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# Controversies and Innovations in Urological Surgery

Edited by

Clive Gingell and Paul Abrams

With 262 Figures

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# Series Editor's Foreword

The title of this book is a challenge. Anyone with the least knowledge of present day urology will know that there are many very controversial aspects of this subject. Urology is not alone in this unsettled environment for there are similar debates in almost all other aspects of surgery. In addition to the rapid changes in technology, an important part of the explanation for these controversies is simply that more surgeons are prepared to admit that no area of their work is so established that it does not bear further scrutiny and assessment.

Argument can be tedious but debate is healthy. This book aims to present material that is debatable: experienced practitioners of each topic explain why an opinion or preference can be sustained. The purist might wish to have these opinions resolved by a well-planned clinical trial, but experience of clinical trials shows that they do not always produce results that are easily translated into a positive change in clinical practice. Would the reader be persuaded more by a statistically significant difference or by an experienced clinician who has reached certain conclusions? Both are risky, but since surgical techniques are often not easily converted into appropriate studies or trials the Editors have obtained the best opinion on each controversy and innovation. The media adore controversy for its own sake. The medical profession accepts controversy but knows that few events in medicine are absolute and few procedures can be done only by one method.

The Editors have planned their material in nine sections, and each section opens with an introduction that sets the scene. The subsequent chapters give state of the art commentaries on each problem or procedure.

An innovation is a new thought, development or technique and the Editors invited their contributors to include innovative material where appropriate. This approach allows the reader to determine how these innovations relate to the changing pattern of management.

The summation of this novel approach to a urological text provides an exciting, readable volume that fulfills the aims of this Series—to provide a useful, stimulating contribution to the clinical practice of urology.

Edinburgh
June 1988

Geoffrey D. Chisholm.

# Preface

The main aim of this volume is to bring the general urologist and urologist in training up to date with some of the many advances in urological surgical practice. There have been considerable developments in this respect, and there often exists a choice of surgical procedures for the same problem. How are these newer techniques undertaken and what is their place in the management of specific urological problems? Certain innovative procedures have recently become well established and are already altering urological surgical practice. There has been an increasing tendency for specialist interests to develop within urology. This trend is inevitable, and for the further development and advancement of urological surgery as a specialty it is necessary. However, it is important for the general urologist to be aware of these developments and be guided in his approach to certain surgical controversies. We have in this volume asked recognised experts to outline their techniques clearly and concisely and we have attempted to evaluate their role in the management of specific problems.

We have also included much less commonly applied surgical procedures, many of which, although well established, are so infrequently undertaken by the general urologist that they engender some degree of concern in the operator. We consider that a description by an expert of his own technique is very appropriate and valuable. We have included a wide range of techniques, from minor to relatively major, that can readily be undertaken with guidance by the general urologist. With the more major procedures, the reader would be prudent to avail himself of more practical help than that given by this book alone. It is not intended that this should be a surgical operative's manual but a practically orientated guide to surgical innovations in urology and their role in current urological practice – a sort of urological "how I do it and why". Therefore, we have included contributions from urologists who have either themselves developed specific surgical techniques or have considerable personal experience in the management of particular urological conditions and are able to provide guidance for the reader who has to deal with these problems.

Bristol, 1988

J. C. Gingell
P. H. Abrams

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Section I

# Extracorporeal Shock Wave Lithotripsy

# Introduction

*J. C. Gingell*

The most spectacular and revolutionary development in urological practice in recent times has without question been the successful introduction of extracorporeal shock wave lithotripsy (ESWL). The research and background of this technique for the non-operative treatment of kidney stones by the Dornier Company is admirably described in this chapter by one of the original medical pioneers, Professor Eisenberger. The machines produced by Dornier in the Federal Republic of Germany have now spread throughout the world, and there are currently approaching 200 in operation in the USA alone. As with any new development, much further research and refinement has been generated, culminating in the rapid appearance of Mark II or second generation machines. Such machines currently appearing on the market are less complex, smaller and cheaper in both capital outlay and running costs than the prototype Dornier machine. The implications are such that most urological centres will acquire their own machine or have ready access to one for the treatment of their patients with stone disease of the upper urinary tract.

At present, all Mark II machines have dispensed with the water bath, and most treatments can be undertaken without the need for general or regional anaesthesia, particularly if a piezoelectric transducer is used to produce the shock wave. The technical details of ESWL machines currently in production in Europe are shown in Table I.1.

Other important considerations, apart from the list price, are the service contract, warranty, service frequency and current back-up provided by the company. At a time of rapid development and progress the facility to modify and adapt the machine in question could also prove to be important.

The choice basically depends upon the method of localisation of the stone, either by ultrasound or the more expensive biplanar X-ray, and

**Table I.1.** Summary of machine data

| Machine data | Dornier HM-4 | Siemens Lithostar | Technomed Sonolith 2000 |
|---|---|---|---|
| Country of origin | Germany | Germany | France |
| Localisation method | Biplane X-ray | Biplane X-ray | Ultrasound |
| Continuous imaging | No | No | No |
| Shock wave transducer | Spark discharge | Electromagnetic | Spark discharge |
| Focal size | 12 × 60 mm | 10 × 90 mm | 15 × 30 mm |
| Shock intensity | Variable 400–1200 bar | Variable to 500 bar | Fixed 800 bar |
| Shock rate | Cardiac frequency | Variable to 1.7 Hz | Cardiac frequency |
| Shock wave gating | ECG and/or respiratory | ECG and/or respiratory | ECG |
| Patient contact | Water cushion | Water-filled bellows and gel coupling disc | Degassed water |
| Mobile equipment | No | No | Moveable |
| Other uses | No | General urological | No |
| Gallstone treatment | Experimental using contrast agent | Experimental using contrast agent | Experimental |
| Room size | 35 $m^2$ | 35 $m^2$ | 25 $m^2$ |
| Installation services | Water supply, drainage, 57 kVA three phase | Base plate, 23 kVA three phase | Water supply, drainage, 4 kVA single phase |

**Table I.1.** (*continued*)

| Machine data | Wolf Piezolith 2200 | EDAP LT.01 |
|---|---|---|
| Country of origin | Germany | France |
| Localisation method | Ultrasound | Ultrasound |
| Continuous imaging | Yes | Yes |
| Shock wave transducer | Piezoelectric | Piezoelectric |
| Focal size | 3 × 6 mm | 4 × 15 mm |
| Shock intensity | Variable to 700 bar | Variable to 1000? bar |
| Shock rate | 0.5–4 Hz | Variable to 160 Hz |
| Shock wave gating | None | None |
| Patient contact | Degassed water | Water enclosed with membrane |
| Mobile equipment | Moveable | Console only |
| Other uses | Lithotomy position available | No |
| Gallstone treatment | Experimental | Experimental |
| Room size | 20 $m^2$ approx | 30 $m^2$ |
| Installation services | Water supply, drainage, 3.3 kVA single phase | 4 kVA single phase |

Details extracted from report by Dr A. J. Sargood, Scientific Officer, South West Regional Health Authority.

the type of shock wave generation used in treatment. An additional factor is the desirability of using the table for additional manoeuvres such as the endoscopic insertion of ureteric catheters, double-J stents, disimpaction of ureteric stones, ureterorenoscopy and percutaneous surgery, and hence the provision of a comprehensive stone service from a single table. Much will depend upon the interface between local requirements and the drainage population to be served. (An ESWL machine would be fully occupied serving a drainage population of about 3 million).

Where space, mobility of the machine, reduced capital costs and revenue consequences with minimal anaesthetic requirements are paramount, then a machine incorporating ultrasound localisation and piezoelectric shock wave production will have distinct advantages. Although ultrasound imaging is becoming increasingly accurate and sophisticated it cannot compete with biplanar X-ray localisation of the smaller stones frequently found in the ureter. Ureteric calculi are a much more common urological problem than renal calculi, and the use of ESWL is increasingly being directed to the treatment of stones in the ureter by treatment in situ or after disimpaction into the renal pelvis. To treat a stone it must be accurately imaged and localised within the shock wave. It is not known at present whether ultrasound localisation is capable of imaging stones much less than 5 mm in diameter; whereas this can be achieved readily by the more expensive machines using biplanar X-ray. The choice therefore depends very much upon what can be realistically expected from the machine and on how easily it can be integrated with the alternative and complementary techniques in stone management described in Section II.

*Chapter 1*

# Development, Indications and Clinical Experience

*F. Eisenberger and J. Rassweiler*

## Concept of Shock Wave Lithotripsy

Geometric focusing is one of the essential principles of non-invasive kidney stone disintegration. The other is the application of shock waves. The existence of shock waves is inseparably associated with extremely high velocities of bodies, i.e. with velocities exceeding the sound velocity in the respective medium. Typical examples are the impingement of rain and sand particles on supersonic aircraft, the collision of meteorites with spacecraft or the effect of high-velocity projectiles on armoured objects (Forssman and Hepp 1980; Hepp 1984).

These branches of quantum physics are involved in the elementary research of an aerospace company, Dornier System, which has carried out substantial work in this field. Within the framework of the respective development work, the transmission of mechanical shock waves through the human body was discovered by chance in the late 1960s. A test engineer touched a target body at the very moment of impact of a high-velocity projectile and felt a kind of electrical shock, though the contact point showed no damage at all (Häusler and Kiefer 1971; Hepp 1984). The idea of using shock wave energy for either military purposes or the destruction of urinary calculi was born. However, there was a long way to go until the first patient was treated by the non-invasive technique of extracorporeal shock wave lithotripsy (ESWL) (Table 1.1).

**Table 1.1.** History of the development of ESWL

| | |
|---|---|
| 1966 | First observation of the transmission of mechanical shock waves through human bodies |
| 1969 | First animal experiments to study the effect of shock waves on biological tissue |
| 1970 | First in vitro destruction of urinary stones with shock waves generated by a special multistage light–gas gun |
| 1971 | Focusing of the shock waves using an ellipsoid |
| 1974–1978 | Systematic in vitro and in vivo experiments with focused shock waves:<br>Effect on kidney stones with different chemical composition<br>Effect on biological tissue<br>Development of a canine kidney stone model<br>↓<br>Development of a prototype lithotripter for animal experiments |
| 7 February 1980 | First clinical application at the Department of Urology, University of Munich |
| 1982 | Installation of the first ESWL centre at the Department of Urology, University of Munich |
| October 1983 | Installation of the second ESWL centre worldwide at Katharinenhospital, Stuttgart |
| 1987 | More than 200 ESWL centres and more than 200 000 treatments worldwide |

# First Investigations

The first investigations were to find out whether the non-invasive disintegration of kidney stones was feasible when carried out with focused and unfocused shock waves, generated by means of light–gas guns (Häusler and Kiefer 1971). In the initial test phase, the generation of only four shock waves took an entire day and produced only a network of cracks in a kidney stone.

These in vitro tests were subjected to the following criteria:

1. Reproducible generation of shock waves
2. Focusing of shock wave energy
3. Acoustic coupling to guarantee energy transfer
4. Localisation of the stone
5. Determination of optimal stone-disintegrating energy

and lead to the development of the prototype of the Dornier lithotripter (Table 1.1).

# Technical Principles of ESWL

## Shock Wave Generation

The discharge of a high-voltage capacitor generates a spark between the two tips of an underwater electrode. The electrode is placed at the geometric focus of a semielliptical reflector. The spark causes explosive evaporation of the water, which in turn produces the shock waves because of its sudden expansion. The underwater electrode guarantees reproducible constant shock wave generation. The shock wave energy (pressure) can be regulated by varying the generator voltage (15–26 kV). After every 1500–2000 shock wave releases, however, the electrode must be exchanged (Fig. 1.1). Shock waves may also be generated by use of piezoelectric elements, electromagnetic elements, impulsed laser beam or microexplosion (lead acid pellets) (Fig. 1.2).

## Focusing

As the shock waves are generated at one focal point of the ellipsoid, all produced energy is collected again at the second focus after being reflected off the walls (Fig. 1.1). Since the second focus ($F_2$) is the point of highest shock wave energy, the patient has to be positioned in such a way that the stone is situated at this point. Focusing of shockwave energy substantially decreases the risk of damaging the surrounding tissue. Other principles of shock wave focusing are spheric alignment of energy sources, using an acoustic lens or pseudoellipsoid reflectors (Fig. 1.2).

**Table 1.2.** Physical characteristics of body tissue

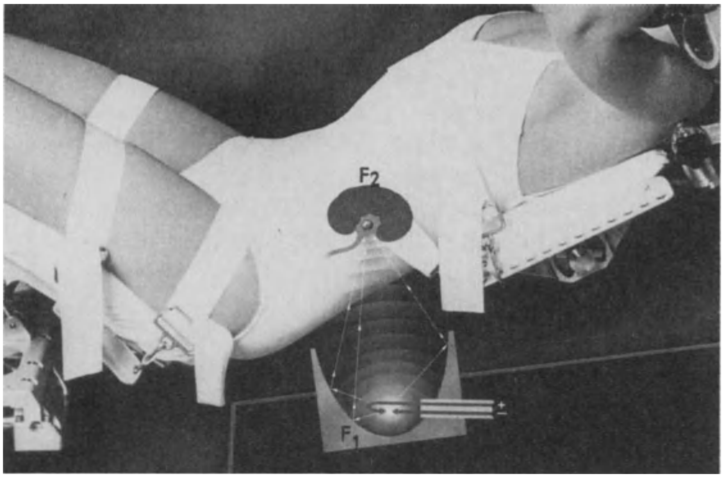
| Material | Sound velocity (m/s) | Density ($g/cm^3$) | Impedance ($g/cm \times s \times 10^5$) |
|---|---|---|---|
| Lungs | 650–1160 | 0.4 | 0.26–0.46 |
| Fat | 1476 | 0.928 | 1.37 |
| Water | 1492 | 0.998 | 1.49 |
| Liver | 1570 | 1.04 | 1.63 |
| Muscle | 1630 | 1.06 | 1.72 |
| Bone marrow | 1700 | 0.97 | 1.65 |
| Bone | 4100 | 1.8 | 7.38 |
| Urinary calculus | 4000–6000 | 1.9–2.4 | 5.6–14.4 |
| Iron | 5100 | 7.9 | 40.3 |

## Acoustic Coupling

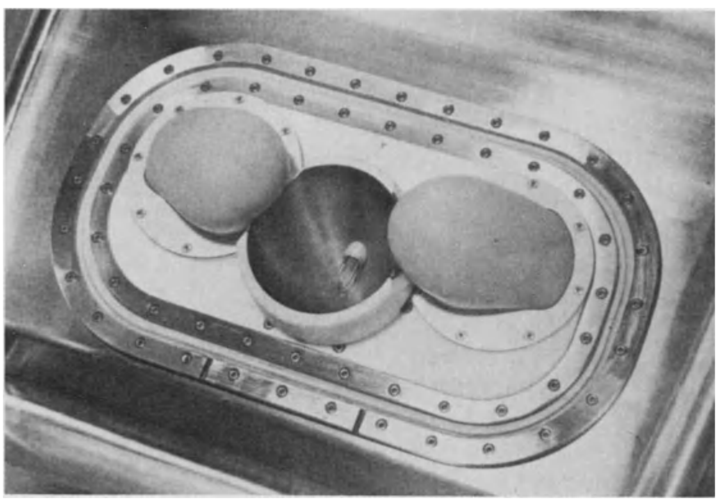
The acoustic resistance (impedance) of water is very close to that of most body tissues (Table 1.2). Therefore, underwater-generated shock waves penetrate the body easily if the patient is put into the water. This guarantees optimal energy transfer. However, "tubless" coupling is possible by use of a water cushion (Marshall et al. 1985), but this may lead to energy loss because of the different interphases (i.e. air bubbles between cushion and skin) (Fig. 1.2).

