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Laparoscopic Colorectal Cancer Surgery

Operative Procedures Based on the Embryological Anatomy of the Fascial Composition

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Foreword

Laparoscopic cholecystectomy is the first procedure experience for almost all laparoscopic surgeons and general surgeons. Laparoscopic surgery has gained a wide acceptance in the field of general surgery and is being applied in many surgical procedures in the world including Japan.

Especially laparoscopic colorectal surgery has become an indispensable technique in gastrointestinal surgery, and its progress is remarkable.

In Kameda Medical Center, Dr. Makio Mike is the division chief of colorectal surgery and is teaching amazing fine techniques based on the embryological membranous anatomy to surgical residents. I must admit that they are learning colorectal surgical techniques very effectively based on the precise clinical anatomy taught by Dr. Mike and are dissecting the right layers to go into.

I am inclined to go into the easy-looking plane to dissect with small amount of blood loss. However, Dr. Mike insists on going into the embryologically correct and right layers. His attitude to teach is moving to me.

There are many authorities of colorectal surgery in the world. But Dr. Mike is an exceptionally eager researcher in embryology and clinical anatomy. He dedicated his life to his respected teacher Dr. Takashi Takahashi and has been developing what his teacher taught him.

I have been looking for a chance for Dr. Mike to be able to publish what he has acquired through his clinical and basic researches as well as teaching experience to our residents.

Finally Igakushoin Publishing Company agreed to publish his work for young surgical residents in the world. I appreciate their generosity and braveness to publish this textbook.

Severe criticisms are welcome to Dr. Mike and me as the editor.

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Preface

The foundations of surgery lie in the underlying general theory. Thus, the most important conclusion that comes to mind when I think of the general theory is the importance of the definition of its "terms". In order to structure a surgical procedure perfectly, we must begin with the definition of the terms to be used during the surgery itself. In addition, it becomes necessary to understand the clinical anatomy underlying the procedures. It follows that it should be the clinical anatomy that withstands visibility in the clinical setting. Thus, if we have different definitions of terms, we cannot have a common ground for communication between surgeons and other staff.

Since February 2004, when I first joined our hospital, 8 years have passed. During this time, laparoscopic procedures in gastrointestinal surgery have come to be considered general surgery and are being performed in every hospital. The surgical procedures and their adaptation have been improved and safety increased significantly. In particular, the number of cases of colorectal cancer surgery is increasing and laparoscopic surgery is no longer considered a specialized surgery. Accordingly, numerous publications and videos have been published and many educational lectures have been given. Through these, the expanding view of the operative field in laparoscopy allows application of the fine surgical technique to be described in detail. Hence, it is comprehensible how the recognition of the correct anatomy has come to be very important in this surgical procedure. Therefore, it is believed that thanks to the correct identification of the fascial composition there have been fewer complications in surgical procedures, which has led to a re-evaluation of surgical techniques based on clinical anatomy.

However, many consider that the understanding of clinical anatomy should be distinguished from that of basic surgical concepts. Originally, according to clinical anatomy teachings, the dissecting layer was presumed to derive from the fascial anatomy based on embryological recognition, and the selection of the optimal layer during surgery should be considered the first fundamental principle. On the other hand, what is lacking in publications and educational lectures of laparoscopic colorectal cancer surgery are detailed explanations of the surgical procedures themselves. Namely, the techniques that are currently being used by surgeons have not yet been described in sufficient detail using the appropriate anatomical terms such that they can be fully understood by anyone. Of course, most abdominal surgical procedures to date have been carried out based on the surgeon's experience and intuition, as is the case in Japan, as well as in the USA, and in Europe. That is, surgeons have not yet ventured beyond the field of surgery, with blood vessel construction based solely on the understanding of traditional anatomical systems. Although the first step for a surgeon is to familiarize himself with human anatomy, a surgeon should not be trapped by traditional experience and thinking. It is necessary to be able to perform laparoscopic surgery understanding the fascial configuration based on the fundamentals of embryology. Thus, a new generation of surgeons will soon be born.

In the practice and teaching of laparoscopic colorectal cancer surgery, I believe that the definition of terms and clinical anatomy as a common language for communication with staff is important. After creating a manual for surgical techniques in laparoscopic colorectal cancer surgery, it has to be of practical use. Herein, by publishing the applications of the procedure, the way of thinking, the definition of the terms, and the clinical anatomy derived from

experience at our hospital, I would like to raise the issue of its importance in the world of the surgeon.

Finally, I am extremely grateful to the leadership of Dr. Nobuyasu Kano, Chief Surgical Director, for his implementation and guidance in laparoscopic colorectal cancer surgery. I profoundly thank and dedicate this book to Dr. Takashi Takahashi, Surgical Director at the Cancer Institute Hospital, who has now passed away. In addition, we profoundly thank the doctors, nurses, and technical staff, and all colleagues who willingly collaborate in day-to-day surgery. In addition, I would like to thank Tsutomu Aoki of the publishing workshop who created the original illustrations over the past 2 years. I am also thankful for the support of my wife Chizuko. We thank Junichi Ito who gave us the opportunity of publishing this book and Shizuo Kawamura who provided editing support.

Kamogawa, Japan
March 2012

Makio Mike, MD, PhD

Contents

Basic Principles

1

1.1 Introduction

Laparoscopic surgery is generally performed for digestive diseases. Laparoscopic procedures are requested particularly for patients with colorectal cancer. Given the fine vision currently available to surgeons with the development of advanced laparoscopic surgery systems, an improved understanding of the fascial composition of the abdomen is necessary. Modern surgical procedures of the colon and the rectum have thus required surgeons to revise their understanding of the surgical anatomy of this region. Complications can be reduced by careful dissection of the correct tissue plane in the abdominal cavity. However, descriptions of the anatomy of the fascial composition have also involved observations that are unrelated to better-known fundamental embryological concepts, causing confusion in the explanation of operative procedures since various terms are often used without a specific definition. A better understanding of the fascial composition is useful not only for the laparoscopic approach but also for open surgery procedures.

1.2 Definition of the Terminology—Dissection, Cutting, Fusion, and Adhesion

In laparoscopic surgery, visual, tactile, and motor skills are limited compared to open surgery or laparotomy. The basic techniques of digestive surgery include dissecting and cutting. To overcome these limits to dissecting or cutting away, the selection of the body posture and the position of the port are important in laparoscopy. The use of a 30° view angle laparoscopy or laparoscopy with a flexible tip enables a multidirectional observation of the surgical field as in laparotomy. With a close view of the operative field, dissection and disconnection also become more precise procedures. Conversely, the close operative field narrows the operative view, and reduces dissections to one small stroke, inevitably increasing the time required for an operation. For these reasons, dissection of the adhesion can be performed using an electrosurgical knife, but an ultrasonically activated device (USAD) is required for dissection with haemostasis.

1.2.1 The Concept of Dissection and Cutting

The aim of surgical treatment is to distinguish between the parts to be preserved and those to be resected, and to leave the former and remove the latter. It follows that the understanding of the fascial composition is of utmost importance. Especially in radical surgical treatment for malignant disease, it is necessary to distinguish the boundaries of the tissue to be removed from those to be retained. Resecting along layers that are reasonably and strictly defined is called "dissection". In particular, the dissection of lymphatic vessels and lymph nodes is referred to as "lymphatic dissection".

The boundaries that are strictly defined are represented as single thin lines. If a line consists of a thick width, the resection procedure along the boundary must be defined as "cutting" or "dividing" rather than "dissection" [1].

1.2.2 The Difference Between Adhesion and Fusion

Adhesion and fusion are common terms in digestive surgery, and the difference between them in clinical anatomy must be clearly understood. Resection in the gastrointestinal tract is possible if we dissect the dorsal side of the fusion fascia in accordance with the embryonic fascial anatomy. Therefore, if the concept of fusion fascia is not understood, it will be difficult to understand the clinical anatomy and the surgical procedure will not proceed smoothly. Of course, this does not lead to better surgical education.

Here, we must reconfirm the definition of the word "fascia". This is because there are many frequent errors in

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the usage of the terms fascial configuration and fascial anatomy. First, fascia is a term applied to masses of connective tissue large enough to be visible to the unaided eye. Such structures are highly variable, but, in general, collagen fibres in the fascia tend to be interwoven and seldom show the compact, parallel orientation seen in tendons and aponeuroses [2, 3]. Furthermore, "fascia is not necessarily intended to cover the muscles. It is those that wrap the surface of other organs (such as the glands) and those that form the membrane as a partition of the loose connective tissue. In addition, the sheath that may be seen around the thick blood vessels also can be described as a kind of fascia" [4].

Frequently used as a reference textbook of clinical anatomy is the French, Cahiers D'Anatomie Abdomen (I) (L. Perlemuter and J. Waligora) [5]. In many of the figures in this book, there are arrows indicating the planes of fusion fascia. For example, two arrows in Fig. 1.1 show the left fusion fascia of Toldt, but these arrows have given rise to misunderstandings regarding the dissecting plane. By definition "In fusion fascia, the mobility of the adjacent serosa is lost and these eventually fuse into a single sheet of connective tissue" [4, 7, 8], the interior of the fusion fascia cannot be dissected. In addition, it is important to understand the difference between fusion and adhesion. Although sometimes the term "physiological adhesion" is used, it is ambiguous whether the word means fusion or pathological adhesion. Thus, the term will not be used herein.

The fascia structure present along the body wall is embryologically represented by the term superficial or deep, defined in relation to the fascia of the skin. The terms anterior and posterior are not used because of their arbitrariness. Thus, the terms ventral, dorsal, left, right, cranial, and caudal are used to define direction and location. These can be expressed definitively irrespective of the direction of the patient. In addition, as a note about the use of directional terms, if there is an anatomical term defined as "ventral", there must also be a "dorsal" side. In addition, with respect to the term "dissection", only two possibilities exist: either dissection between the two fasciae or dissection of the ventral or dorsal side of one fascia. Lymphatic dissection refers to cutting the border of the lymphatic vessels and lymph nodes that lie sandwiched between two or more fasciae, which have been dissected.

1.2.3 The Concept of Dissection in Endoscopic Surgery

The structure of the original gastrointestinal tract is three-dimensional, but laparoscopic surgery is two-dimensional, and dissection is carried out in a one-dimensional plane. To proceed with dissection along a one-dimensional line, it is necessary to obtain a suitable dissecting surface by creating tension from the coordinated movement of the operator's left hand and the assistant's hands. In laparoscopic surgery,

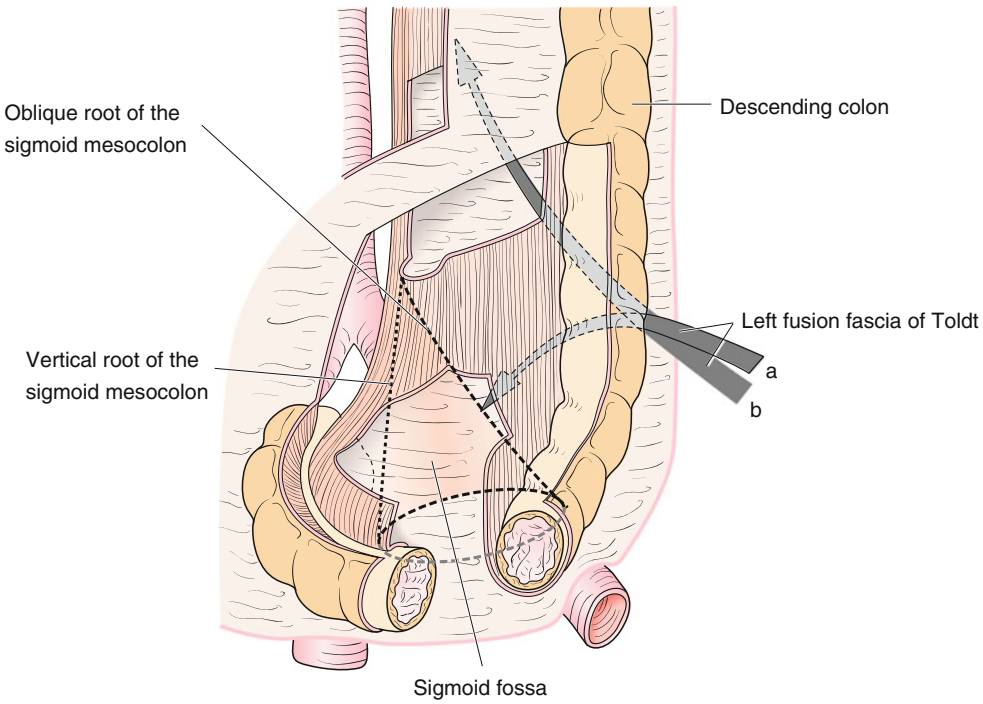

Fig. 1.1 Fascial composition and fusion fascia of the sigmoid colon. Although these *arrows* do not show signs indicating dissection, they indicate a plane where the left fusion fascia has been formed [6, with permission]

as the lines can be clearly visible, it is possible to perform an accurate dissecting procedure. Therefore, the most important thing in performing dissecting manoeuvres in laparoscopic surgery is to visually identify the dissecting layer. Thus, by finding the correct dissecting layer and the dissecting line, it is possible to enter the correct layers using any device. It is possible to find the boundary between the fusion fascia and another fascia. Dissecting the correct layer should not require any haemostasis. In this context, the understanding of the fascia configuration is of fundamental importance.

1.3 Peritoneal Configuration, Body Wall, and Intestinal Rotation in Foetal Life

The basic structure of the peritoneal configuration and body walls in foetal life is shown in Fig. 1.2. A basic understanding of the fascial composition of the body circumference and its interpretations has been provided by Tobin et al. [9] and Sato [10]. According to these interpretations, the structure of the body below the diaphragm can be simplified as a straight intestine within a cylindrical body. Basically, the body composition can then be divided into the composition of the peritoneal cavity (consisting of the cylinder) and the composition of the body wall (consisting of the cylinder wall). In the former, the cranial abdomen includes the dorsal and ventral mesentery, and the caudal abdomen includes only the dorsal mesentery involving the intestine. The latter has a ringed composition, and the body walls are symmetrical in relation to the central position of the muscle layer (Fig. 1.2). The trunk has typically been regarded as an onion-like multilayered structure [11].

The fascial structure present in the body wall is embryologically represented by the term superficial or deep, defined in relation to the superficial skin surface. The terms anterior and posterior are not used because of their arbitrariness. Analogously to the subcutaneous superficial fascia and subcutaneous deep fascia, the deep subperitoneal fascia and superficial subperitoneal fascia exist circumferentially

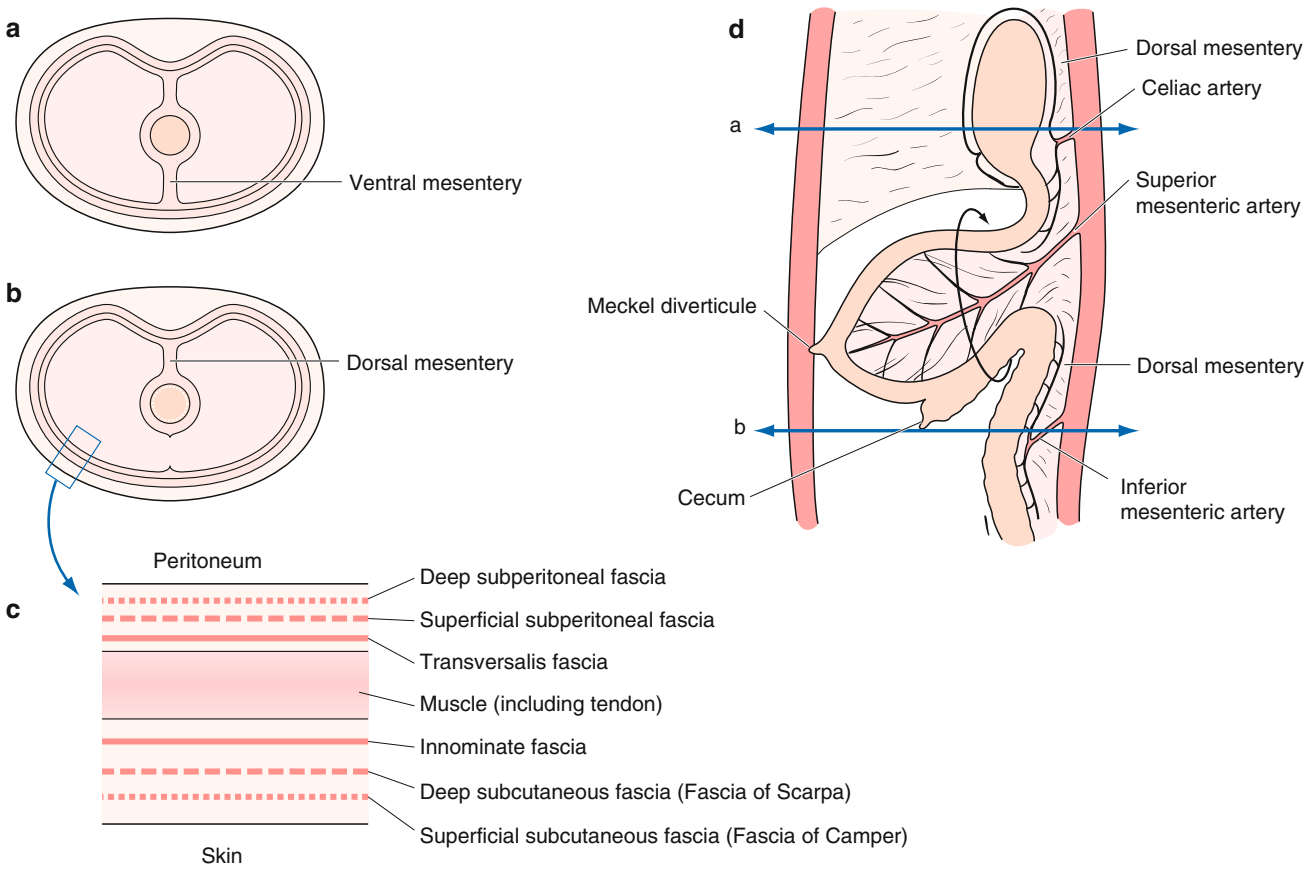

Fig. 1.2 Peritoneal configuration, body wall, and intestinal rotation in foetal life. According to the interpretations of Tobin et al. and Sato, the internal structure of the body can be simplified as a straight intestine within a cylindrical body (**a**, **b**). The basis of body composition can then be divided into the composition of the peritoneal cavity and the composition of the body wall. The body walls are symmetrical relative to the central position of the muscle layer (**c**) [6, with permission]

around the abdominal wall (Fig. 1.2). It is important that the superficial subperitoneal fascia and the deep subperitoneal fascia are independent of each other (Fig. 1.2c) and the two fasciae sandwich the aorta from ventral and dorsal sides directly toward the pelvic space.

Unless the continuity of the two subperitoneal fasciae to the pelvic space is guaranteed, this basic configuration (Fig. 1.2) also becomes imperfect. Therefore, to examine the fascial composition in the pelvic space, the terms deep subperitoneal fascia and superficial subperitoneal fascia will be used herein to refer to the pelvic space in consideration of its continuity from the peritoneal cavity. Unless the continuity of the two subperitoneal fasciae is guaranteed, the textbook of surgical procedures also becomes imperfect.

1.4 Intestinal Rotation and Peritoneum

With regards to the relationship between intestinal rotation and each mesentery, the dorsal mesentery (Fig. 1.2) rotates around the superior mesenteric artery (SMA) (Fig. 1.3) [13]. The concept of fusion fascia is thus indispensable when considering the relationship between the peritoneum and the mesentery at the terminal end of rotation of the intestine. After fusion of the bilateral mesentery with the peritoneum, the fixation of the colon to the retroperitoneum is complete.

When we dissect the plane between the fusion fascia of the colon and the deep subperitoneal fascia, it is often possible to see another fascia, for example in the ascending colon or in sigmoid colon surgery. The mesentery of the colon may not necessarily be constituted by two layers. The peritoneum is the widest among the serosa of the body and is divided into the parietal peritoneum and visceral peritoneum. The parietal peritoneum covers the abdominal cavity, the pelvic cavity, and the diaphragm surface. The visceral peritoneum covers the internal organs of the abdomen and pelvis, and is generally considered to also include the mesentery. Originally, the peritoneum completely covers the entire intestinal tract. The mesentery, including the parietal peritoneum, is made of a fibrous layer (the tunica subserosa) and a surface layer of mesothelium (tunica serosa) [14]. The deep subperitoneal fascia is extended to the colon wall through the dorsal mesentery (Fig. 1.4) [10]. Thus, it may be natural that the mesentery is composed of four fasciae. These features are important in the clinical anatomy of the dissection at the hepatic flexure of the right hemicolectomy and for the dissection of the dorsal side at the Denonvilliers' fascia. The fascia seen on dissection should not be unconditionally believed to be artifacts resulting from surgical interventions. However, what is important is not the number of fasciae, but that the fasciae are used to indicate the correct plane to be dissected.

1.5 Relationship Between the Stomach and Transverse Colon—Particular Relationship at the Centre of the Transverse Colon

It is not possible to ignore the relationship between the stomach and the colon in order to understand the overall image of the colon. With regards to the description of this area, there are many errors in many existing books. To understand the boundaries for dissecting and cutting, you must understand whether the fascia belongs to the stomach or to the transverse colon in every stomach or pancreatic operation.

By applying the intestinal rotation and fusion fascia to this part, it is possible to understand its fascial composition. In other words, what is referred to as the gastro-colic ligament is the ligament stretching between the stomach and the transverse colon, which is none other than the omentum. Originally, two sheets of dorsal mesentery became four sheets and then formed the omentum that extends between the stomach and transverse colon. The third sheet of the dorsal mesentery is the posterior wall of the omental bursa, and the fourth sheet of the dorsal mesentery fused with the ventral side of the transverse mesocolon in foetal life (Fig. 1.5). The omentum is tissue belonging to the stomach, which was formed by the original dorsal mesentery (also known as the posterior gastric mesentery) that is stretched caudally. The transverse mesocolon is composed of a ventral and dorsal leaf (generally an anterior and a posterior leaf); it has no relationship at all with the stomach. The root of the transverse colon lies in the caudal edge of the pancreatic body and tail and the transverse mesocolon extends from there as a characteristic fan-shaped mesentery (Fig. 1.3). In the final process of bowel rotation, the fourth sheet of the dorsal mesentery (omentum) and the ventral leaf of the transverse mesocolon are fused (Fig. 1.5). To better understand these relationships, it helps to consider the connections between the omentum and the transverse mesocolon as if they are divided into two stages during the course of intestinal rotation. In the sagittal sectional view at the centre of the transverse colon, the omentum and mesocolon are irrelevant (Fig. 1.5a), however, the fusion fascia is formed (Fig. 1.5c).

Without fully understanding the underlying anatomy, the current clinical anatomy has been flawed for a number of years. In addition, many surgeons think that the dorsal wall of the bursa omentalis is the ventral leaf of the transverse mesocolon. Therefore, the assumption "When you

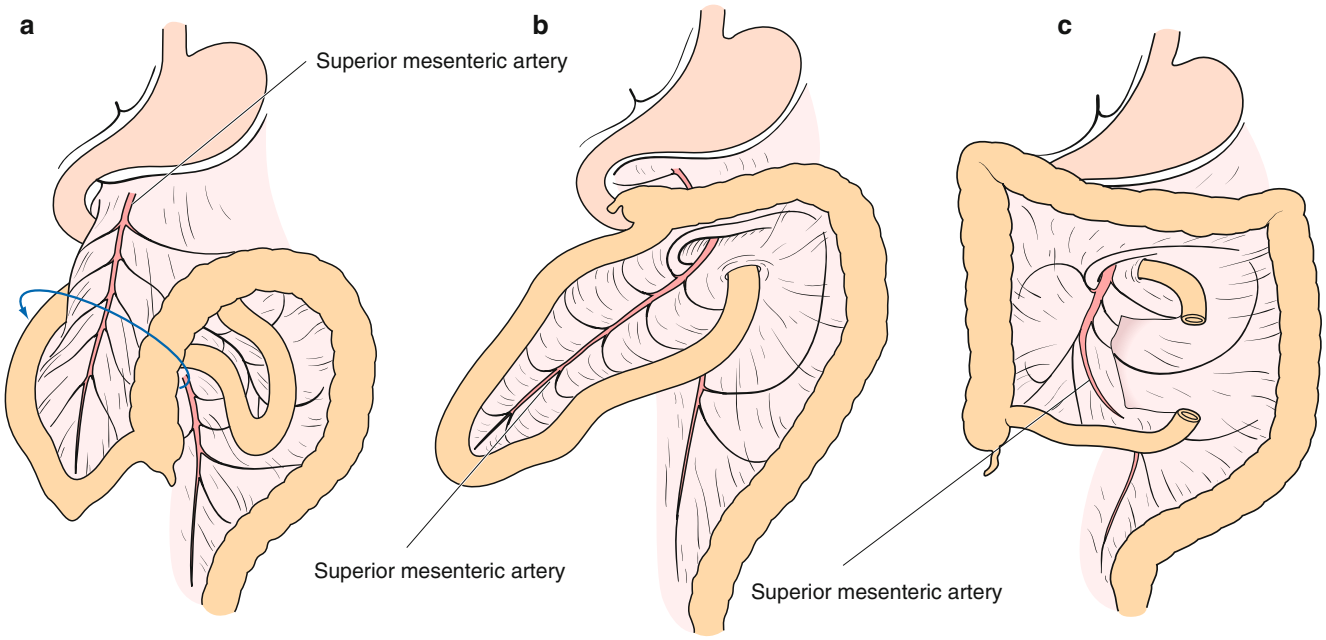

Fig. 1.3 Intestinal rotation and fusion. The dorsal mesentery is rotated around the superior mesenteric artery (SMA) (**a**, **b**). The fusion is formed at the end of the intestinal rotation and most of the colon is fixed to the retroperitoneum (**c**). The SMA is thus defined as the artery that heads to the ileum, 50–100 cm from the terminal ileum. The *blue solid line* indicates the direction of the intestinal rotation [12, with permission]

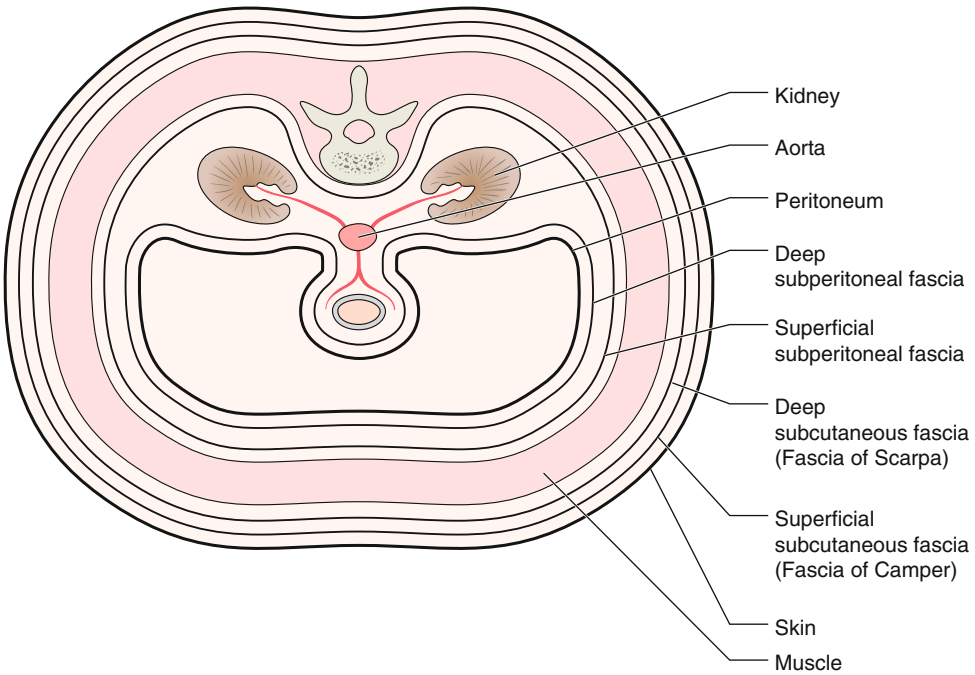

Fig. 1.4 Sato's concept. According to this concept, the deep subperitoneal fascia covers the entire circumference through the dorsal mesentery and the vessel corridor is located between this fascia. However, if this concept were to refer to all the fields within the abdominal cavity, this concept would be unable to respect the operative views in the clinical setting

dissect the ventral leaf of the transverse mesocolon, you will reach the anterior serous surface of the pancreas" is incorrect. In fact, the dissection of "the ventral leaf of the transverse mesocolon" actually refers to the posterior plane of the fusion fascia. Continuing the dissection of the dorsal plane of the fusion fascia, you will reach the behind the pancreas. Considering the bursectomy of the stomach, there are two possible procedures. One method is to dis-

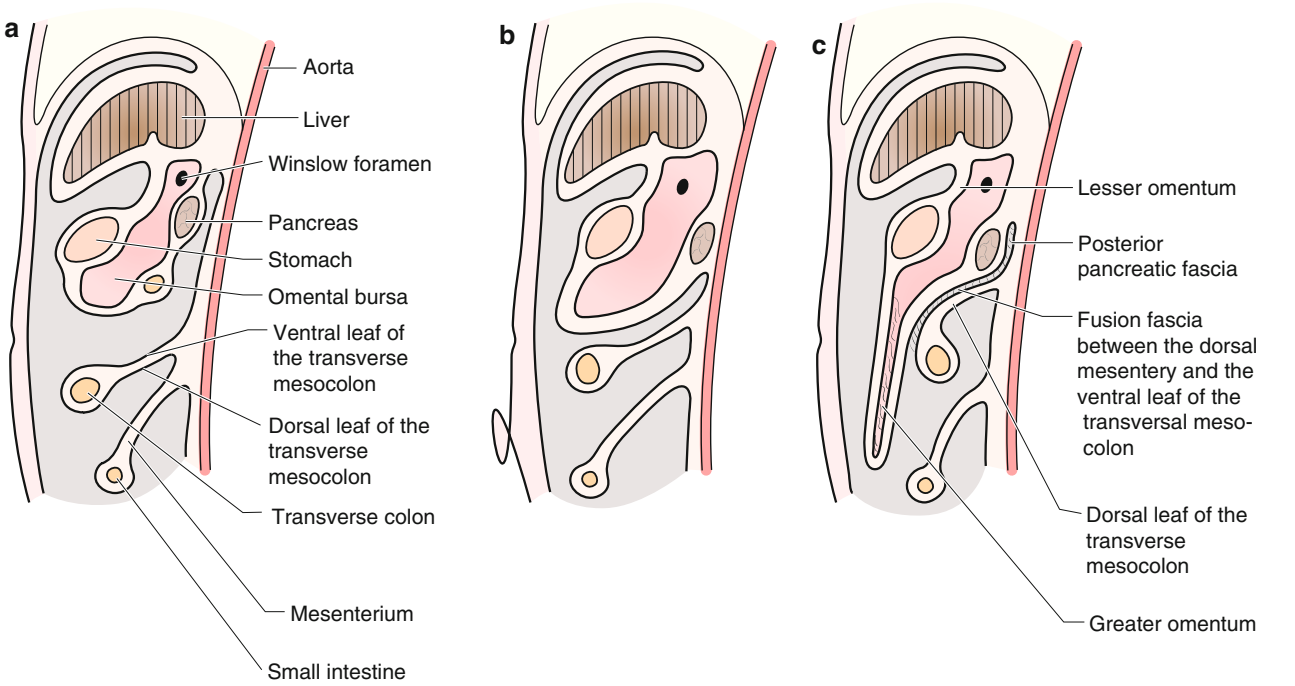

Fig. 1.5 Relationship between the stomach and the transverse colon by the upper abdominal sagittal sectional view. The omentum is tissue belonging to the stomach, which is formed by the original dorsal mesentery stretched caudally. The transverse mesocolon has ventral and dorsal leafs, which are unrelated to the stomach (**a**, **b**). However, the fourth sheet of the dorsal mesentery (omentum) and the ventral leaf of the transverse mesocolon are fused in the final stroke of the intestinal rotation (**c**)

sect between the third sheet and the fourth sheet of the dorsal mesentery (Fig. 1.6b). In this case, this does not include the dissection of the ventral leaf of the transverse mesocolon. Another method is to dissect the dorsal side of the ventral leaf of the transverse mesocolon (fusion fascia) and to cut the fusion fascia at the caudal side of the pancreatic body and to continue dissection towards the dorsal side of ventral fascia of the pancreas (i.e., the third sheet of the dorsal mesentery) (Fig. 1.6a) [15].

1.6 The Presence of Histological Fascia

The histological search of the layers between the bursa omentalis and the dorsal leaf of the transverse mesocolon should identify the third sheet of the dorsal mesentery, the fusion fascia between the fourth sheet of the dorsal mesentery and the ventral leaf of the transverse mesocolon, and the dorsal leaf of the transverse mesocolon. However, on actual histological evaluation, the fusion fascia can only be identified as a layer of intermittent slightly elastic fibres (Fig. 1.7). In other words, it should be noted that all fascia structures cannot be identified histologically [15]. However, if you consider the adipose tissue as an indicator, there appears to be a total of five fasciae (Fig. 1.7).

1.7 Vascular Anatomy and Lymph Node Dissection of the Colon [12]

1.7.1 Vascular Anatomy and Lymph Node Dissection of the Right Colon

First, the SMA should be defined on the right colon. The SMA is a vessel originating directly from the aorta and feeds the entire small intestine as well as the colon up to two-thirds of the transverse colon. Embryologically, the intestine rotates around the SMA, and the peripheral portion of SMA is the yolk sac. The yolk sac is also a portion of Meckel's diverticulum (Fig. 1.2d). The SMA is thus defined as the artery that heads to the ileum, 50–100 cm from the terminal ileum (Fig. 1.8). The branches of the artery should be defined. Here, we define the "colic artery" as those vessels with an independent origin from the SMA. Otherwise, branches without a direct origin from the SMA are indicated as a "colic branch".

Arteries arising from SMA are highly variable compared with the left colon, but the terminal artery from the SMA, the ileocolic artery (ICA) is constantly present. The right colic artery (RCA) is an artery arising directly from the SMA, but is present in only 10–40 % of cadavers (Fig. 1.8b) [16]. In 70–90 % of cadavers, two arteries arise from the

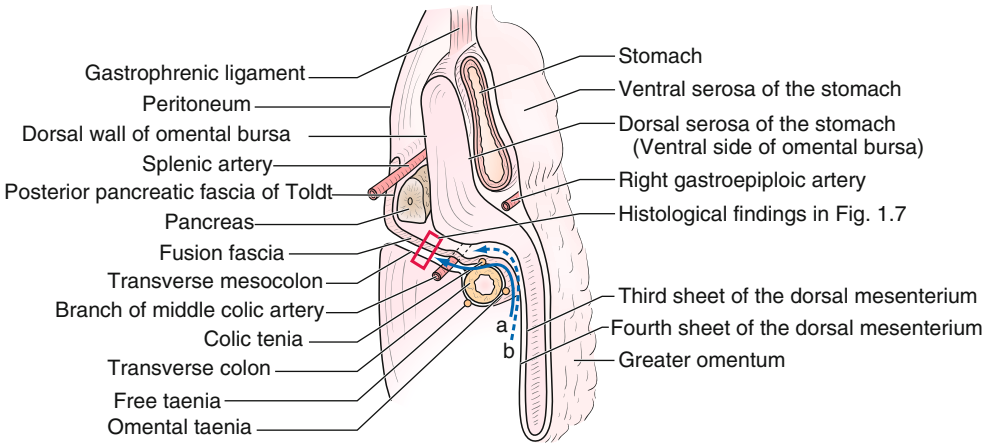

Fig. 1.6 Dissection of the ventral leaf of the transverse mesocolon as in bursectomy. There are two schools of thought regarding the dissection of the ventral leaf of the transverse mesocolon. Namely, there is the true dissection of the dorsal side of the fusion fascia (**a**) and dissection of the ventral leaf as in substantial bursectomy (**b**) that dissects between the third and the fourth sheet of the dorsal mesentery. The latter cannot be said of the dissection of the ventral leaf of the transverse mesocolon

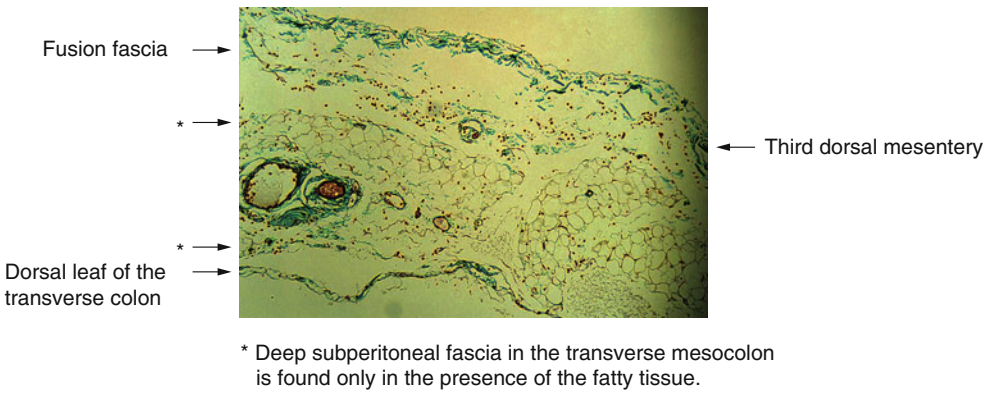

Fig. 1.7 Histological findings from the bursa omentalis to the dorsal leaf of the transverse mesocolon. The dorsal wall of the omental bursa (third sheet of the dorsal mesentery), the fusion fascia between fourth sheet of the dorsal mesentery and the ventral leaf of the transverse mesocolon, and the dorsal leaf of the transverse mesocolon should be visible. However, the fusion fascia can be recognized only as a slightly elastic fibre

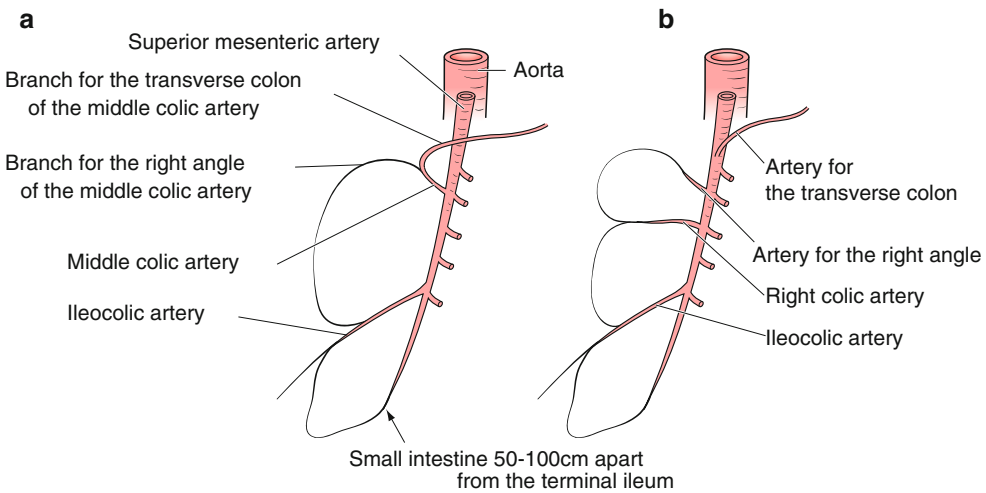

Fig. 1.8 Vascular anatomy of the right colon. The final branch stemming directly from the superior mesenteric artery (SMA) is the ileocolic artery (ICA), and the right colic artery (RCA) branches directly from the SMA to the right colon (**b**). As for the artery of the transverse colon, the artery for the right angle (**b**) or the branch for the right angle of the middle colic artery (MCA) (**a**), the term artery for the transverse colon (**b**) or the branch for transverse colon of the MCA (**a**), is appropriate [12, with permission]

SMA to supply the right colon, while 10–30 % show three arteries. This means that, in many cases, two arteries are present: the ICA and the middle colic artery (MCA) [16].

As for the arteries of the transverse colon, the first artery arising from the SMA to the right is the MCA, which arises from the lower border the pancreas body (Fig. 1.8a) [16]. Then, to avoid using terms such as "right branch" or "left branch" of the MCA, the artery for the right angle or the branch for the right angle of the MCA, and the artery for the transverse colon or the branch for transverse colon of the MCA are considered adequate representations of the arteries originating from the SMA or the branches arising from the MCA.

In the area between the RCA (or, in its absence, the ICA) and the left colic artery (LCA), more than one so-called "MCA" arising directly from the SMA may be found. Among these "MCA", five distinct vessels have been isolated, individually behaving as arteries (with separate origins) or branches: (1) the true MCA (found in 46 % of specimens); (2) the artery for the right angle (32 %); (3) the artery for the transverse colon (12 %); (4) the accessory artery for the transverse colon (3 %); and (5) the accessory left colic artery (7 %) (Fig. 1.9) [17].

In Japan, recommendations for performing lymphadenectomy are based on the arteries according to the Japanese Society for Cancer of the Colon and Rectum (JCCRC) guidelines [18]. The National Comprehensive Cancer Network (NCCN) Guidelines for colon cancer recommend that the lymph nodes should be harvested for pathological examination at the origin of the feeding vessel [19]. However, in reality, since Gillot's concept (Fig. 1.10) [20] was first introduced in Japan in the 1970s, two definitions have been applied in lymph node dissections of the right colon. One involves the dissection of the main lymph node corresponding to the root of the main feeding artery according to the JCCRC [18], while the other is the lymph node dissection according to lymph flow based on Gillot's concept, with dissection of the nodes along the surgical trunk as the main lymph nodes [20].

In Gillot's paper [20], the term "surgical trunk" was adapted to define the superior mesenteric vein (SMV) between the ileocolic vein caudally and Henle's trunk (gastro-colic trunk, GCT) cranially. More generally, the "surgical trunk" is limited to the region of confluence of the SMV, meaning only the right ventrolateral SMV (Fig. 1.10). In the right colon, lymph node dissection along this "surgical trunk" is better than lymph node dissection to the root of the main artery. However, whether lymph node dissection along the surgical trunk is appropriate has not been verified. In addition, formation of the GCT has been noted in 69 % of cases [21].

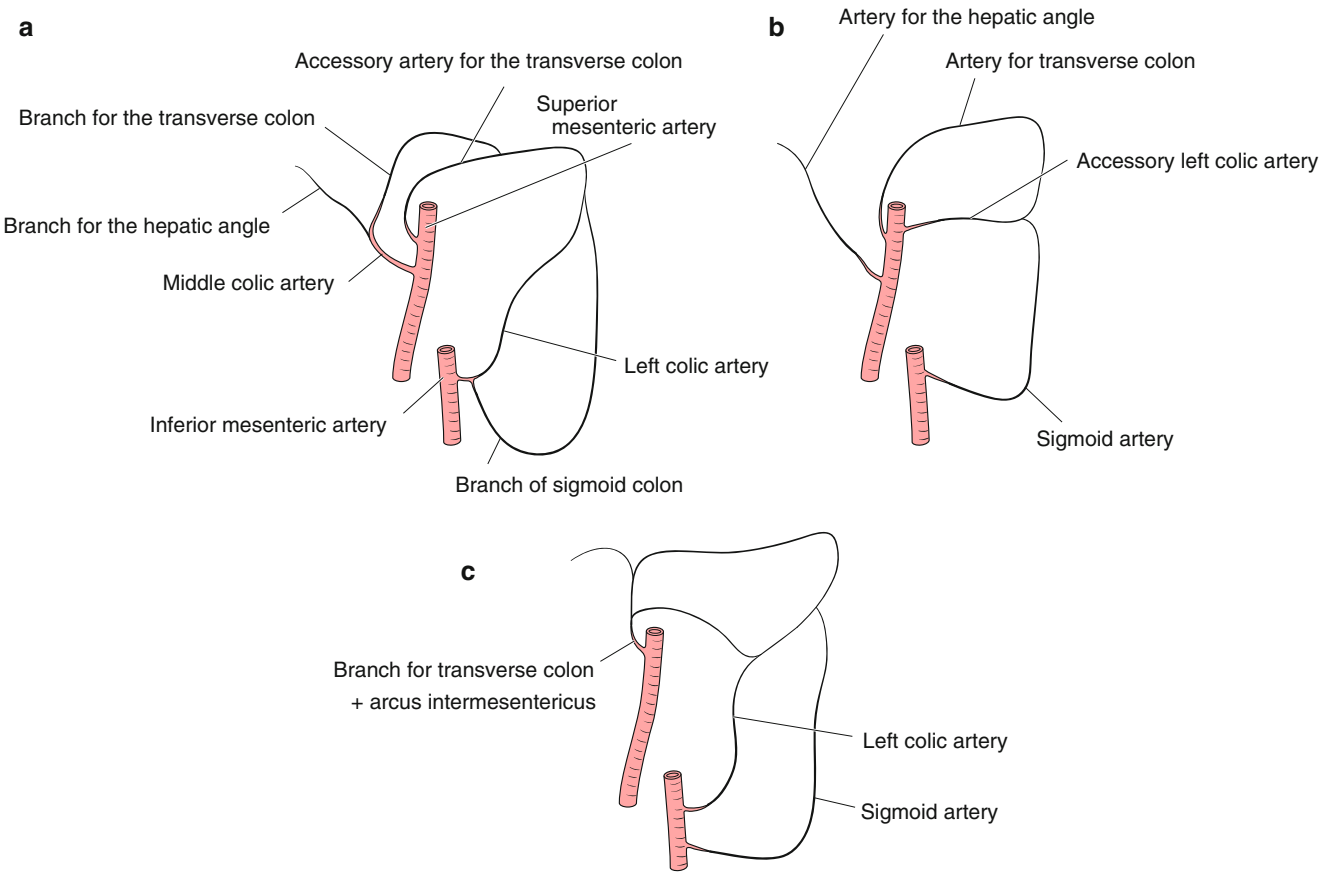

Fig. 1.9 Vascular anatomy of the splenic flexure. Blood flow to this portion is almost entirely from the left colic artery (LCA). For blood flow from the transverse colon to this portion, the term artery for the transverse colon (**b**) or the branch for transverse colon of the middle colic artery (**a**) is appropriate [12, with permission]

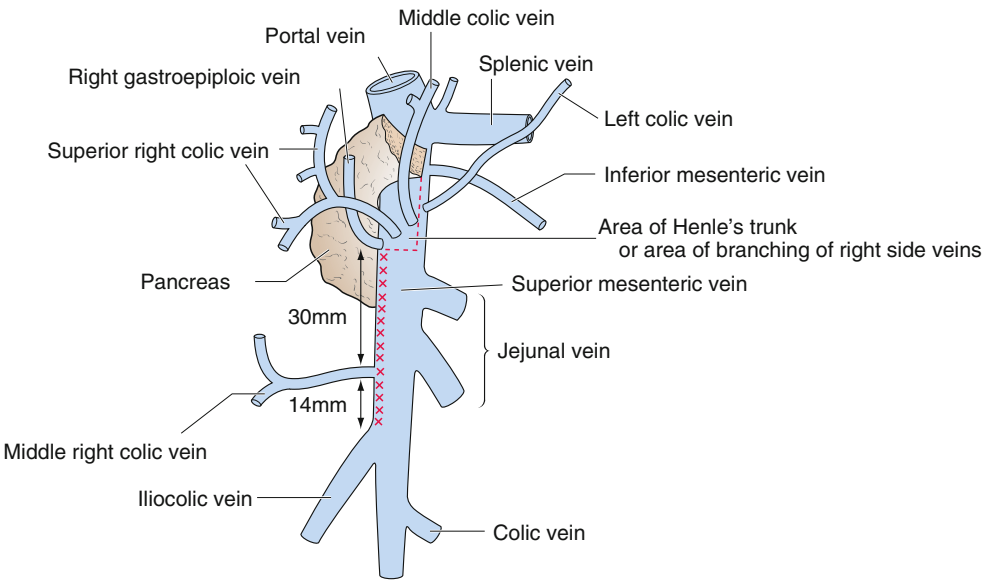

Fig. 1.10 Gillot's concept. The term "surgical trunk" has been adapted to the superior mesenteric vein (SMV) between the ileocolic vein caudally and Henle's trunk (gastro-colic trunk) cranially. Speaking more generally, the "surgical trunk" is limited to the region of confluence of the SMV, meaning only the right ventro-lateral SMV [12, with permission]

1.7.2 Vascular Anatomy and Lymph Node Dissection of the Left Colon

For the left colon, as the inferior mesenteric artery (IMA) is always present, it is important to define the LCA. Unless the artery arising from the SMA provides the only blood supply to the descending colon, the LCA is defined as the first left lateral artery arising from the IMA. Any vessel diverging from the LCA is called a "branch" rather than an "artery", using the same branch-naming system applied to the SMA. According to this definition, the variation of the IMA can be divided into: (1) the LCA acting as the sole artery arising from the IMA (58 %); (2) the first branch of the sigmoid vessel arising from the LCA (27 %); or (3) the LCA and first sigmoid artery together arising from the same site on the IMA (15 %) (Fig. 1.11) [22, 23]. Given these possibilities, those vessels arising directly from the IMA are termed "artery" and those arising from the "artery" are named "branch" (Fig. 1.11).

In many papers, the superior rectal artery (SRA) has been described as the artery immediately after divergence of the LCA from the IMA. In 1908, Miles [24] referred to the route of lymphatic drainage along the IMA. He recommended the division of the IMA just distal to the LCA. Next, the artery just distal to the LCA is not the SRA, but the IMA. Until 1993, in most publications 'high or low ligation of the IMA' is the usual presentation during surgery for cancer of the rectum. Ligation above the origin of the LCA had been defined high ligation and ligation below this level low ligation [25, 26]. However, after Lanz and Wachsmuth, the artery caudal to the origin of the LCA was denominated SRA, and not IMA. SRA is incorrectly denominated as the IMA caudal to the origin of the LCA [27]. Based on common sense, the sigmoid arteries should not diverge from the SRA. The SRA has been defined as the artery following the divergence of the rectosigmoid artery (Fig. 1.11) [28–30]. Such misapplication of the nomenclature should obviously be addressed. Of course, in this paper, the caudal side of the IMA after the diverging of the LCS is described as the IMA.

Concerning the variation of the lymph node dissection, the JCCRC [18] and NCCN [19] do not differ greatly. However, if there is lymph node metastasis in the main lymph node, it means systemic disease according to the world trend. However, only Japan is not exempt from the dissection of high ligation faith forever.

1.7.3 Vascular Anatomy of the Splenic Flexure

The splenic flexure of the colon is defined as extending from one-third of the left transverse colon to the first portion of the descending colon. Blood flow to this portion is almost entirely from the LCA. However, although blood flow from the transverse colon to this portion involves a variety of vessels, "the artery for the transverse colon", and "the branch for the transverse colon" from the MCA are the most commonly used terms (Fig. 1.9).

For colorectal cancer surgery, there are recommendations to improve prognosis through the wide range resection of the intestine and by increasing the number of lymph node dissections. However, using a precise computed tomography (CT) examination preoperatively is also believed to sufficiently further narrow the lymph node dissection procedure. Comparing the reference of detected lymph node metastasis from a current precise CT examination with the pathology results that the surgeon

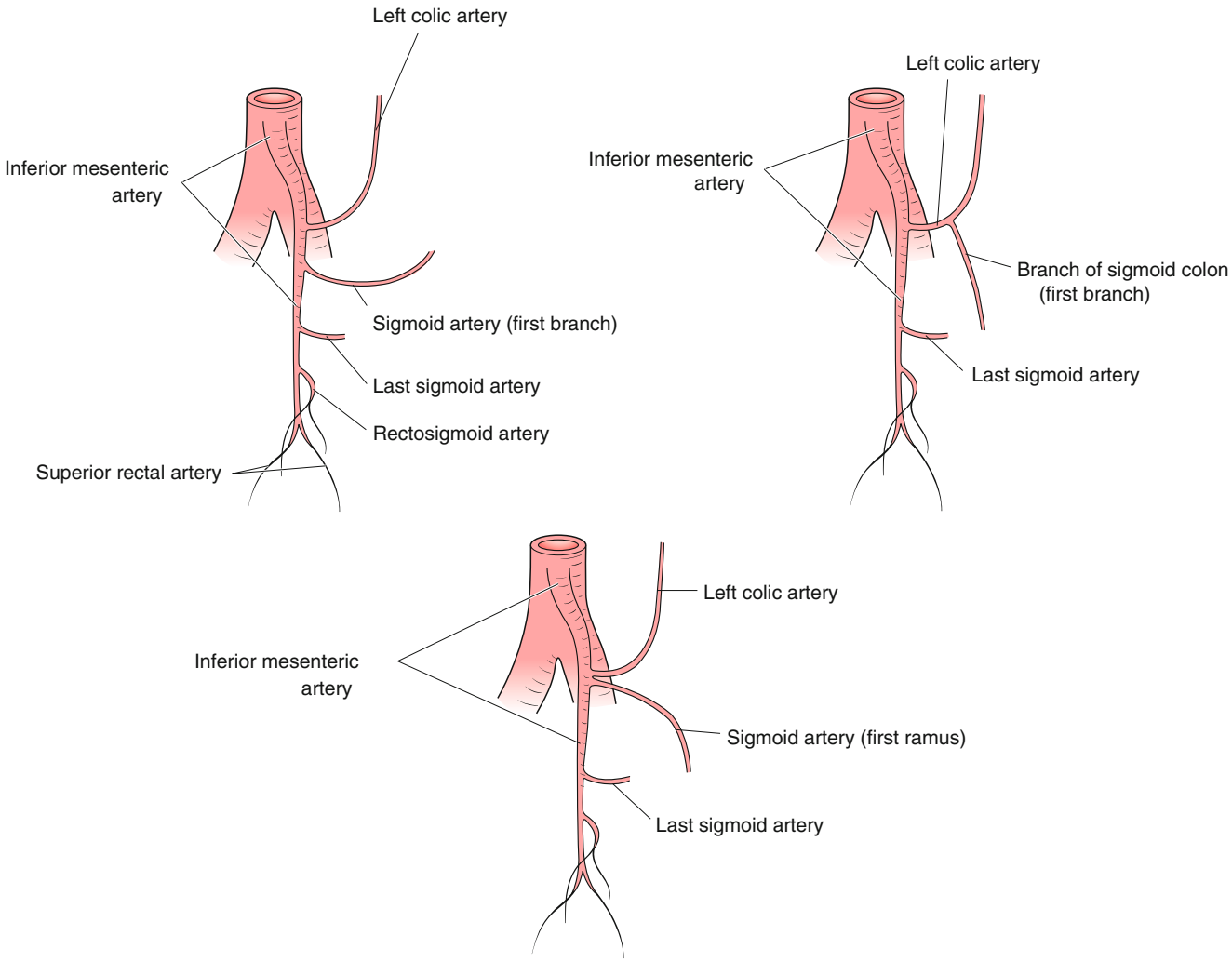

Fig. 1.11 Vascular anatomy of the left colon (especially of the splenic flexure of the colon). The first branch from the inferior mesenteric artery (IMA) to the left is the left colic artery (LCA). The variation of the IMA can be divided into: (1) the LCA acting as the sole artery arising from the IMA; (2) the first branch of the sigmoid vessels from the LCA; or the LCA and first sigmoid artery together arising from the same site on the IMA [12, with permission]

himself obtained by lymph node mapping the resected specimen accurately, we must clarify which provides more of an advantage.

1.7.4 Definitions of Surgical Treatments for Colon Cancer

First, when considering surgery of the colon, the definitions of surgical procedures have been checked. In the JCCRC [18], operative procedures include ileocaecal resection, partial resection of the colon, right hemicolectomy, left hemicolectomy, sigmoidectomy, subtotal colectomy, and total colectomy. However, the definitions of the procedures have not been reported in the JCCR guidelines.

The concept that is accepted by the French as the definition of surgical procedures for colorectal cancer surgery [31] describes the four main arteries of the colon using a square as a model, considered as the backbone of the large intestine (Fig. 1.12a). The four vessels are the ICA, the branch for the right angle of the MCA (or artery for the right angle), the LCA, and the sigmoid artery (Fig. 1.12b). Anomalous arteries in addition to the four main arteries are the RCA, the branch for the transverse colon of the MCA (or artery for the transverse colon), the first branch of the sigmoid colon, and the second or third sigmoid artery (Fig. 1.12c).

In addition, the arrows represent the arteries to the small intestine and to the rectum in this figure (Fig. 1.12c). Based on the above definitions, colon cancer surgery can be defined to include colon segmental resection, hemicolectomy, subtotal colectomy, and total colectomy.

