation. In patients with a normal prothrombin level the dose is halved. When there is anemia it should be improved by blood transfusion. It is advisable, in most cases, to start a broad-spectrum antibiotics (kanamycin, colistin) one day prior to the operation.

The abdomen is entered through a supraumbilical transverse incision. The small gallbladder — if it has developed at all — is usually deeply imbedded in the liver tissue. After having incised the peritoneal covering of the hepato-duodenal ligament with caution, one has to make sure whether it contains the biliary duct, the portal vein and the hepatic artery. The site and size of the hepatic, common bile, and cystic ducts, and the gallbladder are cautiously explored. If the hepatic duct and the common bile duct are not present or seem to be atretic, but the gallbladder is normally developed, this is punctured and aspirated. It may contain only mucus, which points to atresia of the hepatic duct. If the gallbladder contains true bile, then the hepatic and cystic ducts are patent, even if they seemed, macroscopically, to be obliterated. Intraoperative cystocholangiography is performed when the extrahepatic ducts seem to be patent and one wishes to find out if intrahepatic atresia is present.

A. Atresia involving part of the extrahepatic bile passages. In these children some of the following anastomosing operations[2] are carried out:

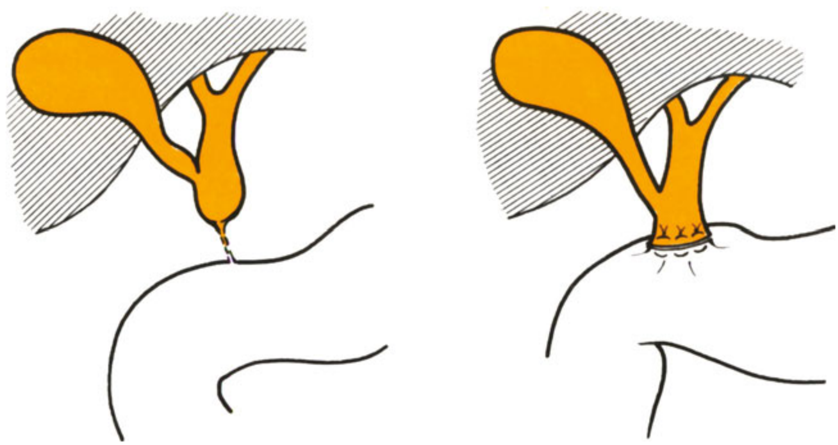

Fig. 225: Atresia of distal common bile duct for which choledochoduodenostomy was performed.

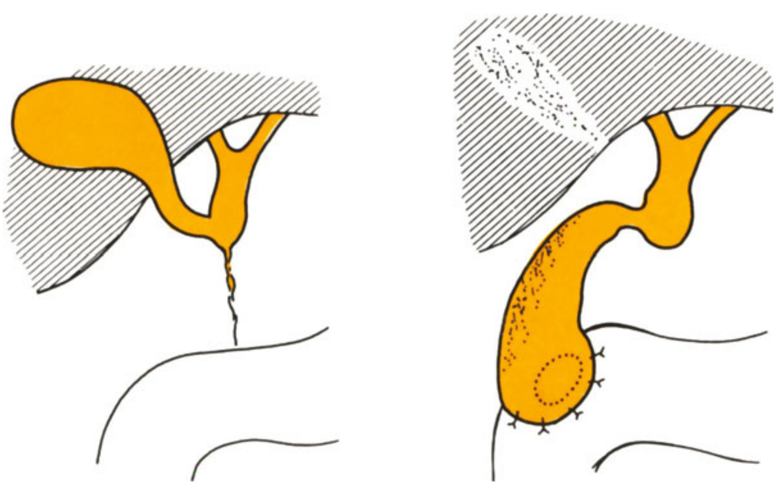

Fig. 226: Atresia of the entire common bile duct for which cholecysto-duodenostomy was perfomed.

In atresia of the distal portion of the common bile duct a choledocho-duodenostomy is performed, end-to-side or side-to-side to the top of the duodenum. *Fig. 225.* We prefer this to a cholecystoduodenostomy, if it is technically feasible. Because of the small size of the organ we usually place only one layer of stitches on a temporarily inserted catheter.

In atresia of the entire common bile duct, when the hepatic duct communicates with the gallbladder, a cholecystoduodenostomy is performed. The

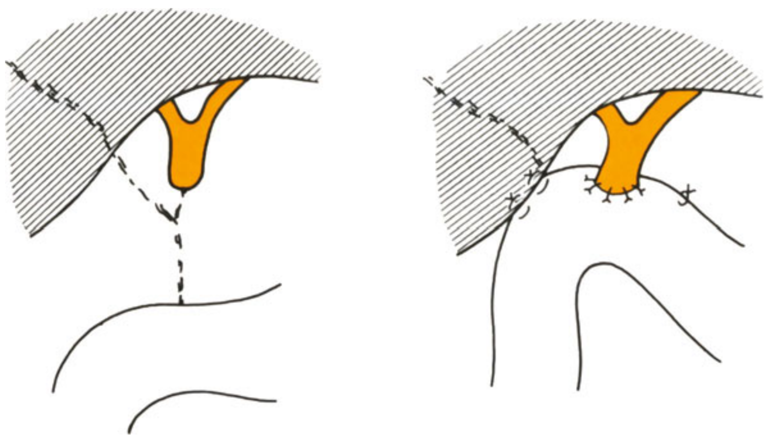

Fig. 227: Atresia of the common bile duct and gallbladder with cystic duct for which hepaticoduodenostomy was performed.

gallbladder is freed from its bed, turned downwards and joined to the duodenum. *Fig. 226.*

If the cystic duct and the gallbladder are obliterated as well, a hepaticoduodenostomy is performed, which is naturally much more difficult. *Fig. 227.*

B. Intrahepatic atresia. This type of atresia was considered to be non-correctable. It was the operation of Morio Kasai (1959), called hepatic porto-enterostomy which the first was crowned with success: a search is made for the bile passages in the hepato-duodenal ligament; if they cannot be found macroscopically, or only their rests are present, these are excised as far as the porta hepatis. An Y-shaped jejunal loop is then joined by a short enterotomy to the porta hepatis.

The most serious postoperative complication is the development of ascending cholangitis, which usually cannot be warded off even by the prolonged administration of broad-spectrum antibiotics.[32] Temporary complete separation of the bilio-digestive anastomosis from the intestinal tract is probably the most reliable method for dealing with this complication (Sawaguchi, 1968). How to carry out such an operation can be seen in the illustration. *Fig. 228.* It is essentially Kasai's operation, which for this purpose has been modified by Suruga.

Postoperative management. Besides the customary postoperative care, it is recommended to promote the flow of bile by i.v. injections of 2% dehydrocholic

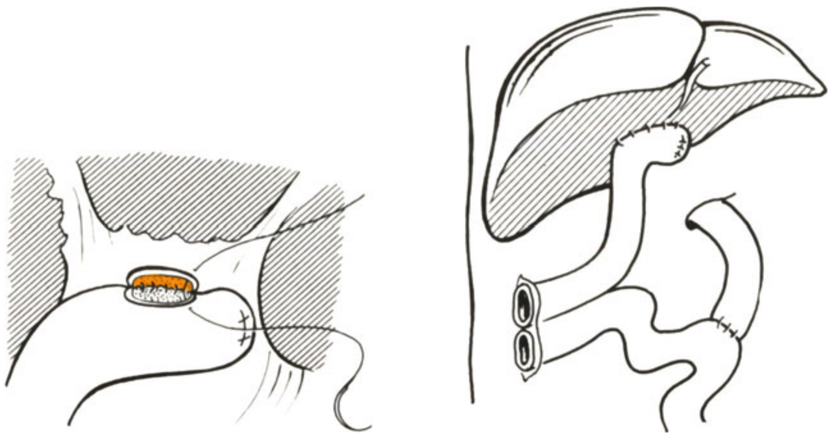

Fig. 228: Hepatic porto-jejunostomy after Kasai-Suruga: (a) Jejunal loop-en-Roux is sutured by a small opening to the porta hepatis in front of the vessels. (b) Anastomosis is temporary excluded by double-barrelled jejunostomy.

acid given for 3 weeks after operation. Then oral choleretics are given for several months. Antibiotics are required for at least 4 weeks after the original operation of Kasai. In the case of Suruga's modification, one week will suffice. Besides, prednisone has been found useful, if there are signs of cholangitis.

A number of other operations for the intrahepatic „non-correctable" atresia have been suggested with great ingenuity and worked out in detail, e.g. artificial bile ducts (Sterling, Champeau), hepatic porto-gastrostomy (Ikeda, Suita), thoracico-esophagostomy (Williams, Dooling, Suruga). *Fig. 229.* However, they seem to be more or less abandoned.

Lymphatico-porto-jejunostomy (Fonkalsrud, Kitawaga, Longmire, Flach) in which a small surface area of the jejunum, deprived of its serosa, is sutured to the porta hepatis, may lead to the formation of lymphatic channels capable of transporting the bile into the intestine.[39]

At present probably Suruga's modification of Kasai's operation seems most suitable for the "non-correctable" type. Transplantation of the liver in infancy has been successfully performed, but although promising it remains a problem yet to be solved (Starzl, Putnam).

A non-operative treatment is also taken into consideration and the possibility of the use of B-proline in the congenital bile atresia is studied in Children' Hospital in Boston by J. Folkmann et coll. (personal communication, 1978). It was found that the amino acid B-proline may be the active agent inducing the bile ducts hyperplasia in animals with fascioliasis.

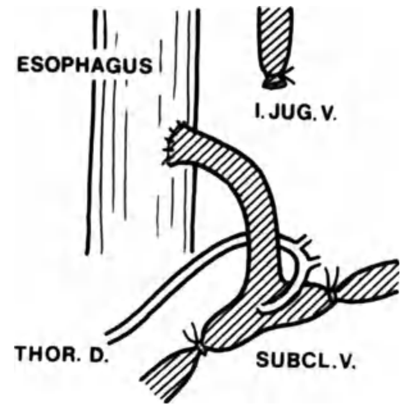

Fig. 229: Anastomosis between thoracic duct and esophagus. Lymph is drained via the excluded section of the left subclavian and jugular veins into the esophageal anastomosis.

Agenesia and Hypoplasia of the Biliary Tract

Agenesis is incompatible with survival and the newborn cannot be saved at present. Hypoplasia, on the other hand, need cause no symptoms throughout life, but may hamper diagnosis, making the distinction from diffuse hepatobiliary stenosis of inflammatory origin, e.g. with sclerosing cholangitis, a difficult matter.[28] In contrast to the latter, however, the hypoplastic duct walls are quite delicate and no lesions can be demonstrated even by histological examination.

Hypoplasia, as pointed out by Lilly, may also be merely a secondary phenomenon associated with some neonatal hepatitis cases, or may accompany extrahepatic biliary atresia or congenital cystic biliary duct dilatation and participate thus in the origin of jaundice. If, following operation of the primary malformation, improvement is not achieved, and if a check several weeks later reveals transition from hypoplasia to atresia, porto-enteroanastomosis is indicated. The author has no personal experience with this.

Dilatations and Cysts of Bile Ducts

A large number of these anomalies has been described and variously designated, producing something of a terminological muddle.

Mostly these are cases of biliary dilatation, by which is understood a congenital limited widening of any portion of one of the bile ducts. Its extent may vary, as does its shape. The underlying cause is most likely a defect in the fibroelastic components in the subserosal and submucal layers of the duct wall.

Only pedunculated cysts deserve to be correctly classified as congenital cysts, or rather as duct diverticula, either extra- or intrahepatic. They originate similarly to dilatations, or perhaps by excessive cell proliferation and vacuolization.

Contemporary investigation techniques, ultrasonic echography, ascending and percutaneous cholangiography reveal these malformation more frequently than was the case in the past, even though pronounced clinical manifestations may be missing. New types and combinations have been demonstrated, which require additions to the classification of Alonso-Lej, Glenn a.o. Classifications taking into account the different surgical procedures required are valuable for the surgeon, for this reason the writer prefers the latest classification of Todani (1978). Some anomalies belong to the category of rarities, while others are of practical significance because of their frequency and account is taken of them accordingly.

Fig. 230ab: Cystic diverticulum of the common bile duct: (a) supraduodenal, (b) prepapillary.

They may also be merely an incidental finding, as symptoms occur occasionally, mainly if delayed or impeded bile flow is produced in the dilatation or cyst. This creates a disposition for bacterial growth and the precipitation of pigment stones inducing evident obstruction and cholangitis.

Extrahepatic dilatations and cysts

These usually involve the extrahepatic ducts in one section and only rarely are multiple or diffuse.

Cystic diverticulum

Cystic diverticulum or pedunculated biliary duct cyst is a rarity, described as early as 1720 by Vater. The pedicle is of varied width and can be radically excised. It may be located in the prepapillary region where the cystic diverticulum bulges convexly into the gut. In such a case its division should be accompanied by papillosphincterotomy. *Fig. 230.*

Cystic dilatation of the common bile duct - choledochal cyst

This anomaly is frequently inaccurately termed "choledochal cyst". This is rarely encountered in adults, as almost half the cases become manifest and are diagnosed by the age of ten, mainly by means of the triad of symptoms: pain, jaundice and palpable mass. This clinical description was made by Douglas in 1852, but the cyst was first reported by Todd in 1818.

Etiology and pathology

In this disorder the common bile duct and usually the common hepatic duct are strikingly elliptically or spherically dilated, thus creating the appearance of a cyst. This dilatation sometimes also involves one or both hepatic branches, but does not extend into the liver, neither does it affect the gallbladder, even if the latter joins the cyst separately from the hepatic duct. The distal common bile duct segment is likewise never dilated; on the contrary, it is typically narrowed, its course anomalous[36] and its opening into the gut small, even indistinct. *Fig. 231.*

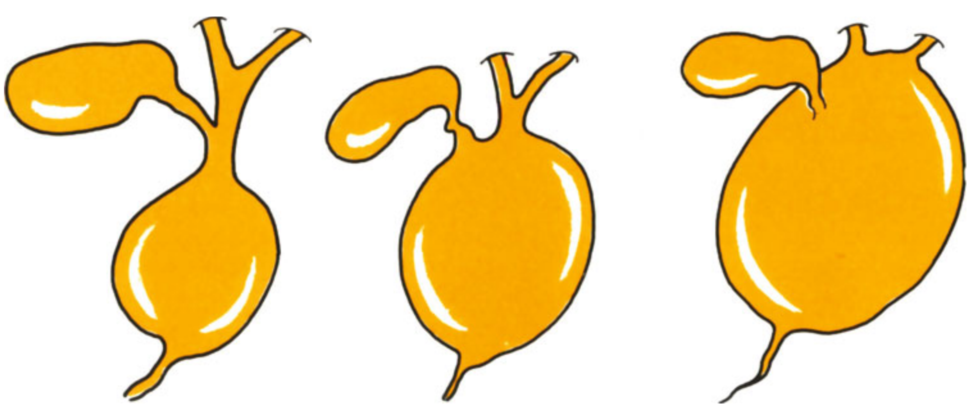

Fig. 231abc: Cystic dilatation of the extrahepatic common duct or "choledochal cyst". (a) Common bile duct opens into cyst, (b) common hepatic duct and separately cystic duct, (c) separately both hepatic ducts and cystic duct.

This malformation impedes bile flow and may thus, according to Olivier, participate in the origin of the "choledochal cyst". The underlying cause of the latter, however, is an embryonic weakening of a common bile duct segment, otherwise dilatation of gallbladder and intrahepatic ducts would accompany it.

Cystic dilatation may vary in size from a golf ball to a child's head, or even larger, containing variously inspissated bile. The cyst wall is composed of non-elastic fibrotic tissue, even several millimetres in thickness, but usually lacking an epithelial lining.

"Choledochal cysts" are rare, but the surgeon must be prepared for them to avoid a catastrophe by embarassed and devastating dissection. Hundreds of cases have been recorded but many more must have remained unpublished.[18, 23, 54, 56]

Clinical pattern

Clinical manifestations of the cyst appear as a rule in the first or second decade and in about 80% of cases surgery is required before the age of 25 is reached. Out of the classical triad: pain, jaundice and palpable mass, each sign may also be present independently, or no symptoms appear at all for a long time.

In neonates jaundice is frequently the sole symptom indistinguishable sometimes from other types of obstructive jaundice. As noted by Lilly, liver biopsy contributes nothing to diagnosis, sonography, however, may not uncommonly disclose a cyst even in this neonatal period.

Later the disorder usually presents by colicky pains, or there is less defined discomfort in the right hypochondrium or the umbilical region, associated with nausea, or more rarely vomiting. In nine out of ten cases an elastic, but sometimes firm, mass is palpable under the costal arch which may extend beyond the midline and may vary in size in the same patient, according to the degree of filling. Jaundice is usually also present, either permanent or intermittent, with acholic stools and bilirubin in the urine. Frequently, however, individual symptoms may escape attention during childhood by their instability.

Onset and severity of symptoms in adults are neither correlated so much to cyst size as to the mounting obstruction in the bile duct. If obstruction is incomplete many years may pass without any symptoms. If, however, in due course, the congenital obstacle narrows or closes by inflammation or enlargement of the cyst, biliary obstruction of a temporary character appears with increasing frequency and intensity, to be followed later by cholangitic attacks, making surgery mandatory or it may terminate in biliary cirrhosis. Liver abscess or portal thrombosis are rare complications.

Only occasionally does an adult seek medical advice right from the start on account of the classical triad without several years history of symptoms, or does excruciating pain due to cyst distension or rupture make urgent surgery unavoidable, or does pressure on neighbouring organs produce violent symptoms. During pregnancy a cyst may present in such a fashion for the first time, exceptionally at the very start of her confinement, such as was the case in a 20-years old female observed personally.

Recognition of a congenital common bile duct dilatation before operation is rarely accomplished. A palpable mass of elastic structure must be differentiated from pancreatic cystoid, hydronephrosis, distended gallbladder and liver cysts. It is characteristic for biliary duct cysts that they fail to follow respiratory excursions, and that they displace the duodenum backwards and medially, and the stomach to the left. Sonography, urography, cholangiography and barium meal examination may also be helpful.

Treatment

Treatment is exclusively surgical, otherwise these patients succumb relatively early to biliary cirrhosis. Exceptionally perhaps aged people lacking pronounced symptoms need not be submitted to operation.

Patients reach the table usually without definite diagnosis, but at laparotomy the cyst must be diagnosed as rapidly as possible, without shock-producing exploration. The presence of a non-pulsating sac of varied size projecting beneath the liver next to a normal gallbladder, and not infrequently overlapping the duodenum is diagnostic. The latter is displaced medially and backwards and frequently adheres to the sac quite firmly. Its contents are explored by aspiration, this is decisive for diagnosis. Bile is aspirated, sometimes amounting to several litres, and of varied appearance according to the presence of infection, and duration of jaundice. It is astounding that in a cyst with such sluggish bile circulation, frequently infected, stones are present in barely 1% of surgical cases.

Subsequent cholangiography, though providing more precise information about the cyst, has no particular practical value, particularly if the sac is large. In any case drainage from the cyst could not be arranged by the normal route, even if the distal deformed bile duct segment could be demonstrated. For this reason the sac is explored from the inside through a small incision and the cystic and hepatic ducts are identified by sight and palpation — not an easy task as a rule. Detection and reliable assessment of the origin and patency of the distal common bile duct segment frequently cannot be achieved at all. Neighbouring viscera are cautiously explored, particularly the liver from which a biopsy specimen is obtained.

Three types of intervention may be employed: drainage, anastomosis and resection, the latter having become the method of choice of some snrgeons.[25] A longitudinal transrectal abdominal incision on the right is suitable. The type of procedure is selected according to the local condition, overall risk, and the surgeon's preparedness. The general rules are, under no circumstances attempt the restoration of flow through the terminal bile duct and papilla, and always remove the gallbladder — which might be a source of further symptoms — and extirpate the cyst as far as possible.

a) Cyst drainage

Mere drainage of the cyst is a quite exceptional, rapid solution in a critical situation. A drain is inserted, e.g. Pezzer's, into the cyst preferably through the previous puncture site. It is fixed by purse string suture and carried outside by

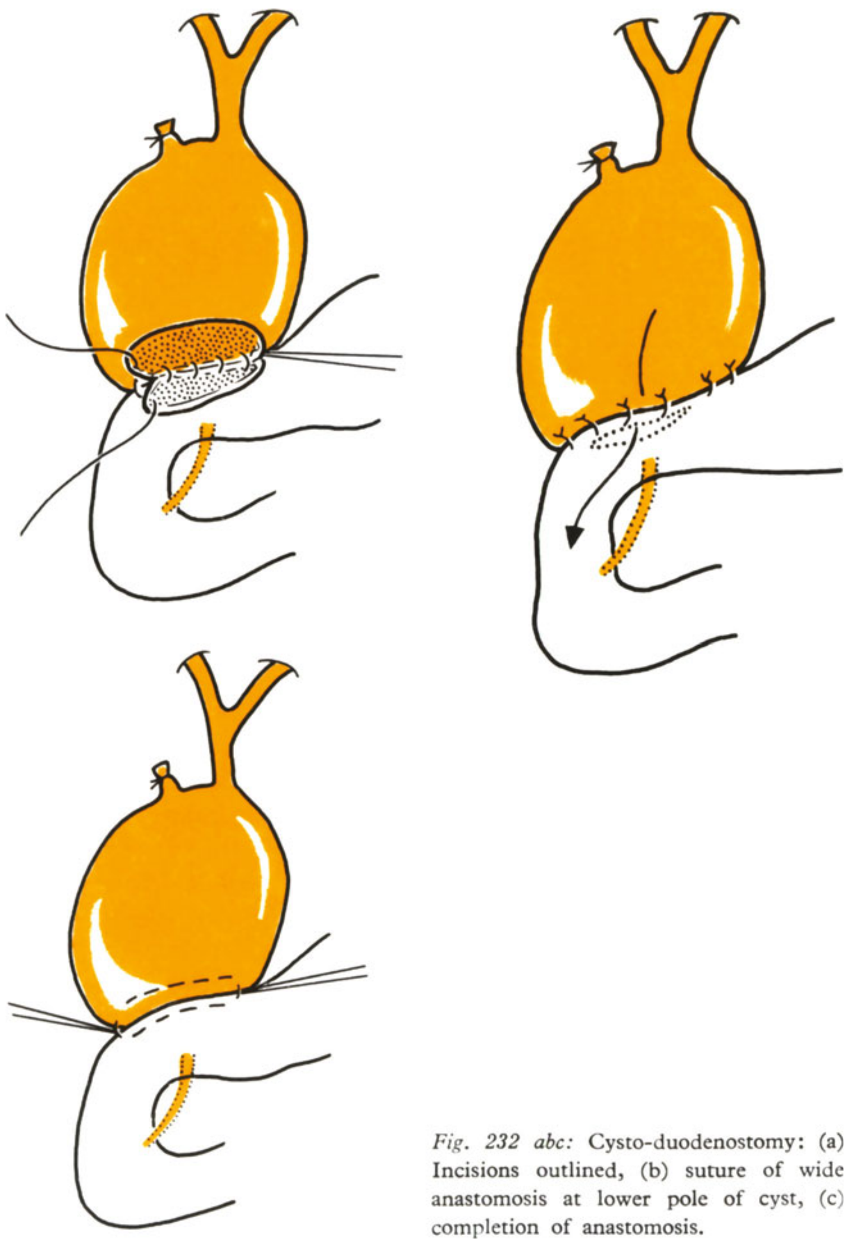

Fig. 232 abc: Cysto-duodenostomy: (a) Incisions outlined, (b) suture of wide anastomosis at lower pole of cyst, (c) completion of anastomosis.

means of a stab incision. Intervention must always be completed in a second stage, a step made more difficult by the biliary fistula.

Plication of the cyst wall has been abandoned altogether.

b) Anastomoses

Nowadays these are considered as mere emergency measures, if a rapid and simple intervention is required. It is none the less still useful in the presence of severe inflammatory lesions and in infancy.

Cystoduodenostomy. — A precondition is a close contact between duodenum and cyst, the latter impinging on the former by its lower pole. After aspiration of the cyst cholecystectomy is performed and the cyst entered as low as possible where it adjoins the duodenum. Its contents are evacuated and submitted for bacteriological investigation. If the hepatic orifice or its branches are identified and found to be narrowed, gentle dilatation is performed. The duodenum is then incised longitudinally close to the opening in the cyst, and the posterior border of the anastomosis sutured with chromic catgut by single stitches tied internally. The external border is sutured in two layers with nonabsorbable stitches tied externally. The anastomosis must be wide, at least 5 cm, and the sac should not flop below its level. *Fig. 232.*

The advantage of an anastomosis with the duodenum is its simplicity and the fact that the posterior border is safeguarded by adhesions between cyst and duodenum. Its disadvantage is food reflux and the emergence of cholangitis even with a wide link.

There is also a distinct tendency for the anastomosis to shrink because sac volume decreases and because a wall without mucosa is sutured. In other instances, however, cyst shrinkage is unexpectedly slow, if its walls are thick and sclerotic.

Cystojejunostomy. — This may be utilized for the same reasons as the duodenal anastomosis, but in the presence of a large, overhanging sac. Operation is identical with the foregoing, only a jejunal loop is used which is sutured side-to-side to the lowest portion of the sac. The loop is passed in front or behind the transverse colon, freely, and its arms connected by a wide anastomosis at a distance of at least 25 cm from the anastomosis with the cyst. The patient is protected from food reflux into the sac still more successfully if a partly excluded jejunal loop after Roux is employed (p. 390). *Fig. 233.*

c) Cyst resection

Radical extirpation of the cyst with hepatico-jejunostomy is considered most effective and becomes pressing in cases where the hepatic orifice in the cyst is found to be stenosed.[17, 25, 31] The entire pathological sac is removed, thus offering the best protection against cholangitis, later cancer, and other complications.

Cyst extirpation. — Following cyst evacuation by puncture cholecystectomy is performed and the upper cyst pole mobilized. Hepatic duct, before its entry into the cyst, is dissected out and a drain or tape passed under it. The cyst is now freed,

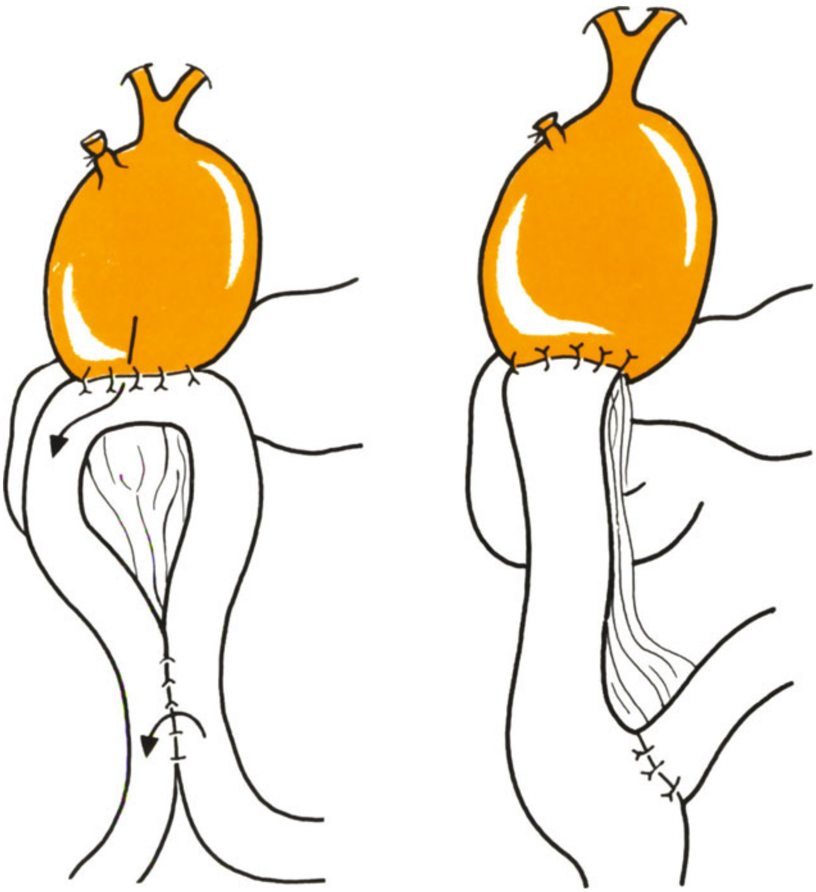

Fig. 233: Cysto-jejunostomy: (a) Employing an omega shaped loop, (b) employing a jejunal-en-Roux loop.

its separation from duodenum and pancreas in the correct plane being particularly difficult, as these are not only stuck together but also connected to it by vascular adhesions. It is best to open the cyst and dissect its walls carefully over an inserted finger. The course of the hepatic artery must be verified early on and protected, as this may be dislodged into an unusual position. Injury to pancreas must be avoided during dissection of the outgoing distal bile duct. The latter is divided below the cyst and the peripheral stump ligated. The common hepatic duct is now gripped firmly immediately proximal to the cyst and divided in front of the clamp. The cyst bed is checked and the jejunum connected to the hepatic duct, preferably as an excluded loop. A drain is placed to the cyst bed. *Fig. 234.* Postoperatively

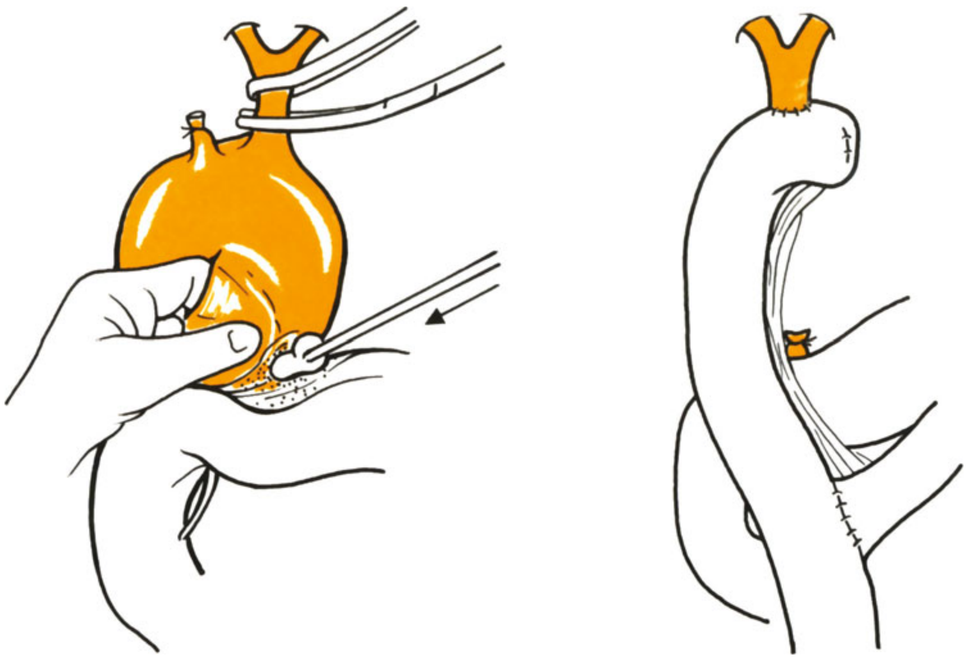

Fig. 234: Extirpation of cyst: (a) Cholecystectomy and mobilization of cyst checked by inserted finger, (b) appearance after extirpation and hepatico-jejunostomy.

there is the menace of pancreatitis and infection, as the cyst vicinity usually harbours inflammatory infiltrations.

If radical operation becomes too hazardous, total extirpation of the cyst, if begun, must be abandoned in time, and at least partial excision performed as far as possible.

Cyst extirpation leaving part of the posterior wall in situ. — With inflammation and firm adhesions between cyst and its bed, removal of the posterior cyst wall may become extremely difficult and there is real danger of large vessels injury, as the latter are not only adherent, but frequently also dislocated. For this reason Lilly had operated several of his last cases in such a manner that he extirpated only the inner lining of the posterior wall from inside of the cyst. The cyst is opened transversely, leaving the posterior wall intact "adjacent to the portal vein and hepatic artery". An arbitrary plane of dissection is selected in the remaining posterior wall which separates it into two layers and the cyst is stripped from the residual posterior wall by blunt dissection. Only a thin shell adherent to the vessels is left.

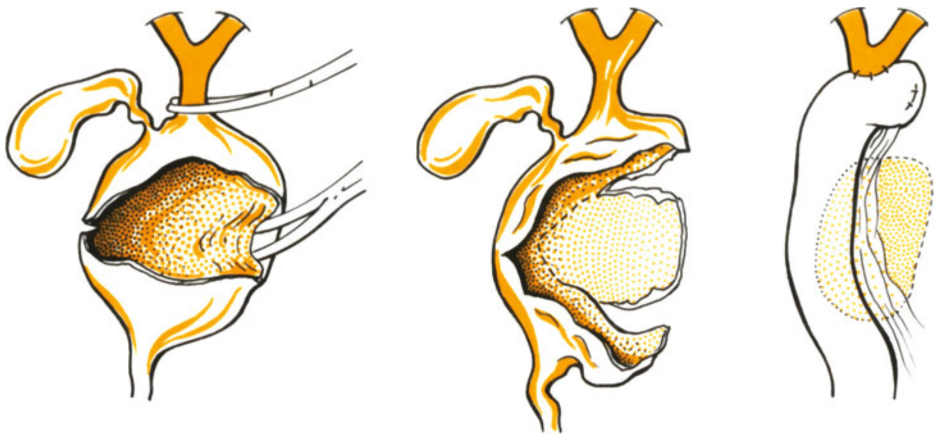

Fig. 235: Cyst extirpation leaving the posterior wall surface in situ (a); leaving a part of the posterior wall in full thickness (b); appearance after extirpation and hepaticojejunostomy (c).

Fig. 236: Subtotal cyst extirpation leaving the upper pole behind.

In other cases of a cyst grown on to the underlying vessels a part of its posterior wall may be left in situ in its whole thickness. The postoperative course in a patient operated in this way by the author was uneventful. *Fig. 235.*

Subtotal cyst extirpation leaving the upper pole behind. — If both hepatic ducts open into the cyst separately, or dissection of the upper pole is risky, this may be left in situ together with the hepatic orifices and only the remaining part of the cyst removed. The jejunum is now sutured to the upper pole remnant. *Fig. 236.*

Prognosis

All the interventions listed — exigent, paliative, and radical — have their indications. The anastomoses preferred previously rid the patient of his symptoms and carry a good prognosis provided stoma stenosis fails to develop. Nevertheless, at present cyst extirpation is increasingly recommended, as its considerable hazard has declined, its surgical mortality of 8% close by approaches that of anastomosis, and its long-term results are even better. A good surgical prognosis depends, however, on cyst operation before the onset of complications, before recurring obstruction and cholangitis have caused irreversible liver damage. It is these lesions which decide the patient's fate, as a rule within three years of operation. Prognosis is also uncertain in patients affected simultaneously by congenital cysts of the intrahepatic ducts, a combination which is more common than previously thought.