## Localisation of the Stone

Localisation of the stone is achieved by use of a positioning device, which is moved under control of a two-axis X-ray system. Both X-ray




a



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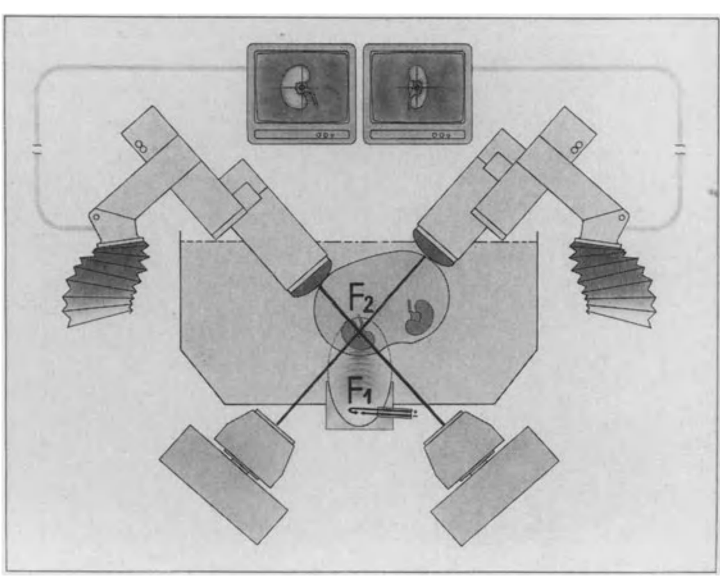



c

**Fig. 1.1a–c.** Shock wave generation and focusing.
**a** Patient stretcher. Stone has to be positioned in the second focus of the ellipsoid ($F_2$). **b** Underwater electrode placed in the first focus of the semiellipsoid. Faraday cage around the tips of the spark provide isolation. Balloons beside the ellipsoid are inflated during X-ray controls to improve fluoroscopic imaging. **c** Two-axis X-ray system (tube at the bottom, movable intensifier, screens with cross-hairs). Cross-hairs are marking $F_2$. Stone-bearing side is declined to prevent the stone from being obscured by the vertebral body on the oblique monitor (particularly in the case of ureteric calculi).

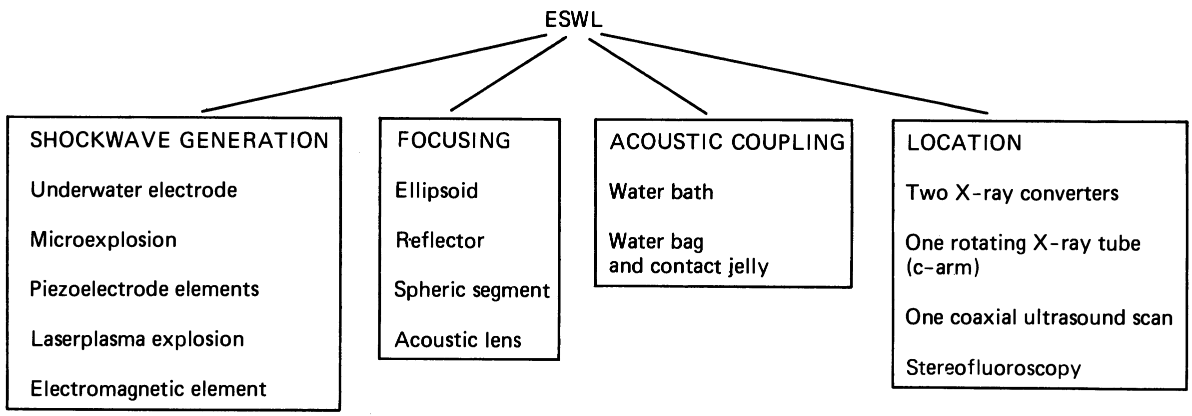



**Fig. 1.2.** Alternatives for technical realisation of ESWL.

converters exactly intersect at the second focus of the ellipsoid reflector. The patient who is positioned on a stretcher is moved in the three dimensions until the stone is centred on both screens (see Fig. 1.1c). For this purpose there are three X-ray techniques with increasing radiation exposure:

Fluoroscopic imaging
Short-time high-current fluoroscopy
Long-time high-current fluroscopy.

To minimise the radiation exposure of the patient, the use of the high-current technique should be restricted (if fluoroscopy does not provide detailed information for exact control of the degree of disintegration).

Ultrasound localisation of the calculi is possible; however, there are some specific shortcomings: (1) ureteric stones in the middle of the ureter cannot be located, (2) determination of the degree of disintegration depends on the experience of the urologist and (3) determination of disintegration may be very difficult because of artefacts (reflexion) superposed on the sonographic pattern. However, at the present time ultrasound localisation has been used progressively in second generation lithotripters.

## Stone Disintegration

Shock waves spread through the body evenly, as the acoustic impedance of most body tissues (except lungs and bones) is close to that of water. When a shock wave reaches the stone it is partially reflected and a portion of the shock wave entering the stone is absorbed due to the abrupt change of acoustic impedance (Table 1.2). This leads to the build-up of a high pressure gradient and subsequently to the formation of

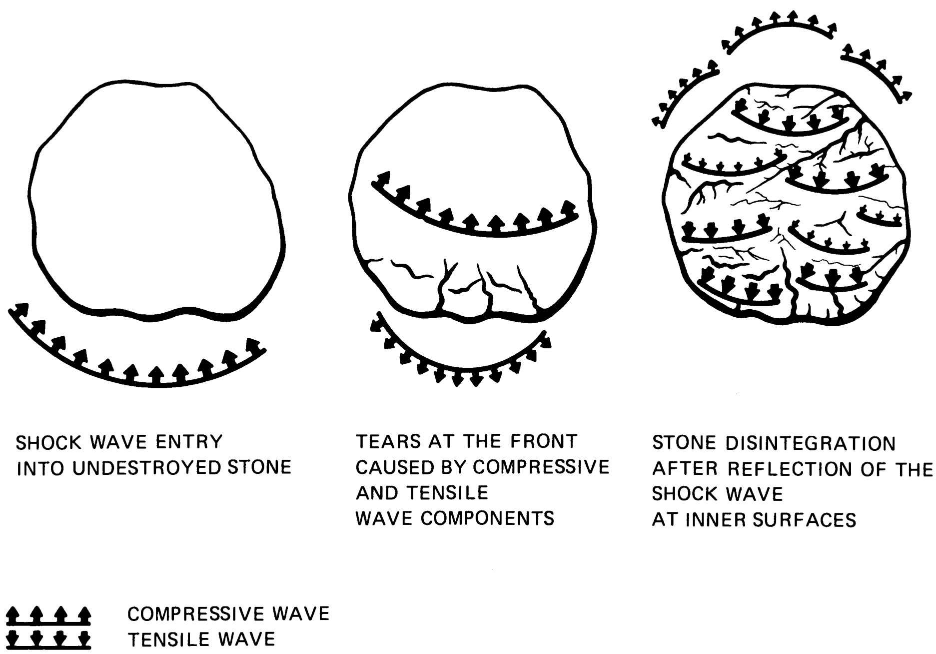



**Fig. 1.3.** Mechanism of stone disintegration by use of extracorporeally induced shock waves based on the principles of sound wave physics.

tear and shear forces (consisting of tensile and comprehensible wave components), which disintegrate the stone when the limit of their comprehensive strength is exceeded.

The penetrating part of the shock wave is reflected at the back of the stone, leading to the same phenomenon. With repeated exposures the stone is finally reduced into smaller and smaller particles from the periphery to the centre (Fig. 1.3). Besides this mechanism, further high-velocity phenomena like cavitation or resonance may contribute to stone disintegration.

All kinds of stones could be destroyed in vitro irrespective of their chemical composition. However, we observed relatively large cystine fragments, which indicates that cystine calculi are still problematic for ESWL treatment.

## In vivo Experiments

After in vitro testing for stone-disintegrating energy, in vivo experiments were begun: cell cultures were examined and animals were subjected to shock waves. First trials showed that the stimulation ability and the proliferative potential of human lymphocytes were not altered after repeated exposure to shock waves. Secondly, it was shown that the serum concentration of haemoglobin increased slightly with the number of

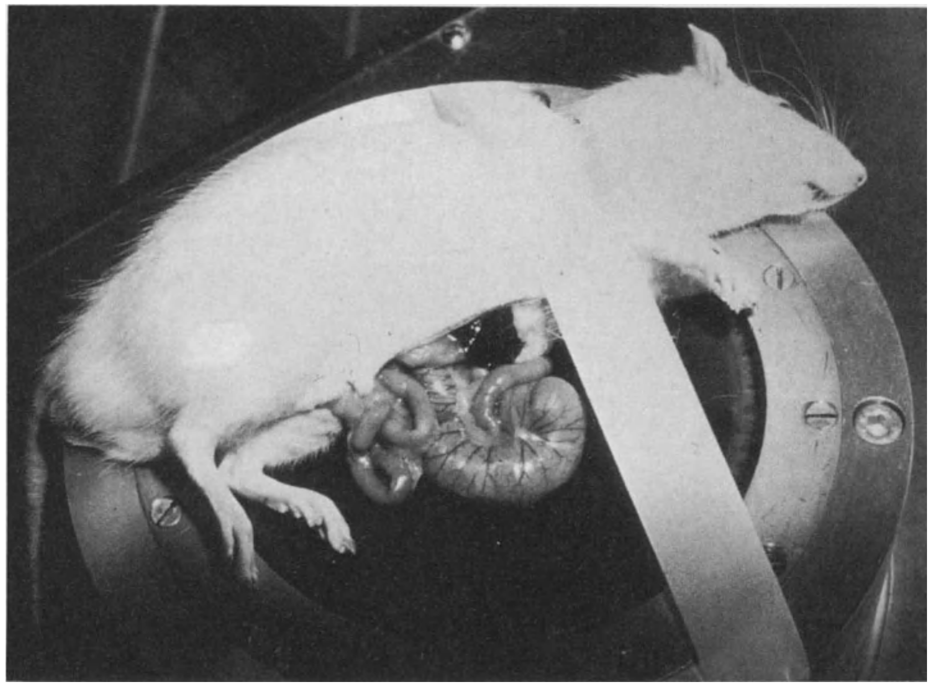


**Fig. 1.4.** In vivo experiments. After shock wave exposure of eviscerated intestine of the rat only minor petechial bleeding was observed. Note "tubless" coupling of shock wave energy.

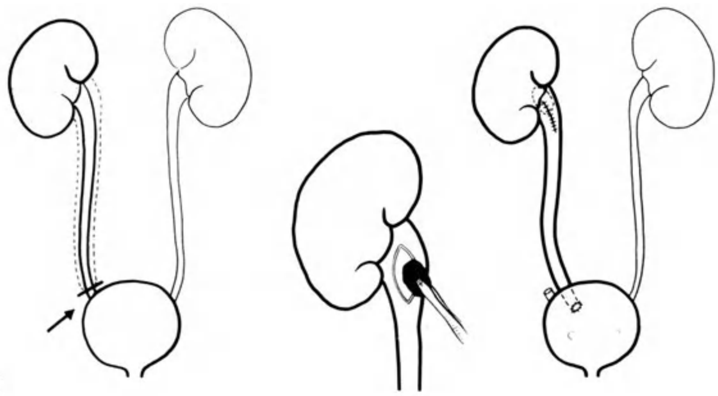
treatments when directly exposed to the shock waves. However, in peripheral blood there was no significant decrease of haemoglobin level.

When vital bones or bone marrow were subjected to shock waves, no damage besides minor petechial haemorrhages were seen, whereas the bones of dead animals were broken. After exposure of eviscerated intestine and parenchymal organs of rats, no damage except minor petechial bleeding was found (Fig. 1.4). Exposure of the lungs, however, led to alveolar rupture and haemorrhage because of the different accoustic impedance between the air-filled alveoli and the parenchyma. This finally resulted in the death of all animals (Eisenberger et al. 1977a, b). After protection of the lungs using Styrofoam no pulmonary deterioration was observed.

Recent preliminary experiments have shown that shock waves may inhibit tumour growth (Russo et al. 1986).

## Canine Kidney Stone Model

As the results of in vitro and in vivo investigations were promising, an experimental series with in vivo destruction of renal calculi was started. For this purpose human kidney stones were implanted into the renal pelvis of mongrel dogs. Because of the small size of the canine pelvis it



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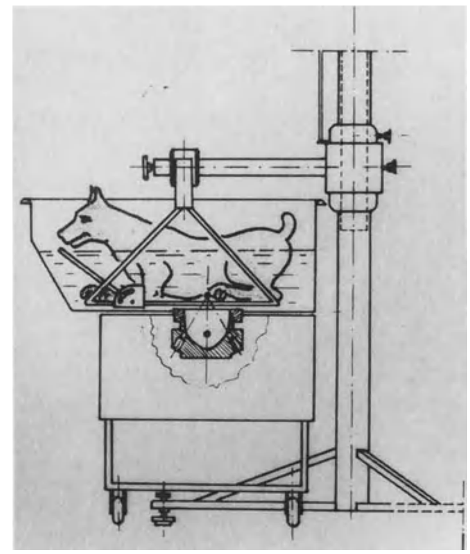

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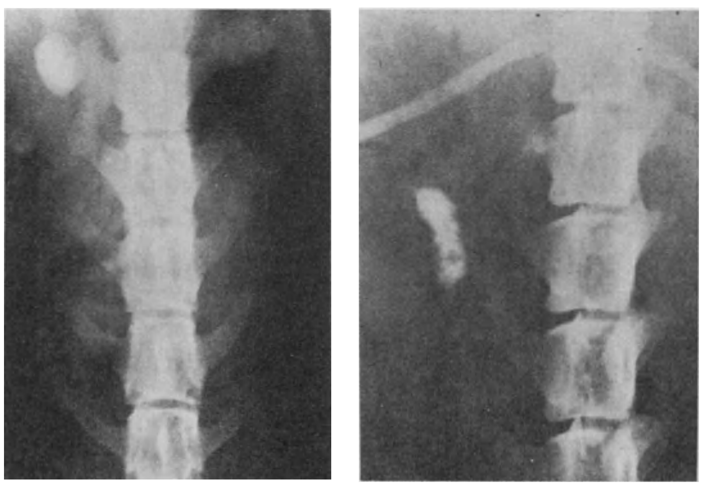

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**Fig. 1.5a–c.** Canine kidney stone model simulating the clinical use of ESWL.
**a** Prevesical ligation of the ureter, followed 2 weeks later by implantation of human calculi in the distended renal pelvis combined with ureteroneocystostomy. **b** Specially designed lithotripter with the ellipsoid at the bottom of the bath-tub (movable in all three planes). **c** KUB film prior to and after ESWL. Complete disintegration of the implanted stone.

was necessary to ligate the ureter 2 weeks prior to the implantation, which was performed with ureterocystostomy of the ligated ureter (Fig. 1.5).