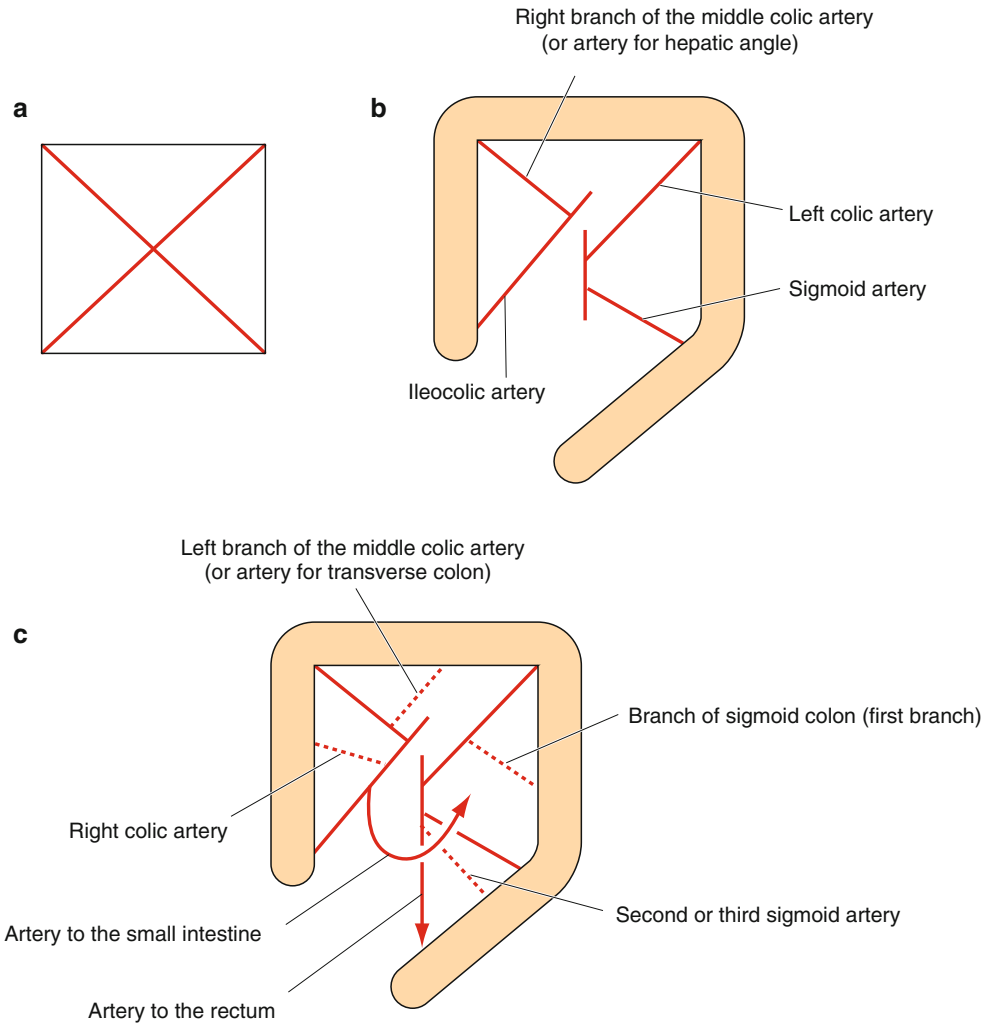

Fig. 1.12 Understanding the basic structure of the colon arteries. The four main arteries of the colon are defined using a square model, considered as the backbone of the large intestine (**a**). The four vessels are the ileocolic artery (ICA), branch for the right angle of the middle colic artery (MCA), left colic artery (LCA), and the sigmoid artery (**b**). Anomalous arteries in addition to the four main arteries are the right colic artery (RCA), the branch for the transverse colon of the MCA, the first branch of the sigmoid colon, and the second or third sigmoid artery (**c**) [12, with permission]

Segmental resection is defined as treatment in which one main artery is divided, whereas hemicolectomy is defined as treatment with division of two main arteries. In this situation, ligation or division of additional colic arteries does not matter. However, in hemicolectomy, a portion of the transverse colon must be resected in addition to the area of the right or left colon. Extended hemicolectomy thus involves excision of additional arteries from the MCA. Subtotal colectomy divides three major colic arteries, and total colectomy divides four main colic arteries (Fig. 1.13) [31, 32].

However, there are problems with these concepts, in that the definition of ileocaecal resection partially overlaps with the definition of right colectomy. In our facility, resection of lesions confined to the caecum is defined as an ileocaecal resection. In addition, although right hemicolectomy plus left hemicolectomy would logically cover the entire colon, in reality this has not been the case. In terms of the embryology of the blood supply, using the left one-third as a border between the right and left colon appears to be a good idea.

1.8 Fascial Anatomy of the Umbilicus and the Method for Insertion of Hasson's Cannula

When performing laparoscopic surgery, surgeons often see the dorsal side of the abdomen wall. The relationship between the median umbilical ligament, lateral umbilical ligament, and the umbilicus is important to the scopist. That is, it suggests the anatomical landmarks and the indication of inclination to the scopist. The anatomy of the inguinal regions should be understood, and it is necessary to check whether there is an inguinal and femoral hernia (Fig. 1.14a). Moreover, understanding the relationship between the median umbilical ligament, lateral umbilical ligament, and the round ligament of the liver, and the umbilical fascia recognised as a thickening of the transversalis fascia, is an anatomical landmark when inserting Hasson's cannula along the umbilical ring in obese patients (Fig. 1.14b).

The relationship between the round ligament and umbilical ring, and relationship between the median umbilical ligament, lateral umbilical ligament, and umbilicus in the

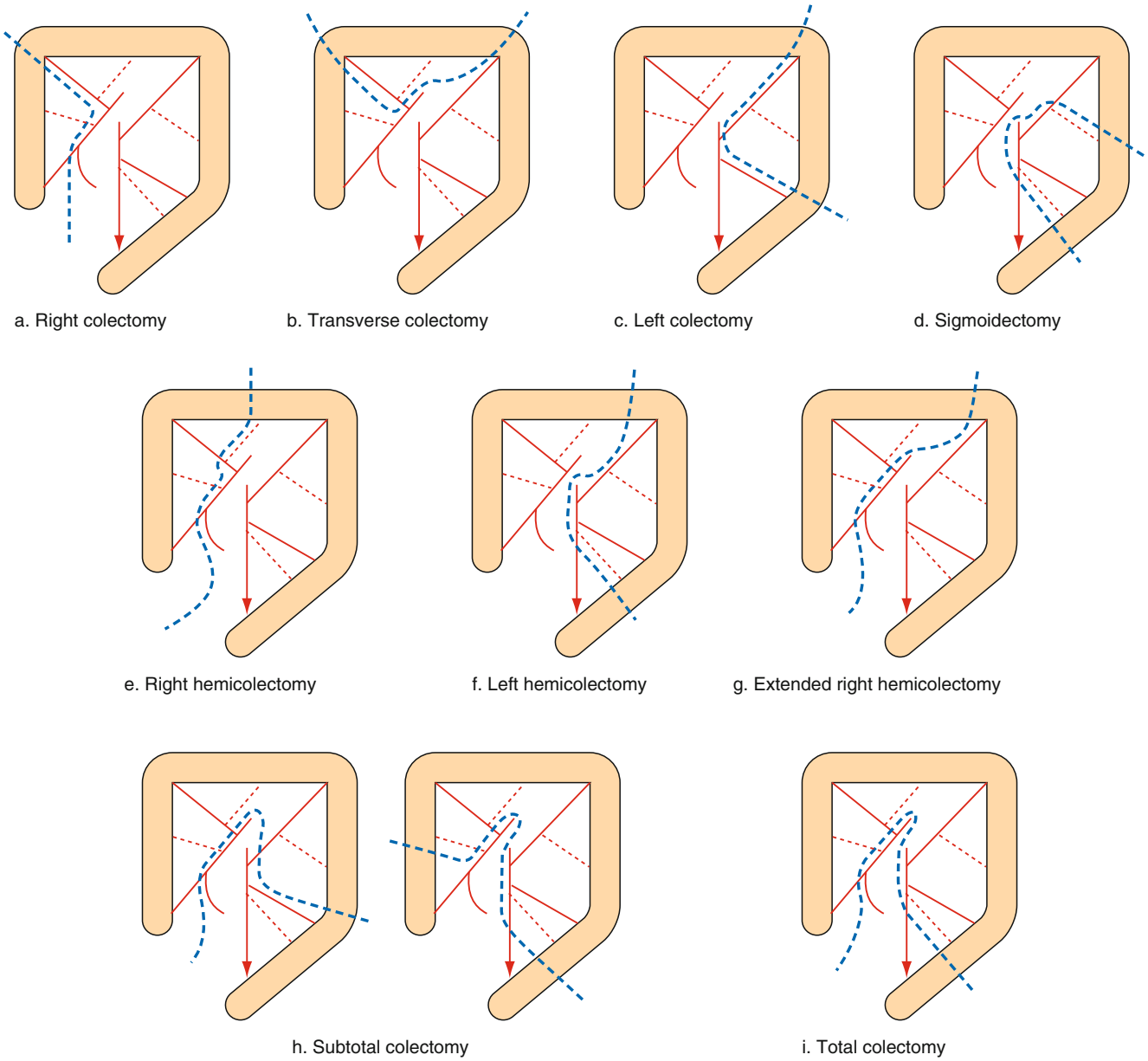

Fig. 1.13 Colon cancer surgery and its definition. Segmental resection is defined as treatment in which one main artery is divided, whereas hemicolectomy is defined as treatment with division of two main arteries. In this situation, ligation or division of additional colic arteries does not matter. However, in hemicolectomy, some portion of the transverse colon has to be resected in addition to the area of the right or left colon. Extended hemicolectomy thus involves excision of additional arteries from the middle colic artery (MCA). Subtotal colectomy divides three major colic arteries, and total colectomy divides four main colic arteries [12, with permission]

abdominal cavity can be divided into two types (Fig. 1.14c). That is, in the open method of inserting Hasson's cannula, especially for obese patients, it is easier towards the abdominal cavity along the umbilical ring. In this case, you can either invade the median umbilical ligament or fall between the divided median umbilical ligament. After the cannula passes through this part, the two methods determine whether the umbilical fascia exists or does not exist, and it follows to the peritoneum after that [33].

1.9 Summary

Considering laparoscopic colorectal cancer surgery, we describe herein the underlying generalities involved. The completeness of the surgical technique must begin with the definition of the terms to be used in the surgical procedures. After that, we need to understand the clinical anatomy for the underlying procedures embryologically. However, the understanding of this embryology must not overpower but it must

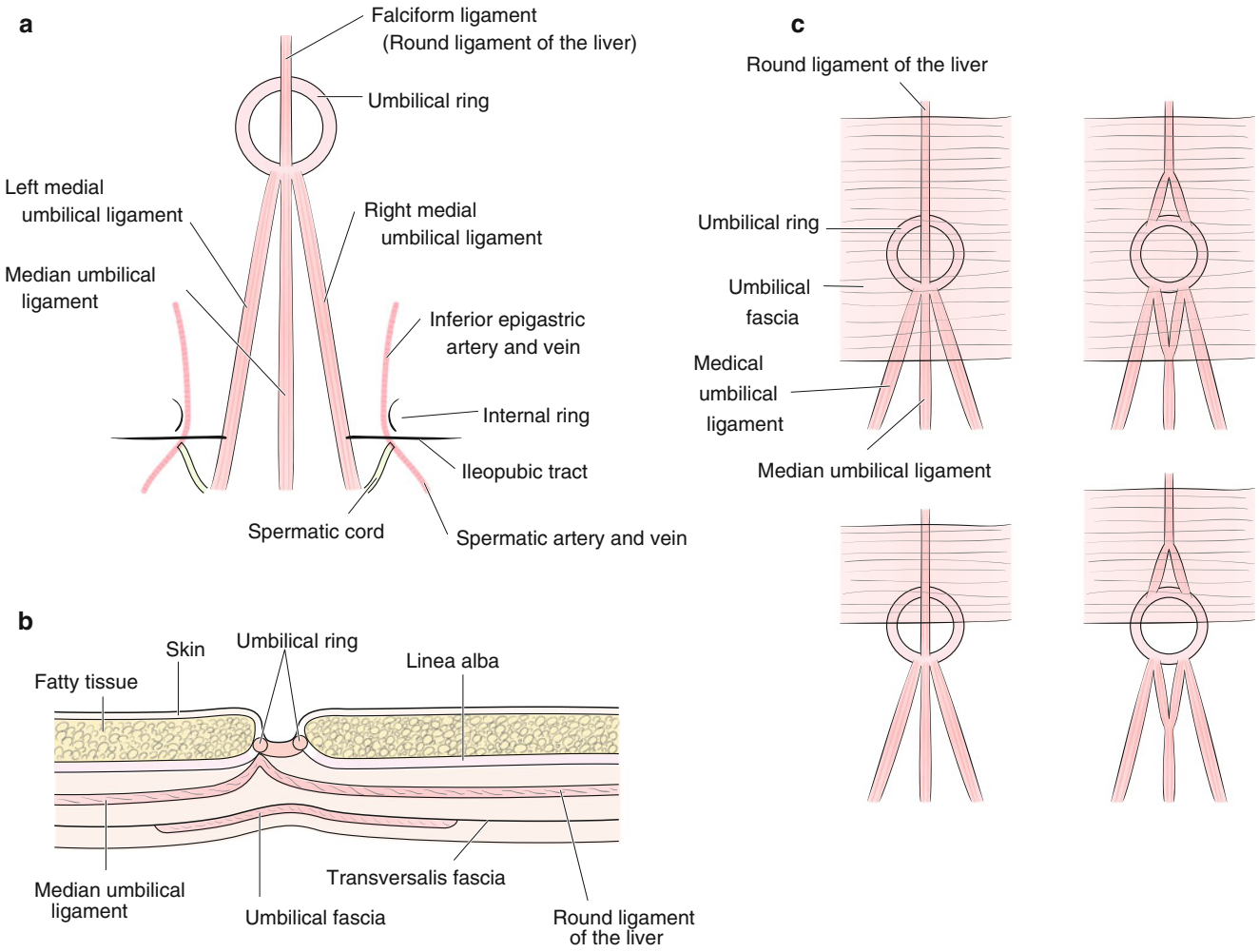

Fig. 1.14 Fascial anatomy of the umbilicus and the lower abdominal wall. There is a median umbilical ligament and lateral umbilical ligament in the caudal side of the umbilicus. An inguinal or femoral hernia can develop on both sides of the ligament (**a**). It is also important to better understand the fascial anatomy of the umbilicus (**b**, **c**)

provide further details on the source, it must be a concept that can withstand visibility in the clinical setting.

In the clinical anatomy of the stomach and transverse colon, by a correct understanding of the clinical anatomy that has been mistaken in the past, it is thought that this will lead to an overall improvement in the corrective clinical anatomy of the abdomen.

In the colon, the definition of the vascular anatomy has not been attempted until now. While it is discussed according to the more common appearance of the vasculature, only the lymph node dissection along the vessel has been emphasized. The JCCRC [18] is among the discussion groups distancing itself from these realities, which may appear unfair. It is assumed that a tailored vascular anatomy is realistically performed to better define the vessels, which is then followed by due emphasis on lymph flow. Thus, it is considered necessary to review the definitions of lymph node dissection.

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Basic Approach

2

2.1 Basic Approach for Colorectal Cancer

2.1.1 Indication

2.1.1.1 Colon Cancer

Factors considered contraindications in cases of laparoscopic resection for colon cancer surgery include advanced invasion to the other organs, bowel obstruction that cannot be decompressed, and larger-sized tumour; however, it is difficult to determine the contraindications for laparoscopic surgery noninvasively. An eventual adaptation of laparoscopic surgery should be determined based on intraoperative laparoscopic findings.

2.1.1.2 Rectal Cancer

Contraindications in cases of laparoscopic resection of the rectum (Laparoscopic low anterior resection [LapLAR] and laparoscopic abdominoperineal resection [LapAPR]) are advanced invasion to other organs with an insufficient circumferential resection margin (CMR), bowel obstruction that cannot be decompressed, and a larger-sized tumour in the pelvic space. Judgment relative to operative indications for laparoscopic resection of the rectum is determined based on many preoperative modalities including computed tomography (CT), magnetic resonance imaging (MRI), and rectal endoscopic ultrasonography (EUS). If the lower rectal cancer is in the advanced stage, preoperative chemoradiotherapy should be selected. Cases that are considered lateral lymph node-positive or having advanced lymph node metastasis are not indicated for immediate laparoscopic resection of the rectum but for chemotherapy and/or chemoradiotherapy.

2.1.2 Marking of the Lesion and Preoperative Treatment

If the lesion is difficult to identify during surgery, preoperative marking is essential. A clip method is carried out a few days before the surgery. It is important for the clip to hit the anal side of the lesion.

The dilatation of the small intestine and the colon significantly compromises the field of view of the laparoscopy, so it is important to perform adequate decompression of the intestinal tract. Although magnesium citrate formulations are prescribed the day before surgery, depending on the case and especially for obstructive type of cancer, fasting, nutrition management, and placement of a long intestinal tube from the anus may also be performed.

2.2 Basic Approach for the Operation

2.2.1 Patient Positioning

For the expansion of the intraoperative view in laparoscopic colorectal resection, the position of the trunk is important for removing the small intestine.

In the left side operation, the patient is placed in the head-down position on the operating table. Sometimes the table is tilted to the right in the left-side operation. The left hand of the patient is spread out and the right hand is attached to the trunk. In the lithotomy position with Levitator™ stirrups the thighs are kept parallel to the trunk as much as possible to avoid interruption of the forceps and thigh. Also, plates are placed to protect the right side of the trunk, and shoulder protectors are attached on both shoulders to prevent the body from sliding head-down. In the left-side operation the operator and scopist are on the right side and the assistant is on the left side.

In the right-side operation, the position of the patient and the operator position are symmetrical to the left-side operation. Opening the lower limbs occurs without the use of Levitator™ stirrups.

2.2.2 Cannula Positioning

The Hasson's cannula (12-mm) is inserted using the open method at the caudal portion of the umbilicus in the supine

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position. In fact, making a vertical incision along the lower edge of the umbilicus, blunt dissection extends to the anterior sheath of the rectus muscle. The sheath is held by Kocher's forceps and is cut vertically. The peritoneum is held and cut vertically in order to enter the abdominal cavity. In obese patients, it is sometimes difficult to insert Hasson's cannula. In these cases, it is easier to dissect near the umbilical ring because this is thinnest section of the abdominal wall.

Using a W suture for both side edges of the fasciae and peritoneum with the curved 3-0 Vicryl™ suture, the wound is lifted. The Hasson's cannula is inserted and fixed with the Vicryl™ sutures to avoid gas leakage (Fig. 2.1). After confirmation that the cannula has been placed in the abdominal cavity, the pneumoperitoneum is created using 10 mmHg. Following the insertion of the laparoscope into the intraperitoneal space, confirm that there are no adhesions around the site where the trocars are planned to puncture. If such adhesions around the trocar site due to a previous surgery are present, the adhesions are dissected from the contralateral side with three ports. If there is a midline incision near the umbilicus, introduce the Hasson's cannula into the abdominal cavity using the open method from one third of the lateral side of the Monro-Richter line.

A minimum number of transverse incisions with a scalpel are incised on the dermis and the subcutaneous tissue is cut with an electrosurgical knife. After dissection of the skin with Pean's forceps, the VersaStep™ (Medtronic, Minneapolis, MN, USA) port system is introduced to bring the ports under laparoscopic view.

The trocars are inserted into the right lateral abdomen (the height of the umbilicus) (10 mm), right lower abdomen (the medical side of right anterior superior iliac spine) (10 mm), left lateral abdomen (the height of the umbilicus) (10 mm), and at the left lower abdomen (medial side of left anterior superior iliac spine) (10 mm). The trocar has a diameter of 10 mm (Fig. 2.2).

For the right-side operation, an auxiliary incision at the upper midline is made. For the left-side operation, the left lower wound is extended for auxiliary incisions because my speculation is there is a reduced possibility of small bowel obstruction after surgery compared with the incision around the navel.

2.2.3 Exposure of the Operative Field

The patient is positioned on the operating table in the head-down position. After moving the transverse colon and omentum to the cranial side, the small intestine that has fallen into the pelvic space is drawn to the cranial side. Next, the small intestine is turned over from the caudal to cranial position, so the posterior leaf is visible (Fig. 2.3). It is sufficient to extend the posterior leaf of the small intestine to the upper abdomen. In patients with central obesity, traction of the small intestine is inadequate because of the weight and thickness of the mesentery, and it is necessary to maintain the head-down position. In addition, gauze for laparotomy can be inserted into the abdominal cavity to fix the root of the small intestine.

2.2.4 Anatomical Landmarks and Searching in the Abdominal Cavity

Since the junior resident is most likely to be the scopist in many situations, it is important that the operator and assistants share all the anatomical landmarks in view. It is not recommended to continue the procedure in the tilted field of view. Recognisable structures in the abdominal wall are the median umbilical ligament, both medial umbilical ligaments, both inguinal regions where the inferior epigastric vessels, spermatic vessels, and spermatic duct will be visible in men (Fig. 2.4).

We must observe the liver surface and the rectovesical pouch. If there is ascitic fluid, it is removed by suction using the Sumius™ tube (Sumitomo Bakeline Co.). If the location of the tumour is obvious, it will be examined for the extent of serosal invasion.

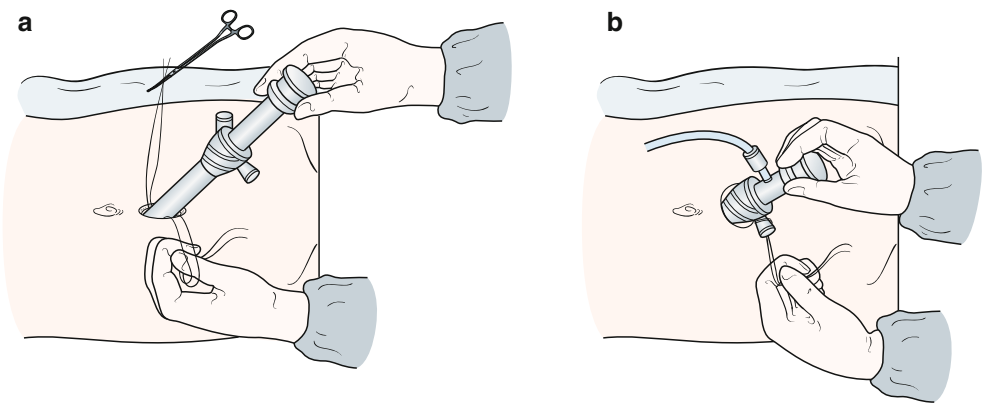

Fig. 2.1 (**a**, **b**) Fixation of Hasson's cannula. Using a W suture of the fascia and peritoneum of both side edges along with the curved 3-0 Vicryl® suture, the wound is lifted. The Hasson's cannula is inserted and fixed with the Vicryl® sutures to avoid gas leakage

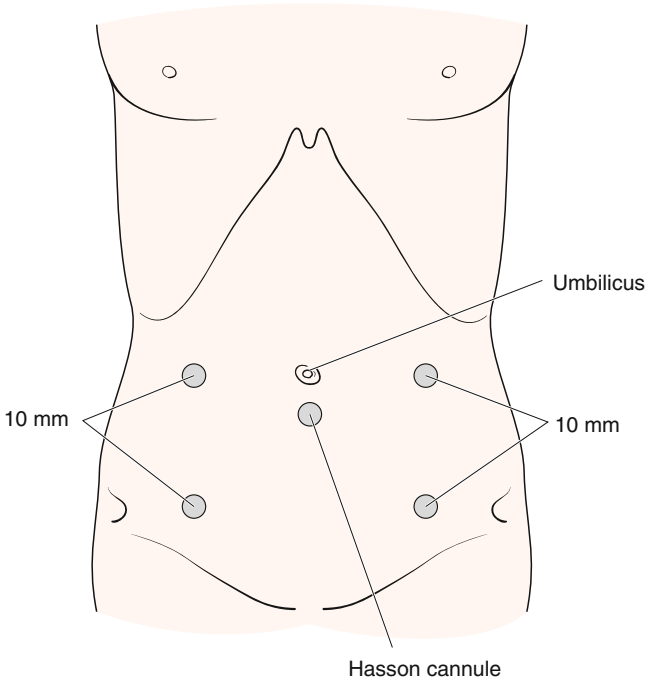

Fig. 2.2 Trocar positions. Trocars are inserted to right lateral abdomen (at the height of the umbilicus), right lower abdomen (medial side of right anterior superior iliac spine), left lateral abdomen (the height of the umbilicus), and left lower abdomen (medial side of left anterior superior iliac spine). The lateral trocars are placed about 10 cm apart, respectively

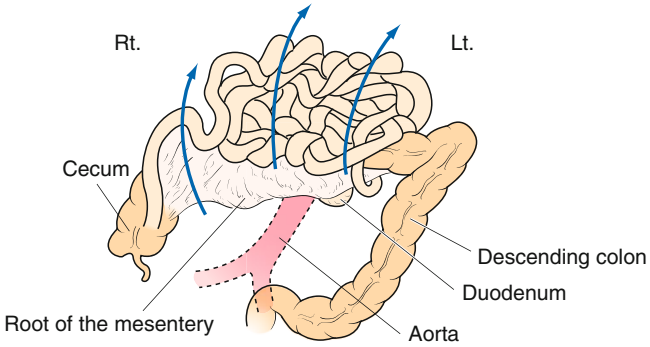

Fig. 2.3 Removal of the small intestine. The patient is placed on the operating table in the head-down position. The small intestine that falls into the pelvic space is drawn to the cranial side. Thereby the small intestine is turned over from the caudal to cranial side, so the posterior leaf widely visible

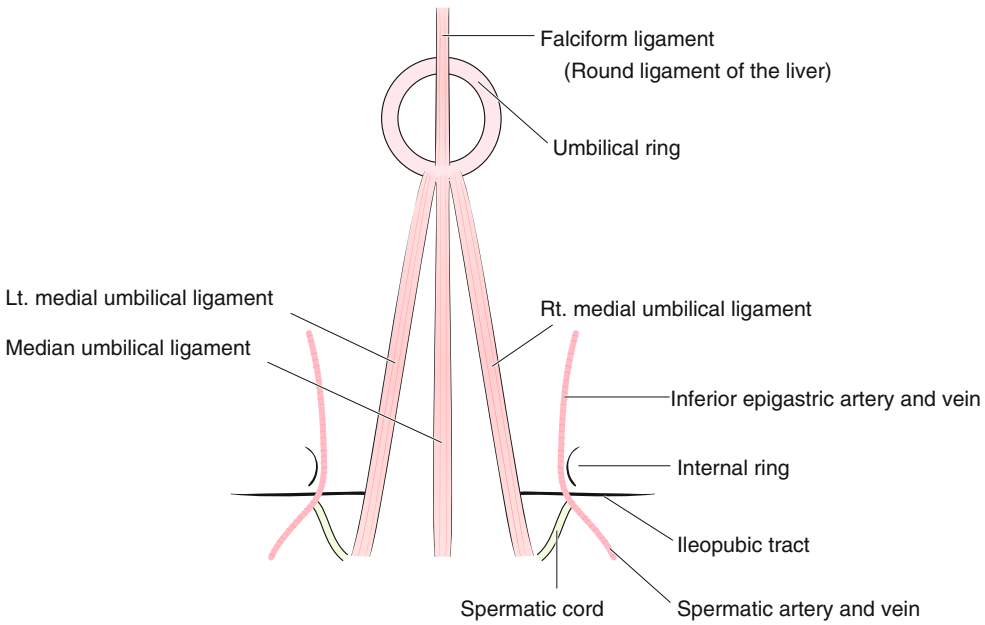

Fig. 2.4 Anatomy of the lower abdominal wall. Recognizable structures in the abdominal wall include the median umbilical ligament, both lateral umbilical ligaments, and both inguinal regions with inferior epigastric vessels, spermatic vessels, and vas deferens visible in men

Laparoscopic Sigmoidectomy

3

3.1 Introduction

Laparoscopic sigmoidectomy (LapS) involves the basic procedures of the laparoscopic surgery. However, many errors occur in the recognition of the correct fascial anatomy and understanding of the surgical technique. Procedures based on clinical anatomy should be performed.

In this procedure, we assume the reader is a beginner in a non-established facility rather than a skilful surgeon in an established facility. Many facilities that currently perform surgery based on inaccurate clinical anatomy are likely already in a condition that cannot be easily rectified. This is also evident from the fact that the basics of the fascia anatomy have not been revised in these facilities.

3.2 Fundamentals Related to the Sigmoid Colon

Basics of the sigmoid colon of each patient must be understood preoperatively. The border of the sigmoid colon and descending colon is defined as the iliac crest (according to the Japanese Classification of Colorectal Carcinoma; JCCC [1]), which is located near the height of the navel. From the supine abdominal X-P and enema examination or computed tomography (CT)-colonography (CTC) it is possible to understand the running of the sigmoid colon. It is desirable that results from both the CT-angiography in addition to the CTC are available. The umbilicus substantially coincides with the aortic bifurcation [2, 3]. In addition, the root of the inferior mesenteric artery (IMA) is an indicator of the lymph node dissection and is often located about 3–5 cm distal from the umbilicus. However, since it is often shifted caudally with age [4], it is necessary to verify this with the CT examination. Performing the operation having this information, you will see the procedure site within the vascular system with the left forceps inserted at the height of the umbilicus.

3.3 Resection Range and Degree of the Lymph Node Dissection

LapS is very similar to open sigmoidectomy, in terms of the resection range and the degree of lymph node dissection, except the approaches into the abdominal cavity. The length and extent of the resection based on the positional relationship of the sigmoid colon differ, also anastomosis are diverse from the oral side to the anal side, thus it is necessary to periodically take into account the methods of anastomosis. Lymph node dissection in sigmoid colon cancer is performed according to the lymph node mapping obtained from the CT examination, which is an improved high quality approach for the detection of lymph nodes. Very few patients are indicated for a high tie operation performed by dividing the root of the IMA for lymph node dissection at the origin of the IMA. A low tie operation reserved for the inferior mesenteric root nodes and the left colic artery (LCA) is sufficient dissection for most cases with sigmoid colon cancer [5]. In addition, we often perform the low tie operation with lymph node dissection at the origin of the IMA.

3.4 Fascial Composition and Fusion Fascia of the Descending Colon and Sigmoid Colon

The descending colon and sigmoid colon are embryologically connected by an abdominal wall through the dorsal mesentery where the vessels and nerves run and control mobility. The mobility of the descending colon disappears after the formation of the left fusion fascia of Toldt that forms between the left (dorsal) leaf of the descending mesocolon and the parietal retroperitoneum at the end of the intestinal rotation. In contrast, the adjacent relationship to the sigmoid colon differs depending on the length and the flexion of the sigmoid colon. Due to incomplete fusion of the dorsal mesentery and retroperitoneum, the fan-shaped sigmoid fossa is typically formed behind the sigmoid mesoco-

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lon in this process (Fig. 3.1). This vertical root and oblique root act as a border between the left (dorsal) leaf of the sigmoid mesocolon and the retroperitoneum. Figure 3.1 (arrows) shows the left fusion fascia of Toldt; dissection along these arrows is impossible because the two fasciae are already fused.

Dissection and mobilisation of the sigmoid mesocolon involves dissecting between the left fusion fascia of Toldt and the deep subperitoneal fascia (Fig. 3.2). The phrase dissection inside the fusion fascia is a fundamental error in consideration of the definition of the word (Fig. 3.3).

In addition, at the cranial-most side of the sigmoid fossa, there is often a small peritoneal recess, which is believed to be formed by a fusion deficit between the descending mesocolon and the parietal peritoneum at the innermost part of the descending colon. This area is known as the intersigmoid fossa, also known as a cause of internal hernia (intersigmoid hernia) (Fig. 3.1). On the other hand, this area is also an anatomical landmark used to identify the ureter; the urinary tract is located on the surface of the iliopsoas, and has been considered generally found parallel to the spermatic vessels. Note that this intersigmoid fossa should not be confused with the sigmoid fossa.

In a cross-sectional view of the caudal part of the sigmoid colon (Fig. 3.4), the sigmoid fossa is added and then the new fascia is added on the ventral (deeper) side of the deep subperitoneal fascia. In Fig. 3.1 considering the sigmoid colon, the left fusion fascia of Toldt and the sigmoid fossa are shown. Arrow I indicates the formation of the fusion fascia between the left (posterior) leaf of the sigmoid mesocolon and the parietal pleura. In addition, arrow II shows that the left fusion fascia of Toldt continues to the cranial side. In Fig. 3.4 a new fascia is added to the ventral side of the deep subperitoneal fascia. This new fascia seems to fuse with the deep subperitoneal fascia at its most cranial part. In the rectum, this fascia is called the fascia propria of the rectum; it is a concept derived from the embryological interpretation of organ dominance of the autonomic nerve fibres by Dr. Takahashi [6–10]. At the most caudal side the sigmoid fossa becomes wider and there may be cases where the fusion fascia is formed on both sides (Fig. 3.5). In this textbook, the fascia covering the mesorectum will be called the fascia propria of the rectum and the continuing fascia from the fascia propria of the rectum laterally will be called the neuro-vascular corridor (For more information, see the Chap. 4).

3.5 Operative Procedures (in Men)

3.5.1 Intraoperative Positions, the Trocar Site and Elimination of the Small Intestine

(See the Chap. 2).

3.5.2 Operative Procedures

Sigmoidectomy is performed using either a lateral or a medial approach. In recent years, the medial approach is performed in most facilities. We believe that the idea of anatomical recognition by the lateral approach is indispensable, so both approaches are destined to become more accepted. The lateral approach is necessary for left colectomy and

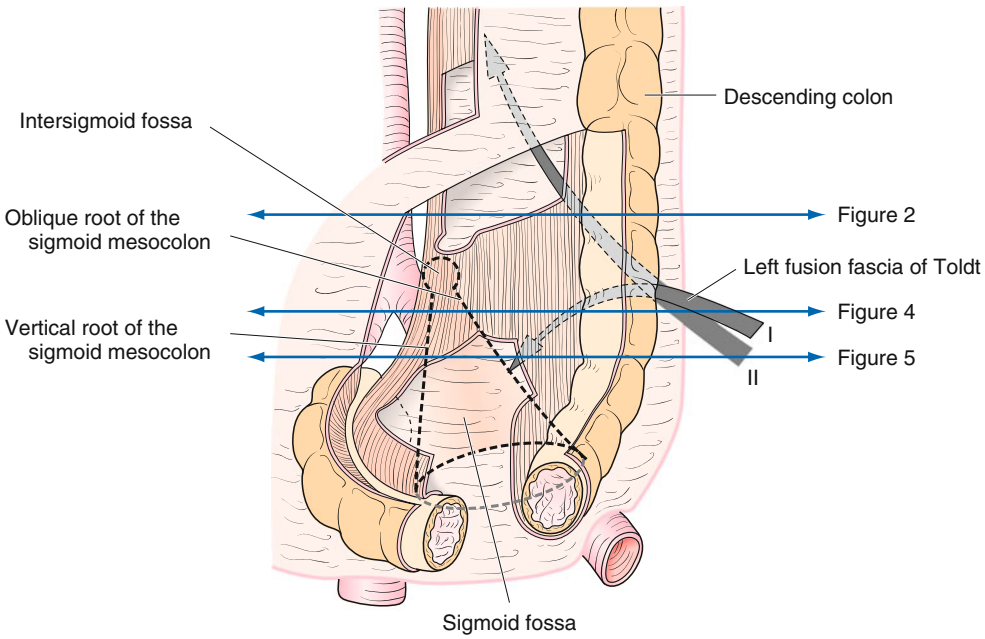

Fig. 3.1 Fascial composition and fusion fascia of the sigmoid colon. Mobility of the descending colon disappears after formation of the left fusion fascia of Toldt with the left leaf of the descending mesocolon fusing to the parietal retroperitoneum at the end of intestinal rotation. The sigmoid colon shows many variations depending on its length and flexion. An incomplete fusion of the dorsal mesentery and retroperitoneum typically results in the formation of the fan-shaped sigmoid fossa behind the sigmoid mesocolon [6, with permission]

resection of the splenic flexure of the colon. In this textbook after the description of the medial approach, the lateral approach is added as supplementary information.

3.5.2.1 Dissection and Mobilisation of the Sigmoid Colon with the Medial Approach

Dissection and Mobilisation of the Sigmoid Colon from the Medial Side

Scope: at the beginning umbilical port, and the right cranial port.

The operator's right hand: a electrosurgical knife with spatula-type blade.

The operator's left hand: holds the bowel forceps from the umbilical port.

Tension is required to aid the procedures using the electrosurgical knife in the medial approach.

It is a mirror image for the assistant.

The assistant's right hand: almost free (or is used for lifting the right caudal rectum to the ventral side with bowel forceps).

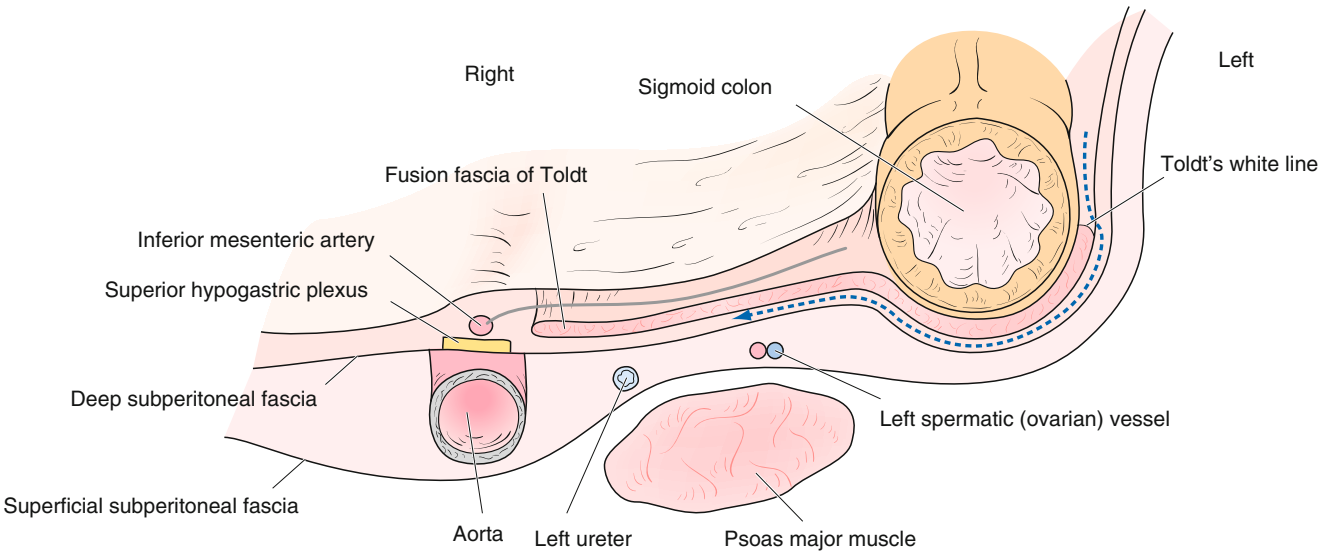

Fig. 3.2 Fusion of the sigmoid mesocolon and its cross-sectional view. The *arrows* indicate the dissecting layer between the fusion fascia of Toldt and the deep subperitoneal fascia by the lateral approach [6, with permission]

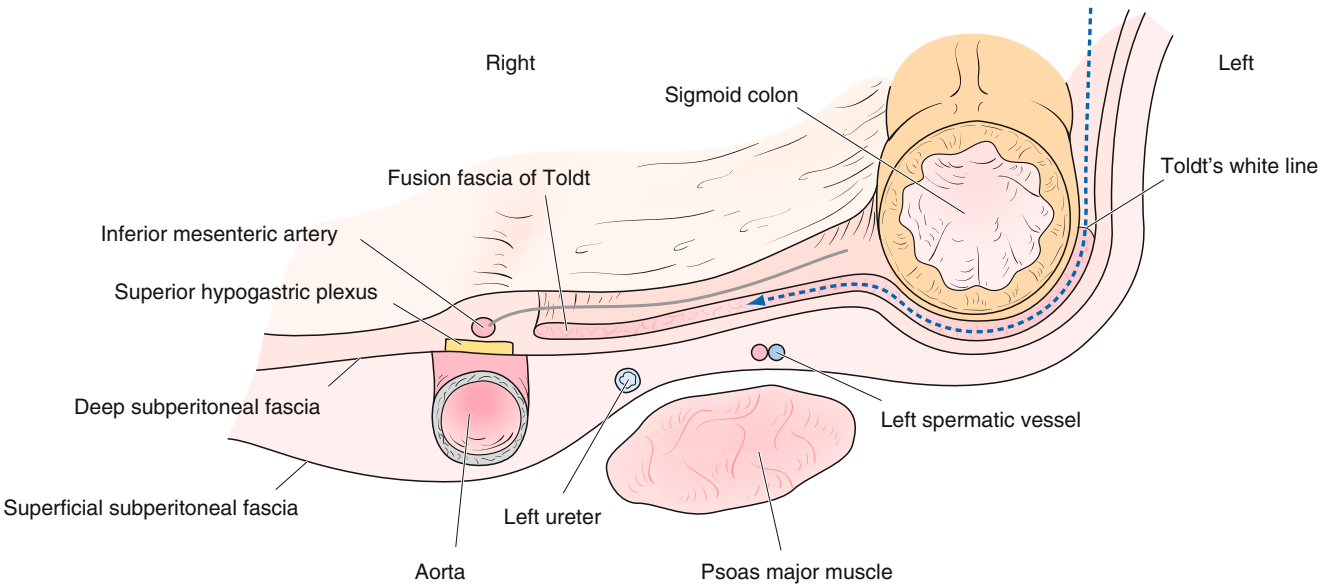

Fig. 3.3 Dissecting layer of the sigmoid colon (Incorrect rationale). The consideration for dissection inside the fusion fascia is a fundamental error derived from the misunderstanding of the definition of the word

The assistant's left hand: lifts the vascular pedicle of the IMA to the ventral-caudal side to form a 30° angle with the aorta.

The medial approach of the sigmoid colon is ultimately the dissection between the fusion fascia of Toldt and the deep subperitoneal fascia. Factors that modify this procedure include the neuro-vascular corridor and the nerves from the inferior mesenteric plexus. The fascia composition in the field of view in which the IMA has been lifted ventrally is clearly different comparing the cranial and the caudal sides

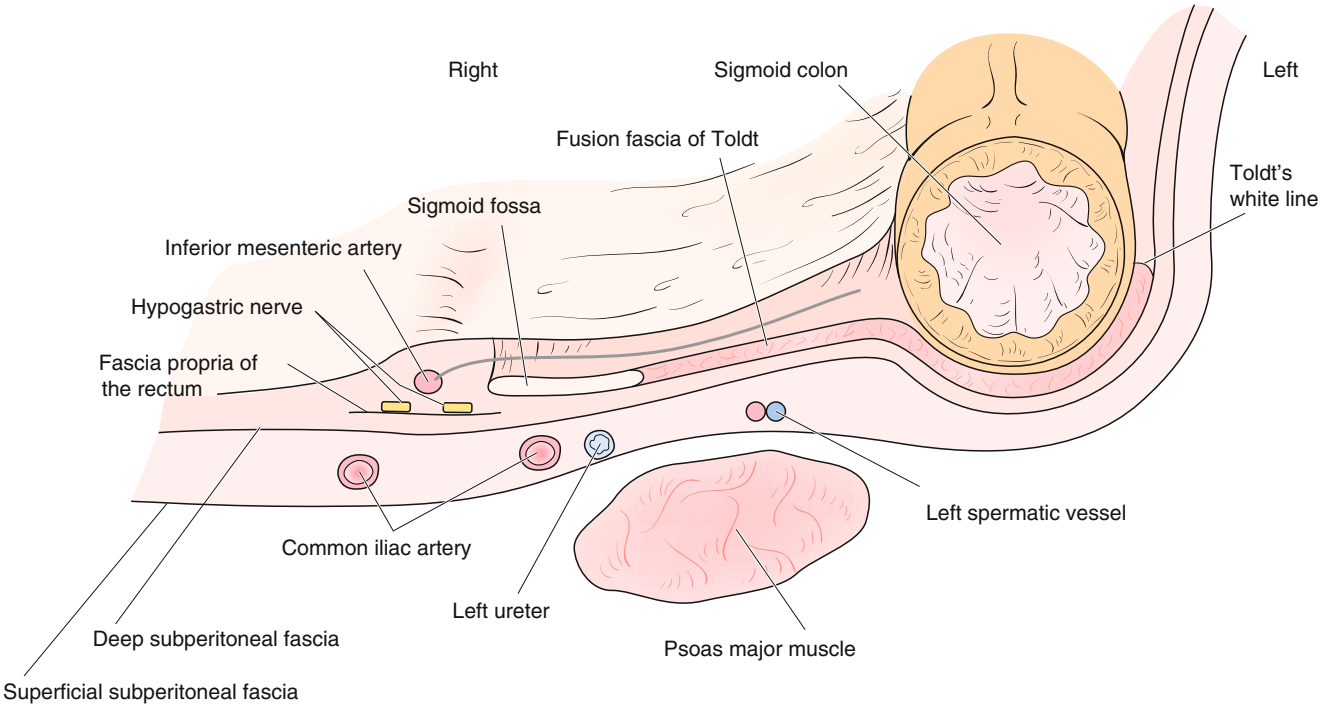

Fig. 3.4 Cross-sectional view of the caudal side of the sigmoid fossa. The sigmoid fossa is added and the new fascia is added onto the ventral (deeper) side of the deep subperitoneal fascia. It is the fascia propria of the rectum [6, with permission]

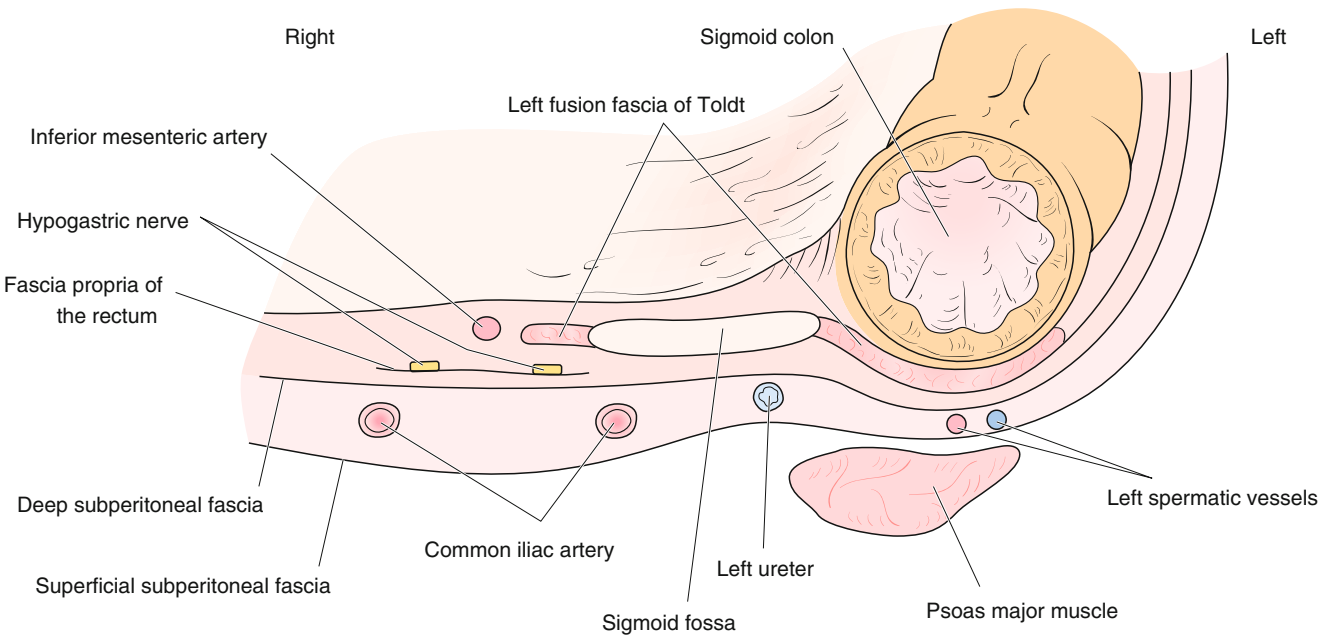

Fig. 3.5 Cross-sectional view of the most caudal side of the sigmoid fossa. At the caudal-most side, the sigmoid fossa becomes wider. There may be cases where the fusion fascia is formed on both sides

of the superior hypogastric plexus. At the cranial side, the ventral side of the superior hypogastric plexus is the dissection plane and the inferior mesenteric plexus should be divided around the IMA (Fig. 3.6a). At the caudal side, the neuro-vascular corridor converges to the superior hypogastric plexus and should be divided at two sites (Fig. 3.6b).

After incision of the peritoneum at the caudal side, the right and left neuro-vascular corridors are divided along the fascia propria of the rectum. Then the deep subperitoneal fascia is lifted ventrally and is dissected dorsally. Continuing the dissection of the deep subperitoneal fascia caudally, the sigmoid fossa comes into view. How to deal with these two fasciae: two routes can be considered (Fig. 3.6b). In the medial approach, the dissection is performed towards the root of the IMA cranially while confirming the left neuro-vascular corridor. In the cranial side of the superior hypogastric plexus, the deep subperitoneal fascia is easily dissected from the left fusion fascia of Toldt (Fig. 3.6a).

The vascular pedicle of the IMA is grasped with the assistant's left forceps and is lifted to the ventral-caudal side to form a 30° angle with the aorta with the laparoscope inserted in the umbilical port (Fig. 3.7). At this time, viewing the right rectal peritoneum can confirm that there is no additional branch of vascular pedicle besides the gripped vasculature.

With the laparoscope inserted in the right cranial port, the surgeon's left hand forceps is inserted in the umbilical port. The surgeon palpates the portion of the promontorium with the forceps to share the recognition of the anatomy with the

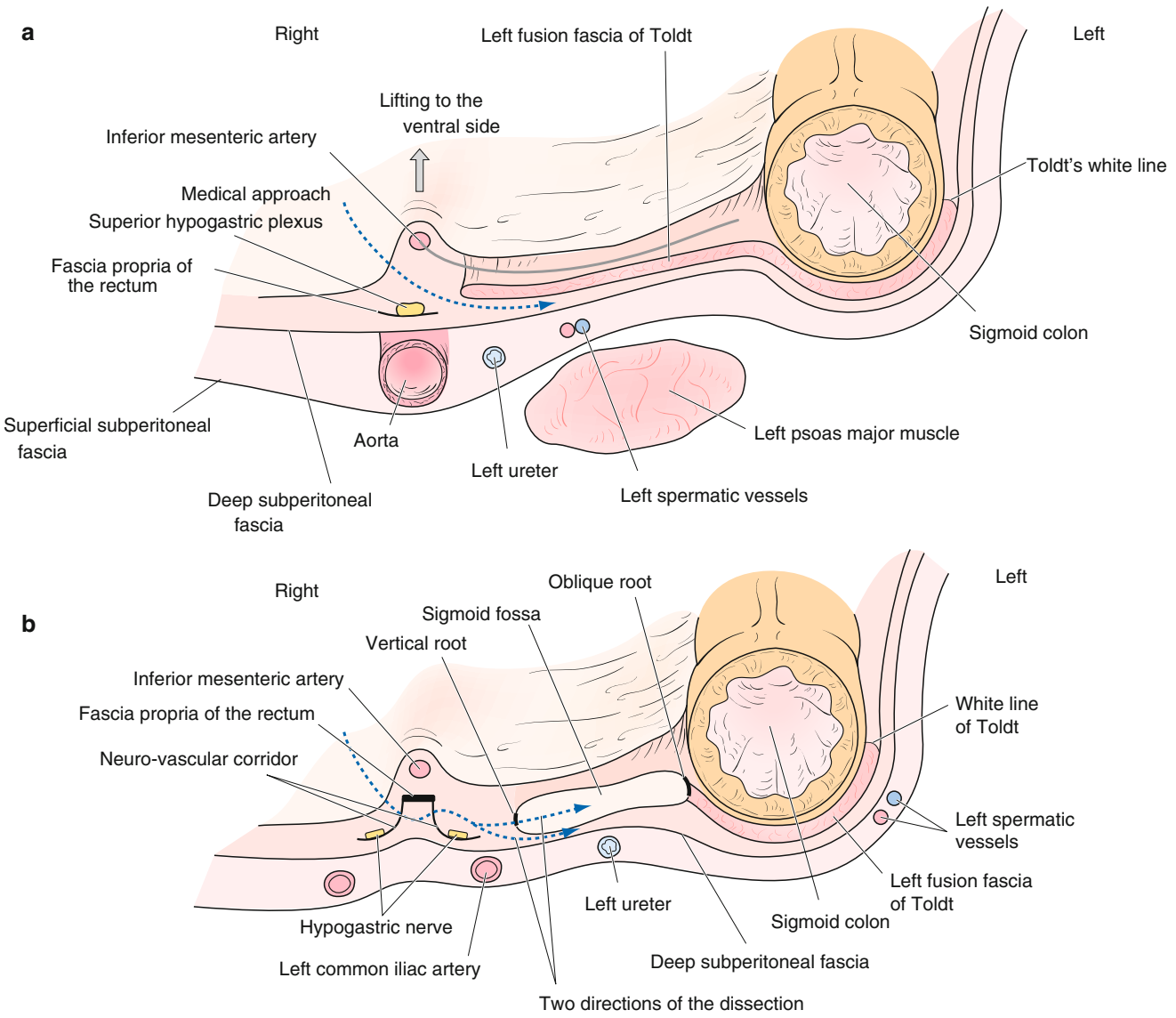

Fig. 3.6 Cross-sectional view of the medial approach. The inferior mesenteric artery (IMA) has been lifted on the ventral side. In the superior hypogastric plexus, the dissecting layer is ventral to the plexus (**a**). In the dissecting layer of the caudal side, the neuro-vascular corridors are divided into two locations and the surgeon can thus enter the ventral side of the deep subperitoneal fascia covering the ureter (**b**)

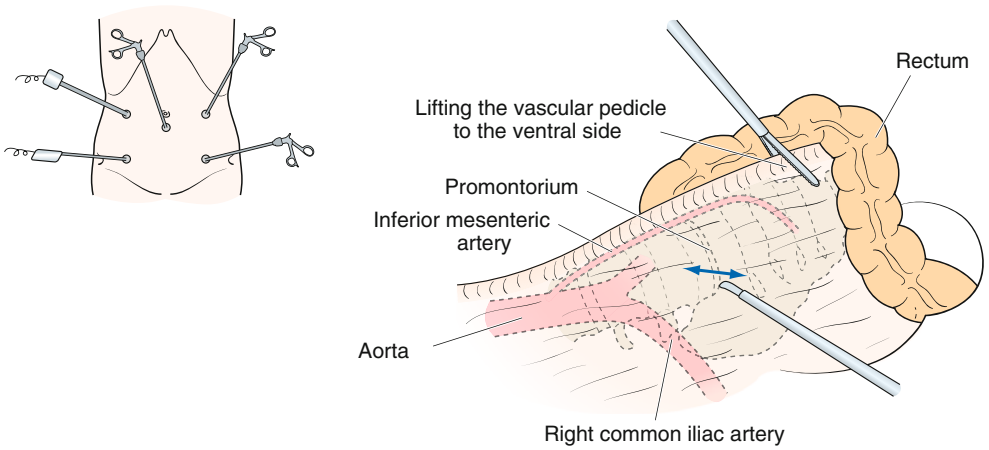

Fig. 3.7 The start of the division and the dissection from the medial side. The surgeon palpates the portion of the promontorium with the forceps. On carefully viewing the sigmoid mesocolon at the ventral side of the promontorium, the boundary between the parietal and visceral pleura is detected by a colour change, and the slightly ventral side of the boundary is incised

staff (Fig. 3.7). On carefully viewing the sigmoid mesocolon at the ventral side of the promontorium, the boundary between the parietal and visceral pleura is detected by a colour change, and the slightly ventral side of the boundary is incised (Fig. 3.7). The incision should be as thin as possible and continue cranially along the IMA. At this point, the neuro-vascular corridor exists as a screen with sufficient width ventro-dorsally.

The surgeon moves to procedures for identifing the fascia propria of the rectum at the promontirium portion. There is no anatomical landmark to aid in this procedure. The procedure alone is essential to dissect the crude tissue with a right angle toward the dorsal side of the rectum that has been lifted ventrally (Fig. 3.8b). After detection of the fascia propria of the rectum, the surface of the fascia propria of the rectum is maintained and the procedure proceeds cranially, dividing the vessels and nerves of the right neuro-vascular corridor along the right side of the fasciae. The left neuro-vascular corridor should not be incised at this time (Fig. 3.9). After dividing the vessels and the nerves of the right neuro-vascular corridor as far as possible to the cranial side, there is a dense tissue around the root of IMA. This is the inferior mesenteric plexus with the lumbar splanchnic nerve and the ascending branches around the IMA (Fig. 3.10). The ascending branches along the IMA should be divided.

After identifying the aortic bifurcation as the anatomical landmark, a triangular fascia from the superior hypogastric plexus to the fascia propria of the rectum can be identified. It is the left neuro-vascular corridor, which contains nerves and small vessels (Fig. 3.10). The vessels and the nerve of left neuro-vascular corridor are divided ventrally from the cranial side (Fig. 3.11). After this corridor is incised, it is possible to identify the deep subperitoneal fascia and the ureter that can then be lifted ventrally to the fusion fascia of Toldt. Continuing the dissection of the deep subperitoneal fascia and the ureter to the dorsal side, typically the sigmoid fossa is revealed. How to handle the fasciae of the sigmoid fossa: two routes can be considered (Fig. 3.6b). Normally it is better to dissect the dorsal side of the sigmoid fossa and dissect the deep subperitoneal fascia as far as possible to the left lateral side. In this way, the spermatic vessels are detected on the major psoas muscle. If the dissection exceeds these vessels, the medial approach is sufficient.

The medial approach is easy to explain using two cross-sections, cranial and caudal. At the cranial side, the deep subperitoneal fascia is dissected from the left fusion fascia of Toldt that is raised like a screen, so it is possible to enter the layer for mobilisation of the sigmoid colon (Figs. 3.10 and 3.12). At the caudal section, if the neuro-vascular corridor is divided, the dissection can be continued towards the dorsal side of the left fusion fascia of Toldt and towards the dorsal side of the sigmoid fossa; the dissection is continued to mobilise the sigmoid colon (Figs. 3.10 and 3.13). As a consequence, the left ureter is confirmed on the dorsal side of the deep subperitoneal fascia. Furthermore, it is easier to dissect and mobilise from the lateral side if the sigmoid mesocolon is sufficiently dissected.

A gauze is inserted so as to align the external position as a guide of the lateral mobilisation.

Dissection and Mobilisation of the Sigmoid Colon from the Lateral Side

Scope: Umbilicus.

The operator's right hand: a electrosurgical knife with spatula-type blade.

The operator's left hand: used to grip the innermost part of the serosa of the sigmoid fossa.

The assistant's right hand: bowel forceps. To act as counter traction to the operator left hand.

The assistant's left hand: free in this procedure.