Radical excision of the entire cyst has the added advantage that it may prevent the later development of cancer, reported in about 3% of cases.[4,25,52] Protection, however, is not absolute. The author, together with the obstetrician Šebek operated a young pregnant female in whom complete obstruction of the cyst had occurred just before parturition. Caesarean section was supplemented by cystoduodenostomy. After 3 years of full health a carcinoma in the operative field was found at relaparatomy. This, however, did not originate from the cyst, but from a malformation of the terminal biliary duct, which would be left behind even in total cyst extirpation.

Short segmental dilatation of common bile duct

This type differs from "choledochal cyst" mainly by its shape and size.[12] A fusiform dilatation is usually not recognized until operation, when it becomes necessary to exclude a very similar dilatation accompanying a peripheral obstacle from stone or stenosis of the papilla, which, however, is not usually limited to a duct segment. Surgery must guarantee adequate bile drainage by anastomosis.

Sometimes a small ovoid dilatation may involve such a small section that both ends, after its resection, can be resutured and continuity thus restored. A condition, naturally, is patency of its distal portion.

Congenital diffuse dilatation of exprahepatic ducts

Longmire, Mandiola, Gordon (1971) term such a dilatated duct "bile duct hypotension". Dilatation is diffuse and extends into the liver. *Fig. 237.* The lesion presents as intermittent cholangitis and jaundice, and occasionally pigment stones are present from childhood. No obstruction can be detected, and accordingly this dilatation is classified with the congenital anomalies. Treatment consists of thorough clearance of the biliary tract and the provision of bile flow through a wide anastomosis.

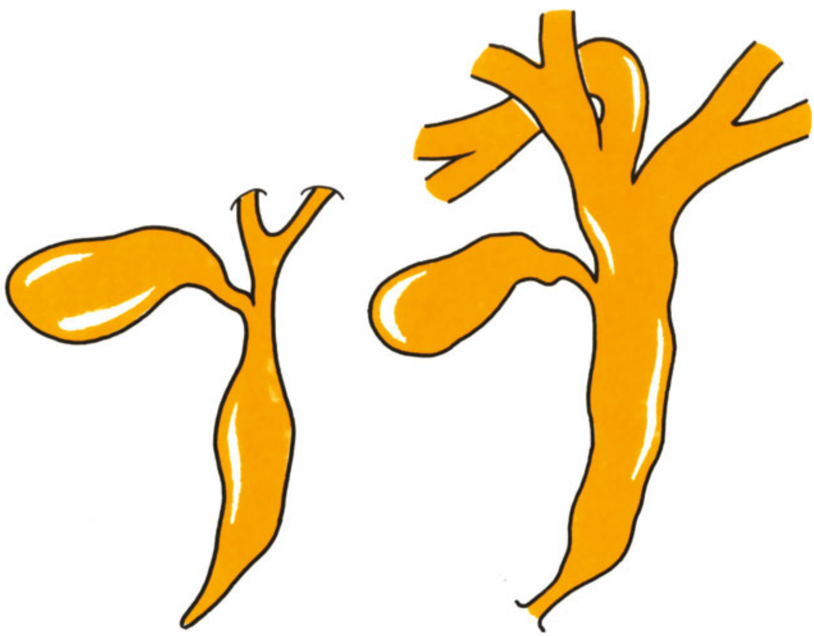

Fig 237ab: Congenital dilatation of extrahepatic biliary duct: (a) Segmental spindle-shaped type, (b) diffuse hypotonic type including also hepatic branches.

A case of such a kind may be an explanation for some "obstructive" jaundice cases in whom no obstruction can be found (p. 355).

Prepapillary cystic dilatation

The terminal bile duct, in the region of the papilla of Vater, forms a spherical elevation projecting into the duodenum. This is a very rare anomaly, and only about 20 cases have been published so far. Wheeler, who reported it first in 1940, called it "choledochocele" for its resemblance to ureterocele.

Nobody has been able so far to diagnose it preoperatively. It originates probably as an impairment of vacuolization of embryonic structures at the biliopancreatic duct terminus. The weakened portion dilates in time and accordingly may only be found between the ages of 15–65 years.

The only constant clinical sign is pain. In about half the cases, however, choledochocele announced itself by vomiting from duodenal obstruction, so that taking into account evidence obtained from a barium meal, the presence of a nonmalignant tumour in the descending part of the duodenum was suspected. In other cases even jaundice was induced, or pancreatitis. It is more than likely that endoscopic diagnosis will at some time become possible.

It is recognized at operation after the duodenum has been opened, appearing as a small rounded structure, from which bile issues through a small orifice after compression. In genuine choledochocele this orifice is situated on the cyst apex, in the previously mentioned prepapillary cystic diverticulum the pouch lies externally to the orifice.[6, 46] *Fig. 238.*

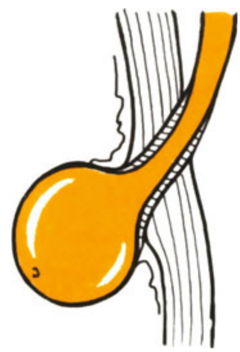

Fig. 238: Prepapillary cystic dilatation of duct termed "choledochocele".

The outer wall of a prepapillary cystic dilatation is covered by duodenal mucosa, while its inner wall has a biliary character, and may show minute ulcerations and granulation tissue tending to bleed and causing melena.

Treatment is surgical: The cystic dilatation of the terminal papilla is transected or amputated and the duct lining sutured to the duodenal mucosa.

Intrahepatic cysts and dilatations

The intrahepatic ductal system may be similarly affected as the extrahepatic ducts by congenital cystic diverticula (cysts) or segmental dilatation.[53] They possess diverse shapes and sizes and occur singly or are multiple, individual saccular cavities being separated by normal or narrowed sections of the duct involved. Females are affected two to three times more often.

Intrahepatic duct malformations remain asymptomatic for years and a correct diagnosis is not usually established until operation, and not infrequently at re-operation undertaken for cholangitis of unknown origin. It is not surprising that, in view of their concealed position, only a few of these anomalies were known earlier, and some were considered exceptionally rare. In recent years they are recognized more frequently, even before operation, particularly by endoscopic cholangiography, or computed tomography. If cystic lesions are of sufficient size demonstration by sonography is also possible.[55]

Cystic diverticulum or pedunculated cyst intrahepatic ducts

The finding of individual cystic diverticula is a rarity, they have been reported e.g. by Schiewen (1968). The author has seen only one such pedunculated cyst, associated with segmental dilatation of the same duct. A cyst on the surface may be extirpated or incised, stones extracted, and drained. *Fig. 239.*

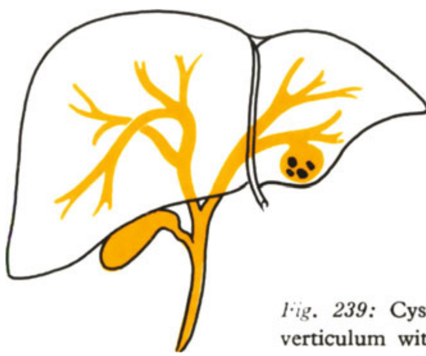

Fig. 239: Cystic intrahepatic diverticulum with stones.

Cystic, saccular or fusiform dilatations of intrahepatic ducts

These are encountered as single or multiple, or as diverse types not accurately classified. Their clinical symptoms do not differ materially from the involvement of extrahepatic ducts: subicterus, pain and recurring cholangitis are common. Jaundice however, is unusual. Dilated intrahepatic ducts, on the other hand, frequently harbour small stones, which may sometimes be found even in the main bile duct having descended there; typically cholecystolithiasis is absent.

Solitary segmental dilatation of spindle shape most commonly involves one or both hepatic ducts before their union in the hilum to form the common hepatic duct. *Fig. 240.* The female patient operated on by the writer simultaneously displayed a quite unusual disposition of the neighbouring vessels, the arteries crossing the duct, beneath the sac in front; bile flow could be adjusted by plastic repair.

Multiple segmental dilatations of intrahepatic ducts were known to Mayo-Robson (1904), but Caroli described one of their types as a separate entity in 1958 designating it "multiple congenital cystic dilatations" which specifically involved only major segmental bile ducts. Such a disorder is rare, occuring either in a pure form or accompanied by congenital fibrosis of the liver, and possibly also by cystic kidney. The term "Caroli's disease" is frequently used nowadays, to include diverse types of multiple congenital intrahepatic duct dilatations. *Fig. 241.*

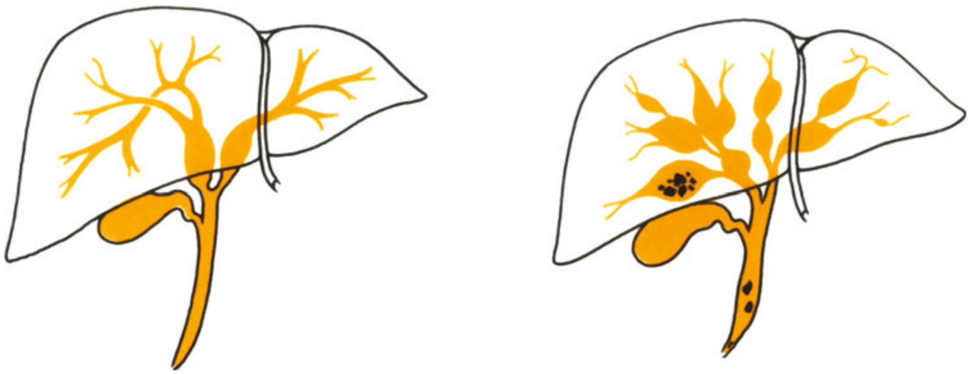

Fig. 240: Spindle-shaped dilatation of both hepatic ducts extending into liver.

Fig. 241: Multiple segmental cystic dilatations of intrahepatic bile ducts (Caroli's disease). A nest of stones in one of the "cysts".

Some of these may exceptionally involve the entire intrahepatic biliary system, more frequently, however, they are limited to a certain duct or corresponding segment or lobe. In children, according to Lilly, they are almost without exception associated with congenital extrahepatic common duct dilatation of varying grades.

Fig. 242: Grey-scale sonography shows cystic dilatations of intrahepatic bile ducts system, confirmed by operation as Caroli's disease. (Vítek).
(b.d. = cystic dilated intrahepatic bile ducts, l = liver, p = pancreas, v.c. = vena cava, ao = aorta, s = = skin, d = diaphragm, v = vertebra)

Clinical pattern

Intrahepatic congenital dilatations usually present with cholangitis attacks, usually affecting older children or adults. As stated before, sonography or computed tomography may disclose liver cysts or cystic dilated bile ducts, but as a rule some peripheral obstruction is looked for as the cause of cholangitis. *Fig. 242, 243.*

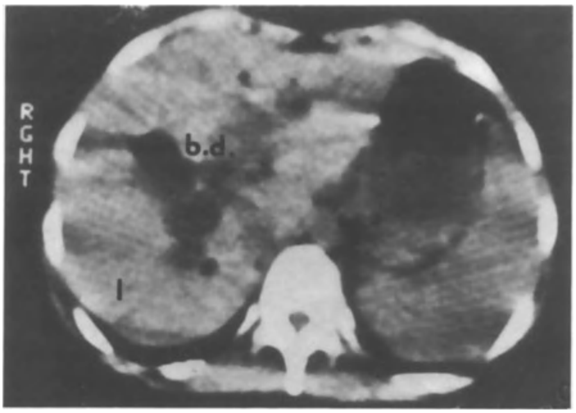

Fig. 243: Computed tomography reveals segmental cystic dilations of intrahepatic bile ducts (Caroli's disease). Verified by surgery. (Heger).

Incidentally intravenous cholangiography may also demonstrate hepatic branches and their lesions. In a majority of cases, however, selective endoscopic cholangiography is required, for which such a suspicion is a rewarding indication. Transhepatic cholangiography likewise, done preferably during operation rather than

Fig. 244: Percutaneous thin-needle cholangiography demonstrates cystic dilatations involving a group of segmental bile ducts – Caroli's disease. (Pirk.)

before, may provide adequate information about the type and distribution of intrahepatic malformations. *Fig. 244.*

Solitary congenital cysts of intrahepatic ducts must be distinguished from cavitating disintegration of tumours, or from echinococcal or liver cysts secondarily linked to the biliary tract. Particularly hard is the differentiation of intrahepatic congenital dilatation with pigment stones from secondarily dilated, infected hepatic branches in lithiasis.[42] The isolated involvement of some branches is in favour of congenital dilatation.

Multiple duct cysts must be distinguished from liver cystosis or from abscess cavities in parasitic infestations. Investigations for parasites and bacteriology of stools and bile may assist, and sometimes also angiographic and histologic methods.

Treatment

Not only the diagnosis but also the treatment of intrahepatic duct malformations is difficult. Mere conservative therapy of cholangitis by antibiotics provides only temporary relief and experience with surgical intervention is limited.

(a) When feasible, partial hepatic resection or lobectomy for multiple but localized ductal malformations is the surgical procedure of choice (Caroli, Walts, Pridgen, Todani, etc.). If such an intervention is too hazardous for the patient, or the surgeon is not prepared for it if the disorder is encountered unexpectedly, the system of cavities located near the surface can be entered by incision of the liver convexity, to remove at least the large accessible stones and perform lavage with an antibiotic solution. By simultaneous choledochotomy the extrahepatic passages are likewise cleared and stenosis of the papilla, if present, treated by means of PST. It is useful to make a wide anastomosis between common bile duct and duodenum or jejunum, in order to facilitate the passage of stones descending from the liver. The hepatotomy incision is sutured after repeated lavage and the vicinity safeguarded by suction tubes (Niederle).

(b) In a similar fashion a solitary, superficially located, cyst of any of the ducts may be opened, cleaned up and drained.

(c) In cystic or fusiform dilatation of one or both hepatic ducts extending as far as the porta hepatis, a high jejunal anastomosis may be undertaken or long-term transhepatic drainage passing through the narrowed segment and the cavity be tried.

(d) If multiple ductal dilatations are discovered, not limited to a definite resectable region, an attempt is made to reduce at least permanently the pressure in the extrahepatic common bile duct by an anastomosis. This may provide a certain protection from progressive dilatations of intrahepatic polycystic malformations which cause bile stasis and impair liver function by pressure on the parenchyma.[20]

Prognosis

Prognosis of congenital polycystic intrahepatic dilatations is less favourable than is the case with the extrahepatic variety. Apart from liver resection, surgical interventions are only palliative. The patients continue to be exposed to the risk of stone formation and recurrent cholangitis. Apart from this, the intrahepatic localization of congenital malformations is accompanied by an increased incidence of malignant tumours: according to Blonstein in as much as 7%, i.e. higher than with common duct cysts. Such cancers develop several decades earlier than would be expected, and can be prevented only in cases where liver resection could be employed.

Dilatations and cysts involving simultaneously both biliary ductal systems, extra- and intrahepatic

Such a combination has been referred to many times. Its incidence is greater than previously thought, and the congenital fault in the walls is probably identical in both localizations.[16] Cystic dilatations of extrahepatic ducts exert pressure on adjacent organs, whereas intrahepatically the liver tissue sustains damage by pressure, and in addition it may be afflicted by congenital fibrosis.

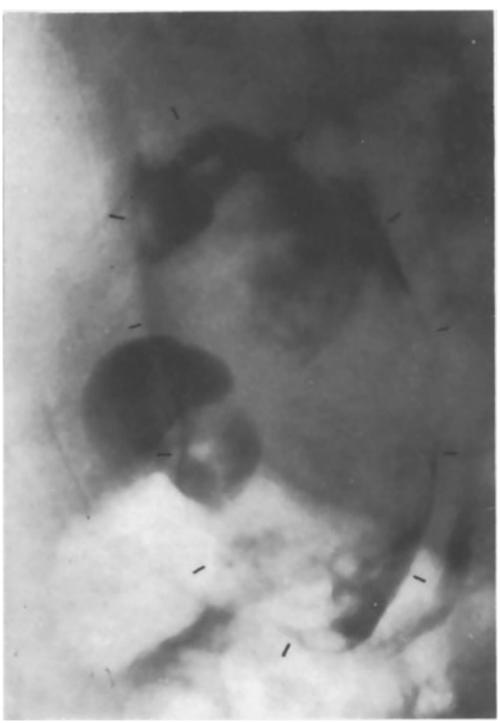

Fig. 245: Congenital cystic dilatations of extrahepatic and intrahepatic bile ducts in 74 year old jaundiced female. Endoscopic retrograde cholangiography shows large ovoid dilatation of the extrahepatic common duct occupied by a voluminous stone. Pancreatic duct being filled, the contrast image of the hepatic branches could not be intensified. (Filling of the duodenal bulb; state after cholecystectomy.) (Skála-Pirk.)

Most commonly various types of "Caroli's syndrome" are associated with some variant of "choledochal cyst". For this reason the intrahepatic ducts should always be explored in the latter case.[35, 45, 48, 51] This is important for therapy and prognosis alike, as the latter is always uncertain or poor in the presence of such a combination. Nevertheless even these patients may live to ripe old age: the author operated on a female aged 75 years in whom this combination of congenital lesions of the intra- and extrahepatic ducts was only diagnosed at that age by endoscopic cholangiography. *Fig. 245.* This provided an explanation at last for recurrent attacks of cholangitis, from which she had been suffering from the age of 24, and for which she had been submitted in her youth to several unsuccessful reoperations. Only by selective removal of the largest stones by hepatotomy and choledochotomy from saccular infected cavities and by the performance of a wide anastomosis between biliary duct cyst and duodenum success could be achieved. This patient has so far been followed-up for six years and remains free from the previous severe symptoms.

Congenital Common Duct Perforation

Generalized or localized biliary peritonitis caused by "spontaneous" perforation of the biliary tract is an uncommon disease in infancy. The etiology is not clear: lithiasis, infection, pancreatic reflux, and trauma are suspected, but congenital malformation may also be a cause.[9, 33, 41] The perforation is namely almost always situated at the junction of cystic and common duct, i.e. at a site of congenital weakness of the biliary tract wall.

Biliary peritonitis without any visible perforation of the duct has also been reported. It must be stated, however, that in some cases the exploration of the biliary tract was inadequate due to the infant's poor general condition.

The symptoms of biliary peritonitis in a newborn are usually subacute with jaundice and evidence of fluid accumulation in the peritoneal cavity. Less frequently, the disease presents as acute peritonitis of great severity.

Surgical treatment consists as a rule in laparotomy with peritoneal drainage, fluid evacuation alone being quite inadequate. In some cases drainage of the main bile duct, cholecystectomy, suture of the perforation, or some type of anastomosis is done.

The prognosis is serious, but most patients can be saved.

Duodenal Diverticula in the Region of the Papilla

These are intestinal diverticula, but possessing such close anatomical and functional relations to the bile duct and its pathology that their inclusion in a book on biliary surgery is useful. Only some of them are congenital, but their problems do not differ materially from the acquired variety.

Diverticula of the papillary region may be genuinely congenital, but most of them — 90%, are pseudo-diverticula acquired, i.e. only mucosal pouches distal to the papilla in the "duodenal window" where the intestinal walls are weakened.[35]

Two types occur —

Parapapillary or juxtapapillary diverticula

These are closely related to the papilla and always projecting behind it. They cause no symptoms, though sometimes displace the duct.

Peripapillary or Vater's diverticula

They are interposed in such a way that the papilla opens into them, more frequently into their pedicle than into the fundus of the pouch. *Fig. 246.* These

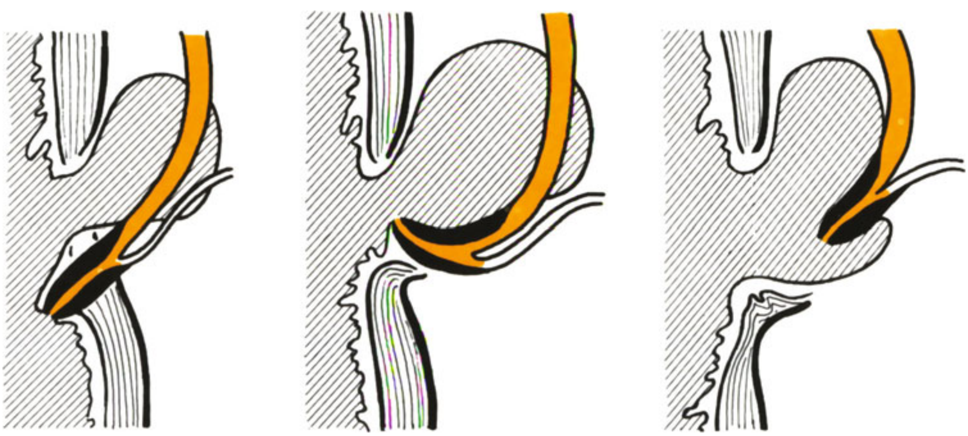

Fig. 246abc: Duodenal diverticulum: Peripapillary situated behind the papilla (a); parapapillary with the papilla opening into neck of diverticulum (b), into the bottom of diverticulum (c).

interposed diverticula, on the contrary, not uncommonly announce their presence by impairment of bile flow, and possibly also by symptoms due to reflux and infection. Such patients complain of dyspepsia and pains, and biliary obstruction or acute pancreatitis are the occasional outcome. Hemorrhage or perforation of these diverticula are exceptionally rare and malignant growth is also a quite sporadic event.

Diagnosis:

Diverticula can, as a rule, be demonstrated adequately by radiology, by combined barium meal investigation of duodenum and cholangiography. Large diverticula may extend beyond the right duodenal border, as if their pedicle was there, even though rising from the region of the papilla. The defect, visible sometimes in the filling of the pouch, represents the papilla, but sometimes only food particles are the cause. Selective duodenoscopy may supplement radiology and render it more accurate. In some cases the diverticulum is only found at surgery.

Peripapillary diverticula are diagnosed by radiological investigation in approximately 0.5–3.5% (Chitambar, Blegen) during operations for symptoms in as many as 5%, and by autopsy in as many as 16% and more (Grant and Retori, Bladwin).

Treatment

The demonstration of a Vater's diverticulum as such is not sufficient cause for surgery. Operation is done on account of symptoms, their origin is looked for, as is a possible connection with the diverticulum. Its filling and emptying is observed during operative cholangiography, while the relationship between papilla and pouch is investigated from the duodenum and pathological lesions noted. If the conclusion can be reached reliably that the diverticulum is the cause of symptoms, its excision can be attempted or at least the hampered bile flow eased by anastomosis.

Direct surgery on the diverticulum is exacting, as access is difficult, it is situated in a dangerous region and mostly elderly people are affected.

Dilatation of a narrowed diverticular orifice from the duodenum has a transient effect only and dangerous tears may be produced (Willex).

Transduodenal diverticulectomy is troublesome, but has already been performed repeatedly with success (Jujeux, Nicol, Niederle, Wilburg, Weil so.). The diverticulum is everted into the duodenum, resected and the defect closed from the gut by suture of muscularis and mucosa. Some advocate supplementary PST (Pinotti). Duct and papilla are controlled during operation by a probe inserted in the duct.

Transduodenal diverticulectomy with duodeno-jejunostomy was successfully performed by Rives. The diverticulum is resected first from the duodenum as in the preceding operation, the duodenum is then deflected and an anastomosis with the jejunum performed on the remaining defect in the duodenal wall.

Diverticulectomy by extraduodenal approach is performed exceptionally (Priston). The duodenum is deflected medially and the diverticulum made evident by insufflation of the duodenum. The external portion of the pouch is small, its excision difficult and visual control of the papilla during suture of the defect from outside the gut is impossible.

Bile duct anastomosis with the duodenum or jejunum is a useful palliative operation for impeded bile flow, if the duct is markedly dilated.

Emergency operations for perforation or hemorrhage are definitely exceptional and the cause is only recognized at operation by the surgeon. Information about the papilla and terminal bile duct is obtained by a probe introduced into the bile duct and suture is attempted from a duodenotomy.

After all these operations bile is drained by T-tube and gastric and duodenal contents aspirated by nasogastric tube. The operative field must be reliably drained with suction tubes.

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BILIARY EMERGENCIES

Acute Progressive Cholecystitis

In most cases of acute cholecystitis early cholecystectomy is advisable even without progressive inflammation. If preconditions for a reliable early operation are not met or if the surgeon prefers to delay operation after the acute phase has passed, acute cholecystitis usually subsides with conservative treatment. In some cases, however, inflammation is progressive, spreads into the surrounding tissues and threatens perforation of the gallbladder. Causes for such evolution are stagnation and obstruction, virulence of infection and damage to the gallbladder wall by inflammation, pressure of stones, and gangrene from impaired blood supply. In particular diabetes and arteriosclerosis in elderly patients exert an adverse effect.

Pains intesify, the fever usually rises, pulse rate increases, leucocyte count goes up and the patient is toxic, and prostrate. Palpation reveals the gallbladder to be greatly distended and acutely tender; tenderness spreads to the neighbourhood and particularly in a distal direction towards the right hypogastrium, where signs of peritoneal irritation make their appearance. If a pericholecystic mass has been formed already, this continues to enlarge .

Faced with such an evolution perforation and peritonitis must be forestalled in time, thus surgery is pressing and even urgent.

Operation. The abdomen is opened by transrectal longitudinal or transverse incision. The gallbladder is aspirated and the exudate and bile from the abdominal cavity are evacuated and collected for bacteriology.

a) Cholecystectomy is preferred to cholecystostomy. The fundus down procedure is adopted, vessels are ligated with great caution. If possible, cholangiography is done. If passage into the duodenum is unimpeded, or if cholangiography has not been done but there is no evidence of duct obstruction, operation is limited to cholecystectomy. Bile duct drainage is advisable if its passage is impaired and is necessary with concurrent cholangitis. Peritonealization of gallbladder bed is not always feasible, but bleeding from the bed, if present, must be controlled by parenchymatous suture and adequate drainage performed.

b) Cholecystostomy is an exceptional measure. Reasons for it, apart from the poor condition of the patient, are mainly the necrotizing bladder neck wall, and dubious condition of its surrounding structures.

Following the evacuation of pus, bile and all stones, a wide tube is placed in the gangrenous gallbladder, covered with omentum, and brought out by the abdominal wall. The gallbladder neighbourhood is drained, and antibiotics applied locally.

c) Direct cholecystostomy without preceding laparotomy may be done in an exhausted patient with exceptionally bad risk, if the distended gallbladder contacts closely the abdominal wall and no signs of diffuse peritonitis are present.

The longitudinal incision is carried over the distended gallbladder, the latter or an abscess are evacuated and an indwelling tube for sump drainage is inserted. *Fig. 247.* The cholecystostomy is then managed according to principles set out in the general chapter (p. 151).

Fig. 247: Direct incision over gallbladder in emergency cholecystostomy.

Acute Emphysematous Cholecystitis

This rare variant of acute cholecystitis is due to anaerobic infection, most often by Clostridium welchii, but also by Escherichia coli or anaerobic streptococci. Gas is found in the lumen as well as in the gallbladder walls, and sometimes in the bile ducts and the neighbouring tissues.

The prime factor is probably cystic artery closure, while resulting ischemia creates conditions for the evolution of infection, frequently even in acalculous gallbladder. In particular elderly patients in poor condition are affected.[8]

Clinical pattern comprises sudden pains, high fever, leucocytosis, and toxic signs. The course is a rapid one. A plain film of the abdomen shows the gallbladder to be distended, containing gas and fluid, with typical translucent stripes in the wall. Such anaerobic infection can develop even after cholecystectomy and other types of biliary surgery. This is announced by particularly high fever, hypovolemic shock, and renal failure.

Urgent operation under antibiotic umbrella is necessary as a rule — cholecystectomy, or only cholecystostomy being performed. Wide-spectrum antibiotics in maximal doses are given. — Prognosis is fatal if surgery is omitted, but even after cholecystectomy much worse than in ordinary acute cholecystitis (Billenkamp).

Biliary Peritonitis

Biliary peritonitis originates through perforation of biliary tract, less often by bile leakage without perforation. Bile escaping from the biliary tract is most often infected, but sometimes not and the resulting peritonitis is the less stormy.

The diagnosis may be difficult; the surgery for biliary peritonitis is always mandatory, otherwise the patient would die as a rule.

Pathology and etiology

Aseptic biliary peritonitis results from extravasation of pure bile alone. Sterile bile produces chemical irritation and necrosis of peritoneum. The resorption of bile causes cholemic toxemia with hemolysis and cardiotoxic effects, depending on the quantity of bile and rate of extravasation. More than 0.25 litres of suddenly extravasated bile leads to shock (Littmann). The loss of fluid due to inflammatory exudation into abdominal cavity results in hemoconcentration and disturbance of homeostasis.

Bacterial biliary peritonitis may arise even in primary aseptic peritonitis because the intestinal microbes sooner or later infect the bile. On the contrary, bile infected primarily causes immediate infectious peritonitis, which is highly dangerous, because bile damages leucocytes and thus cancels out antibacterial defences. Sepsis and bacteremia may result in which gram-negative bacteria are most often implicated.

Clinical pattern

Course and symptoms depend in the first place on the manner of origin, whether with or without perforation, and on whether the bile is infected or sterile. Different types of biliary peritonitis are distinguished: traumatic, postoperative, peritonitis due to perforation of pathologic biliary passages and peritonitis without evidence of perforation.

For the clinical picture and treatment of traumatic and postoperative biliary peritonitis consult the appropriate chapter (p. 461, 490).

Perforation of pathologically altered biliary tract

Pressure by stones is the most common cause of spontaneous biliary tract perforation. In the first place, inflamed gallbladder, particularly its fundus and neck are frequent sites of perforation. — Perforation of common bile duct, usually in front below cystic duct, is rare.[3, 13, 18, 36] If it concerns its posterior wall it may be very dangerous because it is easily overlooked and remains untreated. — Perforation of hepatic ducts is very rare.

Perforation may also occur in acalculous cholecystitis, e.g. typhoid, or in stenotic obstruction of cystic duct. Gallbladder necrosis due to cystic artery thrombosis or partial digestion of its wall following reflux of activated pancreatic juice are sporadically described (Combe, Williams).

Perforation in acute cholecystitis, with or without stones, is the most frequent and typical cause of biliary peritonitis.

Symptomatology: Pain is spreading from the gallbladder region into the lower parts of the right half of the abdomen and phrenic symptom may appear. Failure of intestinal peristalsis and increasing abdominal distension are more expressive.

From general symptoms raised temperatures with relative bradycardia are present. In fully developed bacterial peritonitis with severe toxemia and collapse tachycardia is always found. Number of leucocytes and bilirubin level are raised as a rule.

Local signs of peritonitis are more or less developed, but not so stormy as with perforation of the digestive tract. Per rectum tenderness appears usually after the lapse of several hours and in aseptic peritonitis is not particularly pronounced.

In elderly patients the general collapse contrasts with the not particularly marked local findings. In some cases symptoms of ileus predominate over inflammatory signs. The death rate is high, as much as 45% of advanced perforative peritonitis (Pospíšilík).

Occasionally even perforation peritonitis runs a chronic insidious course, due solely to the toxic action of bile with negligible infection, and after the initial stormy symptoms spontaneous regression sets in. Only mild pains persist during progressive abdominal distension, accompanied by subicterus and mild fever. The general condition remains fairly good for some time, but possibly after several weeks, final breakdown occurs.

Biliary peritonitis in children is very rare.[21] However, we must think of it, if early after birth symptoms of insidious peritonitis arise accompanied by jaundice and elevated bilirubin level. Spontaneous perforation occurs almost always at site of an inborn weakness of the common duct wall at the junction with the cystic duct. At some other time no perforation can be detected at all.

BILIARY PERITONITIS WITHOUT EVIDENCE OF PERFORATION

This type of peritonitis, described at the beginning of the 20th century by Routier, uses also to be designated as spontaneous cholaskos, choleperitoneum, or filtering cholecystitis.[1, 39]

The main cause of bile leakage is in majority of cases damage to the gallbladder or bile duct wall by pancreatic enzymes if there is a common channel and flow through papilla is impaired. Biliary stasis resulting from biliary tract obstruction plays only subsidiary role. According to some authors, however, a microscopic perforation is always present, or a perforation which has already sealed at the time surgery is undertaken (Cole). An apparent non-perforative peritonitis may also originate if the damaged gallbladder is embedded in the liver, or if superficial distended hepatic duct branches have ruptured.

The symptoms differ from biliary peritonitis due to perforation by the completely silent onset and by its slow, even chronic course: Sometimes, however, even this type of peritonitis may run an acute course accompanied by severe toxemia.

Prognosis is somewhat better than in peritonitis due to perforation, mortality amounts to about 15% according to Pospíšilík.

Treatment of biliary peritonitis

A diagnosis of biliary peritonitis, even the mere suspicion of its presence, is an indication for surgery. If bile is encountered a specimen is collected for bacteriological investigation, and also for diastase assay. After aspiration of bile by suction, a search is made for a perforation in the biliary tract, and eventually in the duodenum or jejunum. If no perforation is apparent at first sight, the search for it is continued not only in gallbladder and bile ducts, but also on the liver surface (aberrant bile ducts) and in the retroduodenal common bile duct portion (greenish infiltration under the peritoneum laterally from duodenum). Indirect evidence of perforation is the presence of loose calculi in the abdominal cavity. Cholangiography or instillation of methylene blue into the bile ducts may be of assistance in some instances. Only if the search has been negative can peritonitis without perforation be assumed to be present.

Simple drainage of the abdomen is insufficient for the management of biliary peritonitis.

The following procedure is adopted:

- In gallbladder perforation cholecystectomy and sometimes bile duct drainage is performed
- In perforation of common bile duct or hepatic duct the perforation site is sutured and a T-tube inserted at a separate site into the bile duct.
- If no perforation has been found or in case of bile leakage directly from the liver decompression of the biliary tract is done — preferably by a T-tube in the bile duct. Exceptionally, at least cholecystostomy is done.
- The abdominal cavity is dried and may be rinsed with warm normal saline solution containing neomycine. Drainage is carried out with 1–2 tubes in the subhepatic region; another tube may be placed in the lower pelvis. If considerable paralytic ileus is present the small intestine is evacuated by aspiration. Exceptionally Witzel's enterostomy is performed using the lower ileum.
- Treatment of endotoxic shock consists of the administration of reodextran, corticoids in high doses and heparin, glucose and fructose by drip infusion, antibiotics. Hyperbaroxytherapy may prove useful in the most severe forms of peritonitis.

Prognosis

The overall prognosis of biliary peritonitis is grave, and as high a mortality as 40% has been reported (Ellis and Adair 1974). Poor results are due to several causes: breakdown of homeostasis, toxicity of bile salts, associated bacterial contamination, duration of peritonitis, and predominantly the advanced age of patients.