The prototype of the ESWL apparatus constructed for the experiments on animals consisted of a control and an energy unit, with the ellipsoid attached to the floor of the experimental tub. This experimental device made it possible to concentrate high-energy shock waves on an area of approximately 1.5 $cm^3$, with the dog placed on an adjustable stretcher. The stone localisation was done by means of an X-ray system (Eisenberger et al. 1977a, b).

## First Clinical Treatment

As a direct development of these experiments a prototype for the treatment of humans was constructed and technically improved for clinical use. Basically, this first prototype consisted of two X-ray screens, two converters and the most expensive bath tub in the world.

In February 1980, this method was first applied on a patient in the Department of Urology of the University of Munich (Head: Prof. Dr med. E. Schmiedt) (Chaussy et al. 1982, 1984; Schmiedt and Chaussy 1985), and since then more than 200 000 patients have been successfully treated worldwide (Chaussy and Fuchs 1985).

**Table 1.3.** Urinary stone therapy in the Department of Urology, Katharinenhospital, Stuttgart, from October 1983 to August 1985 ($n$ = 3424)

| Treatment | No. of patients | Percentage |
|---|---|---|
| ESWL | 1811 | 53 |
| PCNL | 661 | 20 |
| URS | 379 | 11 |
| Loop | 420 | 12 |
| OP | 153 | 4 |

PCNL, percutaneous nephrolithotomy;
URS, ureteroscopy; OP, open operation.

## First Serial Lithotripter

In October 1983, the second ESWL unit was installed in our department (Eisenberger et al. 1983; Fuchs et al. 1984; Miller et al. 1984a). Since then more than 5000 consecutive stone patients have been treated, 1811 of which received ESWL treatment (Table 1.3; Fig. 1.6). In Germany, 20 ESWL units are in operation at present (Chaussy and Fuchs 1986).

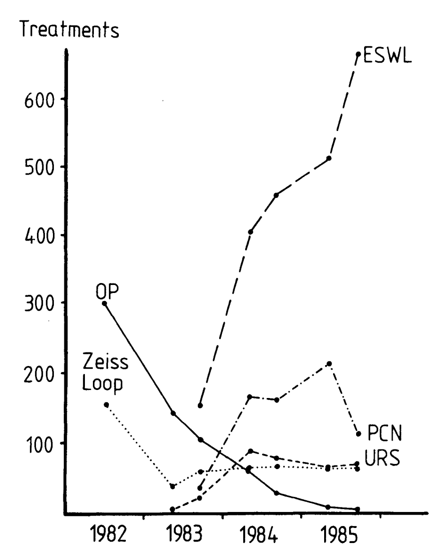
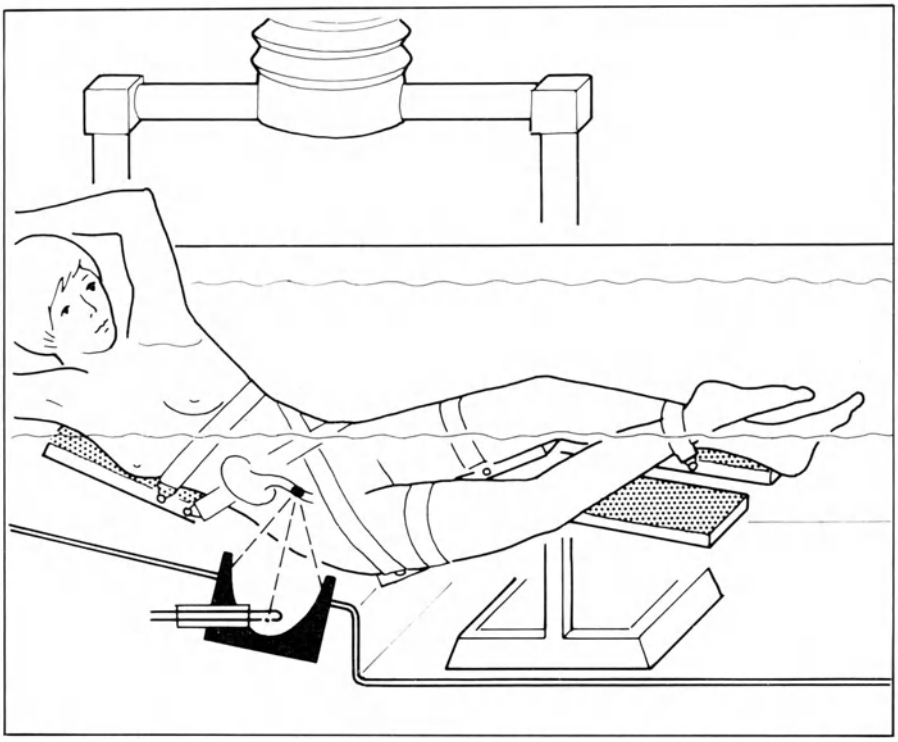



**Fig. 1.6.** Cumulative distribution of the different treatment modalities for urinary stone disease in the Department of Urology, Katharinenhospital, Stuttgart (1982–1985). *OP*, open operation; *PCN*, percutaneous nephrolithotomy; *URS*, ureterorenoscopy.



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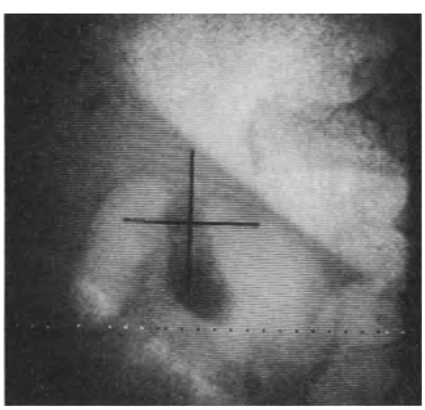

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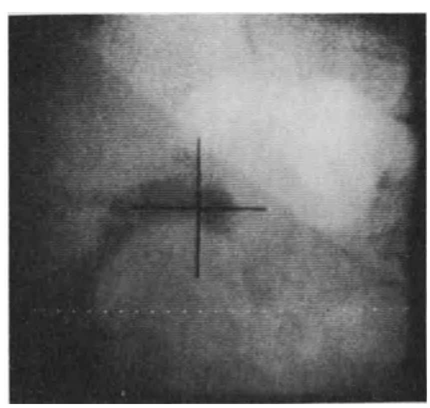

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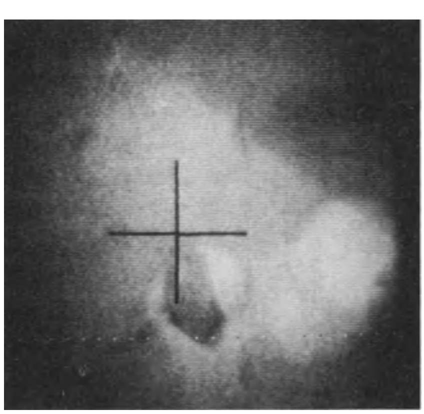
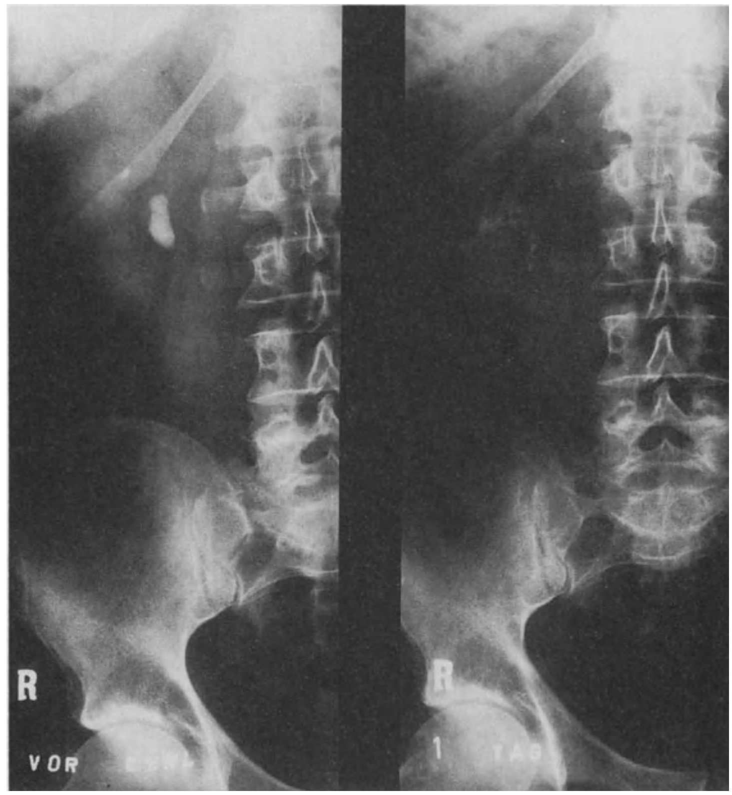


c

**Fig. 1.7a–f.** In situ ESWL for upper ureteric calculi. **a** Positioning technique. Patient is rotated as far as possible to the stone-bearing side to prevent the calculus from being obscured by the vertebral body on the oblique monitor. Crossing of the legs stabilises this position by fixation of the pelvis. **b–d** Focusing technique in a case of large obstructive ureteric stones. Cranial focusing of the stone at the optimal interphase between the stone and the urine (**b**). At the start of disintegration, the middle and lower parts are centred (**c**: quick pic after 400 shock waves; **d**: quick pic after 900 shock waves with fragments in the lower calyceal group). **e,f** KUB X-ray series prior to (**e**, *left*) and after ESWL of the large infundibular stone. Complete disintegration and passage of fragments with formation of temporary *Steinstrasse* in the middle ureter. The patient did not suffer from any pain during the passage of debris.

**Fig. 1.7** (*continued*)

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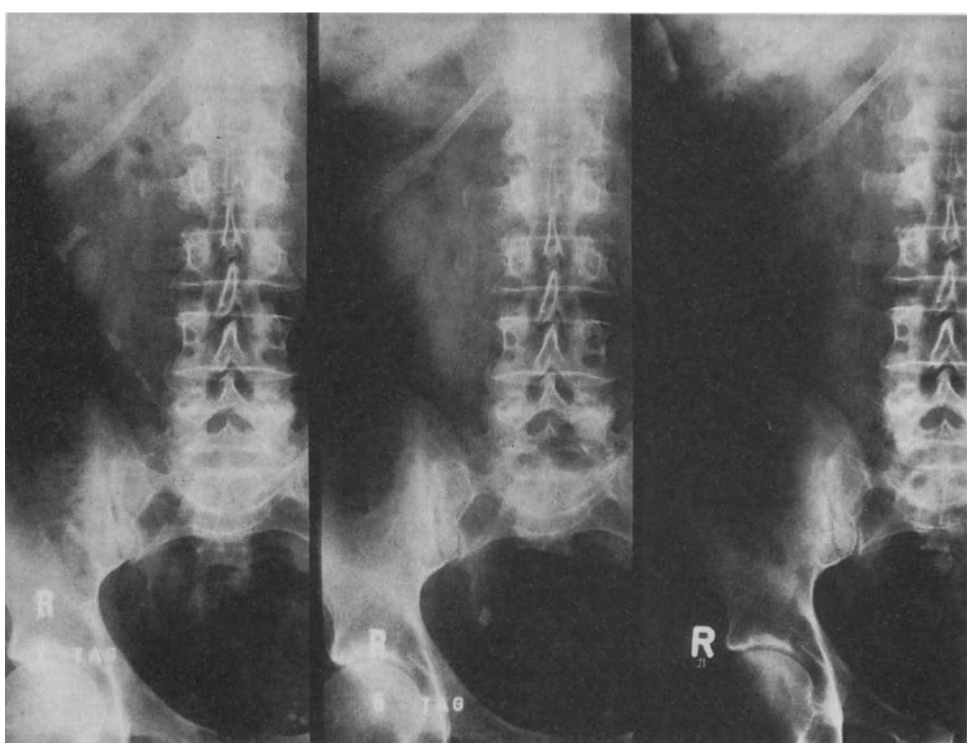



f

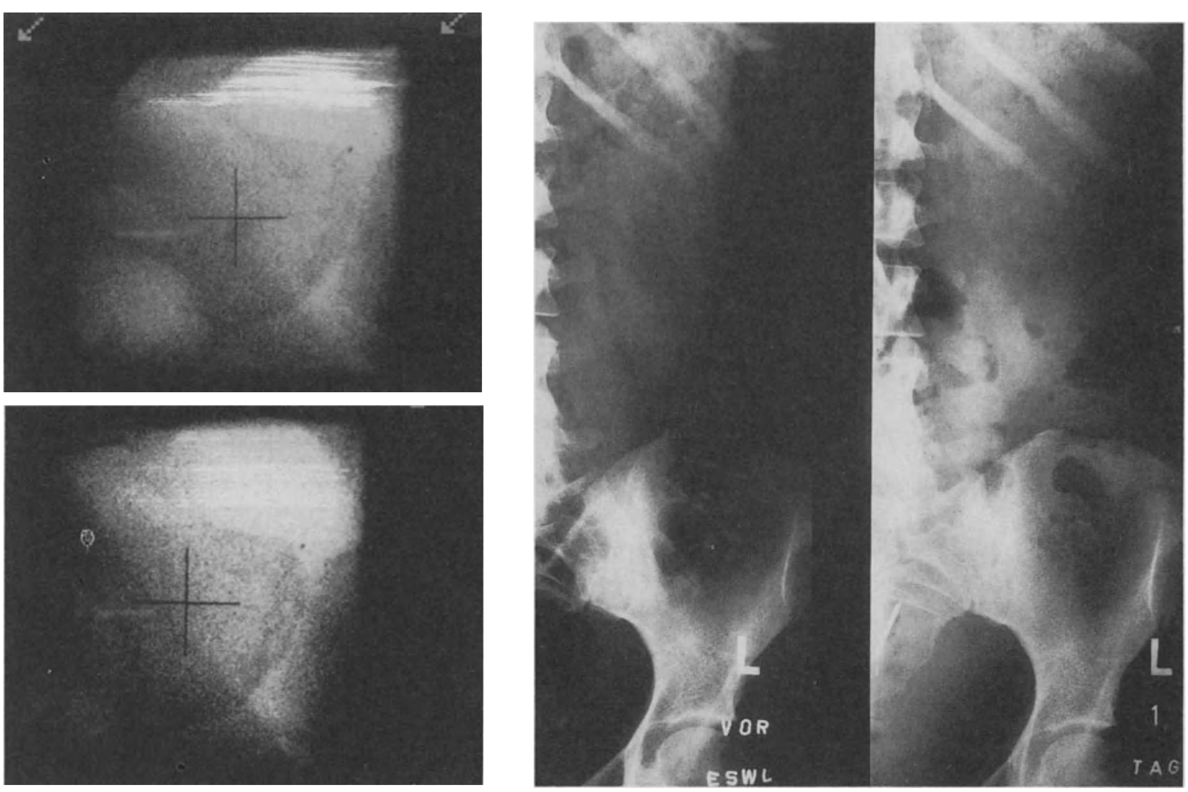
**Table 1.4.** Indications for ESWL treatment in 1811 consecutive cases of urinary calculi

| | |
|---|---|
| Multiple calculi (pelvic/calyceal) | 20% |
| Solitary calculi (pelvic/calyceal) | 51% |
| Borderline stones | 4% |
| Partial staghorn | 4% |
| Complete staghorn | 5% |
| Ureteric calculi | 16% |

68% of partial and complete staghorn calculi are treated by the combination therapy of percutaneous nephrolithotomy (PCNL) and ESWL. About 70% of upper ureteric calculi are treated in situ, 25% after retrograde mobilisation of the stone into the renal pelvis ("push and bang").