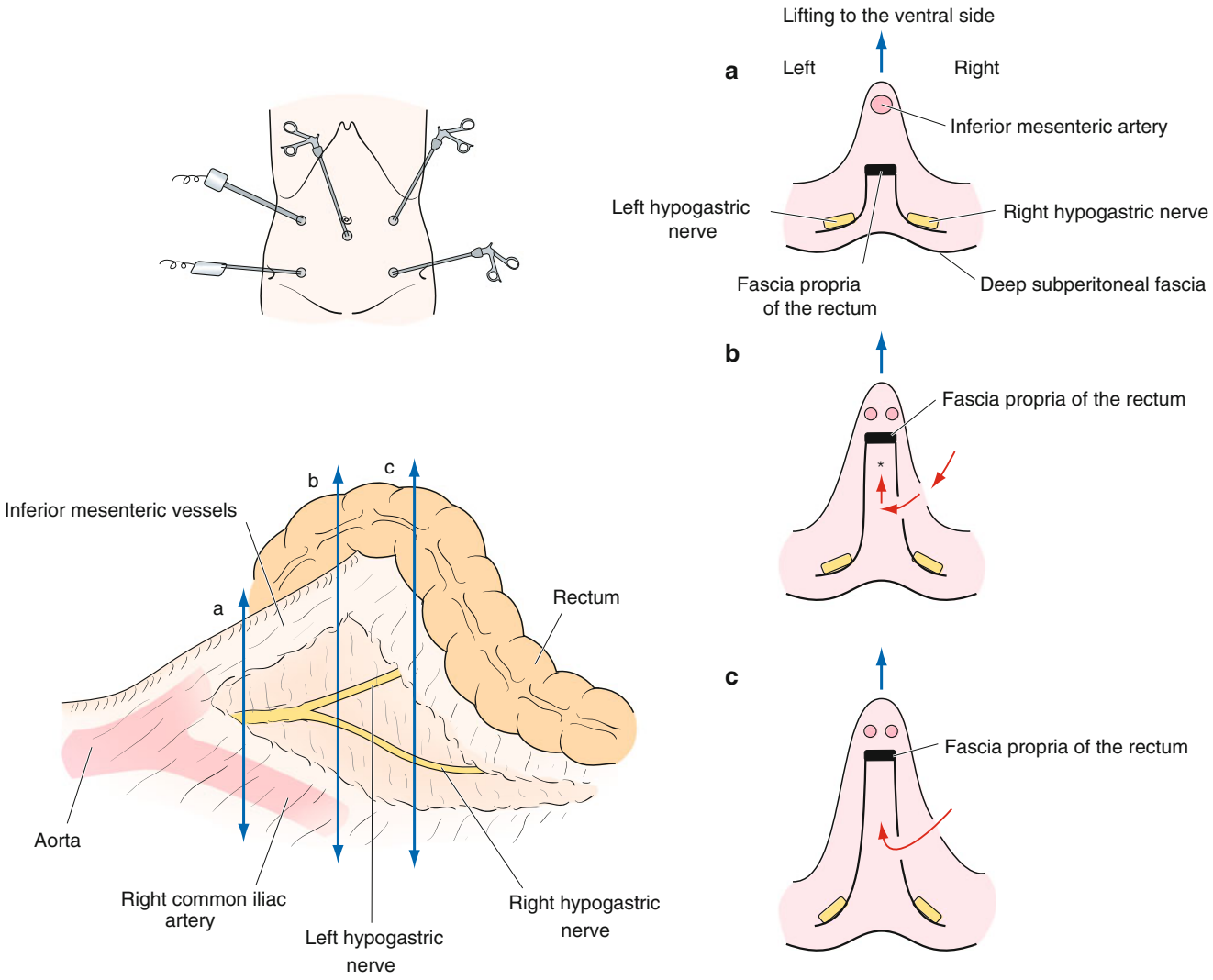

Fig. 3.8 Cross-section view of the division and the dissection from the medial side. The surgeon moves to standard procedures for identifying the fascia propria of the rectum at the promontorium portion (**b**). There is no anatomical landmark to aid in this procedure. Only the procedure is essential to dissect the crude tissue with a right angle toward the dorsal side of the rectum that has been lifted ventrally

The lateral dissection of the sigmoid colon is easy to perform if the medial dissection is performed sufficiently lateral to the left. After dissection of the sigmoid adhesion to the parietal peritoneum, it is possible to find the gauze that has been inserted in the medial approach. As the peritoneum in the ventral side of the gauze is incised along the sigmoid colon, the so-called tunnelling technique can be performed. If the gauze cannot be discovered, Toldt's white line is incised as far as possible to the cranial side and the fusion fascia of Toldt is dissected medially (Fig. 3.14) until the gauze can be discovered inside. If the oblique root of the sigmoid fossa can be divided, the operative field is spread out and it is possible to see the dorsal side of the sigmoid fossa (Fig. 3.15). In this process, the left ureter is confirmed in view and the route to the pelvic space is always in view. Thus, it is possible that the oblique root can be incised in the landmark of the bulge of the fatty tissue of the mesocolon (Fig. 3.16). The mobilisation of the sigmoid colon is completed.

Here, the peritoneal surface on the lateral side of the rectum is in a common field of view with the ureter, and the peritoneum lateral to the rectum is cut viewing the ureter. This peritoneal cutting continues to the rectovesical pouch as far as possible (Fig. 3.17). After the incision in the left peritoneum of the rectum, the dissection continues in the fossa between the ureter and rectum. Consideration of the medial surface is very important, as it is the left neuro-vascular corridor (Fig. 3.18). Originally, the fascia covering the mesorectum was called the fascia propria of the rectum. However, Dr. Takahashi assumed the fascia that is located on the dorsal side of the rectum continues towards the deep subperitoneal fascia caudally, as the rectosacral ligament. The fascia turns

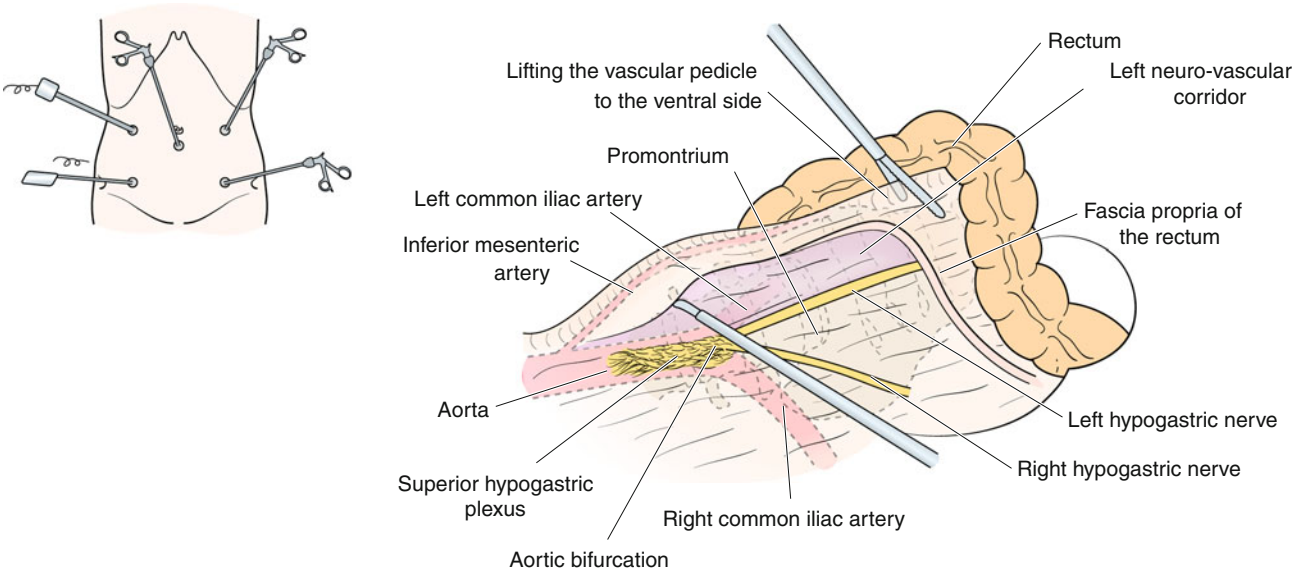

Fig. 3.9 Dissecting of the fascia propria of the rectum leading to the superior hypogastric plexus. After detection of the fascia propria of the rectum, the surface of the fascia propria of the rectum is maintained, and the procedure proceeds cranially, dividing the vessels and nerves of the neuro-vascular corridor along the right side of the fascia. The left neuro-vascular corridor should not be incised

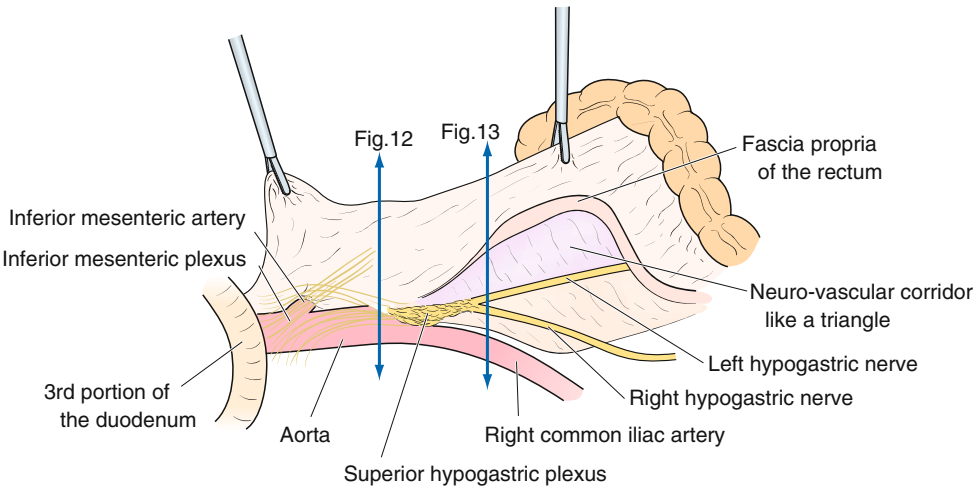

Fig. 3.10 The inferior mesenteric plexus with lumbar splanchnic nerve. After dividing the vessels and the nerves of the neuro-vascular corridor as much as possible, there is a dense tissue around the root of the inferior mesenteric artery (IMA). This is the inferior mesenteric plexus with lumbar splanchnic nerve and the ascending branches around the IMA

up symmetrically from the rectosacral ligament to the superior hypogastric plexus, narrows and fuses to the deep subperitoneal fascia again at the same site. According to Dr. Takahashi, the fascia from the rectosacral ligament to the superior hypogastric plexus is called the fascia propria of the rectum [7–11] (Fig. 3.19). In this textbook, the fascia covering the mesorectum is called the fascia propria of the rectum, and the continued fascia from the fascia propria of the rectum laterally is called "the neuro-vascular corridor".

3.5.2.2 Lymph Node Dissection at the Root of the IMA

Scope: right cranial port.

The operator's right hand: Ultrasonically activated device (USAD).

Incision of the plexus around the IMA.

The operator's left hand: Insertion of the bowel forceps from the umbilical port.

It does a fine operation to help the procedures of the USAD.

It is the mirror image for the assistant.

The assistant's right hand: almost free (or removes the small intestine).

The assistant's right hand: used for lifting the vascular pedicle of the IMA to the ventral-caudal side to form a 30° angle with the aorta using forceps.

According to the lymph node dissection of the cancer, the area of the lymph node dissection is decided beforehand. High tie operation requires the division of the IMA at the root and the dissection of the lymph node at the root of the

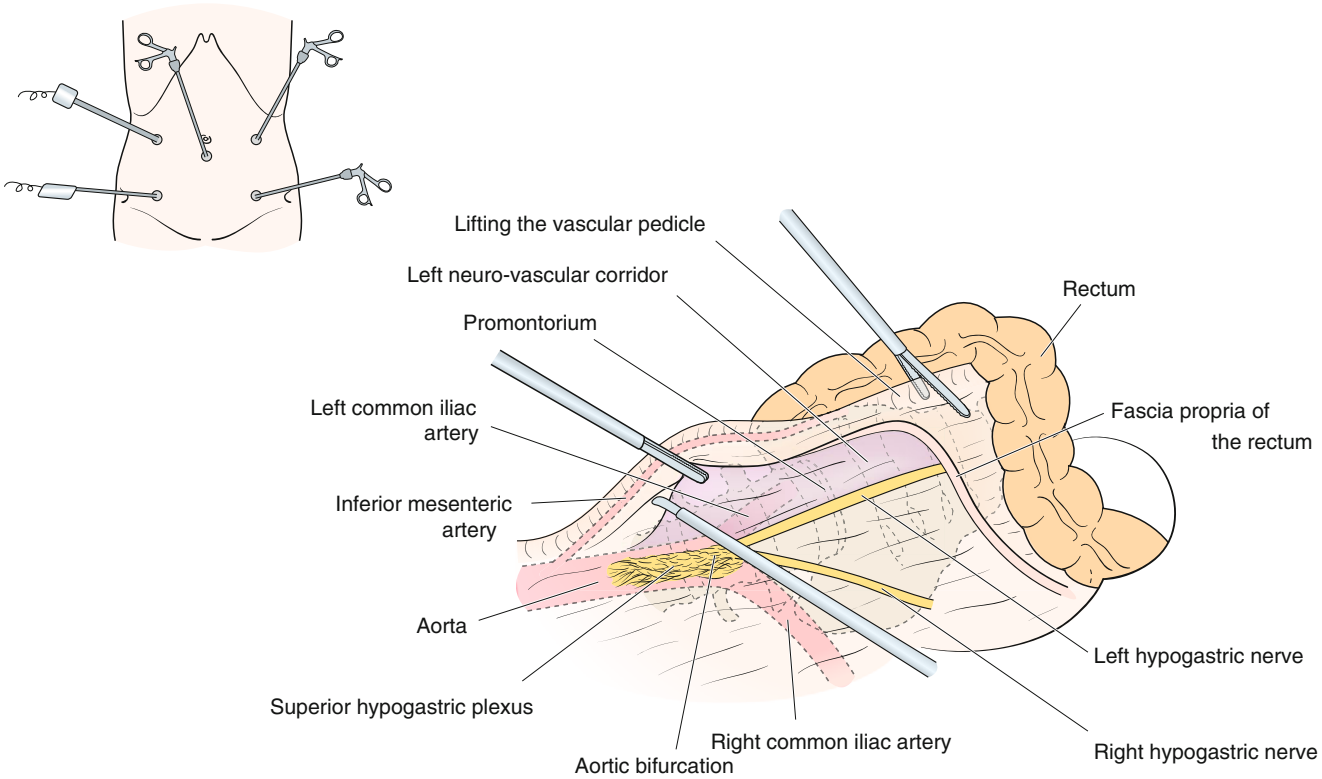

Fig. 3.11 Dissection of the left neuro-vascular corridor. After viewing the aortic bifurcation anatomical landmark, the vessels and the nerve of left neuro-vascular corridor are divided at the ventral side from the cranial side

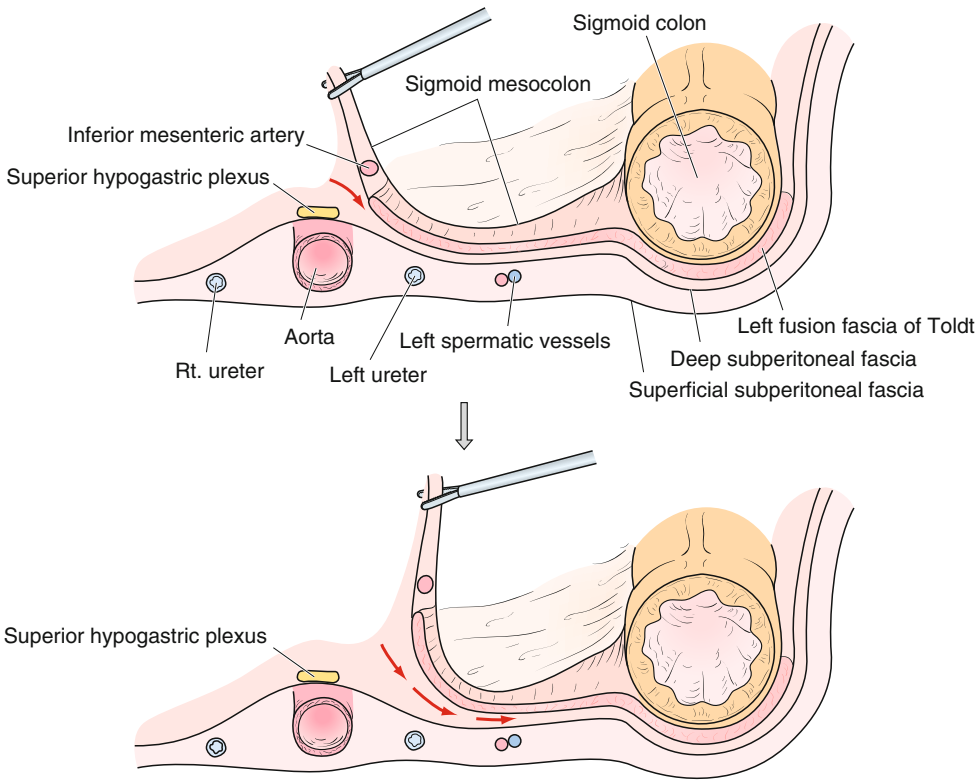

Fig. 3.12 Cross-section of the dissection of the sigmoid mesocolon (cranial side). At the cranial side, the deep subperitoneal fascia is dissected from the left fusion fascia of Toldt that is raised like a screen, so it is possible to enter the mobilisation layer for mobilisation of the sigmoid colon

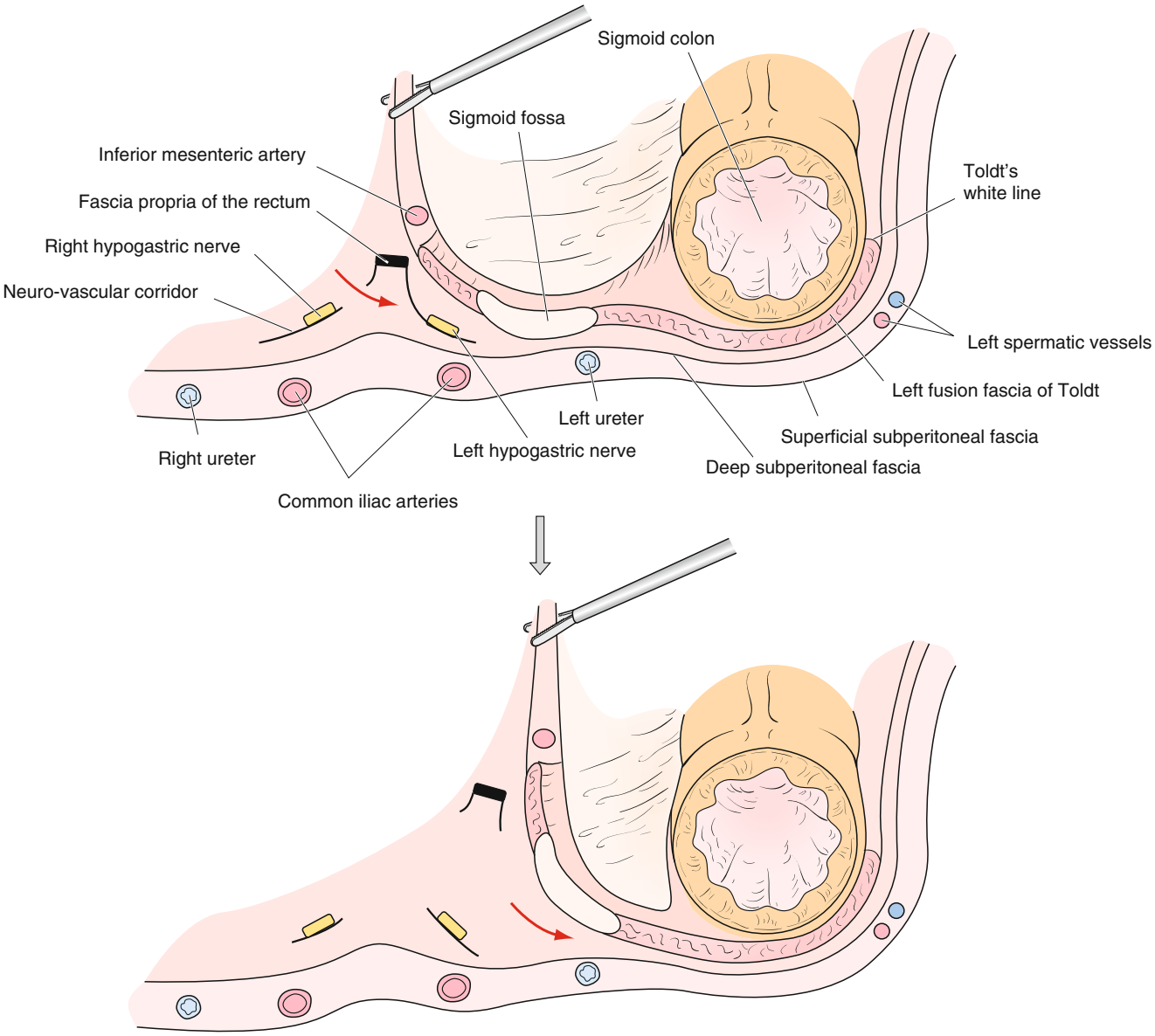

Fig. 3.13 Cross-section of the dissection of the sigmoid mesocolon (caudal side). At the caudal section, if the neuro-vascular corridor is divided, the dissection can be continued towards the dorsal side of the left fusion fascia of Toldt and towards the dorsal side of the sigmoid fossa; the dissection is continued to mobilise the sigmoid colon

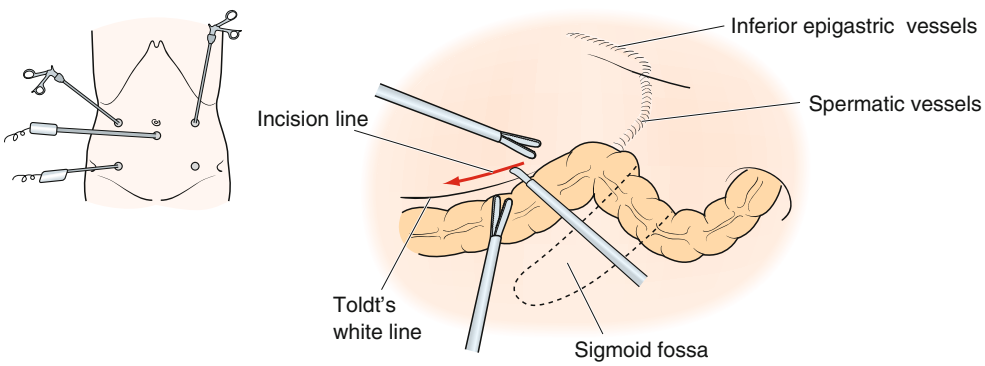

Fig. 3.14 Incising the Toldt's white line in the lateral side of the sigmoid colon. As the peritoneum in the ventral side of the gauze is incised along the sigmoid colon, the so-called tunnelling technique can be performed. If the gauze cannot be discovered, the Toldt's white line is incised as far as possible to the cranial side and the fusion fascia of Toldt is dissected medially

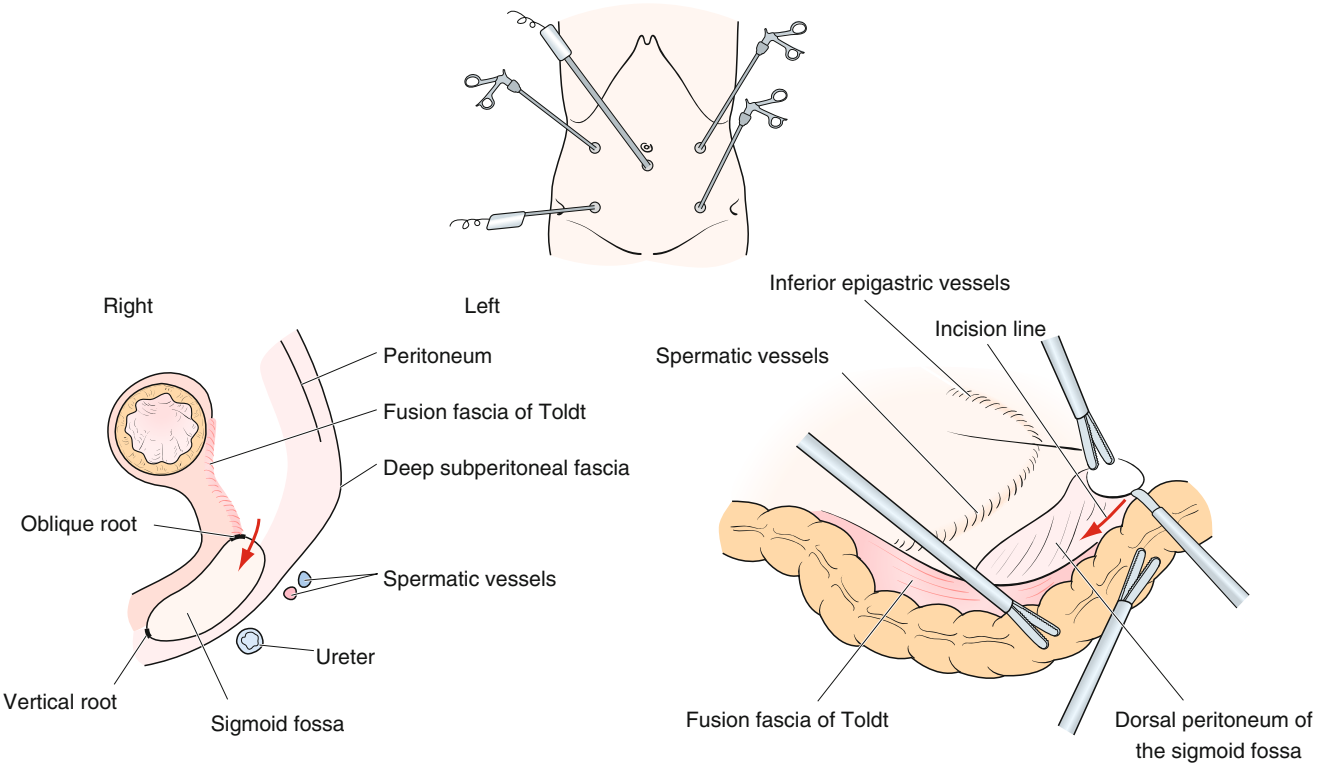

Fig. 3.15 Dissection and incision of the sigmoid fossa. If the oblique root of the sigmoid fossa can be divided, the operative field is spread out and it is possible to see the dorsal side of the sigmoid fossa

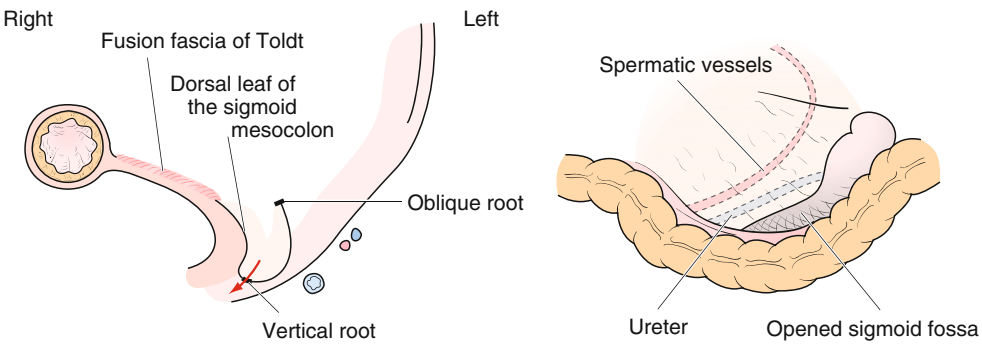

Fig. 3.16 Visual confirmation of the ureter. The left ureter landmark is identified and the route to the pelvic space is always in view. Thus, it is possible that the oblique root can be incised at the landmark of the bulge of the fatty tissue of the mesocolon

IMA. It is a principle to be low tie operation that can preserve the LCA for the blood flow to the colon. Sometimes, sampling of the lymph nodes at the root of the IMA is performed.

In the high tie dissection, this requires extending the severing of the sigmoid mesocolon to the root of the IMA. A nerve bundle from the inferior mesenteric plexus on the right side of the IMA is divided with the USAD; the IMA is exposed except on the left side; the artery is dissected with dissecting forceps, clamped with three Hem-o-lok™ clips (Weck/Teleflex Medical, USA); and the artery is divided (Fig. 3.20).

The assistant's right hand forceps grasps the sigmoid mesocolon to hold the fusion fascia of Toldt like a screen. There is a nerve arcade from the lumbar splanchnic nerve to the superior hypogastric plexus on the left side of the IMA. When the nerve is dissected and dropped from the left fusion fascia of Toldt to be preserved dorsally, the dissecting plane between the fusion fascia of Toldt and the deep subperitoneal fascia continues to be dissected. Along this course the inferior mesenteric vein (IMV) is freed and divided using Hem-o-lok™ clips.

In the low tight dissection, the procedure is identical up to the exposure of the IMA. Next, the scope is inserted from the umbilical port, and the LCA branching from the IMA is detected. The plexus around the LCA is incised along the LCA to expose the LCA. Lymph node dissection around the LCA is performed and the LCA and the branches from the

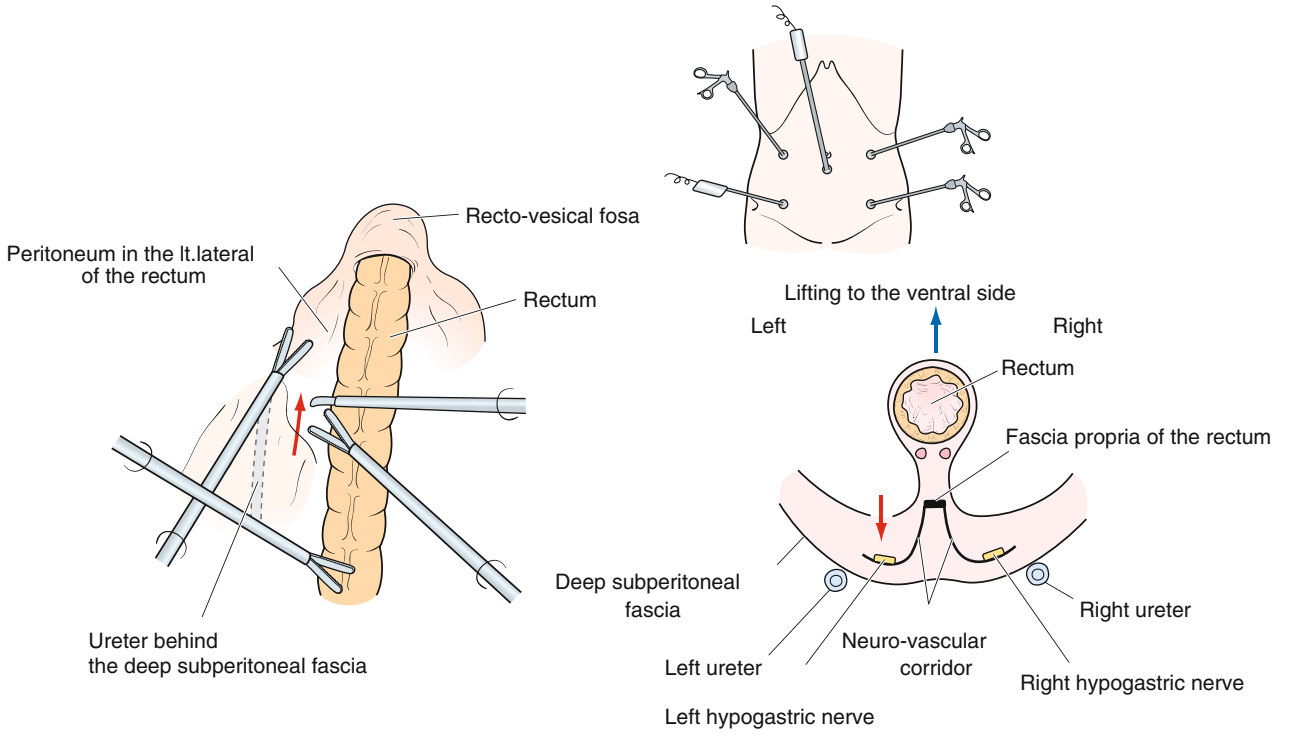

Fig. 3.17 Incision of the peritoneum on the left lateral side of the rectum. The peritoneal surface lateral to the rectum is a common field of view of the ureter, and the peritoneum lateral to the rectum is cut viewing the ureter. This peritoneal cutting continues to the rectovesical pouch as far as possible

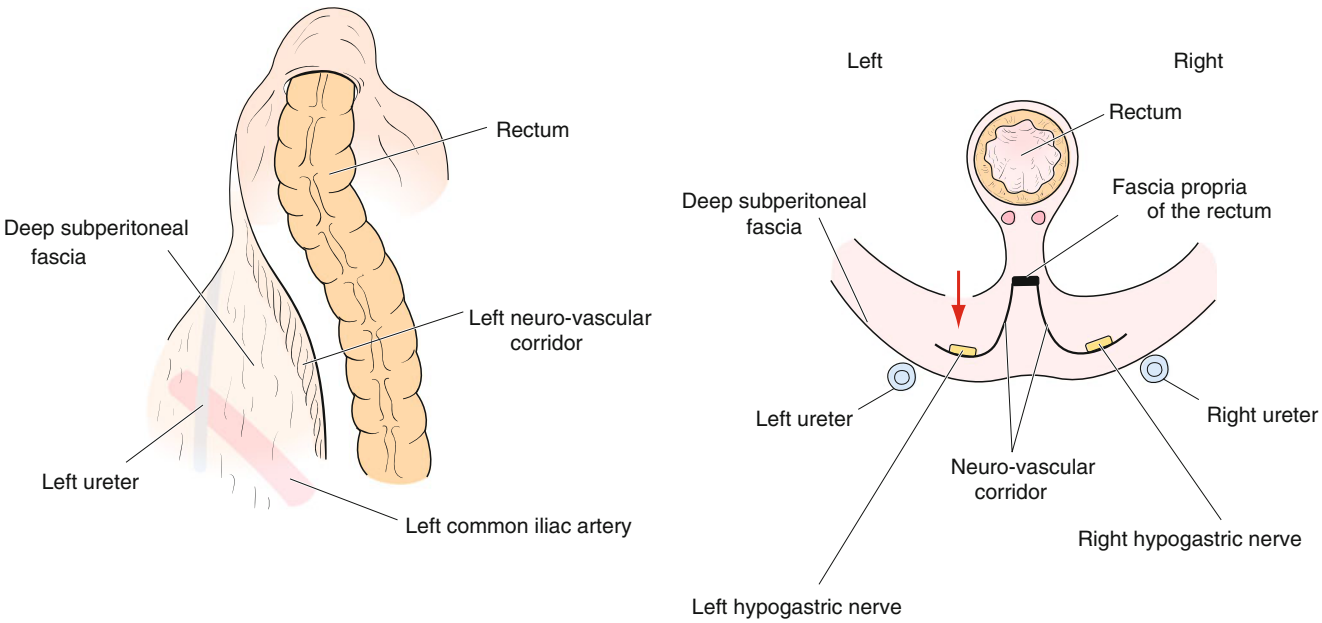

Fig. 3.18 Further dissection of the left lateral side of the rectum. After incision in the left peritoneum of the rectum, the dissection continues in the fossa between the ureter and rectum. Consideration of the medial surface is very important; this is the left neuro-vascular corridor

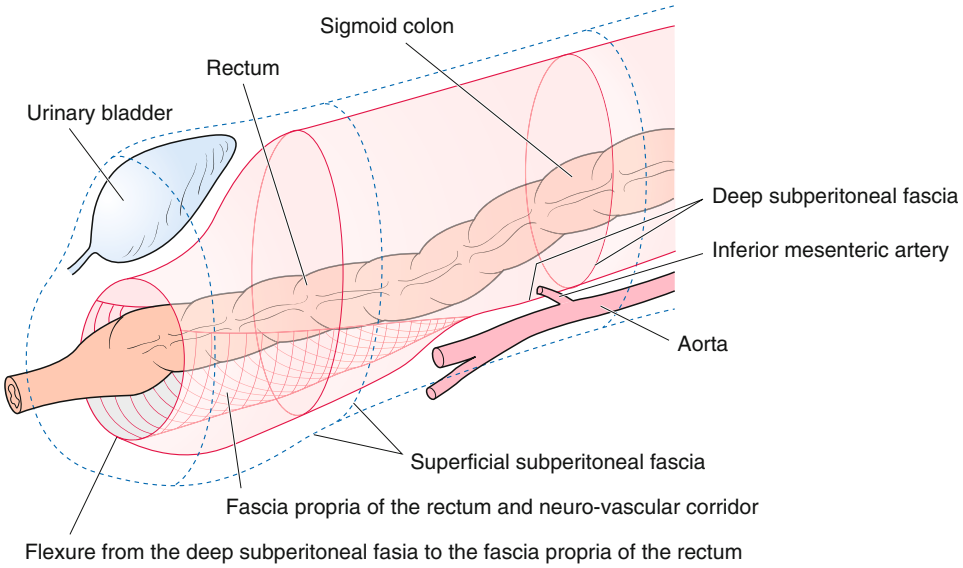

Fig. 3.19 Relationship between the overall picture of the fascia propria of the rectum and the deep subperitoneal fascia. Dr. Takahashi assumed that the fascia that is located on the dorsal side of the rectum continues towards the deep subperitoneal fascia caudally, as the rectosacral ligament. The fascia symmetrically turns up from the rectosacral ligament to the superior hypogastric plexus, narrows and fuses with the deep subperitoneal fascia again at the same site. According to Dr. Takahashi, the fascia from the rectosacral ligament to the superior hypogastric plexus is called the fascia propria of the rectum [6, with permission]

LCA are sufficiently dissected. The IMV is dissected just lateral to the LCA. The IMA just distal from the LCA and the IMV are divided using with Hem-o-lok™ clips (Fig. 3.21). Of course, the IMA and the IMV are simultaneously divided with Laparoscopic GIA™ (Fig. 3.22).

3.5.2.3 Dissection and Mobilisation of the Sigmoid Colon with the Lateral Approach (Supplementary)

Dissection and Mobilisation of the Sigmoid Colon from the Lateral Side

Scope: umbilicus.

The operator's right hand: a electrosurgical knife with spatula-type blade.

The operator's left hand: bowel forceps.

The assistant's right hand: bowel forceps. Provides counter-traction to the operator's left hand.

The assistant's left hand: free in this procedure.

First, the size of the sigmoid fossa should be determined. Without being able to visually verify the adhesion of the caudal-lateral side of the sigmoid colon, the surgeon should focus on the Toldt's white-line at the cranial-lateral side of the most ventral side of the major psoas muscle. A sheet of the serosa is cut with an electrosurgical knife with spatula-type blade from this portion (Fig. 3.23). This incision is performed laterally of Toldt's white line because of the correction of the fascia layer is subsequently easier.

The ventral side of the deep subperitoneal fascia is exposed and dissected continuously. In this situation the "picking-up and cutting the part" procedure is not suitable. It is better to prepare the surface of the deep subperitoneal fascia with an assistant. Dissection of the descending colon is performed to dissect as far as possible toward the cranial side. In the dissecting procedure at this point, although the surgeon may see many fascial layers in the colonic side, considerations concerning of the fascia of this part will be described later. Dissection is performed while keeping the ventral side of the deep subperitoneal fascia covering the spermatic vessels.

The port of the surgeon's left hand present at the height of the umbilicus is matched to the iliac crest, which is the boundary between the sigmoid colon and the descending colon according to the JCCC definition [1]. Therefore, using this reference, following the dissection the sigmoid mesocolon and the descending mesocolon enough to cranial side, the dissection of the sigmoid mesocolon is performed caudally. In this process, it is already possible to confirm the spermatic vessels. At this point, it has often been suggested to check the ureter, however it is not always possible to confirm the position of the ureter. This is because the sigmoid fossa is located there and its size varies based on the fusion between the posterior leaf of the sigmoid mesocolon and retroperitoneum.

Here, using both hands of the assistant, an appropriate operative field will be formed to dissect the sigmoid fossa.

Scope: umbilicus.

The operator's right hand: a electrosurgical knife with spatula-type blade.

The operator left's hand: grips the innermost serosa of the sigmoid fossa.

The assistant's right hand: is used for traction of the rectum to the cranial side.

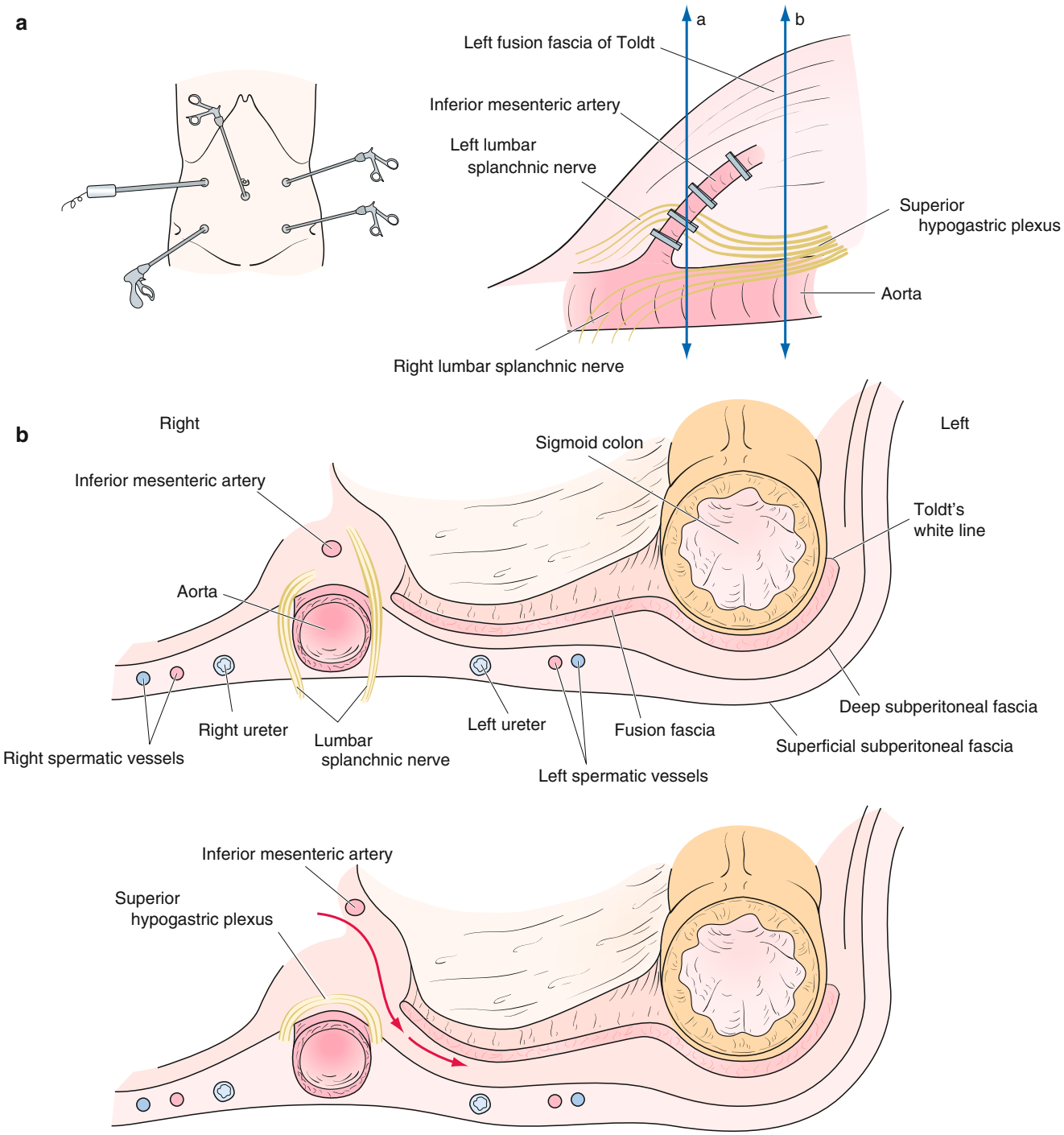

Fig. 3.20 Procedures of the high tie lymph node dissection. In the high tie dissection, the severing of the sigmoid mesocolon needs to extend towards the root of the inferior mesenteric artery (IMA). A nerve bundle from the inferior mesenteric plexus on the right side of the IMA is divided with an USAD (**b**), the IMA is exposed except on the left side. The artery is dissected with dissecting forceps, clamped with three Hem-o-lok™ clips, and the artery is divided (**a**)

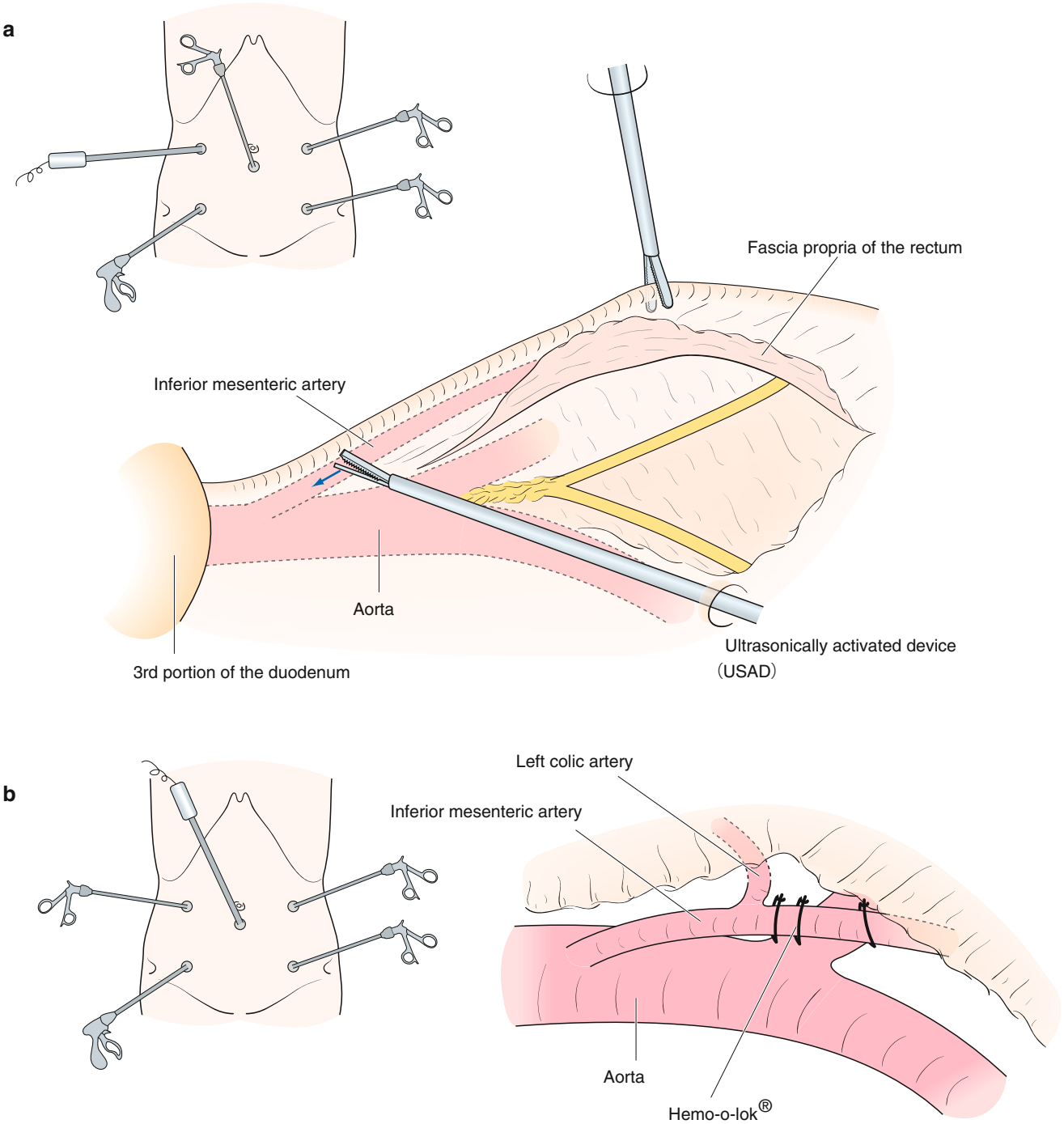

Fig. 3.21 Procedures of the low tie central lymph node dissection. In the low tie dissection, the procedure is same as the high tie procedure up to the exposure of the inferior mesenteric artery (IMA) (**a**). The left colic artery branching from the IMA is detected. The plexus around the left colic artery (LCA) is incised along the LCA to expose the LCA. The lymph node harvest around the LCA is performed and the LCA and the ramus from the LCA are sufficiently dissected. The IMA just distal from the LCA and the IMV are divided using with Hem-o-lok™ clips (**b**)

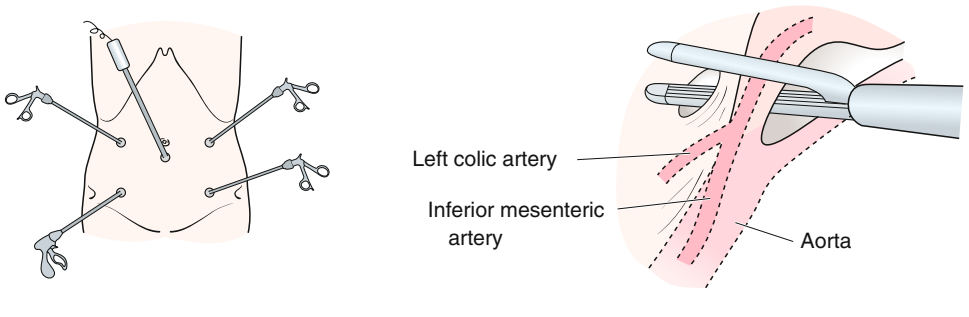

Fig. 3.22 Low tie for the lymph node dissection with Endo GIA™. The inferior mesenteric artery (IMA) and the IMV are simultaneously able to be divided using Laparoscopic GIA™

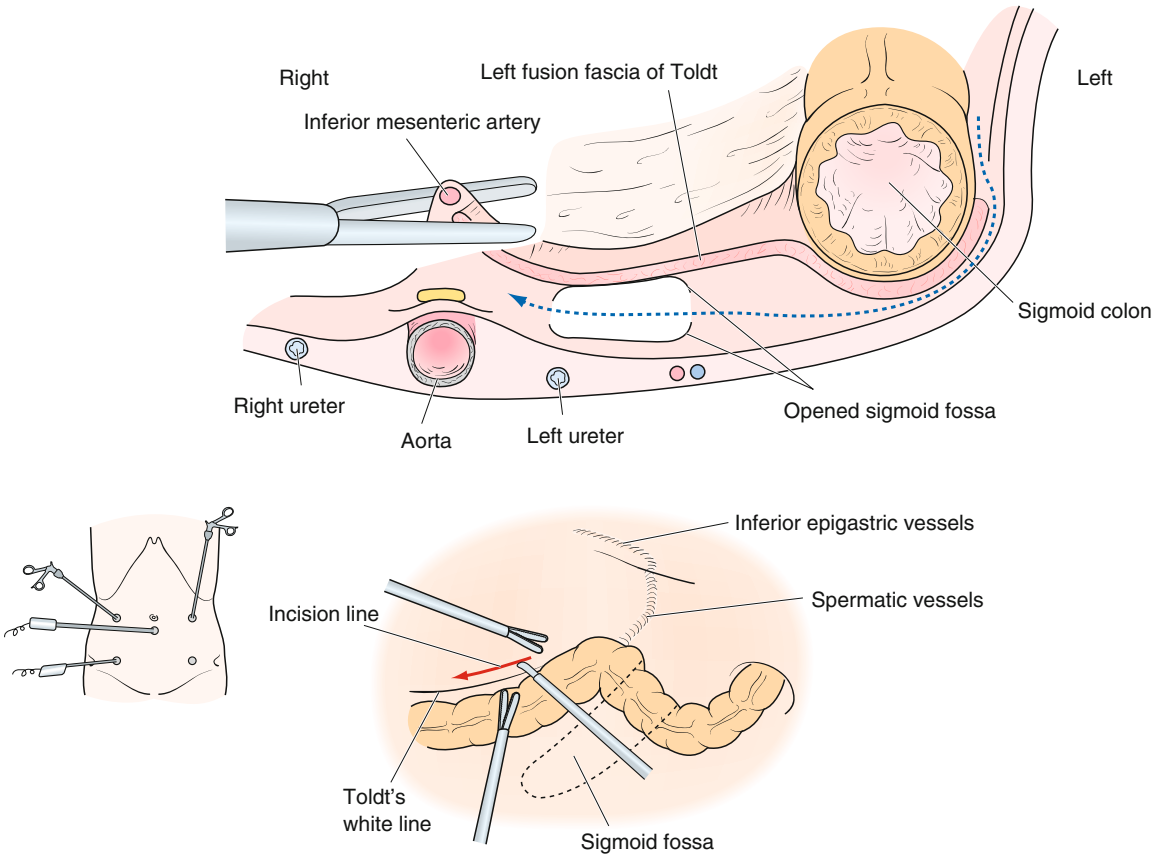

Fig. 3.23 Incising the Toldt's *white line* on the lateral side of the sigmoid colon. The Toldt's *white line* is incised as far as possible cranially from the most ventral part of the major psoas muscle. It is better to incise the lateral side of the *white line* because it is easy to correct the dissecting layer

The assistant's left hand: grips the lateral side of the serosa of the sigmoid fossa.

The sigmoid fossa is the site where the fusion fascia of Toldt is not formed. The oblique root of sigmoid colon is the boundary between the left (dorsal) leaf of the sigmoid mesocolon and the parietal retroperitoneum of the sigmoid fossa. The cutting line can be recognised as a white line (Fig. 3.24). The boundary of the oblique root is cut near the mesocolon. While the assistant pulls the peritoneum of the sigmoid fossa from the lateral-ventral side, the surgeon cuts from the oblique root to the vertical root between the sigmoid mesocolon and retroperitoneum to reach the lateral border of the rectum. Once the bulge of the sigmoid mesocolon is dissected along the medial-cranial side, it is possible to identify the ureter, which is covered with the deep subperitoneal fascia (Fig. 3.25).

When the sigmoid fossa is narrow or missing, it must be dissected from the lateral side and mobilised with the sigmoid mesocolon (Fig. 3.26a). However, in this case, care must be taken not to proceed to the dorsal side of the ureter (Fig. 3.26b).

Dissection and Mobilisation of the Sigmoid Colon from the Medical Side

Following the lateral approach of the sigmoid colon, the medial approach can begin. The relationship between the root of the sigmoid fossa and the bilateral neuro-vascular corridor is shown in Fig. 3.27. The dissection route at the cranial and caudal sides is shown in Fig. 3.28.

For this dissection, the surgeon feels there is a sheet of deviation occurring between the medial dissected plane and

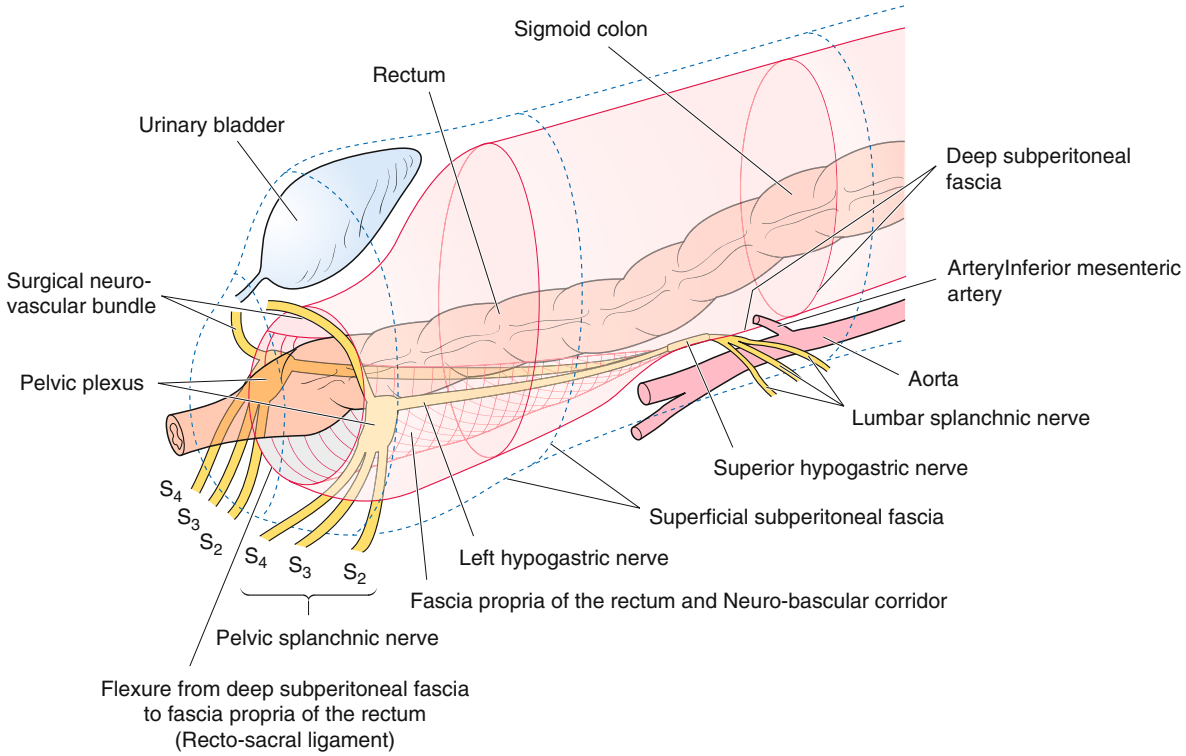

Fig. 3.24 Dissection and incision of the sigmoid fossa. Incision is performed near the oblique root of the sigmoid fossa. The incisional line can be recognized as a *white line*

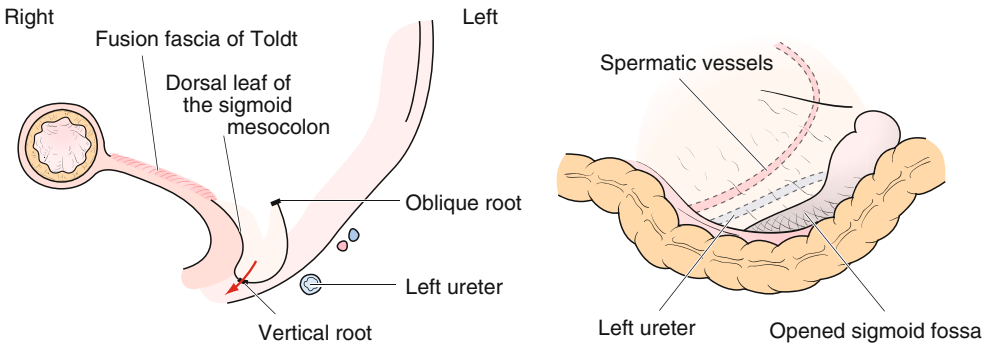

Fig. 3.25 Visual confirmation of the ureter. Incision from the oblique to the vertical root of the sigmoid fossa, it is possible to reach the peritoneum on the lateral side of the rectum. Once dissecting the bulge of the sigmoid mesocolon to the medial-cranial side, it is possible to identify the ureter, which is covered with the deep subperitoneal fascia

the lateral dissected plane. In this regard, an explanation has been proposed whereby the former is the dissection of the ventral side of the deep subperitoneal fascia and the latter occurs inside of the fusion fascia of Toldt (Fig. 3.29). However, this is considered an error in light of the definition of the fusion fascia. Please see the supplementary information in the lateral approach section (For more information, refer to the Chap. 9).

Obese patients, especially those with central obesity, have notable amounts of fatty tissue behind the deep subperitoneal fascia. This is a case in which the spermatic vessels and the ureter cannot be identified. In this case, it is necessary to recognize that the oblique root, the vertical root, and the bulge of left fusion fascia of Toldt on the side of sigmoid mesocolon are the only anatomical indicators.