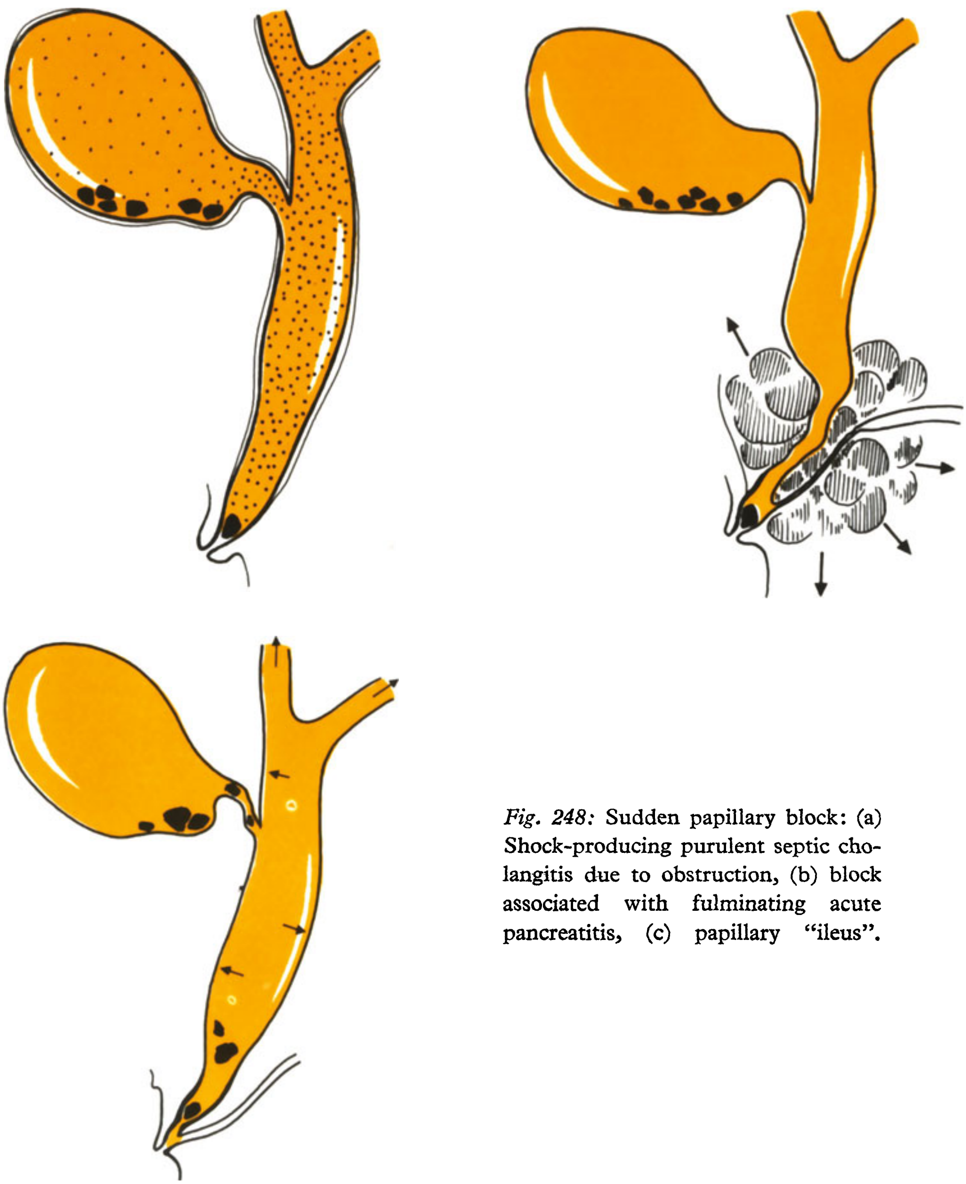

Fig. 248: Sudden papillary block: (a) Shock-producing purulent septic cholangitis due to obstruction, (b) block associated with fulminating acute pancreatitis, (c) papillary "ileus".

Acute Obstruction of Papilla of Vater

There exist three types of acute obstruction of papilla or sphincteric bile duct portion which, by the indeed dramatic evolution of complications may rapidly endanger the patient's life. Acute obstruction may on one occasion induce acute septic cholangitis, on another fatal pancreatitis, or a shock-producing "papillary ileus". *Fig. 248.*

Acute purulent obstructive septic cholangitis

Acute purulent cholangitis is one of the most aggressive forms of biliary infection and it must be distinguished from the less urgent forms, because it requires immediate surgical decompression, otherwise a fatal outcome may occur even after only a few hours (Estrada). It is caused by an accumulation of purulent bile under pressure in the ducts due to their sudden and complete obstruction. It is neither very common nor well known, but is the reason for some unexpected deaths from lithiasis, because small calculi are its most frequent cause.

Blockage of the duct may be caused — apart from calculi — by other obstructions.[29] In order to produce suppuration in the ducts and symptoms of acute toxemia, obstruction must be sudden and complete, such as is the case with stone impaction in the papilla, and must be complicated by the rapid evolution of virulent infection.[19] Gram-negative, mixed intestinal flora is found most frequently in the bile, and sometimes staphylococcus aureus is present. Blood cultures are positive as a rule. Viscous purulent bile stagnates in the dilated ducts proximal to the obstruction, while the walls show inflammatory infiltrations and are thickened. Their entire neighbourhood is edematous. The liver is enlarged, engorged, with incipient necrosis, ranging from centrolobular degeneration to multiple liver abscesses (Hinshaw).

Clinical pattern

Acute purulent cholangitis is characterised by its dramatic onset. There is acute pain, fever with chills, mental alteration and soon jaundice and septic shock make their appearance.[14, 24] Cholangitis in most cases is a sudden complication of previous lithiatic complaints, but may also erupt without preceding overt disease. The acute pain with which the patient is afflicted is evidently caused by excessive ductal pressure. Not only tenderness on palpation is found in the entire hepatic region below the costal arch, but also muscular rigidity. Chills and rigors agitate the patient, and temperature rises usually to reach 39°–40°C. The leucocyte count rapidly rises to 15,000 or 20,000. Amylase may but need not be raised. If observation of evolution is at all possible, blood cultures produce positive results, thrombocytes decrease, hypoglycemia appears and alkaline phosphatase is increased.

There is rapid onset of jaundice, but its intensity is not always proportional to the gravity of the disease. The patient exhibits from the very start a striking mental alteration, in which confusion is followed by lethargy and may end in coma. This is apparently due to acute toxemia and hepatic failure. Hypotension and oliguria appear, intensified by vomiting, fluid loss, fever and inadequate intake. In some instances renal failure is so pronounced that it is designated as the "uremic form of cholangitis". Deterioration of the patient's condition is always an alarming symptom, and in the absence of immediate aggressive therapy, septic shock sets in rapidly leading to death.

Differential diagnosis: Acute pyogenic cholangitis may simulate pylephlebitis, which must be considered if a distant inflammatory abdominal lesion is present. — Liver abscess can suddenly produce similar symptoms and fulminating pancreatitis, originating in lithiasis, may at first be practically indistinguishable. Laboratory and clinical evidence of pancreatitis, however, soon becomes prominent, whereas marked signs of purulent inflammation are missing. It is by the latter also that septic cholangitis differs from "papillary ileus". However, we have encountered elderly patients who failed to respond either by pronounced fever or leucocytosis to their acute purulent infection. All the listed disorders require in any case emergency surgery.

Treatment

It has been shown clearly that the prognosis is directly correlated to early i.e. urgent surgery. Medical treatment is only supportive and supplementary, and by itself carries an impermissible mortality. It is the patients most acutely affected and in a critical condition who need surgical intervention most — as emphasized already by Reynolds and Targan who in 1959 established this clinical syndrome as a separate entity.

Preparation for operation consists of immediate resuscitation by aggressive doses of antibiotics and adjustment of homeostasis. Guidance is provided by central venous pressure, hourly urinary output charts and simultaneous hematological and biochemical data. Minerals, plasma, albumin and, as the case may be, fresh blood and vitamin K are administered by infusion. Hypertonic glucose is indicated in hypoglycemia.

Operation is undertaken without delay as soon as the patient's condition has been stabilized, we are not dissuated from operating by transient improvement. The decisive measure is bile duct decompression by drainage. Only in cases where the patient's condition permits it can the obstacle be removed simultaneously. In every instance is lavage of the ducts delicately but thoroughly performed, using physiological saline with neomycin to remove purulent material. Sometimes cholecystectomy can be added, but never must the patient's life be endangered by unnecessary prolongation of intervention, when more decompression is life saving. If the situation is highly critical and the cystic duct patent, only cholecystostomy may be done, even under local anesthesia. Diabetics and elderly subjects run the greatest risk.

As already stated, prognosis without surgery is gloomy indeed. However, even with surgery patients afflicted by acute pyogenic cholangitis succumb in over 30% of cases.

It is worth considering that nowadays two alternative methods can be used in similar cases for biliary drainage and with less risk than that of emergency operation. Either endoscopic sphincterotomy — or percutaneous transhepatic cholangial drainage (Faber). A condition for the first is the necessary equipment and a highly trained endoscopist (Mc Cotton). The second method is more easily accessible but for its successful performance in a patient in such a critical condition requires great experience (Takada). Neither method has yet passed the acid test i.e. practical application on a large scale.

Acute obstruction of papilla with acute poncreatitis

Very rarely sudden blockage by impaction of a small calculus in the papilla may occur, followed by severe acute pancreatitis lacking septic signs.

Clinical pattern

The patient is afflicted by severe shock-producing acute pancreatitis. Subicterus, if present during the first hours, and if a patient with a "biliary past history" is concerned, the chances are very high that the cause of the pancreatic explosion could be sudden obstruction of the papilla, possibly by quite a small calculus.

The author was able to verify in two cases that prompt removal of papillary obstruction, and in a third case mere bile duct decompression, averted the threatening danger. In the first case — a female aged 58 years — the stone was extracted by small forceps. In the second, the patient — a male aged 73 — was operated 12 hours after the sudden onset of shock-producing pains, at a time when jaundice had already made its appearance and amylase had risen sharply. The stone was removed by papillosphincterotomy and the postoperative course was free from complications, despite the fact that massive edema of the pancreas and its vicinity was present at operation. — In the third case — a male aged 60 years — neither local nor general condition permitted more than insertion of a drain into the dilated bile duct. Four weeks later, after the patient's condition had improved, several small stones were removed from the sphincteric segment.

Treatment

The decision to undertake emergency surgery is arrived at more easily in cases of acute biliary pancreatitis, the more so if obstruction of the papilla is suspected

(Streichenberger and Pelissier, Niederle). Operation may be undertaken even on the first day, after shock has been controlled. In every case comprehensive therapy of pancreatitis is inaugurated at once, with administration of plasma or albumin, or blood transfusion, and in severe shock 500 mg or more of hydrocortisone, if required. Gastric contents are continuously aspirated and the patient should receive 5% glucose with tetracycline and procaine by drip infusion. Guided by laboratory results and central venous pressure, acidosis, electrolyte shift and impaired diuresis are combated.

If intensive therapy for pancreatitis fails to produce marked and rapid regression of signs, and evidence of biliary tract obstruction increases, surgical revision is undertaken. This has to be extremely cautious. If hypertension in the bile duct is found, extraction of an impacted stone or an attempt at papillotomy might be preferable to the insertion of a T-tube, but one must not overreach the mark. Witteneger (1974) reported successful papillosphincterotomies in the first 12–48 hours of acute pancreatitis in a series of 31 patients. This was a remarkable achievement, even though not all the cases were accompanied by such shock-producing obstruction as in the author's series.

If intrabiliary duct pressure is not raised, but the duct is inflamed and stones may be felt in it, bile duct drainage or cholecystostomy may also exert a favourable effect on the evolution of acute pancreatitis.

In simultaneous pancreatitis, suction tubes are selectively placed at operation near the gland or, as the case may be, inserted also under the peritoneum towards it. If localized necrosis of the pancreas is already present, the lesion may be removed, under favourable circumstances, by digitoclasia and drained by suction tube. The golden rule is that during the acute phase of severe pancreatitis both extremes should be avoided — exaggerated restraint or unjustified radicalism.

Papillary ileus

Closure of papilla accompanied by shock and critical hypertension in the biliary tract is termed "papillary ileus". This third type of acute shock-producing obstruction by stone may be unaccompanied by pancreatitis or septic cholangitis. The patient's condition is no less alarming however, he is struck down by the same excruciating, even shock-producing pain and rapid onset of jaundice. Immediate emergency surgery with biliary tract exploration is warranted.

Such an obstruction of the bile duct designated "papillary ileus", in analogy with intestinal obstruction by stone, was encountered three times by the present author. In the first case the papilla was plugged by a small concretion left after cholecystectomy, which would explain the sharp rise in pressure as well as the fact that jaundice appeared within a few hours. Surgical removal of the stone produced a dramatic turn for the better. In the second patient — a female — similar obstruction occurred suddenly by a retained stone of hazelnut size. The patient rapidly went into shock and developed intensive jaundice in half a day. Before surgical intervention could be undertaken the severe pain suddenly subsided, as did jaundice, and itravenous cholangiography performed later revealed spontaneous passage of the stone. The third case, a female patient, suffered from intermittent bile duct obstruction, but steadfastly refused surgery. Permission for hospitalization was only obtained when the patient experienced sudden, shock-producing pain lasting continuously for several hours, and leading to a state of collapse. This patient still possessed her gallbladder, but with a blocked cystic duct progressive jaundice rapidly appeared. Consent for urgent surgery was obtained. Apart from cholecystolithiasis, two small mobile stones were found in the bile duct, and one of pea size impacted in the papilla. The bile was under great pressure, but no signs of pancreatitis were present. The little stone was removed by transduodenal papillotomy, cholecystectomy performed simultaneously, and the remaining stones in the bile duct were extracted through a short incision used for insertion of a T-tube. The bile duct measuring at least 2 cm in diameter at operation, returned to practically normal size as revealed by check cholangiography performed 3 months later. The patient has remained symptomfree.

Papillary ileus differs from severe biliary colic by additional shock and the rapid development of fully fledged jaundice. This occurs sometimes within a few hours if cholecystectomy was done in the past, or with a blocked cystic duct.

Gallstone Ileus

Intestinal obstruction by gallstones usually involves the small intestine, and only sporadically the large. It is often inaccurately termed "biliary ileus" and as such was first described by Bartholini in the year 1654. It is uncommon.[30, 32] Gallstone is the cause of intestinal obstruction in 1–2% of all cases (Benner 0.9%, Dick, Perthes 1–2%, Niederle 1.6%, Haggstrom 7%), but the percentage rises with age. It is most common between 60–80 years and females predominate. Out of the writers 36 surgical cases only 4 were males and half the total was aged 70 and over.

Small intestine obstruction by stone

In order to obstruct the small intestine stones must have a diameter of at least 2.5 cm. Only much larger stones can become impacted in the colon, reaching it directly through a fistula and being arrested usually proximal to a narrowed segment, e.g. pelvic colon following diverticulitis. The largest stone reported so far was Milward's measuring 17×10 cm and weighing 465 g.

Stones may reach the gut in three ways: by fistula, anastomosis or papilla, but obstructive stones pass almost exclusively through a spontaneous biliodigestive fistula, most commonly cholecysto-duodenal, or cholecysto-colic.

Stones passing through the papilla rarely have the diameter required for small intestine obstruction, even though sporadic cases have been reported.[28]

Gallstones may get impacted at any level of the gut, but the lower half of ileum is the site of predilection, followed by jejunum, sometimes even the duodenum or pylorus, and in contrast only rarely the colon or rectum proximal to the anal sphincter.

At the impaction site spasm and edema are induced, decubital necrosis is a risk, followed by perforation. Character and course of ileus are determined chiefly by the level of obstruction.

Clinical pattern

Clinically gallstone ileus resembles other obstructions by colicky pains and vomiting, the passage of stools and wind is impeded and abdominal distension is present. This, however, may sometimes be hard to diagnose because the stone becomes arrested at a high level, and such a type of ileus does not produce abdominal distension. The main reason why gallstone ileus is hard to recognize is due to the fact that it needs not be immediately permanent or complete. The stone in the course of its intestinal passage may get arrested transiently, before becoming permanently impacted.

Ileus due to stone is thus less characteristic, its course is fluctuating and diagnosis delayed. Even nowadays patients are usually submitted to surgery after an average of 2–3 days, but even after 10–14 days after the stone's passage through the fistula, and occasionally even several weeks elapse. The general condition of these cases is usually poor, not only on account of the primary biliary disease, but also due to the advanced age of the victim and the protracted course of the obstruction. As a rule, biliary symptoms exacerbate before the stone penetrates into the gut, to subside afterwards; intestinal colic appears, sometimes hemorrhage, and later variously pronounced signs of intestinal obstruction and migratory pains according to the site of arrest or impaction of the stone. If wedged in the duodenal bulbus, or pylorus, the typical pattern of pyloro-duodenal stenosis is produced. If arrested in the duodeno-jejunal flexure or the upper jejunal loops, a high ileus is induced with gastrectasia and lacking any pronounced distension of intestinal loops. The lower in the small intestine impaction takes place, the more striking the signs of obstruction, distension of loops and succussion splash. In such cases the stone might be palpable on occasion per rectum or through a thin abdominal wall, more often, however, patients are so obese that even intestinal distension is hard to recognise.

Plain films nearly always demonstrate fluid levels as proof of obstruction. Two signs should always be looked for which might point to the lithiatic cause of the obstruction. The first is the presence of gas in the biliary tract, having penetrated via the fistula. The second — stone in the gut, which however, is opaque in only about one-third of cases, or may be shown up by administration of a little barium. *Fig.* 198a. Obstruction by gallstone is one of the most serious complications of internal biliary fistula. It occurs approximately after every tenth,but also every fourth fistula (Portes, Niederle). Only in about half the cases is a correct preoperative diagnosis made (Kazda). Haffner believes that preoperative diagnosis is possible in as much as 85% of cases. Any obscure case of ileus in an elderly female with a biliary past history should arouse suspicion if preceded by an exacerbation of biliary symptoms, and with plain films showing not only fluid levels in the small intestine, but frequently also gas in the biliary tract.

The course of the ileus may vary to such a degree that a variety of types is distinguished (Postiglione and Cremaschi): Hyperacute type with hemorrhages or diarrhoea, acute type with rapid emergence of ileus, subacute type of Leriche, common and "typical", and chronic type, or the Karensky syndrome with long intervals between obstructive episodes; this is also called pseudocarcinomatous type. The last, — recurrent type is rare, with recurring obstruction due to the passage of stones.

Treatment

Therapy is exclusively surgical. Only sporadically could an impacted stone work itself loose spontaneously, traverse Bauhin's valve and pass through the colon without trouble.

The general condition of aged patients is as a rule poor. Rehydration with physiological saline and 5% glucose is required, and losses of other electrolytes must be replaced according to the iontogram: this applies in particular to potassium loss, which occurs with late diagnosis and delayed surgery.

Apart from potassium depletion reduction of proteins is also present. Blood transfusion is sometimes required before surgery is undertaken. Continuous aspiration of gastric and intestinal contents by nasogastric tube is essential. Broad spectrum antibiotics supplemented by vitamins B, C and K are also administered if biliary origin of the ileus is suspected.

Operation is performed speedily on the same day that diagnosis is established. As the abdomen is entered the stone is usually identified easily on the borderline between distended and collapsed loops. A soft clamp is applied to the collapsed gut and it is necessary to find out whether the stone is firmly impacted. If it can be moved easily it is shifted proximally into a dilated but less damaged part of the gut. In no instance must the stone be forcibly expressed or attempts made to crush it. The overlying intestinal wall is usually thinned and internal decubitus may cause it to tear.

The afferent dilated gut is evacuated by aspiration, and lavage and instillation of physiological saline solution with neomycin follows. The emptied loop is then gripped in a soft clamp at some distance proximal to the obstruction. The stone is removed by longitudinal enterotomy of sufficient length to make its cautious removal without damage to the intestinal wall an easy matter. *Fig. 249.* The gut is carefully cleansed and sutured in two layers by atraumatic sutures. The intestinal clamps are now released and the remaining gut explored for any other stones and to identify any major damage caused by the descending stone at sites of stoppage. The lower clamp is only released after the entire oral gut has been evacuated as much as possible, in order to avoid a sudden influx of toxic contents into the distal

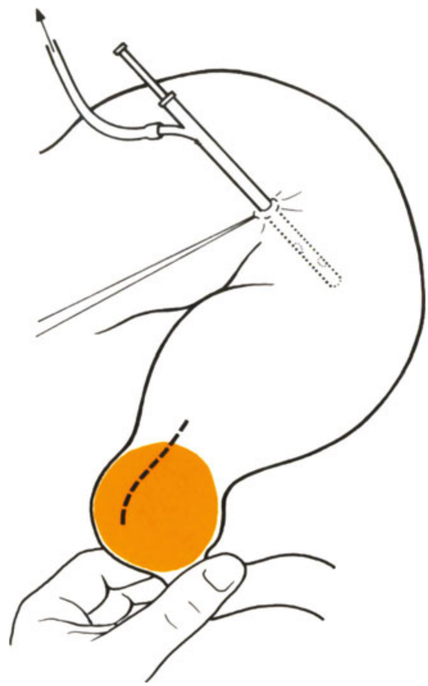

Fig. 249: **Enterolithotomy after evacuation of bowel by puncture aspiration.**

healthy loops. Resection of a gangrenous portion of the gut, or one of doubtful viability is required only exceptionally. The abdomen is closed without drainage, the nasogastric suction is left in position and parenteral nutrition and adjustment of homeostasis continued. According to the grade of intestinal damage oral feeding is resumed.

As far as the biliary fistula is concerned: the biliary tract and fistula are not simultaneously operated on, or even explored in detail.[11, 22] Access from a lower laparotomy is usually difficult and the condition of patients far from good. The fistula closes spontaneously in most cases, and not infrequently this also terminates previous lithiatic symptoms. A decision whether supplementary surgery for cholelithiasis and fistula is still required is not made until later, after the patient has recovered, has been under continual observation, and investigated after an interval of weeks, or even months. Such a procedure reduces immediate surgical mortality and has no adverse effect on the patient's prospects.

Only about one-quarter of the series of our 31 patients who survived their operation for ileus were submitted to a second stage either for fistula or for lithiasis; in only one of these did gallstone ileus recur. In contrast, biliary symptoms were eliminated in 74%, according to follow-up for a minimum period of 5 years.

On the basis of this experience reoperation after recovery from ileus is advised as a rule only for fistula which remains patent or where biliary symptomatology persists and the finding of residual stones and gallbladder or tract lesions requires intervention (cf. p. 373).

Obstruction of colon by stone

Impaction of gallstone in the colon is rare. Surgical procedure is similar to the principles applying to small bowel obstruction. Exceptionally a stone might become lodged in the anal canal proximal to the sphincter, as was the case in one of the author's patients. This stone was removed under an anesthetic following stretching of the sphincter.

The stone penetrates into the colon usually via gallbladder fistula, which probably makes subsequent operation necessary more often than is the case with a cholecystoduodenal fistula.

Pyloroduodenal obstruction by stone

Should the gallstone become wedged in the immediate vicinity of the pyloric or bulboduodenal biliary fistula, not only the clinical pattern will differ, but also a somewhat modified surgical procedure is required.[31, 40] Operation is embarked on following preparation as for pylorostenosis. After the situation has been elucidated by exploration, the stone is removed in the first place by duodenotomy or pylorotomy, or may be "milked" into the stomach and removed from an intact region by gastrotomy. The biliary tract and fistula are always explored concurrently by palpation and probing, but rarely by radiological methods, and dealt with according to the situation (p. 374). Sometimes gallbladder and fistula are removed, sometimes left, while bile drainage into the gut must always be guaranteed as well as adequate stomach evacuation. In most cases an exclusion resection of the stomach is performed. Neither in these cases of pyloroduodenal obstruction, as in genuine biliary ileus, should we feel compelled to undertake immediate exacting biliary tract surgery. Thus we avoid the high surgical risk in exhausted patients, who sometimes may remain symptom-free permanently, even though a fistula with a small empty gallbladder has been left in situ.

Prognosis of surgery for gallstone ileas

Mortality from biliary ileus used to be forbidding, but is declining gradually. Fifty years ago it was 73% according to Moore, 25 years ago still about 40% and recent statistics show only 10–5% (Kune). However, even some older Czech papers reported zero mortality (Kostlivý, Snopek). Out of the 36 patients of the author's series operated during the past 26 years only 5 were lost, i.e. 14%.

This decline in mortality was influenced by improved diagnosis, but chiefly by the great strides made in resuscitation.

Results of simple enterolithotomy are usually satisfactory in about 3/4 of patients. The danger of recurrent obstruction due to stones retained in the gallbladder or overlooked in the gut is small, hardly 5%. However, sometimes biliary symptoms persist and require further surgery which is usually quite exacting.

Volvulus of the Gallbladder

Volvulus or better torsion of the gallbladder means rotation round its cystic duct as a stalk. This is a rare event and occurs in a gallbladder freely suspended from the liver.

It was first reported by Wendel in 1898 and only a few hundred cases have been published so far.[4, 20, 43] Elderly people are mainly affected, and frequently thin females with enteroptosis.

The gallbladder must be exceptionally mobile, which is usually due to an abnormally long mesenteric suspension and long cystic duct, or as the case may be by loss of peritoneal fat following slimming. Torsion takes place by sudden distension of the gallbladder due to acute inflammation or obstruction by stone, or accompanies some other incident — acute appendicitis, small intestine volvulus, — or from displacement during pregnancy.

Torsion may be of varying grades: incomplete, with intermittent painful episodes, or complete, by 180° or more degrees. In such a case strangulation block is produced, constricting not only the cystic duct stopping any bile flow, but also the vessels, thus impairing circulation, and in particular venous drainage. The gallbladder is distended, reddened or purplish in colour, and suspended from the twisted cystic duct. Its walls are saturated by congestion and are becoming gangrenous in places, but rarely perforate. Sanguinous fluid is, however, present in the vicinity.

Clinical pattern

Torsion and strangulation occurs suddenly and are heralded by sharp persistent pain in the right hypochondrium. The patient usually vomits, is apathetic, and no flatus is passed. The abdomen is tender, sometimes distended, with muscular rigidity in the right upper quadrant, where a mass may sometimes be palpable which changes position with respiration and resembles an acutely inflamed gallbladder. Per rectum findings are negative at first but Rovsing's sign is positive. The patient is subdued by pain, his pulse rate is increased and his temperature raised, but shock is absent. Jaundice is not seen, and laboratory data or plain films, apart from local distension of intestinal loops, are uncharacteristic.

With incomplete gallbladder torsion the course is inconspicuous, symptoms may persist for several days, even weeks, before they culminate in manifestations of strangulation and peritonitis. If torsion is relieved spontaneously, symptoms may be of short duration and disappear altogether.

Diagnosis is only approximate as a rule — a sudden abdominal emergency.

Treatment

Operation consists of detorsion and cholecystectomy. Ligation of vessels and cystic duct must proceed cautiously, in order not to damage a pulled down bile duct or the hepatobiliary hilar vessels.

If operation is performed in good time, the prognosis is favourable and surgical mortality below 5%. In late operations prognosis is poor.

Hemobilia

The term "hemobilia" signifies hemorrhage into the bile passages. For a surgeon only major or even massive hemorrhage is of importance. Flooding of the biliary tract with blood is most frequently encountered if a communication occurs between the blood circulation and the biliary tree. The term hemobilia was coined by Sandblom (1948), and he also mentioned the first case described in Glisson's book "Anatomia hepatis".

The cause of hemobilia may be general (cholemia or hemorrhagic diathesis) or local, of surgical character: e.g. trauma, vascular lesions, inflammation, tumour, or hemobilia of unknown origin. Minor hemobilia may accompany lithiasis or cholangitis, and is often after the removal of bile duct stones. The frequency of hemobilia, particularly from the liver, is increasing due to traffic accidents.

Clinical features

The signs of major hemobilia are most often melena, and rarely hematemesis. The triad of Grove, typical for this "surgical" type of hemobilia, is hemorrhage into the upper digestive tube (90%), colicky pains in the upper right abdominal quadrant (70%), and signs of obstruction of the biliary tract, even jaundice (60%, according to Sandblom). The most convincing evidence may be bleeding from the T-tube in a patient with biliary drainage; in other cases "worm-like" clotted blood casts from the bile duct or a silvery-grey colour of the acholic stools may point to hemobilia. The origin of bleeding is now more often recognized due to better diagnostic methods, particularly due to angiography.

Hemobilia from the liver and intrahepatic ducts

This most often originates from central tears or hematomas due to blunt or penetrating injury. The latent period between the accident and the manifestation of the hemobilia may be several days, but even months. Traumatic hemobilia is namely often characterized by the triad of Sandblom: accident, free interval and digestive tract hemorrhage. One should, therefore, in cases of hemorrhage into the upper parts of the digestive tube of uncertain origin inquire also about past abdominal injuries.

Bleeding from the intrahepatic bile ducts may, in exceptional cases, start at an operation (caused by a sharp spoon or by a roughly inserted rigid tube), and equally rare is its occurrence in puncture biopsy of the liver,[5] which we met only three times among our 650 cases of puncture biopsy.

Hemorrhage from a liver abscess, in particular of ameboid origin, or from

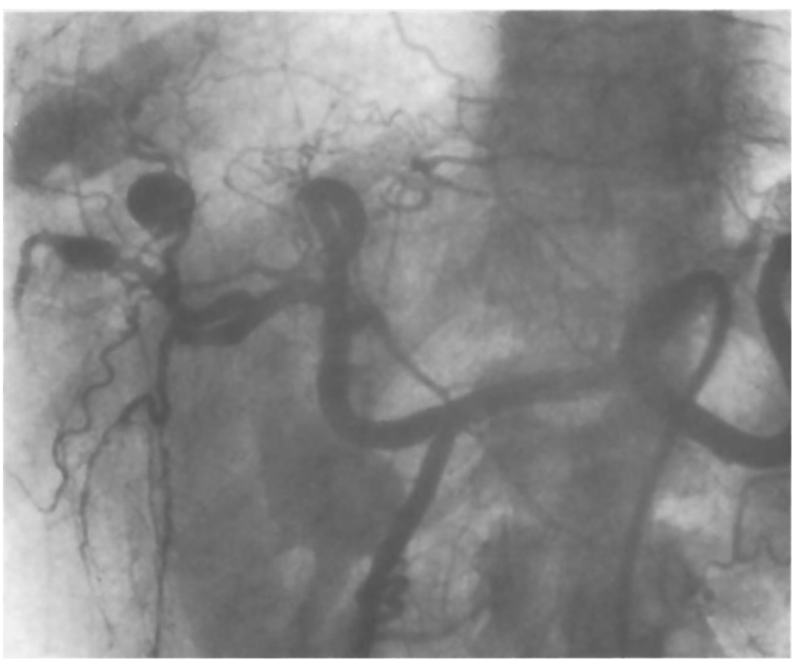

Fig. 250: Selective arteriography in a 69 year old female patient revealed two small intrahepatic aneurysms which were the cause of recurrent life-threatening hemobilia. The patient could be saved by ligation of the supplying arterial branch. (Horák – Sudek).

a hydatid cyst, is rare in our part of the world. The same thing may be said about the "tropical" hemobilia from ascaris infestation of the biliary tract.

A seldom cause of intraductal bleeding may be aneurysm of intrahepatic branch of hepatic artery. In 1955 Kirklin demonstrated for the first time a ruptured aneurysm of the liver by means of emergency spot angiography. Such a selective arteriography via hepatic artery is the most important method for all these above mentioned cases of intrahepatic hemorrhage. Present arteriogram (*Fig. 250*), provided by courtesy of Sudek, revealed two small intrahepatic aneurysms as the cause of recurrent life-threatening hemobilia in his patient. Thus this 69 year old patient could be definitely saved by ligation of the supplying arteral branch.

From the less invasive diagnostic methods sonography and computed tomography are mostly helpful in the search for the source of bleeding.

Hemobilia from the extrahepatic bile passages

This is most often due to operative injury, e.g. a transfixion-ligature. Hemorrhage caused by pressure of a tube or a stone is exceptional and may resemble the hemorrhage occuring in cases of glandular proliferating cholecystitis. Hemobilia manifests itself by bleeding from the T-tube or into the intestine. Methods of examination to be used are endoscopy and sometimes biligraphy, or instrumental cholangiography and angiography, which is considered to be the main diagnostic aid.

Hemorrhage after sphincterotomy or from a papillary tumour, and hemorrhage from a fistula into the duodenum after passage of a large stone (p. 370) are not regarded as cases of a true hemobilia because the blood drains directly into the digestive tract.

Idiopathic hemobilia is a hemobilia of unknown origin, and such patients are kept under permanent control.

Treatment

The treatment is, initially, conservative in most cases, by blood transfusion, or in some special cases, e.g. after biopsy, by selective angiographic embolisation.[33, 49, 50] The danger of lethal bleeding increases if the hemorrhage recurs. Hemobilia after injury to the liver or after a complicated operation on the biliary tract very significantly contributes to the indication for reoperation.

If it is found on operation, that the hemorrhage is from intrahepatic ducts, this is most often either from a cavity within the liver caused by the trauma, or from an inflammatory focus or ruptured aneurysm. Three types of operation may be considered:

a) Exploration of the cavity with transfixing ligatures of the bleeding vessels and ligation of the opened bile ducts; drainage of the cavity, the abdomen and the common bile duct. It is usually not easy to find the cavity, and recurrence of the hemorrhage.

b) Ligature of a branch of the hepatic artery.[44, 46] Ligature of the main hepatic artery may lead to necrosis of the liver. One should always administer large doses of broad-spectrum antibiotics, quickly restore the blood volume and keep the patient fasting for at least a week after operation.

c) The most effective but exacting method is resection of the involved segment of the liver.[34] This was carried out successfully for the first time in 1957 by Thoremet.

In hemobilia from the extrahepatic passages, the surgical procedure is determined by the situation found at operation. Most frequently it is a faulty common suture which leads to a communication, or even to the formation of a false aneurysm, between bile duct and hepatic artery. At the operation, the artery is compressed, the faulty suture or the aneurysm is removed, and the artery repaired if it cannot be ligated. Only after this is the opened bile duct dealt with by suturing, inserting a drain or, if there is a risk of stenosis, by forming an anastomosis.

Exceptionally, one is forced to reoperate because of hemorrhage after papillo-sphincterotomy, in which case thin transfixing ligatures will usually be found sufficient. If the operation does not reveal the cause of hemobilia, one should at least drain the bile duct externally.

The successful treatment of hemobilia calls for a good diagnostician and an experienced surgeon.