## **Indications** (Table 1.4)

The first indications for the treatment of renal calculi by ESWL were radiopaque single, pelvic or calyceal stones up to 1 cm in diameter without obstruction of the collecting system distal to the stone (Chaussy




a b c

**Fig. 1.8a–c.** In situ ESWL for lower ureteric stones. **a,b** Fluoroscopic control during treatment (high-current technique). **c** KUB X-ray series prior to (*left*) and after ESWL of a prevesical ureteric stone. The stone has disappeared completely immediately following treatment (*right*).

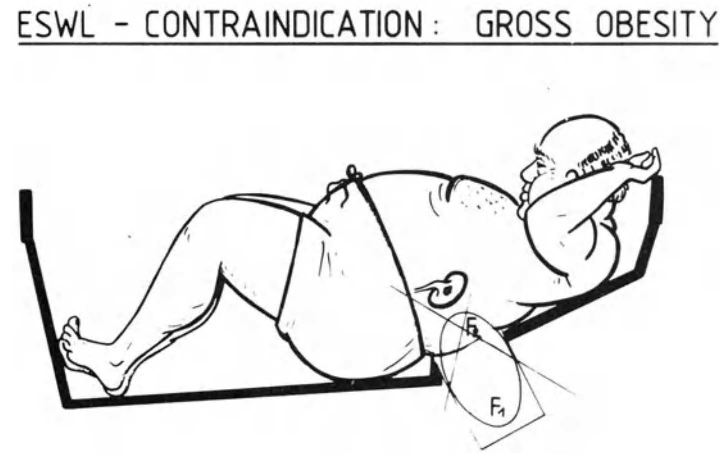



**Fig. 1.9.** Gross obesity, a technical contraindication of ESWL. Because of enlarged subcutaneous fat posteriorly, the stone cannot be focused in $F_2$.

et al. 1982). As experience of the method has increased, the indications have been extended to include multiple calculi, larger stones up to partial staghorns and high ureteric calculi, i.e. above the iliac crest (Fig. 1.7). Moreover, we have now successfully treated prevesical ureteric calculi (Fig. 1.8).

Radiolucent stones can be treated by additional administration of contrast dye. However, localisation of the fragments during shock wave exposure *still remains problematic*. For these cases, we prefer percutaneous nephrolithotomy. CT-density has not provided any additional information for ESWL treatment (Rassweiler et al. 1985a).

*Contraindications* are untreated bleeding disorders and gross obesity. A body weight of 130 kg represents the upper limit of patient size. Moreover, in some patients the stone cannot be positioned into the second focus, because of enlarged subcutaneous fat posteriorly (Fig. 1.9).

Children smaller than 100 cm can be treated by ESWL with the use of special strapped Styrofoam boards, except in the case of upper calyceal calculi (increased risk of pulmonary damage).

## Preoperative Preparation

Patients are prepared as for open renal surgery, including laxatives, nil by mouth after 10 p.m. the day before and sodium loading (1000 ml) in the morning. Bowel preparation prevents screening difficulties caused by intestinal gas. This also avoids adverse effects on the intestine, since intestinal gas represents an interphase for shock waves (risk of intestinal paralysis). In the presence of urinary tract infection, antibiotics are given according to the sensitivities.

## Anaesthesia

We prefer epidural anaesthesia using a 90% catheter; general anaesthesia is restricted to special cases (spinal deformation, nervous patient). Furthermore, ESWL can also be performed under analgo-sedation or local cutaneous and paravertebral anaesthesia. However, this cannot be recommended for general use. The advantage of epidural anaesthesia is that the catheter can be left for several days (multiple ESWL sessions, regional treatment of pain).

The high-frequency jet ventilation (HFJV) technique decreases the respiratory-dependent movement of the stone and increases the efficacy of the shock wave application (about 30% less shock waves per treatment; Meyer et al. 1985). However, this kind of anaesthesia is more invasive and time consuming. Recently, as the result of two modifications of the Dornier HM3 (new generator, larger ellipsoid), which provide a remarkable reduction of shock wave energy at the surface of the skin, we have been able to treat 92% of our patients by use of intravenous analgesics (i.e. 100–200 mg Tramadol) alone.

## Treatment

After localisation of the stone, ECG-triggered (to avoid induction of cardiac arrhythmia) shock wave application starts. The focusing method and the choice of generator voltage depends on the size and location of the stone (Table 1.5). After every 100–200 shock waves X-ray control is performed to determine the degree of disintegration and for further adjustment (see Fig. 1.7). We start at low energy (16–18 kV) to achieve fine fragmentation of the calculus. The number of shock waves should not exceed 3000 applications per kidney (mean 1240 per treatment). The

**Table 1.5.** Rules of ESWL treatment: technique and choice of generator voltage

| | |
|---|---|
| *ESWL in one session* | |
| "Crystal-like" pelvic stone[a] | Start with low energy (15–16 kV) |
| Impacted calyceal stone, ureteric stone | Start with high energy (20–22 kV) |
| Multiple renal calculi | Start with the smallest stone<br>Treat lower calculi first |
| Borderline stones/partial staghorn calculi | Start with the pelvic parts |
| Large, obstructive ureteric stone | Focus on the upper rim of the stone |
| Poorly visible ureteric stone | Administer contrast dye |
| *ESWL in more sessions* | |
| Remnants of staghorn stone following PCNL | Start with the stone parts in the cranial calyces |
| ESWL monotherapy for staghorn stone | Start with the pelvic and the upper calyceal parts |
| *Maximal number of shock waves per session* | |
| Single pelvic or calyceal stones | 2000–2500 |
| Multiple stones, staghorn calculi | 2500–3000 |
| Ureteric stones | 3000 |

PCNL, percutaneous nephrolithotomy.
[a] Calcium oxalate-dihydrate.

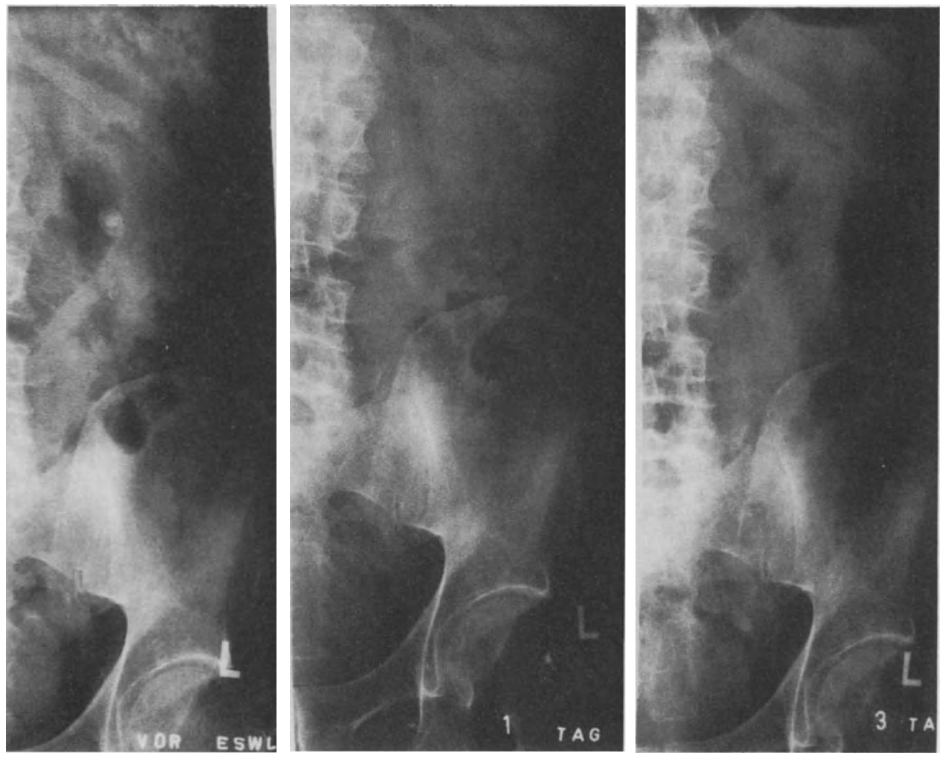


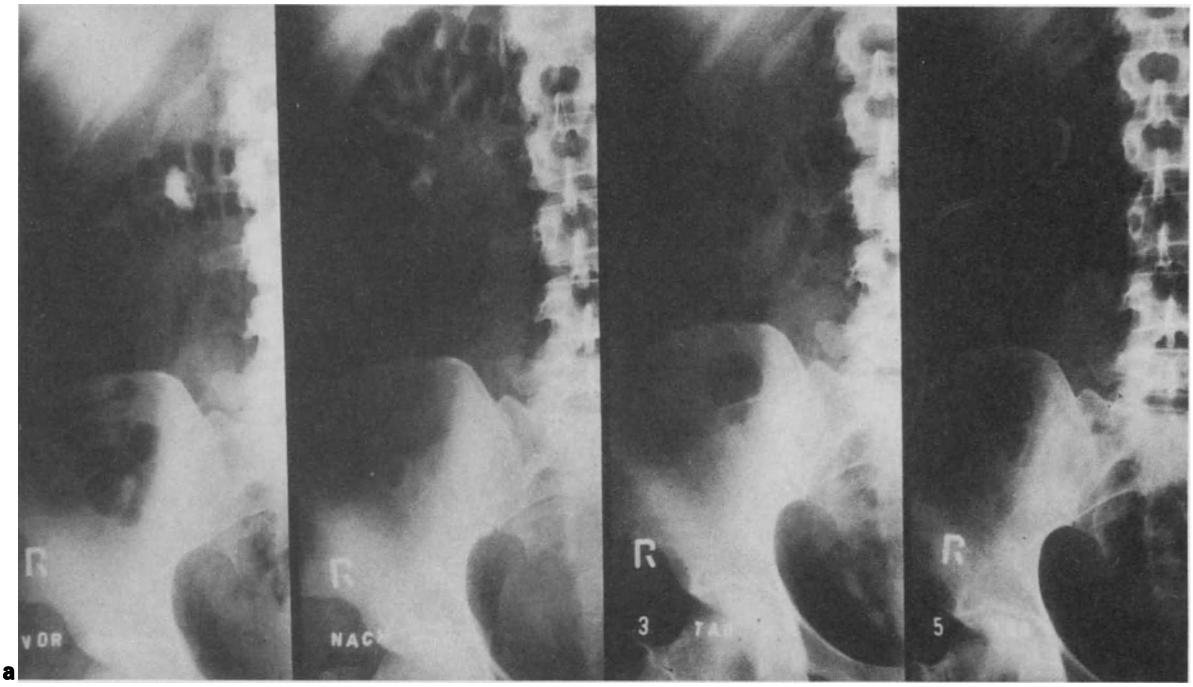

**Fig. 1.10.** Follow-up control of ESWL in a case of an "easy stone". Half-sided KUB films show complete disintegration and passage of the stone fragments in the 3 days following ESWL (*left* to *right*).

mean duration of the treatment is 40 min. Fluoroscopic time depends on the experience of the urologist (mean 11 quick pics (high-current technique) and 90 s of fluorotime). The mean radiation exposure amounts to about 0.14 Gy per patient.

## Post-ESWL Management

Investigation by means of a plain X-ray film and ultrasound is performed on the first, third and fifth day. If complete disintegration of the stone is documented and no ureteric obstruction or fever occurs, the patient is discharged (Fig. 1.10).

*Auxiliary measures* are indicated in the case of persistent colic or acute pyelonephritis caused by ureteric obstruction (*Steinstrasse*). We prefer in such cases to insert a percutaneous nephrostomy tube: the distended ureter regains peristaltic activity, resulting in spontaneous passage of the fragments in almost all cases (Fig. 1.11). Ureteroscopy should be restricted to persistent prevesical fragments (*Steinstrasse*).

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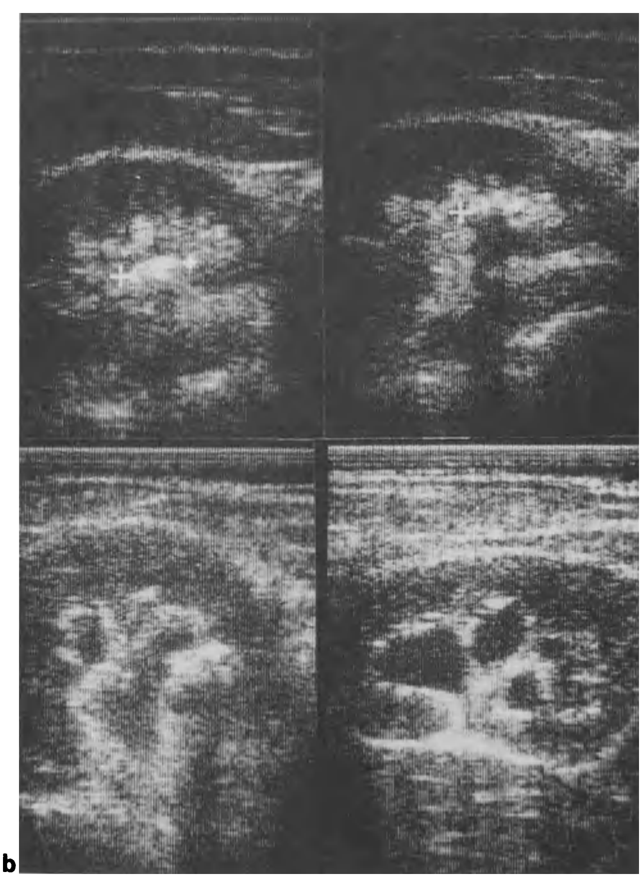


b

**Fig. 1.11a,b.** Follow-up of ESWL in "problem stones"—auxilliary measures. **a** KUB X-ray films before (*left*) and after ESWL show complete disintegration of a large pelvic stone with formation of a prevesical *Steinstrasse* on the 3rd day (*3 TAG*). Because of hydronephrosis (see **b**) and concomitant acute pyelonephritis with fever, percutaneous nephrostomy had to be performed. Two days later (*5 TAG*) all fragments have passed and the nephrostomy tube has been withdrawn. **b** Ultrasound investigation before and after ESWL shows disintegration of the calculus with fragments in the lower calyceal group (*above*). On the third day after ESWL remarkable distension of the renal pelvis and upper ureter can be seen (*below*); therefore the percutaneous nephrostomy tube was inserted under ultrasonic guidance.