The above procedure is a basic procedure also suitable for the dissection of the left colon and the splenic flexure. Therefore, it is preferred to use the lateral approach for the dissection of the sigmoid colon, which means that understanding half of the approach to the splenic flexure this paves the way to left colectomy.

3.5.2.4 Dissection of the Dorsal Side of the Rectum

Scope: umbilicus.

The operator's right hand: a electrosurgical knife with spatula-type blade.

The operator's left hand: spreads the procedure, especially in the dissection of the fascia propria of the rectum and repeatedly catches the parts the right hand has dissected.

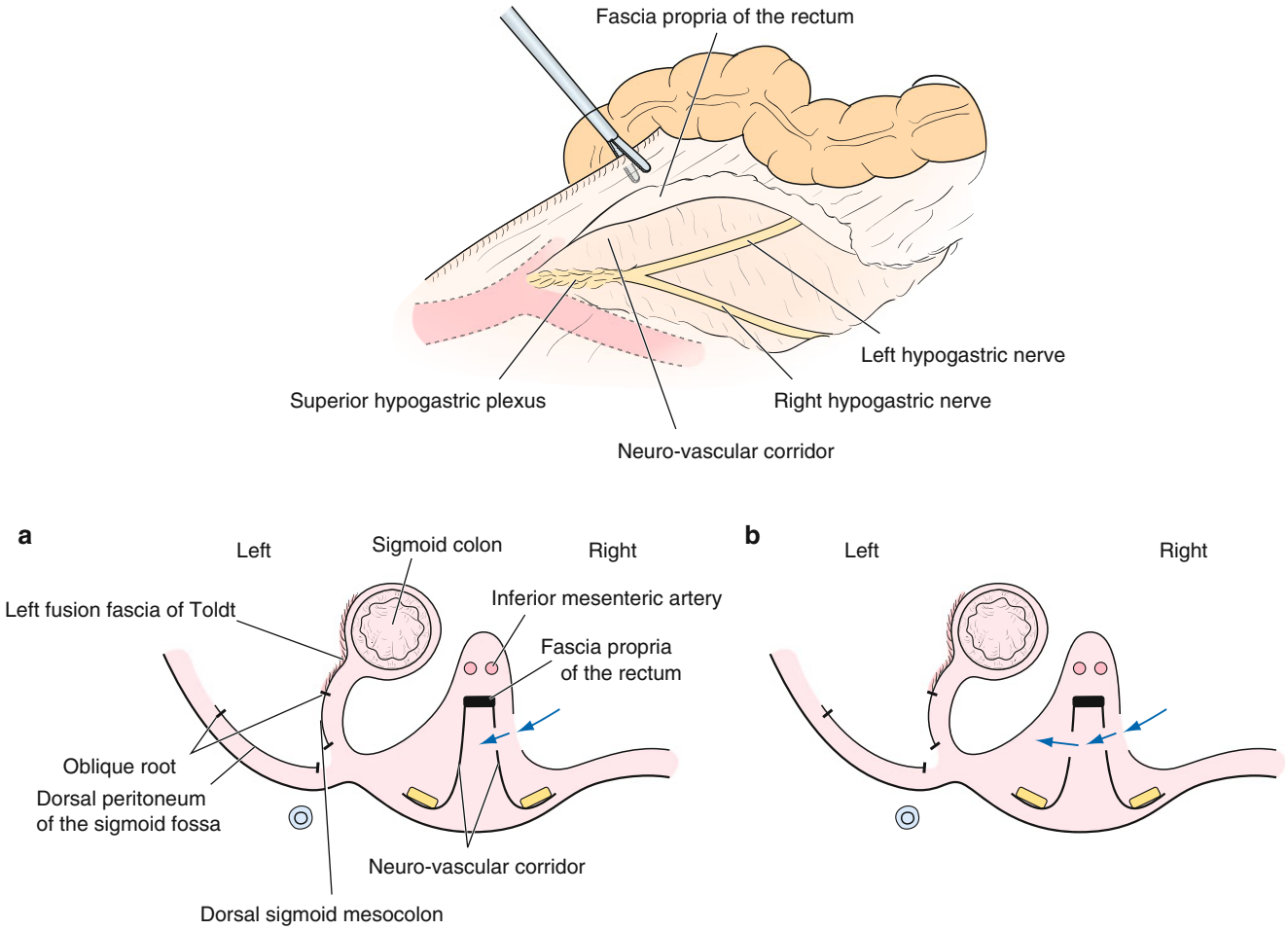

Fig. 3.27 Cross-sectional view of the dissection and mobilisation by using the lateral approach. Following the lateral approach of the sigmoid colon, the medial dissection is begun. The relationship between the root of the sigmoid fossa and the bilateral neuro-vascular corridor is shown (**a**, **b**)

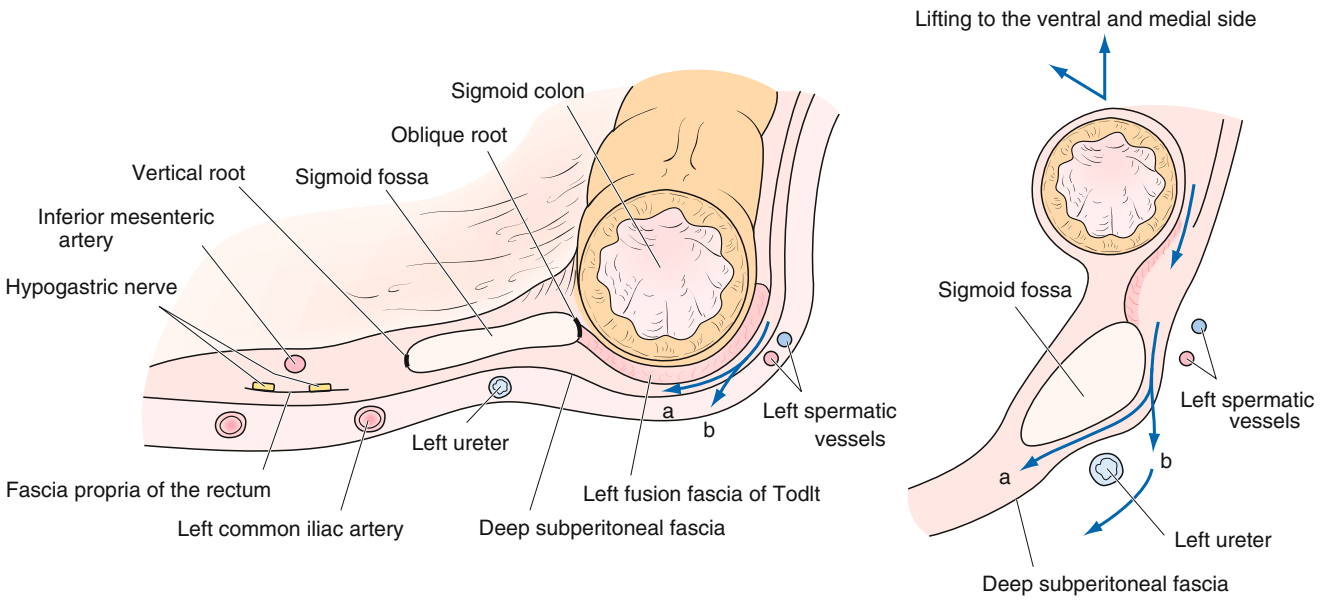

Fig. 3.26 Dissection and incision of the sigmoid fossa. When the sigmoid fossa is narrow or missing, it should be dissected from the lateral side and mobilised with the sigmoid mesocolon (**a**). However, in this case care must be taken not to proceed to the dorsal side of the ureter (**b**)

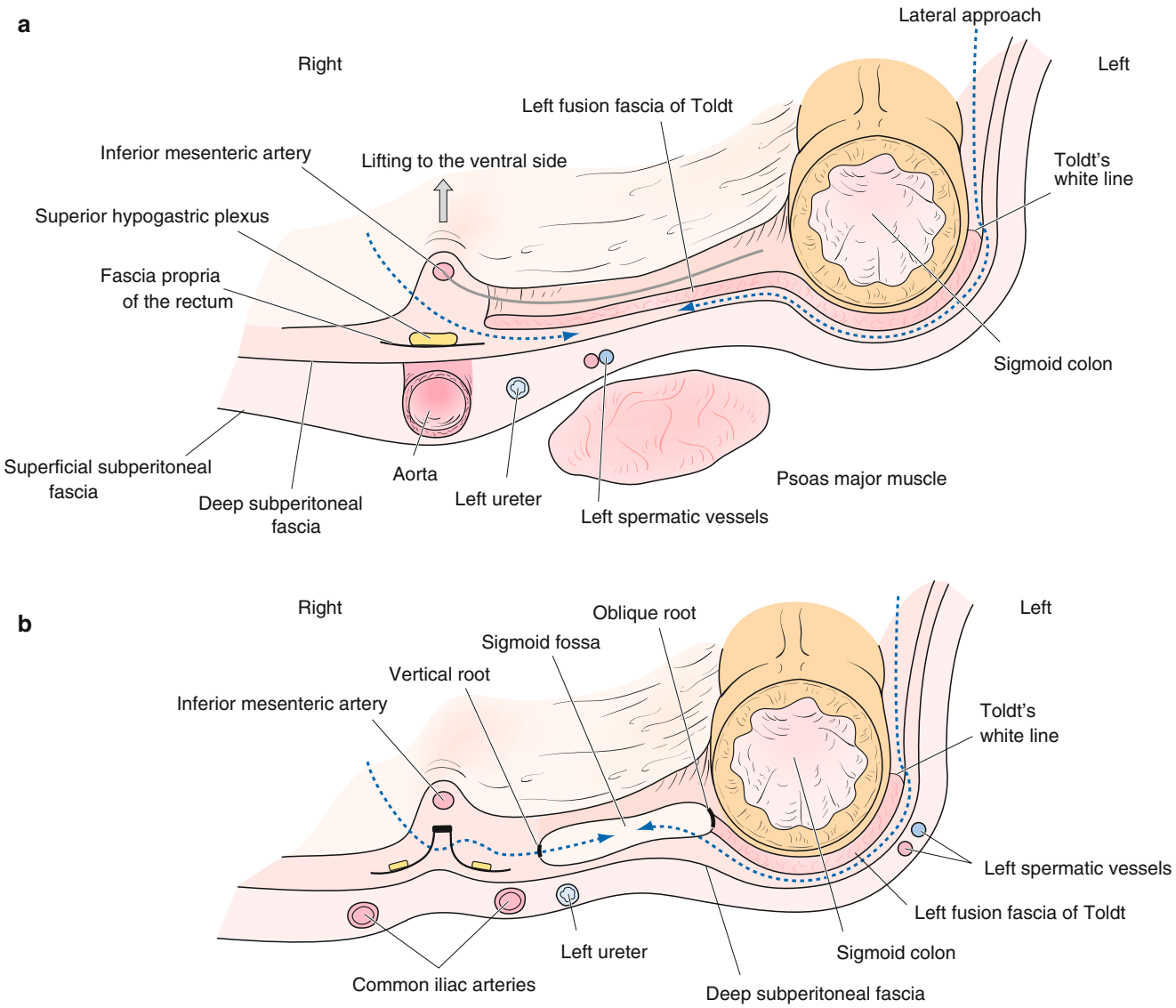

Fig. 3.28 Cross-sectional view of the dissection route at the cranial (**a**) and caudal (**b**) sides by using the lateral approach. The dissection route at the cranial and caudal sides is shown

The assistant's right hand: spreads out the operative field.

The assistant's left hand: maintains the ventral traction of the fascia propria of the rectum.

After ligation of the vessels and the dissection and mobilisation of the sigmoid colon, the view shifts to the pelvic space. Again, the incised bilateral peritoneum of the rectum is divided further. In this process, it is important for the assistant to spread out the dorsal side of the rectum. More specifically, while the cranial side of the division of the vessels is held by the assistant's right hand, the fascia propria of the rectum, which has already been partially dissected, is grasped and lifted ventrally with the assistant's left hand. As a result, the crotch portion is Y-shaped, formed by the hypogastric nerve and the superior hypogastric plexus, and appears in the operative field on the dorsal side of the rectum. Dissection of the fascia propria of the rectum in the dorsal-midline proceeds as far as necessary; the rectal branches of the hypogastric nerves are extended repeatedly and are divided near the rectal attachment. Subsequently, the bilateral peritoneum of the rectum is divided (Fig. 3.30).

3.5.2.5 Division of the Sigmoid Colon or the Rectum at the Anal Side

Scope: umbilicus.

The operator's right hand: USAD.

The operator's left hand: makes a surgical plane of the mesorectum with the assistant's right hand for division.

The assistant's right hand: spreads out the mesorectum.

The assistant's left hand: performs traction of the rectum to the cranial and ventral sides.

In the ventral view of the rectum with laparoscopy, the anal distance from the lesion is measured by the Sizer™, and the part is marked with a Hernia stapler™. This Hernia stapler™ is the indication to divide the rectum.

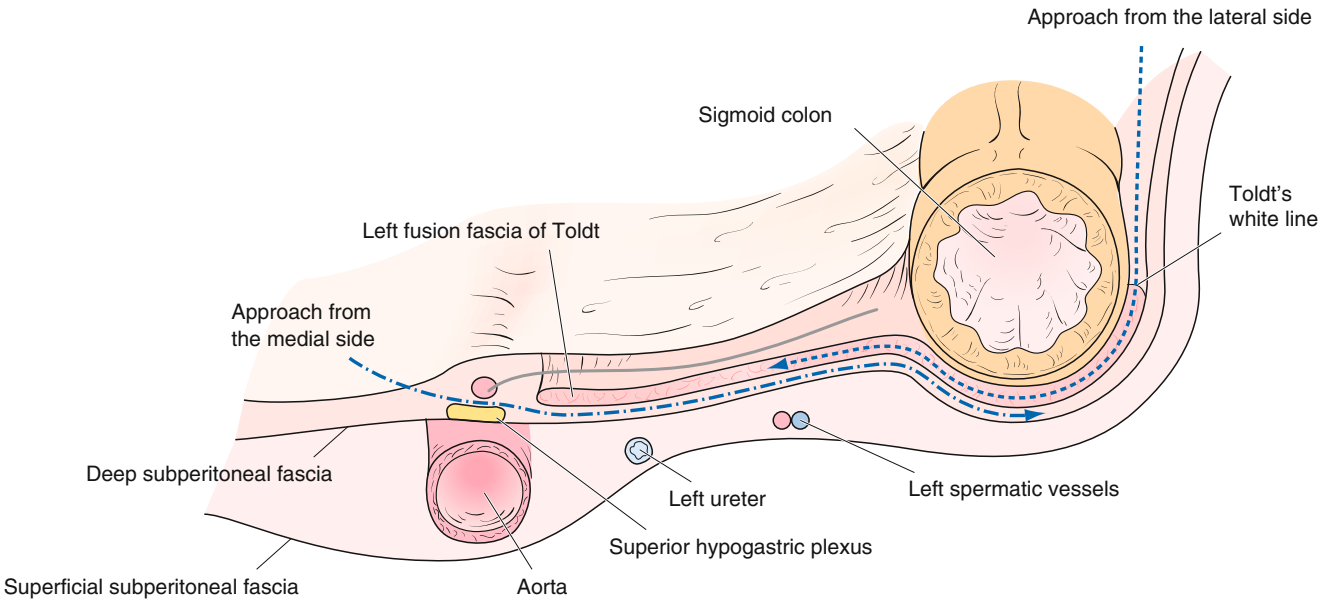

Fig. 3.29 Dissecting layer of the sigmoid colon (Incorrect rationale). The surgeon feels there is a sheet of deviation occurring between the medial dissected plane and the lateral dissected plane. In this regard, there has been an explanation that the former is the dissection of the ventral side of the deep subperitoneal fascia and the latter is inside of the fusion fascia of Toldt. However, this is erroneous in light of the definition of the fusion fascia

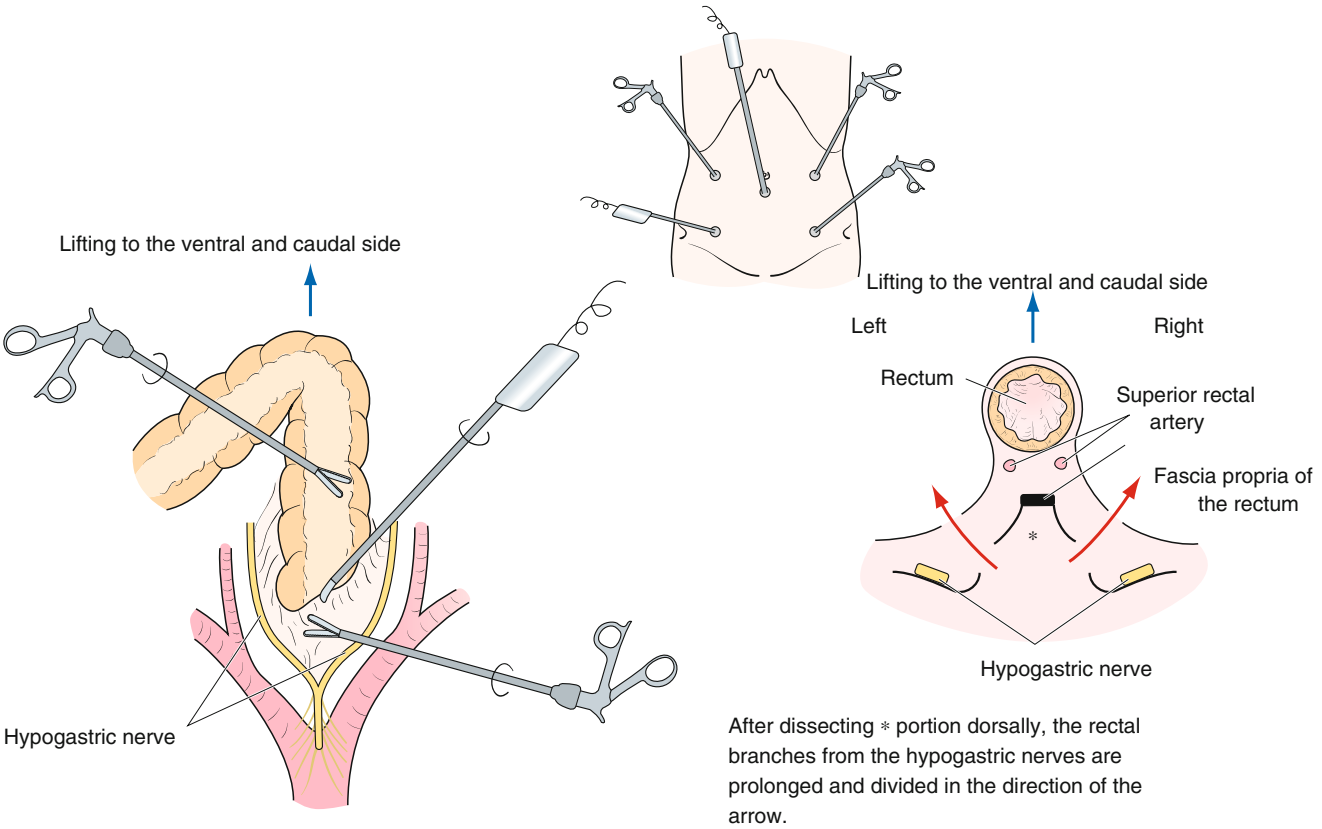

Fig. 3.30 Field of view and the dissection of the dorsal side of the rectum. It is important for the assistant to spread out the dorsal side of the rectum sufficiently. The crotch portion is Y-shaped, which is formed by the hypogastric nerve and the superior hypogastric plexus apparently located in the operative field in the dorsal side of the rectum. Dissection of the fascia propria of the rectum in the dorsal-midline proceeds as far as required, and the rectal ramus of the hypogastric nerves are prolonged and divided near the rectal attachment

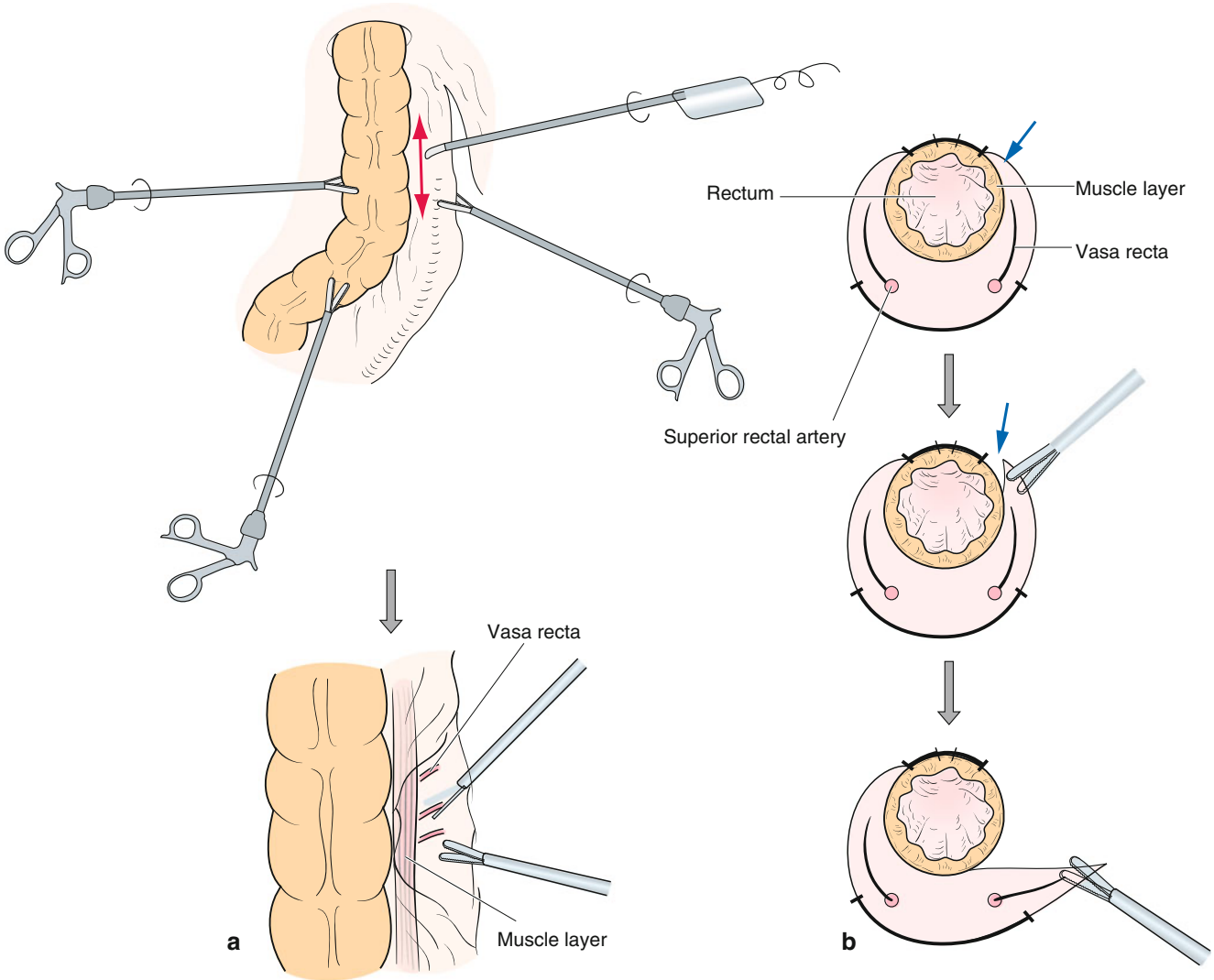

Fig. 3.31 Incision of the serosa of the rectum and dissection between the mesorectum and the muscle layer of the rectum. In preparation for the division of the mesorectum (**a**), just outside serosa, where the muscle layer can be seen through the serosa, is incised along the rectum. Dissecting between the mesorectum and the muscle layer, the terminal vessels are sealed with USAD. After sealing, the mesorectum is dissected and divided (**b**)

In preparation for the division of the mesorectum is spread out with the assistant's hands and is divided with the USAD (Fig. 3.31a). Immediately outside the serosa, where the muscle layer can be seen, the serosa is incised along the rectum. Dissecting between the mesorectum and the muscle layer, the terminal vessel is then sealed with the USAD. After sealing the vessels there are loose areas to dissect (Fig. 3.31b). In addition, immediately outside, the serosa is incised by the same technique and the muscle layer is exposed. Subsequently in the dorsal view of the rectum, the mesorectum is dissected from the muscular layer and divided by the USAD. Viewing the left incisional line, the division of the mesorectum is completed.

Scope: umbilicus.

The operator's right hand: Endo-GIA™.

The operator's left hand: holds the forceps or Clamp forceps™.

The assistant's right hand: removes the surrounding tissue.

The assistant's left hand: maintains traction of the sigmoid colon or the rectum to the cranial side.

Grasping is achieved on the cranial side of the incisional portion with Clamp forceps™ from the left cranial port; the sigmoid colon or the rectum is divided along Clamp forceps™ with the End-GIA™ (Fig. 3.32).

3.5.2.6 The Procedure from the Auxiliary Incision

The incision of the left lower port is extended about 5 cm and the LapDisc™ is mounted on the wound. Holding the anal side of the sigmoid colon and retracting it to the outside of the abdomen, the sigmoid colon is excised with a purse-string instrument™ after division of the mesocolon for the lymph node dissection. The anvil head of the PCEEA™ (Premium circular end-to-end anastomosis™) is equipped with a purse string suture (Fig. 3.33). The anvil head is returned to the abdominal cavity following closure of the LapDisc™.

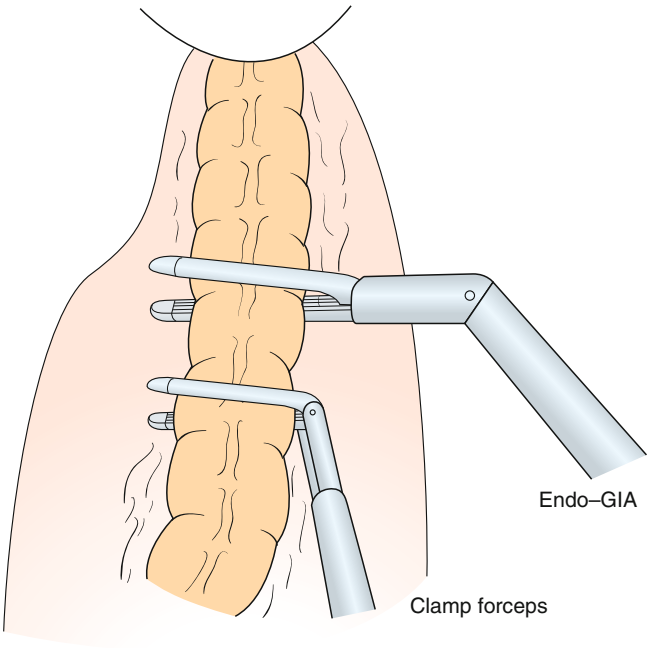

Fig. 3.32 Division of the intestine of the anal side. Grasping the cranial side of the incisional portion with Clamp forceps™ from the left cranial port, the rectum is divided along guided by Clamp forceps™ and with End-GIA™

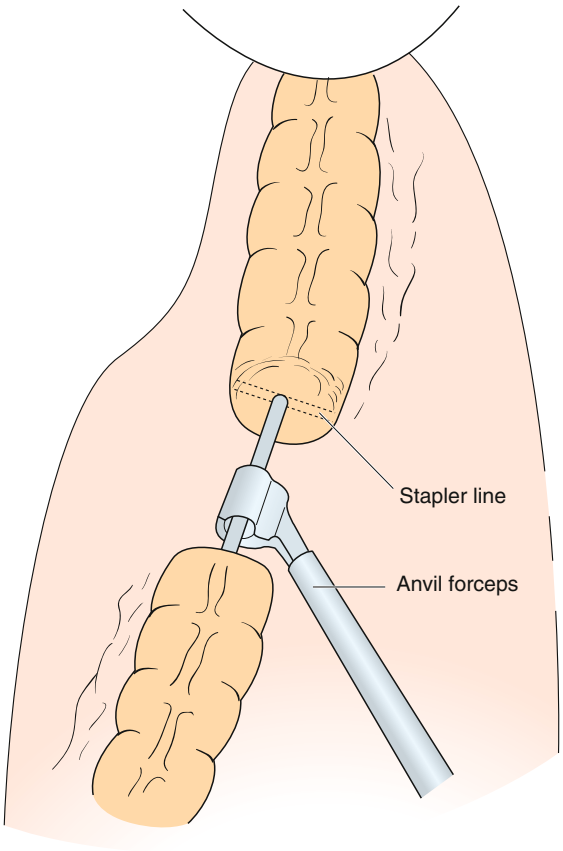

Fig. 3.34 Intestinal anastomosis with double stapling technique. The anvil head is coupled with a circular end-to-end anastomotic instrument (PCEEA™) with forceps or anvil forceps, and the double stapling technique is used to perform laparoscopy

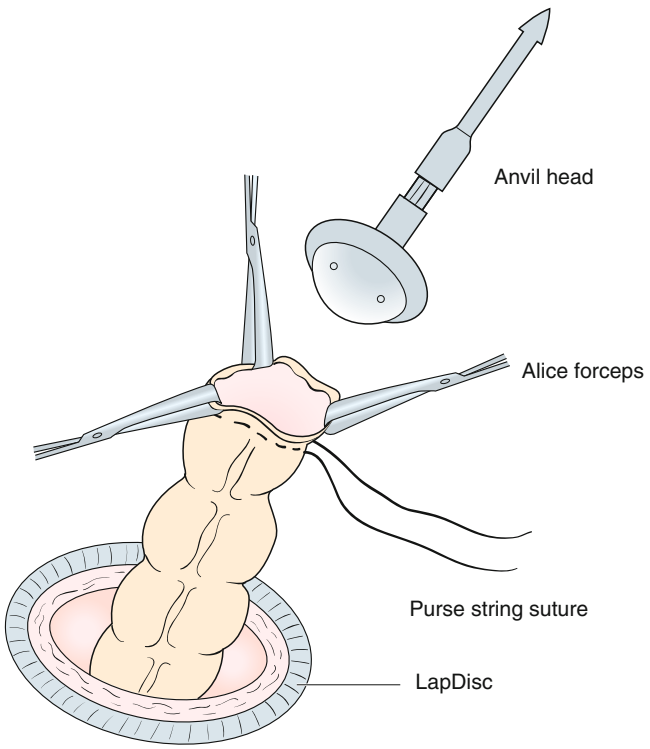

Fig. 3.33 The procedure by auxiliary incision. The anvil head of the PCEEA™ (Premium circular end-to-end anastomosis)™ is equipped with purse string suture

3.5.2.7 Anastomosis

Scope: umbilicus.

It reveals the anastomotic site during anastomosis formation angle by the scope.

The operator's right hand: operates the anvil head of the circular stapler (Endo-GIA™) using forceps or the anvil forceps.

The operator left hand: almost free.

The assistant's right hand: removes the surrounding tissue.

The assistant's left hand: removes the surrounding tissue.

Following establishment of re-pneumoperitoneum, the anvil head is coupled with a circular end-to-end anastomotic instrument (PCEEA™) with forceps or anvil forceps, and the double stapling technique is performed in laparoscopy.

The anastomosis instrument is carefully inserted into the anal canal and the centre rod should penetrate the centre of the stump near the staple line. It is important to avoid torsion of the intestine and pinching of tissue into the anastomosis. The double stapling technique is completed (Fig. 3.34).

3.5.2.8 Drain Insertion and Wound Closure

After anastomosis, the Dual Drain™ is inserted into the left upper port to the lowest portion of the pelvic space. The port site incision is closed with sutures. The left lower incision is closed with 0 PDS-II, and the skin is closed with a skin stapler or subcuticular 4–0 PDS-II sutures.

3.6 How to Understand the Fascial Composition

For dissection procedures of the sigmoid mesocolon from the retroperitoneum in sigmoid colon cancer, the lateral approach and the medial approach have been described using the cross-sectional view. Although the anatomy of this area is simple compared to the anatomy of the stomach, there are many concepts that have caused confusion. This is a problem that should be resolved.

When the fascial composition is considered, Tobin et al. [12] and Sato [13] offer a theory on the generation of the gastrointestinal tract, especially the basic fascial composition around the body circumference. In this interpretation, the fascial composition of the sigmoid colon shows the continuity with the entire colon. This continuity should always be recalled during general abdominal surgery.

3.6.1 Deep Subperitoneal Fascia

While the dissection between the fusion fascia of Toldt and the deep subperitoneal fascia is performed, additional fascia may be considered in the mesocolon side. However, surgeons should not consider the fascia encountered intraoperatively as an artifact. What is important here is not the finding of the number of fasciae, but identifying the correct layer according to the fascia as an anatomical landmark. Therefore the landmark of the lateral approach is the deep subperitoneal fascia present in the ventral side of the spermatic vessels and the ureter. However, the landmark of the medial approach is the left fusion fascia of Toldt and the fascia continuing from the fascia propria of the rectum, that is "the neurovascular corridor".

It should be noted that "ureter-hypogastric fascia" is used to denote the pelvic cavity instead of the deep subperitoneal fascia, but is inappropriate terminology because the ureter and the hypogastric nerve are completely unrelated. "Prehypogastric fascia" is used instead of the fascia propria of the rectum, which is also inappropriate because the description of the origin of the fascia in the ventral side of the hypogastric nerve is not present. Aside from the arbitrary terminology, it is considered that the term is not to be adopted since there is no precise definition of the word.

Due to the variation of the fusion between the left (dorsal) leaf of the sigmoid mesocolon and the retroperitoneum, the sigmoid fossa is formed. It is for this reason that the concept of the dissection of the sigmoid colon from the retroperitoneum is difficult. The sigmoid fossa has an oblique root and a vertical root, the ventral side is the left (dorsal) leaf of the sigmoid mesocolon, and the dorsal side is the parietal peritoneum. Therefore, the lateral approach does not include the total resection of the sigmoid fossa but the division of the sigmoid fossa along the oblique root and the vertical root. Thus, these procedures can lead to the identification of the ureter.

3.6.2 Fascial Composition of the Dorsal Side of the Rectum – The Fascia Propria of the Rectum

In further considering the sigmoid colon, it is essential to understand the fascial composition of the dorsal side of the rectum. The important fascia is the fascia propria of the rectum that acts as a landmark for the dissection of the dorsal rectum. The fascia may also be referred to in different ways, however herein it is defined as the innermost fascia wrapping the around the mesorectum. Although the relationship between the fascia and the subperitoneal fascia is well defined, it is not as clear for the sigmoid colon and the understanding of the fascia composition of this part is unsatisfactory. In the interpretation of basic fascial composition around the body circumference by Tobin et al. [12] and Satoh [13], no fascia other than the two subperitoneal fasciae in the subperitoneal space are considered present. Thus, the fascia propria of the rectum should be considered as the third fascia. Of course, if the description of the fascial composition in the pelvic space is not made with the uniformity of the abdomen, the fascial interpretation of the cylindrical structure is biased. Therefore, while the parietal pelvic fascia continuing from the superficial subperitoneal fascia and the visceral pelvic fascia continuing from the deep fascia are indispensable they are not related to each other. This is a major principle in the attempt to try to understand the fascia composition in the pelvic space and the fascia composition of the entire trunk. It must be considered the origin of the fascia propria of the rectum as this basis [14]. (For more information, refer to the Chap. 4).

3.6.3 Anatomical Landmarks in the Medial Approach

In the medial approach the anatomical landmark for the peritoneal incision is the promontorium located behind the IMA pedicle. Carefully viewing the sigmoid mesocolon at the

ventral side of the promontorium, the boundary between the parietal and visceral pleura is detected by a colour change, and the marginal ventral side of the boundary is incised. The medial approach is the dissection of the fascial composition from behind the IMA pedicle to the sigmoid fossa. To be able to identify the fascia propria of the rectum dorsally to the rectum, a very useful dissection procedure is to proceed cranially dividing the vessels and nerves of the neuro-vascular corridor along the right side of the fascia propria of the rectum. After dividing the left neuro-vascular corridor, a space is obtained between the fusion fascia of Toldt and the deep subperitoneal fascia.

3.6.4 Anatomical Landmarks in the Lateral Approach

In the lateral approach it is important to incise Toldt's white line as far as possible cranially. The dissection maintains the surface of the deep subperitoneal fascia ventral to the spermatic vessels as the only landmark. Subsequently, the dissection of the dorsal peritoneum of the sigmoid fossa is continued and the oblique and the vertical roots are incised to detect the ureter. It enables the operator to reach the correct left neuro-vascular corridor. Without the detection of the spermatic vessels, the bulge of the fatty tissue covered with the fusion fascia and the oblique, and the vertical roots are considered the only landmarks to dissect the correct plane especially for those with central obesity.

In this chapter, we have described laparoscopic sigmoidectomy. Even when selecting the desired approach, there can be no progress in surgery without a proper understanding of the definitions and terminology or of the clinical anatomy.

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Laparoscopic Low Anterior Resection of the Rectum

4

4.1 Introduction

Outcomes of rectal cancer treatment depend on the operative technique adopted. Complications vary, and can occur during mobilisation of the rectum, with damage to the ureter, the autonomic nerves, and the rectum itself. Complication rates can be reduced by careful dissection of the correct tissue plane in the pelvic space. To date, fascial composition of the pelvic space has been studied based on clinical anatomy and histological examination of cadaveric specimens. However, clarification of fascial composition is clearly limited, to a certain extent, in histological examinations compared with clinical anatomy. Some degree of dissociation must exist between the histological examination and clinical anatomy. Surgeons should not consider fascia encountered intraoperatively as an artefact. To address these difficult issues, considerations should be made purely from the perspective of clinical anatomy. Originally, the trunk was embryologically regarded as a multi-layered structure (in analogy like an onion) [1]. Understanding the fascial composition of the abdomen is comparatively easy when approached from this perspective. If this theory is adapted to the pelvic space in order to avoid antilogy, an understanding of the fascial composition of the pelvic space should also be possible (See the Chap. 1).

4.2 Resection Range and Degree of the Lymph Node Dissection

Laparoscopic low anterior resection (LapLAR) compared with LAR with laparotomy is similar in terms of the resection range and the degree of lymph node dissection, except for their respective approach to the abdominal cavity. Lymph node dissection of the rectum is performed based on lymph node mapping information obtained by computed tomography (CT) imaging studies that have improved to sufficiently high quality to detect lymph nodes. There are only a few patients indicated for high tie operation performed with division the root of the inferior mesenteric artery (IMA) for lymph node dissection at the root of IMA. Low tie operation, which is reserved for inferior mesenteric root nodes and the left colic artery, is a suitable dissection procedure for most cases of rectal cancer.

4.3 Fascial Composition and Fusion Fascia of the Rectum

In order to match the surgical procedure with knowledge of the clinical anatomy, it is essential to have a basic knowledge of gastrointestinal embryology. In other words, an understanding of the embryonic peritoneal placement and the relation to the body wall, as well as the resulting clinical anatomy obtained from the knowledge of the fusion concepts are essential (See the Chap. 1).

The pelvic fascial composition will be discussed below with a cross-sectional view of the pelvis from the cranial side to the caudal side (Fig. 4.1). However, it should be noted that operative procedure begins at the promontory and is often in the order (2)(1)(3)(4)(5).

4.3.1 Level of Aortic Bifurcation (Fig. 4.1 (1))

The superior hypogastric plexus divides to form the right and left hypogastric nerves in the caudal centre of the aorta. A fascia is present at the ventral (deeper) side of the deep subperitoneal fascia that covers the ureter and the aortic bifurcation (Fig. 4.2). This fascia fuses to the deep subperitoneal fascia in the most cranial part, and is called the fascia propria of the rectum. The deepest fascia is thought to be the fascia propria of the rectum according to Dr. Takahashi, based on his concept derived from embryological considerations of organ dominance of the autonomic nerve fibres [3–7]. The deep subperitoneal fascia turns back to the cranial side as the recto-sacral ligament and forms the fascia propria of the rectum (Fig. 4.3). The fascia propria of the rectum then

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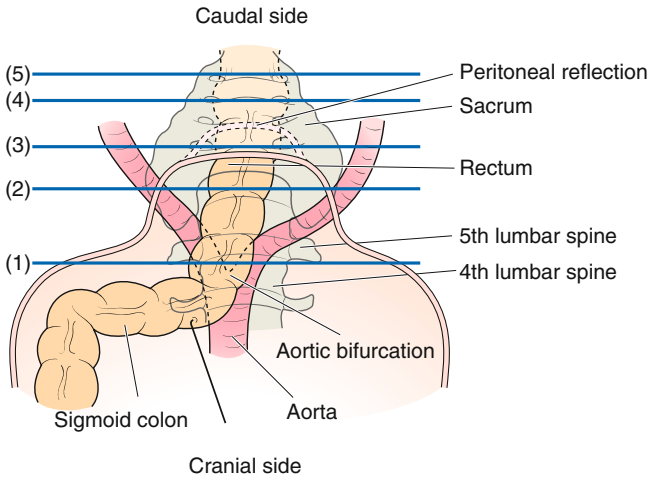

Fig. 4.1 Cross-sectional view of the pelvic space. The pelvic fascial composition will be discussed with a cross-sectional view of the pelvis from the cranial side to the caudal side. However, it should be noted that the operative procedure begins at the promontory and is often in the order (*2*)(*1*)(*3*)(*4*)(*5*) [2, with permission]

converges towards and fuses with the deep subperitoneal fascia at the superior hypogastric plexus (Fig. 4.4). However, as this part is located on the dorsal side of the sigmoid mesocolon, there may be notable resistance for acceptance of the term if given the name the fascia propria of the rectum. The reason for this will be explained later.

4.3.2 Level of the Promontorium (Fig. 4.1 (2))

This represents the starting point for the medial approach in LapLAR (Fig. 4.5b, arrow). The space between the deep subperitoneal fascia and the fascia propria of the rectum broadens (Fig. 4.5a). At this level the recto-sigmoidal mesenterium is markedly shortened (Fig. 4.5a). This section originates from the fascial propria of the rectum and the neuro-vascular corridor. In other words, this is the portion that lines the mesorectum and the corridor of the neural branches from the hypogastric nerve (Fig. 4.5b).

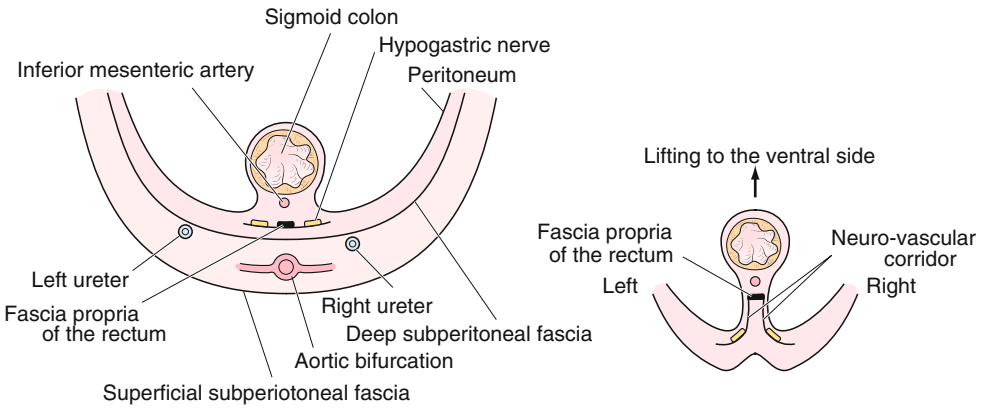

Fig. 4.2 Level of the aortic bifurcation (Fig. 4.1 (1)). The superior hypogastric plexus divides to form the right and left hypogastric nerves in the caudal centre of the aorta. A fascia is present at the ventral (deeper) side of the deep subperitoneal fascia that covers the ureter and the aortic bifurcation. This fascia fuses to the deep subperitoneal fascia in the most cranial part and is called the fascia propria of the rectum [2, with permission]

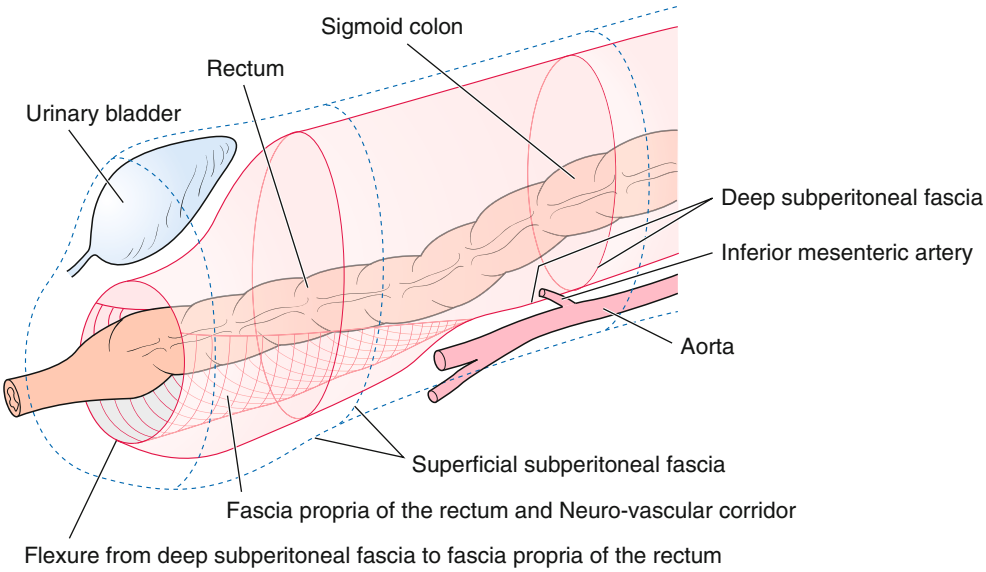

Fig. 4.3 The fascia propria of the rectum in accordance with the concept of Dr. Takahashi. The deep subperitoneal fascia turns back to the cranial side as the rectosacral ligament and forms the fascia propria of the rectum. The fascia propria of the rectum is the route for the autonomic nerve fibres [2, with permission]

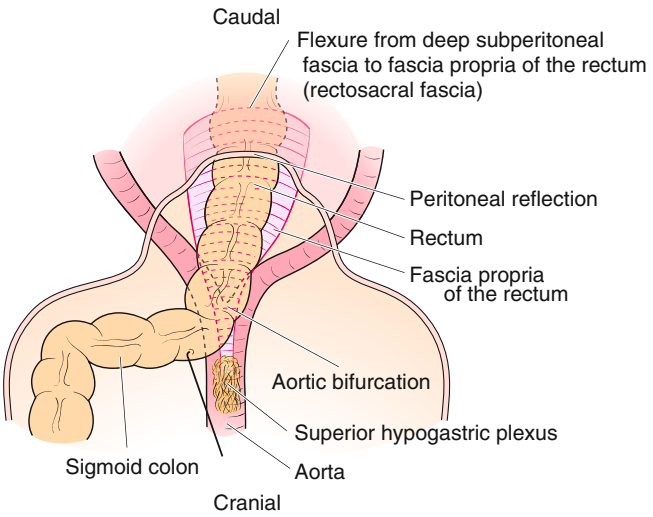

Fig. 4.4 The fascia propria of the rectum from the ventral view. The fascia propria of the rectum converges towards and fuses with the deep subperitoneal fascia at the superior hypogastric plexus

4.3.3 Level of the Rectovesical Fossa (Fig. 4.1 (3))

Part of the rectum is covered with peritoneum only in the rectovesical fossa. The annulus of the deep subperitoneal fascia shrinks with respect to the cranial side and covers the internal and the external iliac arteries and the ureter on the lateral sides, and then continues towards the ventral side of the rectovesical peritoneum that shifts into Denonvilliers' fascia. The fascia propria of the rectum, as a fascia of the deepest part, is spread caudally. The fascia then closes at the reflection of the deep subperitoneal fascia, which has become the rectosacral ligament (Fig. 4.6a). The retrorectal space is difficult to visualise if the ventral side of the rectum is elevated (Fig. 4.6b*).

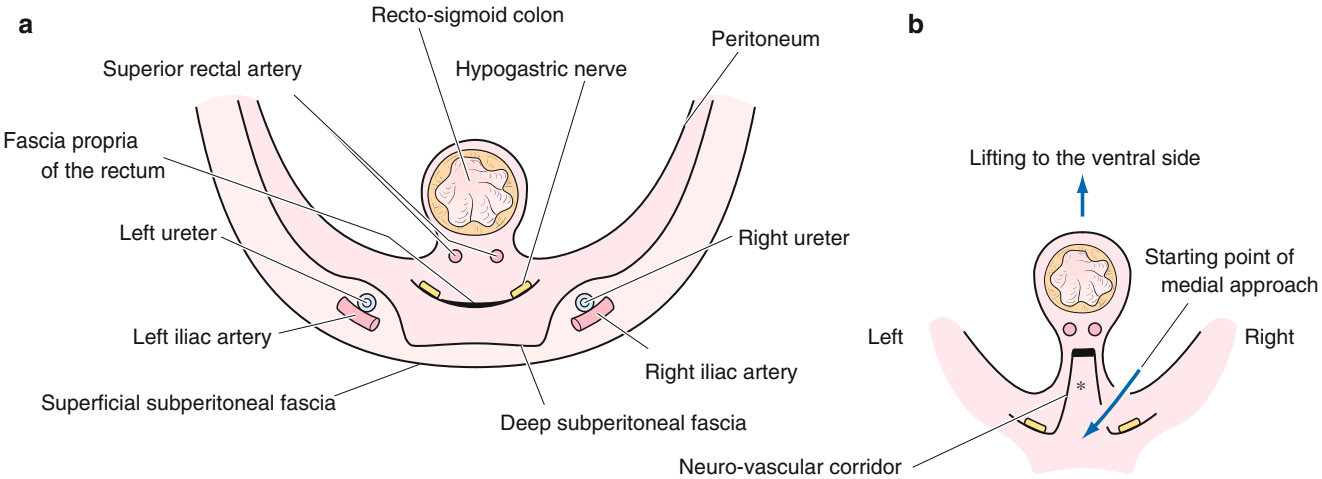

Fig. 4.5 Level of the promontorium (Fig. 4.1 (I)). This represents the starting point of the medial approach for laparoscopic low anterior resection (LapLAR) (**b**, *arrow*). The space between the deep subperitoneal fascia and the fascia propria of the rectum broadens (**a**) [2, with permission]

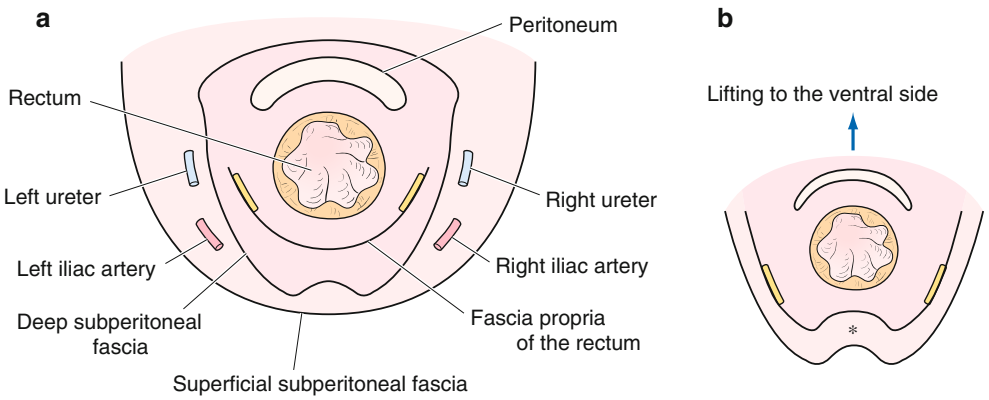

Fig. 4.6 Level of the rectovesical fossa (Fig. 4.1 (3)). The fascia propria of the rectum, as a fascia of the deepest part, is spread caudally (**a**). The retrorectal space is difficult to visualise if the ventral side of the rectum is elevated (**b***) [2, with permission]

4.3.4 Level of the Lateral Ligament (Fig. 4.1 (4))

The space between the fascia propria of the rectum and the deep subperitoneal fascia in the dorsal rectum is closed at this level, and becomes the position for mutual reflection (rectosacral ligament). The two fasciae are fused on the lateral sides of the rectum. The pelvic plexus is then formed, with connective tissue binding the middle rectal vessel, lymph ducts and branches of the rectal nerve, thus forming the lateral ligament (Fig. 4.7).

On the ventral side of the rectum, the deep subperitoneal fascia exists just ventrally to Denonvilliers' fascia. This represents the deep subperitoneal fascia that forms the boundary between the urogenital organs and the rectum, as well as the abdomen. The neurovascular bundle can be confirmed if the dissection on the medial side is advanced to the right or left (Fig. 4.7). However, since neurovascular bundles are covered by prostate fascia by definition [8], the neural branch-sprouting out from the pelvic plexus and towards the prostate along the rectum is referred to as the "surgical neurovascular bundle" for convenience (Fig. 4.7).

A supralevator space is apparent if the rectosacral ligament is incised on the posterior side of the rectum (Fig. 4.7, solid arrow). This space has been confirmed to lead to a bladder-sided space and to the bladder front cavity (Retzius space) from the lateral side of the rectum (Fig. 4.7).

4.3.5 Level of the Caudal Portion of the Terminal End of the Deep Subperitoneal Fascia (Fig. 4.1 (5))

The ventral side is the final line of the deep subperitoneal fascia. The end of the caudal side is the perineal body. There should be a slight remnant of the deep subperitoneal fascia at this point (Fig. 4.8).

The rectum migrates to the anal canal. The pubococcygeus muscle and the iliococcygeal muscle together form the pelvic floor. They are covered with a superficial subperitoneal fascia. The final portion of the rectum is surrounded by the hiatal ligament that is responsible for the synchronisation of the rectum, bladder neck (upper portion of the vagina), and motion of the pubococcygeal muscle. The anococcygeal raphe is located between the hiatal ligament and the coccyx. The puborectal muscle on the caudal side of the hiatal ligament supports the dorsal side of the anal canal [9] (Fig. 4.8).

4.4 Operative Procedures (in Men)

4.4.1 Intraoperative Positions, Trocar Site and the Elimination of the Small Intestine

(See the Chap. 2).

4.4.2 Operative Procedures (Figure Shows the Case of Men)

For details relative to the dissection of the sigmoid colon and dissection of central lymph nodes, see the section on Laparoscopic sigmoidectomy (See the Chap. 3).

4.4.2.1 Dissection in the Lesser Pelvis (Especially in the Retrorectal Space)

Scope: umbilicus.

The operator's right hand: an electrosurgical knife with spatula-type blade.

The operator's left hand: performs traction of the fascia propria of the rectum to the ventral-caudal side.

The assistant's right hand: assists in the fine manoeuvres of the operator.

Assistant's left hand: adequately raises the fascia propria of the rectum to the ventral side.

The bilateral parietal peritoneum along the rectum is excised towards the rectovesical fossa. It is important that the assistant maintains the spread of operative field. The vascular stump is retracted ventrally by the assistant's right hand, and the assistant's left hand catches the fascia propria of the rectum and retracts it to the ventral side sufficiently enough to provide an adequate surgical plane. Next, given that the assistant's right hand is free, the assistant eliminates what has now become an obstacle to the operator by his right hand.

In the field of view of the retrorectal space, the fascia propria of the rectum is dissected from the dorsal side midway between the branches of the hypogastric nerves (Fig. 4.9). Furthermore, it is conducted towards the pelvic floor as far as possible without moving to the lateral sides of the rectum (Figs. 4.5b*, 4.6b*, and 4.9). After dissecting the retrorectal space, the rectal branches stemming from the hypogastric nerves are extended and divided (Fig. 4.9).

The operator dissects and cuts along the midline towards the caudal-ventral side using his right hand while holding the ventral rectum caudal-ventrally with forceps in his left hand. At the midline, the retrorectal space is dissected as far as possible, and the rectosacral ligament, which is the fold of the deep subperitoneal fascia leading towards the

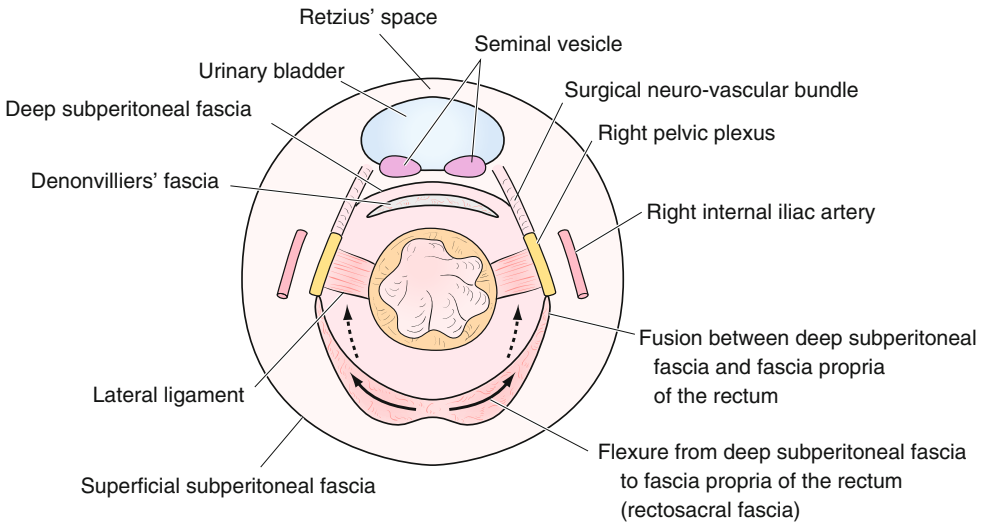

Fig. 4.7 Level of the lateral ligament (Fig. 4.1 (4)). The space between the fascia propria of the rectum and the deep subperitoneal fascia in the posterior rectum is closed at this level, and becomes the position of mutual reflection (rectosacral ligament). On the ventral side of the rectum, the deep subperitoneal fascia lies just ventrally to Denonvilliers' fascia. The surgical neuro-vascular bundle can be confirmed if the dissection on the medial side is advanced to the right or left. A supralevator space is apparent if the rectosacral ligament is incised on the posterior side of the rectum (*solid arrow*). This space has been confirmed to lead to the bladder-side space and to the bladder front cavity (*Retzius' space*) from the lateral side of the rectum [2, with permission]

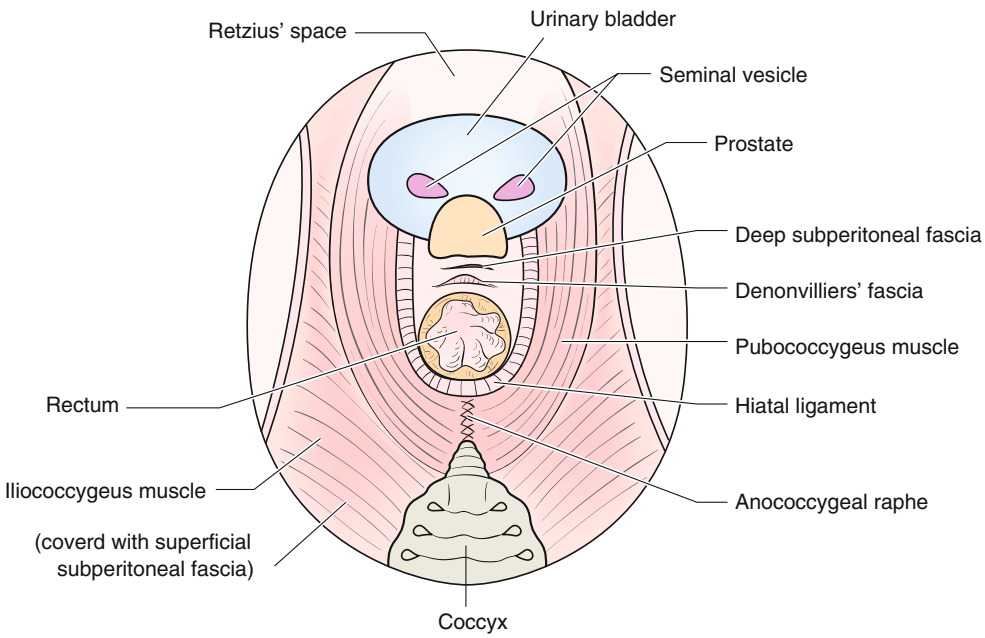

Fig. 4.8 Level of the caudal portion of terminal end of the deep subperitoneal fascia (Fig. 4.1 (5)). The ventral side is the final line of the deep subperitoneal fascia. The end of the caudal side is the perineal body. There should be a slight remnant of the deep subperitoneal fascia at this point. The pubococcygeus muscle and the iliococcygeus muscle form the pelvic floor. They are covered with the superficial subperitoneal fascia. The final portion of the rectum is surrounded by the hiatal ligament. The anococcygeal raphe is located between the hiatal ligament and the coccyx. The puborectal muscle on the caudal side of the hiatal ligament supports the dorsal side of the anal canal

ventral-cranial side, is identified (Figs. 4.3, 4.4, and 4.7). Because the neural branches from the hypogastric nerves are close to the rectum, it is important to proceed without removing the midline. By cutting the rectosacral ligament (Fig. 4.7, solid arrow line), the pelvic floor can be reached. At this point, the supralevator space can be dissected off like a comma-shaped jewel on both sides, and the dissection along the inside of the pelvic plexus can be performed.