Traumatic Damage of the Biliary Tract

Biliary tract injury may be caused by an accident or during surgery, particularly at operations on the bile passages, at percutaneous cholangiography or at biopsy. Operative injuries are much more frequent and are dealt with in the next chapter.

Trauma of the biliary pathways, on the contrary, is very rare. Injury of the gallbladder manifests itself by acute symptoms and its course is stormy, whereas the symptoms of an isolated injury of the common duct may be inconspicuous and develop insidiously.

Injury of the gallbladder

Injuries of the gallbladder represent only 2% of all abdominal accidents, open or closed (Penn). They are more often caused by gunshot or stab wounds than by blunt force in traffic accidents, by a blow or a fall. Not many closed injuries have been reported so far.[9, 37]

The gallbladder injury may be of different type:

– Contusion, combined sometimes with hematoma of the gallbladder wall or hemorrhage into its cavity. The blood-clots may obstruct the common duct and cause jaundice. "Traumatic cholecystitis" may develop due to infection of the blood in the gallbladder.

– Avulsion of the gallbladder from its bed, partial or even complete, may cause its torsion or threatening abdominal hemorrhage and leakage of bile.

– Rupture of the gallbladder or of the cystic duct is the most frequent type of injury. The bile leaks into the abdomen, the gallbladder is threatened with gangrene. The tear occurs more easily in a wall damaged by an impacted stone.

The gallbladder injury is, for the most part, combined with trauma of the liver (75% of the cases) or of the intestine, and the clinical picture is a mixture of subjective symptoms and objective signs. Manifestations of a sole gallbladder injury are known from its isolated trauma, which occurs only rarely. In such cases, contusion manifests itself in the same way as cholecystitis, whereas in cases of rupture peritoneal signs develop quickly. This acute reaction, which is in contrast to that in perforation of the bile duct, is produced by the massive escape of concentrated bile, which, moreover, may already be infected.

There are, however, cases where even a gallbladder injury remains latent in spite of the large quantity of bile accumulating in the abdomen. This is probably due to slow leakage and sterility of the escaping bile. The patient has only moderate pains, is flatulent and conspicuously inert. After a few days, the patient becomes slightly jaundiced, the temperature may rise and the pulse rate increases. Mental changes, especially apathy, develop due to chemical intoxication. The abdomen still remains without peritoneal signs, but there may be evidence of free fluid and abdominal puncture may reveal the presence of bile.

Treatment

Gallbladder injury is a case for emergency surgery and, with the exception of the latent form of choleperitoneum, the operation is, as a rule, performed in time. The tear or other lesion of the gallbladder is usually detected easily at the operation and cholecystectomy is performed. Cholecystostomy should be reserved for critical situations only. Naturally, injuries of other organs are searched for and treated as well. The bile is aspirated and the peritoneal cavity is sufficiently drained.

Injury of the main bile duct

Injury of the bile duct was mentioned by Fizeau as early as 1806. Such an injury, open or closed, is even more rare than that of the gallbladder. Only a few hundreds of isolated duct injuries have been described up to the present time. They are usually combined with injuries of other organs and occur particularly in car-accidents, in overrun persons or in those buried alive. Contusion, perforation and even complete rupture of the common bile duct are known to occur.[7] The latter may be found as an isolated injury after a blunt trauma, the duct being ruptured just ahead of its entrance into the pancreatic groove.

These shock producing accidents produce various symptoms, according to which organs are injured simultaneously, often obscuring the signs of bile peritonitis. If the bile gets infected by the escaping intestinal contents, virulent bacterial peritonitis develops. On the other hand, in the case of isolated rupture of the bile duct the escaping sterile and non-concentrated liver bile hardly causes any intensive peritoneal irritation. For that very reason such isolated ruptures may not be recognized and are a surprise finding at an operation carried out weeks later for ascites.

Clinical features

In an isolated injury of the bile duct, when the shock has been got under control, only diminished peristalsis and intestinal distension persist. The injured patients have a normal temperature, a normal pulse rate, and no pains. However, they remain depressed and progressively lose weight. Slight jaundice develops only after a number of days, the temperature is slightly raised, and ascites manifests itself, both clinically and radiologically. One rather suspects hemoperitoneum or some other insidiously developing peritonitis, in spite of the fact that such a large accumulation of blood or exudate could hardly cause such small symptoms. Preoperative abdominal puncture reveals choleperitoneum.

Treatment

A rupture of the bile duct is usually recognized early after the accident during an emergency operation indicated by a penetrating abdominal injury or, after a blunt trauma, by signs of hemorrhage or peritonitis. Any trace of bile in the abdominal cavity makes it imperative to explore the liver, the biliary tract and the duodenum. A retroperitoneal hematoma in the subhepatic region and yellowish-green edema of the hepatoduodenal ligament should lead one to look for some hidden tear of the common duct, either in the hilum or in the duodeno-pancreatic region.

A perforated or torn bile duct is sutured with accurate atraumatic stitches. If the suture is not possible or if the injury affects the retroduodenal part of the duct, end-to-side anastomosis with the duodenum is indicated. A T-drain is inserted through a separate incision and the neighbourhood is adequately drained.

If the bile duct is torn together with the pancreatic duct or in its neighbourhood, the pancreatic duct must first be identified and the draining of pancreatic juice ensured. If one fails to probe the pancreatic duct, the neck of the pancreas may be transected and retrograde sondage is carried out (Balsano). After repair of the papillary region a jejunal loop is interposed between the separated parts of the pancreas and both ends of the transected pancreatic duct are joined to the jejunum on both sides.

Some other difficulties are met with during a late operation for a choleperitoneum whose development has escaped notice. The patient, weakened by chronic intoxication and loss of bile, is in particular need of plasma and vitamins. At laparatomy, some litres of bile are found free in the peritoneal cavity or encysted in the liver region, but the tear is rarely seen at first sight. It is concealed by yellowish edema extending from below the liver to the duodenum and into the retroperitoneal space. The tear may be hidden high in the hilum, or the ends of the torn duct have retracted. The perforation can, in some cases, be made evident by intraductal injection of blue dye or by cholangiography.

At this stage the repair of the injured bile duct is difficult. The ducts are thin and collapsed, and their walls and the surrounding tissue are fragile due to the necrotizing effect of the bile. The retracted duct ends cannot be brought together freely. The patient's resistance is low so that the operation should be effective but quick and non-stressing.

The bile is aspirated from the abdominal cavity and good peritoneal drainage is provided for. Drainage alone should never be relied upon without dealing with the perforation. One should always try to repair the duct or to establish a bilio-duodenal anastomosis, if it is easy to perform. Otherwise we have, in many cases, only inserted a T-tube for derivation of the bile as an emergency measure. Cholecystectomy need not, as a rule, be performed.

These patients must remain under control even after healing, because a stricture may develop easily and would need an early reoperation.

The prognosis of biliary tract lesions is serious, particularly if they are recognized too late. The immediate mortality rate is estimated to amount to as much as 20%.

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SURGICAL FAILURES AND REINTERVENTIONS

In biliary surgery failures occur occasionally the cause of which rests not only in the severity of the disease, or poor condition of the patient, but is due to medical error. This may already be the case at the decision for operation and preparatory stage, and many take place during its progress, while even the postoperative period itself is not exempt. If such errors be known, they may as a rule be prevented and every surgeon should pass a kind of "final test" on them in order to make biliary surgery still more successful.

A correctly indicated and skilfully performed operation should avoid any unnecessary harm to the health or even threat to the life of the patient.

Surgical failures may be subdivided according to their cause, and according to the period at which they occur:

Errors in indications for surgery
Faults in preoperative patient preparation
Operative mistakes and injuries
Immediate postoperative complications
Late persistant symptoms and surgical failures

Errors in Indications for Surgery

Such errors are common and may prove serious. The general practitioner resident or radiologist may bear part of the responsibility, but the main burden rests on the surgeon, because he either agrees with, or personally advises surgical intervention.

Mistakenly advised operations

The author considers it a mistake to advise operation for asymptomatic stones in youthful subjects, or towards life's close. Such a preventive cholecystectomy, however, is not refused during the 5th or 6th decade, provided the patient is not a bad surgical risk.

It is also incorrect to advise operation for complaints of uncertain origin, which may easily be blamed on incidentally discovered gallstones. Even if symptoms cannot be adequately explained as due to their presence, further search may be frequently prematurely terminated and cholecystectomy clamoured for, which understandably often fails to give subsequent relief.

A doubtful and sometimes "escapist" indication is also the so-called "dysfunction" of the biliary tract or the idea that an obscure infection has its focal source in the gallbladder. Such disorders may exist, but are rare and the proposed operation must be adequately substantiated and deliberated.

Diagnosis must be in doubt if the patient has never experienced typical attacks of colic, inflammation or jaundice. One must not rely on controversial sonography or on inadequate films only; or rely in such cases on an investigation revealing merely a hypotonic gallbladder or its impaired evacuation, or on a single investigation showing non-opacification. If such a patient suffers from dyspepsia, cholecystectomy must not be advised without preceding detailed clinical analysis.

However, it is unjustified to refuse operation in the presence of convincing lithiatic symptoms, because radiological investigation, usually of doubtful quality, has failed to demonstrate stones. This is particularly the case with a small number of tiny non-opaque calculi with the appearance of peppercorns, which cannot be easily palpated through the gallbladder wall even during operation and are found only after it is opened. Following cholecystectomy, however, symptoms tend to disappear.

An erroneous, even dangerous indication, is obviously one based on the wrong diagnosis, e.g. confusion with nephrolithiasis, hiatus hernia, hepatitis, peptic ulcer, pancreatitis or even with coronary heart disease. If findings fail to explain unequivocally all of the patient's symptoms, further detailed investigation must be insisted on. The failure of an unnecessary biliary operation, even if recommended by another physician, is in the first place the surgeon's responsibility. If biliary disease is associated with yet another disorder, such as irritable colon, pancreatitis or the patient is of neurotic disposition, it must be explicitly stated before operation that relief from all his symptoms cannot be expected.

Badly timed operations

Impatience and omission to choose the most suitable time for surgery are both mistakes which may seriously endanger the patient. Acute cholecystectomy, for instance, advised by the author at the beginning of cholecystitis, must not be turned into an inflexible even dangerous principle, to be enforced in cases where diagnosis is not clear and preparation cannot be completed adequately. Only really menacing peritoneal signs would compel us to perform an emergency operation under such circumstances. Surgical deaths in cases of coronary infarction simulating cholecystitis, not however of the hyperacute type, are known to the author, where electrocardiographic investigation could not establish the correct diagnosis at the onset.

It is also not good practice to embark on surgery during jaundice, at a time when a turn for the better has occurred and the jaundice is distinctly resolving. A short delay in such a case can only benefit the patient and his preparation for surgery. Complete subsidence of jaundice, however, is not awaited, as sometimes it only fluctuates and might deepen again.

Early reoperation is advised only if deemed essential, as tissues in the region are still fragile. In cases e.g. of reoperation for missed stones in the ducts, or for a recent post-operative biliary fistula, it is rare that intervention cannot be delayed and safely performed after an interval. Even with simple acute cholecystitis, if the opportunity for surgery during the first days has been missed, delay is enforced until the dangerous subacute phase has subsided.

It is a mistake, on the other hand, to operate late in some urgent situations. In the case of dramatic acute biliary catastrophes the patient's fate may be decided within the first day or few hours. This applies particularly to the apoplectic type of "papillary ileus", hyperacute septic cholangitis, aggressive pancreatitis due to obstruction of the papilla, or massive hemobilia. Indication for surgery is also urgent, however, in threatened gallbladder perforation, if biliary ileus is suspected etc.

As far as the approach to elective operations is concerned, it is frequently the patients who hesitate, but sometimes the physician also, not only if lithiatic symptoms are relatively mild, but also in cases where the bile duct is already involved. In the latter case delay is a grave mistake even in the absence of jaundice. It is particularly irrational to avoid operation in the presence of diabetes, or with patients suffering from other chronic progressive diseases, in which the complications of lithiasis in any case will make operation at a later date unavoidable, but at a greater age and with increased hazard.

Admission of patients with uncomplicated but cumulative attacks of colic should not be delayed. They cannot always be controlled even with maximum care up to a late operation date and may culminate by producing a condition of such gravity that intervention may have to be delayed still further.

Operation is sometimes deferred unnecessarily in patients with jaundice: either because the jaundice subsides spontaneously, or because selective investigation is not correctly timed. Current methods allow the establishment of a diagnosis of mechanical obstruction relatively rapidly. If, exceptionally, jaundice still remains of obscure origin even at the present time, three weeks constitute the extreme limit of expectation, after which period surgical risk rises steeply.

The pediatric surgeon likewise, confronted with neonatal jaundice, must not miss the time limit of the first few weeks for operation of biliary atresia, in view of the fact that biliary cirrhosis with all its complications develops relatively rapidly in childhood.

As far as reoperations are concerned, it is hard to advise patients who have previously undergone surgery, sometimes even repeatedly for retained stones or strictures, and who have lost faith and courage to undergo further operations. However, in such cases recent or persisting obstruction with cholangitis carries the threat of progressive hepatic lesions, whereas a realistic, even though sometimes uncertain, chance for cure lies only in additional surgery. It is necessary to insist without compromise on the avoidance of delay.

Errors in Preoperative Patient Preparation

Preoperative preparation may sometimes exert a far-reaching effect on the risks run and the course of operation and the postoperative period. The surgeon participates in any errors regarding its extent and timing. He must thus also be reminded of some principles which, however, should not be applied schematically.

In dealing with an uncomplicated biliary disorder in an otherwise healthy subject admission to the surgical ward should be preceded by complete investigation, thus shortening preoperative stay to a minimum period of 1–2 days to avoid unnecessary exposure to nosocomial infection. There should, however, be enough time to get acquainted with both surgeon and anesthetist in whose hands the patient will place himself, and one should not underestimate this psychological preparation, which is meant to dispel any anxieties regarding the danger of intervention, and postoperative pain. Explanation though optimistic should be matter of fact and should not keep anything hidden.

If the patient suffers from other disorders apart from biliary disease, such as hypertension, venous insufficiency of the lower limbs, bronchitis, urinary tract infection etc., these should be treated before admission in such a fashion that improvement, which might be only temporary, coincides with admission to the surgical department. —A point often forgotten in the preparation for biliary surgery is weight reduction in obese subjects.

In-patient preparation under continual laboratory surveillance is required for elderly and debilitated patients. Preparation in the more complicated forms of biliary disease associated with jaundice, cholangitis, pancreatic attacks or other complications is a matter of course, and must not be overlooked. It would be a mistake to devote one's attention merely to any liver damage and to assess surgical risks only from bilirubin levels, albumin concentration and hemocoagulation status and not take note of other factors and in particular of renal function.

Correction of all disturbances need not, and frequently with urgent cases even cannot, be ideal and complete at the time of operation. It must be taken into account whether the patient is likely to gain or lose by carrying it still further: intervention which might be delayed excessively may by itself constitute a causative therapy.

As already stated preparation for surgery must be properly timed. Preliminary treatment of not far advanced associated chronic disorders requires several weeks, but adjustment of disturbances due to the biliary disease several days. An antibiotic "umbrella" is commenced in elderly subjects with threatened hepatic or renal failure, if infection is present, in particular cholangitis, with jaundice, and especially in diabetics, immediately before operation.

Operative Mistakes and Injuries, their Prevention and Immediate Repair

Some incident or error may occur in every biliary operation, this may be damage or injury to the biliary tract and its neighbouring viscera or an inadequately or unsuitably performed surgical intervention.

Shock

As far as shock is concerned; patients with protracted disease associated with denutrition, hypovolemia — and patients with some associated diseases, particularly cardiopulmonary — tend to develop shock more easily with biliary surgery.

However, if in the course of operation blood-pressure suddenly falls or signs of shock make their appearance, this must not be blamed exclusively on pathological lesions and the poor preoperative status of the patient, or on anesthesia with insufficient oxidation, or even other hypotensive influences, without first excluding the surgical intervention itself as the primary cause:

- Major, particularly sudden blood loss, inadequately compensated.
- Compression of the hepatobiliary hilum, particularly if protracted.
- Compression of large vessels, particularly of vena cava, by a retractor. This mechanism is little known, but it can be easily verified how simple it is in the course of retraction of duodenum with stomach and colon to the left, to press forcibly on pancreas and deep vessels with the retractor. For this reason the viscera mentioned are exclusively retracted manually in the depth of the wound.

Injury

When surgical errors are discussed, trauma is usually assumed to be concerned. Injury to vessels and ducts is most common, but the liver, pancreas or duodenum may also be damaged. It is difficult to estimate how often such injuries occur, particularly as the minor are without sequelae and the major are not discussed. Such surgical trauma is estimated to occur once or twice in a series of 500 operations according to statistics from outstanding centres.[78] In the author's biliary operations the figure was 0.3%.

As a rule the surgeon is to blame through lack of experience and knowledge, underestimation or presumption, hasts or fatigue, lack of exposure and careful dissection, and sometimes even through sudden fright.

It is easily brought about by anatomical disposition such as different variants in the course of vessels and the arrangement of bile ducts, or by pathological changes such as friable, inflamed, edematous tissues, rigid involved adhesions, vascular sclerosis etc.

Risk is also increased by operations in regions of difficult access at a high hilar level or juxtapapillary. It would be a mistake, however, to assume that trauma is most common with complicated operations, as in such cases the surgeon tends to compensate the pitfalls by redoubled attention. It is common knowledge that most incidents accompany just simple cholecystectomy. Glenn, Maingot and others declared the principle that cholecystectomy must be proclaimed a dangerous operation. It may occassionally prove even fatal, or leave permanent sequelae. Nevertheless most errors can be prevented.

VASCULAR INJURIES

Erroneous ligation of the hepatic artery or acute hemorrhage may occur during operation.

Ligation of one of the hepatic arteries or its branches occurs either as an error by mistaking it for a ligated cystic artery, or following its injury, or if brisk hemorrhage is managed blindly.

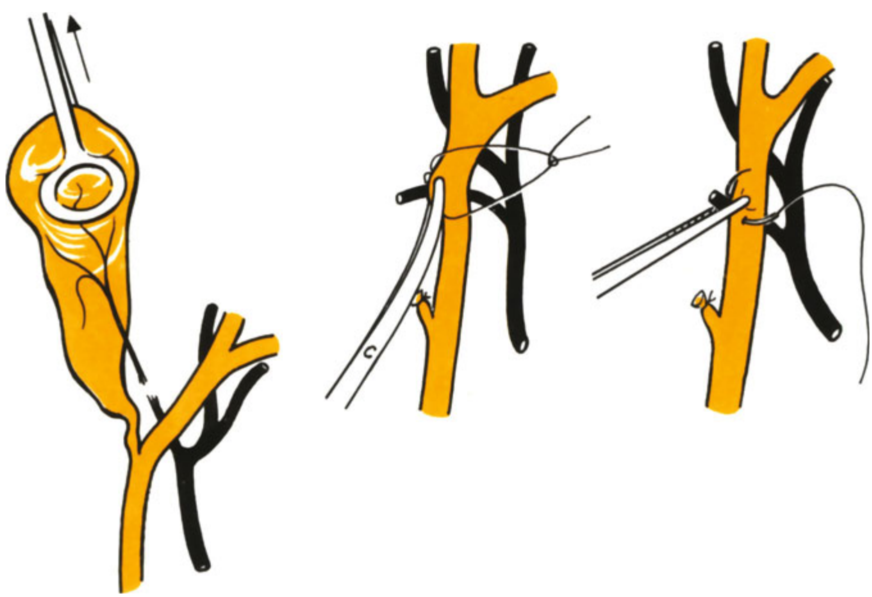


Fig. 251: Hemorrhage during cholecystectomy. (a) Excessive traction on gallbladder tears cystic artery which is shorter than cystic duct, (b) inaccurate ligature or (c) transfixion of bleeding artery may inadvertently include the hepatic duct.

Confusion with the cystic artery and erroneous ligature of the hepatic artery, from which it issues, is most likely, if it courses parallel with the cystic duct.

Brisk hemorrhage is more usually encountered during cholecystectomy than during duct dissection. Its most frequent source is a torn cystic artery, more rarely the right hepatic artery and quite exceptionally a. hepatica propria or communis. Portal vein injuries hardly ever occur and other major venous hemorrhage may be encountered only if portal hypertension is present.

The cystic artery is always shorter than the coiled cystic duct thus it may sometimes be torn by forcible traction on the gallbladder. The risk is increased by friability of tissues or sclerotic lesions in the vicinity of neck and cystic duct. Sometimes the vessels are more exposed to trauma by their course. Variability in their numbers, site of origin and course must be taken into account. It is not permissible to blame "anomalies" when only vascular variants are concerned, as these are present in as much as one-third of cases. The cystic artery may be short, or torn from its origin in the hepatic artery, or the latter is included in the ligature. *Fig. 251.* The cystic artery may be situated in front of the cystic duct, and two cystic arteries are present in one-fifth of patients, the second artery causing surprise by joining the gallbladder from a different side (cf. p. 194).

Direct injury of the hepatic arteries is more easily caused if their course is unusually close to the cystic duct, or if hemostasis is done blindly. In elderly subjects sclerotic vessels are tortuous and are more inclined still to hug the gallbladder neck and thus be liable to injury.

Hemorrhage and faulty ligatures may be prevented by careful dissection. To avoid mishaps or inclusion of the hepatic artery in the ligature, the cystic artery is not ligated until one has verified that it is passing to the gallbladder, where it branches, and ligation is performed close to its wall. — Before choledochotomy we make sure either by palpation or puncture aspiration that the hepatic artery or its branch is not passing in front of the duct, as is the case in about one-tenth of subjects.

If sudden hemorrhage occurs obscuring the field of operation, vessels are not blindly clamped, nor in the direction of the pulsating spout. Index finger and thumb are first used to compress the hepatoduodenal ligament bearing the hepatic artery, blood is now removed by suction, and the source of bleeding dissected out, then

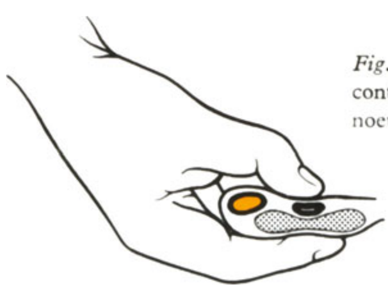


Fig. 252: Hemorrhage must be controlled first by Pringle's manoeuvre.

the vessels are carefully ligated. *Fig. 252.* The vessels sometimes retract deeply and cannot easily be found, in which case the surgeon may dare to apply a suture ligature. The hepatic duct might hereby possibly be caught, however, or the hepatic artery injured, thus producing renewed, still greater hemorrhage. If the cystic artery has been avulsed from its origin, the breach is closed by atraumatic suture.

A torn hepatic artery can only exceptionally be reconstructed. Luckily it is usually not the sole source of arterial blood for the liver. We verify this by ascertaining whether blood issues back from the hilar end of the interrupted vessel, whether yet another vessel pulsates in the hepatobiliary hilum or approaches the hilum directly from elsewhere, or whether liver colour is changing as a whole or in part, but the latter indicator is the least reliable.

Ligation of a hepatic artery used to be considered fatal in most cases within two to three days. It was shown, however, that this incident was not always followed by septic necrosis of the liver, even if it concerned the hepatic artery proper. At first the liver receives oxygen from the portal vein and the blood circulation in the intrahepatic arteries may be adjusted by collaterals within 12–24 hours (Mays). Occasionally the liver is protected by an accessory or supportive artery. Favourable variants of hepatic arteries obviously cannot be counted on and their possible presence is not known at operation. Therefore it is necessary to support the portal circulation immediately and to make sure that the venous blood from the splanchnic region returns as much oxidized blood as possible and without toxi-infectious agents. Blood volume is quickly restored, because hypovolemic shock affects particularly this region. Broad-spectrum antibiotics are started and the patient is kept fasting for a week or more after operation. The antibiotic "umbrella" presumably not only disinfects the gut, but possibly also protects the hypoxic liver from excessive bacterial growth and impairment of enzymatic processes, thus improving the chances of survival (Colle).

Injuries to the right hepatic arterial branch, if a replacing independent artery is present on the right, carry a better outlook for adjustment. Resection offers a chance in cases where the affected liver segment remains discoloured, but in actual practice it appears hardly feasible, to perform such an additional risky intervention.

Compared with the dramatic threat produced by interference with the arterial circulation of the liver, it may appear almost trifling to mention surgical division of the small transverse duodenal artery in the course of papillosphincterotomy. If, however, we omit to transfix the bleeding points on the incisional borders, marked melaena might be produced postoperatively, which may require blood transfusion.

INJURY TO THE BILE DUCTS

Similar to vascular injury, this occurs most often in cholecystectomy, as worldwide data confirm.[36] It is uncommon with complicated biliary operations. Apart from this, the bile duct may be injured during operations on neighbouring viscera, duodenum and pancreas. In biliary operations proper bile duct injury, similar to vascular injury, occurs most often in the Calot's triangle region at the junction with the gallbladder, or more rarely in the distal bile duct or the hepatic branches. Trauma consists of duct ligation, a "flush tie" put on the duct, its strangulation by suture of wall injury producing a tear, or its complete severance. However, dangerous consequences may be produced by mere bruising of the wall or interference with its blood supply which is poor and easily jeopardized, particularly in the supraduodenal biliary duct portion.

How often bile duct injury occurs at operation is hard to determine. The surgeon is hardly aware of most instances, and only about 15% are said to be recognized and immediately repaired. In the author's view this percentage is higher, but the cases are not recorded if of a minor character and immediately and accurately repaired. The others are sometimes followed by biliary fistulas or stenoses, leading to severe strictures which on occasions have catastrophic consequences.

It is frequently impossible to determine subsequently why the trauma occured, but most mishaps could be prevented. It must be considered a tragedy that at least one-third must definitely be blamed on the surgeon himself. The search continues for ever more sophisticated surgical methods on how to repair the sequelae of injury — strictures, but the main effort must be directed towards their prevention.

Causes of bile ducts injury

Circumstances and causes leading to their injury though well known are continuously repeated.

Most commonly bile duct injury occurs during cholecystectomy by performing hemostasis "blindly". Traction on the gallbladder or its dissection sometimes leads to avulsion of the cystic artery and brisk hemorrhage obscures the operative field. An impulsively applied hemostat may only rip the remainder of the artery, but simultaneously grip and bruise the hepatic duct, and in particular its right branch. It may also happen that the duct together with the vessels is caught in the suture and a stricture is produced, or possibly a communication between artery and duct resulting in later hemobilia.

The hepatic duct is torn relatively frequently during dissection from long parallel and adherent cystic duct. *Fig. 253.*

In other cases the bile duct wall might be caught up in the cystic duct ligature if excessive traction is applied to its stump, or ligature of its friable remains is attempted after avulsion. Ligature of a wide cystic duct applied at low level might also strangle the main bile duct.

Removal of the gallbladder from freshly edematous tissue is unusually easy. This is an additional inducement for acute operation in recent cholecystitis. However, inflammatory edema sometimes obscures a clear view and vessels, gallbladder and cystic duct may be so fragile that they tear evenwith cautious dissection and ligature.

Dissection in chronic lesions is difficult. Removal of a gallbladder firmly adherent or penetrating into the duct, or isolation of a small shrunken gallbladder cemented in adhesions, may even produce a large defect in the common bile duct wall. Orthograde cholecystectomy should be performed in these cases, with the gallbladder opened and a probe inserted into the common bile duct.

The bile duct — with tragic consequences — may also be divided or ligated

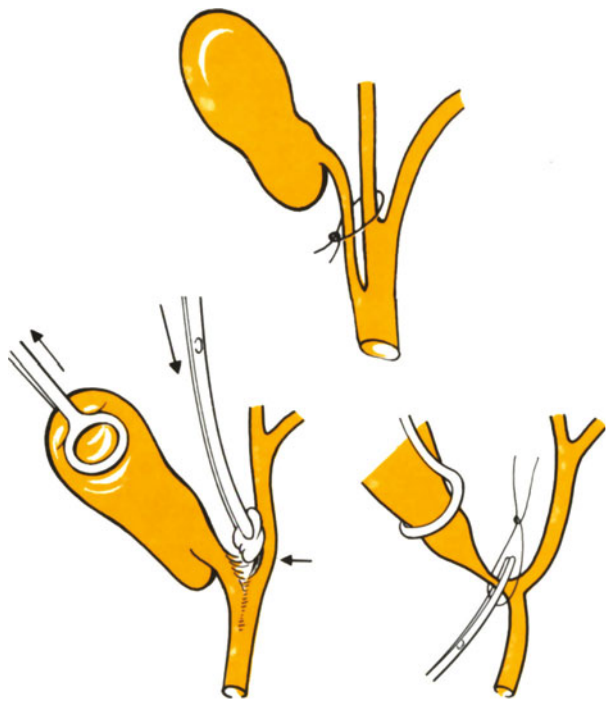


Fig. 253: Erroneous cystic duct ligation with closely adjacent slender hepaticus branch (a). – Hepaticus injury during dissection of adherent cysticus (b). – Inclusion of drawn out wall of choledochus in cysticus ligature (c).

instead of the cystic duct, the latter having been swallowed by the passage of an outsize stone. The bile duct in such cases mimics a continuation of the gallbladder and its distal portion is erroneously considered its cystic duct. *Fig. 254.*

Anatomical variants of the duct system may also form pitfalls. A segmental duct, or exceptionally a thin hepatic duct may be mistaken for, and ligated instead of the cystic duct if dissection is inaccurate. Faulty ligatures might be applied particularly if the segmental duct opens into the gallbladder or the cystic duct or, on the contrary, the cystic duct opens into the segmental duct. Anomalies, such as missing cystic duct with interposition of gallbladder into the hepatic duct, are rarities. *Fig. 255.*

A less developed segmental branch may be ligated erroneously as an irrelevant accessory duct, although this is really a variant of the union of hepatic branches.

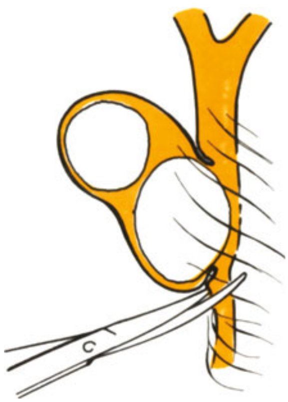


Fig. 254: Division of choledochus mistaken for cystic duct, the latter having been expended by the passage of a large stone.

In roughly one-quarter of patients the right hepatic duct is divided into two independent segmental ducts. Division of a thin branch need not immediately present by bile extravasation, as bile secretion during surgery is depressed. Only a very

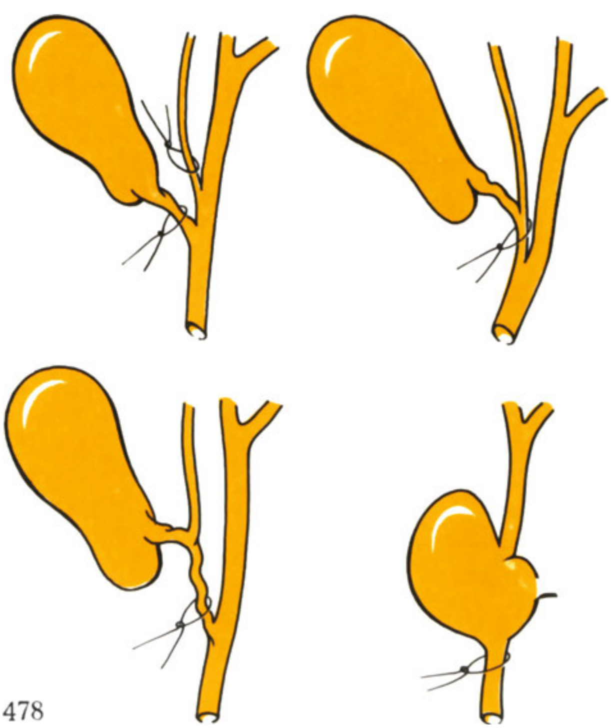


Fig. 255: Faulty ligatures of bile ducts. (a) Ligation of segmental hepatic duct mistaken for an accessory duct, (b) of segmental duct into which the cystic duct opens, (c) of cystic duct into which a segmental duct opens, (d) of main bile duct if the gallbladder is interposed in the hepato-choledochus.

fine duct may be ligated without ensuing harm, otherwise repair by anastomosis should be attempted.

Injury to the bile ducts occurs, though more rarely, in other regions, and not only at the juncture between gallbladder and main bile duct. For instance during probing of the papilla, or removal of stones impacted in the sphincteric segment severe damage may be caused to the bile duct wall, or a "false passage" produced. Hepatic ducts might similarly be injured, and not even the balloon catheter used for extraction of small stones or selective cholangiography is entirely without risk.

Bile duct vitality may be compromised — mainly in its supraduodenal sector — by unnecessarily extensive dissection. Bile duct narrowing may be caused by an incorrectly sutured choledochotomy incision or by a restricting peritonealization. The latter is also unsuitable because an accumulation of blood or bile under the peritoneum might induce later fibrotic constriction. *Fig. 256.*

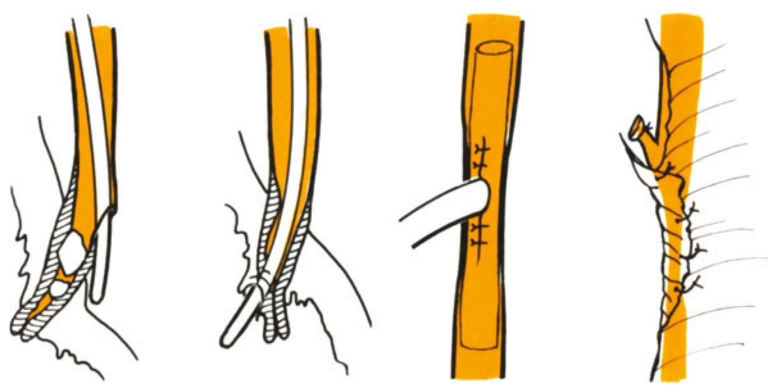


Fig. 256: Injury to choledochus: By rough probing of the terminal segment (a), or of the papilla (b), by the insertion of a large T-tube (c), by the tight peritonealization (d).

Bile duct drainage is also represented as a common cause of injury and subsequent stenosis. This may have been due to the employment of wide T-tubes whose shoulders were not cut to shape, and constricting sutures. With the author's technique not a single instance of stenosis following use of the T-tube has been recorded in over 1000 operations.

Apart from biliary surgery, the retroduodenal and terminal sections of the bile duct may be injured during operations in the vicinity, such as those for deep-seated duodenal ulcer (Schmitt, 1977), parapapillary diverticulum or fistula between bile duct and duodenum. The duct, therefore, is delineated in advance by the insertion of a catheter.