## Upper Ureteric Stone

Using a special positioning and focusing technique (see Fig. 1.7), we could increase our success rate for in situ ESWL of upper ureteric stones to 85% (including 10% second session). Therefore, retrograde mobilisation of the stone (ureteric catheter, ureteroscopy) is only indicated:

1. In emergency cases (colic, fever, hydronephrosis) together with insertion of a double-J stent.
2. If the stone cannot be located because it is too close (less than one finger breadth) to the spine or because of gross obesity or spinal deformation.
3. If in situ ESWL failed (Rassweiler et al. 1986).

## Combination of ESWL and Percutaneous Nephrolithotomy

### Borderline Stones

Calculi of more than 2.5 cm in diameter are called "borderline stones" because there is a difference of opinion as to whether ESWL or percutaneous nephrolithotomy (PCNL) is preferable in these cases (Miller et al. 1985b).

**Table 1.6.** Complications and side effects in 1811 consecutive cases of ESWL

| | |
|---|---|
| Colic | 34% (range 5%–40%) |
| Fever | 17% (range 1%–31%) |
| Septicaemia | 1% |
| Perirenal haematoma | 0.3% |

The incidence of colic and fever depends on stone size (see Table 1.7). All perirenal haematomas could be managed conservatively.

The arguments for ESWL are that it is non-invasive and as a consequence has the lowest rate of severe complications compared to all other methods (Table 1.6). On the other hand, problems with the passage of fragments after ESWL directly correlate with the overall stone mass. There is an increasing rate of ureteric obstruction because of the formation of prevesical *Steinstrasse*. This results in a higher number of auxiliary measures following ESWL (Figs. 1.11, 1.12).

In a retrospective study we have evaluated two groups of patients who underwent ESWL monotherapy (see Table 1.5). Those with kidney stones up to 2.5 cm in diameter we called "easy stones" and those with stones of a larger size we called "problem stones" (Tables 1.7, 1.8). We observed a significant difference between the two groups with regard to pain, fever, auxiliary measures and hospital stay (Eisenberger et al. 1985a, b; Gumpinger et al. 1985).

**Table 1.7.** ESWL complications

| Complication | Easy stones (<2.5 cm) | Problem stones (>2.5 cm) |
|---|---|---|
| Colic | 24% | 34% |
| Fever | 5% | 36% |
| Auxiliary measures | 6% | 28% |
| Mortality | 0 | 0 |
| Hospital days (after treatment) | 4 | 10 |

**Table 1.8.** Auxiliary measures after ESWL

| Auxiliary measure | Easy stones (<2.5 cm) | Problems stones (>2.5 cm) |
|---|---|---|
| Ureteral manipulation (UC, loop, URS) | 5% | 22% |
| Percutaneous nephrostomy | 1% | 4% |
| Open operation | — | 2% |

UC, ureteric catheter; URS, ureteroscopy.

In the case of *borderline stones*, PCNL guarantees a better retrieval of the stone fragments (Fig. 1.12).

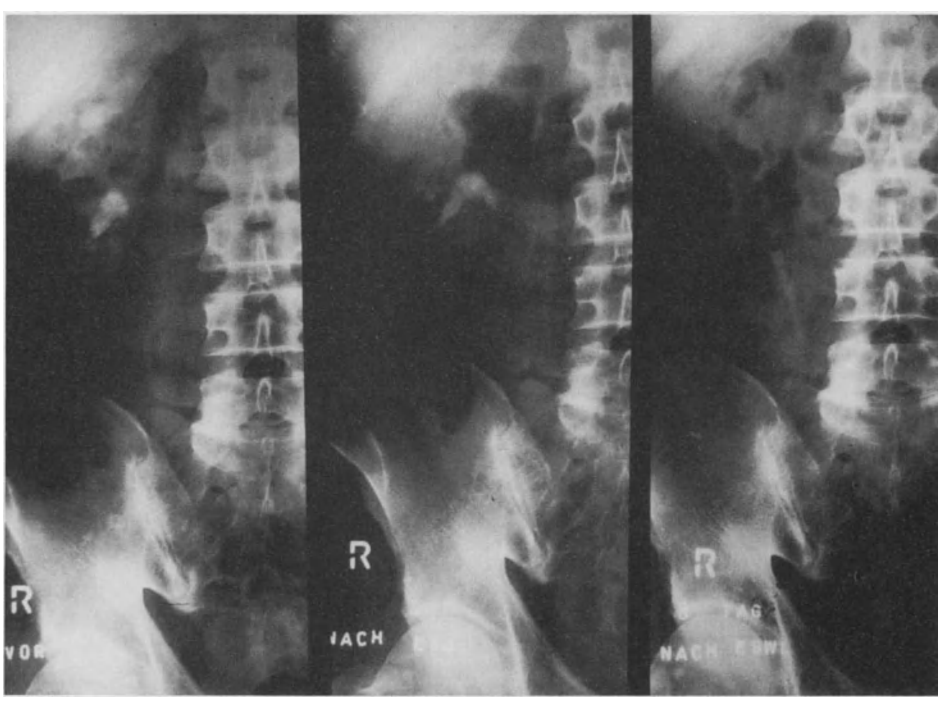


**Fig. 1.12.** ESWL monotherapy in a case of partial staghorn calculus. The KUB X-ray series demonstrates complete disintegration of the stone following 2500 shock waves. However, on the third day (*right*) a large *Steinstrasse* is seen in the upper ureter which finally had to be removed by antegrade ureteroscopy.

## Staghorn Calculi (Partial, Complete)

Larger calculi up to partial and complete staghorn stones are treated with PCNL as the first step. Any residual particles are then disintegrated by shock waves in a second or third session after 4 days (Fig. 1.13).

Experience in the treatment of staghorn calculi has shown that by a combination of both techniques the disadvantages—the technical difficulties with increasing complication rate in PCNL and the increased rate of side effects and auxiliary measures caused by problems with stone passage after ESWL—can be overcome (Fuchs et al. 1984; Miller et al. 1984b; Alken et al. 1985; Eisenberger et al. 1985b, c; Miller et al. 1985a). Therefore, this combination has become the treatment method of choice in complicated stone disease in our department, and we have now treated more than 200 cases (Fig. 1.14). However, it has to be noted that only about 65% of the patients are stone free after an 18-month follow-up.

## What Is Left for Open Surgery?

In the case of renal calculi associated with pelviureteric junction (PUJ) stenosis, pyeloplasty should be done with removal of the stone (Fig. 1.15). Moreover, large stones with a narrow collecting system, stenosis of the infundibula and large peripheral and central stone mass should be treated by open surgery.

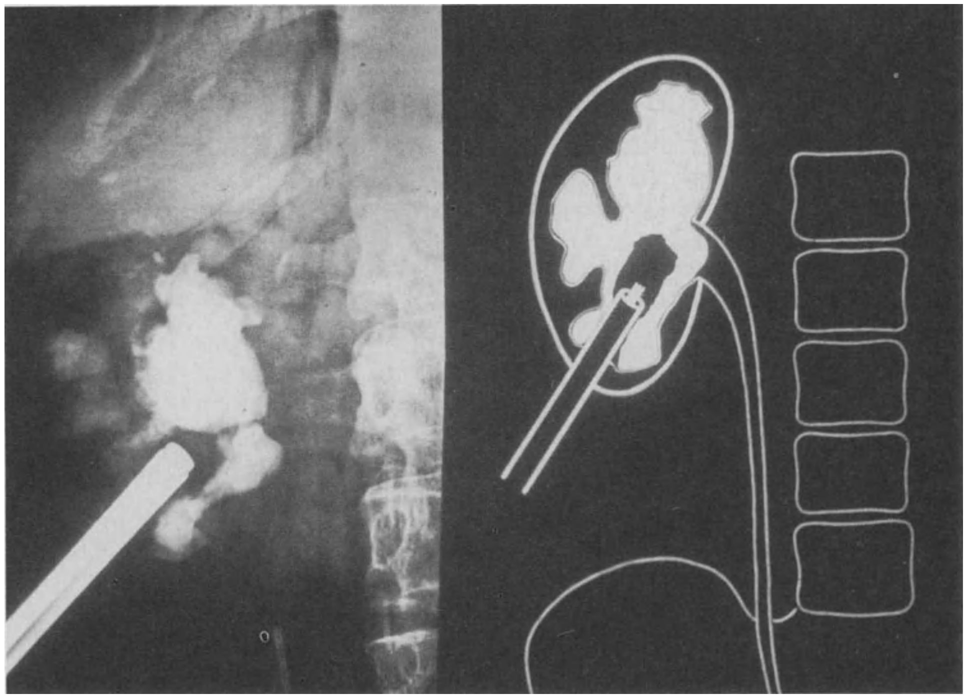
## Conclusion

Extracorporal shock wave lithotripsy has proved to be a safe and reproducible technique for the treatment of upper urinary stones. Complete disintegration can be achieved in 97% of renal calculi. Three months after the treatment 75% of patients are completely stone free, and only 5% need retreatment because of the residual fragments (Table 1.9).

**Table 1.9.** ESWL results (3-month follow-up) in 1811 patients treated from October 1983 to August 1985 in the Department of Urology, Katharinenhospital, Stuttgart

| | |
|---|---|
| Stone free | 75% (range 63%–87%) |
| Remnants requiring no treatment | 20% (range 10%–25%) |
| Retreatment | 5% (range 2%–12%) |
| Multiple session | 13% (range 6%–36%) |
| Auxiliary measures | 13% (range 4%–38%) |

The range of the different values corresponds to the different type of calculi (single, multiple stones, borderline stones, partial and complete staghorns).



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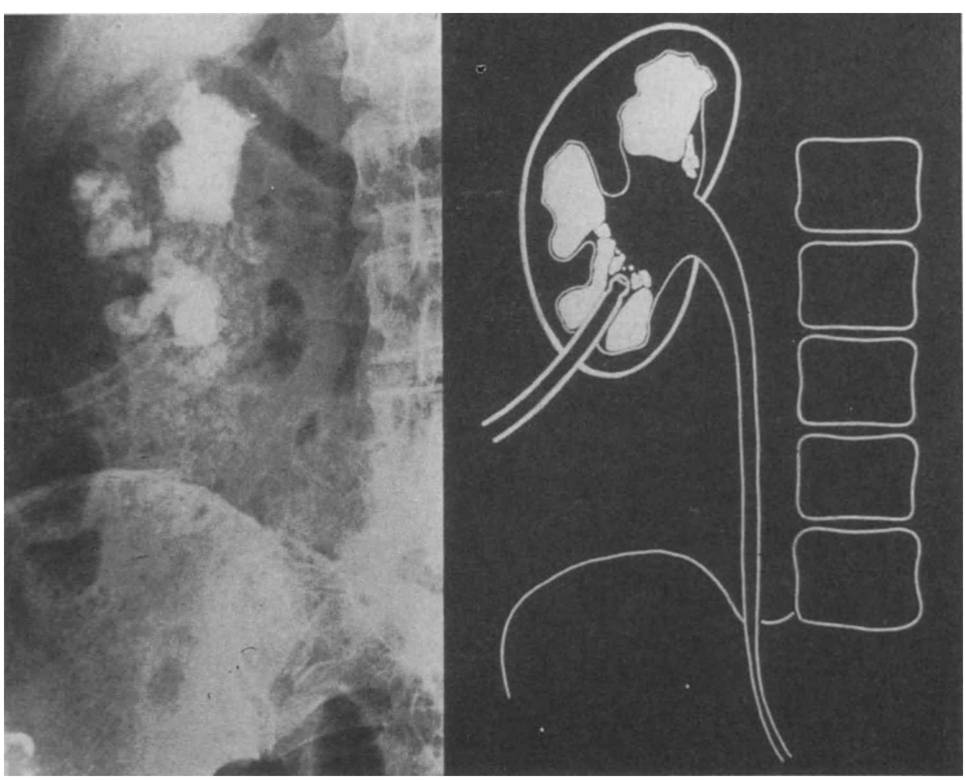
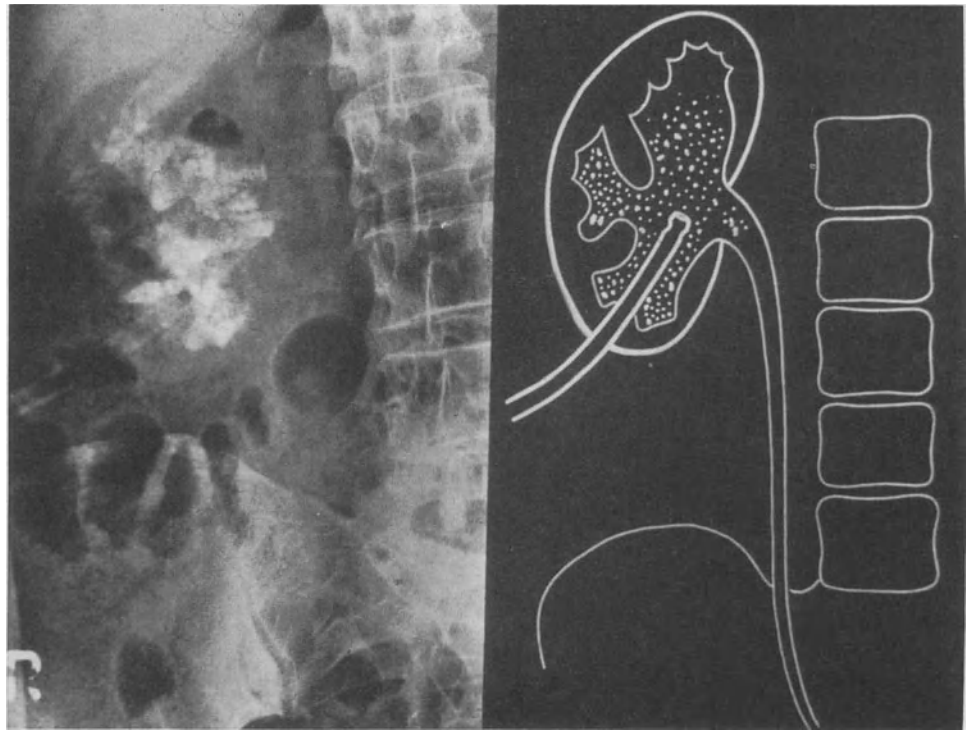


b

**Fig. 1.13a–d.** Combination treatment (ESWL+PCNL) in a case of complete staghorn stone. **a** Intraoperative control during PCNL shows removal of stone parts in the lower calyceal group and renal pelvis. **b** KUB film prior to ESWL shows remnant stone mass in the calyceal groups, whereas the pelvic stone part has been removed by PCNL.