At this point, the rectal branches from the pelvic plexus are raised to the ventral side, and the space between the rectum and the pelvic plexus can be visualised (Fig. 4.7, dotted arrow). It is possible to cut off the rectal branches from the pelvic plexus near the mesorectum (Fig. 4.7, dot-

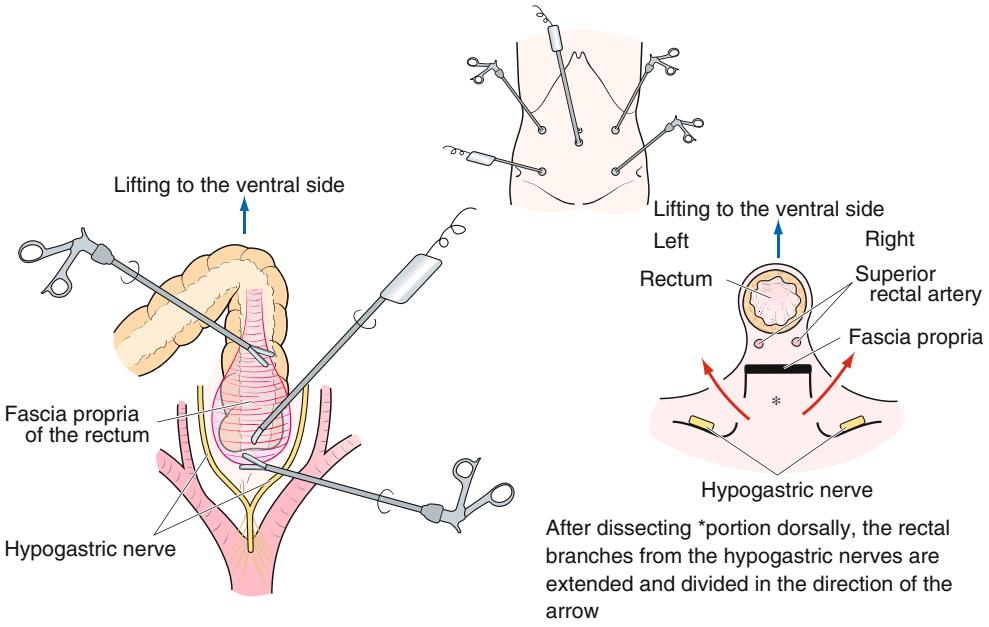

Fig. 4.9 Field of view and the dissection of the retro-rectal space. It is important that the assistant maintains the extent of the operative field. In the field of view of the retro-rectal space, the fascia propria of the rectum is dissected from the dorsal side midway between the branches of the hypogastric nerves. After dissecting the retro-rectal space, the rectal branches stemming from the hypogastric nerves are extended and divided

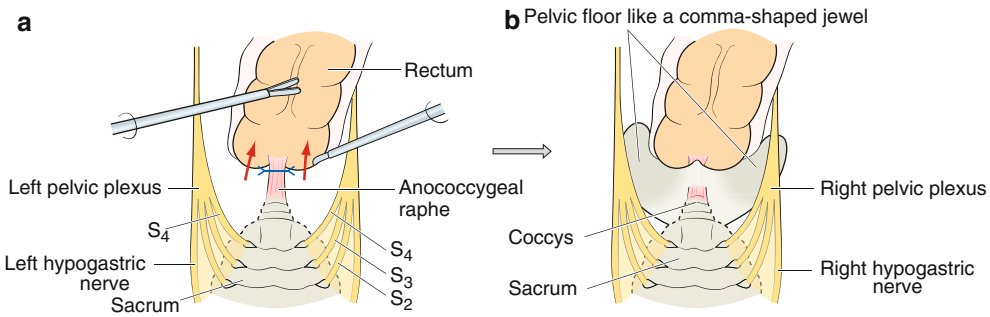

Fig. 4.10 Disconnection of the anococcygeal raphe (**a**). After performing the dissection of the rectum in the caudal-ventral direction on the bilateral side on the pelvic floor, the supralevator space assumes a comma-shaped jewel form (**b**). In addition, the anococcygeal raphe is removed from the midline of the rectum and is divided at the hiatal ligament (**a**)

ted arrow). Furthermore, following the exposure of the caudal edge of the S4 pelvic splanchnic nerve and the division of the branch to the rectum, the levator ani muscle is sufficiently visible. By dissecting the rectum along the caudal-ventral direction on the bilateral side, the supralevator space forms a shape similar to that of a comma-shaped jewel (Fig. 4.10b).

After the supralevator space is dissected like a comma-shaped jewel, and the rectum is dissected to the caudal-ventral side, the anococcygeal raphe that runs from the coccyx to the rectum can be seen. Furthermore, if the anococcygeal raphe is dissected along the slightly bilateral side, it is possible to expose the anococcygeal raphe even more clearly (Fig. 4.10a). The rectum is dissected further to the caudal side and the anococcygeal raphe is then divided at the hiatal ligament (Fig. 4.10a). When the hiatal ligament is incised along the rectum at the bilateral side, the puborectal muscle, which is located behind the hiatal ligament, can be seen as having a V-shape at the dorsal side because the U-shaped becomes V-shaped when raised ventrally (Fig. 4.8). Having dissected the inside of the puborectal muscle, it is possible to enter the anal canal.

In the presence of bleeding within the area of the pelvic floor, it is difficult to continue surgery using this surgical plane. Thus, it is important to proceed with adequate haemostasis.

4.4.2.2 Incision and Dissection of the Ventral Side of the Rectum (Dissection of the Ventral Side of Denonvilliers' Fascia)

Scope: umbilicus.

The operator's right hand: an electrosurgical knife with spatula-type blade.

The operator's left hand: develops the ventral side of the rectum.

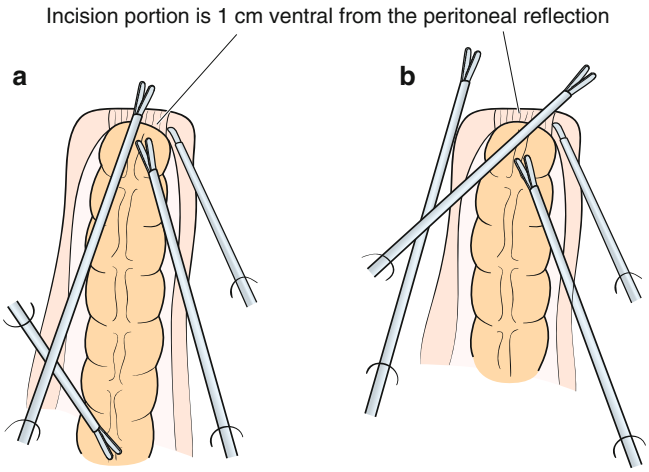

Fig. 4.11 Dissecting and dividing of the ventral side of the rectum. At about 1 cm from the transition of the serosa in the rectovesical fossa, the serosa incision should be performed and bilateral peritoneal divisions are continued. A plane for dissection is established by both hands of the assistant and by the surgeon's left hand. (**a**) If the rectum falls within the operative field. (**b**) If the separating portion is likely to expand

The assistant's right hand: ensures traction of the serosa at the urinary bladder ventrally (or traction of the serosa at the urinary bladder to the lateral-ventral side).

The assistant's left hand: ensures traction of the rectum cranially (or traction of the serosa at the urinary bladder to the lateral-ventral side).

For the dissection of the retrorectal side, if the field of view is felt to be insufficient for the procedure, dissection of the ventral side of the rectum should be performed.

At approximately 1 cm from the transition of the serosa to the rectovesical fossa, the serosa incision should be performed and bilateral peritoneal divisions continued (Fig. 4.11). If the rectum falls within the operative field, the assistant's left hand bowel forceps grips the rectum and can lead it to the cranial side. The assistant's right hand bowel forceps lift the serosa ventrally at the urinary bladder to form a counter-traction with the bowel forceps in the operator's left hand (Fig. 4.11a). The dissection is easily visualised; the visualisation of the surface plane for dissection is established by the assistant's hands and the operator's left hand. It is also possible for the assistant to control the side of the urinary bladder and for the operator to control the rectal side (Fig. 4.11b).

At the medial part, the procedure continues with the dissection of the caudal tissue from the ventral side of Denonvilliers' fascia. In other words, this is achieved by entering between the dorsal side of the deep subperitoneal fascia and the Denonvilliers' fascia. Without continuing to dissect on both sides, it is important to dissect the median in order to reveal the inner sides of the bilateral seminal vesicles (Fig. 4.12). The dissection continues between the dorsal side of the seminal vesicle and Denonvilliers' fascia. If the seminal vesicle is confirmed to be covered with the deep subperitoneal fascia, it is not to be mistaken for the dissecting layer. Following careful haemostasis of the small veins from the cranial and lateral side of the seminal vesicles, the dissection can continue towards the caudal side. It is better to dissect the Denonvilliers' fascia caudally as far as possible. There are visible dents indicating the passage to the supralevator space along the bilateral side of the rectum.

With regards to the dissection of the dorsal side and the ventral side of the rectum, the optimal order has not yet been determined. Therefore, if the field of view can be secured and the traction for the view is effective, it is better to continue to advance the field of the operation. Repeating the dorsal and the ventral dissection is appropriate.

4.4.2.3 Dissection of the Right Lateral Ligament

Scope: umbilicus.

The operator's right hand: an electrosurgical knife with spatula-type blade or an ultrasonically activated device (USAD).

The operator's left hand: maintains traction of the dorsal side of the rectum to the left.

The assistant's right's hand: maintains traction of the rectum ventrally.

The assistant's left hand: maintains traction of the rectum to the cranial and ventral side.

In order to divide the right rectal branches from the pelvic plexus, the method involves the separation of a sheet of the branches using an USAD in the dorsal view of the rectum. Subsequently, a sheet of branches can be divided from the ventral side of the rectum without causing any further damage to the pelvic plexus (Fig. 4.13). Advancing the dissection along the ventral side along inner surface of the pelvic plexus, the operator ultimately reaches the seminal vesicle that was previously dissected on the ventral side. In this way, a sheet of rectal branches from the pelvic plexus is guided like a tent towards the rectum. If the apex of the tent can be treated sharply by an electrosurgical knife and dissected bluntly, the so-called lateral ligament can be completely excised (Fig. 4.14).

4.4.2.4 Dissection of the Left Lateral Ligament

Scope: umbilicus.

The operator's right hand: an electrosurgical knife with spatula-type blade.

The operator's left hand: maintains traction of the dorsal side of the rectum to the right.

The assistant's right hand: maintains traction of the rectum ventrally.

The assistant's left hand: maintains traction of the rectum to the cranial and ventral sides.

The method of division of the left rectal branches from the pelvic plexus requires the division of a sheet of the branches

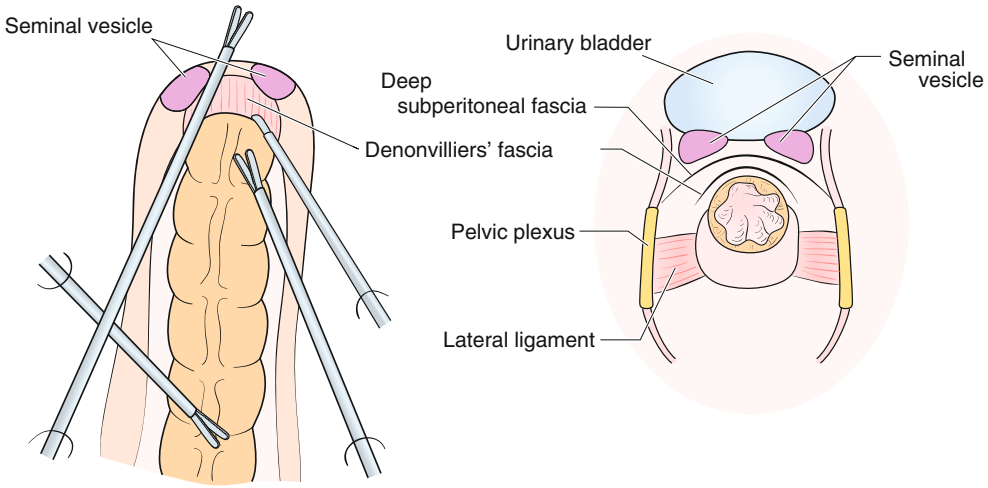

Fig. 4.12 Dissection between Denonvilliers' fascia and the deep subperitoneal fascia. At the medial part, the procedure requires to continue the dissection caudally along the dorsal side of the deep subperitoneal fascia from the ventral side of Denonvilliers' fascia. If the seminal vesicle is confirmed covered by the deep subperitoneal fascia, it is not to be mistaken for the dissecting layer

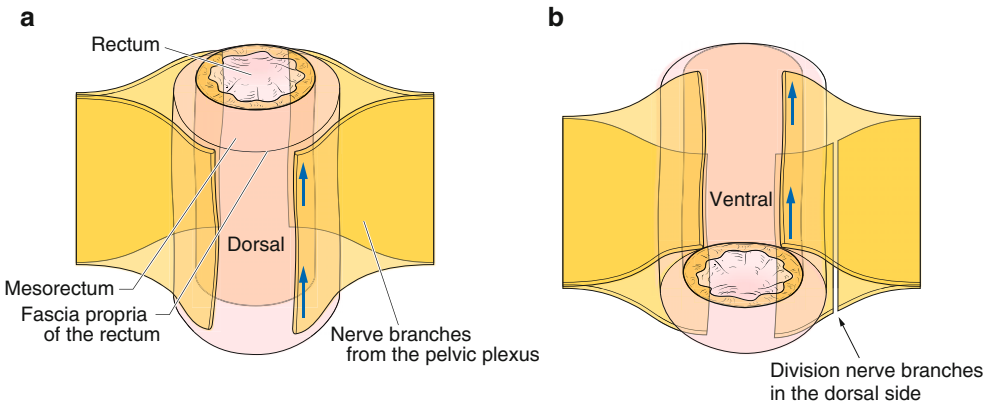

Fig. 4.13 Imaginary view of the division of the rectal branches from the pelvic plexus. To divide the rectal branches from the pelvic plexus, the procedure involves the separation of a sheet of branches in the dorsal view of the rectum (**a**). Subsequently, a sheet of branches can be divided from the ventral side of the rectum without causing any further damage to the pelvic plexus (**b**)

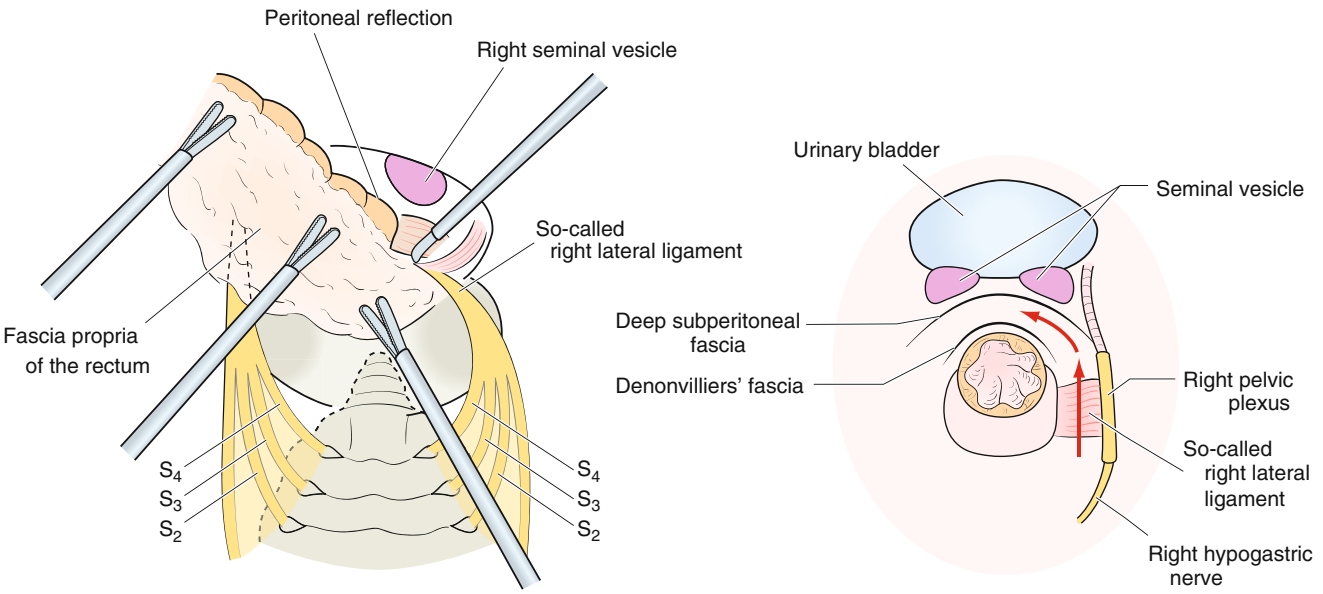

Fig. 4.14 Dissection and division of the right lateral ligament. The pelvic plexus is guided like a tent towards the rectum. If the apex of the tent can be treated sharply by electrocautery and dissected bluntly, the so-called lateral ligament can be completely excised

using an electrosurgical blade knife in the dorsal view of the rectum. Next, a sheet of the branches can be divided from the ventral side of the rectum without any further damage to the pelvic plexus (Fig. 4.13). The procedure on the ventral side is identical to that of the right side (Fig. 4.15).

4.4.2.5 Further Dissection and Cutting of the Ventral Side of the Rectum (Division of Denonvilliers' Fascia)

Scope: umbilicus.

The operator's right hand: an electrosurgical knife with spatula-type blade and USAD.

The operator's left hand: controls the ventral side of the rectum.

The assistant's right hand: controls the prostate to the ventral side.

The assistant's left hand: controls the prostate to the ventral side.

The dissection between the seminal vesicle and the Denonvilliers' fascia (i.e. between the deep subperitoneal fascia and Denonvilliers' fascia) has progressed to some extent, and it proceeds further to the caudal side (Fig. 4.12).

Blunt dissection is continued to reveal the ventral side of Denonvilliers' fascia. It is easy to dissect Denonvilliers' fascia from the seminal vesicle, while it becomes increasingly difficult to dissect the fascia from the prostate. Further dissection towards the caudal side is necessary to divide Denonvilliers' fascia and dissect the dorsal side of Denonvilliers' fascia.

With sufficient distance from the tumour, the dissection proceeds along the rectum on the bilateral sides of Denonvilliers' fascia to the supralevator space. Here, the nerve branches from the pelvic plexus and vessels (i.e. lateral ligament) can be divided. By dissecting off and avoiding damage to the surgical neurovascular bundles, the rectal dissection for the total mesorectal excision (TME) procedure is completed. In the absence of the division of Denonvilliers' fascia or if the distance from the tumour is adequate, it is not necessary to separate Denonvilliers' fascia for anastomosis to be performed.

In the case of a tumour-specific mesorectal excision (TSME), a longitudinal incision at the outermost part of Denonvilliers' fascia will be performed in order to expose the muscle layer of the rectum at this point. Then, it will be possible to enter the loose portions between the mesorectum and muscle layer and to divide the entire mesorectum circumferentially. However, it is not recommended to incise into the mesorectum blindly because of possible injury to the muscle layer.

Dissection of rectum off the pelvic floor (just above the anal canal) is completed by the above procedure.

4.4.2.6 Division of the Rectum

Scope: umbilicus.

The operator's right hand: Endo-GIA™.

The operator's left hand: free to remove the surrounding tissue using forceps.

The assistant's right hand: ensures access for the Endo-GIA™.

The assistant's left hand: maintains traction of the rectum cranially.

The rectum is cut with a flexible Endo-GIA™ (Fig. 4.16)

4.4.2.7 The Procedure from the Auxiliary Incision

The incision of the left lower port is prolonged about 5 cm and the LapDisc™ is mounted on the wound. Holding the anal side of the rectum and retracting it to the outside of the abdomen, the rectum is excised with a purse-string

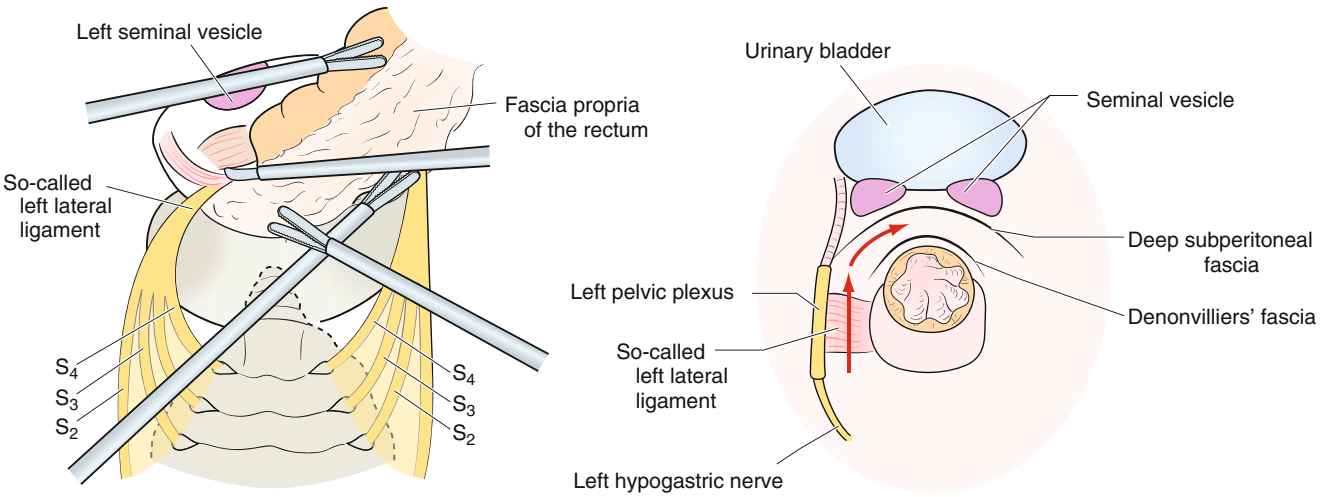

Fig. 4.15 Dissection and division of the left lateral ligament. Similarly, if the apex of the tent of the lateral ligament can be achieved, it can be disconnected sharply by electrocautery and dissected bluntly

instrument™ after division of the mesocolon for the lymph node dissection. The anvil head of the Premium circular end-to-end anastomosis™ (PCEEA) is equipped with the purse string suture (Fig. 4.17). The anvil head is returned to the abdominal cavity following closure of the LapDisc™.

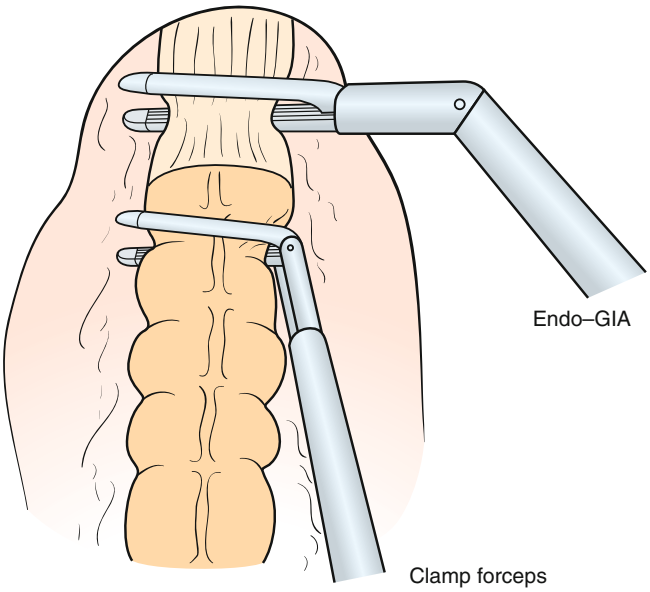

Fig. 4.16 Division of the rectum. The rectum is cut with flexible Endo-GIA™. In the lower division, it becomes a diagonal separation

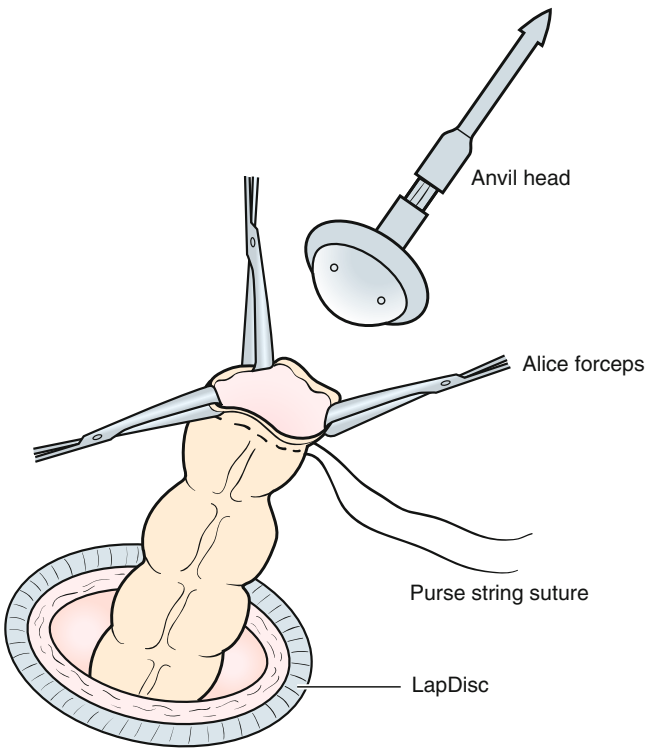

Fig. 4.17 The auxiliary incision procedure. The anvil head of the PCEEA™ (Premium circular end-to-end anastomosis)™ is equipped with purse string suture

4.4.2.8 Anastomosis

Scope: umbilicus. Shows an anastomosis during anastomosis with an angled scope.

The operator's right hand: Operation of the Endo-GIA™.

The operator's left hand: Operation of the Endo-GIA™ and removal of the surrounding tissue.

The assistant's right hand: Removal of the surrounding tissue.

The assistant's left hand: Removal of the surrounding tissue.

Following achievement of re-pneumoperitoneum, the PCEE™ is introduced into the anus and the trocar penetrates the position near the linear stapler of the rectum. After removing the trocar from the body, the trocar is removed from the abdominal cavity by pulling the string attached to the trocar tip. Next, the anastomosis is performed using the double stapling technique (DST) (Fig. 4.18). It is important to carefully avoid intestinal torsion and pinching of tissue into the anastomosis.

4.4.2.9 Insertion of a Drain and Closure of the Wound

After anastomosis is obtained, the sealing test is performed. Next, a Dual Drain™ is inserted from the left upper port and placed behind the anastomosis. The wound is mass-closed with interrupted 0-PDS™ sutures. Hasson's cannula is

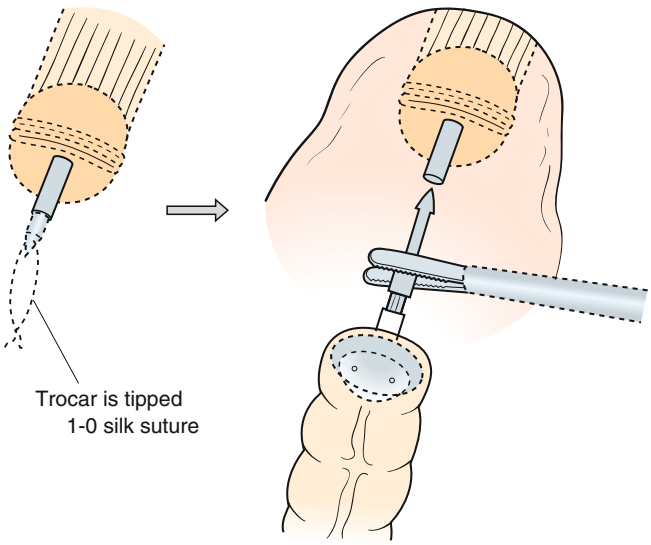

Fig. 4.18 Anastomosis by the double-stapling technique. The PCEEA™ is introduced into the anus and the trocar penetrates the positions near the linear staples of the rectum. After removing the trocar from the body, the trocar is removed from the abdominal cavity by pulling the string attached to the trocar tip. Next, the anastomosis is achieved using the double stapling technique (DST)

closed with a 3-0 Vicryl™ suture and staplers or 4-0 PDS-II buried sutures. The port incisions are closed with staplers or with 4-0 PDS-II buried sutures.

4.5 Intersphincteric Resection of the Rectum (ISR)

4.5.1 Dissection the Anal Canal from the Cranial Side

Dissection of the dorsal side of the rectum is begun by advancing part of the lateral side of the comma-shaped jewel to the ventral-medial side. It is necessary that the bilateral sides are dissected fully to expose the anal sphincter muscle. After dissecting the lateral side of the hiatal ligament, the puborectal muscle bundle is identified, and the medial side is dissected from the ventral to the dorsal side. The hiatal ligament and the puborectal muscle have become V-shaped by traction to the ventral side of the rectum. The oblique part of the hiatal ligament and the puborectal muscle that is now V-shaped are dissected off towards the intersection of the V inflection. When the dissection is performed at the bilateral side, the intersection of the V forms a gap and the longitudinal muscle of the anal canal is verified at this position (Fig. 4.19).

Returning to the ventral side of the rectum, the branches from the pelvic plexus to the rectum and the anal canal are fully divided. Finally, Denonvilliers' fascia is dissected up to the attachment of the prostate and divided at that point. This allows for almost a TME of the rectum (Fig. 4.20). If the division of the rectum is impossible based on the fluoroscopic examination, an intersphincteric resection (ISR) and coloanal anastomosis for low rectal cancer is performed.

4.5.2 Procedure from the Anus in the ISR

ISR is performed with the patient in the modified Lloyd-Davies position [10] (Fig. 4.21).

The anus region is widened using a anal retractor so that it does not tear the anal canal. If the surgeon cannot extend the anal stenosis, a few millimetre-sized vertical incisions are made on the intersphincteric sulcus and a lateral internal sphincterotomy is performed to dilate the anus. While a surgical surface on the anal canal is created using the anal retractor, an incision is made along the circumference of the dentate line. After mounting the Lone-Star retractor to the anus (Fig. 4.21), on the dorsal side of the anal canal, the incision progresses to the dorsal side along the union of the longitudinal muscle and is then spread to the bilateral side. At this point, the lateral sides of the incision are sutured with 3-0 Nurolon ™ to close the anal canal (Fig. 4.22a). Further incision and closure of the anal canal with sutures is advanced sequentially. Finally, the anal canal is closed circumferentially. While pulling the suture threads, the dissection is continuous with the detached parts from the abdominal cavity. Thus, the rectum and lymph nodes can be excised and retracted from the anus (Fig. 4.22b).

The sigmoid colon is divided and the coloanal anastomosis is achieved with 3-0 PDS-II sutures by hand stitching.

4.6 Fascial Composition of the Pelvis—Fascia Propria of the Rectum [2]

Given the fine vision available with the development of laparoscopic surgery, an improved understanding of the fascia composition is required. Modern surgical procedures of the rectum have thus required surgeons to revise

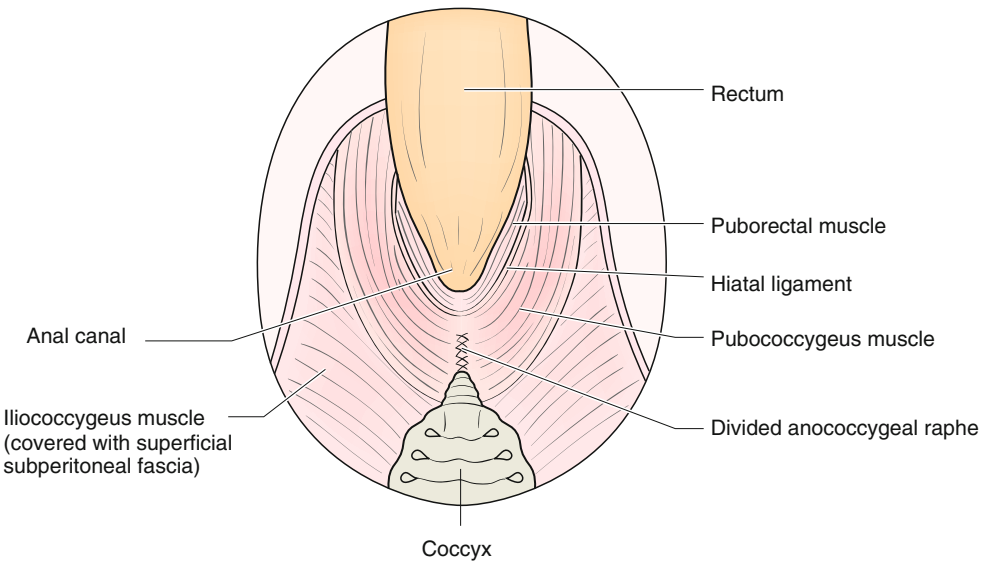

Fig. 4.19 Dissection of the anal canal. After dissecting the lateral side of the hiatal ligament, the puborectal muscle bundle is located and the medial side is dissected from the ventral to the dorsal side. The hiatal ligament and the puborectal muscle become V-shaped due to the traction to the ventral side of the rectum. The oblique part of the hiatal ligament and the puborectal muscle is dissected off towards the intersection of the V inflection. When the dissection is performed at the bilateral side, the intersection of the V forms a gap and the longitudinal muscle of the anal canal is verified at this position

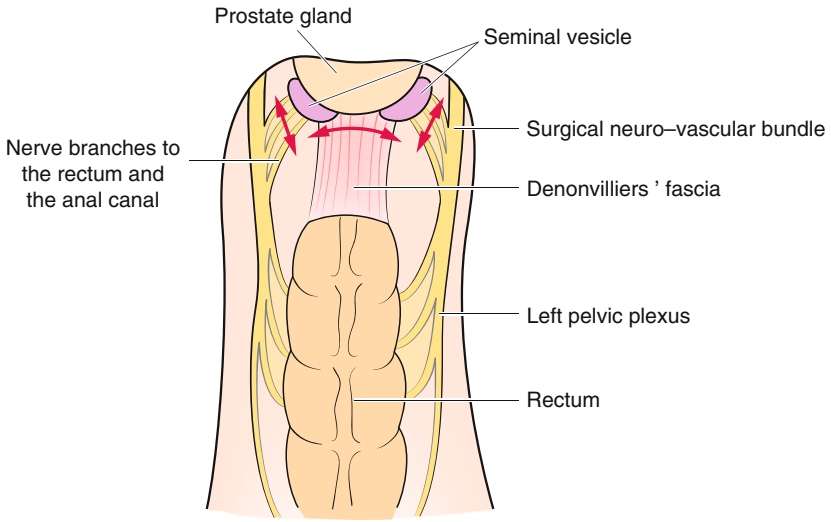

Fig. 4.20 Division of Denonvilliers' fascia. The branches extending from the pelvic plexus to the rectum and the anal canal are divided fully. Finally, the Denonvilliers' fascia is dissected up to the attachment of the prostate and is then divided at that part

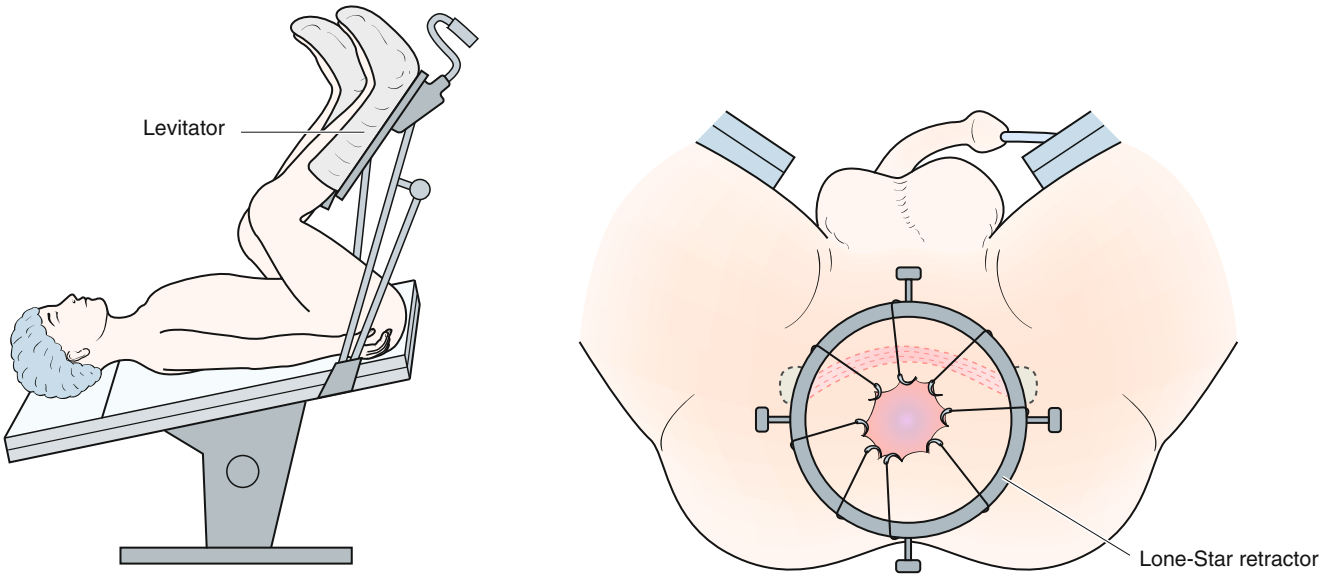

Fig. 4.21 Position for the intersphincteric resection. The intersphincteric resection (ISR) is performed with the patient in the modified Lloyd-Davies position. The Lone-Star retractor is mounted onto the anus

their understanding of the surgical anatomy of this region. Various findings have also been reported for the low anterior resection of the rectum. In addition, many terms without strict definitions have been introduced, although a standardisation of terms relative to the fascial composition from the abdomen to the pelvic space has not been achieved.

The fascial composition of the colon is comparatively simple, so it is easy to understand. However, in order to understand the fascial configuration of the pelvic space, the configuration of all organs in the abdominal cavity must be considered according to the interpretation by Tobin et al. [11], Sato [12], and Takahashi [3–7]. The continuity of the fascia must always be recognised in both the pelvic space and the abdomen.

The most important fascia is the fascia propria of the rectum that acts as an anatomical index for the dissection of the dorsal side of the rectum. Here, this fascia is defined as "the most internal (deep) fascia wrapping the meosrectum". Consideration of the relationship between the fascia propria

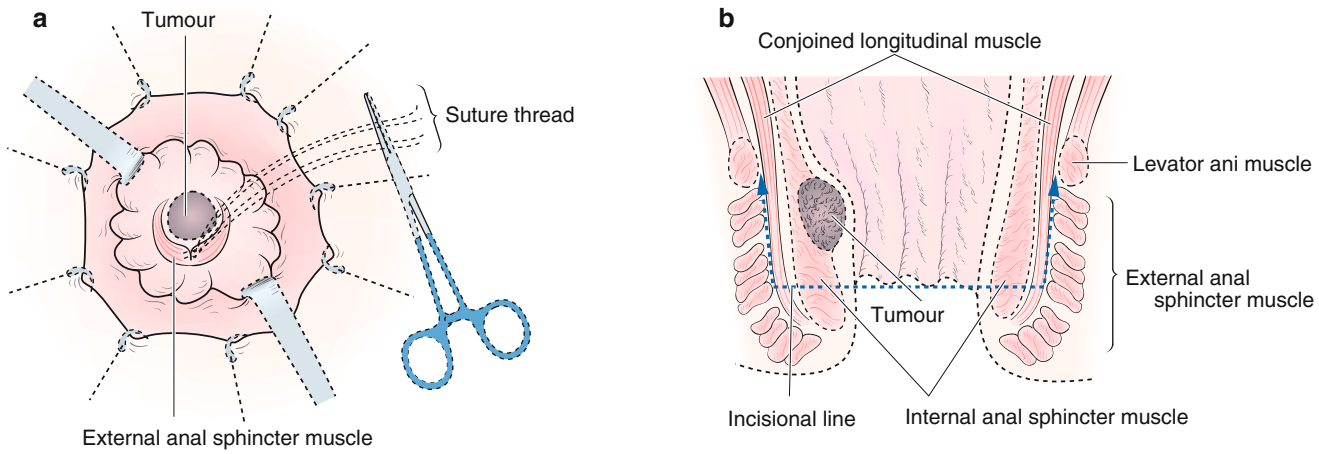

Fig. 4.22 Procedure from the anal side in intersphincteric resection. While a surgical surface on the anal canal is created using the anal retractor, an incisional is made along the circumference of the dentate line. From the dorsal side of the anal canal, the incision progresses to the dorsal side of the union of the longitudinal muscle and is then extends to the bilateral side. At this point, the lateral sides of the incision are sutured with 3-0 Nurolon™ to close the anal canal (**a**, **b**)

of the rectum and the subperitoneal fascia in the sigmoid mesocolon is needed to clarify this issue. This issue must be addressed, as the current understanding of the configuration of the perirectal fascia is inadequate. In this interpretation of basic fascial composition around the body circumference by Tobin et al. [11] and Sato [12], no fasciae other than the two subperitoneal fasciae in the subperitoneal space are considered to be present. These two fasciae can thus be properly called the visceral pelvic fascia (a continuation of the deep subperitoneal fascia) and parietal pelvic fascia (a continuation of the superficial subperitoneal fascia) in the pelvic space, existing in isolation and not continuous with each other. The fascia propria of the rectum must thus be defined as a third sheet in order to correctly theorise the continuity of the fascia. Generation of the fascia propria of the rectum must be examined on the basis of this fact [4].

Dr. Takahashi mentions the origin of the fascia propria of the rectum by examining the relationship between organ control of the autonomic nerve fibres, the nerve plexus, and the ganglion. That is, innervation by the sympathetic and parasympathetic nervous system is present along the superior mesenteric artery on the oral side from one third of anal side of the transverse colon.

However in the inferior mesenteric artery, the nerve accompanying the same artery is only sympathetic, and the parasympathetic nervous system seems to control the colon and rectum in a retrograde manner from the pelvic plexus through the hypogastric nerve and the superior hypogastric plexus (Fig. 4.23). A strong connective tissue that replaces the nerve plexuses and is present in the artery circumference is necessary as a corridor for both the sympathetic and parasympathetic nerve systems. The strong connective tissue present is considered to be the fascia propria of the rectum. That is, structurally from the caudal to cranial direction on the dorsal side of the rectum, the fascia propria of the rectum shows left-right symmetry and converges in a cranial direction. Furthermore, it is the fascia propria of the rectum from which the deep subperitoneal fascia protrudes at the caudal part in a cranial direction. In other words, this part of the reflection represents the rectosacral ligament. The fascia propria of the rectum seems to fuse again with the deep subperitoneal fascia at the cranial tip [6]. The fascia propria of the rectum is then accompanied by the hypogastric nerve including the parasympathetic fibres from the pelvic plexus and the sympathetic fibres from the superior hypogastric plexus. The pelvic plexus is formed with connective tissue on the lateral sides of the rectum at the beginning of the fascia propria of the rectum. The superior hypogastric plexus is found in the fused part between the fascia propria of the rectum and the deep subperitoneal fascia [6] (Fig. 4.24).

According to the theory by Dr. Takahashi described above, the fascia propria of the rectum is defined as the autonomic nerve corridor from the pelvic plexus to the superior hypogastric plexus. The gap between Dr. Takahashi's theory and reality is that many surgeons understand that the fascia propria of the rectum is on the dorsal fascia of the rectum and that the nerve branches from the hypogastric nerve run towards the left and right sides of this fascia. For the former, Dr. Takahashi expressed the idea that the fascia propria of the rectum includes the hypogastric nerve and the neurovascular fascia with its branches. According to this theory, realistically it may be inconvenient that the fascia propria of the rectum is referred to as the portion corresponding to the sigmoid colon. In addition, the neurovascular fascia of the rectal

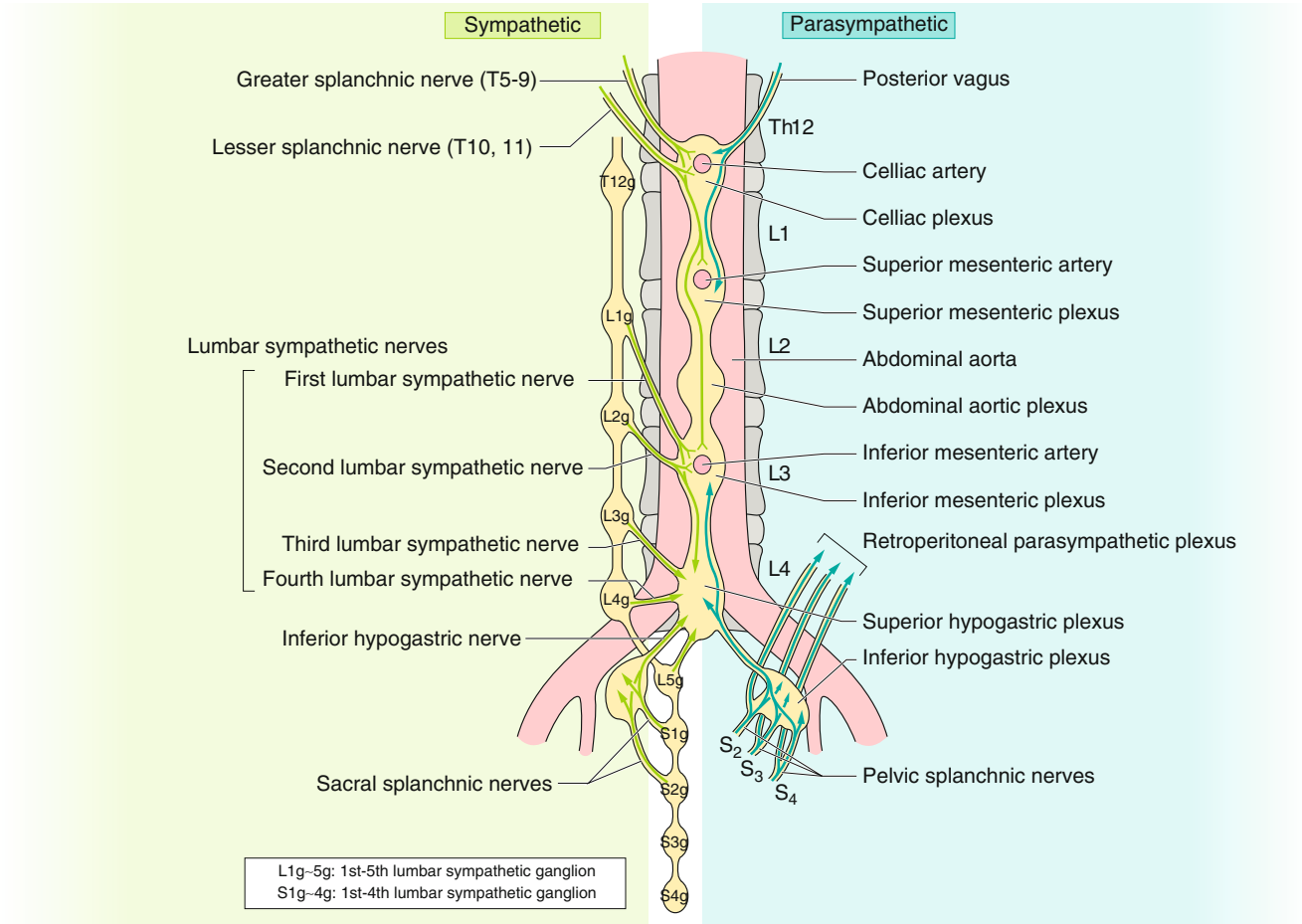

Fig. 4.23 Innervation by the sympathetic and parasympathetic nervous system. Innervation by the sympathetic and parasympathetic nervous system is present along the superior mesenteric artery (SMA) on the oral side up to one third of the anal side of the transverse colon However in the inferior mesenteric artery (IMA), the nerve accompanying the same artery is only sympathetic, and the parasympathetic nervous system seems to control the colon and rectum in a retrograde manner from the pelvic plexus through the hypogastric nerve and the superior hypogastric plexus [13, with permission]

branches from the hypogastric nerve must be referred to as the fascia propria of the rectum. However, if the fascia of the sigmoid colon continuing to the fascia propria of the rectum is called by another medical term, an originally functionally integrated fascia will be defined by different terms. This is not desirable from an embryological standpoint.

Furthermore, in order to fill in the gaps of this definition in Dr. Takahashi interpretation, many surgeons leave the concept of the fascia propria of the rectum unchanged. However, there would be a strong possibility for a better understanding if the fascia that continues from the fascia propria of the rectum is defined by a different name. Herein, we named the fascia continuing from the fascia propria of the rectum the "neuro-vascular corridor" (Figs. 4.2 and 4.3). This expression is very convenient for describing the surgical technique.

The medical term "ureter-hypogastric fascia" is currently used in Japan but it is not entirely appropriate because the ureter is securely separated from the hypogastric nerve by the deep subperitoneal fascia. Furthermore, the idea that urology and surgery share the same fascia is inappropriate from an embryological point of view.

4.7 Current Issues and Proposal of the Fascial Composition of the Rectum [2]

Outcomes of treatment for rectal cancer are dependent on the operative technique used, although complication rates vary [14, 15]. Complications can arise during the mobilisation of the rectum, resulting in damage to the ureter, autonomic nerves, and the rectum itself. Complication rates can be reduced by careful dissection of the correct tissue plane in the pelvic space [16]. Heald's description [17] of total mesorectal excision (TME) is considered the

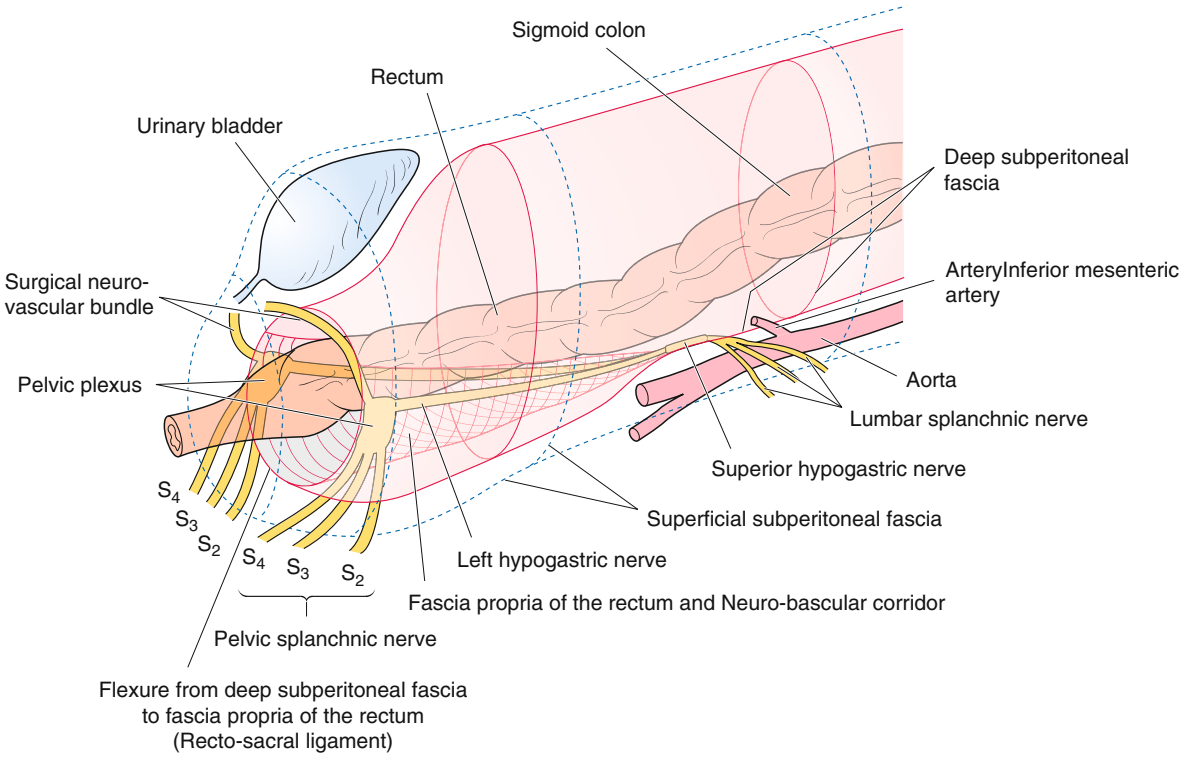

Fig. 4.24 Fascial configuration and autonomic nerves surrounding the rectum. The fascia propria of the rectum is accompanied by the hypogastric nerve, including parasympathetic fibres from the pelvic plexus and sympathetic fibres from the superior hypogastric plexus. The pelvic plexus is formed with connective tissue on the lateral sides of the rectum at the beginning of the fascia propria of the rectum, and the superior hypogastric plexus is located at the fused part between the fascia propria of the rectum and the deep subperitoneal fascia [2, with permission]

"Bible" of rectal cancer surgery. This excellent treatment concept improves the prognosis of surgical treatment for rectal cancer. However, "Heald's procedure was developed with an awareness of the importance of complete excision under direct vision of the envelope of lymphovascular fatty tissue surrounding the rectum and its mesorectum" [18] and has not been considered from the perspectives of clinical anatomy and embryology. Laparoscopic surgery has generally been performed for rectal cancer in recent years. The operative procedure thus needs to be described in detail taking advantage of the fine vision made possible by modern laparoscopy. In addition, this technique can be performed in the narrow pelvis by distinguishing the approach and fascial composition in an operative field where blood vessels and nerves are crowded [19, 20]. Modern surgical procedures of the rectum have thus required surgeons to revise their understanding of the surgical anatomy of this region [21]. Reviews of the fascial composition of the colon and rectum circumference are thus periodically required. However, the description of the anatomy of fascial composition has also mainly directed observation away from a fundamentally embryological concept, causing confusion regarding explanations of operative procedures according to various terms used without any clear definitions [16, 22–27].

The fascial composition of the colon is comparatively simple if intestinal rotation and the term fusion fascia are understood. However, perirectal fascia configurations can be considered from three perspectives by focusing on specific consideration of the fascia propria of the rectum on the dorsal side of the rectum, Denonvilliers' fascia on the ventral side of the rectum, and the lateral ligament. In many papers, consideration of the dissection of this portion has been added on the basis of histological retrieval [24, 26, 27]. However, the lack of consideration common to all such studies involves the relationship of the configuration of the fascial composition extending from the pelvis to the cranial abdomen. That is, where the fascial composition in the pelvic space has been reviewed previously, no papers have mentioned the continuity of the fascial composition with the peritoneal cavity. In

addition, many terms without strict definitions have been introduced, because a unification of terms referring to the fascial composition from the abdomen to the pelvic space has not yet been accomplished [16, 22–27].

The composition of fascia originally observed intraoperatively cannot be anatomically and histologically identified [28, 29], and only clinical anatomy seems capable of permitting examination and guiding understanding [23]. Moreover, fascial composition according to histological examination is considered with accompanying vessels, nerves, and fatty tissue as indicators. Use of only histological and anatomical examination is not feasible. In the light of these vague concepts, the exceptional fasciae are the fascia propria of the rectum and Denonvilliers' fascia that should be considered to be distinct from the subperitoneal fascia. That is, the two fasciae can be distinguished histologically and should be emphasised from an embryological standpoint.

Here, when we raise the issues related to the fascia composition in the low anterior resection of the rectum, these include: (1) the number of sheets to be considered in the sigmoid mesocolon; (2) the definition of the fascia propria of the rectum; (3) the definition of the recto-sacral ligament; (4) the fascial configuration in the ventral side of the lower rectum, especially the Denonvilliers' fascia; and (5) the fascial configuration on the lateral sides of the rectum. Solutions need to be considered for these problems.

4.7.1 Fascia Composition of the Sigmoid Colon

When the dissection between the fusion fascia of Toldt of the sigmoid colon and the deep subperitoneal fascia is performed, further sheets of the fascia may be encountered intraoperatively. That is, the mesentery would not necessarily be composed of two sheets of fascia. Originally, the peritoneum covered the entire intestinal tract and the mesentery was the same structure that also included the parietal peritoneum, and it may be a matter of course to consider that the peritoneum is formed by a fibrous layer (the tunica subserosa) and a surface layer of mesothelium (tunica serosa) [30]. In addition, there is also the idea that the deep subperitoneal fascia is extended to the intestinal tract through the dorsal mesentery [31], thus it may be considered that the mesentery is formed by four fasciae. From these ideas, it is believed to be premature that fascia encountered intraoperatively be considered as an artefact. However, to apply this theory to further the understanding of the clinical anatomy of the entire abdomen is misleading because of the complexity of the fascial composition.