Prevention of operative bile duct injury

Bile duct injury can be prevented only by persistently attentive and cautious procedure. Biliary surgery, however, confronts us in each patient with different situations, and unexpected surprises. For this reason alone an experienced surgeon is required who always operates carefully, without undue haste and respects the dangers of even an apparently simple cholecystectomy.

A clear view of the operative field is essential, as a result of an adequate incision, lighting, assistance and relaxation. The surgeon must know, and take into account, all the different variants of the bile duct system, in particular in Calot's triangle.

Traction on the gallbladder must be measured, dissection painstaking, and systematic, and each structure identified adequately before ligation or division.

In sudden hemorrhage the blind application of clamps is never done, arteries in the biliary stalk are compressed instead and the vessels dealt with in a clear field without further harm.

If adhesions hamper a proper view and if bile duct disposition is not clear, several modes of obtaining information are available: operative cholangiography, insertion of a catheter into the common bile duct, check up by finger introduced in the opened gallbladder. After removal the galllbladder is inspected to see whether or not it harbours another orifice in addition to that for the cystic duct.

In some exceptional situations removal of the gallbladder is not forced, if its dissection could be dangerous for the patient. To know the limits of such surgical intervention carries no stigma for the surgeon, and is no sign of lacking technical skill, but on the contrary, shows ripe judgement.

Another aspect of the prevention of operative injuries: the surgeon must be sensitive to pathologically altered tissues and must be able to manipulate with instruments in the bile ducts with the minimum of trauma, and must know how to drain and suture without causing any narrowing or bile escape. Also the final revision of the operative field is of great significance.

Repair of fresh injuries

In so far as the main bile duct is concerned, it may perhaps happen to any surgeon that it is injured during operation, but it is highly improbable that the experienced surgeon would fail to register this injury immediately.[31] Several main guide lines apply to the repair of a fresh bile duct injury.

The injury, once recognized, should be immediately repaired during the operation.[77] Fresh repair, though hampered by the fact that the duct may be narrow and is thin-walled, or on the contrary because the tissues are pathological, is performed nevertheless under much more favourable conditions than in later reoperations. Tissues are not yet damaged by bile extravasation or local inflammatory reaction, and the damage may frequently be repaired reliably without sequelae.

Repair must of course be performed by an experienced surgeon otherwise it is sometimes preferable just to drain the duct proximal to the site of injury carefully and to call skilled help without delay for definitive treatment.

The type and extent of the injury is ascertained first and then the method of treatment to be adopted. Only intact tissue can be sewn, anastomosis must be wide and suture without tension.

Small mural injuries are sutured with atraumatic sutures and the main bile duct drained by separate incision, thus never at the suture site.

A larger mural defect may sometimes be successfully covered by a gallbladder or cystic duct remnant. A venous patch graft has already been used with success. In such a case the duct is as a rule drained, but of separately courses. *Fig. 257.*

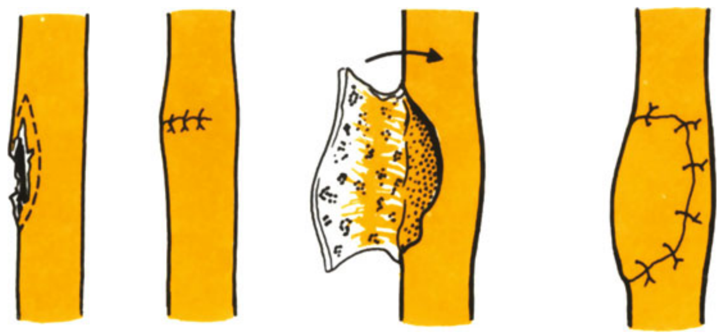


Fig. 257ab: Choledochus tear closed by transverse suture (a). – Repair of larger defect with remnant of gallbladder or cystic duct (b).

For disruption of the duct even if accompanied by tissue loss, following division or crushing by a faulty ligature, repair by duct reconstruction should always be tried initially using end-to-end suture. Adequate mobilization of the duodenopancreatic block is particularly essential and only if now both duct ends can be brought together quite freely, is suture with a few accurate stitches done in one layer in order to avoid narrowing of the duct. *Fig. 258.* Fine chromic catgut is used as suture material, or silk and atraumatic sutures are inserted at the mucosal borders and tied externally. The T-tube is inserted by separate incision; it should never be close fitting, i.e. it must be thinnner than the duct lumen, to avoid splinting of the suture, its sole function being bile drainage. Trials of substituting parts of the ducts by some prosthesis have been abandoned entirely. All such attempts have terminated so far in stricture, obstruction or elimination of the prosthesis.

If injury or defect concerns a long section of the duct, this poses a problem

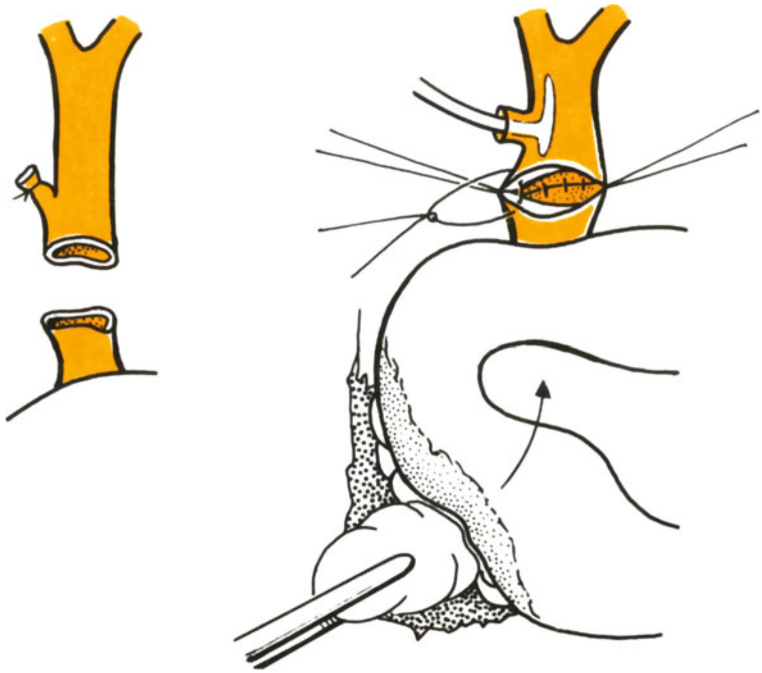


Fig. 258: Reconstruction of divided common duct, its ends are approximated by mobilization of duodenum with pancreas.

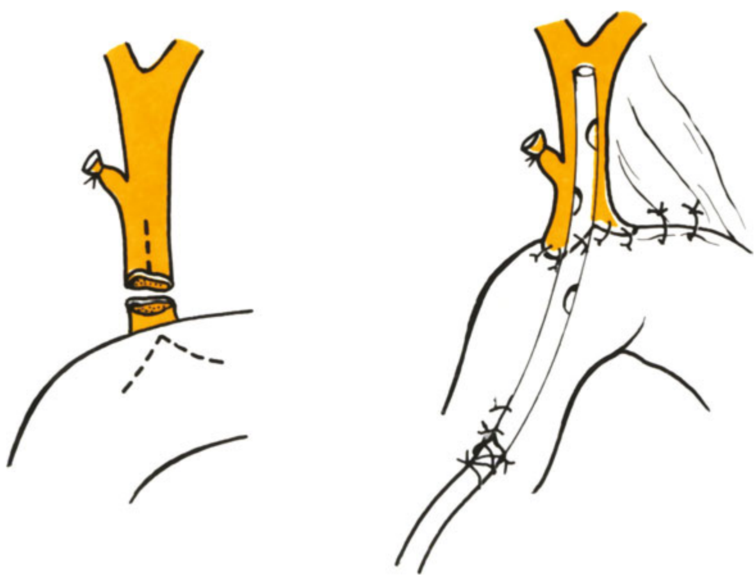


Fig. 259: Anastomosis between common duct and duodenum end-to-side. The narrow duct was widened by an incision, the duodenum opened by a V-shaped cut and a narrow drain pulled through the anastomosis brought out through the gut.

if its ends cannot be brought into approximation as is also the case if a narrow duct is injured or injury affects the terminal part of the common bile duct. In such cases terminolateral anastomosis of the upper stump with duodenum or jejunum is indicated, in such a fashion as to avoid tension at the connection. Anastomosis must be wide; thus in a narrow calibre duct a longitudinal and in the gut a V-shaped incision is of assistance. The peripheral stump is inspected for any small stones, whereafter it can, but not necessarily, be ligated. *Fig. 259.*

Following every repair of injuries the neighbourhood is adequately drained. Here suction tubes are best.

Signs and sequelae of injuries not recognized until after operation, and suitable time for their repair

Only a small proportion of bile duct injuries, hardly one-sixth, are recognized immediately during operation and can be repaired at once. In the other instances the mishap announces itself after the operation, though this is a rule quite soon: — by intraabdominal hemorrhage or, more often, by peritoneal biliary irritation, possibly leading to peritonitis, external fistula or jaundice. In some cases sequelae of injury to the duct reveal their presence after many weeks or months by variously pronounced signs of cholangitis and obstruction.

Any duct damage has a tendency to heal by stricture, not only in cases where the duct was constricted or ligated, but also after incomplete tears or complete disruption with extravasation of all the bile. Similar sequelae are also produced by the irritation of duct and tissues in its vicinity by bile which has escaped. Bile then stagnates proximal to the emerging stenosis and nearly always becomes infected. Even if jaundice does not appear and obstruction is neither complete nor persistent, stasis in conjunction with infection always produces early liver damage and may culminate in later biliary cirrhosis if treatment has failed. Timely surgical intervention is thus imperative, but that suitable time is not always synchronous with the moment of diagnosis.

Immediate abdominal reoperation is mandatory for hemorrhage (p. 489) or in the presence of peritoneal signs, if bile is escaping from the injured duct into its vicinity and into the abdominal cavity. If an accumulation of bile is discovered subhepatically or biliary peritonitis is present, the possibility of duct injury must be entertained, apart from other possible causes (p. 490). Even if the site of bile duct injury can be identified, a definitive operation is rarely done under these circumstances with the possible exception of the first day when conditions are similar to those at operation. Otherwise the bile and effusion are merely evacuated from the abdominal cavity and bile drainage ensured by a tube inserted into the duct proximal to the site of injury, and in addition the abdomen is properly drained. Repair of the injury is left to the second stage after 3–4 weeks, at a time when local conditions for suture will be more favourable and the patient's condition improved.

In other cases, likewise, an injury is suggested soon after surgery by the appearance of a biliary fistula, jaundice or cholangitis, but in spite of that, reoperation is in most instances deferred to await more favourable local conditions for reliable intervention. Early and delayed surgical treatment of iatrogenic biliary fistulas has already been discussed in the appropriate chapter (p. 366). If such injury presents as bile drainage from the peritoneal subhepatic tube and from the wound with massive bile loss, no jaundice, or only slight discolouration develops. Parallel with the cessation of bile drainage more marked jaundice develops after a few days or weeks which is sometimes fluctuating with its intensity being inversely proportional to the bile loss. If no jaundice develops there is increasing hope that the fistula may have closed spontaneously. If closure is complete and the patient symptomless, check investigation is carried out approximately after two months, and further measures adopted according to the result.

If repeated bouts of cholangitis occur, operation should not be deferred for more than two months. If jaundice persists or increases in intensity, intervention should be speeded up to within 3 weeks. Otherwise, however, it was shown that a recent biliary fistula should preferably be left to "mature"; and in cases where permanent closure fails to occur and the patient is not menaced by jaundice, reoperation is not embarked on until at least 3 months have elapsed.

In cases where the main bile duct was tied or constricted at operation, jaundice itself is an early symptom appearing even during the first days and not accompanied by extravasation of bile. It fluctuates only exceptionally or even wanes e.g. if an internal bilio-digestive fistula forms. As a rule, however, jaundice persists, the stools are pale, even white, and the temperature rises. In such cases an interval for reoperation of 2–3 weeks is recommended.

Sometimes a compromise must be made in all the instances quoted between the tendency to delay surgery to allow local conditions to settle, and the endeavour not to harm the patient by an expectant attitude. There is always sufficient time, however, for adequate preoperative preparation.

If sequelae of operative injury appear after several weeks or even months, fibrostenosis is bound to be present and any recent inflammatory reactions can be counted on to have resolved. Operation in such a case is advisable as soon as proper investigation and preparation of the patient can be completed.

Postoperative manifestations and late sequelae of some unrecognized injuries and the technique of postoperative revisions and reoperations are considered in later paragraphs (p. 522).

INJURY OR DAMAGE OF NEIGHBOURING ORGANS DURING BILIARY SURGERY

Liver injury

The liver is liable to injury during operation in two ways: during dissection of the gallbladder and by retractor pressure.

During dissection of the gallbladder from its fossa several small vessels are divided, and sometimes some fine biliary canaliculi also.

One somewhat larger — canalis subvesicalis — frequently traverses the fossa longitudinally towards the hepatic duct. All these delicate structures should and can be either tied or transfixed during suture of the fossa without harm. Otherwise bile oozes unnecessarily from it, even though only transiently and may be removed by subhepatic tube suction.

The gallbladder sometimes has become so firmly adherent or has perforated in the fossa as to make subserous blunt "shelling out" avoiding liver tears impossible. Any bleeding and torn tissue is compressed by a warm moist pack and the fossa later sutured over. A drain is always placed in the area, as temporary bile leakage is possible.

The liver, particularly if enlarged always suffers from retractor pressure. This cannot be avoided altogether, but damage is not obvious after operation. Despite this the assistant should retract the liver gently and with feeling, and only for the required time. The end of an excessively tilted retractor should never dig into the liver parenchyma.

Liver injury by puncture or excision, or interference with its blood supply by hepatic artery injury have already been mentioned in the appropriate section (p. 475).

Pancreas injury

The pancreas is most commonly bruised or injured in the course of difficult extraction of impacted small stones from the terminal bile duct, and particularly during papillosphincterotomy. If access to the papilla is poor it must not be lifted by catheter or levered by metal probe, but approximated by gentle drawing or pushing. Otherwise forcible manipulation may on occasions result in postoperative pancreatitis, which can terminate fatally. Likewise dilatation and probing of a tubular stenosis produces edema and possibly even inflammatory irritation in the neighbouring parenchyma, but perforation of the duct, however, must be quite exceptional. The danger of acute pancreatitis is resisted in advance (p. 264) following every more exacting procedure in the terminal bile duct.

Pancreatic damage due to probatory excision is viewed with apprehension and transduodenal puncture substituted in preference. Protection by introduction of a suction drain in the area is required.

Duodenal injury

This is most likely in reoperations when it has become adherent to the liver undersurface. Mobilization is accompanied by tearing of the serous coat and exceptionally perforation of the gut. Denuded surfaces and perforations must be immediately sutured over.

The posterior duodenal wall may be injured, even pierced, during probing of the sphincteric biliary duct segment by a rigid instrument with the danger of retroperitoneal cellulitis, similar to the extraperitoneal perforation of a duodenal ulcer. Equally dangerous is an extended or complete sphincterotomy, if it penetrates the entire intestinal wall. The injury may heal if duodenal contents are aspirated by gastroduodenal tube and bile diverted by tube drain from the bile duct.

Technical and tactical errors

The surgeon is guilty of an error not only through direct injury of the biliary passages, but actually by any technical slip. The most common lapses will be listed:

By grasping a distended gallbladder in clamps the surgeon himself may drive a stone from the gallbladder into the bile duct during the operation. For this reason the contents should first be evacuated by puncture. Before probing the cystic duct the absence of any stone should be verified by palpation, otherwise it must be "milked out" in advance. *Fig. 117.*

Mere ligation of a short and wide cystic duct stump is not sufficiently reliable, and it is advisable to transfix the stump distal to the ligature by a suture.

The bile duct should not be stripped for more than the essential extent, and only fine atraumatic sutures may be used, placed accurately so as not to impair the vitality of its wall. Inaccurate and coarse stitches are also a common shortcoming in the suture of anastomoses and one of the causes of their retraction.

Probing of the papilla by a catheter exceeding 6 mm in diameter is superfluous, sometimes even traumatizing, and damage may induce stenosis.

Another not infrequent error of technique is faulty insertion of the T-tube. It must not emerge through the anastomosis suture and should not be wide. Instead of a transverse arm short clipped wings will do, as the latter are bent over easily during removal of the tube and do not tear the duct opening. The subhepatic drain likewise may cause harm if it presses on the suture or compresses the duct. A not sufficiently appreciated mistake is insufficient peritonealization of the gallbladder fossa to which unnecessary adhesions of other viscera develop. Further, excessively tight bile duct and cystic duct stump peritonealization may cause accumulation of bile and blood in the retroperitoneum.

Accidents and failures of biliary surgery may also be due to faulty strategy and tactics.

This concerns in the first place incompletely performed operations with retained stones in the duct or an overlooked stenosis of the papilla. It is dubious, as a matter of principle, to be satisfied with a mere cholecystolithotomy or cholecystostomy in cases where cholecystectomy can be tolerated by the patient and represents a definitive cure. It is wrong to preserve the gallbladder if the bile duct is utilized for a biliodigestive by-pass or if sphincterotomy has been done.

Wide sphincterotomy for tubular stenosis, or gallbladder anastomoses in non-malignant disorders are inadequate interventions. No harm need ensue, on the other hand, if for some overriding consideration a remnant of gallbladder or a long cystic duct stump is left provided these remnants do not harbour stones. No calculi must be left either in the blind biliary duct pouch following lateral bile duct anastomosis.

It is wrong to omit bile duct exploration solely because the gallbladder contained a large solitary stone. It is also incorrect to neglect complete removal of stones from the ductal system and to rely on their spontaneous passage through a wide papillosphincterotomy. Sometimes insufficient exploration of the other abdominal viscera is reprehensible if these are accessible during biliary surgery without harming the patient.

Few operations exist with so many pitfalls and unexpected hidden snares as is the case with biliary surgery. Bad judgment, technical errors, a moment of inattentiveness, these may all cause such harm to the patient in a single moment that their repair may continue until the end of his life. Most errors may be prevented, however. Apart from early operation, this is the second great opportunity for the application of preventive efforts in biliary surgery.

Postoperative Complications and Urgent Reoperations

Following biliary surgery any kind of complication may arise as is the case after every major operation, particularly in the epigastric region, and in an elderly subject. Some complications, however, are particularly characteristic for these patients, or are directly connected with the biliary tract intervention. A number need never arise if due care is devoted to their prevention.

Complications in common with other abdominal operations

The most frequent non-specific complications observed in our patients following biliary operations were bronchopneumonia, pulmonary infarction, phlebothrombosis, and cardiac failure.

Particularly, myocardial infarction is listed amongst the more common causes of death after biliary surgery. It arises in persons with ischemic heart disease and is observed more frequently during the second half of the patients hospital stay. Its incidence, however, is certainly less high than its clinical diagnosis. Smith has stated that "his patients after biliary surgery do not die from a coronary". This is meant to convey, with deliberate overstatement, that an unexplained tachycardia or state of collapse immediately after operation should always arouse suspicion of some serious abdominal complication in the first place, such as pancreatitis, biliary peritonitis or hemorrhage. This must be excluded, even if there is a suspicious ECG, before adopting an "escapist" diagnosis of infarction. Interpretation of equivocal ECG changes is aided by comparison with a preoperative tracing. In the author's series of biliary operations myocardial infarction was the cause of 7% of fatalities.

Diabetic deterioration following biliary surgery may be unexpected, pronounced and swift. Glucose tolerance even in mild diabetes may temporarily sharply deteriorate, but, surprisingly, later improve. For this reason daily postoperative blood sugar estimations and urine tests are required, administration of glycids and insulin adjusted sensitively.

Intrinsic complications of biliary surgery

Peritoneal symptoms, sometimes accompanied by evidence of shock, arising soon during the first day, indeed even hours, after surgery, may be due to abdominal hemorrhage, escape of bile or acute pancreatitis.[6, 63] Medical causes of shock, such as myocardial infarction, acute pulmonary edema or pulmonary embolism are hardly ever encountered during the first days and are not accompanied by clear evidence of peritoneal irritation.

Their possible presence could be entertained only after the exclusion of an abdominal cause, and then only with certain reservations.

INTRAABDOMINAL HEMORRHAGE

Major hemorrhage in the operative region is encountered very rarely, has mechanical causes or is due to infection and necrosis, and is more likely in disturbances of hemocoagulation, in particular affecting jaundiced patients.

If the patient bleeds immediately after the operation, the cause is practically always a mechanical one. Intraabdominal hemorrhage presents with pain and bleeding from the subhepatic tube. If, however, the tube is thin, it easily becomes plugged and bleeding need not be externally apparent, and pain is at first commonly ascribed to the wound. Accordingly such hemorrhage is more often recognized by tachycardia and blood pressure decline in a patient who is pale and bathed in cold sweat. In contrast to postoperative shock, however, signs of collapse return after blood transfusion and, as a rule, also after changing the position and lavaging the subhepatic tube blood issues from it. The author expresses full agreement with Olivier's experience that hemorrhage itself is not usually as dangerous as delayed diagnosis. Surgical revision is undertaken at once and commonly discloses abundant blood and clots, particularly beneath the liver. The whole region is inspected, particularly the cystic artery ligature site, but hemorrhage originates as a general rule however from the fossa or its borders. After evacuation of clots hemostasis is accomplished by simple ligatures or suture ligature, or the fossa pulled together by mattress sutures through the parenchyma, if hemorrhage from a small artery is no longer encountered. A new and wider subhepatic drain is placed in position and blood loss fully replaced. Prognosis is usually good.

Hemorrhage appearing after several days is more dangerous. It arises on the basis of infection, necrosis or autodigestion by pancreatic or biliary secretion. It is rare, and most likely presents with repeated sudden hemorrhage from the subhepatic tubes. Immediate laparotomy is here also required, but treatment is difficult. Sometimes the situation tempts the surgeon to pack the wound, this, however, is not a safe method. An attempt is also made to control the primary cause of hemorrhage, and to adjust any impairment of hemocoagulation.

HEMOBILIA AND BLEEDING INTO THE DIGESTIVE TRACT

One of the rare complications of biliary surgery is hemobilia. The biliary drain may begin to emit, intermittently or massively, blood mixed with bile, or pure blood. This usually leaks into the digestive tract at the same time producing melena. Such hemobilia may arise several days or even weeks after operation on the biliary tract. It is caused either by bleeding from a damaged or inflamed duct wall, — or by a brisk hemorrhage from an adjacent artery, either injured or included in the biliary duct suture. Sloughing of the suture or formation of a small aneurysm produces a communication between artery and duct and blood flows briskly into the biliary tract. Surgical revision usually succeeds in separating vessel and duct, the defects being sutured or excised. — If minor intermittent hemorrhage occurs, or there is an admixture of blood in the bile, gentle lavage of the tube may be tried first to prevent blockage of the duct. Blood loss is compensated by transfusion and aggressive doses of antibiotics are prescribed if hemobilia is suspected in connection with cholangitis. — In some instances blood may appear in the bile draining from the tube as presenting symptoms of an overdose of anticoagulants. This is verified by prothrombin time test and any disturbance of hemocoagulation is rapidly controlled.

Intestinal hemorrhage. Sporadically melena, even more rarely hematemesis, occurs in patients during the first days after biliary surgery. This may be a result of papillosphincterotomy during which a small duodenal wall artery has been transected, or may be due to associated other disorders, peptic ulcer or varices. It is also necessary to ascertain, by T-tube lavage, whether this is not in fact a case of duct hemorrhage i.e. hemobilia.

If bleeding following transduodenal sphincterotomy is suspected, an expectant attitude is usually adopted. Such hemorrhage was encountered only three times in more than 700 PST performed by the writer, and surgical revision was not required. If there is major intestinal hemorrhage its source should be identified by endoscopic or radiological means, and managed adhering to the principles for such hemorrhages.

ESCAPE OF BILE INTO THE ABDOMINAL CAVITY

Extravasation of bile does not usually produce pronounced shock, but rather peritoneal irritation accompanied by bile drainage through the subhepatic tube or leakage from the abdominal incision. Manifestations and consequences of the abdominal escape of bile vary according to their cause and drainage methods, and in particular, according to how early and how massively an extravasation has occurred.

If bile oozes from the gallbladder fossa this does not cause marked symptoms until the second day. The patient remains apathetic, his pulse rate is high, and he is afraid to take deep breaths on account of pain, but blames the wound. If bile starts to flow from the subhepatic tube, the true cause is revealed. Peritoneal signs must be searched for even if no bile flows from the tube, because the latter may be compressed or abutting. One must repeatedly make sure that tenderness does not extend further to the right from the wound under the arch, and does not spread downwards producing muscular rigidity. Even if bile is draining from the tube, this may also escape into the abdomen and if the tube drain cannot control leakage from the fossa, surgical revision for biliary peritonitis soon becomes necessary. In actual practice this is a rare event, and then it usually suffices to evacuate the bile and to insert parenchymatous sutures through the fossa, and introduce a wider suction tube under the liver.

Bile leaks alongside the T-tube, or through a biliary duct suture or anastomosis commonly occur only several days later. Seepage by the side of the tube inserted in the bile duct can be controlled as a rule by raising the T-tube suction effect by placing the receptacle deep under the bed and the opening under a water seal. Our assumption may be verified by cholangiography. Several days later bile flows exclusively through the T-tube and the neighbouring fistula has closed spontaneously. If bile oozes through a primary duct suture, a low negative pressure is applied to the subhepatic safeguard tube, and this is left in position until the fistula obliterates.

The most difficult situation confronts us in dehiscence of a bilio-digestive anastomosis. Usually this does not occur until several days after the intervention; when at least partial adhesions have formed in the vicinity offering some hope that continual, sometimes prolonged suction drainage of bile through a tube close by will achieve healing of the anastomosis. Expectations are obviously higher in cases where an excluded Roux loop has been used for the anastomosis, than in cases where, apart from bile, intestinal contents also can leak through the defect. In such patients the entire stomach contents are also aspirated through a duodenal tube, wound secretions drawn off intensively, and its neighbourhood protected from meceration by alkaline juices. Only exceptionally is surgical intervention feasible — if extensive gaping of the suture occurs during the first two or three days after the operation. These are very tricky operations, and must be conducted individually according to the given situation. The operative field is not yet too friable and edematous, and the suture can still be repaired or the defect covered by sewing an adjacent viscus over it. If a duodenal anastomosis is involved, the afferent link can be excluded by gastric resection; if a jejunal anastomosis is present, the afferent loop can be excluded after Roux.

In acute bile extravasation following operative injury or a slipped cystic duct ligature, revision should be undertaken as soon as possible (p. 483). The onset of biliary peritonitis is heralded by stormy symptoms: tenderness and rigidity, raised temperature and blood pressure reduction — or its manifestations may be strikingly discrete, and the possibility of a developing cholaskos is suggested only by abdominal distension accompanying a state of sub-ileus, a touch of jaundice and positive results of puncture aspiration. The variations in pattern and evolution are determined by the presence of infection and the rate of bile extravasation. In both cases, however, revision of the abdomen is urgent. All fluid is aspirated from the abdominal cavity, the source of bile escape is repaired, antibiotics instilled and drains placed in the subhepatic and the affected region, particularly the small pelvis. Patients must be prepared for such an intervention, by the administration of plasma, and antibiotic umbrella.

FAULTS OF EXTERNAL BILIARY DRAINAGE

Impairment of free biliary drainage through the T-tube may be an indication of some postoperative complications or by itself interfere with a normal postoperative course.

If bile fails to flow through the tube during the first hours or days, this may be a manifestation of severe liver damage by cholestasis, in a case where during surgery only "white bile" was found in the bile duct. A rising flow favours improvement of liver disturbance. A diminishing bile flow in later days may be due to plugging of a thin tube, its wrong position or constriction, or, on the contrary, may indicate complete restoration of flow through the papilla. Tube patency is tested by lavage and radiological check, and if necessary, the tube is removed or changed for a new one.

Excessive outflow of watery bile amounting sometimes to veritable hydrocholeresis of several days duration is sometimes encountered after operations on patients with neglected cirrhosis. In most cases, however, increased bile drainage is a sign of impeded flow into the gut. This may be temporary with edema of papilla or pancreas; its onset is immediately after surgery and recovery is spontaneous in a few days. If, however, massive external biliary drainage persists, an obstacle in the periphery is apparently present, such as a stone or stenosis, confirmation can be obtained from cholangiography. If the stone concerned is small, it can sometimes be flushed out, dissolved, or even extracted under radiological control. If the stone is large, or stenosis persists, reoperation will be required. The time for this depends on whether closure is complete, or allows a longer interval; the latter being advantageous for the patient.

In sporadic instances of abundant outflow through the tube duodenal reflux may be present. This is recognized not only by the large quantity of fluid greatly exceeding half a litre, but also by its light colour or colourless appearance, and usually, its increased amylase content. Duodenal reflux is caused by excessive T-tube suction effect, particularly in the presence of sphincter of Oddi insufficiency after papillosphincterotomy, or by transpapillary insertion of the tube into the duodenum. Large losses of fluid, bile and also duodenal contents may rapidly be reflected by signs culminating in shock. Losses must not only be made good, but the suction effect must be reduced, even up to a positive biliary duct pressure (+12 cm) or the tube closed altogether or removed.

ACUTE POSTOPERATIVE PANCREATITIS

This is a much feared complication immediately after biliary surgery, in particular after operations on the papilla and terminal bile duct. The pattern is not usually typical, pain need not be a prominent feature, and some of its other manifestations may be obscured during the postoperative period, or ascribed to the surgery itself; mild forms may escape detection altogether.

For these reasons, the possibility of pancreatitis must be kept in mind with patients whose pains are not adequately explained by the operation, in whom an otherwise unexplained rise in pulse rate appears, who are apathetic, with a drop in blood pressure and evidence of shock, in particular following papillosphincterotomy, or a difficult stone extraction from the sphincteric segment. A very common and early sign is also a decline in diuresis, sometimes jaundice and, in severe forms, mental alteration.

Physical examination results on the recently operated abdomen are insignificant, slight distension and tenderness in the epigastrium are ascribed to the operation. Only rarely is suspicion aroused by tenderness in the lumbar region and along the colon, by hemorrhagic secretion from the subhepatic tube or a pleural effusion. The persistence of ileus may be conspicuous at a time when peristalsis should already have returned to normal. Diagnosis, however, is not as a rule established until a rise of amylase in blood, urine and other available fluids assists the differentiation from hemoperitoneum and early biliary peritonitis.

Postoperative pancreatitis is linked to surgical intervention, and thus amylase activity must accordingly be monitored from the first day following all operations in the bile duct-duodenal junction region. A similar close watch must be kept on diuresis, alterations in the blood picture, and on the ECG. A rise of blood urea is an unfavourable omen.

The incidence of pancreatitis after biliary surgery varies in different series, but it occupies one of the first places amongst causes of death after PST; it is for this reason that some surgeons prefer to give it a wide berth. Slight rises in amylase were found by the author even after simple handling in the region of pancreas and papilla, in up to 20% of cases, and this may occur also after some operations without pancreatitis. However, a marked elevation of activity speaks clearly in favour of pancreatitis.

Prevention and treatment

We are unable to protect the patient from acute postoperative pancreatitis otherwise than by gentle and cautious surgical technique, and by some immediate preventive measures. Not only forcible papillosphincterotomy or the vehement extrac-impacted stones, but also rough dilatation, pressure on the pancreas during probing or rapid injection of contrast medium and sometimes transpapillary drainage is dangerous. Patients thus threatened are immediately treated with tetracycline, trasylol, bile duct drainage and aspiration of gastric contents; application of Venalot and Mercurascan may also be helpfull (p. 264). A search is made for the initial symptoms of pancreatitis and threatened shock combated, as this is the main cause of death. Surgical revision is required only in an uncertain situation, or for critical progression of symptoms, particularly in cases where biliary drainage was not guaranteed. Timely operation and peritoneal drainage and dialysis apparently contributed to the saving of 3 of the author's patients with an explosive course of pancreatitis. During the past 5 years no fatality from pancreatitis has been recorded, but otherwise this was a fatal complication of PST in 1,3%.

POSTOPERATIVE JAUNDICE

Many postoperative complications are accompanied by subicterus or icterus, which may be their main feature. Before surgery this represents a manifestation of a complicated biliary tract disorder, but even postoperatively mechanical obstruction of the bile ducts must be the foremost consideration.[44, 58]

Jaundice may be produced by surgical injury of the main bile duct, which may not have been noticed by the surgeon, or which he has not dealt with adequately. Following ligation of the main bile duct rapidly mounting jaundice develops during the first days. Otherwise, injury, or even total severance of the duct, initially produces signs of biliary fistula, and only later after many days or weeks, when a stricture develops, does jaundice make its appearance (p. 484).

Postoperative jaundice may sometimes be explained by a residual stone which has descended to block the papilla after operation. Suspicion is aroused by enhanced biliary flow through the T-tube and by painful sensations if the latter is compressed. A stone can be demonstrated by check cholangiography, and its removal by conservative means attempted. If this fails and obstruction is complete, reoperation must be embarked on. If, however, it is intermittent, surgery may be delayed (p. 492).

Mild transient jaundice of mechanical origin may also appear following operations of the papilla if the bile duct has not been drained. This persists until edema or inflammation due to the surgery have subsided.

A yellowish tinge of the sclerae or even jaundice appears in some patients after operation. This is fleeting, cholestatic in type and of obscure etiology, connected obviously somehow with surgical trauma. The patients make no complaints, and the yellowish tinge soon resolves. Damage may have been caused by vehement lavage, or rapid injection of contrast medium, or bile flow may be transiently hampered by swelling of papilla or pancreas, if the bile duct has not been drained. Such patients are managed on the lines for threatened pancreatitis.

Jaundice may also be hepatic in origin — particularly through loss of compensation in pre-existing hepatic disease, or in Gilbert's syndrome if fasting is prolonged. For its assessment knowledge of biochemical data before operation is very valuable, as is routine liver biopsy, performed during operation.

Pronounced jaundice may be due to severe hemolytic reaction following transfusion or from other causes. In such cases the direct bilirubin reaction is positive in the blood, but the stools are not acholic. An ill omen is jaundice accompanying postoperative, particularly anaerobic, sepsis.

Toxic damage of the liver by drugs or other substances such as halothane during anesthesia is rare. If the latter occurs, it usually follows the second employment of this anesthetic, when even the first time it produced a painful reaction with fever, leucocytosis, subicterus and elevation of transaminases. Hepatitis is quite severe, frequently with cholestatic features, and mortality amounts to 20%. Energetic treatment as in threatened hepatic coma is required.