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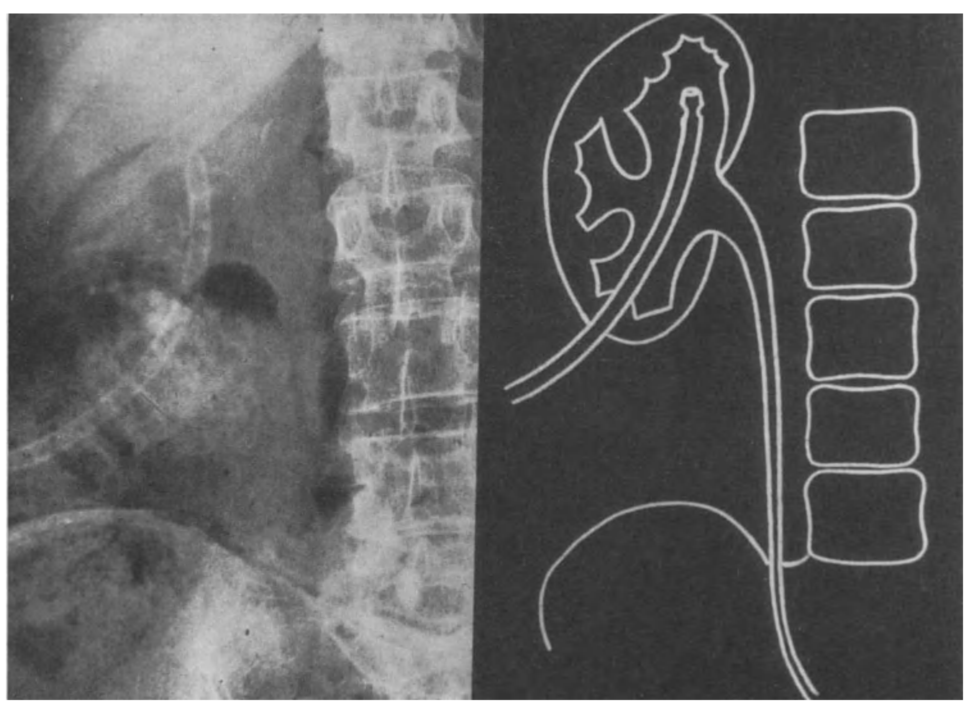


d

**Fig. 1.13** (*continued*) **c** KUB film after second ESWL session demonstrates complete disintegration of the calyceal stone parts. **d** KUB film 5 days after the second ESWL session documents that the patient is nearly stone free with only a few fragments left in the lower calyceal group. The stone fragments passed either via the nephrostomy tube or via the ureter without causing any colic or pain to the patient.

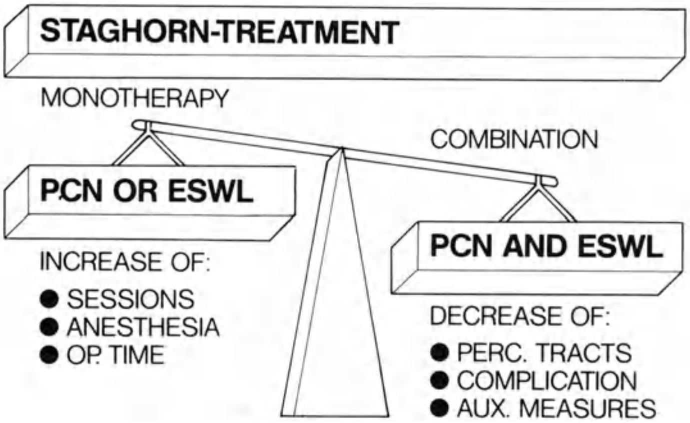



**Fig. 1.14.** The advantages of the multimodal therapy for complicated stone disease. (*PCN*, percutaneous nephrolithotomy)

In combination with the new endourological techniques such as PCNL and ureteroscopy more than 95% of patients can be treated without the need for open surgery. Even cases of recurrent stone formation seem to be treatable. This could not be achieved previously, despite major improvements in surgical technique including cooling, clamping, radial

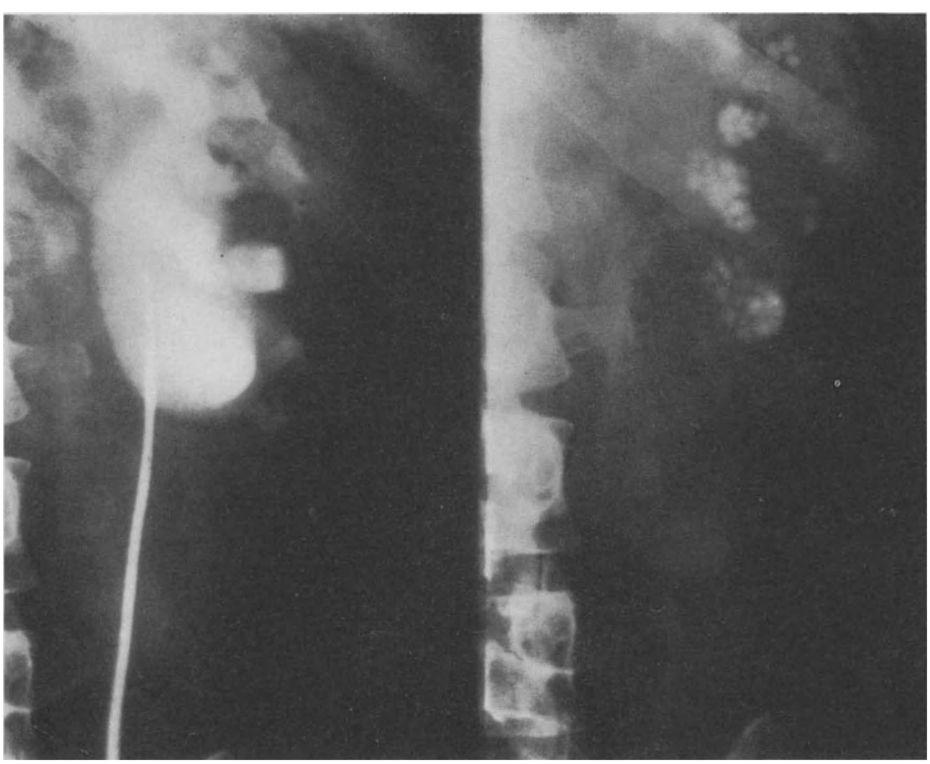


**Fig. 1.15.** Nephrolithiasis with concomitant PUJ stenosis—a remaining indication for open surgery.

nephrotomies and intraoperative ultrasound location of calculi (Smith and Boyle 1968; Stephenson et al. 1976; Ueda and Momose 1982; Sturm et al. 1984).

## References

Alken P, Hardeman S, Wilbert D, Thüroff J, Jacobi GH (1985) Extracorporeal shock wave lithotripsy (ESWL): alternatives and adjuvant procedures. World J Urol 3: 48–52

Chaussy C, Fuchs G (1985) Erfahrungen mit der extracorporalen Stoßwellenlithotripsie nach 5 Jahren klinischer Anwendung. Urologe [A] 24: 305–309

Chaussy C, Schmiedt E, Jocham D, Brendel W, Forssmann B, Wather V (1982) First clinical experience with extracorporeally induced destruction of kidney stones by shock waves. J Urol 127: 417–420

Chaussy C, Schmiedt E, Jocham D, Schiller J, Brandl H, Liedl B (1984) Extracorporeal shockwave lithotripsy (ESWL) for treatment of urolithiasis. Urology 23: 59–66

Eisenberger F, Schmiedt E, Chaussy C et al. (1977a) Berührungsfreie Harnsteinzertrümmerung. Stand der Forschung. Deutsches Ärzteblatt 74: 1–5

Eisenberger F, Chaussy C, Wanner K (1977b) Extrakorporale Anwendung von hochenergetischen Stoßwellen – ein neuer Aspekt in der Behandlung des Harnsteinleidens. Akt Urol 8: 3–15

Eisenberger F, Fuchs G, Miller K (1983) Erfahrungen mit der berührungsfreien Nierensteintherapie (ESWL). Ärzteblatt Baden Württemberg 12–15

Eisenberger F, Fuchs F, Miller K, Rassweiler J (1985a) Non-invasive renal stone therapy with extracorporeal shockwave lithotripsy (ESWL). In: Heuck FH, Donner W (eds) Radiology today 3. Springer, Berlin Heidelberg New York, pp 161–167

Eisenberger F, Fuchs G, Miller K, Rassweiler J (1985b) Extracorporeal shockwave lithotripsy and endourology – an ideal combination for the treatment of kidney stones. World J Urol 3: 41–47

Eisenberger F, Gumpinger R, Miller K, Horbaschek H, Skeblitz H (1985c) Stereoröntgen in der Endourologie. Urologe [A] 24: 342–345

Forssmann B, Hepp W (1980) Stoßwellen in der Medizin. Medizin in unserer Zeit 4: 10–14

Fuchs G, Miller K, Rassweiler J (1984) Alternatives to open surgery for renal calculi: percutaneous nephrolithotomy and extracorporeal shockwave lithotripsy. In: Schilling W (ed) Klinische und experimentelle Urologie (Bd VIII) Zuckschwerdt Verlag, Munich, pp 153–177

Gumpinger R, Miller K, Fuchs G, Eisenberger F (1985) Antegrade ureteroscopy for stone removal. Eur Urol 11: 199–202

Häusler E, Kiefer W (1971) Anregung von Stoßwellen in Flüssigkeiten durch Hochgeschwindigkeitstropfen. Verh Dtsch Physik Ges, p 786

Hepp W (1984) Survey of the development of shockwave lithotripsy. Dornier Medical Systems. User Letter 1–10

Marshall F, Makofiki R, Mark F et al. (1985) Shockwave destruction of renal calculi: new technical modifications. J Urol 133 [A]: 118

Meyer WH, Klosterhalfen H, Becker H, Schulte am Esch J, Koch E (1985) Effektivitätssteigerung der extracorporalen Stoßwellenlithotripsie (ESWL) durch high-frequency-jet-ventilation (HFJV). Akt Urol 16: 252–254

Miller K, Fuchs G, Rassweiler J, Eisenberger F (1984a) Financial analysis, personnel planning and organizational requirements for the installation of a kidney lithotripter in a urological department. Eur Urol 10: 212–215

Miller K, Fuchs G, Bub P, Rassweiler J, Eisenberger F (1984b) Kombination von perkutaner Nephrolithotomie (PCN) und extracorporaler Stoßwellenlithotripsie (ESWL) – eine neue Möglichkeit zur Behandlung von Nierenausgußsteinen. Akt Urol 15: 317–321

Miller K, Fuchs G, Rassweiler J, Eisenberger F (1985a) Treatment of ureteral stone disease: the role of ESWL and endourology. World J Urol 3: 53–57

Miller K. Gumpinger R, Fuchs G, Rassweiler J, Eisenberger F (1985b) Antegrade Ureteroskopie – das Ende der offenen Chirurgie beim hohen Harnleiterstein. Akt Urol 16: 291–293

Rassweiler J, Buck J, Miller K, Fuchs G (1985a) Computertomographische Steindichtemessungen zur Steinanalyse vor extrakorporaler Stoßwellenlithotripsie (ESWL). Akt Urol 16: 30–35

Rassweiler J, Miller K, Fuchs G, Eisenberger F (1985b) Kosten und Nutzen der berührungsfreien Nierensteinlithotripsie. Lebensversicherungsmedizin 37: 80–85

Rassweiler J et al. (1986) ESWL – first choice therapy for ureteral calculi. Paper presented at Pan-American congress of urology. Sao Paulo, 6 February 1986

Russo P, Stephenson R, Mies C et al. (1986) High energy shockwaves suppress in-vitro and in-vivo tumor cell growth. J Urol 135 (2): 866

Schmiedt E, Chaussy C (1985) Die extrakorporale Stoßwellenlithotripsie von Nieren- und Harnleitersteinen. Deutsches Ärzteblatt 82: 247–252
Smith MJ, Boyle NH (1968) Anatrophic nephrotomy and plastic calyraphy. J Urol 99: 521
Stephenson TP, Bauer S, Hargreave TB, Turner-Warwick RT (1976) The technique and results of pyelocalycotomy for staghorn calculi. Br J Urol 47: 751–758
Sturm W, Marx FJ, Chaussy C, Eisenberger F (1984) Zum Stellenwert der Unterkühlungsmethode zur operativen Steinentfernung. Urologe [A] 23: 9–12
Ueda T, Momose S (1982) Modified inferior pyelocalycotomy for staghorn calculi and multiple stones: the use of renal pedicle clamp and fibrin coagulum. Urol Int 37: 49–56

Section II

# Endoscopic Innovations

# Introduction

*J. C. Gingell*

Recent advances in endoscopic urological instruments have opened up a whole new field of urological practice described in this section. The development of purpose-built nephroscopes has allowed percutaneous stone removal to replace open surgical removal of renal calculi in all modern urological units. The detailed technique is comprehensively described by Whitfield, who undertakes his own renal access, an aspect of the procedure which in many units is performed by a radiologist. As he rightly indicates in his contribution, this can be the most difficult step in the operation and demands a skill that all urological trainees should endeavour to acquire. The range and design of the instruments themselves and the necessary accessories of forceps and stone baskets have developed only by the close cooperation of urologists and instrument manufacturers. Indeed, this has proved to be the most encouraging and continually productive aspect of urological endoscopic development and in no small measure has contributed to the advances outlined in this section. This particularly applies to ureteroscopy, described by Miller. The development of the rigid ureteroscope has had a major impact upon the management of the all-too-common and painful problem of ureteric calculi. He describes well the therapeutic options of in situ treatment of larger calculi or their disimpaction for percutaneous removal or extracorporeal shock wave lithotripsy (ESWL). Clearly no single technique can be adapted to manage all stones in the upper urinary tract, and individual skills and experience must be acquired to make full and appropriate use of the various options available.

The inclusion of the contribution by Fowler on flexible endoscopy of the lower urinary tract is entirely appropriate. The arguments in favour of its routine use in outpatient or day-case screening are convincing and probably cost effective in the long term. It is highly likely that most urological units will acquire this facility and that more flexible probes than those currently available for diathermy or laser destruction of small bladder tumours will be developed so that the major role of this instrument in diagnosis will expand inevitably into the realm of therapy.

The innovative contribution from O'Donnell on the use of the endoscopic injection of Teflon to cure vesicoureteric reflux in children is destined to have the same impact on open antireflux surgery that percutaneous stone removal and ESWL has already achieved for renal calculi. The results as presented are impressive and add a new therapeutic dimension to the management of this common urological problem in childhood.

*Chapter 2*

# Percutaneous Stone Removal Techniques

*H. N. Whitfield*

The technique of percutaneous nephrolithotomy (PCNL) has been developed over the past 5 years and is now established as a standard method of removing stones from the kidney (Reddy et al. 1985; Segura et al. 1985; Whitfield 1983a). Firstly, a transparenchymal track must be established between the collecting system of the kidney and the skin. Secondly, the stone must be removed. These two steps may be performed under the same general or epidural anaesthetic as a one-stage procedure; alternatively, the track may be established under local anaesthesia and kept patent for 48–72 h by a nephrostomy tube before the stone is removed.

## Formation of a Nephrostomy Track

The part of the procedure concerned with the formation of a nephrostomy track may be performed either by a radiologist or by a urologist (Kellett et al. 1983; Whitfield 1983b). The track must be placed very accurately, and this may often be the most difficult step in removing a stone. With practice, however, there are very few collecting systems that cannot be punctured.

The patient should be placed prone and semi-oblique so that the side to be operated upon is raised. Wedges placed under the patient between the subcostal margin and the iliac crest help to maintain the correct position.