4.7.2 Definition of the Fascia Propria of the Rectum

For the fascial composition of the dorsal side of the rectum, two fasciae, the presacral fascia and the fascia propria of the rectum, have been considered to exist between the sacrum and the rectum according to histological retrieval using cadaveric material [25, 27]. Furthermore, according to the definition of the mesorectum used in Europe and the USA, the fascia propria of the rectum is identified as the endopelvic visceral fascia and covers the mesorectum including the perirectal fatty tissue [32]. This is a cause of confusion regarding the term endopelvic visceral fascia. That is to say, the existence of the term visceral fascia requires a guarantee of the term parietal fascia, which has not been defined. The fascia propria of the rectum must thus be defined as a third sheet in order to theorise continuity of the fascia. Generation of the fascia propria of the rectum must be examined on the basis of this fact.

The fascia propria of the rectum is defined as "the most internal (deep) fascia wrapping the mesorectum, which is then accompanied by the hypogastric nerve, including parasympathetic fibres from the pelvic plexus and sympathetic fibres from the superior hypogastric plexus for supply to the sigmoid colon and rectum". However, for the surgeon that has considered the fascia propria of the rectum as the fascia contacting the mesorectum in the dorsal side of the rectum, it may be hard to understand that the fascia propria of the rectum is defined according to a completely different concept in this theory.

4.7.3 Definition of the Rectosacral Ligament

Two possibilities must be considered regarding the rectosacral ligament in relation to the fascia propria of the rectum. One is the opinion that the rectosacral ligament is a surgical artefact [24, 26, 33]; while the alternative is that the rectosacral ligament is present and significant [27, 34–36]. However, naming the rectosacral ligament "Waldeyer's fascia" is improper, as Waldeyer did not refer to the ligament in his original paper [36].

Dr. Takahashi's theory [4, 5] clarified the existence of the rectosacral ligament and examined the meaning of the continuation from the deep subperitoneal fascia to the fascia propria of the rectum as a portion of the flexure, based on the innervation to the rectum.

4.7.4 Fascial Configuration in the Ventral Side of the Lower Rectum, and in Particular About Denonvilliers' Fascia

Consideration of the ventral side of the rectum may be the based on Denonvilliers' fascia. It can be said that it is a relatively tight tissue towards the caudal side from the rectovesical fossa. Further, between the seminal vesicle-prostate and the rectum there is evidently the deep subperitoneal fascia described by Tobin et al. [11] and Sato [12].

With regards to the origin of Denonvilliers' fascia, the literature can basically be divided into two camps: fusion theory [23, 37–39] and condensation theory [40, 41]. The former opinion seems to have predominated [42–44]. Furthermore, there are few papers that report that the fascia propria of the rectum exists between Denonvilliers' fascia and the rectum and continues towards the fascia propria of the rectum on the dorsal side of the rectum [16, 26, 45]. In addition, there are also a few papers in which the fascia propria of the rectum is present along the entire circumference of the lower rectum [22, 26]. The weakness of these papers is that the fascia propria of the rectum has not been proven circumferentially in the upper rectum where it is in the presence of serosa. Furthermore, an additional problem is that the continuity toward the subserosa of the sigmoid colon has not been demonstrated. In conclusion, the fascia may be present, and it is reasonable to consider that four sheets are present in the mesentery and the intestinal wall [30, 31]. Accordingly, the fascia is not related to the fascia propria of the rectum.

In addition, there is a discussion about whether the dorsal or the ventral side of the Denonvilliers' fascia should be dissected during the surgical procedure in rectal cancer [46–49]. The philosophy of rectal cancer surgery is that the lymph node dissection of the inner side of the deep subperitoneal fascia between the digestive organ and the urogenital organ is to be performed and the sufficient circumferential resection margin should be ensured. Therefore, it can be rightly considered to dissect between the deep subperitoneal fascia and the Denonvilliers' fascia in the ventral side of the lower rectum. There is also an opinion that the dissection should not be performed in the ventral side of the Denonvilliers' fascia because it does not damage the nerves [46], but surgeons do not bend the surgical philosophy with too much fear of nerve damage. The deep subperitoneal fascia is continuous from the abdomen to the pelvic space, it should be recalled that it does not differ from the concept of Tobin et al. [11] and Sato [12]. In other words, it is correct to dissect between the Denonvilliers' fascia and the deep subperitoneal fascia because of the continuity of the dissecting plane on the dorsal side of the rectum, it is considered the dissecting surface that Heald referred to as the 'Holy Plane' [50].

4.7.5 Fascial Configuration in the Lateral Sides of the Rectum

The lateral side of the rectum is hardly discussed within the context of the fascial composition because this side is a passage of the nerve branches from the pelvic plexus to the rectum. That is, it is the only site where it is difficult to be conscious about the continuity of the ventral and dorsal sides of the lower rectum. During the surgical procedure, reaching the pelvic floor after dividing the rectosacral ligament in the dorsal side of the rectum, it is possible to divide the rectal branch from the pelvic plexus near the rectal wall. Therefore, the literature discussing this portion is mostly derived from the surrounding fascial composition [51–53]; there is also literature that does not use the term lateral ligament [54]. In surgery, the process proceeds first on the dorsal side and then on the ventral side where the dissecting surface can easily be identified, it is important to proceed towards the lateral side at the end of the procedure.

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Laparoscopic Abdominoperineal Resection of the Rectum

5

5.1 Introduction

In the treatment of rectal cancer, the spotlight has been placed on how to preserve the anus. In fact, it has become possible to perform anal sparing surgery in many cases using intersphincteric resection of the rectum (ISR) for rectal cancer. However, the indication for laparoscopic abdominoperineal resection (LapAPR) of the rectum for rectal cancer has not diminished. The surgical technique involved requires the laparoscopic resection of the low anterior rectum. However, procedures beyond the rectosacral ligament must maintain sufficient distance from the rectum and/or the anal canal, and is defined as the circumferential resection margin.

5.2 Stoma Site Marking and Preoperative Treatment

Stoma site marking is performed together with a certified wound-ostomy-continence nurse.

5.3 Operative Procedures (in Men)

5.3.1 Treatment of the Anus

The anus is closed using two purse-string sutures with a 0-monofilament suture. The handling of the needle is necessary to fully raise the tissue using fine sutures in order to prevent leakage of stool during the operation.

5.3.2 Intraoperative Positions

The patient is placed in the lithotomy position with Levitator™ stirrups with both thighs strapped to linearize to the trunk as much as possible. In order to improve the field of view in the anal operation, the knee is bent further, which is a modification of the Lloyd-Davies position [1]. As a result, the anus is widely accessible, and an optimal field of view of the ventral and lateral sides of the anal canal is ensured (Fig. 5.1).

5.3.3 Operative Procedures

See the relevant laparoscopic sigmoidectomy (LapS; Chap. 3) and laparoscopic low anterior resection (LapLAR; Chap. 4) sections for the dissection and mobilization of the sigmoid colon and the rectum.

5.3.3.1 Additional Dissection in the Lesser Pelvis (Especially in the Retrorectal Space)

Scope: umbilicus

The operator's right hand: an electrosurgical knife with spatula-type blade

The operator's left hand: maintains traction of the fascia propria of the rectum to the ventral-caudal side

The assistant's right hand: assists in the fine manoeuvres of the operator

The assistant's left hand: lifts the fascia propria of the rectum to the ventral side as required

The procedure to reach the pelvic floor after dissection of the recto-sacral ligament is similar to that of LapLAR; however, after reaching the pelvic floor, the operative procedure differs.

At this point, the caudal edge of the S4 pelvic splanchnic nerve that rises from the sacrum can be confirmed. Here, the rectum is dissected bilaterally to the caudal-ventral side, the supralevator space resembles a comma-like space, but the procedure must not extend to the nearby the anorectal region (Fig. 5.2).

In the retrorectal space, when dissection is performed toward the caudal side, the anococcygeal raphe is visually recognized as directed from the coccyx to the rectum. If the dissection is performed slightly distant from the midline, the anococcygeal raphe is clearly exposed (Fig. 5.2). A minimal dissection of the bilateral mesorectum is

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performed far from the hiatal ligament. The anococcygeal raphe is divided near the coccyx and the levator ani muscle is divided into a U-shape using an ultrasonically activated device (USAD) (Fig. 5.2). Distancing from the rectum as far as possible, the iliococcygeus muscle and the pubococcygeus muscle (the levator ani muscle) are divided to the ventral side into a U-shape by the USAD, to expose the granular fatty tissue of the ischiorectal fossa (Fig. 5.3).

When bleeding occurs before reaching the pelvic floor, the field of view is no longer visible for the operation. Thus, sufficient haemostatic control is mandatory.

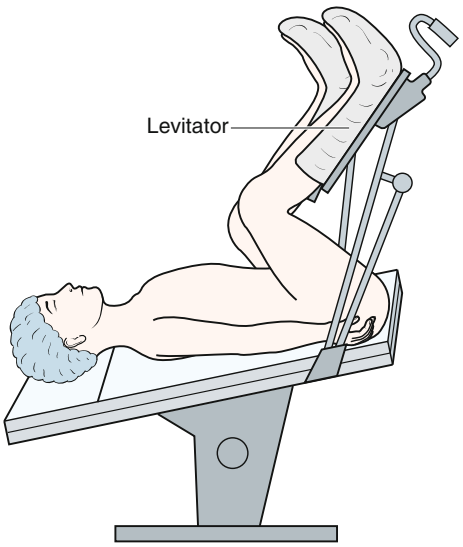

Fig. 5.1 Modified Lloyd-Davies position. The knee position is bent further, which is a modification of the Lloyd-Davies position, the anus is widely accessible, and ensures an optimal field of view of the ventral and lateral sides of the anal canal

5.3.3.2 Further Dissection of the Ventral Side of the Rectum

Scope: umbilicus

The operator's right hand: a spatula-type electrosurgical knife and an USAD

The operator's left hand: controls the ventral side of the rectum

The assistant's right hand: controls the prostate to the ventral side

The assistant's left hand: controls the prostate to the ventral side

It is important to dissect sufficiently as far as possible between the prostate and Denonvilliers' fascia. Denonvilliers' fascia is separated from the prostate at the terminal end by an USAD. In addition, at the lateral portions of the rectum, the rectal branches from the pelvic plexus are further divided using the USAD.

5.3.3.3 Division of the Sigmoid Colon

Scope: umbilicus

The operator's right hand: an electrosurgical knife with spatula-type blade and Endo-GIA™

The operator's left hand: grasps the sigmoid mesocolon with the forceps

The assistant's right hand: grasps the sigmoid mesocolon with the forceps

The assistant's left hand: maintains traction of the sigmoid colon to the cranial side

After determining where the sigmoid colon is to be divided, the sigmoid mesocolon is divided from the cranial stump obtained from the lymph node dissection. In cooperation with the assistant, a view of the mesocolon is obtained and the mesocolon is divided with the USAD and the sigmoid colon is then divided using a flexible Endo GIA™ (Fig. 5.4).

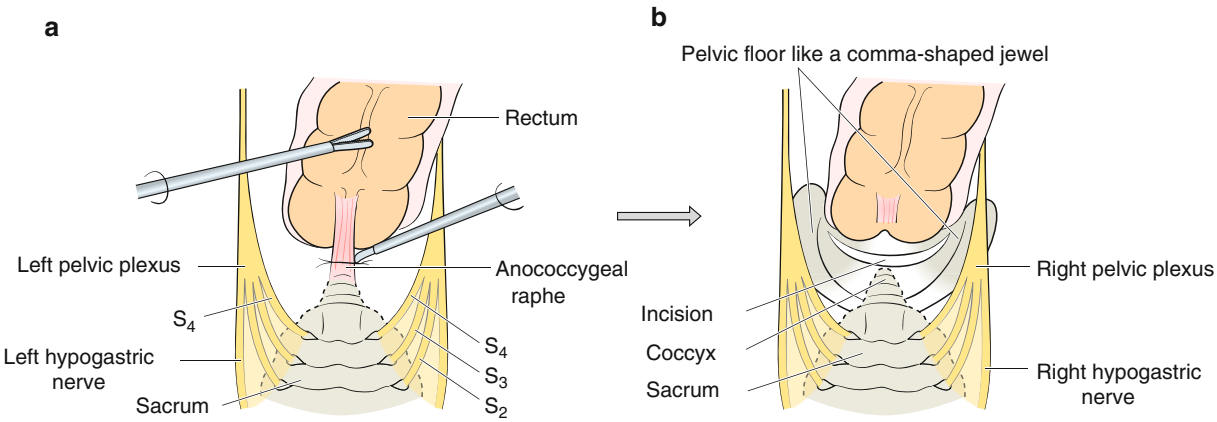

Fig. 5.2 (**a**, **b**) Disconnection of the anococcygeal raphe. This dissection of the left and right sides of the mesorectum is performed minimally and distally to the hiatal ligament. The anococcygeal raphe is divided near the coccyx and the levator ani muscle is divided into a U-shape using an ultrasonically activated device (USAD)

5.3.3.4 Operation from the Perinaeum

The anus is sutured and closed with purse-string sutures. The patient is in the modified Lloyd-Davies position with further bending, and the perinaeum is fully visible. Following a second thorough disinfection of the perineum, an incision is made several centimetres distant from the anal verge (Fig. 5.5). The anatomical landmarks are the coccyx on the dorsal side, bilateral ischial tuberosity on the lateral side, and the perineal body on the ventral side in men. Although the skin guideline acts as the midpoint between the above and the closed anus, a broad skin excision does not lead to a better dissection. A Loan-Star wound retractor™ is used to raise the edge of the skin incision (Fig. 5.5). The subcutaneous fat is excised. If the lesion is a far advanced cancer, the incision is made using the medial edge of the gluteus maximus muscle as an index.

Without exposing the gluteus maximus muscle, which is located dorsally and bilaterally, the dissection proceeds towards the coccyx tip as the anatomical landmark, there the granular fatty tissue of the ischiorectal fossa becomes visible. It is possible to reach the peritoneal cavity easily on the ventral side of the coccyx. Since the levator ani muscles have been divided into a U-shape, the passage between the abdominal cavity and the perineum may be incised into a U-shape at this point (Fig. 5.3)

Here, the dissection continues further towards the ventral side from the outside to expose the superficial transverse perineal muscle and to divide the rectal branches. In the ventral midline portion, the bulbocavernosus muscle, the external anal sphincter muscles, the levator ani muscle, and the horizontal stripes of perineum are combined resembling a tough connective tissue, which is defined as the perineal

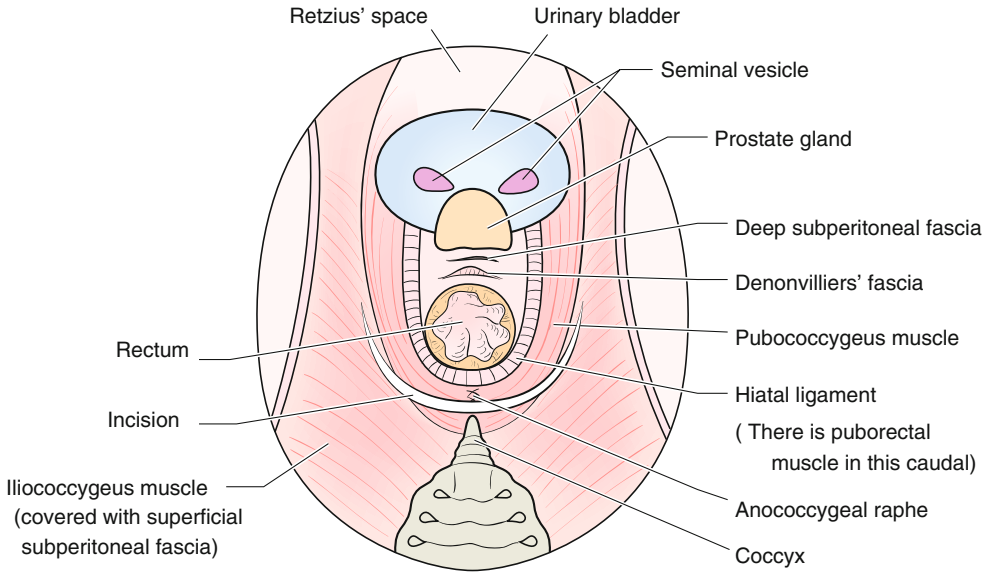

Fig. 5.3 Division of the levator ani muscles. Distancing from the rectum as much as possible, the iliococcygeus muscle and the pubococcyeus muscle (the levator ani muscle) are divided to the ventral side in a U-shape by USAD, to expose the granular fatty tissue of the ischiorectal fossa

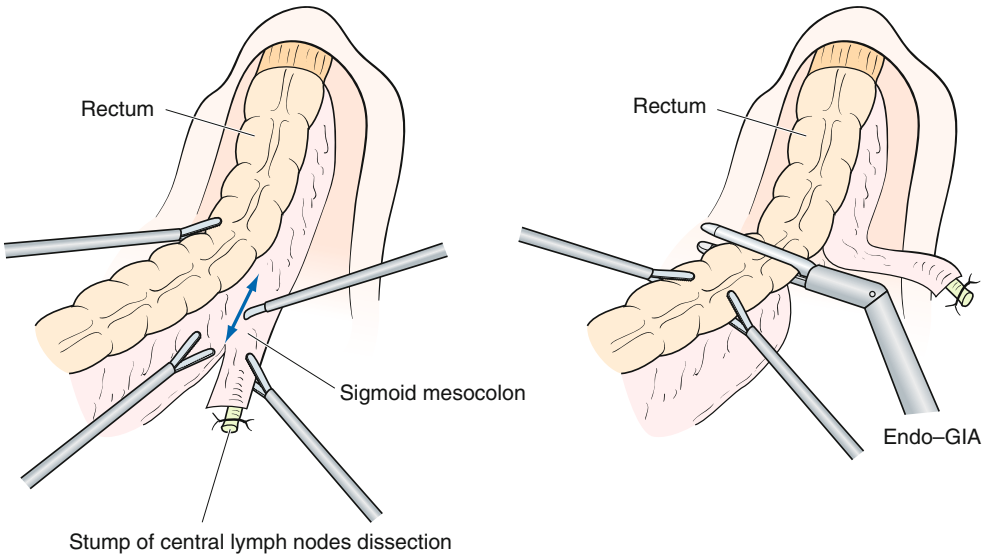

Fig. 5.4 Division of the sigmoid colon. The sigmoid mesocolon is divided from the cranial stump of the central lymph node dissection. In cooperation with the assistant, a view of the mesocolon is obtained and the mesocolon is then divided using a USAD. The sigmoid colon is divided using the flexible Endo GIA™

body (Fig. 5.6). The bilateral levator ani muscle is further exposed with the muscle retractor by the assistant and divided. Approximately three-quarters of the circuit of the pelvic attachment of the levator ani muscle are exposed by this manoeuvre (Fig. 5.6).

Next, the rectum is inverted towards the perineal side. The surgeon grasps the inverted rectum for counter traction and dissects the ventral side of the pelvic adaptation of the levator ani muscle. Palpating the dorsal side of the prostate, the site where the prostate and puborectalis muscle are attached to the rectal wall is carefully divided using an electrosurgical knife (Fig. 5.7). However, if the prostate and the Denonvilliers' fascia are disconnected from the abdominal cavity, the inversion step is not required. The dissection is advanced further from the prostate. Finally, the division of the perineal body is completed to end the manoeuvres. As this site is very close to the urethra diaphragm, the urinary catheter in men is used as the guide to avoid further damage.

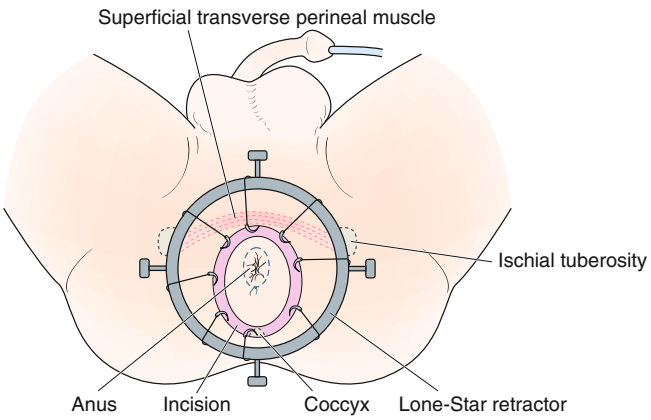

Fig. 5.5 Perineal procedures. The anus is sutured and closed with purse-string sutures. The patient is in the modified Lloyd-Davies position and bent further, the perinaeum is fully visible. Following thorough disinfection, an incision is made several centimetres distant from the anal verge and a Loan-Star wound retractor™ is used to raise the edge of the skin incision

5.3.3.5 Endo-colostomy and Insertion of the Drain

After re-establishing pneumoperitoneum, the Lloyd-Davies position is pushed slightly back, and the haemostasis of the pelvic space is confirmed, and irrigation of the pelvic space is performed. The subcutaneous tissue is closed with 0-PDS™ sutures, and the skin is closed using 2-0 Nylon™ vertical mattress sutures to complete the perineal procedure.

A Dual Drain™ is inserted into the pelvic space from the right lower port.

The centre of the colostomy site is held with Kocher's forceps and lifted to the ventral side. A circular skin incision with a diameter of 2 cm is performed as the dermis is sufficiently exposed (Fig. 5.8). Thus, the dermis having good vascularization is visible. The subcutaneous fat is dissected off to reach the anterior rectus sheath. A cross-like incision is made on the rectus sheath and the rectus muscle is opened bluntly with muscle retractors to reach the posterior rectus sheath. The posterior rectus sheath and the peritoneum are divided. This will ensure that the path is not excessively narrow and impedes bending. After confirming that the sigmoid colon is not twisted, the colon stump is induced outside the abdominal wall. The anterior and posterior rectus sheath is sutured with a 4-point fixation using 3-0 PDS-II™ thread.

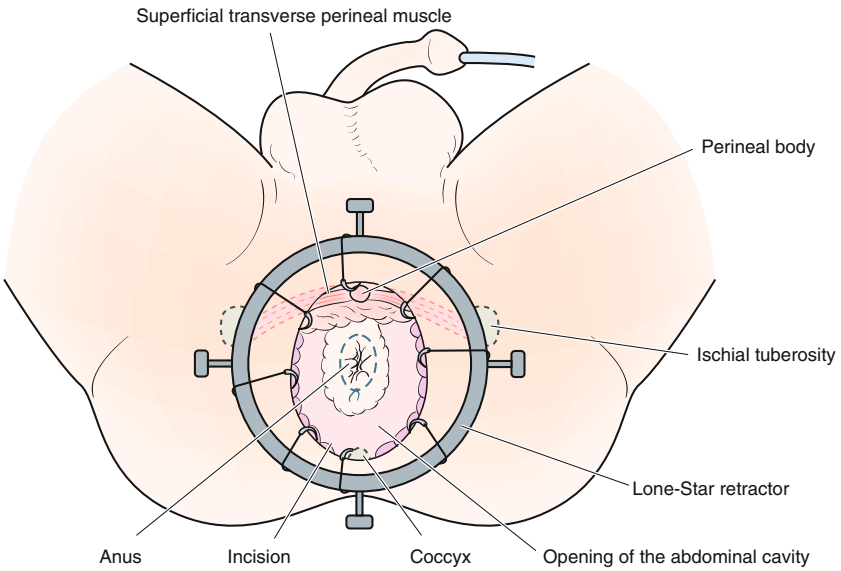

Fig. 5.6 Reaching from the perineum to the abdominal cavity. Without exposing the gluteus maximus muscle that is dorsal and bilateral, the dissection continues along the coccyx tip as the anatomical landmark, and the granular fatty tissue of the ischiorectal fossa becomes visible. It is possible to easily reach the peritoneal cavity on the ventral side of the coccyx. The dissection proceeds further moving towards the ventral side from the outside to expose the superficial transverse perineal muscle. The bilateral levator ani muscle is further exposed and divided. Approximately three-quarters of the circuit involving the pelvic attachment of the levator ani muscle are exposed by this manoeuvre

The sigmoid colon is induced again outside the abdominal wall, however only recently we have begun to use the retroperitoneal route under laparoscopic view to prevent post-operative parastomal hernia. The sero-muscular flap of the sigmoid colon is fixed with a 3-0 PDS-II™ thread used previously to approximate the rectus sheath (Fig. 5.8). The stump is covered with a wet gauze.

5.3.3.6 Closure of the Port Puncture Wound and Maturation of the Stoma

The port sites are closed with skin staples or inverted 4-0 PDS-II™ thread; the incision wound is covered with dressings to prevent contamination. Next, the colostomy is opened. First, the excess intestine is cut and haemostasis is achieved. The stump of the colon is matured with a 4-0 PDS™ suture and intermittent inverted manoeuvres are performed to flutter the stump outside and to raise it about 1 cm (Fig. 5.9).

5.4 Concept of Abdominoperineal Operation

In 1908, Miles described in the Lancet that procedures for encouraging lymph flow in the cranial direction was important in abdominoperineal resection of the rectum [2]. As a result, the concept of the cranial direction of lymph node dissection has been established. For this reason, the abdominoperineal resection of the rectum is called the Miles operation today.

As mentioned above, without a complete understanding the fascial composition of the pelvic space it is not possible to refer to the anatomy of the rectum. The starting points include is the theories of Tobin et al. [3], Sato [4] and Takahashi [5–9]. These theories are based on embryology, so understanding the embryology of the intestinal tract is essential. According to these authors, the continuity in the fascia composition of the abdominal and pelvic cavity must be secured (Fig. 5.10).

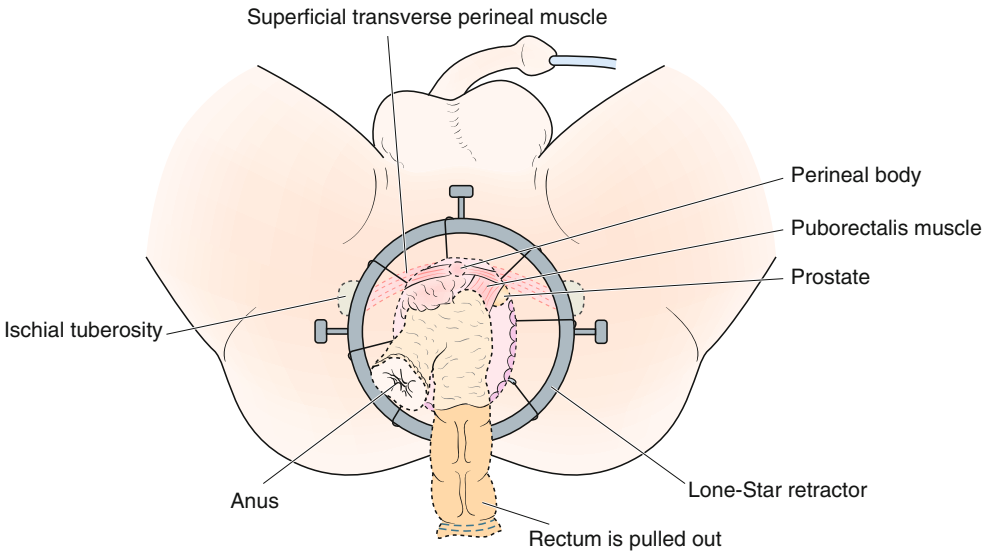

Fig. 5.7 Inverting the rectum and dividing the puborectalis muscle. The surgeon grasps the inverted rectum for counter traction and dissects the ventral side of the pelvic adaptation of the levator ani muscle. After palpating the dorsal side of the prostate, the site where the prostate and puborectalis muscle are attached to the rectal wall is divided carefully using small incisions using an electrosurgical knife

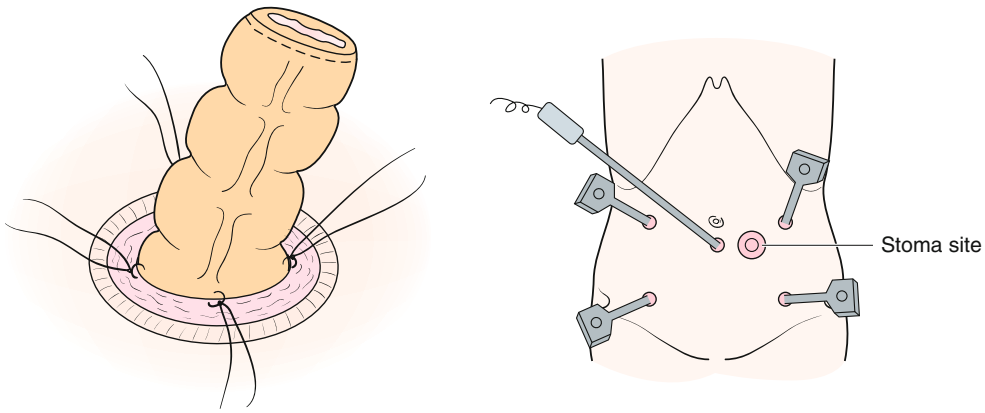

Fig. 5.8 Sigmoid colostomy. The centre of the colostomy site is held with Kocher's forceps and is lifted to the ventral side. A circular skin incision with a diameter of 2 cm is made once the dermis is sufficiently exposed. The sigmoid colon is induced outside the abdominal wall and the sero-muscular flap of the sigmoid colon is fixed with a 3-0 PDS™ thread to approximate the rectus sheath

Furthermore, in the abdominoperineal resection of the rectum it is necessary to understand the anatomy once the pelvic floor is reached. However, not many papers have been published reporting a detailed the description of this anatomy. This is because the concept of the fascial composition of this section is directly connected to anal function and this has not yet been clearly studied. In this textbook, we pick up from Shafix's paper [11] with respect

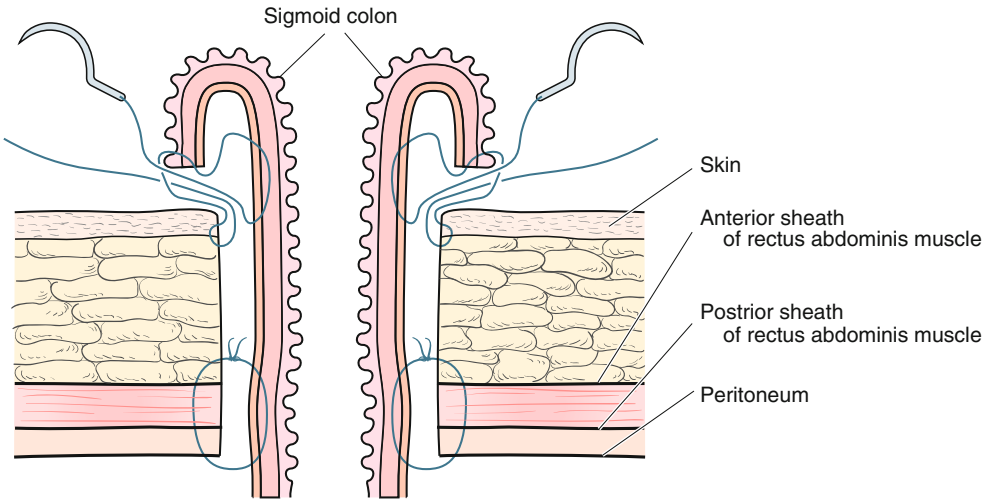

Fig. 5.9 Maturation of the colostomy. The colostomy is opened. The stump of the colon is sutured with 4-0 PDS™ suture and intermittent inverted manoeuvres are performed to flutter the stump outside and to raise it about 1 cm

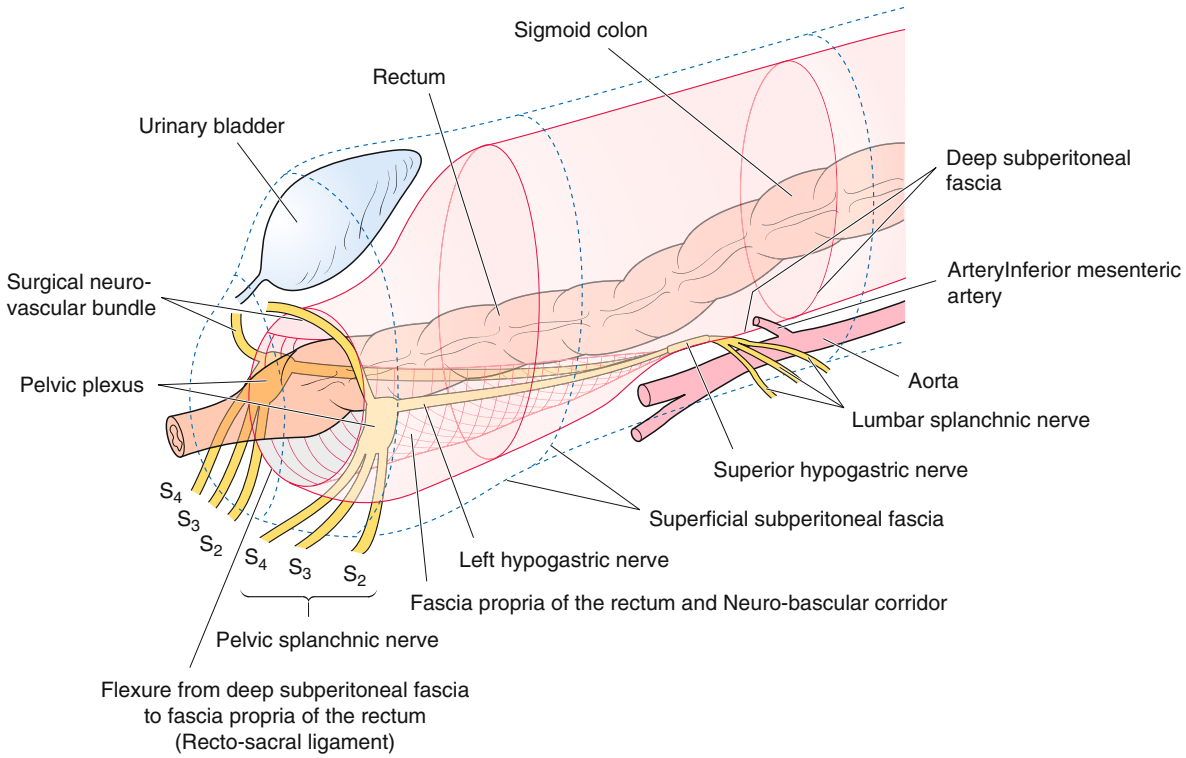

Fig. 5.10 Continuity in the fascia composition of the abdominal and pelvic cavity. The theory of Tobin et al., Sato, and Takahashi are based on embryology, thus understanding of the embryology of the intestinal tract is essential. According to these authors, the continuity in the fascia composition of the abdominal and pelvic cavity must be secured [10, with permission]

to function and anatomy of the pelvic floor and we concur that his interpretation is also easy to understand for most surgeons (Fig. 5.11).

Generally, the phrase "after dissection with total mesorectal excision (TME) of the rectum" means that the dissection procedure relative to the fascia propria of the rectum in the dorsal side of the rectum and the Denonvilliers' fascia in the ventral side of the rectum is completed. However, although it is also reported in the paper by Heald [12], the surgeons have considered the resecting side of the rectum, but have never looked at the dorsal side, i.e. the levator ani muscle side. In other words, the field of view of the dorsal side of the pelvic space does not become sufficiently clear at moment in which the TME procedure is completed. According to the theories by Tobin et al. [3], Sato [4], and Takahashi [5–9] the levator ani muscle (composed of the iliococcygeus muscle and the pubococcygeus muscle) is covered by the superficial subperitoneal fascia (Fig. 5.12) and the levator ani muscles are present on the dorsal shallow layer. Dissection from the anococcygeal raphe to the hiatal ligament must not be excessive in the abdominoperineal resection of the rectum (Fig. 5.11). This operation is fundamental to ablate the anorectal tube and its surrounding tissue maintaining its cylindrical shape. This operation should not lead to "waisting" (or "necking" in the resected specimens), which simply means not getting excessively close to the lesion [13]. Therefore, the tip of the coccyx should be sufficiently visible, and it is important that the anococcygeal raphe and the levator ani muscles are divided from this part to form the U-shaped incision line and that fat of the ischiorectal fossa is exposed.

With the development of laparoscopic surgery, and thanks to the improvement in the components of the field of view of the pelvic floor, this now becomes every surgeon's optimal field of view. Thus, the anatomical recognition of each of the sites and definition of new terminology becomes necessary. Surgeons must understand the fascial composition of the pelvic space and muscular configuration present in a field of view that differs from what was previously accessible.

5.5 Fascial Composition in the Parasacral Approach (Kraske Operation)

There is a surgical procedure involving the lower anterior resection of the rectum for rectal cancer. It is a posterior resection procedure of the rectum described by Paul Kraske, currently known as the Kraske operation. Kraske incised the skin on the midline of the sacrum from the dorsal end of the anus to resect a part of the sacrum [14]. It was considered a radical operation, but in the end was a palliative procedure given the results obtained.

Even today, there is a condition that is considered an adaptation of Kraske operation, known as the parasacral approach. Compared with the transanal resection, the advantages of the parasacral approach include: (1) the ability to detect lymph nodes in the mesorectum and (2) a relatively good field of view that allows tumour resection to be performed maintaining a certain distance from the tumour. Hence indications for proctectomy with the parasacral approach include: (1) the presence of a swollen lymph node in preoperative ultrasound diagnosis in the mesorectum near the primary lesion, and histological diagnosis, (2) difficult transanal resection due to the occupation site and size of the tumour, and (3) patients who cannot tolerate open surgery,

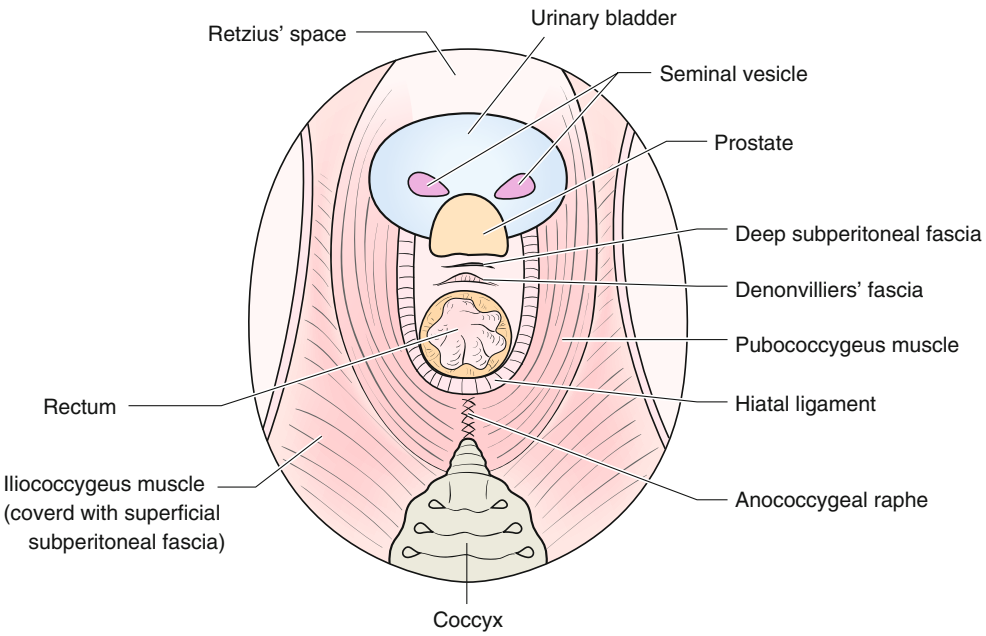

Fig. 5.11 Caudal cross-section the deep subperitoneal fascia. Shafix's anatomy: this is the so-called supra-levator space, which leads from the lateral side of the rectum to the lateral side of the urinary bladder and the Retzius' cavity. Pubococcygeus muscle and iliococcygeus muscle form the pelvic floor muscles. Puborectalis muscle is located in the anal side of the hiatal ligament and supports the dorsal side of the anal canal

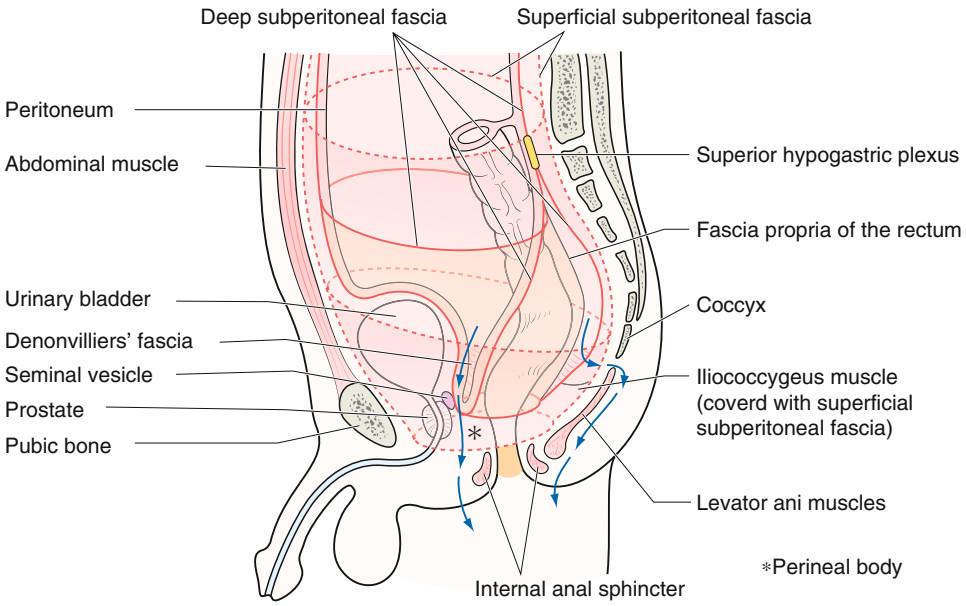

Fig. 5.12 Anatomy for avoiding wasting. From the theory by Tobin et al., Sato, and Takahashi the levator ani muscle is covered by the superficial subperitoneal fascia. The anococcygeal raphe and the levator ani muscles are separated from the coccyx to form the U-shaped incision line and the fat of the ischiorectal fossa is exposed. This allows wasting to be avoided. *Blue arrow*: indicates the dissecting direction of the abdominoperineal resection (APR) of the rectum

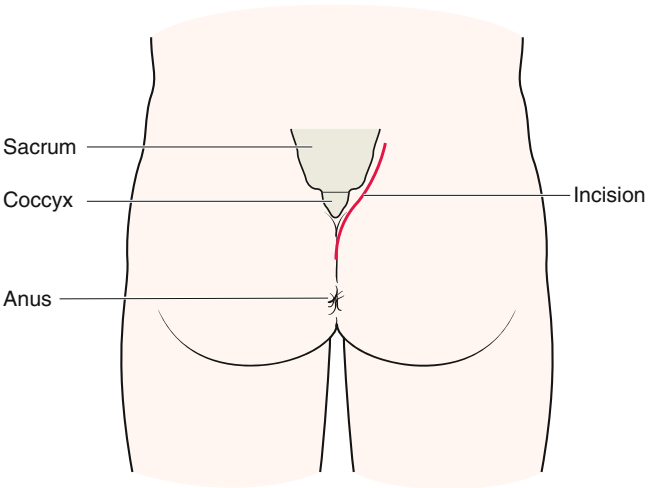

Fig. 5.13 Body position and incision. In the jack-knife position, an incision is made along the diseased side of the sacrum

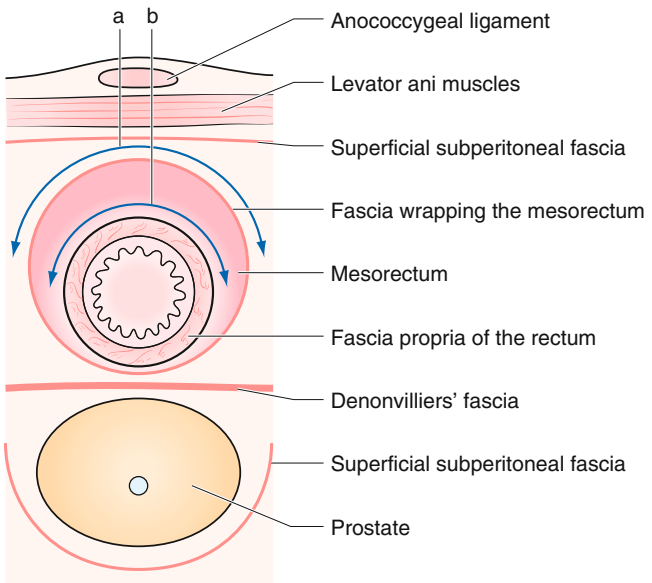

Fig. 5.14 Dissecting layer of the parasacral approach. This method dissects around the fascia wrapping the mesorectum (**a**). After incision of the fascia enveloping the mesorectum and the mesorectum, the muscle layer is exposed and the rectal wall is dissected near the muscle layer (**b**)

such as the elderly and high-risk patients, even though the procedure is an adaptation of open surgery. Although the tumour location for this adaptation should be within 5 cm of the anal verge, it is also possible to approach the lesion in the upper rectum. However, if the circumference of the tumour is long, the indication is difficult.

The patient is placed in the jack-knife position on the operating table. An incision is performed along the diseased side of the sacrum (Fig. 5.13). After dividing the subcutaneous fat, the anococcygeal ligament (also referred to as the anococcygeal body) is cut and the levator ani muscle appears as the dissection of the fatty tissue of the rectosciatic fossa advances further. After exposing the levator ani muscle, it is divided from the cranial to the caudal side with an electrosurgical knife (Fig. 5.14). Since the levator ani muscle is a thin muscle, it is easy to proceed with the manoeuvre while the bilateral incised muscle is sutured with supporting threads, and thus it becomes easy to delay suturing the muscles.

The puborectal muscle is present on the anal side of the levator ani muscle and the muscle bundles run so as to surround the rectum to form stable muscle bundles. There is a very narrow area between the coccyx and the puborectal muscle, thus the procedure is preceded by dividing the coccyx (Fig. 5.15).

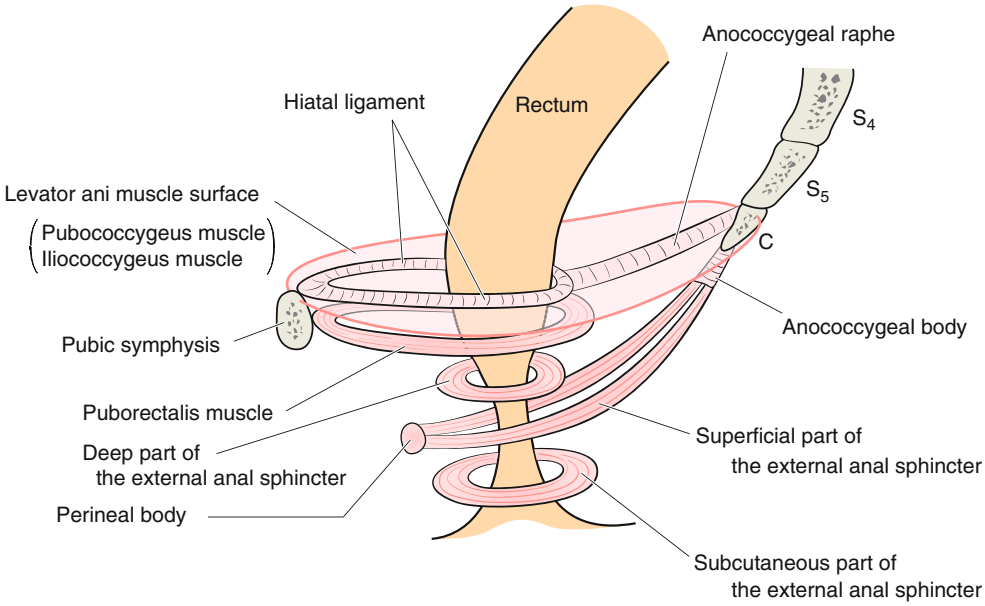

Fig. 5.15 Positional relationship of the levator ani muscles and the puborectal muscle. The puborectal muscle is present at the anal side of the levator ani muscles and the muscle bundles travel by surrounding the rectum. As the distance between the coccyx and the puborectal muscle is very narrow, the procedure advances as occurs after the resection of the coccyx. *Red solid line*: indicates the range of the levator ani muscles

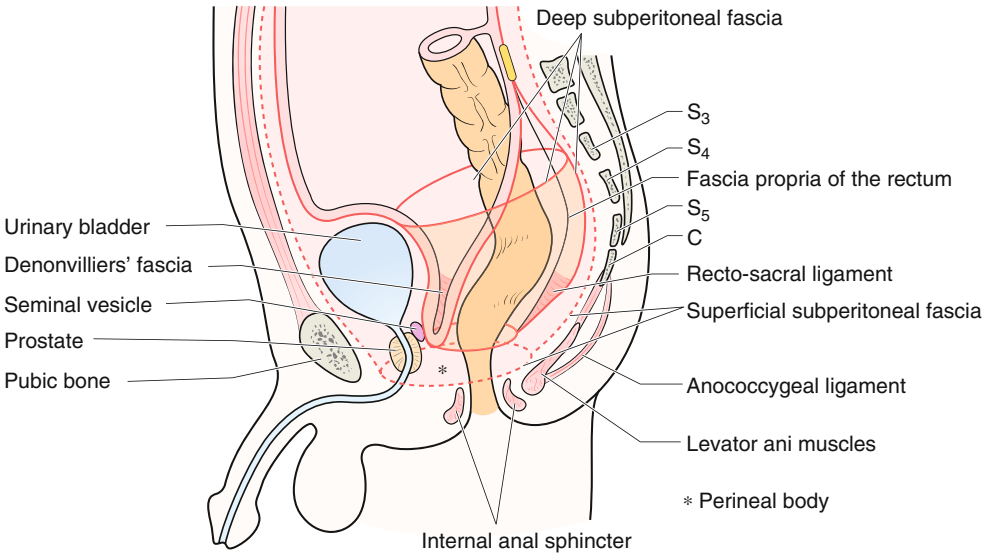

Fig. 5.16 Lateral view of the anal region. The superficial subperitoneal fascia is present in the ventral side of the levator ani muscle, and after division of this fascia the fascia covering the mesorectum appears. Although this is easily considered as the fascia propria of the rectum, this fascia has not been named according to Dr. Takahashi's concept. *Red solid line*: represents the range (surface) of the deep subperitoneal fascia. *Red dotted line*: represents the range (surface) of the superficial subperioneal fascia

The superficial subperitoneal fascia is present on the ventral side of the levator ani muscle, and after division of this fascia, the fascia covering the mesorectum appears (Figs. 5.14 and 5.16). Although this is easily confused as the fascia propria of the rectum, the fascia propria of the rectum does not exist in the caudal side of the rectosacral ligament according to Dr. Takahashi's concept [5–9]. Therefore, this fascia remains nameless, it is merely considered the continuation of the deep subperitoneal fascia from Sato's theory [4].

In the parasacral approach, the dissecting range of the rectum is significantly different based on the position and size of the lesion. There are two dissecting layers in the rectum (Fig. 5.14). In the first, after the fascia covering the mesorectum appears, the dissection of the retro-rectal space (presacral space) is performed along the outermost layer as far as possible without injuring them. The surrounding fatty tissue and the lymph nodes in the mesorectum are to be removed. In the other layer, an incision is made on the fascia covering the mesorectum either vertically or horizontally. After a sharp dissection of the fatty tissue in the mesorectum and reaching the proper muscle of the rectum, the dissection follows along the muscle (Fig. 5.13).

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Laparoscopic Right Colectomy

6

6.1 Introduction

In the laparoscopic right colectomy (LapRC) surgical technique (including ileocaecal resection), it is easy to understand the fascial composition based on the medial-retroperitoneal approach, and thus the surgical technique becomes evident. Our laparoscopic right colectomy surgeries have a general rule that the procedures involving division of the mesentery, ligation of vessels, and anastomosis are to be performed under small auxiliary laparotomy of the epigastric region due to its "rapidity" and "safety".

6.2 Resection Range and Degree of Lymph Node Dissection

As has already been described in the Chap. 1, since the concept of the surgical trunk by Gillot [1] (Fig. 6.1) was first introduced in Japan in the 1970s, two main views are prevalent with regards to lymph node dissection for right colon cancer. Namely, lymph node dissection of the main lymph node based on the dominant artery root and lymph node dissection of the surgical trunk based on the lymph flow of Gillot [2]. No definitive conclusions have been reached as to which is more correct; however, the former calls for the dissection of portions where the lymph flow is missing, while in the latter the theory of lymph flow is only emphasised and whether the dissection of all this part is actually clinically meaningful has not been determined.

6.3 Fascial Composition of the Right-Side Colon

As for the configuration of the right colon, it can be considered as divided into a simple fusion fascia between the colon and retroperitoneum at the caudal side (Fig. 6.2) and a relatively confused fusion fascia at the cranial pancreatoduodenal portion (Fig. 6.3). In the former, the right colon and retroperitoneum are fused to become the right fusion fascia of Toldt and the ascending colon is buried in the retroperitoneum (Fig. 6.2a, b). In the latter, it is easy to understand the fascial composition if the embryologic processes are divided into two stages (Fig. 6.3a, b). That is, the second portion of the duodenum that was accompanied by a dorsal mesentery falls to the right, forming the posterior pancreatic fascia of Treitz between the parietal peritoneum and the pancreatoduodenal region (Fig. 6.3c). Then, the ascending colon covers the head of the pancreatoduodenal region when the intestinal rotation is completed, and it forms the right fusion fascial of Toldt and the anterior pancreatic fascia (Fig. 6.3e). In other words, the right fusion fascia of Toldt is divided into the posterior pancreatic fascia of Treitz dorsally and the anterior pancreatic fascia ventrally at the margin of the second portion of the duodenum (Fig. 6.3e). Additionally, the hepatic flexure is located at the transition of the transverse colon with the mesocolon and the ascending colon, in which the mesocolon is fused with the posterior abdominal wall.