LIVER FAILURE

Liver failure with coma may occur after biliary surgery if the liver has been severely damaged by protracted obstruction with cholangitis, as well as after laparotomy erroneously undertaken for jaundice of hepatic origin (p. 343). Failure may also occur with a combination of cholelithiasis and primary liver disease, such as cirrhosis.[11, 81]

A special type is acute necrosis, sometimes occurring after ligation of hepatic artery or one of its main branches. This threatens immediately after operation, particularly if prevention is inadequate, and may terminate fatally in a few days (p. 475).

Signs of impending liver failure include inversion of sleep rhythm with mental alteration. The patient displays a fixed stare, perception is blunted, speech slurred, and hepatic foetor is pronounced. Flapping tremor makes its appearance. A serious sign is rapid deepening of jaundice, rise in temperature and multiple hemorrhages. The patient declines into apathy and gradually sinks into the deep unconsciousness of coma.

Apart from leucocytosis, laboratory findings show profound decline in prothrombin complex activity, reduction of albumins and rise of ammonia blood levels. Renal failure is frequently associated (hepatorenal syndrome).

Prevention of hepatic failure stems from its etiology. Treatment is nonspecific and its effect uncertain, it should, however, be conducted energetically, as survival is possible. The main principles according to Sherlock are as follows: intravenous administration of glucose and especially vitamins, omit proteins from the diet, and limit resorption of nitrogenous substances from the gut by high enemas, lactulose and neomycin — if renal function is adequate. Homeostasis of ions must be maintained, disturbances of hemocoagulation corrected, and anemia compensated by fresh blood transfusions. Ampicillin is a useful antibiotic and corticosteroids are as a rule prescribed.

RENAL FAILURE

Renal disturbances may arise after operation in patients with known nephropathies, as well as in subjects with previously normal kidney function. Surgical patients with advanced obstructive jaundice following operations in the terminal bile duct region are particularly imperilled. The origin of such failure is not always quite clear. It is, however, usually of extrarenal type.

The most important postoperative disorder is the reduction of blood volume. Apart from a combination of other unfavourable influences of surgical trauma, activation of infection, and in particular the endotoxins of intestinal bacteria play a role. Oligemia and hypoxemia are particularly dangerous in chronic nephropathy, where the mechanisms of compensation are a priori limited.

The quantity of urine passed during the first day after operation is always reduced and the kidneys reduce sodium excretion. If adverse factors are not removed and the conditions corrected, blood urea may rapidly rise, even if diuresis is still adequate. An alarming signal of renal failure is progressive oliguria, elevation of urea nitrogen and creatinine blood levels, derangement of sodium excretion and urine osmolarity.

The prognosis of these states used to be grave indeed. Currently, apart from prevention and timely correction of postoperative disturbances, some patients may be saved by hemodialysis. Dawson's advice was found useful as regards prevention: In patients at risk, commence mannitol infusions even before surgery, and maintain diuresis by this means during the immediate postoperative period. A logical step, though not yet confirmed by practical experience, is the proposed preoperative gut sterilization or the administration of taurocholate (Bailey, 1976).

RETAINED STONES IN THE BILE DUCTS

Retained stones still belong to the most common postoperative complications. They sometimes fail to present as complications if no symptoms are produced, — nor can they be designated as true failures if deliberately left behind in order not to overtax the patient's strength.

Retained stones are currently found in 2–10% of cases.[19, 35, 65, 89]

Ottinger, (1974) reported 5%; Arianoff, (1973) 0.5–8%, and following interventions for choledocholithiasis 2–15%; in a personal series (1975) of 1 178 operations for choledocholithiasis the number of residual stones declined due to operative cholangiography in the last 10 years from primary 11 to 3 per cent. Orloff (1978) estimates that retained stones after choledocholithotomy are found in about 10–13% in the immediate postoperative period and later a still unknown additional number.

Stones detected in the ducts after biliary surgery may be genuinely residual, because they were overlooked or could not be removed, but they also frequently represent recurrent, newly formed stones. These cannot always be easily distinguished from retained ones with whom they are associated or whose volume they enlarge, being formed independently in other instances. A high cholesterol contents is mainly in favour of residual stone, and so is its polyhedral shape, and particularly the fact that it resembles stones already removed at the first operation.

New stones are formed some time after operation, particularly in cases of sluggish bile flow; they thus belong to the late complications to be dealt with further on.[49, 60]

How can stones be overlooked?

This is usually due to the fact that the ducts have either not been explored at all, or only inadequately, and that interpretation of findings was incorrect. Indications for exploration of the choledochus are sometimes too restricted. Palpation and probing by themselves provide no certainty and many surgeons still fail to exploit operative cholangiography, despite the fact that it has been proved reliably that its standard use reduces the risk of overlooked stones (Way, Magarey et al.). Berci reported in 1978 that by using the most modern technique of fluorocholangiography coupled with trained interpretation stones escaped detection in only 1% of a series of 300 operations.

Accordingly, not even cholangiography is infallible, particularly if the ducts are widely dilated or packed with small stones high up into the hepatic branches. Investigation must be combined, in particular with choledochoscopy, a method which by itself is capable of reducing the incidence of residual stones to 2% (Berci, 1978).

Alas, not even painstaking exploration and clearance always achieve the detection of all stones present, and the surgeon, be he ever so experienced, who has never overlooked a stone does not exist. It is rational, therefore, to perform for the sake of safety a preventive drainage operation such as PST, or better still an anastomosis, in some cases.[37, 38, 64]

The fate of retained stones.

Retained stones fail to cause symptoms during the early postoperative period in the vast majority of cases, be they small or large. Postoperative cholangiography reveals their presence either at the identical site or migrating to the periphery. Further controls sometimes fail to detect them, either because of their spontaneous passage or because the interpretation of previous films was erroneous.

Only infrequently does a retained stone produce symptoms soon after surgery by occasional sensations of pressure or by enhanced biliary drainage when the tube is being closed. Occlusion of the papilla by a descended stone may induce jaundice or cholangitis soon after the T-tube has been withdrawn and a biliary fistula may develop.

Later manifestations of residual or recurrent stones, most often attacks of colic or intermittent incomplete obstruction, will be dealt with in the chapter on late postoperative complaints (p. 513).

Treatment

Retained stones confront the surgeon with a serious decision on further measures, mainly as regards early surgical revision. It used to be the custom to embark on it immediately after the detection of stones, and for this reoperation it was considered advantageous to leave the T-tube in position in order to rapidly identify the choledochus by it. It transpired that surgery during the first days or weeks is more difficult and hazardous than after a longer interval, when the choledochus may be found equally well or even better, and without a drainage tube.

For these reasons and also because a number of highly successful methods are currently available for getting rid of the stones dispensing with surgery altogether, early operation should only be undertaken if acute menacing choledochus obstruction develops and revision becomes unavoidable. Otherwise surgery is delayed, and if attempts at stone extraction by nonsurgical means fail, or they are not voided spontaneously, guidance is obtained by their manifestations. These sometimes allow revision to be undertaken even after the lapse of several months.

Nonsurgical removal of retained stones

If a missed stone is detected immediately after operation by check cholangiography via the T-tube, its removal without operation should be attempted.

Currently several methods are available:

1. Spontaneous passage is encouraged and small residual stones are floated out.
2. An attempt is made at dissolving the stones by the instillation of chemicals via the T-tube or by their oral administration.
3. A trial can be undertaken at removing residual stones through the sinus tract of the in-dwelling T-tube.
4. Nonsurgical methods also include the possibility of assisting the passage of residual stones by performing duodenoscopic papillosphincterotomy, or to extract them afterwards from below using instruments guided through the endoscope.

1. The spontaneous passage of remaining smaller stones may be assisted by brisk walking, drainage closure and by normal saline washes. A warmed solution is injected daily, preferably under manometric control, for at least one week. It is advisable to verify by cholangiography whether the calculus is lighter or heavier than the bile, and accordingly perform the lavage either lying down or sitting up. Combination with anesthetic may enhance the prospect of washouts.

2. There is not always an exact borderline between flushing and dissolving stones, and both these components may assert themselves.[1, 2] The first better known trial of washing out gallstones with simultaneous attempts at their disintegration was performed by Walker (1891). Volatile solvents of cholesterol, such as ether and chloroform, are the main constituents of known successful methods of stone expulsion after Pribram and after Best. *Fig. 260.*

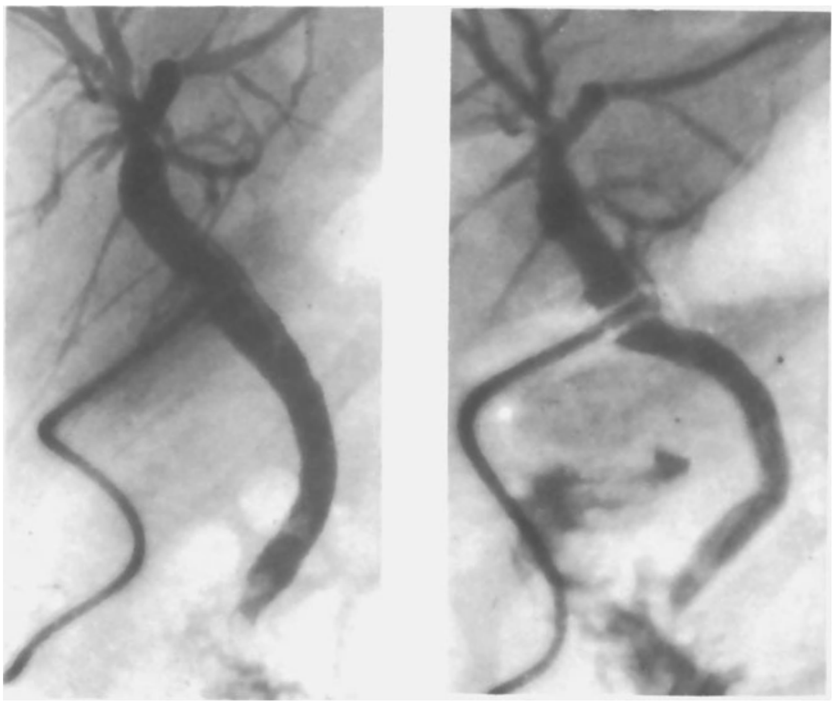


Fig. 260ab: Dissolution of residual stones: (a) After operation for cholelithiasis, a cholangiographic check through a T-tube showed three polyhedral stones in terminal portion; (b) after one week's dissolving and lavage by Pribram's method, there is no evidence of stones.

In the case of ether the increase of intraductal pressure by the rapid release of vapours plays a major role and may assist in the propulsion of stones, but even cautious drop-by-drop instillation may produce unacceptable pain.

Chloroform is not used widely for fear of causing liver damage, though this has not been observed following instillation by drain.

Clinical successes after heparine applied by common bile duct infusion of saline, as advocated by Gardner, are probably only due to mechanical washing of the duct, as it has not been proved to increase cholesterol solubility.[29]

At the present time bile salt solutions are being tried, as they were also found to be effective solvents. Infusions of sodium cholate are most readily available.[45] Dissolution occurs slowly, lasting even in the case of suitable cholesterol stones often 1–2 weeks, but is successful in over half the cases. Treatment is accompanied by diarrhoea which can usually be controlled with cholestyramine. Occasionally mild pancreatitis has occurred.

In recent clinical trials mono-octanoin appears a 2–3 fold more effective solvent of cholesterol stones and T-tube infusions are well tolerated. However, success with this method can be expected in not more than about two-thirds of cases.

If patients are treated in whom no T-tube was inserted, or where it has been removed already, long-term dissolution of retained stones by means of chenodexycholic acid, or apparently the still better ursodeoxycholate by os, may be attempted. Success is obtained in about one-half of cases. As yet this method is mostly reserved for research centres.

As far as dissolution of recurrent stones is concerned, which are pigment stones not containing cholesterol, or only small amounts of it, no substance has been discovered as yet which could dissolve them. Experiments have been con-

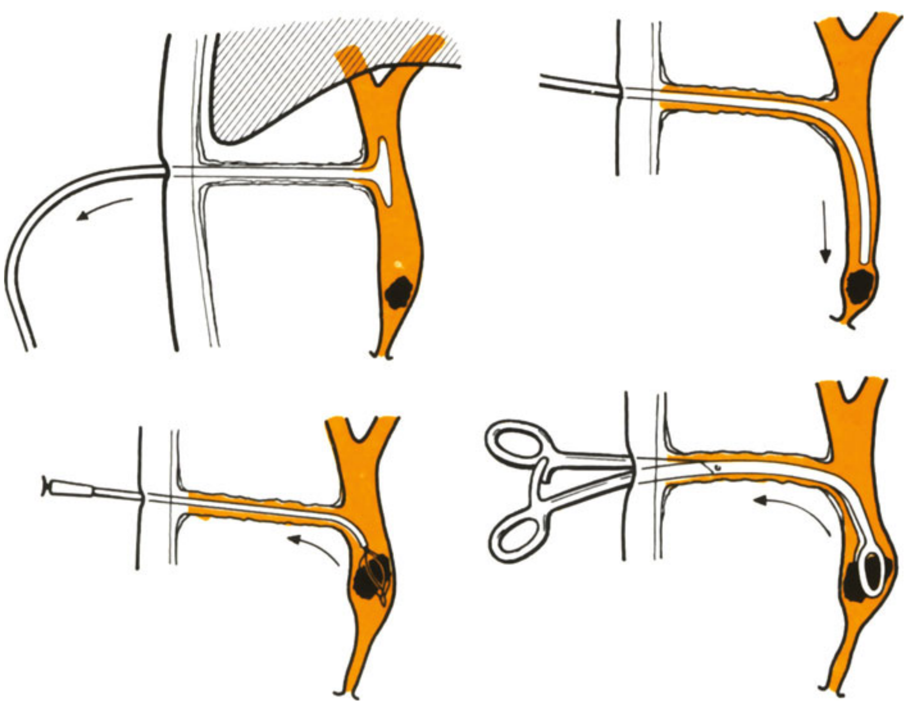


Fig. 261: Non-operative instrumental removal of residual stones: (a) A wide T-tube is withdrawn after "maturation" of the sinus tract; (b) attempt to push the stone into gut using a catheter with a terminal opening; (c) attempt at stone extraction with Dormia's wire-basket; (d) attempted stone extraction with fenestrated forceps.

ducted so far with the administration of glucaric acid (Schoenfield, 1974). — Finally, also ultrasonics have been used to bring about disintegration of stones (Bean, Davies 1977, Koch 1977).

3. Under certain conditions it is possible to extract retained stones by an instrument inserted through the T-tube, or preferably, through the tract following its withdrawal. *Fig. 261.* The most important thing is that he who attempts instrumental removal of a stone, a radiologist as a rule, must possess much patience, skill and adequate experience.

Mazariello, in 1978, reported experience with 1 086 patients over a period of 14 years with success in 95.9% of patients and with 1 death only, due to pancreatitis. Other complications in 85 cases (pains, cholangitis, pancreatitis, and false passage in fistula tract) subsided with medication, and only two of them required operation. This author favors the use of a variety of extraction instruments to cope with various situations.

One may attempt to push a stone out using, during cholangiography, a catheter with a terminal opening. *Fig. 262.* A better instrument is Fogarthy's balloon

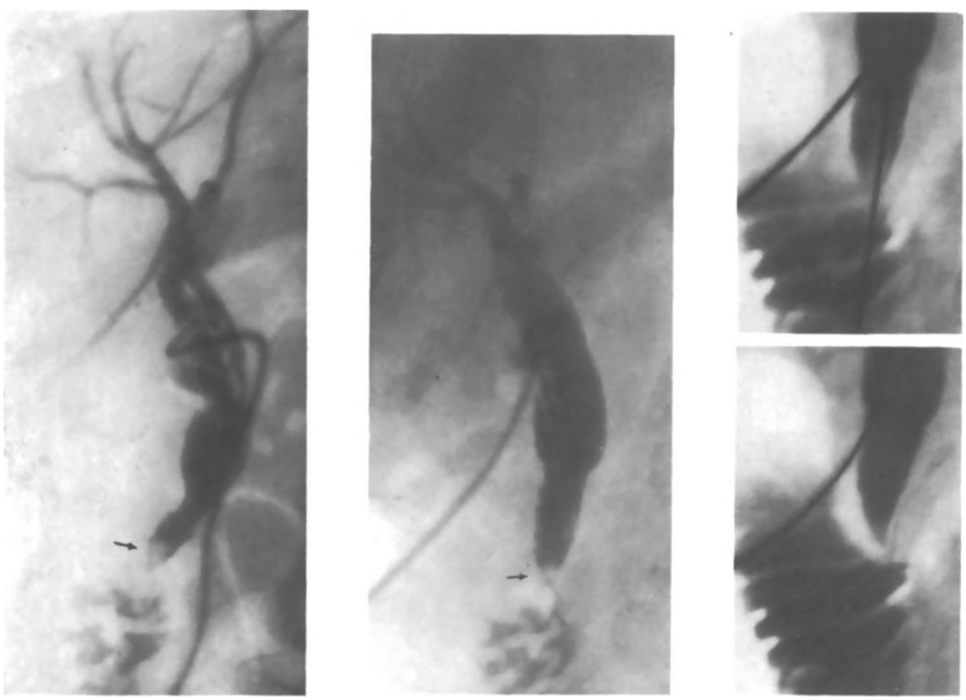


Fig. 262a–d: Non-operative removal of residual stone with aid of instruments: (a) Cholangiographic check through T-tube shows stone left in front of papilla; (b) after three weeks, T-tube replaced by straight tube; (c) with this tube, reinforced by metal guide, the stone could bepushed through into duodenum (d).

catheter (Baita, 1974). For pushing or pulling out a stone one may also use Mondet's long flexible forceps. For attempts at extracting a stone, however, the basket of Dormia catheter is preferably used. *Fig. 263, 264.* Distance-manipulation of the terminal part of Dormia's loop is possible with Burhenne's catheter.

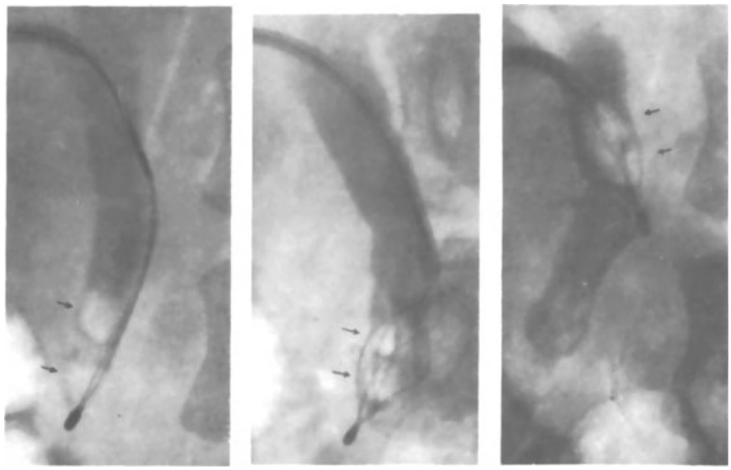


Fig. 263abc: Non-operative extraction of two stones left in common bile duct: (a) Passing the Dormia's basket through the sinus tract from the indwelling T-tube, (b) opening basket and getting hold of both stones, (c) checking their removal.

Patterson has pointed out that it is of advantage to combine some method of dissolving and flushing stones with their extraction.

These methods, which are more the domain of radiologists than of surgeons, are attended by disadvantages and risks.[14, 69] A necessary condition is an (undesirably)

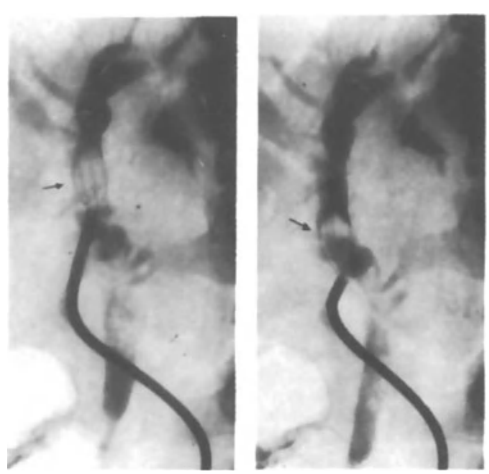


Fig. 264: Non-operative removal of stone left in hepatic duct: (a) Stone grasped in Dormia's basket, (b) pulling it into canal of extracted T-tube.

thick T-tube kept in situ for a number of weeks. Failures are numerous, especially since there are not many opportunities for trying a method which is fraught with the danger of injury and infection. The instrumental removal of remained stones should be reserved for suitable cases only and performed by an experienced radiologist.

4. Recent advances in endoscopy make it possible to remove residual and recurrent stones also by means of transduodenal endoscopic sphincterotomy. Stones may be extracted or pass spontaneously after papillotomy.

Safrany (1978), who has a four years experience with this method in 562 patients, was successful in 93% of them. According to his report — "complications consisting of bleeding, retroperitoneal perforation, pancreatitis, cholangitis, and stone impaction occured in 6.9%. In 10 patients (1.9%), complications made emergency surgery necessary and resulted in 5 deaths for a mortality rate of 1%."

The principle of endoscopic papillotomy is mentioned further, in the paragraph dealing with reoperations for papillary stenosis (p. 519). The attempt at extracting a common duct stone is undertaken with the Dormia basket catheter under fluoroscopic control. The procedure, which avoids the risk of anesthesia and of abdominal operation, is not exacting and can be used even in high risk patients. Since its introduction by Classen and Demling in 1974 the indications of endoscopic "papillolithotomy" were broadened, and good results, low morbidity and mortality rates make it a valuable technique also in other highly expert hands.[28, 47, 59, 74] However, we fully agree with Zimmon, that caution and judgment must temper our enthusiasm until more long-term results will be available.

Persistent or Late Symptoms of Surgical Failures and Late Reoperations

The vast majority of patients discharged from the surgical wards following biliary surgery, bearing in mind (primarily place) operations for lithiasis, are rid both of disease and symptoms. Normal diet is gradually resumed, even though some patients adapt themselves permanently to intolerance for certain foodstuffs. Only a minor proportion is discharged by the surgeon with some dissatisfaction and fears, even if symptoms are absent. This concerns patients where the actual findings did not conform with preoperative assumptions, or the intervention could not be performed reliably and to perfection: e.g. patients with known retained stones in the passages. Likewise uncertain is the future of patients who suffered main bile duct injuries during surgery and who are menaced by stenosis. However, even in some operations whose immediate result is satisfactory to surgeon and patient alike, a permanent cure of the biliary disease is not always achieved.

In about a third of cholecystectomy cases surgical healing is not accompanied by the full clinical effect desired, and these patients return for medical advice on account of a variety of symptoms, most commonly pain. In the thirties Pribram coined for these the term "postcholecystectomy syndrome" imagining that the loss of the gallbladder was its cause. After this view had been refuted the term survived only as a convenient and unnecessary label.[41]

No uniform postoperative syndrome exists, only a multitude of "syndromes" of widely differing significance, biliary and non-biliary, with and without colic. Symptoms at first sight similar may have different causes, and identical diseases diverse manifestations, affected in some of their phases by the trigger or modifying mechanism of the nowadays so common neuroses or reactive states.

Postoperative symptoms thus cannot be blamed even remotely in every instance on the failure or inadequacy of cholecystectomy or other biliary operation. The mere presence of an abdominal scar must not produce the superficial view that even a completely new disorder is somehow connected with the operation.

Not even an attack of colic, after which the disappointed patient sometimes returns, needs to be proof of surgical failure. It may be due to other causes such as an irritable colon, migraine, hiatus hernia or some forms of pancreatitis. This attack of colic may, however, also be caused by spontaneous cure of residual choledocholithiasis, the so-called "last colic", or by expulsion of clots or debris left after operation in the duct.

The small group of surgical cases who suffer symptoms of genuine biliary origin and are due to organic lesions, are understandably of the greatest interest to the surgeon.

SURGICAL FAILURES

Which are the surgical causes of late symptoms encountered following biliary surgery?

Most commonly stones are the reason. Sometimes their removal was not feasible, sometimes they were missed, and sometimes they have newly formed proximal to an obstacle, or round foreign bodies such as stitches.

Stenoses at any level of the ductal system occupy the second position. They are more common in reoperation cases. Stenosis of the papilla, however, could have been overlooked during the first intervention, particularly if a functioning gallbladder was present preventing major biliary duct dilatation. It could have originated after forcible dilatation or as restenosis after PST, or due to action of retained stones. Likewise, deformation and stenosis of the bile duct in head of pancreas region need not have been correctly assessed at first operation, or are a sequel of postoperative pancreatitis.

Postoperative traumatic fistulas or strictures are even occasionally at the root of late symptoms, commonly originating in the hilar region, and more rarely narrowing is due to adhesions in the vicinity.

A serious cause of impaired patency is also stenosis of anastomosis. The main reasons for its development are a narrow calibre duct, suture under tension, and inflammatory environment.

Persisting dilatation of the bile duct damaged by protracted obstruction and inflammation may cause stagnation of bile with formation of "mud" and secondary stones (Mallet-Guy, 1967).

A long cystic duct stump used to be considered a source of painful sensations, but it causes difficulties only if it is the site of inflammation or retained stones.[20] The same applies to gallbladder remnants, or the whole gallbladder incorrectly left behind after PST or anastomosis.

On rare occasions remnants of an indwelling drain in the duct or food residues and stones in the blind "sump" of a lateral anastomosis are responsible for the late failures.

Obliterative cholangitis or tumour of some biliary tract segment missed at operation may also be a sporadic cause of postoperative troubles.

Pathological lesions found during revision following biliary surgery need not be the only ones present, and in particular with repeated reoperations several pathological findings may be encountered either simultaneously or in succession.

CLINICAL PATTERN AND DIAGNOSIS

Surgical disorders of the bile ducts and papilla during the later period following biliary surgery are, as a rule, characterized by an asymptomatic interval between operation and initial symptoms, by the intermittency of symptoms even with persisting disease and finally by the symptoms themselves.

The asymptomatic interval is of varying duration and only rarely do symptoms emerge during the first hospital stay. In most cases — about two-thirds — symptoms emerge during the first year, but in some cases the interval may last for many years: a patient was operated on by the author after a quiescent interval lasting 20 years, for a disintegrated endoprosthesis, and another for retained stone which caused no trouble for 23 years. A protracted asymptomatic phase thus need not necessarily mean that the disorder has been cured, e.g. by passage of the stone.

It is a common mistake to imagine that a persisting lesion or choledochal disease is bound to manifest itself by permanent complaints. The intermittent character, on the contrary, is encountered regularly not only in valvular obstructions but also in stenoses of stable calibre.

The nature of symptoms and signs, is understandably diverse according to their basic above mentioned cause. Attacks of colic, cholangitis with temperature spikes resembling malaria, various grades of obstruction as well as pancreatic attacks may be either combined or occur in isolation. A great proportion of patients remains permanently anicteric, some suffer transient jaundice and only a few are reoperated on account of persisting icterus.

Attacks of pain are the commonest symptom. They represent the sole symptom in a third of cases, and even by themselves arouse suspicion of biliary tract involvement. They resemble preoperative colic, but frequently epigastric pain is well marked. In contrast, monosymptomatic septic temperatures or even slightly fluctuating jaundice not infrequently divert attention from the correct diagnosis. The longer the interval before the patient reaches the surgeon, the more complete are the signs and symptoms.

The clinical picture of tight anastomoses is similar, but trouble starts as a rule sooner. They sometimes stop permanently after a few initial febrile attacks, sometimes due to elimination of infection. In cases of continued stoma shrinkage they gradually intensify and are accompanied by cholangitis in as much as 90% of cases. Transient jaundice also occurs, but it is sometimes absent altogether even with cholangitis.

If small stones or inflammation in the remnant of cystic duct or gallbladder are the cause, signs of raised intraductal pressure are naturally missing, which is such a common characteristic of all stenosing and obstructing postoperative lesions of the bile duct.

More profound information on the etiology of all late postoperative symptoms, and material assistance in the differential diagnosis of their causes, is provided by ancillary investigations.

Intravenous cholangiography is the initial method used in anicteric patients. It can chiefly demonstrate stones, but also bile duct stenoses. No more can be demanded from it than is within its range. Findings are chiefly reliable only when the entire duct can be visualized and is not unduly dilated. In the author's case material stones verified later were demonstrated in only 60% of cases and stenosis of papilla or pancreatic bile duct segment was only indirectly revealed by its dilatation. Frequently small, clinically irrelevant cystic duct remnants are seen, but a large stump containing stones sometimes fails to fill.

In more advanced obstruction or with anastomosis the main bile duct frequently cannot be visualized at all, or appears as a faint shadow. Most errors of interpretation of cholangiograms arise from an effort to extract something at any price from films which in reality defy interpretation. A diagnostically valuable cholangiographic sign is the width as such of the main bile duct, if it can be compared with parameters preceding the last operation. If dilatation has occurred only following operation, and in particular, if intrahepatic branches are likewise dilated, and if contrast medium remains for over 2 hours in the ducts, an obstruction is very probable. Only about 10% of ducts with an obstruction are less than 10 mm in width, apparently because dilatation is prevented by thickening of their walls and adhesions.

Biochemical data, particularly changes in enzyme activity, are merely evidence of a certain grade of cholestasis, but only about one half of anicteric patients with choledochal disorders display increased alkaline phosphatase activity. An effort is generally made to test soon after an attack of pain. The same applies to tests of pancreatic serum enzyme activity.

Cholangiography and laboratory tests facilitate the recognition of an existing postoperative syndrome of incomplete bile duct obstruction, but not of its cause. Endoscopic cholangiopancreaticography is of great assistance in this respect.[12, 54] It should be performed in doubtful cases without exception. It is particularly useful, apart from sonodiagnosis, computed tomography, and percutaneous transhepatic cholangiography,[56] in patients with jaundice, for the diagnosis of which the same rules apply as before biliary surgery (p. 333). In addition, serum hepatitis is a possibility to be considered for differential diagnosis if jaundice has arisen within six months after operation.

ERCP also frequently aids in the investigation of a choledochoduodenal anastomosis, if the standard check procedure for patency — the barium meal — fails to clarify the situation (Papp, 1977). The stoma may at the same time be inspected with the duodenoscope and assessed, though its size is not the only parameter evaluating its drainage function.

INDICATIONS FOR REOPERATION

Diagnosis of postoperative symptoms has two steps, and if we succeed in recognizing the existence of an organic disorder, we must also endeavour, at least with some approximation, to establish its anatomical character. Finally a decision must be taken whether the condition is sufficiently serious to warrant consideration of reoperation.

Indication for reoperation is a serious and sometimes fateful decision. This must be supported by reliable or highly probable conviction that the biliary symptoms of the patient are permanent, serious and of a surgical character.

Incontestable indications include:

- persistent obstructive jaundice;
- persistent external biliary fistula;
- postoperative or traumatic strictures, verified or highly probable;
- stenoses of biliodigestive anastomoses acccompanied by clear evidence of impeded passage;
- stones present in the bile ducts are still the most common and obvious reason for reoperation, provided their presence has been reliably confirmed, or suspicion is very strong. If symptoms are produced, patients' consent is readily obtained. Operation, however, is insisted upon even in their absence, except in high-risk cases;
- verified stones in cystic duct stump or gallbladder remnant if they are the probable cause of symptoms;
- suspicion of stenosis involving papilla or pancreatic segment of bile duct associated with the incomplete obstruction syndrome supported by cholangiographic evidence. In the absence of positive radiological findings, the clinical pattern is of decisive importance: operation is advised with attacks of cholangitis, pancreatic irritation or obvious signs of cholestasis, even though of a transient character. On the contrary, decision is deferred if complaints are vague, while if none are present, surgery is omitted; in this case even if cholangiographic appearances are suspicious. ERCP can assist greatly in the decision making process, if a suspicion of stenosis is thereby confirmed or another surprising explanation contributed.

Exploratory laparotomy is advised only exceptionally following biliary surgery, if marked symptoms remain unexplained after exhausting all available diagnostic means, and provided their character is organic.

After establishing indications for reoperation it remains to solve another important question, i.e. when to operate. The choice of time for intervention must be made individually: it may be a mistake to rush the operation, or to delay it superfluously. Particularly with repeated reoperations such delays sometimes only provide a smoke screeen for the embarassmanet or unwillingness to resort again to surgery, although this will later be required in any case.

The diverse time limits are already apparent from the itemized list of indications presented above and are certainly shortest in obstructive jaundice or septic cholangitis. No undue delay, however, should occur before surgical revision in pronounced stricture of bile duct or an anastomosis. With external biliary fistula strategic consideration must be given not only to the damage arising from delay, but also to the necessary "maturation" of the fistula which requires a reasonable time interval (p. 366).

As far as stones in the bile ducts, stenosis of papilla or other surgical causes of postoperative symptoms are concerned, the more pressing these symptoms are and the more reliable the diagnosis, the earlier should intervention occur. Episodes of cholangitis, transient jaundice and pancreatic attacks underline the urgency for surgery. In high risk cases we stand to gain by preparation, even if some time is lost. Advanced age enforces consideration about the rationale and extent of surgery and indications are governed chiefly by the urgency of symptoms and the general condition of the patient.

Late reoperations

Biliary operations continuously increase in number, and alas reoperations follow suit. Approximately 3–5 percent of biliary operations for non-malignant disease are accounted for by reoperations (Kourias 1977, Schmidt 1977). Specialized centres where complicated cases are concentrated for repeated interventions have as large a proportion of reoperations as 10 or more percent (Juvara 1973, Niederle 1975).

Reoperation was, and remains an exacting intervention, not only for patient, but also for the surgeon. Immediate mortality is usually higher and failures are more common than after primary intervention. The decision to recommend reoperation thus carries much responsibility and should be performed under the best conditions.[11, 18, 43, 80]

The patient must be properly prepared, also psychologically. It is usually not easy to explain postoperative failure, and to persuade the patient that another operation is necessary. In this connection the prognosis and risks of the proposed surgery must be explained, as well as the risk threatening from delayed surgery.

It can be an undoubtedly tricky question where reoperation should be performed. It is convenient if intervention is carried out at the original hospital, but if a highly complicated reoperation is expected, it is no disgrace to turn to another centre with a wide experience and equipped with every facility for this work and thus reduce to a minimum the hazard that the patient suffers another disappointment.

The reason for reoperations in our region is most frequently some kind of stenosis or stones in the bile ducts. Residual stones were previously found in over 70–80% of reoperations, nowadays, following the introduction of systematic operative cholangiography, they have declined to less than 50% of reoperated cases. There is, however, a number of other, previously mentioned, surgical causes of great diversity. In spite of this, in the vast majority of reoperations the principles of surgical tactics and technique are similar as at the start of the primary intervention.