The initial needle puncture to establish a nephrostomy track may be performed either under ultrasound control or using uniplanar or biplanar radiology. In either case it is helpful if the pelvicalyceal system is full. Standard intravenous urographic contrast medium may be given to

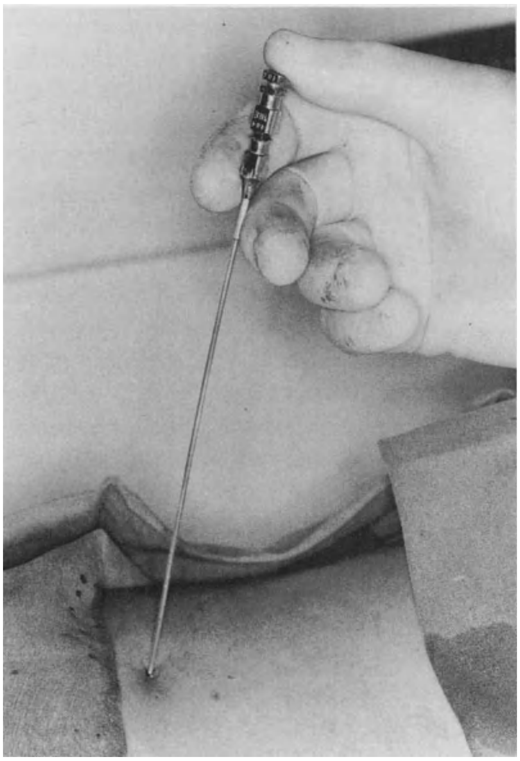


Fig. 2.1. A Longdwell needle.

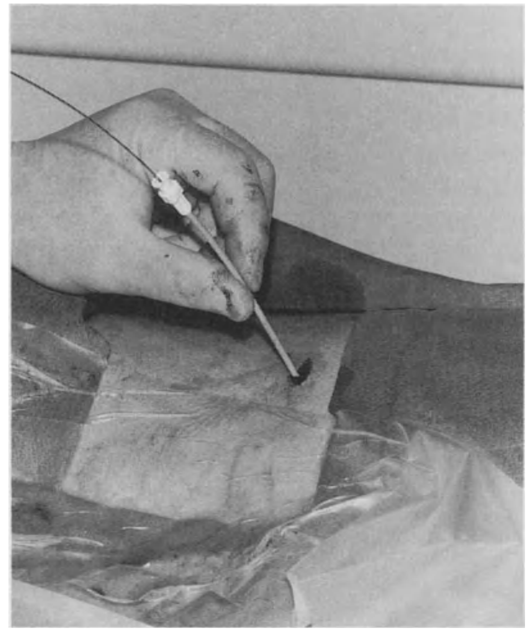


Fig. 2.2. A Teflon dilator being inserted over a Lunderquist guide wire.

outline the collecting system. Alternatively, a retrograde ureteric catheter can be passed and the upper urinary tract outlined and a little distended by contrast mixed with methylene blue.

The skin puncture is usually made between the 12th rib and the iliac crest lateral to the lateral border of the erector spinae. Occasionally, a puncture may have to be made between the 11th and 12th ribs if the kidney is high lying, but transpleural tracks may produce a pneumothorax.

A lower calyx is the usual site of entry into the collecting system. The aim should always be to enter a calyx as peripherally as possible to avoid the large venous sinuses which lie posterior to the calyceal infundibulum. The track must be transparenchymal so that urinary extravasation is minimised after removal of the nephrostomy tube postoperatively.

When uniplanar radiographic screening is employed, the depth of the needle can be gauged by observing the differential movements on respiration of the tip of the needle and the calyx to be punctured. Once the needle enters the substance of the kidney the needle shaft will be observed to move with respiration. Puncture of the collecting system is confirmed when urine or contrast stained with methylene blue is obtained on aspiration of the needle. A variety of different needles is available, but whichever is chosen must be of a sufficient calibre to accept a guide wire. The present author's preference is for a Longdwell needle which has an outer Teflon sheath (Fig 2.1). When the needle has been removed, a guide wire is inserted, over which the dilators are passed. Stiff "coat-hanger" guide wires of the Lunderquist variety have flexible tips of differing lengths which provide sufficient anchorage to enable the track to be quickly and safely dilated without the risk of kinking the guide wire during the dilatation process (Fig. 2.2).

Graded Teflon dilators are available in sizes ranging from 6 FG to 30 FG. A track can easily be formed using these or the graded metal, telescopic bougies. Intermittent screening is used to check that the guide wire remains within the collecting system and that the dilators are being passed to the correct depth. Balloon dilators are advocated by some, but fascial layers may be difficult to dilate. Previous surgery with resulting perinephric fibrosis should be considered as a contraindication to their use.

The calibre of the track that is required will depend on the size of the stone to be removed. In practice, there is little difference in terms of difficulties and risks between dilating to 26 FG, the minimum which is likely to be needed, and 30 FG, the size which it is not often necessary to exceed. Whatever size of track is needed, the final dilator should be of the Amplatz variety, over which an outer sheath can be fitted (Fig. 2.3). The dilator is then removed, but the guide wire should be left in situ. The sheath not only tamponades the track and reduces any bleeding but also provides a conduit from the skin to the collecting system which can be endoscoped safely and repeatedly.

Experimental studies have shown that the process of dilating a nephrostomy track in this way is safe. The theoretical risk of arteriovenous fistula formation does not occur in practice. This is probably because vessels, particularly arteries, are pushed aside by the bouginage and not ruptured. Histological sections of kidneys subjected to dilatation in this way show that healing occurs rapidly to leave only a fine linear scar (Webb and Fitzpatrick 1985).

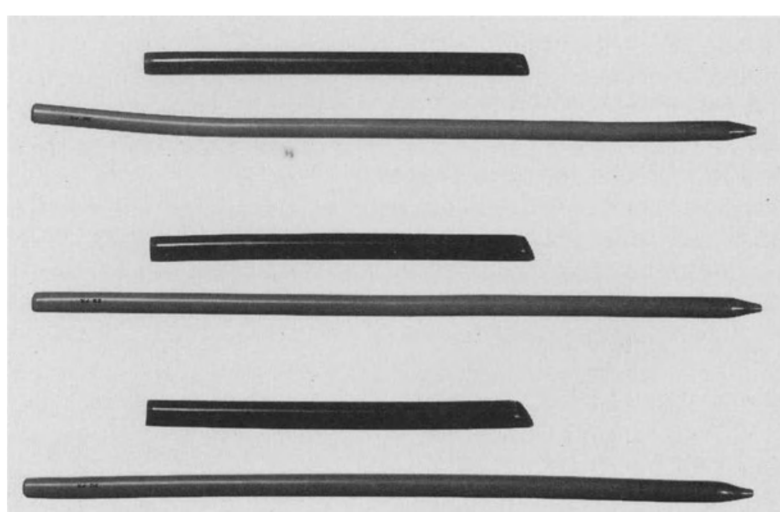


**Fig. 2.3.** Amplatz dilators and sheaths, 26–30 FG.

## Stone Extraction

If the stone is small enough to be removed intact down the track, a variety of instruments is available. An ordinary operating cystoscope or operating urethrotome can be used in conjunction with a flexible stone basket. However, both flexible stone-grasping forceps and stone baskets of various designs have limited application. Flexible forceps easily catch mucosa and cause sufficient bleeding to hinder vision. Stone baskets may not open satisfactorily in a small collecting system, and the room for manoeuvring to ensnare the stone is limited. The basket, when closed, is quite rigid and can easily perforate the renal pelvis.

There are now available from several manufacturers rod lens system nephroscopes with an eyepiece offset either obliquely or at right angles. These nephroscopes incorporate a channel which will accommodate non-flexible stone-grasping instruments (Figs. 2.4, 2.5). Also available is a triradiate grasping instrument with a telescope which passes down the middle. A flexible nephroscope may be necessary very occasionally to reach parts of the kidney not accessible with a straight instrument. Either a choledochoscope or a purpose-built flexible nephroscope is suitable.

All nephroscopes rely on a flow of irrigant to provide clear vision. The rate of flow varies in different instruments and depends on whether there is an instrument in the instrument channel. The irrigant used should always be normal saline at 37°C. The use of non-isotonic solutions can lead to a "TUR" type of reaction in the event of fluid extravasation. Because of the large volumes of irrigant that may be used in a prolonged procedure, a very significant fall in core temperature will occur unless the irrigant is at body temperature.

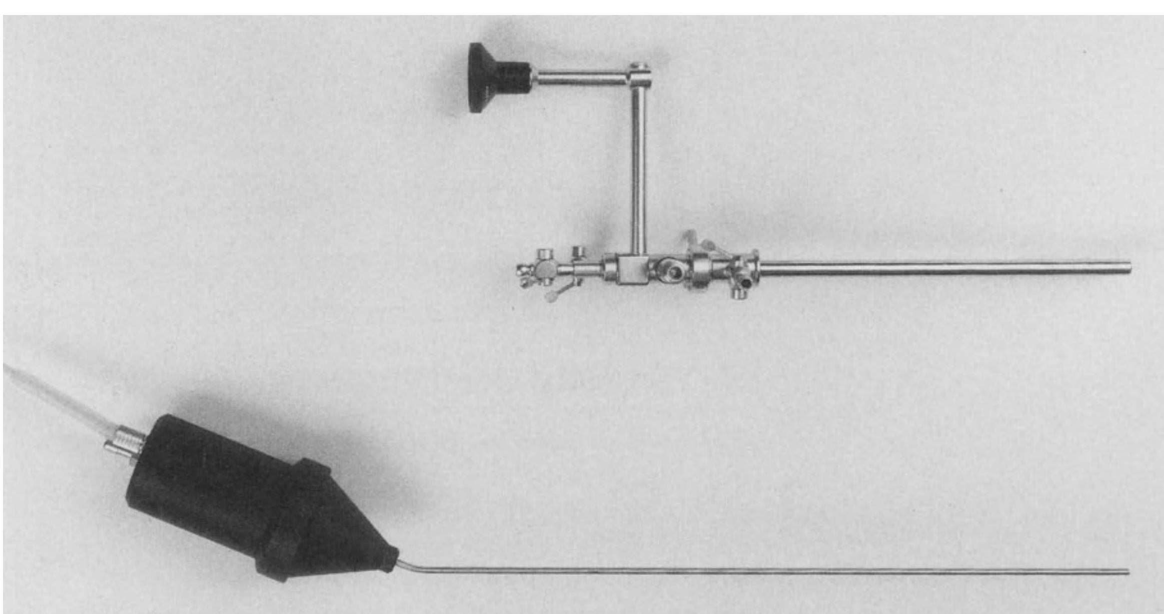


**Fig. 2.4.** A right-angled offset eyepiece nephroscope with an ultrasound probe.

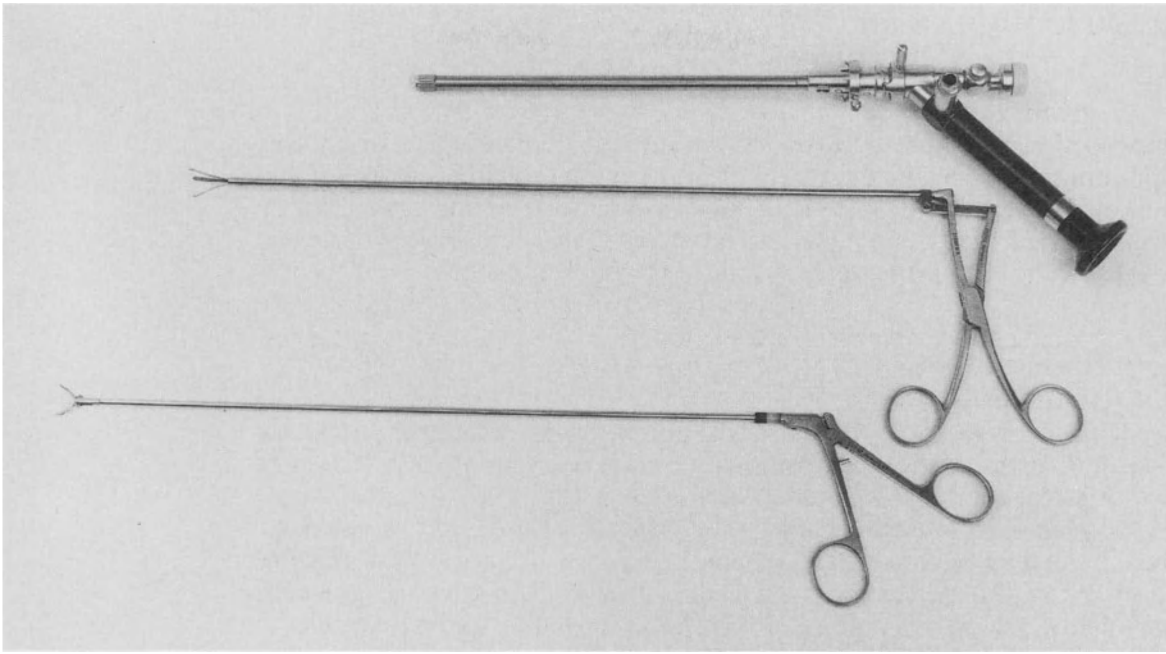


**Fig. 2.5.** An obliquely offset eyepiece nephroscope with two different rigid grasping forceps.

Stones which are too large to be removed intact can be disintegrated either by ultrasonic lithotripsy (USL) or electrohydraulic lithotripsy (EHL). Ultrasonic probes are straight and must be passed down a rod lens nephroscope. The stone is disintegrated into fine sand, which is evacuated down a suction channel within the probe. The advantage of this technique is that stone fragments are actively sucked on to the end of the probe where they are disintegrated. Stone clearance is achieved on a vacuum cleaning principle. Some stones, for example uric acid, cystine and some calcium oxalate stones, are extremely hard and may disintegrate only very slowly by this method. Triple phosphate stones, on the other hand, are well suited to removal by this method.

By means of EHL, stones are disintegrated into small fragments which are then removed through the nephrostomy track. The power and frequency of impulse repetition can be varied. The danger with EHL arises if the probe is discharged when in contact with the collecting system, as perforation will occur. The process of fragmentation may tend to disperse the stone fragments into inaccessible parts of the pelvicalyceal system. Attemps to minimise stone dispersion by using Lithogel have been reported (Hasun et al. 1985).

## Indications for PCNL

In centres where extracorporeal shock wave lithotripsy (ESWL) is not available, over 90% of all renal stones should be removed percutaneously, together with a significant proportion of stones lying within the upper third of the ureter. Even in centres where ESWL is available any stone more than 3 cm in diameter will need to be debulked prior to ESWL treatment.

Two-stage procedures are usually easier to perform than one-stage operations. Any bleeding that has occurred at the time of establishing the nephrostomy track will have settled down within 48–72 h. Visualisation of the stone is then not a problem. However, with increasing experience most stones can be removed in a one-stage operation.

## Stones in The Renal Pelvis

Stones lying within the renal pelvis are the most straightforward to remove percutaneously. If the maximum diameter of the stone is not greater than 0.8 cm it is possible to remove the stone intact. Larger stones must first be disintegrated. The larger the stone and the smaller the renal pelvis the more difficult the procedure becomes. Just as with conventional open surgery, a stone that occupies the whole of a small intrarenal pelvis would be more difficult to remove percutaneously than a similar sized stone lying freely within a large extrarenal pelvis.