In addition, with regards to the relation between the transverse colon and the second portion of the duodenum, three fusion patterns can be considered in three degrees of fusion. That is, there are fusions between the ventral leaf of the transverse colon and about half of the second portion of the duodenum (Fig. 6.4a), between the ventral leaf of the transverse colon and the entire second portion of the duodenum (Fig. 6.4b), and almost no fusion (Fig. 6.4c)

In order to dissect the right colon from the pancreaticoduodenum, the relationship between the anterior pancreatic fascia, the posterior pancreatic fascia of Treitz, and the right fusion fascia of Toldt, and between the transverse mesocolon and the anterior pancreatic fascia must be considered. In right colon cancer, in order to dissect the colon from the retroperitoneum, it is necessary to dissect between the right fusion fascia of Toldt and the deep subperitoneal fascia. However, since the right colon is depressed on its dorsal side compared with the left colon, the lateral approach of the right colon tends to be a difficult and uncertain procedure (Fig. 6.2b). The right fusion fascia of Toldt is close to the deep

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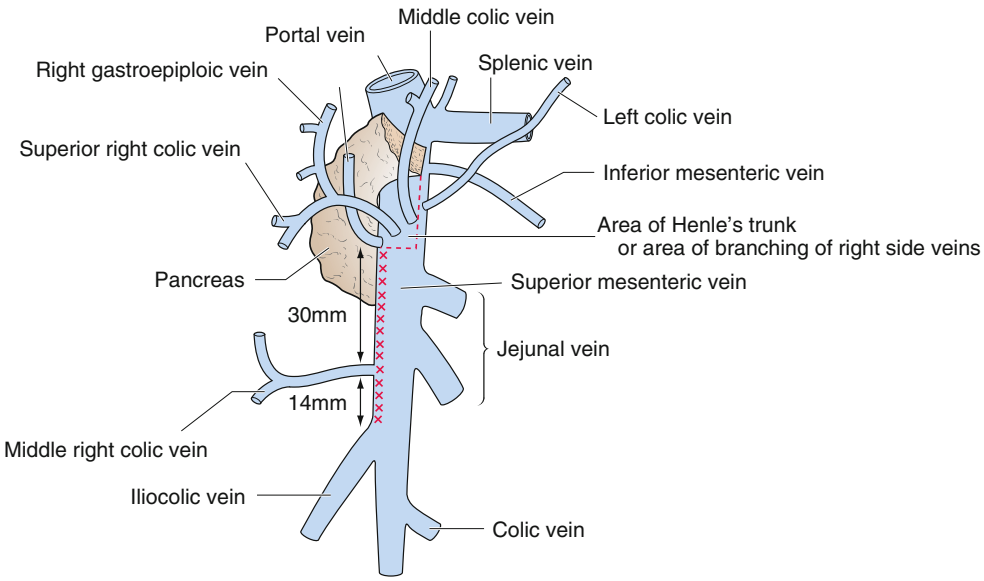


Fig. 6.1 The concept of surgical trunk by Gillot. The surgical trunk refers to an approximately 44-mm section from the cranial side of the ileocolic vein to the most caudal side of Henle's trunk. Lymph nodes are present in the ventral and lateral side of the superior mesenteric vein

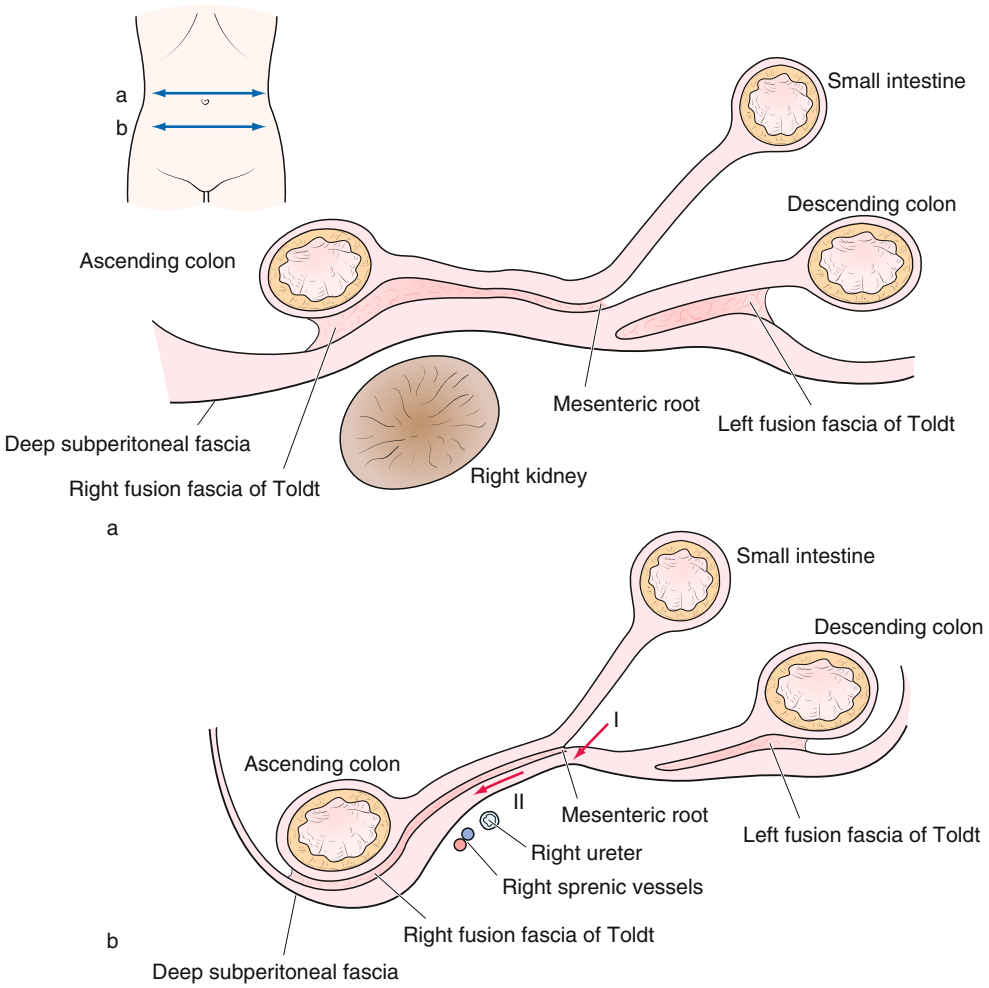


Fig. 6.2 Fusion and its cross-section with the ascending mesocolon (**a**, **b**). The right colon and retroperitoneums are fused to become the right fusion fascia of Toldt and the ascending colon is buried in the retroperitoneum (**b**). *Arrow I* indicates the first incisional position of the retroperitoneal approach. *Arrow II* indicates a dissecting layer between the fusion fascia of Toldt and the deep subperitoneal fascia (**b**)

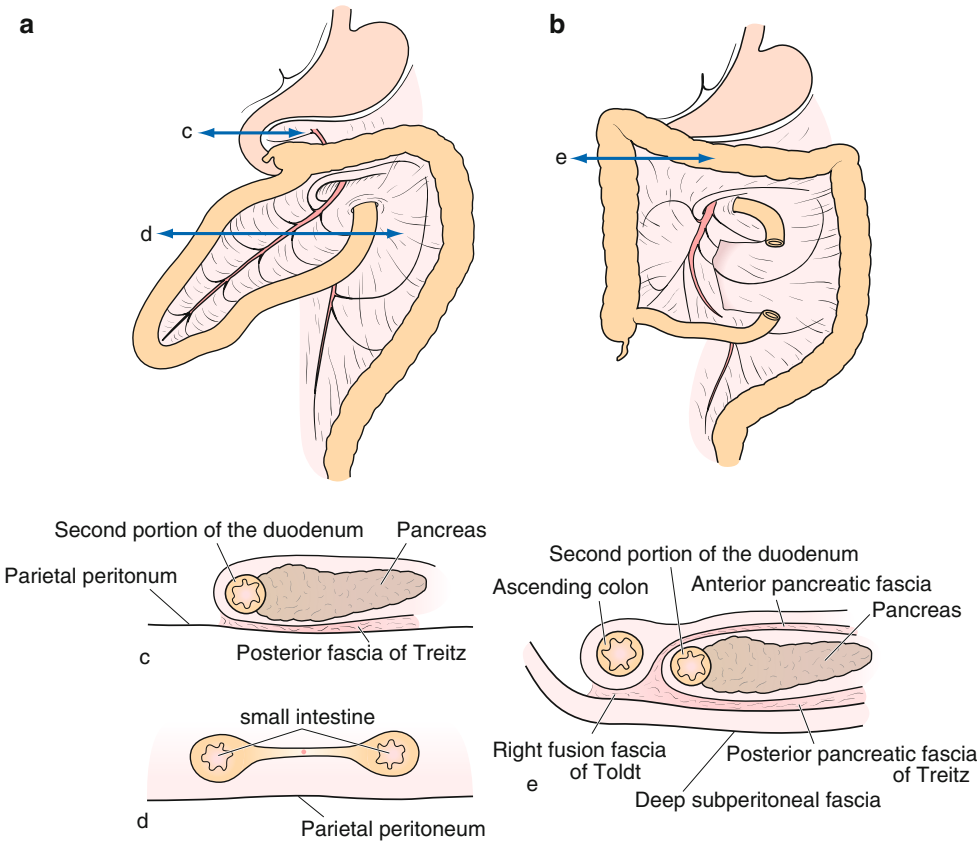


Fig. 6.3 Intestinal rotation and the relationship of each mesenterium. Originally, two sheets of the dorsal mesentery are rotated around the superior mesenteric artery. It is easy to understand the fascial composition of the pancreatoduodenal portion if the embryological process is divided into two stages (**a**, **b**). That is, the second portion of the duodenum that was accompanied by a dorsal mesentery falls to the right, forming the posterior pancreatic fascia of Treitz between the parietal peritoneum and the pancreatoduodenal region (**c**). Then, the ascending colon covers the head of the pancreatoduodenal region when the intestinal rotation is completed, and it forms the right fusion fascia of Toldt and the anterior pancreatic fascia (**e**)

subperitoneal fascia in the paracolic gutter of the lateral of the ascending colon (Fig. 6.2b). Thus, if one attempts to dissect the colon from this side, there is a tendency to enter the dorsal side of the deep subperitoneal fascia, and place the urinary tract and the spermatic vessels on the discharge side, and be in danger of lifting the right kidney. In contrast, it is easier to dissect between the right fusion fascia of Toldt and the deep subperitoneal fascia along the mesenteric root because this region is rich in fat and connective tissue (Fig. 6.2b I, II). In addition, since the deep subperitoneal fascia in the pancreaticoduodenal section continues onto the dorsal side of the posterior pancreatic fascia of Treitz behind the pancreas head, dissection of the right colon from the dorsal side is easy provided that the ventral side of the deep subperitoneal fascia is maintained (Fig. 6.3e). As the dissection is continued using this approach, the right colon can be dissected freely without any damage to the other organs because the urinary tract and the spermatic vessels are now located on the dorsal side of the deep subperitoneal fascia. From the above discussion, it can be deduced that laparoscopic right colectomy is recommended to be performed using the medial-retroperitoneal approach.

6.4 Operative Procedure (in Men)

The medial-retroperitoneal approach that precedes the dissection between the right fusion fascia of Toldt and the deep subperitoneal fascia is a basic procedure. This surgical procedure takes advantage of laparoscopic surgery as it may be easier to dissect the colon from the retroperitoneum and this may mobilise the colon earlier.

6.4.1 Incision of the Peritoneum in the Mesenteric Root

Scope: umbilicus

The operator's right hand: an electrosurgical knife with spatula-type blade

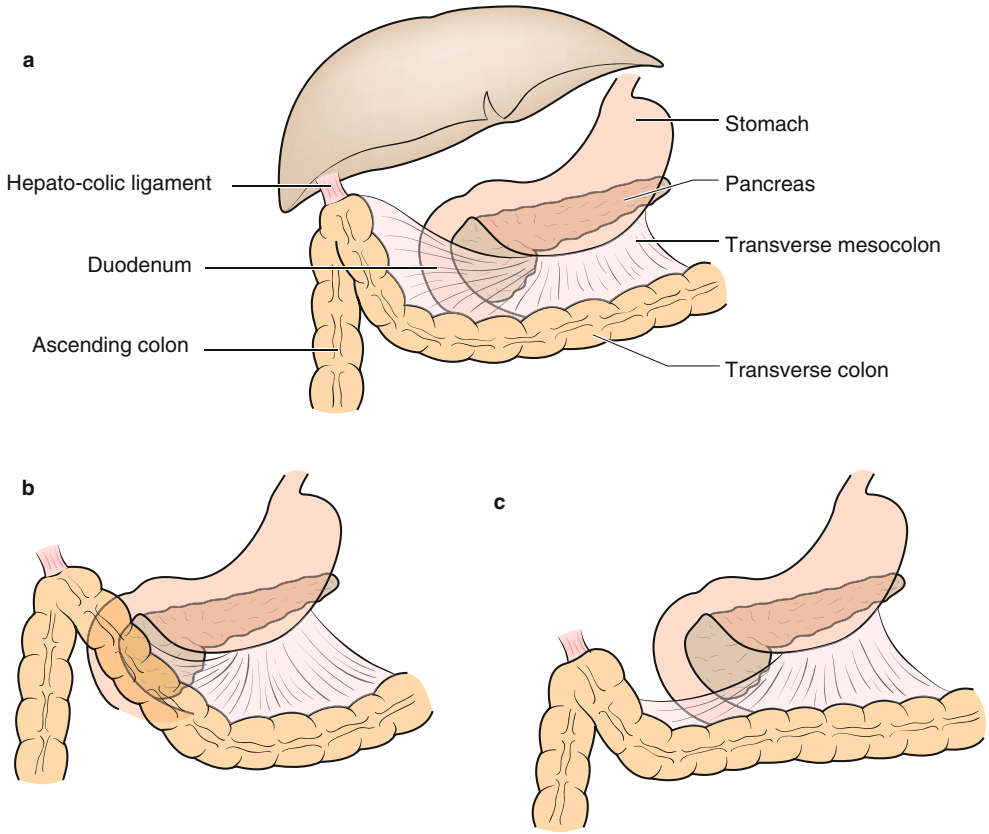


Fig. 6.4 Fusion between the transverse colon and the duodenum. Three fusions can be considered in three degrees of the fusion. That is, cases can be divided where there is a fusion between the ventral leaf of the transverse colon and about half of the second portion of the duodenum (**a**), between the ventral leaf of the transverse colon and the half second portion of the duodenum (**b**), and almost no fusion (**c**)

The operator's left hand: provides a surgical plane where the dissection is to be performed and divides in countertraction together with the assistant. Usage of bowel forceps

The assistant's right hand: grips the root of the appendix or the caecum with bowel forceps.

The assistant's left hand: grasps the terminal ileum or the mesentery of the small intestine with bowel forceps to orient the surface towards the operator in countertraction with the right hand.

The patient lies in the head-down position on the operating table. The scope is inserted through the umbilical port. The assistant lifts the mesentery of the small intestine to the ventral side with two forceps to establish a surgical plane for the mesentery and to prevent the small intestine from entering the operative field (Fig. 6.5). The operation begins with the incision of the peritoneum at the base of the mesentery of the small intestine near the second portion of the duodenum moving from the cranial-medial side to the caudal-lateral side with a spatula-type electrosurgical knife (Fig. 6.5, arrow I, II). Along this course, as the deep subperitoneal fascia with the retroperitoneum is lifted ventrally, the incision should be performed for several centimetres along the ventral side (Fig. 6.6a) and the deep subperitoneal fascia should be dissected towards the dorsal side from the fusion fascia of Toldt (Fig. 6.6b).

If the duodenum cannot be seen through the fascia from the retroperitoneum, it may be easier to direct the mobilisation of the cecum to the cranial side. In this case, however, it is necessary to be careful not to proceed further into deeper layers. Therefore, it is important to dissect the fascia dorsally while correcting the fascia composition of the caecal wall that is being lifted ventrally. Lifting the caecum and the terminal ileum, the dissection is performed just dorsal of the right fusion fascia of Toldt and slightly enough cranially (Figs. 6.2b II and 6.5 II).

6.4.2 Dissection of the Fusion Fascia of Toldt from the Deep Subperitoneal Fascia

Scope*:* umbilicus

The operator's right hand: an electrosurgical knife with spatula-type blade

The operator's left hand: prepares a surgical plane to the section where the dissection is to be performed and divides in countertraction together with the assistant. Usage of bowel forceps

The assistant's right hand: grasps the dorsal side of the caecum and lifts it cranially and ventrally to provide tension to the dissecting plane.

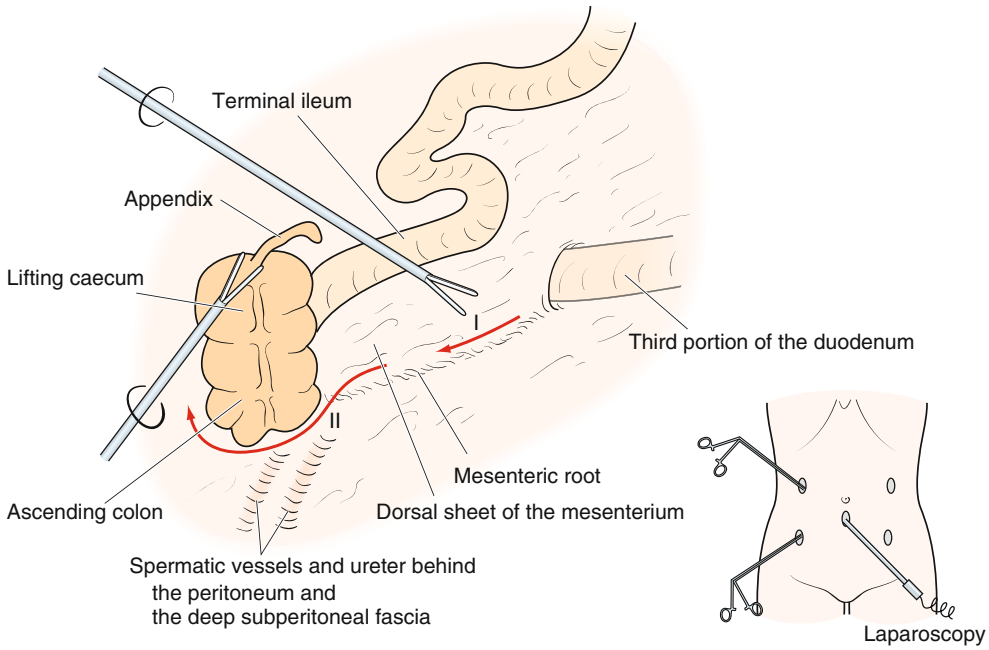


Fig. 6.5 Cutting and dissection at the base of the mesentery of the small intestine. The assistant lifts the mesentery of the small intestine to the ventral side using two forceps. The operation can prevent the small intestine from entering into the surgical field, as it is possible to secure a good field of vision. The operation begins with the incision of the peritoneum at the base of the mesentery of the small intestine near the second portion of the duodenum moving from the cranial-medial side to the caudal-lateral side with an electrosurgical knife with spatula-type blade

The assistant's left hand: grasps the terminal ileum or the dorsal side of the small intestine to orient the surface towards the operator in countertraction with the right hand.

The dissection is continued towards the second portion of the duodenum with a blunt dissection (Fig. 6.7). Blunt dissection of the fusion fascia of Toldt from the deep subperitoneal fascia is performed from the midline caudally and towards the right side laterally. It can be easily dissected in a short time with little bleeding (Fig. 6.7). The ureter and spermatic vessels can be seen on the dorsal side of the deep subperitoneal fascia without any damage. If the dissection is difficult, cancer invasion is strongly suspected. If so, the dissection should advance towards the more dorsal side of the deep subperitoneal fascia.

In the surgical plane from the right fusion fascia of Toldt to the posterior pancreatic fascia of Treitz (Fig. 6.7), the duodenum can be seen where the right fusion fascia of Toldt is divided into two sheets laterally of the duodenum (Fig. 6.8b). The posterior pancreatic fascia of Treitz is cut on the ventral side of the third portion of the duodenum (Fig. 6.7 I) and the division continues down the right lateral side along the ventral side of the third portion of the duodenum (Fig. 6.7 II). Next, the ventral side of the second portion of the duodenum is dissected bluntly from the anterior pancreatic fascia as far as possible to the cranial side. Finally, the transition from the right fusion fascia of Toldt to the posterior pancreatic fascia of Treitz is excised and the continuous plane from the right fusion fascia of Toldt to the anterior pancreatic fascia is formed (Figs. 6.7 I, II and 6.8 I, II). Indeed, without the knowledge that the right fusion fascia of Toldt divides into the ventral and dorsal fusion fascia in the duodenum, the above operation could not be performed. In addition, the dissection arrives at the pancreas head after dissecting ventrally and medially along the duodenum.

The dissection of the ascending colon is performed as far as possible along the dorsal side of the hepatocolic ligament. Incidentally, when the dissection around the right kidney advances towards the ventral side of the deep subperitoneal fascia, one should be cautious not to dissect the dorsal side of the fascia.

6.4.3 Linearization of the Ascending Colon and the Transverse Colon

Scope: umbilicus

The operator's right hand: divides the omentum between the ascending colon and the transverse colon by means of an ultrasonically activated device (USAD).

The operator's left hand: grasps the omentum between the ascending colon and the transverse colon to assist the division.

The assistant's right hand: grasps the omentum between the ascending colon and the transverse colon to make a plane of the omentum

The assistant's left hand: pulls the transverse colon laterally to the left

The operating table is placed in the flat position. The small intestine is returned to the caudal side, and the operative field is on the right side of the gastrocolic ligament.

The omentum between the ascending colon and the transverse colon is divided by an USAD and linearized for the

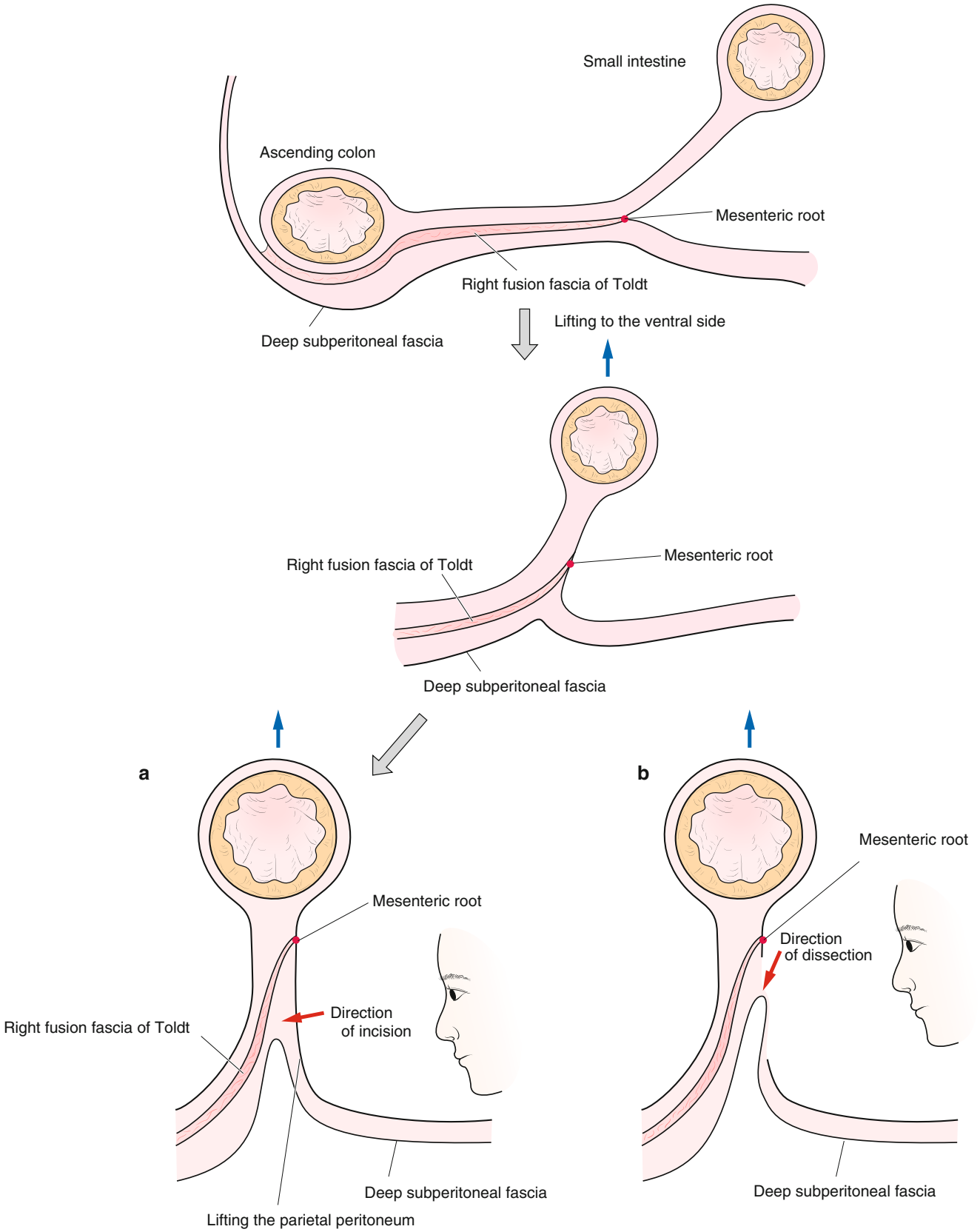


Fig. 6.6 Appearance and interpretation of the incision and dissection line. The deep subperitoneal fascia with the retroperitoneum is lifted to the ventral side and the incision is performed along several centimetres along the ventral side (**a**). The deep subperitoneal fascia should be dissected from the fusion fascia of Toldt towards the dorsal side (**b**)

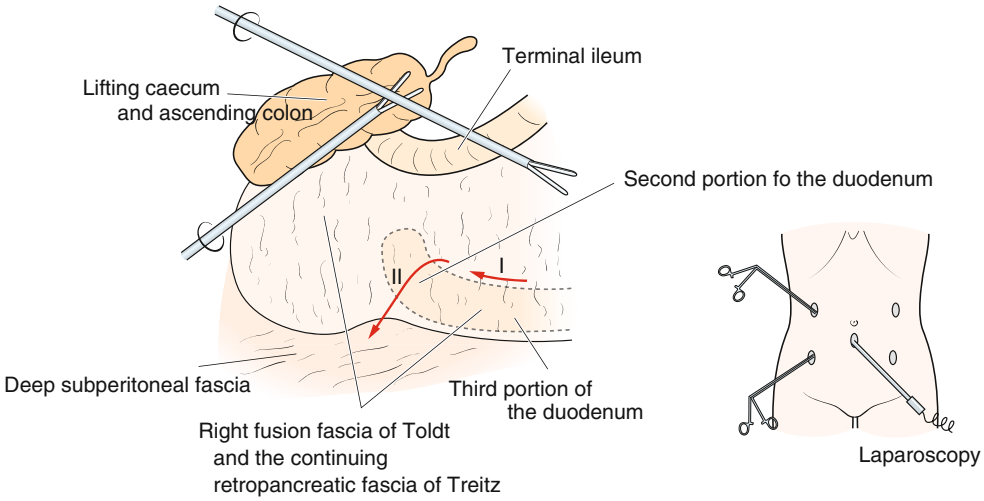


Fig. 6.7 Dissection of the right colon from the deep subperitoneal fascia. The second and third portion of the duodenum can be seen through the fusion fascia of Toldt and its continuing fascia, the posterior pancreatic fascia of Treitz

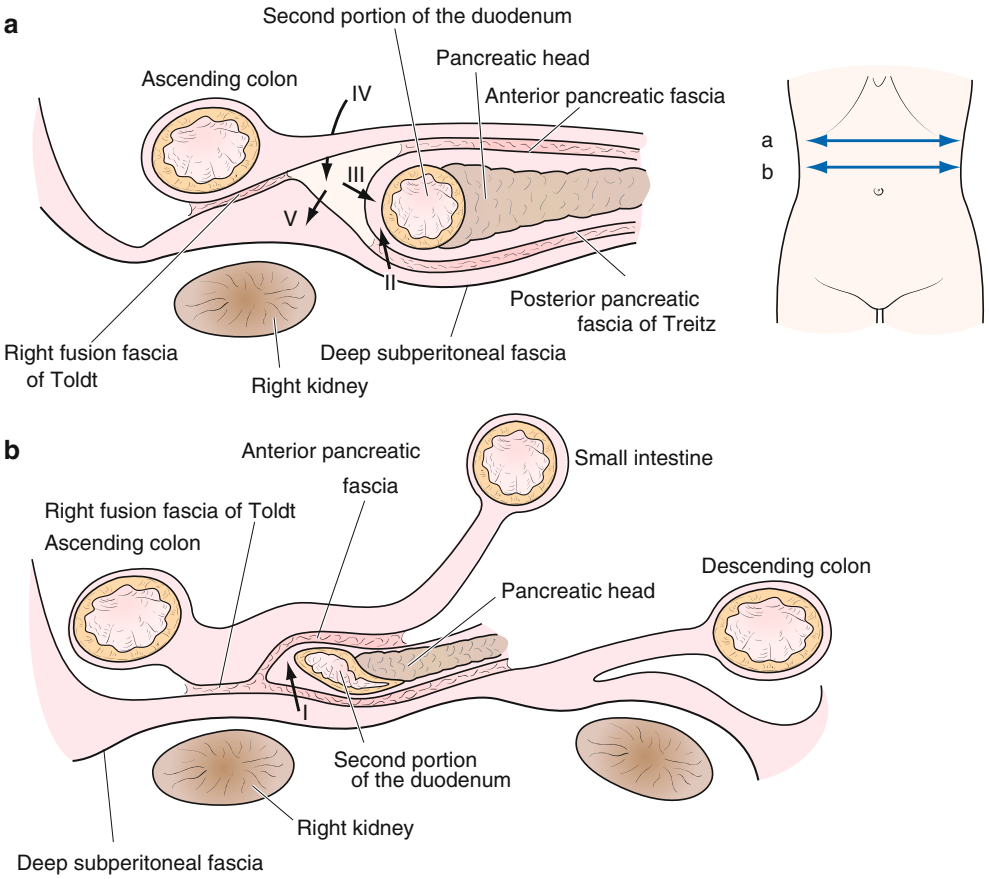


Fig. 6.8 Fusion fascia and cross-section of the ascending colon and the pancreaticoduodenal organ. Dissection enters the surface of the duodenum at *arrow I* (**b**), and proceeds cranially to *arrow II* (**a**). The craniocaudal dissecting layer is achieved by carrying out divisions by *arrow III* approaching from the cranial side. A simplified dissecting layer is shown from *IV* to *V* (**a**)

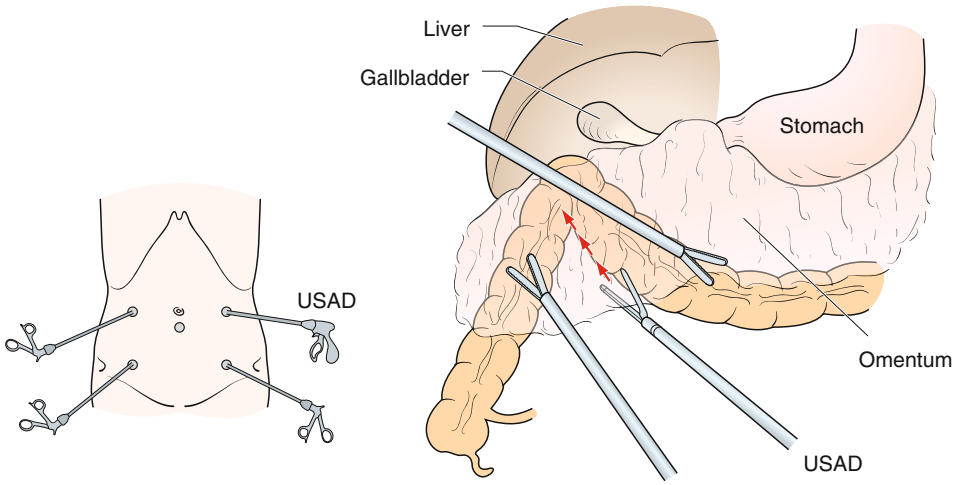


Fig. 6.9 Linearization of the ascending colon and the transverse colon. The omentum between the ascending colon and the transverse colon is divided by an ultrasonically activated device (*USAD*) and is linearized. As a result, towing of the hepatic flexure of the colon is facilitated

ascending colon and the transverse colon (Fig. 6.9). Of course, any omentum attached to the cancer should not be removed.

6.4.4 Dissection and Division of the Hepatic Flexure of the Colon

Scope: umbilicus

The operator's right hand: dissects the omentum from the transverse colon by an USAD

The operator's left hand: controls the omentum

The assistant's right hand: grasps the ascending colon coordinated with the right hand to establish a surgical plane of the omentum between the ascending colon and the transverse colon

The assistant's left hand: grasps the transverse colon tows it to the left lateral side in coordination with left hand to make a surgical plane in the cranial and right lateral side of the transverse colon

We have already mentioned that the formation of the hepatocolic ligament has three patterns due to the fusion between the transverse colon and the duodenum (Fig. 6.4). Accordingly, the relationship between the anterior pancreatic fascia and the transverse mesocolon also triples. Figure 6.4a shows the case of the ventral leaf of the transverse mesocolon and about half of the anterior pancreatic fascia forming the fusion fascia. Figure 6.4b shows the ventral leaf of the transverse mesocolon and the entire anterior pancreatic fascia forming the fusion fascia. Figure 6.4c shows a case with no fusion fascia

Here, the hepatic flexure of the colon is dissected and divided within the field of vision of the transverse colon. Given the standard fascial composition as shown in Fig. 6.4a, the dissection enters between the fusion fascia (between the ventral leaf of the transverse mesocolon and the fourth sheet of the dorsal mesentery) and the third sheet of the dorsal mesentery (Fig. 6.10 I–IV). The dissection advances laterally and dorsally (Fig. 6.10 V, VI). The fusion fascia (between the ventral leaf of the transverse mesocolon and the fourth sheet of the dorsal mesentery) continues directly to the anterior pancreatic fascia or towards the right fusion fascia of Toldt. Thus, the cranial portion of the hepatocolic ligament separated from the colon is divided to enter the retroperitoneal space where it has already been dissected from the caudal side. In other words, the ventral leaf of the anterior pancreatic fascia can be entered by dissecting the omentum from the taenia coli of the transverse colon at the medial side of the second portion of the duodenum (Fig. 6.10 I–IV). Continued dissection of the omentum to the lateral-cranial side leads to the hepatic flexure of the colon. Finally, by dividing the peritoneum at the hepatic flexure, the mobilisation of the hepatic flexure is completed (Fig. 6.10 V, VI). These procedures are simplified if the ascending colon and the transverse colon are linearized. Instead, by sequentially dissecting the ventral-lateral side of the duodenum caudally, eventually the operator reaches the dissected retroperitoneal space (Fig. 6.10 VII). That is, the right fusion fascia of Toldt separates the two fasciae, the anterior pancreatic fascia and the posterior pancreatic fascia of Treitz. When the posterior pancreatic fascia of Treitz is divided, the fusion fascia of Toldt becomes continuous with the anterior pancreatic fascia (Figs.6.8 I, III and 6.10 VII).

When a continuous surface from the right fusion fascia of Toldt to the posterior pancreatic fascia of Treitz is sufficiently dissected to the cranial side lateral to the second portion of the duodenum, the peritoneum lateral to the second portion of the duodenum is visible in the retroperitoneal space (Fig. 6.8a IV, V). However, the right colon remains fixed to the duodenum, and mobilisation remains incomplete. The dissection is none other than Kocher's

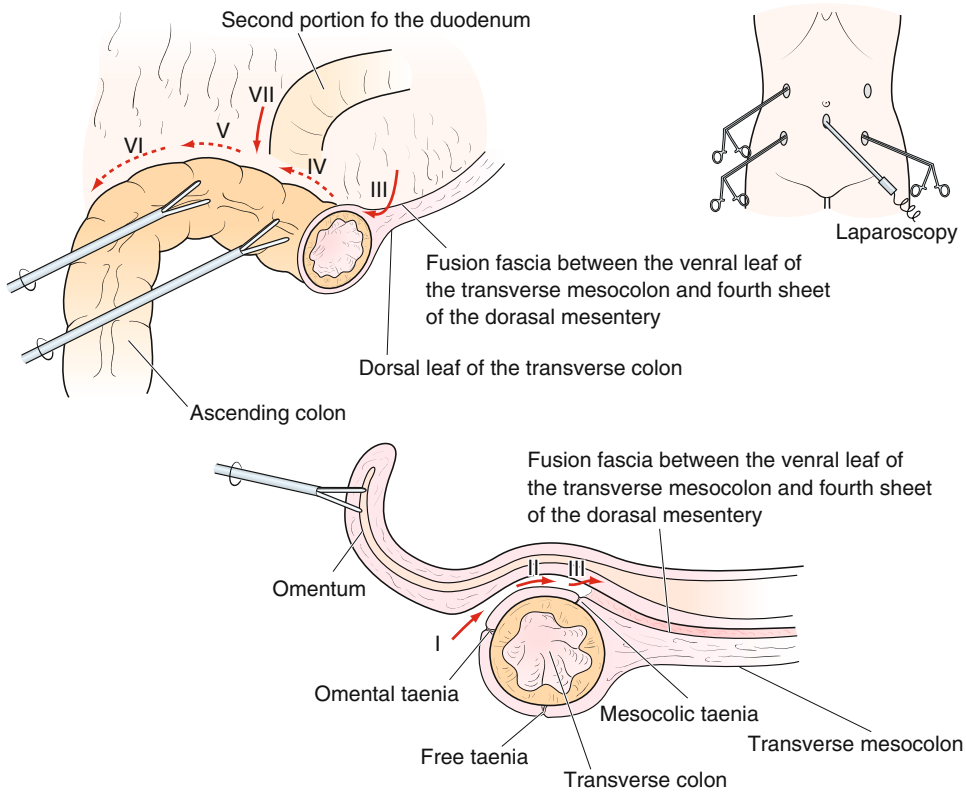


Fig. 6.10 Dissection and division of the hepatic flexure of the colon. The ventral side of the anterior pancreatic fascia can be entered by dissection of the omentum from the taenia coli of the transverse colon at the medial side of the second portion of the duodenum (*I–IV*). Continuing the dissection of the omentum to the lateral-cranial side, the hepatic flexure of the colon is reached. Finally, dividing the peritoneum at the hepatic flexure, the mobilisation of the hepatic flexure is completed (*V*, *VI*). Sequentially, the ventral-lateral side of the duodenum is then dissected caudally. Alternatively, dividing the ventral fascia (the anterior pancreatic fascia) caudally, the dissected retroperitoneal space can be connected by this manoeuvre (*IV*, *V*, *VI*)

mobilisation that is performed in upper abdominal surgery [3].

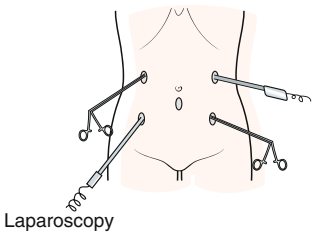
On the cranial side, Fig. 6.11a, b shows an oblique cross-sectional view of the fascia dissection of the right fusion fascia of Toldt. On the caudal side, the posterior pancreatic fascia of Treitz is divided to some extent and the continuing surface from the fusion fascia of Toldt to the anterior pancreatic fascia has already been secured (Figs. 6.8b I and 6.11c). Beginning at the dorsal side, the laparoscope is moved towards the right lower port and the surgical field consists of the lateral view of the duodenum and the ascending colon. On the lateral side of the second portion of the duodenum, by excising the posterior pancreatic fascia to the cranial side, the anterior pancreatic fascia continues on towards the ventral leaf of the transverse mesocolon or the fusion fascia (between the ventral leaf of the transverse mesocolon and the fourth sheet of the dorsal mesentery) (Fig. 6.11c). Continuing the dissection along the surface of the anterior pancreatic fascia may lead to the transverse mesocolon (Fig. 6.11d). This manoeuvre fully mobilises the right colon and the right transverse colon.

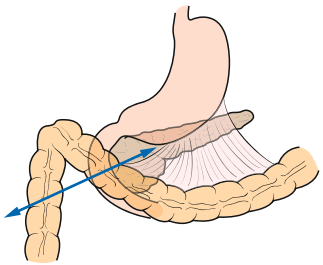
6.4.5 Lymph Node Dissection of the Surgical Trunk

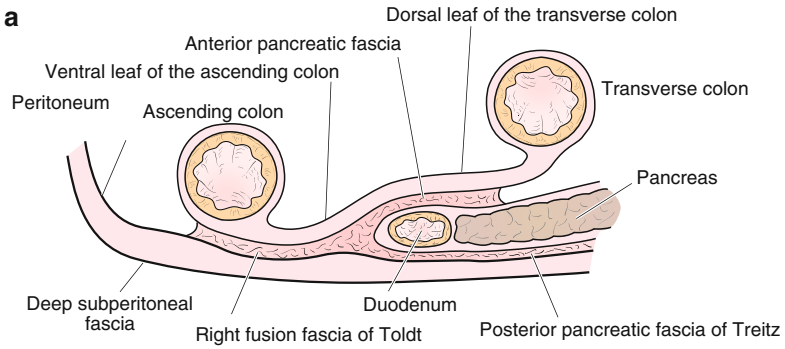
Sometimes, a lymph node metastasis along the surgical trunk can be detected preoperatively with computed tomography (CT) examination, and lymph node dissection of the surgical trunk can be performed. The manoeuvre is identical to the medial approach for right colon cancer. Lifting the ileocolic vessels with Babcock forceps by the assistant's left hand, the dissection moves past the ileocolic vein and moves along the superior mesenteric vein (SMV) distally. While exposing the surface of the SMV, the procedure continues to the cranial side (Fig. 6.12). The ileocolic artery and vein are identified, a Hem-o-lok™ clip is applied, and then divided. The lymph node dissection is performed until the gastrocolic trunk is reached.

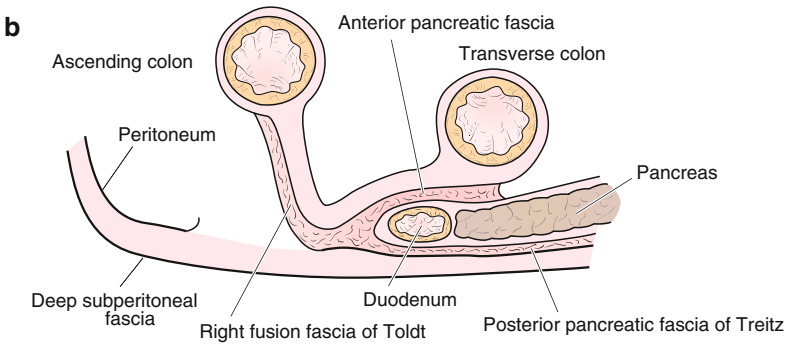
6.4.6 Small Auxiliary Incision

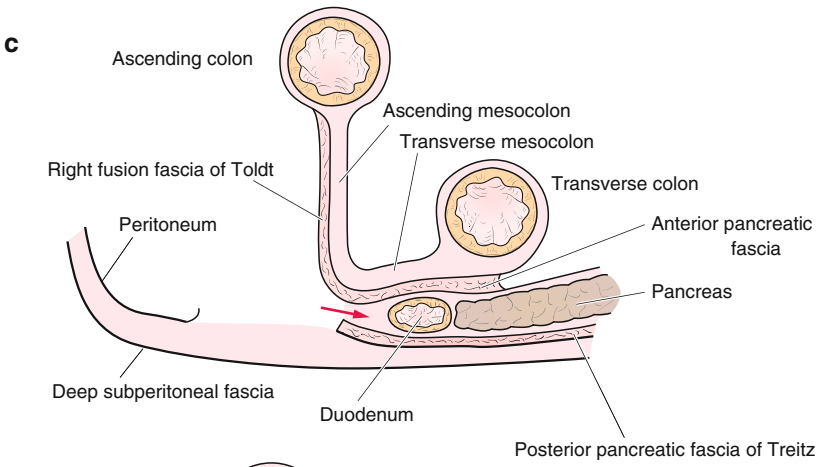
The pneumoperitoneum is interrupted and a small incision is made at the epigastric midline of the abdominal wall. The











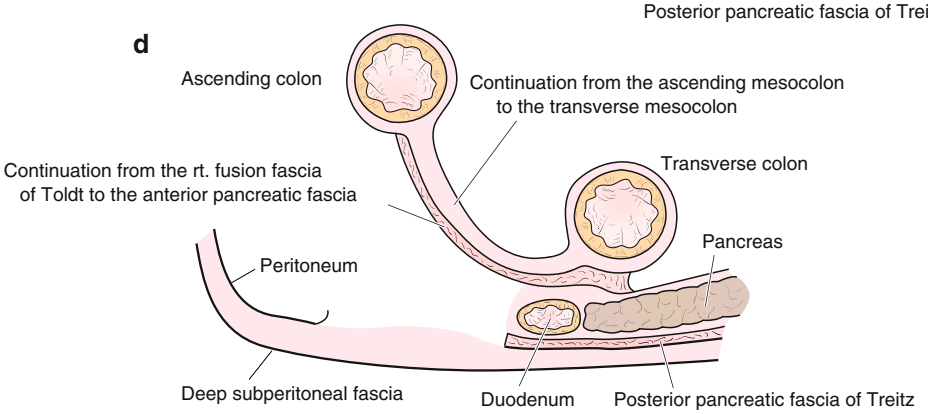


Fig. 6.11 Fascial composition and the dissection of the second portion of the duodenum. Oblique cross-sectional view of the fascia dissection of the right fusion fascia of Toldt (**a**, **b**). The post-pancreatic fascia of Treitz is divided to some extent and the continuing surface from the fusion fascia of Toldt to the anterior pancreatic fascia has already been secured. On the lateral side of the second portion of the duodenum, by additional cutting of the posterior pancreatic fascia to the cranial side, the anterior pancreatic fascia continues towards the ventral leaf of the transverse mesocolon or the fusion fascia (between the ventral leaf of the transverse mesocolon and the fourth sheet of the dorsal mesentery) (**c**). Further dissection of the continuous surface of the anterior pancreatic fascia may be extended to the transverse mesocolon (**d**). This manoeuvre fully mobilises the right colon and the right transverse colon

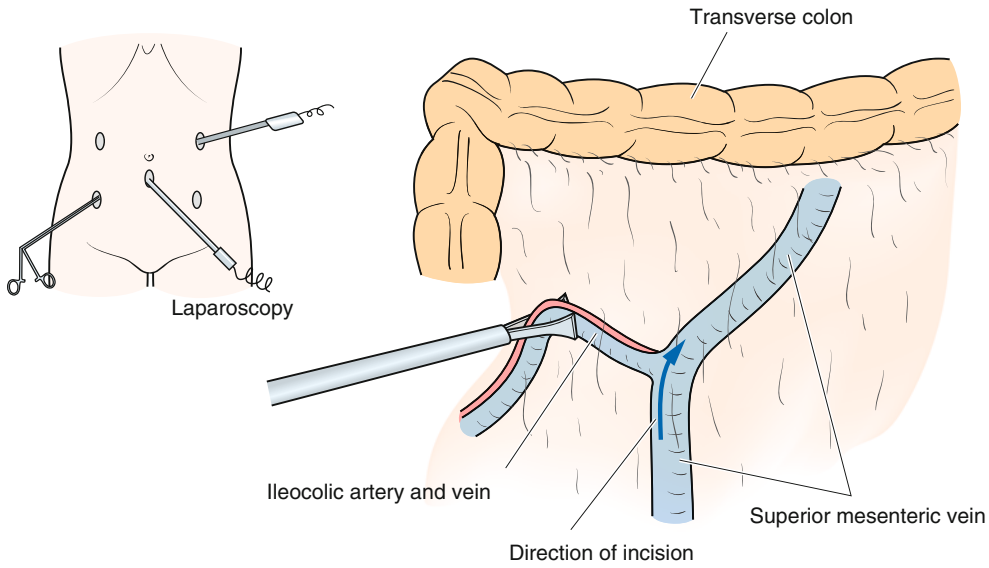


Fig. 6.12 Lymph node dissection of the surgical trunk. The manoeuvre is performed similarly to the medial approach for right colon cancer. Lifting the ileocolic vessels with Babcock forceps using the assistant's left hand, the dissection begins along the superior mesenteric vein (SMV) distally to the ileocolic vein. While exposing the surface of the SMV, the procedure continues cranially. The ileocolic artery and vein are identified and treated with Hem-o-lok™ and divided. The lymph node dissection is performed until the gastrocolic trunk is reached

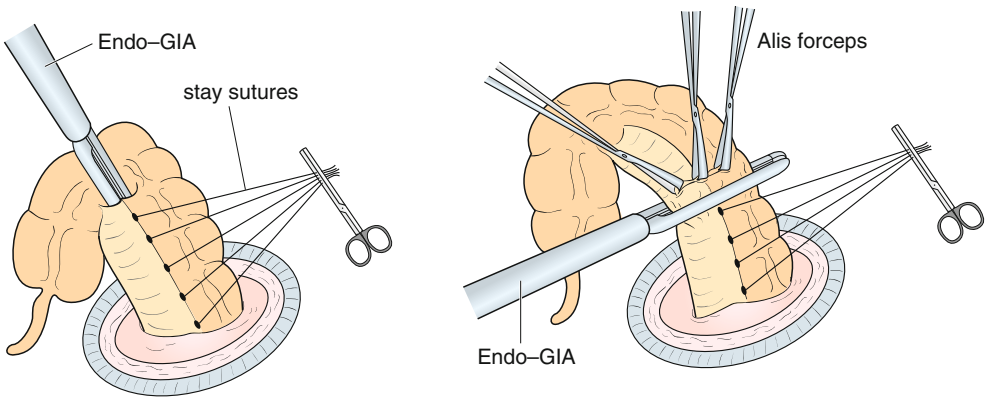


Fig. 6.13 Lymph node dissection and anastomosis of the intestine from the auxiliary incision. The intestinal tract is pulled out of the auxiliary incision in order to perform lymph node dissection and anastomosis

length of the incision is usually about 5 cm, but it should be a length suitable enough to pull out the tumour without any difficulty. A Wound Retractor™ is used to protect the wound from contamination.

6.4.7 Intestinal Resection and Anastomosis

Usually lymph node dissection, intestinal resection, and anastomosis are performed outside the abdominal cavity. It is carried out by functional end-to-end anastomosis using Endo-GIA™ or hand-sewn anastomosis (Fig. 6.13). It is important to adequately confirm that there is no twist before anastomosis is created. Closure of the mesentery is not required. Following completion of anastomosis, the anastomotic portion is returned to the abdominal cavity. The transverse colon and the terminal ileum are positioned and aligned parallel to the anastomosis, and the anastomosis is covered by the omentum to prevent any eventual bending (Fig. 6.14).

6.4.8 Wound Closure

Next, the pneumoperitoneum is performed again to detect bleeding and the final position of the anastomosis. The wound is closed with 0-PDS-II™ and 4-0 PDS-II™ buried sutures.

6.5 Clinical Anatomy in the Medial-Retroperitoneal Approach for Right Colon Cancer

The dissecting procedure of the right mesocolon in right colon cancer includes many descriptions of the medial to lateral approach. Although the clinical anatomy in the caudal side is very simple, the cranial side is complicated because of the relationship between the pancreatoduodenum organ, the transverse colon and the omentum.

When considering the fascial composition, the interpretations by Tobin et al. [4] and Sato [5] offer a simplified

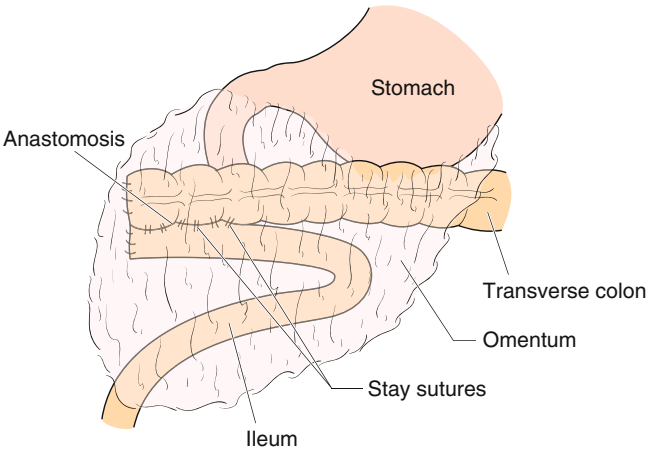


Fig. 6.14 Intraperitoneal placement in vicinity of the anastomosis. The transverse colon and the ileum are positioned in parallel with the anastomosis and then covered with omentum on the ventral side to prevent bending of the anastomosis

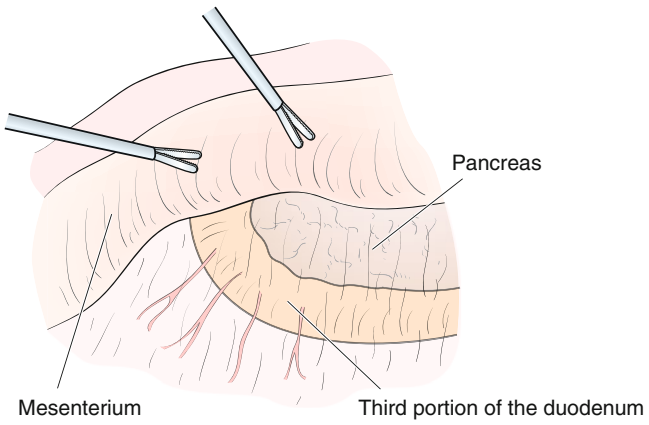


Fig. 6.15 Errors in recognition of the dissecting layer. Shown is a common surgical field using the medial approach. Small vessels run towards and continue along the second and third portions of the duodenum. From a clinical anatomy standpoint, this figure would be facing the right fusion fascia of Toldt, namely inside of the mesocolon. With regards to lymph node dissection, this surgical field is not appropriate

version for human body generation below the diaphragm, in which they advise to always be aware of the continuity of the fascia in the abdominal cavity. This continuity should also always be kept in mind during right colon surgery.

In the right colon, the mobility of the caecum is determined by the variety of fusion fasciae located between the dorsal leaf of the mesocolon and the parietal peritoneum. In addition, the right colon has relations with the fusion between the pancreaticoduodenum, the transverse colon, and the omentum, in addition to a complex fascial relationship with the hepatic flexure. However, when the hepatic flexure of the colon is considered a state that is neither elevated nor fixed, it is possible to attempt to simplify the fascia composition in this part (Fig. 6.3). After the posterior pancreatic fascia of Treitz is formed behind the pancreas and provided that the hepatic flexure of the colon is covered to the pancreas head, the right fusion fascia of Toldt becomes continuous with the posterior pancreatic fascia of Treitz and the anterior pancreatic fascia (Fig. 6.3e). However, understanding the fascial relationship between the anterior pancreatic fascia and the transverse mesocolon is difficult. This is because it is hard to determine continuity considering the fascial configuration in the ventral view and in the dorsal view. That is, the ventral leaf of the transverse mesocolon is fused with fourth sheet of the dorsal mesentery and continues towards the hepatocolic ligament dorsally. When the fusion fascia between the ventral leaf of the transverse mesocolon and the fascia of the duodenum is formed, it is located on the dorsal side of the transverse mesocolon. In other words, the ventral leaf of the ascending mesocolon continues towards the dorsal leaf of the transverse mesocolon due to a twist of the mesocolon (Fig. 6.11).

The anatomical landmark of the medial-retroperitoneal approach in laparoscopic right colectomy is the third portion of the duodenum, a mesenteric root, and the caudal portion of the caecum. By lifting the mesenteric root of the terminal ileum ventrally the dissection line from the duodenum to the caecum becomes apparent. When dissecting the mesenterium, the dissection plane can be entered from the mesenteric root to the ventral side of the deep subperitoneal fascia. When the third portion of the duodenum is not apparent from the retroperitoneal field of view, lifting of the caecum ventrally and dissection of the ventral side of the deep subperitoneal fascia allows the identification of the duodenum.

The medial approach is a dissection method applied to the dorsal side of the ileocolic vessels that involves lifting and dissecting of vessels. Through this method, it is possible to enter directly into the ascending mesocolon itself. As a consequence of the method, there is a tendency to dissect off the second portion of the duodenum remaining on the ventral side of the fusion fascia of Toldt and on the anterior pancreatic fascia. Given the meaning of dissection is to excise lymph nodes in en-bloc wrapping in the mesocolon, it is difficult to say that this procedure considers the fascia configuration. As an example of the possible field of vision, an image of the small vessels associated with the fascia extending from the right retroperitoneum to the duodenum, is shown in Fig. 6.15. This figure shows that the same fascia covers the right retroperitoneum and the duodenum. That is, from a clinical anatomy standpoint, as the deep subperitoneal fascia and the duodenum have no relationship in terms of fascial composition, this figure is seen as the right fusion fascia of Toldt itself (Fig. 6.8).

Therefore, the result is a dissection of the mesocolon, which is contrary to the principles of lymphadenectomy whereby the surgeon intends to dissect the lymph nodes only between two mesenteries in full range. Any dissection along the lifted ileocolic vessels is an error because the principle of lymph node dissection should be performed in wedge shape.

The medial-retroperitoneal approach is the elected procedure in the principle of lymphadenectomy because it continues to dissect the ventral side of the deep subperitoneal fascia and the surface of the duodenum.

In order to enter cranially into a layer on the dorsal side of the anterior pancreatic fascia, the transverse colon and the ascending colon are linearised, and the dissection surface lies in a tangential direction with the assistant's and the surgeon's left hand. Therefore, it is relatively easy to proceed to the hepatocolic fascia.

For full mobilisation of the right colon, it is necessary to understand that the dissection is performed just on the surface of the duodenum and the separating fusion fascia is divided along the dorsal-lateral side of the second portion of the duodenum.

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Laparoscopic Left Colectomy

7

7.1 Introduction

In laparoscopic left colectomy (LapLC), the mobilization of the sigmoid colon and the splenic flexure of the colon are necessary. Although the surgical technique in the splenic flexure of the colon is not easy due to the thickened omentum, it is ensured with an understanding of the fascial configuration. With regards to lymph node dissection, the region of the inferior mesenteric artery (IMA) is a dissection region and it is important to dissect around the left colic artery (LCA).

7.2 Resection Range and Degree of the Lymph Node Dissection

LapLC is similar to open left colectomy in terms of resection range and degree of lymph node dissection, except for the approach to the abdominal cavity. In the left colon including the splenic flexure of the colon, lymph flow is mostly to the IMA due to its embryological hindgut origin. Therefore, it is necessary to dissect from the LCA [1–3].

7.3 Fascial Composition and Fusion Fascia of the Left Colon and the Splenic Flexure of the Colon

The root of the transverse mesocolon is on the caudal edge of the pancreatic body and tail, and the mesocolon spreads out from there in a characteristic fan-shape (Fig. 7.1). The dorsal mesentery consists of two sheets originally and then becomes four sheets, forming the omentum between the stomach and the transverse colon. A third sheet of the dorsal mesentery becomes the dorsal wall of the omental bursa, while the fourth sheet of the dorsal mesentery and the ventral leaf of the transverse colon are fused (Fig. 7.2). To understand the fascial composition, it is easier if one considers the relationship between the omentum (i.e. dorsal mesentery) and the transverse mesocolon in two stages during the intestinal rotation. In the longitudinal section as shown in Fig. 7.3a, the omentum and the mesocolon have no relation; however, they subsequently form a fusion fascia as shown in Fig. 7.3b.

The splenic flexure of the colon is defined as the terminal one-third of the anal side of the transverse colon leading to the first portion of the descending colon [4]. It is the site of transition between the transverse colon having a certain degree of mobilisation and the descending colon with fixation to the retroperitoneum by fusion (Fig. 7.1).

The left mesocolon forms the left fascia of Toldt in fusion with the peritoneum of the dorsal abdominal wall (Fig. 7.4). However, in the sigmoid colon the fan-shaped sigmoid fossa is typically formed behind the sigmoid mesocolon due to incomplete fusion of the dorsal mesentery and retroperitoneum (Fig. 7.4b). Thus, the mobilisation of the left colon requires dissection between the left fusion fascia of Toldt and the deep subperitoneal fascia. The only anatomical landmarks for this dissection are the spermatic vessels and the ureter (Fig. 7.4 dotted line).

In addition to the fusion between the transverse colon and the omentum and the fusion between the descending colon and the retroperitoneum, it is also necessary to further consider the relationships between the omentum and the diaphragm and between the omentum and the spleen.

In the fixation of the splenic flexure of the colon, there are two fixing ligaments to consider. The first is the left colophrenic ligament, which connects the splenic flexure of the colon and the diaphragm. The colo-phrenic ligament is considered to be formed upon closure of the left protrusion of the bursa omentalis (Figs. 7.5 and 7.6c, d). The second is the colo-splenic ligament. It is a secondary vertical ligament formed by the parietal peritoneum between the splenic flexure of the colon and the spleen or by the leftmost part of the transverse mesocolon (Figs. 7.5 and 7.6d).

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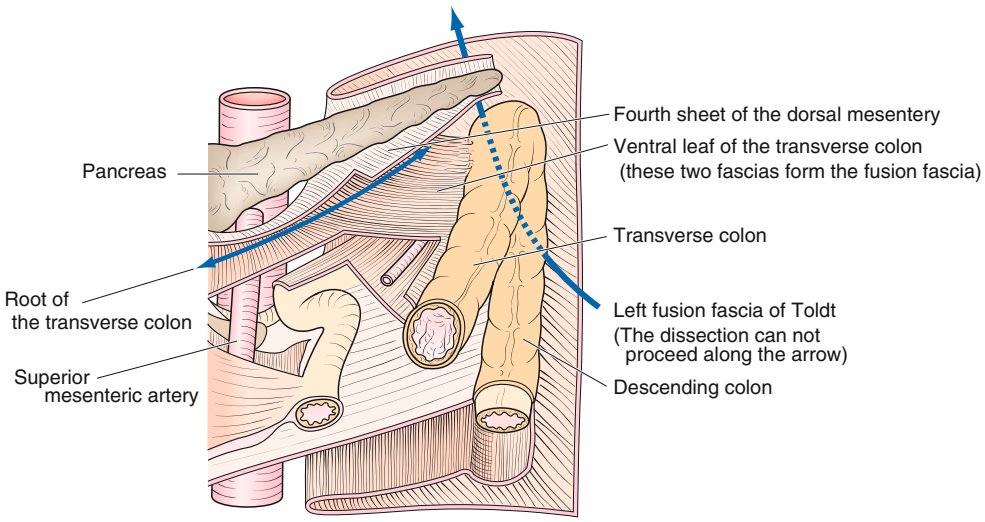


Fig. 7.1 Relationship between the transverse colon and the descending colon. The root of the transverse colon is on the caudal edge of the pancreatic body and tail. The fourth sheet of the dorsal mesentery and the ventral leaf of the transverse colon are fused

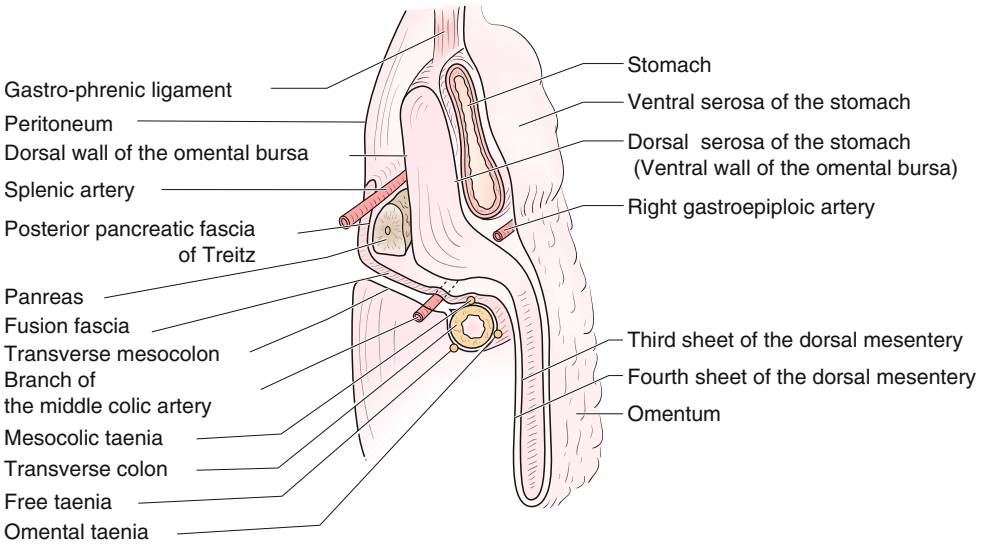


Fig. 7.2 Relationship between the stomach and the transverse colon. The third sheet of the dorsal mesentery becomes the dorsal wall of the omental bursa, and the fourth sheet of the dorsal mesentery and the ventral leaf of the transverse colon are fused

From the above, it is important to understand that the clinical anatomy of the splenic flexure of the colon is a three-way relationship including the transverse colon and the omentum (dorsal mesentery), the descending mesocolon and the deep subperitoneal fascia, and two fixing ligaments – the left colo-phrenic ligament and the colo-splenic ligament.