Basic common procedure

A transverse incision in the right epigastrium is chosen as a rule, provided already present scars do not force us to select another site. By the transverse incision, at least from its external portion, access to the free peritoneal cavity can mostly be obtained. The outer border of the right lobe of the liver is identified and any viscera stuck or adhering to its undersurface moved aside, advancing mainly by blunt dissection, from the external aspect in a medial direction. *Fig. 265.* Progress

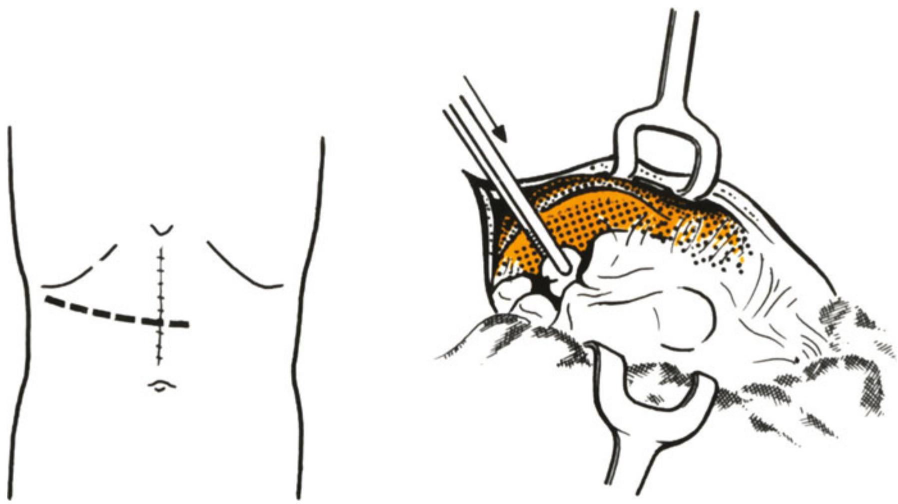


Fig. 265: Transverse incision most commonly used for reoperation, and step-by-step separation of adhesions, done closely beneath liver from external to medial aspect.

is sometimes rapid, sometimes only step by step and with great patience, to avoid hemorrhage or surface tears of adherent viscera. Penetration is thus carried forward along the undersurface of the liver until the area of the gallbladder fossa is reached. The latter is often merely suggested by a band of scar tissue or by the fact that an adjacent viscus or the omentum firmly adhere to it. In similar fashion dissection is continued, sometimes sharply, but mostly bluntly, by fingers and moist pledgets held in hemostats. The descending part of the hepatic flexure is mobilized and pulled downwards exposing the duodenum. This provides an excellent landmark for in what manner and how far to proceed in the direction of the hepatoduodenal ligament and foramen of Winslow. We must not drop deeper below the level of duodenum and pancreas. Only then, with a finger introduced under the hepatoduodenal ligament, and with a clear idea about the depth and course of the bile duct and hepatic artery, and possibly also about the location of the biliary duct lymph node, can adhesions between duodenum, stomach and liver, as well as adhesions with the abdominal wall, be displaced or sharply divided, and the liver hilum approached. It is unnecessary, sometimes even harmful, to disrupt adhesions of stomach fundus for a greater distance. However, a clear view of the operative field must be obtained and at least the pylorus and duodenal bulbus exposed, and the right kidney identified by palpation in the retroperitoneum. The duodenal flexure is almost regularly pulled beneath the liver, and its serosa tears easily, but by successive gentle disruption of delicate adhesions, and with constant hemostasis, it proves relatively simple to displace the duodenal knee bend in a downward and medial direction, and thus expose and unfold the entire border of the ligament with the biliary

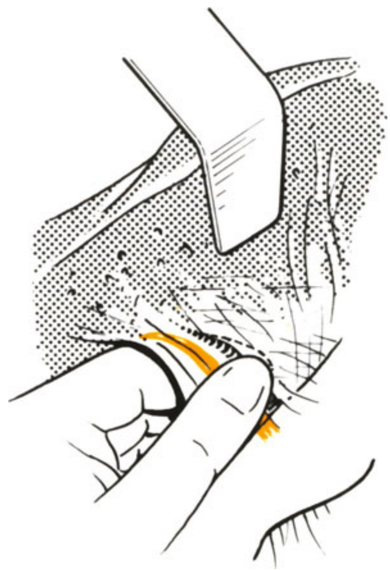


Fig. 266: Exploration of hepatoduodenal ligament region from the foramen Winslowi and search for hepatic artery pulsation, choledochus lymph node and choledochus.

bundle as far as the hilum. The hepatoduodenal ligament can be identified visually and by palpation. Often the presence of a dilated choledochus, sometimes of a cystic stump —an excellent landmark — is suggested, and information about the course of the hepatic arteries is provided by the finger inserted into the foramen Winslow palpating their pulsation. *Fig. 266.*

Specific procedures

Further procedure is governed by the assumed reason for reoperation, and by the lesions found to be present. Surgical revision is mainly concerned with the bile ducts or their anastomoses, but operation is sometimes undertaken for symptoms due to a gallbladder left behind, its remnant, or a cystic duct remnant. Occasionally reoperation is really the second stage of an intervention not completed originally on account of the risk.

PATHOLOGICAL LESIONS IN THE RETAINED GALLBLADDER OR CYSTIC DUCT

The gallbladder has to be removed as a rule after cholecystostomy performed as an exigency at the previous operation, as described earlier (p. 151). Likewise a gallbladder mistakenly left behind at the first operation, when sphincterotomy was carried out, or an anastomosis with the bile duct performed, usually has to be removed subsequently, as the operations interfere with its function to such a degree that bile stagnation and inflammation readily occur, frequently causing symptoms *Fig. 267.*

It is sometimes necessary to remove a gallbladder which itself has been utilized

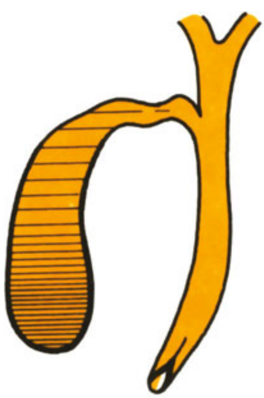


Fig. 267: Stagnation of contents and inflammation in the gallbladder left behind after papillosphincterotomy.

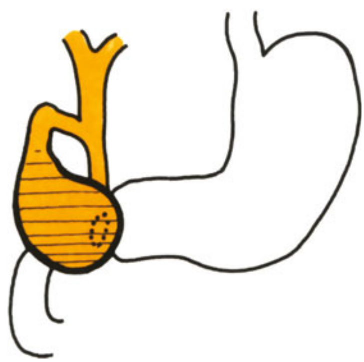


Fig. 268: Cholecystitis following cholecystogastrostomy performed for non-malignant stenosis.

for long-term anastomosis in cases of non-malignant obstruction — a late manifestation of incorrect anastomosis. Reflux and stagnation arising after a time produce severe cholecystitis and cholangitis, so that the anastomosis has to be eliminated and cholecystectomy performed. Usually, however, impeded bile flow through the terminal bile duct still persists, and thus gallbladder anastomosis is substituted by a link between bile duct and gut. *Fig. 268.*

In the cases referred to cholecystectomy is not usually a technical problem. In contrast, painstaking dissection is required in removing an embedded gallbladder remnant left during a contingency situation at the previous operation. It is removed only if we are firmly convinced that it really is the cause of major symptoms, which is probably quite an exception.

The so -called "cystic duct syndrome" in which pains were thought to be due to a long, but otherwise intact cystic duct or amputation neuromas in its wall, is no longer recognized. Trouble is caused only by a stump containing small stones which is the seat of inflammation. *Fig. 269.* Its extirpation is usually simple. Should a lateral defect arise in the main bile duct on this occasion, it is preferable to close it by transverse suture, rather than to introduce the T-tube through this opening. If surgical revision merely discloses the presence of a long, but otherwise intact cystic duct stump, the search for another cause of the symptoms must be continued.

OVERLOOKED AND NEWLY FORMED STONES IN THE DUCTS

Some retained stones can be successfully removed after operation from the bile ducts non-surgically, or they may be passed spontaneously. *Fig. 270.* Following perfection of duodenoscopic technique for papillary probing one may also some-

Fig. 269: Small stone and inflammation in cystic duct stump.

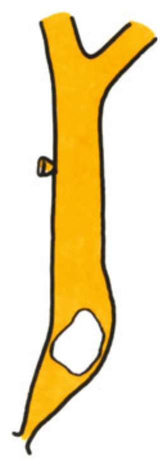


Fig. 270: Overlooked residual stone in common bile duct.

times succeed in extracting a tiny remaining calculus by means of the fiberscope, either with or without transection of the papilla (p. 519). Such operative stone extraction, however, should be attempted only by an exceptionally versed endoscopist and only in carefully selected cases.

Several retained stones, particularly of larger size, often require reoperation. *Fig. 271.* It is advisable to wait several weeks or even months as about 10-20% are still passed spontaneously or it transpires that the radiological picture shows only "pseudocalculosis", due, for instance, to air bubbles, adhesions etc. Waiting,

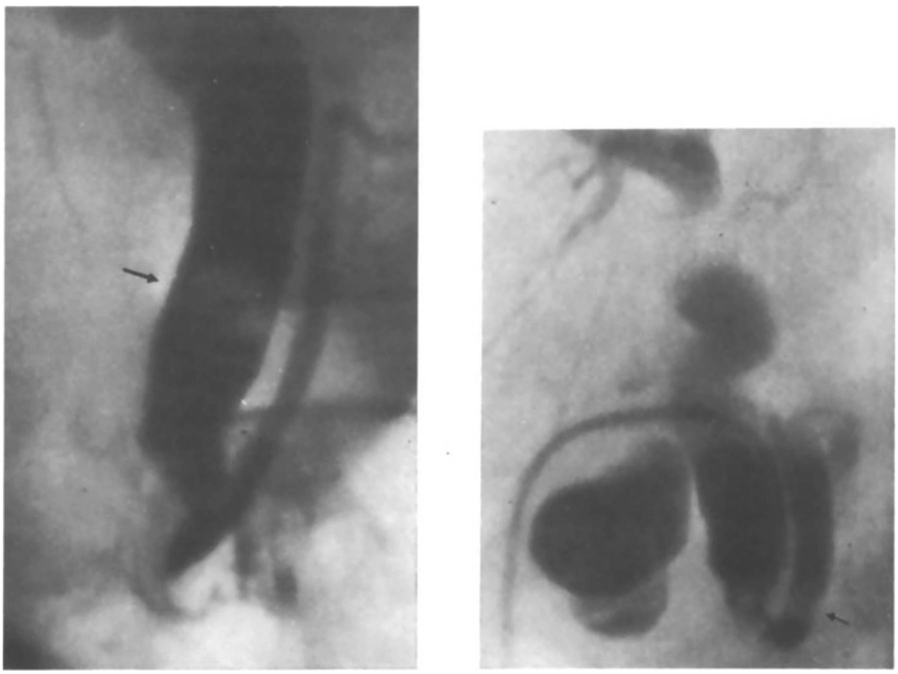


Fig. 271ab: Postoperative check cholangiography reveals: (a) Overlooked stone in common duct; (b) small retained stones in front of papilla and residual long cystic duct stump with stone; spiral course of cystic duct which opens in papillary region.

however, is mainly in the interest of providing complete rest for the operative region. Following such an interval operation is advised before clinical evidence of obstruction appears. Support for our decision is provided by familiarity with the operation protocol, radiological checks at first operation, current laboratory evidence of anicteric obstruction, and chiefly, of course, by the permanently positive radiological evidence of stones. Patients pressed for their consent to reoperation are reluctant to give it before the stone announces its presence by repeated colics or subicterus and cholangitis. If up to this point an expectant attitude and monitoring of laboratory and radiological data was possible, now no further delay with reoperation is permissible.

During operation the dilated bile duct is identified usually without difficulty, even though bile may not be under pressure at this time. Identification proceeds in the manner already described, but sometimes a palpable stone takes us there rapidly. By needle puncture or through a catheter inserted via the cystic duct stump or by stab incision in the bile duct a bile sample is collected and cholangiography performed. At the puncture site the bile duct is opened by longitudinal choledochotomy and any stones found extracted in the same fashion as in primary operations (p. 231). If the stone can be palpated at the outset of the operation in the accessible supraduodenal segment of the duct, it may be arrested there and the duct opened over it by direct lithotomy, without previous radiological checks. This speeds up procedure in cases where the search for the bile duct would be hard and dislodgment of the stone to a less accessible position can be prevented. Cholangiographymay be done after its removal and intervention completed according to its result, or exploration finished first blindly by forceps and lavage to be followed by secondary cholangiography. The choledochoscope is also used for checks more often than in primary operations.

Whilst removing stones and exploring the ducts, no exclusive reliance is ever placed on data from the original operation and preoperative investigation. These cannot provide reliable information about the number and position of stones, and less about their combination with other lesions, so common particularly with newly formed stones. If it is merely a question of one or a few largish stones, reoperation is simple and shorter than the preceding intervention. If they can be extracted easily and bile flow into the gut is completely unimpeded, operation can be terminated by bile duct suture on some occasions, or a T-tube inserted.

If, however, additional lesions apart from the stones are detected, in particular a wide biliary duct, stenosis of the papilla or another type of duct narrowing, this must be dealt with simultaneously, or free biliary drainage guaranteed in another way. In the case of newly formed stones, such obstructions are in reality the primary cause of the trouble and the main reason for reoperation. As is the case with calculi, operation is performed on similar lines to the first intervention.

Main modification of reoperation are thus: the abdominal incision and search for a bile duct obscured by adhesions, — and on the other hand the termination of intervention. In reoperations more often than in primary surgery a greatly dilated bile duct is encountered, thus even after mere extraction of calculi operation is completed by an anastomosis. The latter is also useful following forcible dilatation of a stenotic papilla, particularly if the dilated duct was found to harbour secondary calculi and muddy debris, which would certainly reappear in the stagnating bile. In combinations of stones with other stenoses, either pancreatic, iatrogenic or anastomotic, a wide anastomosis is again similarly performed to restore flow. Primary suture or T-tube insertion, as stated, terminates only simple lithotomy for retained stones in a bile duct that has not yet become atonic.

Following a carefully and effectively performed reoperation for stones, patients usually remain symptomfree and if a new reoperation should be required, this is more likely to be for stenosis than for stone. It is noted with interest that immediately after these interventions, yet, even after repeated and exacting reoperations, these patients are not usually markedly prostrated, and not infrequently support a complex intervention better than the primary operation. Apparently the adhesions left by the previous operation give protection from a major peritoneal reaction, and the terrain as well as the whole organism are better prepared for insult from the operative region.

FOREIGN BODIES IN THE BILE DUCT

Only sporadically does one find nowadays a complete or partial obstruction of the duct by a retained indwelling tube or prosthesis respectively, as the cause of postoperative symptoms. This was chiefly due to rubber drains which had disintegrated, become encrusted, and required reoperation even after a number of years. They can be suspected from the past history and they can be demonstrated mainly by cholangiography — preferably retrograde endoscopic, rather than intravenous. *Fig. 272, 273.*

Fig. 272: Remnants of disintegrated indwelling drain in extrahepatic bile duct.

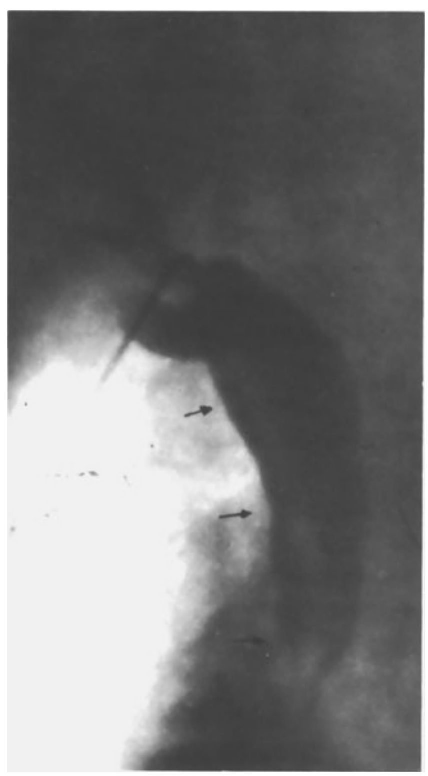


Fig. 273: Retained transverse arm of T-drain 9 years after operation. Primary cholangiography during reoperation showed a longitudinal streak of reduced opacity in common bile duct; this being the torn-off and encrusted part of the drain, which had not come away spontaneously.

Their removal may prove troublesome because of disintegration and fragments may be displaced as far as the hepatic branches. It is necessary to extract them patiently and without residue with forceps, and wash them out, otherwise cholangitis will recur. The operation is terminated by T-tube insertion into the bile duct. This facilitates not only lavage and the direct application of antibiotics, but also reliable postoperative checks that all foreign bodies have been removed.

STENOSIS OF PAPILLA

Parallel with the reduction of retained stones in recent times, stenosis of the papilla has shifted to a more forward position amongst the causes for reoperation, and in conjunction with strictures of anastomoses, has become the leading finding in repeated reoperations. *Fig. 274, 275.* In contrast to primary biliary operations,

Fig. 274: Stenosis of papilla overlooked during cholecystectomy.

Fig. 275: Recurrence of papillary stenosis after operation for cholelithiasis and after divulsion of the papilla of Vater. Cholangiography during reoperation shows dilated common bile duct contrast column ending bluntly near the papilla, with passage into duodenum being retarded.

when stenosis of the papilla was a feature in only 10% of all cases, and when it was almost invariably associated with lithiasis, it was found in as many as 40% of our reoperations, and in only about half of these cases combined with calculi.

A suspicion of stenosis before reoperation is uttered with still greater reserve than is the case with retained stones. Otherwise surgical revision is similar in principle to primary operation, and a knowledge of the detailed record of the first operation is very helpful.

The bile duct in stenosis is found to be wide, and the appearance and thickness of its walls depend more on the presence of calculi and cholangitis. Exploration is commenced with radiology, may be combined with cholangiometry, but the values measured are fully significant only if no stones are simultaneously present in the duct. Of decisive importance for recognition and assessment of stenosis is probing and direct inspection of the papilla by duodenotomy, the latter also being valuable in avoiding the mistaking of a benign for a neoplastic stenosis. *Fig. 276.*

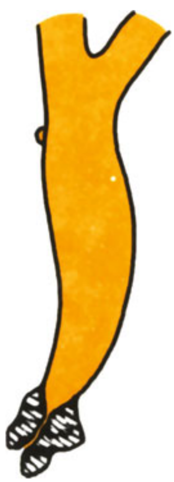


Fig. 276: Tumour of papilla overlooked at cholecystectomy.

At reoperation restenosis may also be met with following forcible dilatation of the papilla or PST, when its border is found to be thickened and sometimes also furrowed.[24, 85] Sporadically, but rather more often than in primary operations, a so-called "wide stenosis" is encountered, particularly with an atonic bile duct.

The decision about the best intervention, i.e. the choice between dilatation, PST and anastomosis, does not differ materially from that in the primary operation (p. 257). Anastomoses, however, are utilized much more often for a final solution, sometimes even combined with dilatation or sphincterotomy.

With this procedure reoperation results are satisfactory even in cases of papillary restenosis.

Duodenoscopic papillotomy

Instead of reoperation duodenoscopic revision of the papilla has been tested recently, combined with endoscopic papillotomy using a high frequency diathermic probe if stenosis is present.[27, 40, 42, 92] A flexible steel wire is enclosed by a teflon catheter, fixed at its tip, and remaining uncovered in a groove extending for the last 3 cm. Retrograde cholangiography is performed first. The catheter is then inserted to the required depth through the narrowed papilla under endoscopic and radiological control. The wire is pulled, bending the catheter tip, and making the wire emerge from its groove like a bow string, touching the orifice at the selected site in its circumference. The papilla is now transected by weak coagulation current for 1–2 cm in length. If calculi are present in the sphincteric biliary duct segment, these can be pulled down with a Dormia loop or they may pass spontaneously. *Fig. 277.*

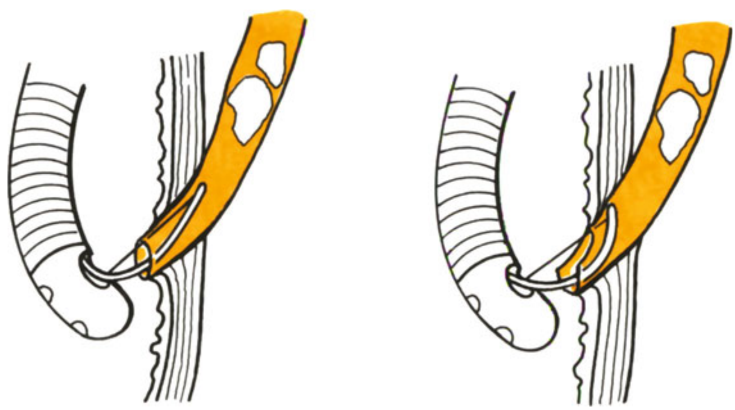


Fig. 277ab: Duodenoscopic papillotomy: (a) Catheter with enclosed flexible steel wire introduced through stenotic papilla, (b) the wire is pulled, forming a bow string, and papilla transected at the selected site and to the required depth by weak coagulation current.

Endoscopic papillosphincterotomy is beset with the same hazards as operation, but infection is more of a danger than hemorrhage or pancreatitis.[23] In addition there is the possibility of a faulty incision and the surgeon is averse to the fact that the other parts of the biliary passages escape his direct control. Endoscopic intervention depends not only on first rate technical equipment, but also on masterly skill in the use of the instrument and on experience (Demling). Endoscopic papillotomy has already been performed repeatedly with success, and the mortality reported so far is lower than with surgical sphincterotomy. In suitable cases it will probably be applied if the patient refuses permission for reoperation or the latter would be too much of a burden. Endoscopic intervention must, at present, remain the domain of specialized centres.

Chronic lesions of the pancreas following repeated acute attacks are the surgical cause of postoperative symptoms in about 8% of cases. They are, accordingly, encountered at reoperation much more commonly than at primary operation. This is easily understood in view of the many years of exposure to pancreatic inflammations and sometimes also to possible trauma suffered by the terminal bile duct and pancreas during preceding surgery. *Fig. 278.*

Fig. 278: Compression of pancreatic segment of common bile duct which escaped recognition during cholecystectomy.

Laparotomy discloses the presence of an indurated pancreas or one with irregular fibrocystic lesions of various extent, the probe becoming stuck just as it passes into the pancreatic segment. Debimetry and cholangiography are very unreliable, particularly in view of false positive interpretation.

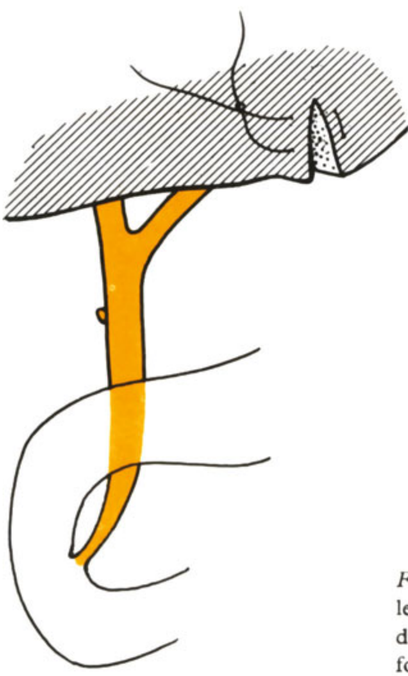
Choledochoduodenostomy is the best treatment for pronounced tubular stenosis, but a search is always made for other causes of postcholecystectomy symptoms, in order to deal with them simultaneously. The prognosis of such patients is uncertain and follow-up necessary.

If operation reveals that the root cause of symptoms lies not only in the deformation and compression of the pancreatic bile duct segment, but in the more serious lesions of the pancreas, with stenosis and dilatation of Wirsung's duct, intervention must sometimes be supplemented by an anastomosis between pancreatic duct and gut or, exceptionally, by partial pancreatoduodenectomy.

RARER CAUSES OF OBSTRUCTED BILE FLOW FOUND AT REOPERATION

A dilated atonic main bile duct may sometimes be the sole independent finding with postoperative complaints exhibiting the character of intermittent obstruction. *Fig. 279.* This may be a congenital dilatation, not properly assessed at the primary operation, or it may be an acquired dilatation persisting after the removal of the obstacle. We always remain in doubt in such a case whether

Fig. 279: Dilated flabby common duct with retarded biliary flow.



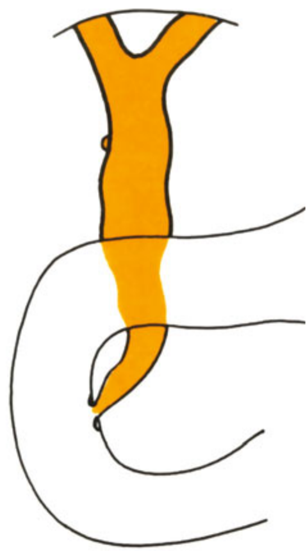


Fig. 280: Manifestations of surgical cholestasis without ascertainable obstruction during reoperation. Excision from liver for biopsy.

this is the main or true cause of the symptoms. Detailed investigation is required to exclude another obstruction or lesion, before we settle for a diagnosis of atonic main bile duct dilatation. Biliary drainage is improved by an anastomosis between bile duct and duodenum. Papillosphincterotomy, even total, would not be an adequate measure. In case of utterly uncertain findings and particularly if jaundice is present, liver biopsy is essential. *Fig. 280.*

Similar doubts are raised, as with the isolated findings of a dilated main bile duct, if the duct is found to be constricted only by adhesions or lymph nodes. *Fig. 281.* This is considered adequate evidence, if the duct is only dilated proximal to them, otherwise the search for other lesions must be continued.

Sporadically reoperation disclosed the presence, overlooked previously, of congenital stenosis in the hepatic branches or the extremely rare primary stenosing cholangitis. The latter could be linked to the surgical trauma of the first

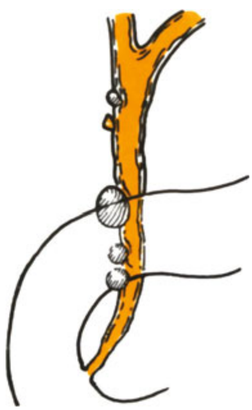


Fig. 281: Narrowing of the main bile duct by enlarged inflamed nodes.

operation, or could originate independently; a very similar carcinomatous infiltration of the duct must always be taken into account. Biopsy serves to render the diagnosis accurate. Operation must be modified in the presence of such unusual lesions. Palliative measures have to be resorted to frequently, such as drainage, intubation of the duct, relief anastomosis or PST.

SEQUELAE OF INJURIES

Abdominal trauma involves the biliary tract only exceptionally and thus symptoms requiring reoperation are produced only sporadically.

Reoperation is as a rule concerned with sequelae of surgical injury, either with strictures of the bile ducts, or, more rarely, with an external biliary fistula, or quite exceptionally with hemobilia also. This is an important group, representing about 8.2% in the author's series of reoperations. It concerns patients who arrive or are transferred, sometimes from other hospitals, who before their arrival have undergone 2–5 new operations and who frequently remain stigmatized throughout their lives by an error committed at the primary operation.

Injury recognized during surgery should be repaired immediately (p. 472).

Urgent reoperation is made necessary by the dramatic signs of an overlooked or badly repaired injury, which arise during the first postoperative hours or days (p. 490).

Late reoperation, the subject of this chapter, is indicated for symptoms following spontaneous closure of an external fistula or following failure of previous corrective operations, or if sequelae of the injury become evident long after the primary operation.

In all such cases we are undoubtedly dealing with manifestation of a fibrotic stricture and can count on the fact that the fresh inflammatory phase has resolved. Operation in such a case is indicated as soon as possible, but following proper investigation and preparation of the patient.[32, 33] Fine needle percutaneous transhepatic cholangiography or retrograde endoscopic cholangiography are most often applied for the localization and visualization of the stricture. Fistulography may always be used before fistula closure. — The object of preparation is in the first place to improve the patient's nutritional status, if necessary by parenteral methods. If cholangitis is a feature and in patients with liver damage, the administration of broad spectrum antibiotics several days before operation is advisable.

Principles of surgical procedure

Surgical measures for strictures cannot be readily compared with operations for recent injuries. Sclerotic changes and infected bile are to be blamed for the pronounced tendency of new anastomotic connections to retract. Duct suture should be (theoretically) placed in tissue freed from granulations and scars. The ends used for the anastomosis should be bordered by mucosa, adaptation must be accurate to prevent bile leakage, no tension must be produced, and the anastomosis must be of sufficient width. One-layer suture is used as far as possible. Frequently considerable defects and destruction of the main bile duct are encountered, with the hepatic duct stump retracted high and almost inaccessible in the hilum. Accordingly it is necessary in the first place to locate the stricture and only later can a decision about the method of repair be arrived at.

The first steps of laparotomy are as in other reoperations (p. 000), but differ commonly by the still more difficult search for the main bile duct, which may even be missing in a certain section, or be completely obliterated. *Fig. 282.* The quest for the stricture in also made harder by massive adhesions following bile extravasation and an enlarged liver. Remnant of an external fistula or small internal fistula between the injured bile duct and the duodenum may sometimes serve as a landmark.

For locating the common duct or its peripheral stump the typical choledochal lymph node, constantly situated externally and below it, serves as landmark, in some cases the gastroduodenal artery lying in front of it behind the duodenum serves the same purpose. In its supraduodenal portion the duct lies, in relation to the hepatic artery, more superficially and externally.

Finding the hepatic duct or its retracted stump may be even more difficult.

Fibrous tissue is patiently removed and dissection of the hilum is done advancing from in front, between liver and the predicted hepatic duct course. This should be more superficial than the palpable arterial pulsation, but it must be taken into account that the artery may cross the hepatic duct in front (about 10% of cases), and that variations even of the segmental arteries are not uncommon.

Fig. 282: Postoperative stricture of common duct.

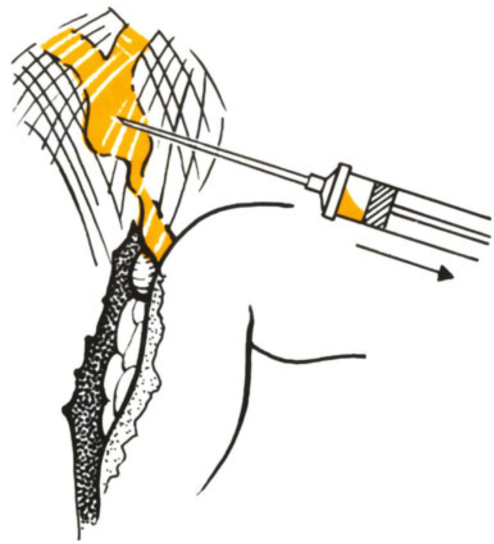


Fig. 283: Search for common duct by needle aspiration. The typical choledochus lymph node serves as a landmark.

The branches of the hepatic duct lie in the porta invariably nearest the surface and the segmental arteries are directly underneath or at their side. The portal vein runs always deeper down, with the exception of its left branch which sometimes curves round the left hepatic duct (p. 30). All aberrant vessels can, however, be avoided by cautious dissection.

If the hepatic duct cannot be found, some surgeons recommend preliminary dissection of the hilar vessels and determination of its position from them. This procedure is dangerous and usually superfluous. If we should fail to locate the duct from in front, an approach to the hepatic branches and their junction is tried by the "suprahilar route", already described (p. 394). This is relatively safe and leads to a comparatively intact area. This however, is the last extrahepatic approach, and accordingly we always try first to advance there from the hilum from below.

The presence of the hepatic duct stump in the hilum may sometimes only be suggested by a hard lump or scar or as an elastic enlargement of the dilated duct.

The stump can often be found at a considerable depth (2–4 cm) only by puncture and it is preferable to advance towards it along the needle with the tip of a hemostat or fine scissors, rather than to inject contrast medium at once. The dammed up bile with slimy debris and stones is released and exploration of the anatomy and dilatation of hepatic branches carried out by suitable instruments and cholangiography. *Fig. 283.*

Selection of surgical procedure and technique.

The method of repair is determined by the site and extent of the stricture, the size of the defect, and by changes in the vicinity and the general condition of the patient. Each case must be decided on its own merits.

External drainage of the duct proximal to the obstruction is a contingency measure. We abstain from exploring the stricture, but insert a drain proximally into the duct. This will later serve for radiological evaluation of the stenosis. The second, definitive operation is embarked on after the reasons for the emergency procedure have been eliminated.

Plastic repair of the stricture is only rarely feasible, if a short incomplete stenosis is found in an accessible duct. This is freed from the surroundings and the duodenum mobilized. The scar is split longitudinally and sutured transversely. A T-tube is usually inserted by separate incision and a suction drain placed under the liver. *Fig. 284.* Results of plastic repair are permanently satisfactory in about 70% of cases.

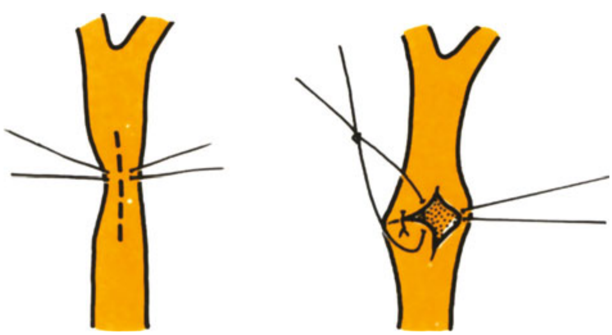


Fig. 284: **Plastic repair of a minor stricture by longitudinal division of the duct and transverse suture.**

Resection of stricture. This is possible only in short circular strictures of the supraduodenal common duct. In order to facilitate approximation of the duct ends and their suture, duodenum and pancreas are mobilized. The defect must not exceed 0.5–1.5 cm following scar resection. The patency of distal bile duct and papilla is verified. The dimensions of the duct ends must be congruent. They are accurately sutured, edge to edge by about 8 stitches tied externally. Duct and neighbourhood are drained as in plastic repair. *Fig. 285.* Duct reconstruction is the most physiological stricture repair and gives about 80% satisfactory results. It can be performed only sporadically, however.

Bile duct anastomoses are indicated for all infraduodenal strictures, for the supraduodenal sector only if plastic repair or reconstruction are not possible.

Infraduodenal strictures which are more likely to originate after operations for

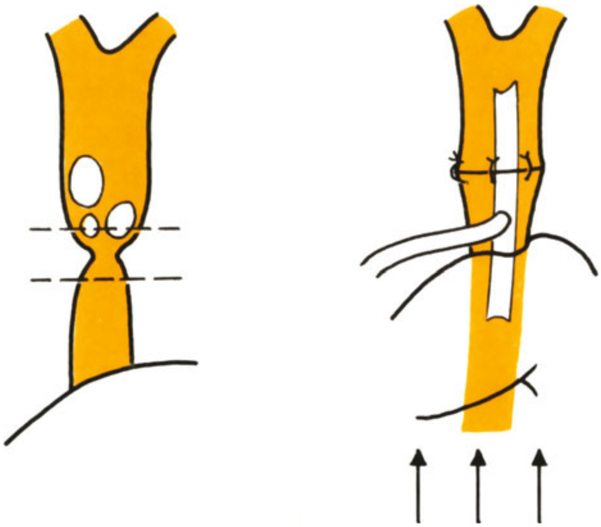


Fig. 285: Resection of short choledochus stricture followed by end-to-end suture after mobilization of duodenum with pancreas. T-tube inserted into choledochus by separate incision.

penetrating duodenal ulcer, are not dissected, but verified by probing, radiology or, as the case may be, duodenotomy. They are usually excluded by termino-lateral choledocho-duodenostomy. Papillosphincterotomy is useful only in some iatrogenic strictures of the papilla proper.