After dividing the omentum from the omental taenia, the dissection of the omentum is initiated by entering the layer between the third sheet of the dorsal mesentery and the fusion fascia (i.e., between the fourth sheet of the dorsal mesentery and the ventral leaf of the transverse colon) at the taenia coli. This layer can continue to be dissected towards the left side, so the splenic flexure of the colon can be pulled away caudally (Figs. 7.3c and 7.6a, b). To continue these manoeuvres to the ventral side of the deep subperitoneal fascia in the descending colon, the left fusion fascia of Toldt is divided (Fig. 7.6c). Thus, along this course, the hanging band – the left colo-phrenic ligament and the colo-splenic ligament – can be cut unknowingly in the splenic flexure of the colon (Fig. 7.6d).

However, there are notable differences in the amount of omentum located at the splenic flexure of the colon, and in some cases, a large amount of omentum is interposed. Therefore, the principle of dissection and dividing is to maintain a dissecting surface that is as close as possible to the serosa of the colon.

If the procedure through the omental bursa is performed, it is necessary to enter the dorsal side of the third sheet of the dorsal mesentery at the leftmost side of the omental bursa and to divide the left fusion fascia of Toldt (Fig. 7.7a–d).

7.4 Operative Procedures (in Men)

Because the main lymph node is located around the IMA in this procedure, the sigmoid colon should be mobilized with the medial approach sufficiently enough to linearize the sigmoid colon from the rectum. The LCA is divided, and the descending colon is dissected from the deep subperitoneal

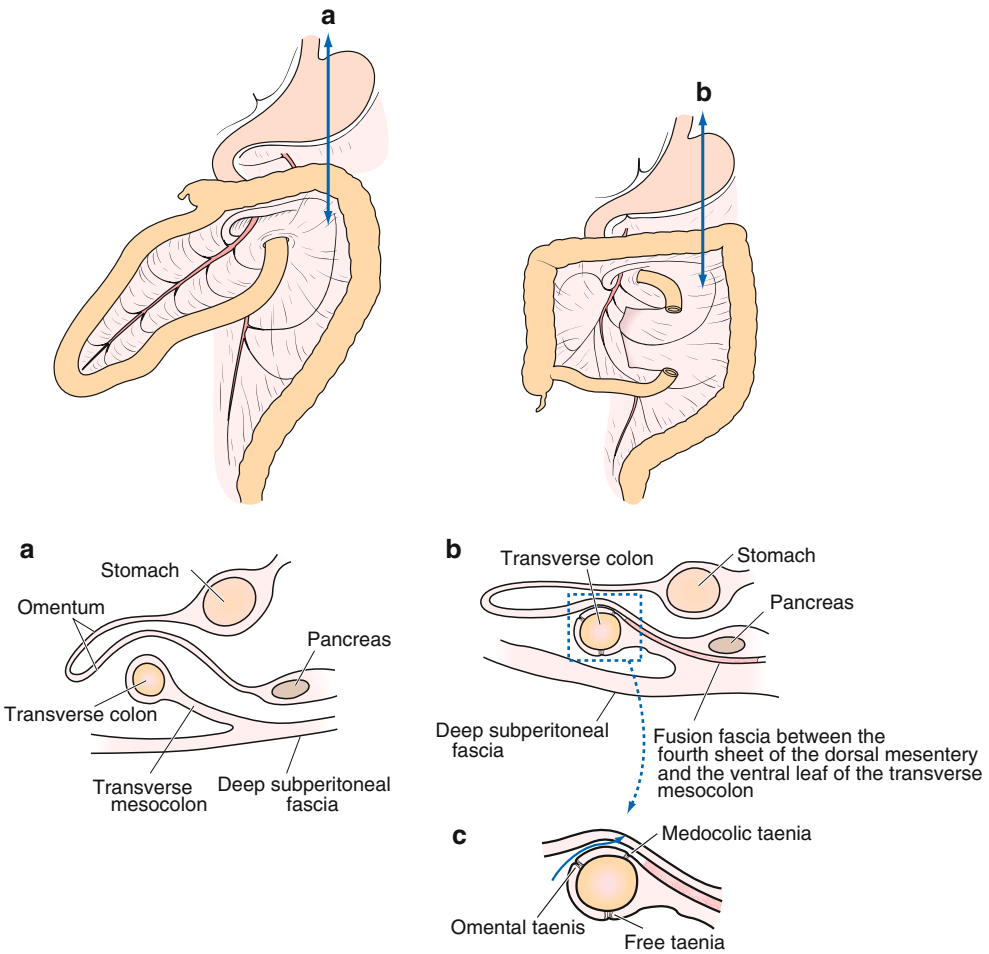


Fig. 7.3 Relationship between intestinal rotation and the transverse mesocolon. In the longitudinal section during the intestinal rotation, the omentum (dorsal mesentery), and the mesocolon have no relation (**a**); however, they form a fusion fascia when the intestinal rotation is completed (**b**)

fascia. After mobilisation of the left colon is completed, a small auxiliary incision is performed along the upper midline.

The procedure involving the transverse colon to the splenic flexure of the colon is performed on a flat operating table, and the small intestine is positioned back into the pelvic space. In the case in which the splenic flexure of the colon is too high to dissect, an additional 5-mm trocar is inserted for operator's left hand at the epigastric region.

7.4.1 Dissection and Mobilisation of the Sigmoid Colon Using the Medial Approach

1. Dissection and Mobilisation of the Sigmoid Colon from the Medial Side
2. Dissection and Mobilisation of the Sigmoid Colon from the Lateral Side

The above procedures were described in the sigmoidectomy section (see the Chap. 3)

7.4.2 Lymph Node Dissection at the Root of the IMA

Scope: right cranial port.

The operator's right hand: holds the ultrasonically activated device (USAD)

Incision at the plexus around the IMA.

The operator's left hand: inserts the bowel forceps from the umbilical port

Suitable for fine operations to assist in USAD procedures

It is the mirror image for the assistant.

The assistant's right hand: almost free (or available to remove the small intestine), When the LCA is divided, the ventral sheet of the sigmoid mesocolon forms a screen when pulled.

The assistant's left hand: lifts the vascular pedicle of the IMA to the ventral-caudal side to make a 30-degree angle with the aorta using forceps.

In contrast to a sigmoidectomy, a lymph node dissection involves the division of the LCA from the IMA. Whether the LCA is branched from the IMA at any level, the cranial portion of the IMA should be dissected to achieve mobilisation of the

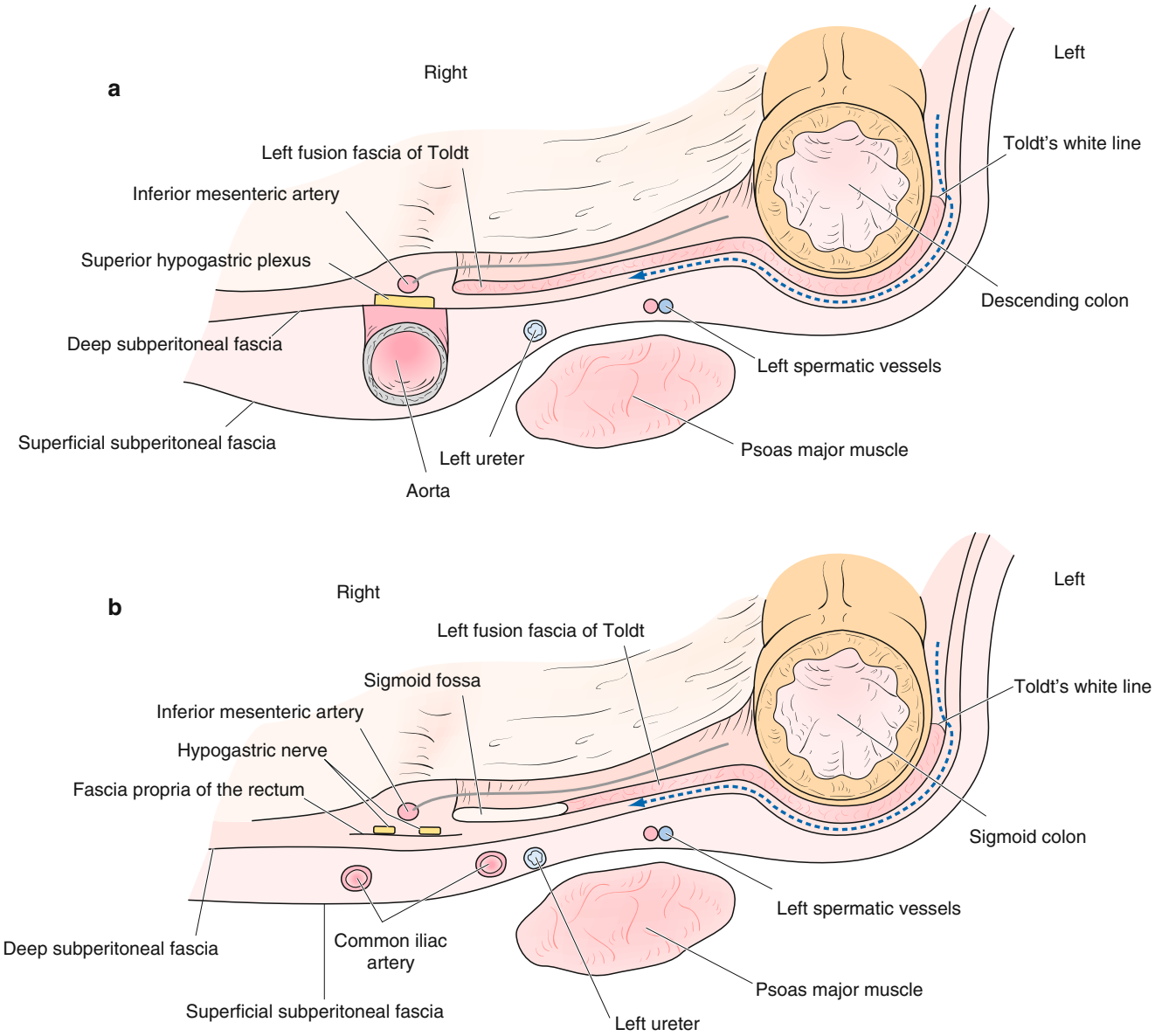


Fig. 7.4 Fascial composition of the left colon. The only anatomical landmarks for dissection between the fusion fascia of Toldt and the deep subperitoneal fascia are the spermatic vessels and the ureter [5, with permission]

descending colon. Of note, there are a few cases in which the root of the IMA should be divided for lymph node dissection.

The serosa of the right mesocolon of the sigmoid colon is divided further cranially to the root of the IMA. Nerve bundles from the lumbar splanchnic nerve (inferior mesenteric plexus) to the right side of the IMA are divided using an USAD and the outer membrane of the IMA is exposed. Similarly, the nerve bundles ventral to the IMA are divided and the IMA is dissected to the caudal side to detect the LCA. The assistant grasps the sigmoid mesocolon to form a like screen-like shape with his right hand coordinated by his left hand. After the LCA is fully dissected, it is separated and secured using double Hem-O-lok™ clips (Fig. 7.8).

Viewing the fusion fascia of the Toldt like a screen, the left arcade of the lumbar splanchnic nerve that is lifted to the ventral side is dissected towards the dorsal side. Next, maintaining the surface of the deep subperitoneal fascia that has been dissected, the dissection continues towards the cranial side from the medial side. The dissection from the sigmoid colon to the descending colon proceeds in this fashion (Fig. 7.9).

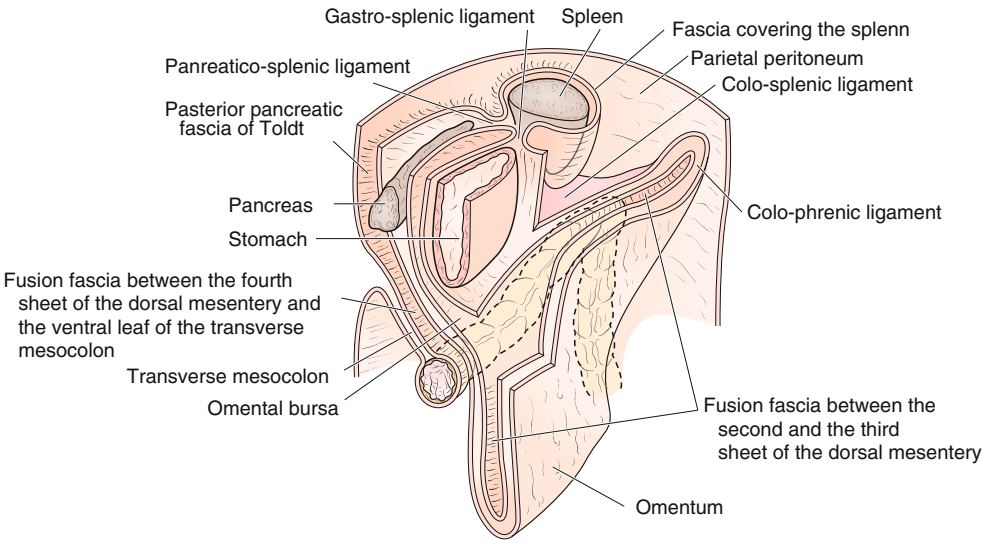


Fig. 7.5 Relationship between the omentum and the colo-phrenic ligament/colo-splenic ligament. The colo-phrenic ligament is considered to be formed from the left protrusion of the bursa omentalis that has been closed. The colo-splenic ligament is a secondary vertical ligament formed by the parietal peritoneum between the splenic flexure of the colon and the spleen or by the leftmost part of the transverse mesocolon

7.4.3 Mobilisation of the Descending Colon

Scope: Umbilicus.

The operator's right hand: an electrosurgical knife with spatula-type blade or USAD.

The operator's left hand: grips the innermost serosa of the descending colon.

The assistant's right hand: maintains traction of the sigmoid colon to the caudal-medial side.

The assistant's left hand: controls the transverse colon.

The white line on the lateral side of the descending colon is divided. The mobilisation of the sigmoid and the descending colon is performed by dissecting the left fusion fascia of Toldt from the deep subperitoneal fascia cranially. On the cranial side, once the boundary between the adipose tissue enclosed by the left fusion fascia of Toldt and the deep subperitoneal fascia is confirmed, the ventral side of the deep subperitoneal fascia is exposed (Fig. 7.10) and dissection extends to the splenic flexure of the colon. Along this course, the dissection is continuous with the layer that has been dissected from the medial side.

Near the splenic flexure of the colon, the dissection between the left fusion fascia of Toldt and the deep subperitoneal fascia is shifted to the medial side, and dissection proceeds in close proximity of the colon. Here, priority is given to the ventral side of the deep subperitoneal fascia to be dissected medially rather than the division of the peritoneum. If the dissection sets too close to the spleen, it means that the dissecting plane has been misjudged. Thus, it is necessary to perform a correction from the caudal side.

According to the above procedure, when the splenic flexure of the colon is shifted to right medial side, the dissection has entered the dorsal side of the colo-phrenic ligament and the colo-splenic ligament (Fig. 7.10a). Thus, the hanging band, the left colo-phrenic ligament, and the colo-splenic ligament can be easily dissected and divided near the colon.

7.4.4 Approach from the Gastro-Colic Ligament

Scope: Umbilicus.

The operator's right hand: an electrosurgical knife with spatula-type blade or USAD.

The operator's left hand: maintains traction of the transverse colon to the right-caudal side.

The assistant's right hand: maintains traction of the transverse colon to the left-caudal side.

The assistant' left hand*:* maintains traction of the omentum to the ventral side (In some cases: an additional 5-mm trocar is inserted for the operator's left hand at the epigastral region.)

The patient is placed on the operative table is in the back flat position. The assistant separates the omentum from the omental taenia of the transverse colon towards the left side. The operator adds traction to the transverse colon to have a view of the omental taenia of the transverse colon. The dissection of the omentum begins by dividing the omentum from the omental taenia and by entering between the third sheet of the dorsal mesentery and the fusion fascia (i.e., between the fourth sheet of the dorsal mesentery and the ventral leaf of the transverse colon) at the taenia coli (Figs. 7.1, 7.3c, and 7.11a, I–III). The dissecting layer in this part is relatively loose and can be directed to the dissection of the descending colon side gradually. This layer can continue to the dissecting layer of the ventral side of the deep subperitoneal fascia if the

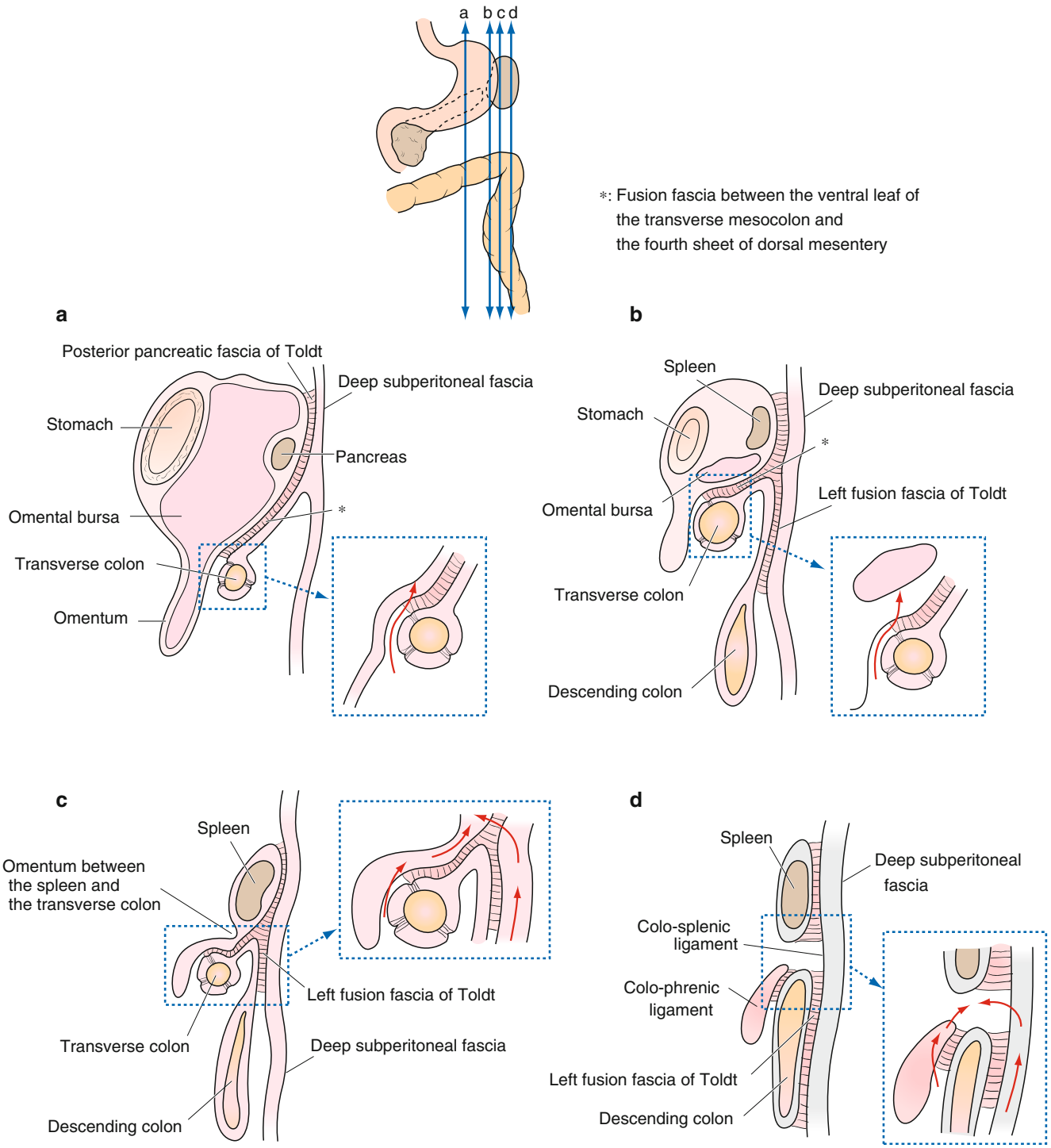


Fig. 7.6 (**a**–**d**) Fascial configuration of the transverse colon, descending colon and the splenic flexure of the colon. There is a variation in the fascial configuration of this part determined by the degree of entry of the omentum between the spleen and the transverse colon. Two hanging bends called the colo-phrenic ligament and the colo-splenic ligament are visible (**d**)

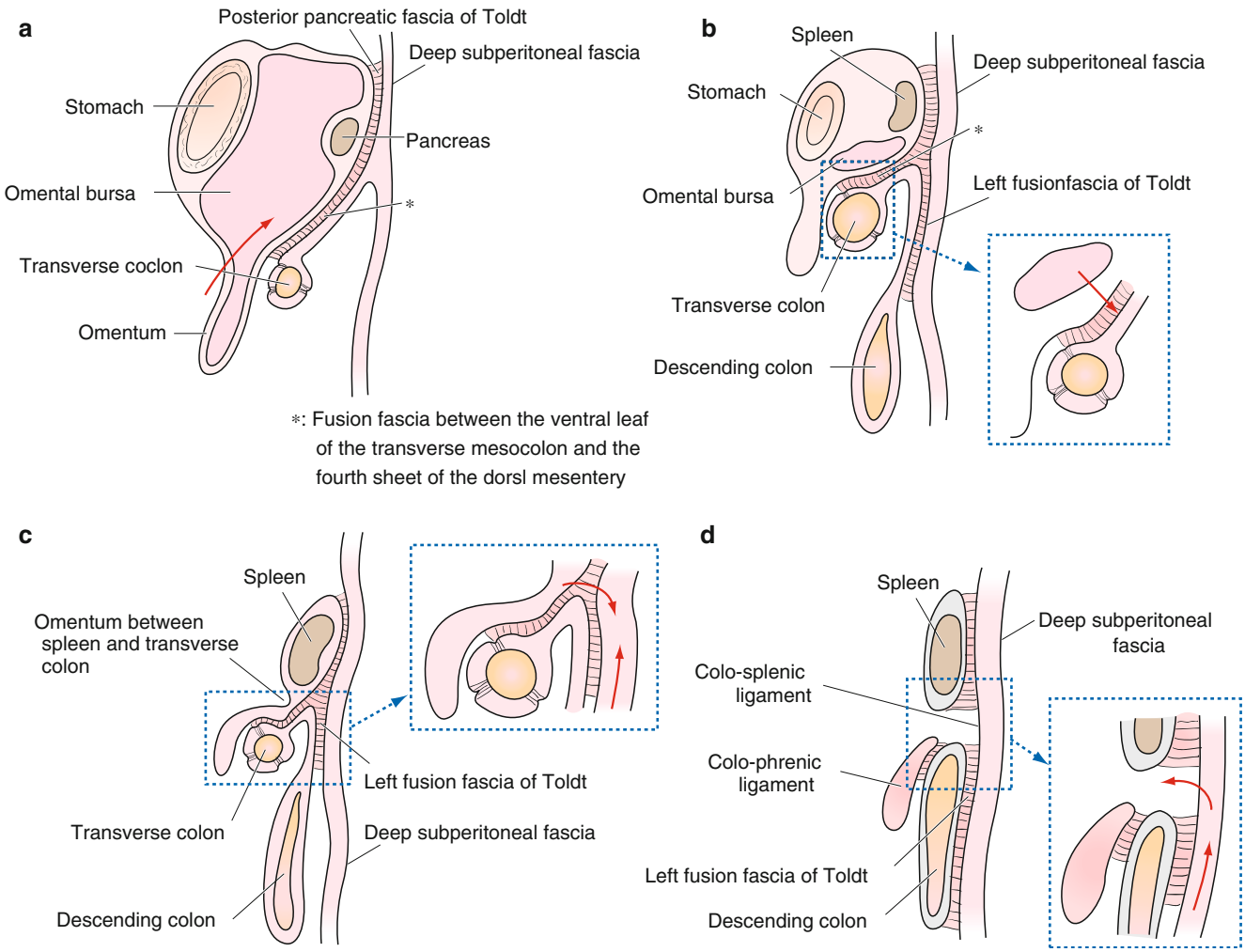


Fig. 7.7 (**a**–**d**) Procedure through the bursa omentalis. If the procedure through the omental bursa is performed (**a**), it is necessary to enter the dorsal side of the third sheet of the dorsal mesentery at the leftmost side of the omental bursa (**b**) and to divide the left fusion fascia of Toldt (**c**). The procedure through the omental bursa requires more omentum to be separated in order to continue to the dissection layer of the descending colon, and thus is more complicated

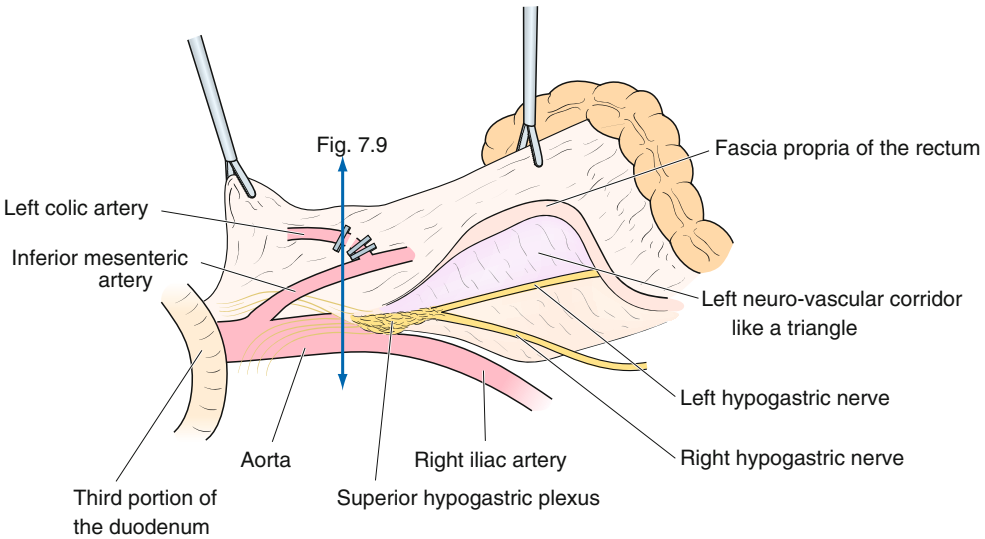


Fig. 7.8 Lymph node dissection at the root of the inferior mesenteric artery. Nerve bundles, departing from the lumbar splanchnic nerve (inferior mesenteric plexus) to the right side of the inferior mesenteric artery (IMA), are divided by an ultrasonically activated device to detect the left colic artery (LCA). The assistant grasps the sigmoid mesocolon to form a screen or fan-like structure with his right hand coordinated by his left hand. After the full dissection of the LCA is achieved, it is separated and secured using double Hemo-lock™ clips

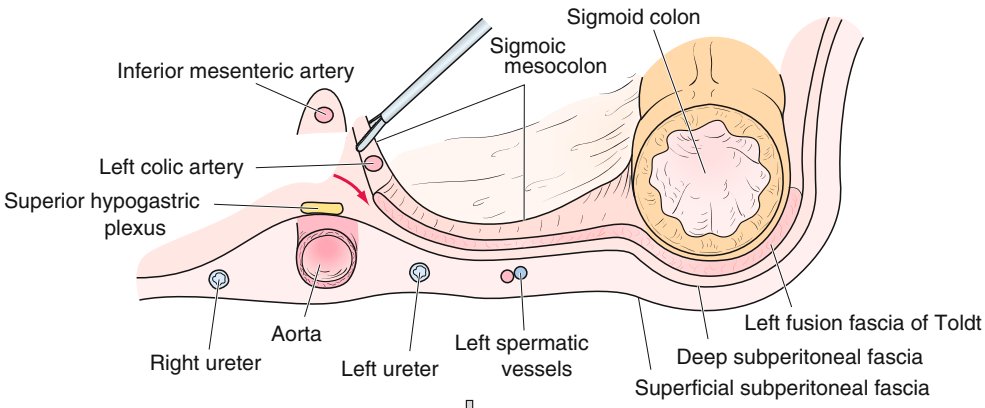
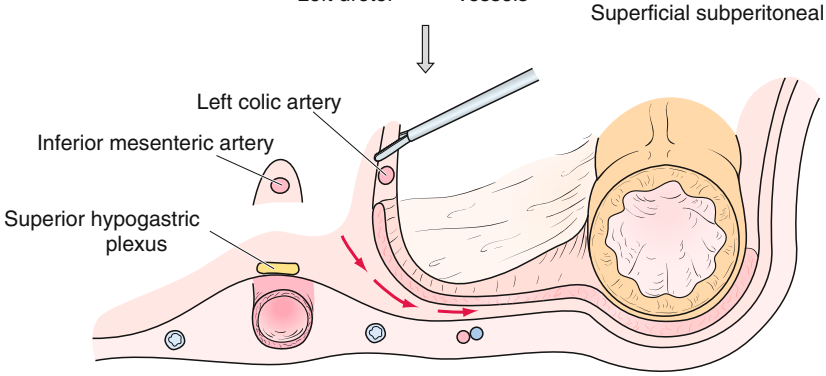


Fig. 7.9 Cross-sectional view of the dissection and mobilisation of the descending colon in the medial approach. Maintaining the surface of the deep subperitoneal fascia that has been dissected, the dissection continues from the medial side to the cranial side. The dissection from sigmoid colon to the descending colon proceeds likewise



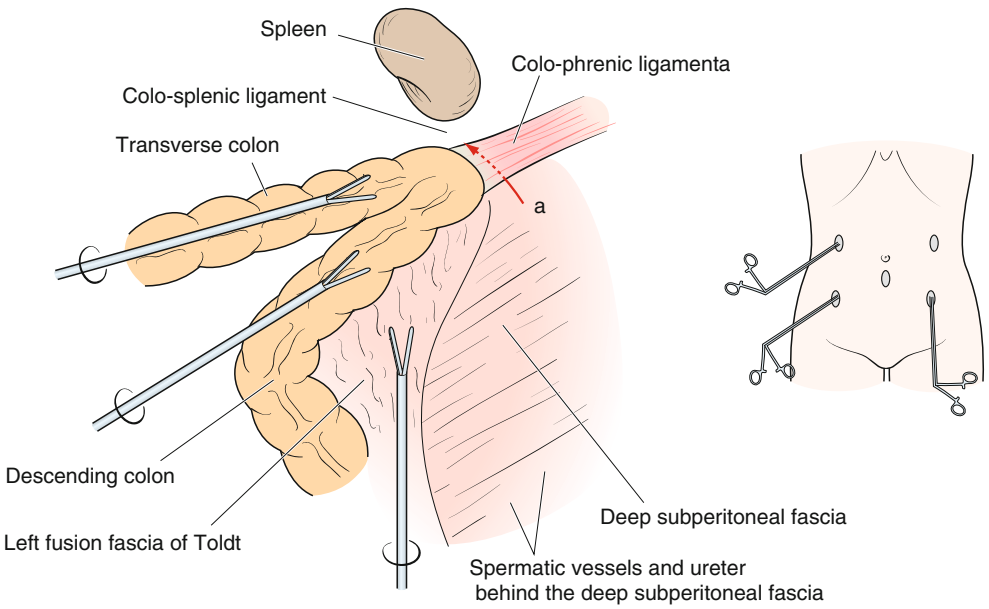


Fig. 7.10 Mobilisation of the descending colon. The descending colon is dissected and mobilised on the ventral side of the deep subperitoneal fascia towards the splenic flexure of the colon from the caudal side

left fusion of Toldt is cut at the splenic flexure of the colon (Figs. 7.6c and 7.11b).

When performing the procedure via the omental bursa, it is necessary to re-enter the dorsal side of the third sheet of the dorsal mesentery at the left-most portion and cut the left fusion fascia of Toldt. The approach through the omental bursa is likely easier. However, the procedure through the omental bursa requires more omentum to be separated in order to continue to the dissection layer of the descending colon, and thus is more complicated. It is difficult to say

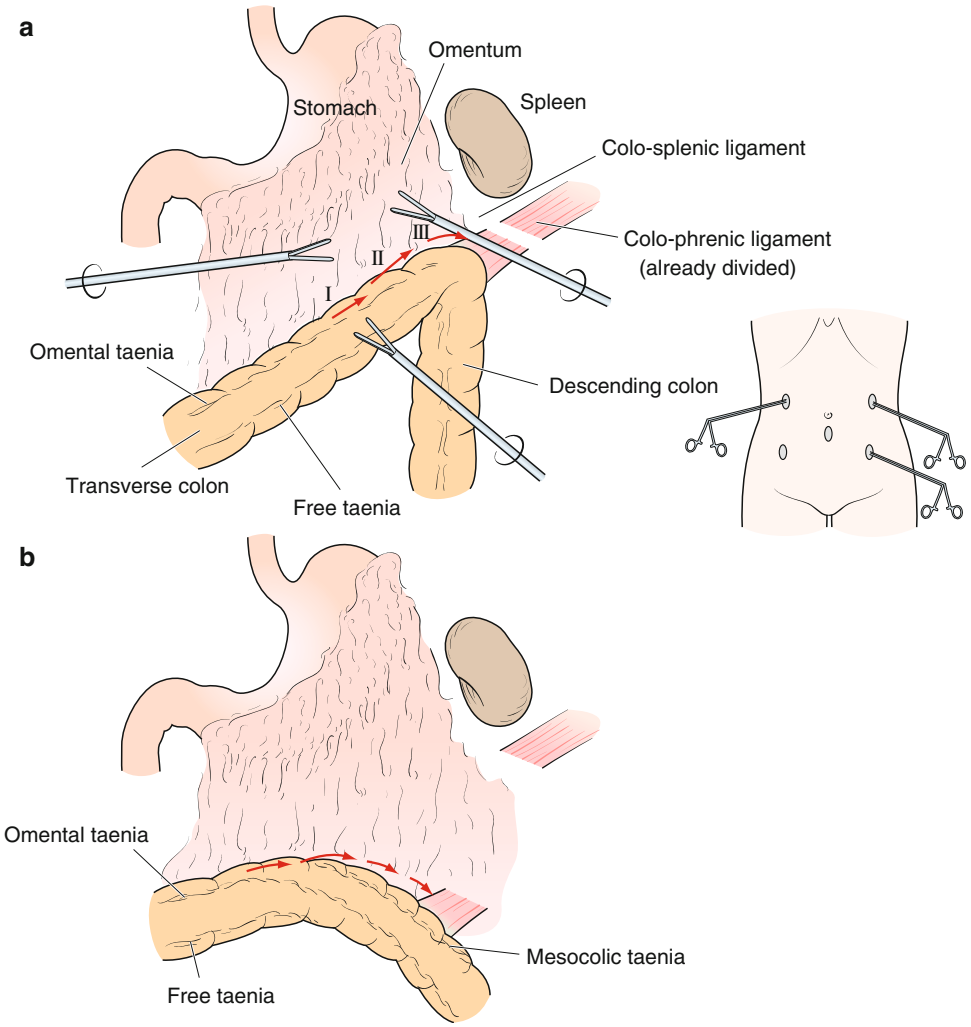


Fig. 7.11 Dissection the transverse colon. The assistant adds traction to the transverse colon to have a view of the omental taenia of the transverse colon. The dissection of the omentum begins by entering the third sheet of the dorsal mesentery and the fusion fascia between the fourth sheet of the dorsal mesentery and the ventral leaf of the transverse colon at the taenia coli. The dissecting layer at this section is relatively loose and can be directed towards the dissection of the descending colon side gradually. This layer can continue to the dissecting layer of the ventral side of the deep subperitoneal fascia if the left fusion of Toldt is cut at the splenic flexure of the colon

whether the procedure is reflective of the surgical plane in the clinical anatomy (Fig. 7.7). However, in transverse colon cancer, if the omentum is to be excised, this procedure through the omental bursa could be considered an option (Fig. 7.7).

In the case of an obese patient, if it is difficult to perform the above procedure, a 5-mm port is inserted into the epigastric region for the USAD to divide the omentum.

7.4.5 Small Auxiliary Incision

Usually a small auxiliary incision is made in the upper midline abdomen after pneumoperitoneum is stopped. The length of the incision is usually about 5 cm; it is considered an optimal length to allow the tumour to be pulled out without difficulty. A Wound Retractor™ is used for the protection of the wound margin from contamination.

Segmentectomy is suitable for paracolic lymph node dissection of the left colon [1–3], as lymph node metastases are mostly located in the paracolic area and around the left colic artery.

7.4.6 Intestinal Resection and Anastomosis

Functional end-to-end or side-to-end or end-to-side anastomosis is performed with a PCEEA™ and an Endo-GIA™. If mechanical anastomosis cannot be performed, a hand-sewn anastomosis is executed.

7.4.7 Wound Closure

The port site incision wounds are closed with skin stapler or buried sutures. In addition, the upper midline wound is closed in a double layer with delayed absorbable sutures. No abdominal drains are necessary.

7.5 Mobilisation of the Splenic Flexure of the Colon

The mobilisation of the splenic flexure of the colon is often performed using the lateral approach from the sigmoid-descending colon and using the medial approach from the omentum. The former is a simple fascial composition because the left fusion fascia of Toldt is formed between the dorsal leaf of the sigmoid-descending mesocolon and the retroperitoneum. However, the fascial composition between the stomach and the transverse colon is difficult to understand because the omentum is formed from the dorsal mesentery, while the fusion fascia is formed from the fourth sheet of the dorsal mesentery and the ventral leaf of the transverse mesocolon.

Furthermore, during the actual procedure, since the omentum shields the field of view, the procedure is difficult. Therefore, it is necessary to understand the fascia composition of the splenic flexure of the colon including the relationship between the transverse colon, the diaphragm, and the spleen.

When considering the fascial composition, the simplified interpretation by Tobin et al. [6] and Sato [7] of the structure of the body below the diaphragm can be used, always taking into consideration the continuity of the fascia in the abdominal cavity. This continuity should also always be kept in mind during surgery of the splenic flexure of the colon [8]. Moreover, in considering the fascia structure of the splenic flexure of the colon, it is important to determine which fascia should be recognized as the anatomical landmark. In other words, for the dissection of the sigmoid-descending colon, the deep subperitoneal fascia, which is ventral to the spermatic vessels, and the ureter are suitable anatomical landmarks, while the fascia on the side of the colon side should never be considered as an anatomical landmark [5]. In addition, the third sheet of the dorsal mesentery is an anatomical feature suitable for the dissection of the fascia of the transverse colon as is the fascia of the dorsal side of the omental bursa [9]. For the dissection of the mesentery from the retroperitoneal fascia, many fasciae may appear but it is important to consider which fascia is an anatomical feature for correct dissection [5].

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Laparoscopic Subtotal Proctocolectomy

8

8.1 Introduction

Proctocolectomy and ileorectal anastomosis is a surgical procedure indicated for familial adenomatous polyposis proposed by Lockhart-Mummery [1] that takes into account the quality of life. In recent years, this method has represented a step forward, and subtotal proctocolectomy (total colectomy and lower anterior resection of the rectum) has begun to be performed using laparoscopic surgery procedures. Lymph node dissection for combined colorectal cancer is also possible with laparoscopic surgery.

In addition, using the intersphincteric resection of the rectum (ISR) procedure, it is possible to resolve almost any issue encountered in colorectal surgery, for example, ileal pouch-anal anastomosis (IPAA).

Through the understanding the fascial composition of the large intestine and integrating the surgical procedure to each site of the large intestine, subtotal and total coloproctectomy can be performed.

8.2 Resection Range and Dgree of Lymph Node Dissection

The area of the entire colon and most of the rectum is considered the resection range. For comorbid cancers, laparoscopic subtotal proctocolectomy and subtotal proctocolectomy with laparotomy are similar in terms of resection range and degree of lymph node dissection, with respect to other interventional approaches in the abdominal cavity. Lymph node dissection of the transverse colon is performed through a supra-umbilical incision.

8.3 Operative Procedures

The patient is placed in the head-down position on the operating table in laparoscopic view:

1. Mobilisation of the right colon is performed using the medial-retroperitoneal approach. (See theChap. 6).
2. Mobilisation of the sigmoid colon is performed using the medial approach, and the rectum is divided by total mesorectal excision (TME). (See the Chaps. 3 and 4).

   (In the case of the ISR procedure, the rectum is dissected as far as possible to the anal canal; and if possible, the sigmoid colon is divided. (See the Chap. 4)).
3. Mobilisation of the left colon is performed. (See the Chap. 7).

Placing the patient in the supine position:

4. Mobilisation of the splenic flexure is continued by dissection. (See the Chap. 7).
5. Mobilisation of the hepatic flexure and the complete mobilisation of the right colon are performed. (See the Chap. 6).
6. Finally, with a small auxiliary incision placed at the supra-umbilical midline, the entire colon and the rectum is removed outside of the abdominal cavity, and the vascular ligation of the transverse colon is performed, preserving the ileocolic vessels.
7. The ileum is mounted using the anvil head of the PCEEA™ and an ileorectal anastomosis is created using the double-stapling method.

Reference

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M. Mike, *Laparoscopic Colorectal Cancer Surgery*, DOI 10.1007/978-981-10-2320-0_8

Unresolved Fascial Composition

9

9.1 Considerations Regarding the Sites of Unresolved Fascial Composition

In the surgical procedure described, those sites where doubts still exist about the fascial composition in the abdominal cavity consist of the following four locations:

1. Near the second portion of the duodenum in the mobilization of the right colon, the fascial configuration obtained when the dissection between the right fusion fascia of Toldt and the deep subperitoneal fascia is performed,
2. Following the dissection between the left fusion fascia of Toldt and the deep subperitoneal fascia, a few sheets of fascia appear to the left fusion fascia of Toldt. Particularly after fascial dissection using the lateral approach, a sheet of fascia remains visible in the operative field. This is not comprehensible. Only after the complete division of the sheet is achieved can the optimal layer be ensured.
3. A transparent fascia is present on the dorsal side of the Denonvilliers' fascia.
4. In the Kraske parasacral approach, there is a fascia on the dorsal side of the rectum of the caudal side of the rectosacral ligament.

If the above are considered based on the idea that the mesentery can be identified by at least four sheets of fascia rather than two according to Sato's concept [1] (Fig. 9.1), then they can be re-interpreted as follows:

1. It is understandable that many of the fasciae exist in the second portion of the duodenum when the mobilization of the right colon is performed using the medial-retroperitoneal approach (Fig. 9.2).
2. When observing the fascial composition in cases in which the mobilization of the sigmoid colon is complex, it is sufficient to focus one's attention only on the deep subperitoneal fascia as an indicator (Fig. 9.3). As interpreted, the fascial structure that presents at the start of the medial-retroperitoneal procedure in right colectomy (see the Chap. 6; Fig. 6.6) is considered to be the same as that in the sigmoidectomy procedure. That is, the traction to the ventral side of the sigmoid mesocolon would create a new fascia (Fig. 9.4).
3. The Denonvilliers' fascia is often described in fusion theory due to the fact that two fasciae of the peritoneum have been fused [2–7]. Therefore, an additional fascia present on the dorsal side of the Denonvilliers' fascia is of course the fascia involving the rectum (Fig. 9.5) because the deep subperitoneal fascia continues towards the subserosal region of the rectum (Fig. 9.1). However, the continuity of this fascia to the dorsal and cranial side is currently unresolved.
4. In Kraske operation, the fascia on the dorsal side of the rectum caudal to the rectosacral ligament is not resolved by Sato's interpretation (Fig. 9.6).

As a basis for understanding the fascial composition, we have mentioned Sato's interpretation. However, the adaption of Sato's interpretation to all intestinal sites must be discouraged. Because the purpose of our clinical anatomy is to determine the significance of those structures visible during surgery in the clinical setting, an excessive emphasis on Sato's interpretation is not relevant to clinical anatomy and

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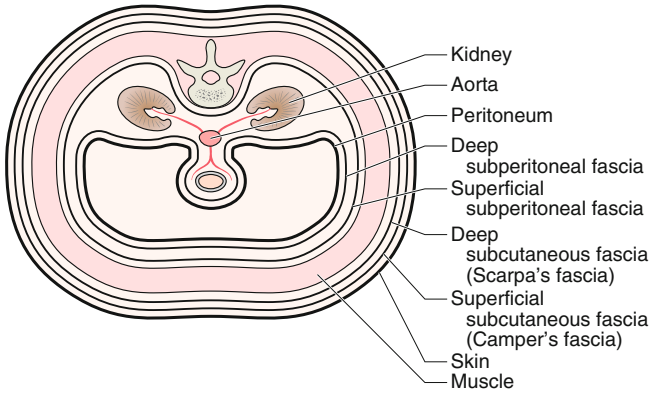

Fig. 9.1 Sato's concept. According to Sato's concept the deep subperitoneal fascia covers the entire circumference of the dorsal mesentery and the vessel corridor lies within this fascia. However, if this concept is applied to all fields within the abdominal cavity, it can be supported by all views in the clinical setting

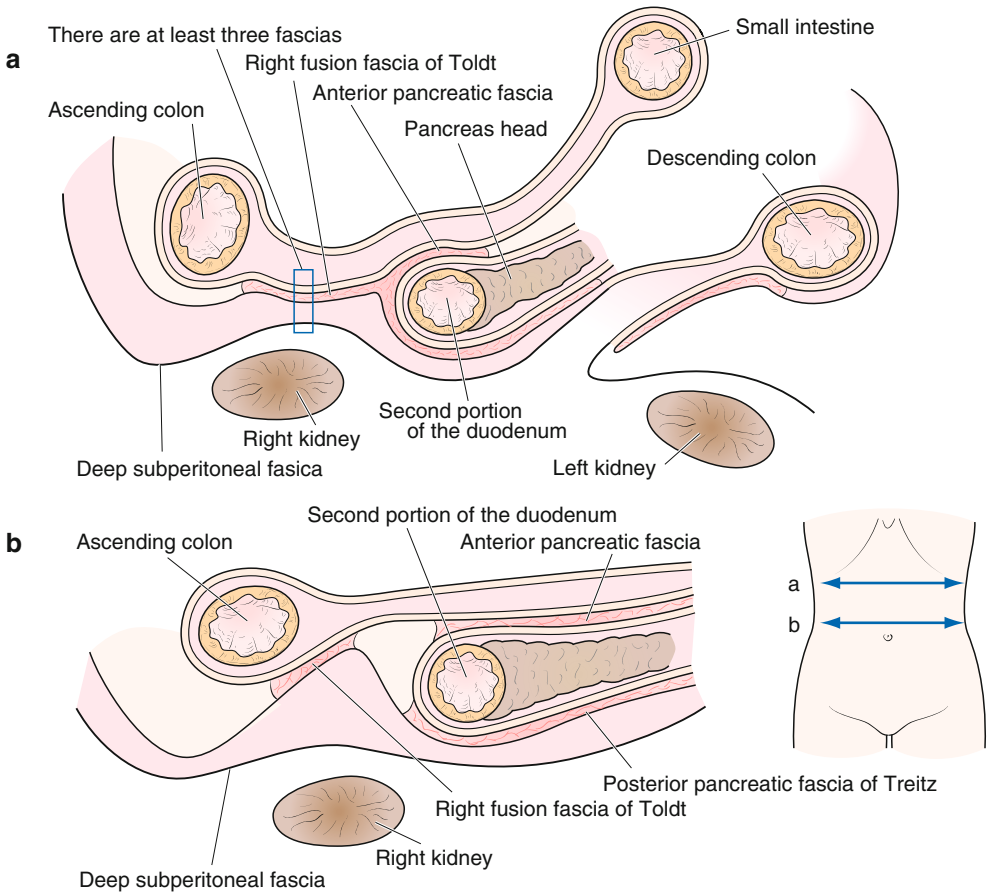

Fig. 9.2 (**a**, **b**) Fascial composition in the mobilisation of the right colon. Based on Sato's concept it can be appreciated that many fascia exist in the second portion of the duodenum when right mobilisation is performed using the medial-retroperitoneal approach

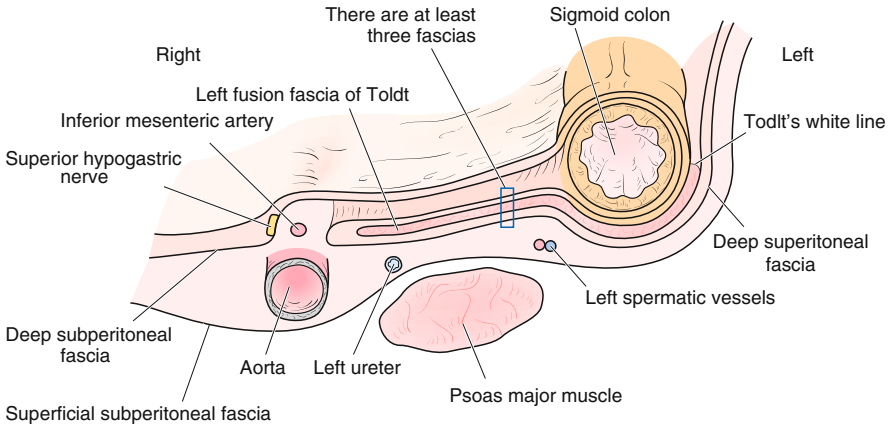

Fig. 9.3 Fascial composition in the mobilisation of the sigmoid colon. It is thus possible to discuss the fascial composition during the mobilisation of the sigmoid colon, since it is sufficient to focus one's attention only on the deep subperitoneal fascia as an indicator

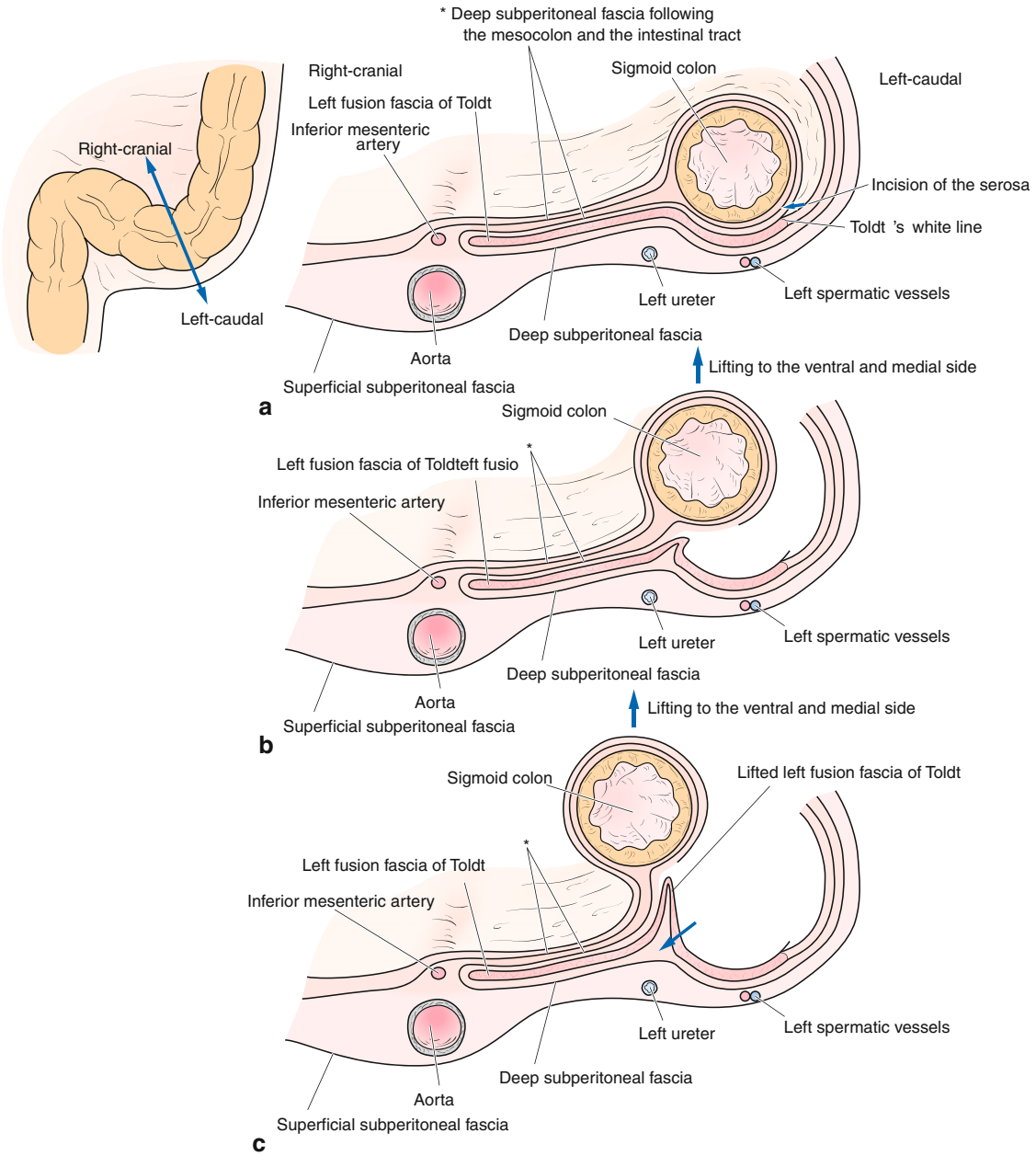

Fig. 9.4 Interpretation of the fascia structure in the mobilisation of the sigmoid colon. According to Sato's interpretation, the fascia structure that appears at the start of the medial-retroperitoneal approach in right colectomy is considered to have the same mobilisation. (see the Chap. 6; Fig. 6.6). The traction to the ventral side of the sigmoid mesocolon would create a new fascia (**c**)

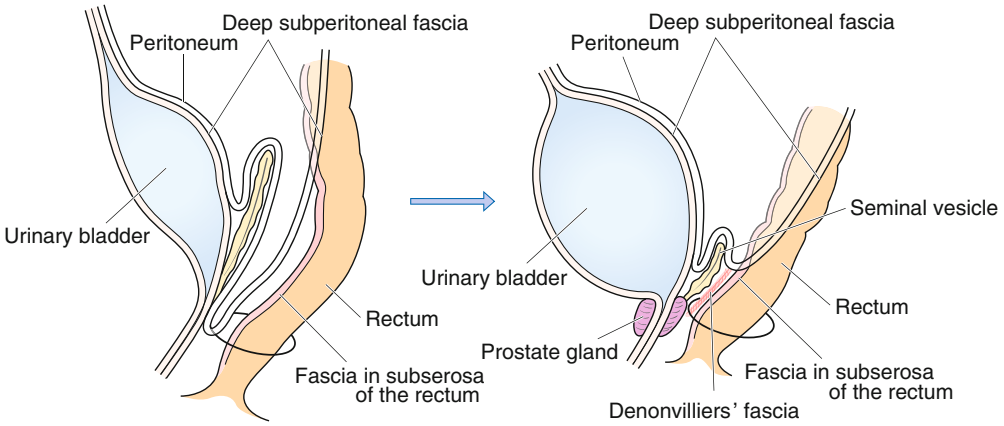

Fig. 9.5 Development of fascial composition of the Denonvilliers' fascia portion. The additional fascia present on the dorsal side of Denonvilliers' fascia is of course the fascia relative to the rectum; hence the deep subperitoneal fascia continues towards the subserosal region of the rectum. However, the continuity of this fascia towards the dorsal and cranial sides remains unresolved

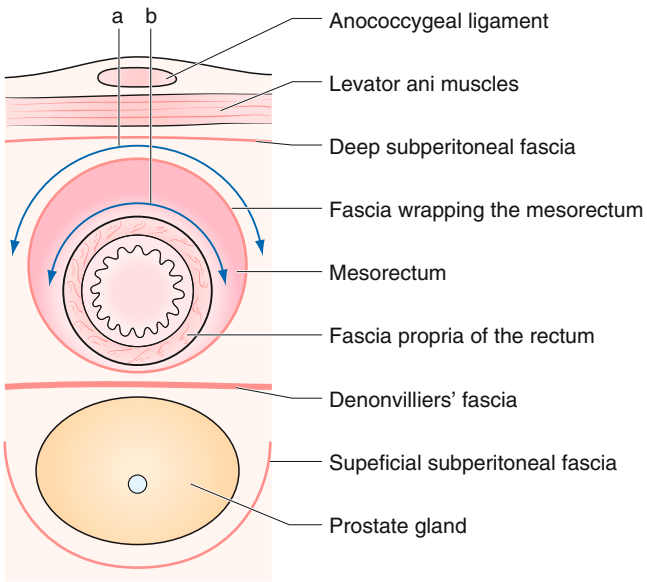

Fig. 9.6 Fascial composition in Kraske procedure. The fascia on the surface of the rectum beyond the rectosacral ligament is an unresolved fascia according to Sato's interpretation

cannot be used to support the concept that the omentum is formed by eight fasciae originating from the dorsal mesentery in clinical practice. Therefore, the origin of this fascia has not been considered here, the clinical anatomy simply refers to the idea of whether surgery can be successfully completed when this fascia is an anatomical feature.

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