Supraduodenal strictures, i. e. those in the hepatoduodenal ligament region are first carefully dissected and resected, and if the duct cannot be reliably reconstructed, connected in a similar way to duodenum or jejunum or restored by interposition of a jejunal segment. (Wheeler). The stricture level is the decisive point. If a jejunal loop after Roux is used, any distance can be bridged without tension. The lower stump of the divided duct can be left untied.
Fig. 286.

The results of various anastomoses in surgical strictures are worse than in most of the other indications, as they depend more on the extent of sclerotic scar lesions than on the actual type of anastomosis.

Hilar anastomosis may be necessary after injuries to which the hepatic and cystic duct junction region is most frequently exposed. After detection of a high level stricture, very accurate information must be obtained on the course of hepatic

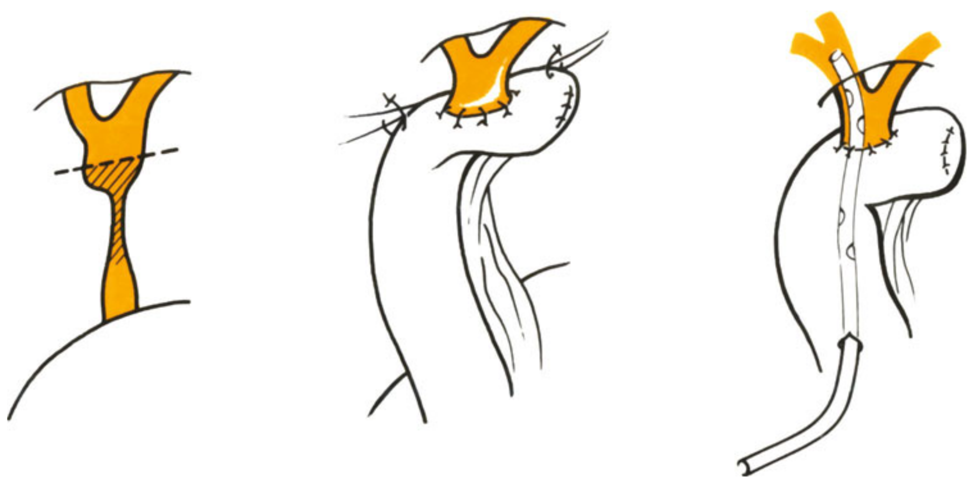


Fig. 286: Resection of a long stricture and suture of the hepatic stump to a jejunal loop prepared after Roux. A tube can be inserted through the stoma and brought outside through the gut.

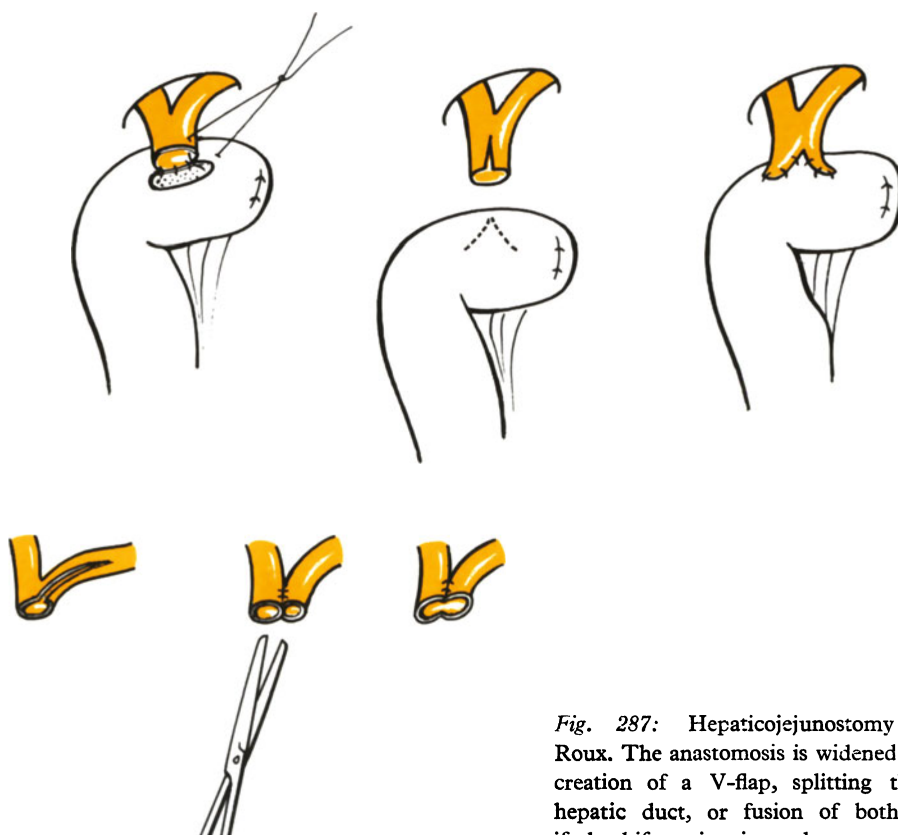


Fig. 287: Hepaticojejunostomy after Roux. The anastomosis is widened by the creation of a V-flap, splitting the left hepatic duct, or fusion of both ducts if the bifurcation is no longer available.

duct branches, the possible presence of stones, and mainly, whether the link between right and left liver lobe at their junction has been preserved. They are cleared by gentle lavage, or if necessary, with forceps. The peripheral stump of the common duct does not require ligature.

The hepatic duct remnant is freed from scar tissue and its borders, stripped of granulations and viable, are prepared as well as possible for the anastomosis by adequate resection, otherwise the new link is bound to shrink and may even totally disappear. We endeavour nevertheless — in reasonable measure — to keep the duct end sufficiently long to make suture of the anastomosis possible.

If we succeed in exposing at least several millimetres of healthy rim of hepatic duct, bifurcation or hepatic duct branches, a classical type anastomosis is performed (p. 389). As a rule a jejunal loop excluded after Roux is employed and the duct remnant is sutured to it end-to-side. Sometimes no completely healthy tissue is available above the stricture and restenosis can be avoided by various means:

The anastomosis is widened as much as possible by incising the common hepatic duct or its left branch, or by linking the ends of the hepatic branches to create a larger common orifice. If the left branch has been exposed by the suprahilar route, it is opened longitudinally as far as possible and connected side-to-side. *Fig. 287.*

Great emphasis is placed on the fact that the mucosa of duct and gut should be accurately adapted during suture of the anastomosis. However, the lining may be damaged, sometimes even deep in the duct remnant at the bottom of the liver crater.

Several methods have been proposed for lining such a channel with intestinal mucosa: Cole and Warren recommended the insertion of a cone of intestinal mucosa sutured with catgut to the drain. The author did not succeed with this method; the mucosa became necrotic. — Smith's proposal is simpler: a seromuscular disc is cut from the jejunal loop, but the mucosa left. Through it a fenestrated balloon catheter with holes in front and behind the balloon is inserted

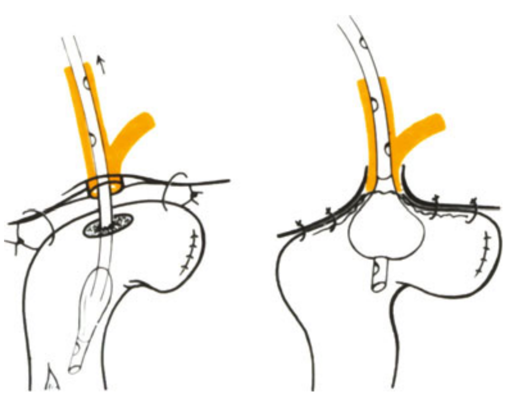


Fig. 288: Smith's modification of plastic repair of hepatic duct stricture using intestinal mucosa. A disc of serosa is cut out of the jejunum; the distal end of a balloon catheter is pushed from the gut through the exposed mucosa and pulled up through the stricture and liver. The inflated balloon is used to hitch up the mucosa into the stricture which is thus lined by it.

into the gut, its other end being hitched up through hepatic duct and liver outside. Traction exerted on the catheter following inflation of the balloon drags the mucosa into the duct. The anastomosis is not sutured but only the jejunum is anchored to the liver undersurface in the vicinity of the duct opening. *Fig. 288.* The balloon catheter is left in position for 3 weeks. *Fig. 289.*

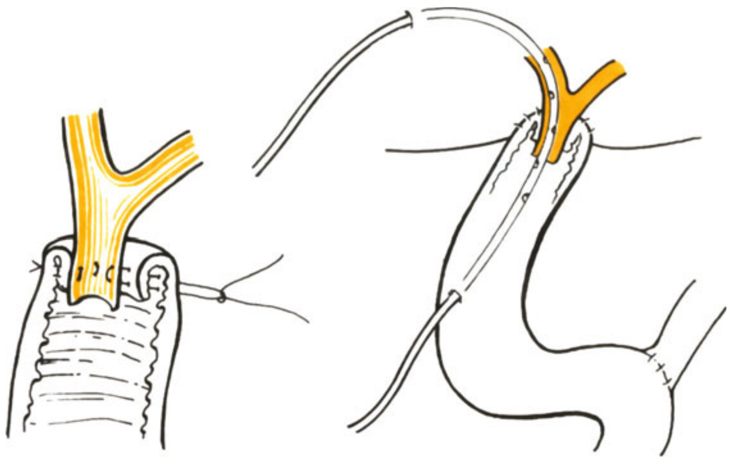


Fig. 289: Glenn's modification of terminal hepaticojejunostomy: Intestinal mucosa of the inverted border of the jejunal loop is brought in contact with the bile duct mucosa.

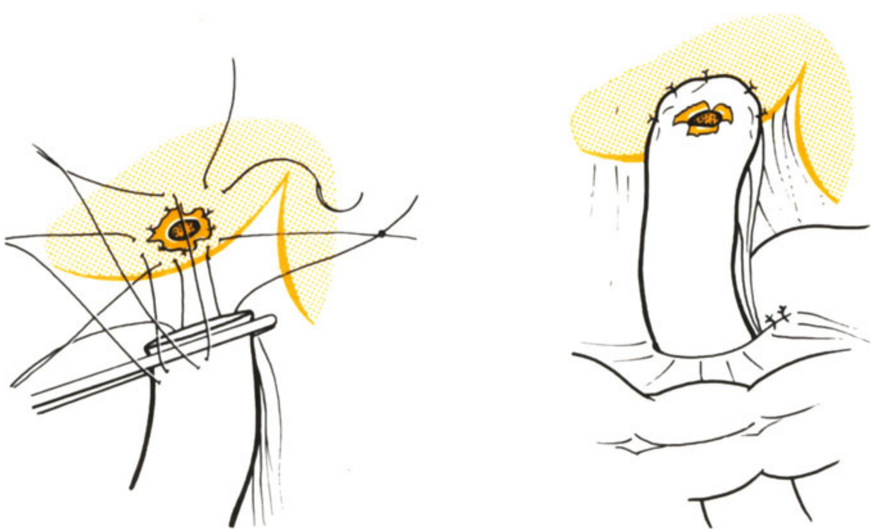


Fig. 290: Hilar anastomosis after Puestow: The short sclerotic stump of hepatic duct is incised in three places and the everted edges sutured to the liver undersurface. Sutures are placed to surround it by the end of the excluded jejunal loop. Conclusion of the anastomosis by suspension of the loop in the neighbourhood.

The author has found two methods useful in similar critical situations: In cases where at least part of the duct border has been preserved, though it may be fibrotic and not valuable for an anastomosis, a technique similar to that of Puestow, Allen, Kirstley a.o. is adopted. The duct borders are incised in 3–4 places, everted and sutured with chromic catgut fan-like to the adjacent liver under-surface. A fair-sized lateral opening is made in the excluded jejunal loop and its edges sutured widely to the liver capsule along the circumference of the everted duct borders, but without actually touching them. *Fig. 290.*

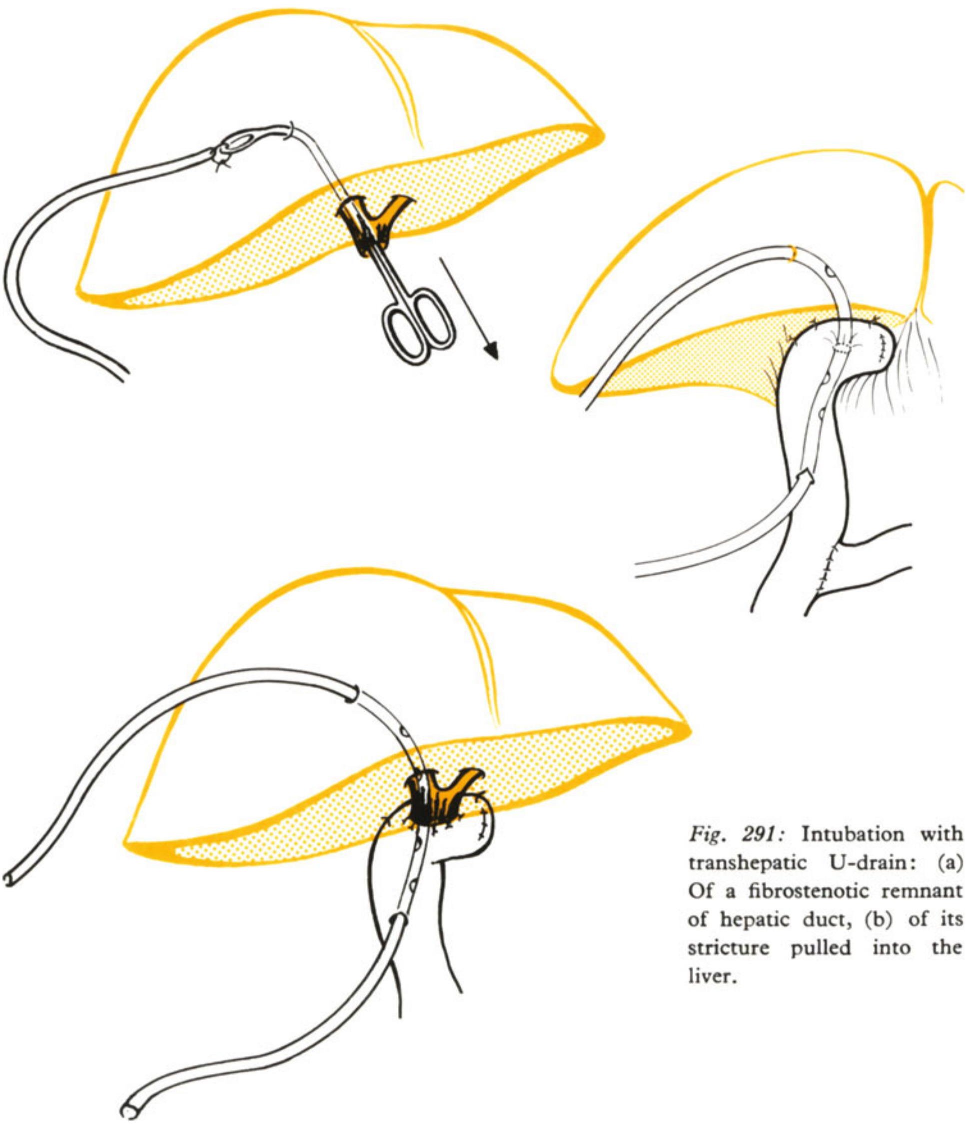


Fig. 291: Intubation with transhepatic U-drain: (a) Of a fibrostenotic remnant of hepatic duct, (b) of its stricture pulled into the liver.

If a poor quality duct is deeply embedded in a fibrotic liver, its partial exposure can at least be attempted in order to obtain the rim for eversion by chipping the adjacent liver tissue away, or the other method can be used and patency of the narrowed and constricted duct is guaranteed by protracted intubation.[17, 83] The excluded jejunal loop is sutured to the liver undersurface close to its orifice and the intubation drain, inserted deeply beyond the stenosis, is taken through the gut out of the abdomen. Still better, the other end of the drain is also taken outside, diahepatically. *Fig. 291.* Such an „endless" drain is resorted to mainly in recurrent stenosis of a hepaticojejunostomy, if it has inaccessibly retracted into the liver. The associated technical procedure will be described later (p. 534).

Intrahepatic anastomoses are not usually advised for iatrogenic strictures (p. 398), except for relapse in high level stenosis.

Prognosis of surgically treated traumatic strictures

Mortality and morbidity of corrective operations cannot be accurately calculated. Great differences exist between stricture types and surgical interventions. It may only be stated generally that repair of iatrogenic injury depends most on the first treatment, but if a stricture has already developed, results depend on the patient and skilful surgical care which does not hesitate to use repeated reoperations. It is a general rule too, that the more proximal the level of injury, or the higher in the hilum the stricture has formed, the worse the outlook for the patient involved. It was estimated that only about half the patients with stricture could be permanently cured, but the situation is improving continuously. Nevertheless, we should always be very cautious with the prognosis of each, even seemingly successful operation, and patients should be kept under continual surveillance to detect even discreet signs of threatened fresh obstruction in time.

POSTANASTOMOTIC COMPLICATIONS

Indications for reoperation include stenoses of the anastomosis, often combined with its obstruction by pigment stones. In only a small number of instances are symptoms in cases with anastomosis due to a retained or wrongly connected gallbladder, and as stated earlier, a choledochal blind sac or permanent excessive reflux from the intestine is rarely to blame. Quite sporadically a Roux anastomosis has to be corrected on account of the blind loop syndrome or for an excessively long afferent limb.

Stenoses of biliodigestive anastomoses represent almost 14% of findings, a high percentage amongst reoperations in the author's series. Partly high anastomoses most often performed for iatrogenic strictures are in question, and also partly anastomoses performed for other reasons, and more distally, on the common duct. Whether stenosis is due to the fact that the anastomosis was under tension, as is commonly the case in hepaticoduodenal anastomoses, or because it was too narrow from the start performed on an undilated duct, or whether gradual stricture was due to inflammation and retraction, it represents an absolute indication for reoperation, which should not be delayed for too long. The obstruction of a narrowed stoma is usually intensified in addition by newly formed stones and, occasionally, by complications from the excluded terminal bile duct.

In principle we may distinguish reoperations of lower common duct anastomoses, which are usually easier, and reoperations of high anastomosis in hilum and porta hepatis, which are counted amongst the most difficult biliary intervention. Sufficient experience, ample time and sometimes an excess of patience is required for their repair.

Reoperation of lower anastomoses

Any changes in the anastomosis are ascertained first: whether it is tented or practically obliterated or whether the gut still borders widely on the duct connected to it.

In the second eventuality the anastomosis is freed only from in front and a little from the sides and the stoma entered by longitudinal incision of the duct extending as far as the gut. We are never satisfied with mere stretching of a stenosed stoma. Debris and small stones are removed and washed out of the duct, remaining projecting and sometimes encrusted stitches are extracted and the longitudinal discision sutured transversely. Tension on the suture is relieved by serosa stitches. The stoma can be widened sufficiently by such a plastic procedure and if its circumference is sutured in scar-free tissue, hope is considerable that restenosis can be avoided. *Fig. 292.*

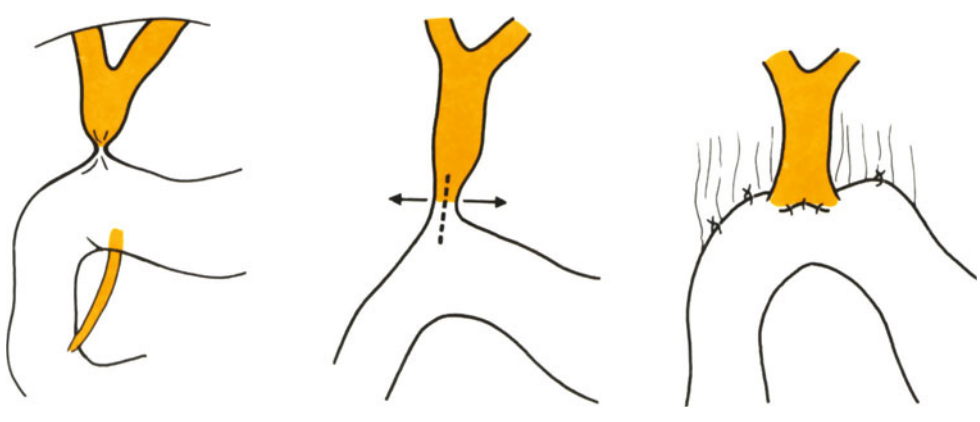


Fig. 292: Stenosis of hepaticoduodenostomy due to excessive tension. Plastic repair by longitudinal division of anterior border of stricture and its widening by transverse suture.

If the anastomosis is found to be drawn out tent-like or obliterated, a common enough event, particularly with duodenal anastomoses, it is freed from all sides and the link resected. A new wide anastomosis is performed in a healthy part of the duct, either again with the duodenum, or preferably with the jejunum. *Fig. 293.* Its success depends on the adequate removal of scar tissue and on whether suture of relatively undamaged viable structures can be accomplished, as well as

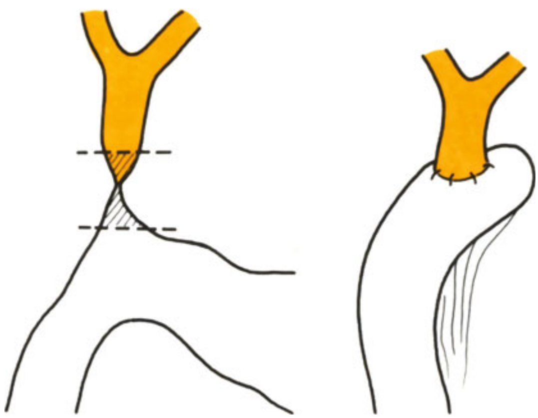


Fig. 293: **Resection of obliterated hepaticoduodenostomy and performance of a hepaticojejunostomy after Roux.**

on the accurate apposition of the rim of viscera to be sutured. The stoma must be wide; for this reason the end of a narrow duct is widened by a longitudinal cut. The gut is suspended to the neighbourhood, or to the liver undersurface, to avoid tension on the anastomosis and suture.

If it is found that the original anastomosis was not correctly indicated, or has already met the temporary demand and serves no useful purpose, and evidence is obtained of guaranteed free biliary drainage through the papilla, the anastomosis can be eliminated. Such "desanastomosis" may be performed only rarely, as the narrow stoma would hardly cause trouble and force us to reoperate if the bile duct had regained patency.

Reoperation of higher anastomoses

If stenosis of a high anastomosis performed in the hilum or even the porta hepatis is concerned, valid procedures for various intrahepatic anastomoses have been given earlier (p. 398). These are much feared reoperations, requiring not only great and wide experience, but also inventiveness, as situations may be encountered where none of the usual procedures is reproducible and a different, new solution must be found. For this reason patients with obstructed high anastomoses should be concentrated at special centres. Otherwise fresh failures occur, and long drawn-out invalidity continues with social losses and even family tragedies.

It is not always possible for such anastomoses, frequently deeply embedded in the liver, to comply with the demands for a reliable and permanently patent anastomosis. Operation must be performed in altered tissue, where sufficient remnants of hepatic ducts are not available, and the obliterated stoma may not even be found. A blind search for the dilated hepatic ducts must be undertaken by needle puncture. Nonetheless mere dilatation of the stenosis is rejected in principle. Only exceptionally would we resolve to create one of the complex and tricky intrahepatic anastomoses. In such a difficult, even hazardous situation, when the stoma has retracted as a narrow or obliterated channel into the indurated liver, it is considered better and safer according to positive experience, to be satisfied with longterm dilation of the stenosis by intubation drain. This applies in particular to cases where previous operations have failed, and stenosis of anastomoses performed at successively higher levels up to the porta hepatis has recurred.

The anastomosed gut is mobilized from in front up to the point where its tip is retracted into the fibrotic liver tissue. The loop is now entered by a short oblique incision directed towards the assumed obliterated stoma. From inside the gut a search is now made for it by inspection; a catheter or small hemostat is now thrust through at the site oozing bile, or the lowermost small depression into the dilated hepatic duct branches. Dammed up bile and debris are released, the contents of the bile ducts aspirated and washed out, exploration by instruments and radiology continued. We must make sure that the opened canal communicates with both liver lobes.

The sclerotic liver canal is now cautiously dilated with a hemostat or rigid moistened catheters, gradually up to a diameter of 6–8 mm. Long curved forceps or a suitably modelled cannulated semirigid catheter with an opening at the tip are inserted through the widened opening up to the liver. It is advanced cautiously via one of the dilated intrahepatic ducts, selecting one in whose direction the parenchyma of the liver convexity will be penetrated as close to its anterior edge as possible. Either right of left lobe will do, provided their junction is intact. If this is not the case, a separate tube would have to be hitched through each lobe. By means of the inserted instrument a fairly rigid moisture proof plastic material tube is drawn through. The intubation tube must resist corrosion, softening or encrustation, and not become blocked too easily. Tube diameter is selected to fit the dilated stricture snugly and 8–10 openings are made in it closely spaced proximally and distally to the stricture. One end of the intubation tube traversing the liver is taken through the abdominal wall through a stab incision, while the other is pulled through the gut and taken outside at another site, after the original intestinal loop has been sutured to the liver undersurface adjacent to the duct. *Fig. 294.*

The transhepatic U-shaped tube is a form of "endless" tube. It can be rinsed through at any time and, if necessary, renewed, being prepared in advance according to the original. Its management is described in the general chapter on drainage (p. 161). According to the author's experience and in agreement with others, the results of such intubation are correlated to its duration. It is certainly insufficient to maintain it for only a few weeks or months.

Patients with such protracted intubation, lasting even more than a year,

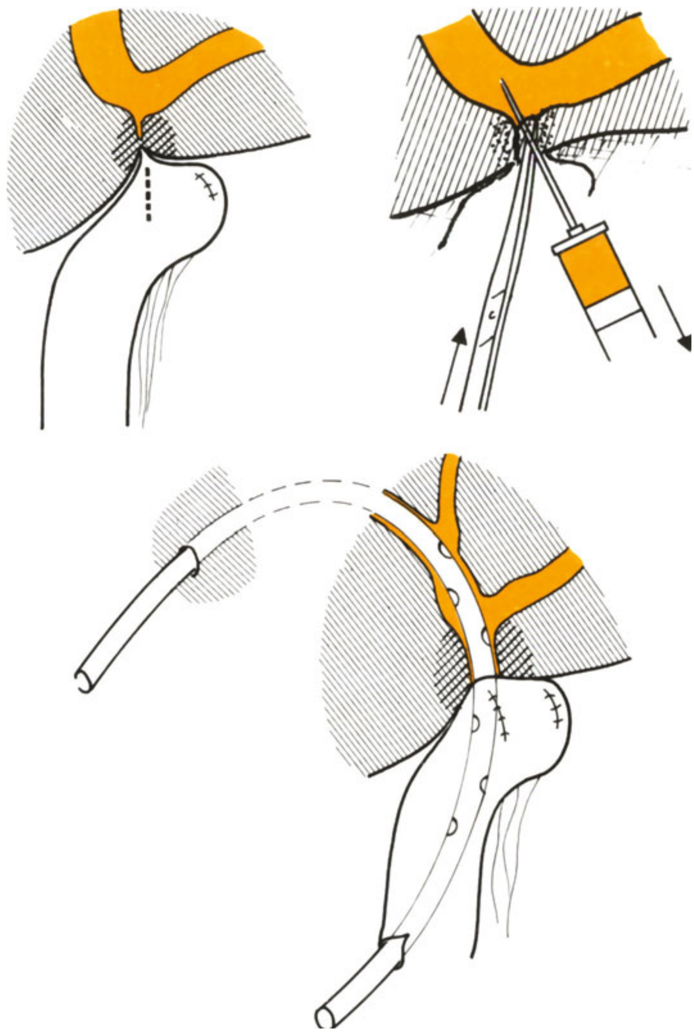


Fig. 294: Fibrotic stricture of hilar anastomosis of the bifurcation and the jejunum; search for dilated hepatic ducts from inside the jejunal loop, by means of needle puncture, and probing of obliterated stoma with hemostat. Intubation of intrahepatic stricture by endless U-drain.

remain under constant supervision, even though they may be able to manage the tube satisfactorily themselves. Its patency is checked by lavage and radiology, and biochemical test results are studied. *Fig. 295.* Signs of cholestasis may regress only slowly or not disappear completely even after a long period. This is apparently due to the fact that the liver parenchyma was already irreversibly damaged at the time of reoperation. The extent of damage cannot be assessed in advance. For this reason diahepatic intubation is maintained permanently in patients menaced by biliary cirrhosis. Patients become reconciled to this as a rule, as drainage offers at least some hope to those otherwise without expectation.

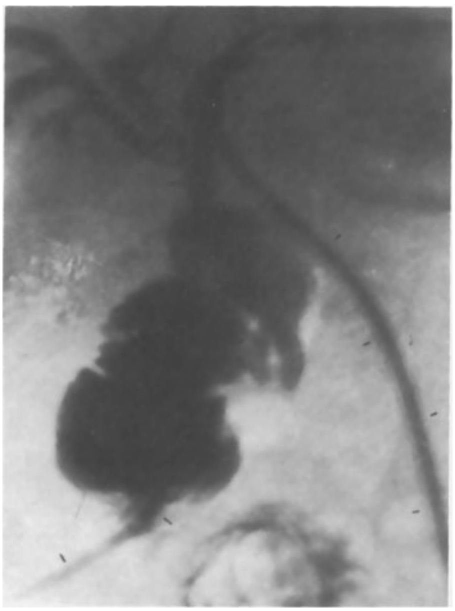


Fig. 295: Radiological check of the patency of transhepatic intubation performed for recurrent sclerotic stricture of a hilar anastomosis, and lasting more than three years.

The prognosis of reoperations and intubation for anastomotic stenoses in particular after repeated interventions, is always uncertain, and only after an interval of about four years free from symptoms is there considerable hope that a permanent success has been scored.

Terminal bile duct "cul-de-sac syndrome" is a relatively rare complication of side-to-side choledochoduodenostomy. Regurgitated food debris combined with "sumping" of bile or small calculi trapped in the terminal bile duct may produce pains and evidence of inflammation, and sometimes obstruction of the stoma. The syndrome is thus a consequence of impeded papillary patency and of reflux through a lateral anastomosis. It is therefore not enough to clear the bile duct at reoperation, but essential to improve biliary drainage, e.g. by sphincterotomy, sometimes also to prevent reflux by a change of anastomosis. *Fig. 296, 297.*

Fig. 297: Blind pouch of common bile duct with stone in lateral choledochoduodenostomy; demonstrated by contrast medium instilled by catheter into duodenum, – the choledochus was filled by reflux.

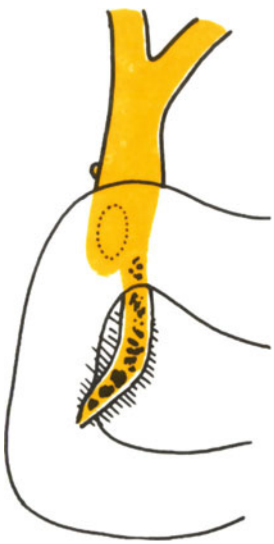


Fig. 296: Blind pouch of terminal bile duct with stones and food residues in lateral choledochoduodenostomy.

The "reflux intolerance syndrome" is also rare. Such an anastomosis can sometimes be eliminated, if papillary drainage has been restored — in other cases the unsatisfactory anastomosis has to be substituted by another using an excluded jejunal loop. Exclusion of the duodenum by gastric resection could also be helpful, provided there was an additional reason for it. Permanent symptoms due to reflux may occur not only with an anastomosis, but also with a gaping papilla following total PST. Exclusion of the duodenum is likewise recommended in this case.

Incorrectly established anastomosis. Amongst other symptoms following jejunal anastomoses of little practical significance, reoperation is very occasionally required for a long blind Roux loop segment, or because the anastomosis provides bile drainage too far away from the stomach. *Fig. 298.* In the first instance amputation of the excessive blind loop segment is adequate, in the second the anastomosis is shifted proximally, so that bile and food become earlier mixed.

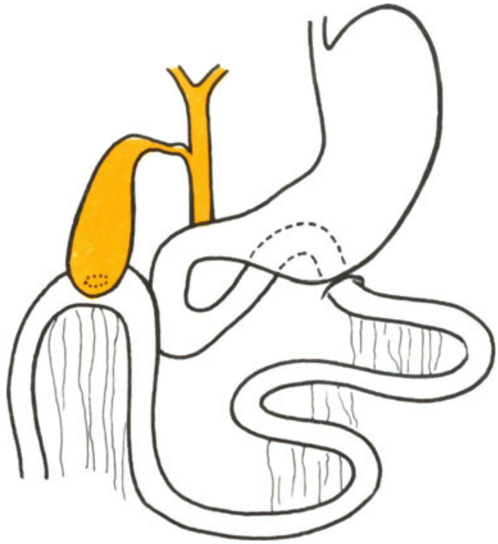


Fig. 298: Cholecystojejunostomy mistakenly performed too far aborally in the gut.

Results of reoperations

Immediate mortality in reoperations for non-malignant biliary tract lesions ranges between 1–9%.

Acute revision was necessary in only less than one per cent in the author's series of 5 490 benign biliary operations, however, at the cost of heavy 12 per cent losses. On the other hand, 658 late reoperations, partly very difficult ones, were subjected to a surprisingly low, one per cent mortality, — similar to statement of Moorhead or Mallet-Guy.

Late prognosis depends understandably on the various reasons for reoperation, and on the method by which they were treated. Mallet-Guy was successful in 79% (1970), and Kourias in 76% of cases (1973). It is necessary to keep in constant touch with the patient, and where it is feared that not even reoperation will succeed permanently his trust must be gained by a correct explanation of the situation in order to make him willing to undergo further surgery if that may be required in the future. Although we agree with Warren that the result is usually poor if more than three reoperations are required, this is not always the case. In particular with reoperations for the sequelae of surgical injury hope must never be abandoned. We have to try and try again to maintain adequate bile drainage, even at the expense of new interventions, all the more difficult the higher in the hilum or inside the liver they have to be performed, and even at the price of long-term or even permanent intubation drainage. For these patients, however, this is the one remaining genuine chance.

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