Stones which are causing obstruction either acutely or chronically at the level of the pelviureteric junction (PUJ) are difficult to remove. Mucosal oedema around the stone and spasm of the renal pelvis above it result in the stone becoming firmly impacted. In these circumstances, it is often best to disintegrate the stone since attempts to disimpact it may result in disruption of the PUJ.

A stone which lies in the pelvis of the upper moiety of a duplex kidney may prove to be impossible to remove percutaneously. All other stones in the renal pelvis, including those in a horseshoe kidney, can be removed via a percutaneous approach.

## Calyceal Stones

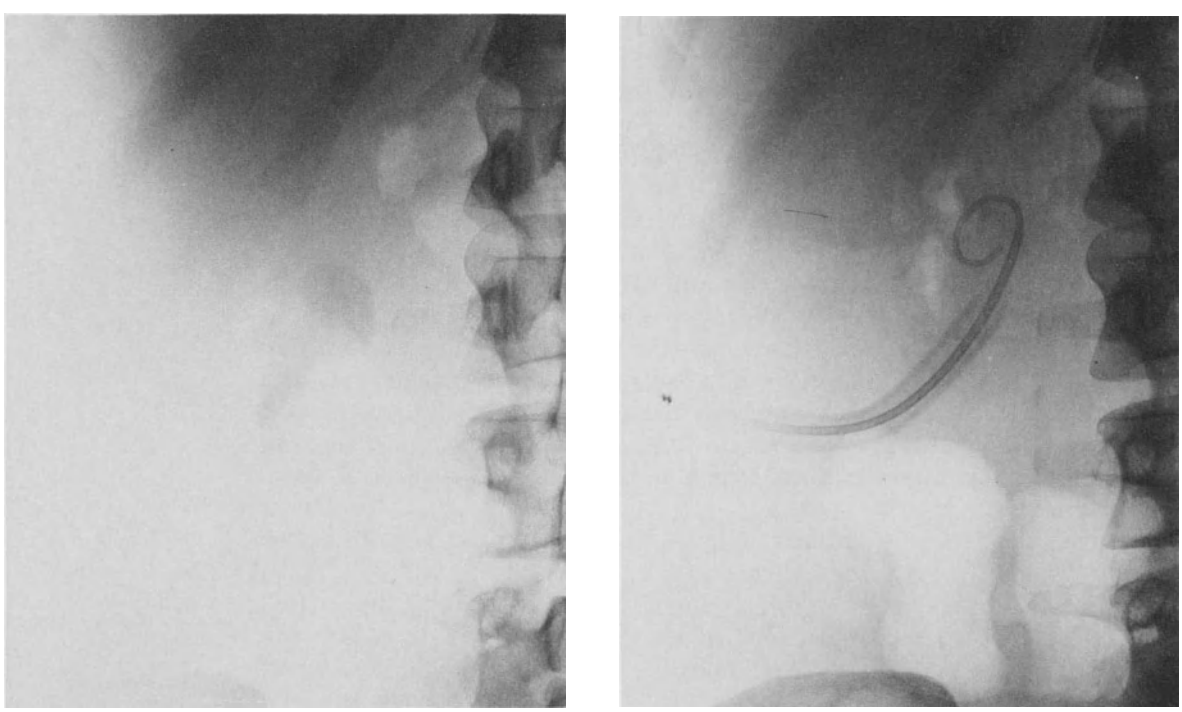
Most calyceal stones can be removed percutaneously, but pinpoint accuracy in positioning the track is called for. The operator must define whether the stone-bearing calyx lies anteriorly or posteriorly. If a track is made into an anterior calyx and the stone lies posteriorly, access will prove impossible with a rigid instrument. A direct puncture on to the stone must be made. However, stones in an upper calyx of a high-lying kidney may be very difficult to remove percutaneously. A puncture above the 12th rib may enable a satisfactory track to be made which is not too oblique.

## Ureteric Stones

Many stones which must be removed from the upper third of the ureter can be treated by a percutaneous approach. Ideally, the stone should first be pushed back into the renal pelvis from where retrieval is uncomplicated. A large ureteric catheter is passed and direct pressure on the stone from below may result in the stone moving backwards into the renal pelvis. Sometimes, normal saline forced through the catheter under pressure succeeds in blowing the stone back. On other occasions the stone can be disimpacted from the ureter by passing a guide wire through the ureteric catheter and jiggling the stone from below with it. Stones which remain impacted can be removed from the upper third of the ureter with a flexible nephroscope, or sometimes a rod lens instrument can be passed down the ureter. However, disimpaction even under direct vision is not easy, and ureteric perforation can occur.

## Contraindications to PCNL

When several stones are lying in different calyces, or in the case of a staghorn calculus with many calyceal extensions, the advantages of percutaneous removal become less marked. Several tracks and often several operating sessions will be required to achieve complete stone clearance. If ESWL is not available such cases may still be best dealt with by conventional open surgery. However, partial staghorns can be very satisfactorily treated by PCNL (Fig. 2.6).



a b

**Fig. 2.6a,b.** A recurrent partial staghorn stone composed of cystine which was completely removed in a one-stage PCNL. **a** Preoperative control; **b** postoperative control at 24 h.

Very occasionally, patients who are obese may not be suitable for PCNL. The distance between the skin surface and the collecting system is greater than the length of the operating instruments. Such patients may also be overweight for ESWL.

## Results of PCNL

If a high rate of success of stone removal by PCNL is to be achieved, correct case selection is essential. The operator must have a three-dimensional image showing the relationship of the stone, the collecting system and the proposed line of the nephrostomy track. Renal pelvic stones are easier to remove than both upper ureteric and calyceal stones. It is more difficult to remove large stones which require disintegration than small stones which can be removed intact. Two-stage procedures are easier than one-stage operations.

There is a well-recognised learning phase in surgery, especially endoscopic surgery, and PCNL is no exception. It is sensible to limit the complexity of stones which are attempted until some experience on simple cases has been built up. One of the main differences between endoscopic and open surgery in the kidney is that the margin of error in percutaneous surgery is small. If bleeding occurs, if the track is lost, or if the collecting system is perforated, there may be no alternative but to abandon the procedure. However, the option may exist for a further attempt at percutaneous stone removal after an interval, which will vary according to the complication.

The success rate will depend not only on correct case selection and the experience of the operator but also on the instruments which are available. The full potential of the technique can only be fulfilled when a comprehensive range of purpose-built nephroscopes and stone-grasping instruments is available. The question is often asked whether EHL is better than USL, but there is no easy answer. Some surgeons have a personal preference; some types of stones disintegrate better by one method than by the other; it is sometimes an advantage that the electrohydraulic probes are flexible; ultrasound probes incorporate a suction channel; ultrasound does not damage the wall of the collecting system. When both methods are available the chances of successful stone removal are maximised.

In a recent report (Whitfield and Mills 1985), 98 out of 105 pelvic stones (93%), 27 out of 38 calyceal stones (71%) and 5 out of 7 (71%) ureteric stones were completely removed. These figures include cases treated when purpose-built instruments were not available, when the experience on which to base case selection was being built up and when the technique itself was in its infancy. Better results should now be achieved by any department of urology in which the technique is practised.

## Complications of PCNL

Percutaneous nephrolithotomy is a very safe procedure. In the present author's series no patient died, no patient required open surgical exploration as an emergency and no patient has subsequently developed evidence of an arteriovenous fistula. The incidence of stone recurrence appears to be no higher after PCNL than after open surgery (Marberger et al. 1985). Complications can be minimised by meticulous technique.

### Bleeding

The amount of bleeding that occurs during dilatation of the track is very variable. Not once in 150 patients was the bleeding during this step sufficient to necessitate abandoning the procedure. In one patient a 2 unit transfusion was needed. One patient required transfusion for bleeding which occurred after stone removal in a two-stage procedure, and another patient required a 3 unit transfusion for a secondary haemorrhage on the 10th postoperative day.

When bleeding occurs at a time when the access track is still patent, a large-bore nephrostomy tube should be inserted to tamponade the track. If bleeding is very heavy the nephrostomy tube should be spigoted to encourage haemostasis by further tamponade. Antifibrinolytic agents should be avoided since the resulting rubbery blood clots are very difficult to remove. If bleeding fails to respond to these conservative measures, arteriography and highly selective arterial embolisation may be considered.

### Septicaemia

The risk of provoking septicaemia should be minimised by prescribing prophylactic antibiotics to all patients undergoing PCNL (Charlton et al. 1986). An oral drug active against Gram-negative organisms (e.g. trimethoprim, cephalexin, nitrofurantoin and ampicillin) is sufficient. If a urinary tract infection is present preoperatively or if the stone is thought to be infective in origin, an aminoglycoside should be given. Septicaemia is no more common after PCNL than after conventional open surgery.

### Residual Stones

The aim of surgery is always to achieve complete stone clearance. If residual fragments remain, management will depend on the size and position of the stones, the symptoms caused and, in the long term, the rate of increase in size. If the retained fragments are small and asymptomatic, they are termed "non-surgical stones". A conservative policy of management can safely be followed. Larger residual fragments in the pelvis and calyces may be removed via a further percutaneous procedure, although very occasionally an open operation may be necessary.

If stone fragments pass into the ureter the nephrostomy tube must be left draining until the fragments have passed spontaneously or until they have been removed endoscopically from above or below. In the last resort an open operation may be necessary.

It is possible to minimise the risk of stone fragments passing into the ureter by leaving a ureteric catheter or a Fogarty balloon catheter within the ureter at the time of stone disintegration. The tip of the catheter or the balloon should lie at the level of the PUJ.

Residual fragments that are left behind in the track may safely be treated conservatively, since they seldom cause complications. If a discharging sinus persists it is not difficult to explore the track and remove the stone fragment.

## Perforation

The collecting system, usually the renal pelvis, can be perforated by direct trauma from a nephroscope or by an instrument passed via a nephroscope. With the electrohydraulic lithotripter a perforation will occur if the electrode is discharged while touching the wall.

The management of a perforation should be to abandon the procedure immediately the complication has been recognised. A nephrostomy tube should be left to drain the system and healing can be confirmed by a nephrostogram after 1 week. After this time a further attempt at endoscopic stone removal can be made.

## Extravasation

The risk of extravasating irrigating fluid has been greatly reduced by using Amplatz sheaths. Not only do these tamponade the track and reduce bleeding, they also provide a low-pressure irrigating system. If the track is being endoscoped via an Amplatz sheath and if the collecting system is not perforated, it is very difficult for a significant volume of fluid to be extravasated and absorbed. The complications of absorption can be further reduced by using 0.9% saline as the irrigant. This fluid should be at body temperature.

## The "Perc Casualty"

Very occasionally, a patient who has a stone for which percutaneous removal is planned will end up having multiple procedures. A one-stage operation is abandoned before stone removal, the second stage is not successful and either further percutaneous surgery or an open operation proves to be necessary. In retrospect the patient and the surgeon recognise that a conventional open operation would have been preferable. Such eventualities should be avoidable by recognising the complexity of the stone(s) to be removed and forewarning the patient accordingly. With increasing experience the "perc casualty" becomes a rare event.

## Conclusions

There is abundant evidence that PCNL on its own is a safe, effective and economical method of removing renal stones (Wickham et al. 1983; Mayo et al. 1985). The morbidity in terms of pain, postoperative chest complications, deep vein thrombosis, pulmonary embolism and paralytic intestinal ileus is lower than after conventional open surgery (Rittenberg et al. 1985). The period of hospitalisation and the time required for convalescence are reduced (Brannen et al. 1985). Percutaneous surgery is also an essential adjunct in many patients undergoing ESWL. The rapid development of the technique and its adoption in all major centres of urology will ensure that the best possible treatment becomes available to patients with renal stones.

## References


Brannen GE, Bush WH, Correa RJ, Gibbons RP, Elder JS (1985) Kidney stone removal: percutaneous versus surgical lithotomy. J Urol 133: 6–12

Charlton M, Vallancien G, Veillon B, Brisset JM (1986) Urinary tract infection in percutaneous surgery for renal calculi. J Urol 135: 15–17

Hasun R, Ryan PC, West AB, Fitzpatrick JM, Marberger M (1985) A new approach to the problem of residual stones after electrohydraulic nephrolithotripsy. Br J Urol 57: 605–609

Kellett MJ, Miller RA, Wickham JEA (1983) The role of the radiologist in percutaneous renal surgery. Br J Urol [Suppl]: 27–30

Marberger M, Stackl W, Hruby W, Kroiss A (1985) Late sequelae of ultrasonic lithotripsy of renal calculi. J Urol 133: 170–173

Mayo ME, Krieger JN, Rudd TG (1985) Effect of percutaneous nephrostolithotomy on renal function. J Urol 133: 167–169

Reddy PK, Hulbert JC, Large PH et al. (1985) Percutaneous removal of renal and ureteral calculi: experience with 400 cases. J Urol 134: 662–665

Rittenberg MH, Koolpz H, Keeler L, McNamara T, Bagley DE (1985) Pain control: comparison of percutaneous and operative nephrolithotomy. Urology 25: 468–471

Segura JW, Patterson DE, Leroy AJ et al. (1985) Percutaneous removal of kidney stones: review of 1000 cases. J Urol 134: 1077–1081

Webb PR, Fitzpatrick JM (1985) Percutaneous nephrolithotripsy: a functional and morphological study. J Urol 134: 587–591

Whitfield HN (1983a) Percutaneous nephrolithotomy. Br J Urol 55: 609–612

Whitfield HN (1983b) Percutaneous nephrolithotomy: the urologist on his own. Br J Urol [Suppl]: 97–102

Whitfield HN, Mills V (1985) Percutaneous nephrolithotomy: a report of 150 cases, Br J Urol 57: 603–604

Wickham JEA, Miller RA, Kellett MJ (1983) Percutaneous nephrolithotomy, results and cost effectiveness. Br J Urol [Suppl]: 103–106

*Chapter 3*

# Ureteroscopy

*R. A. Miller*

## Introduction

The introduction of the rigid ureteropyeloscope (Karl Storz GMBH) by Perez-Castro Ellendt and Martinez Pinero (Perez-Castro Ellendt and Martinez Pinero 1980) has lead to unprecedently rapid clinical and instrumental advances (Ford et al. 1984). There is little doubt that in 1987 no urologist can afford to be unfamiliar with this technique. Concomitant advances in percutaneous nephrolithotomy (PCNL) (Miller 1985; Miller 1986) have complemented ureteroscopic techniques and should be considered as a single entity: upper tract endoscopy or "Endourology", as the Americans have termed it. In this chapter the indications, techniques, complications, management of cases and instrumentation will be considered.

## Indications

There are two broad groups of indications: diagnostic and therapeutic. Diagnostic endoscopy may be carried out to elucidate the cause of upper tract haemorrhage, filling defects, strictures of the ureter and positive cytology. Therapeutic endoscopy is used for the treatment of calculi, retrieval of foreign bodies, resection of tumours (biopsy and diathermy), division of strictures including pelviureteric junction (PUJ) stenosis and placement of double-J stents. There are no absolute contraindications to ureteroscopy, but conditions affecting urethral access such as fixed hips are clearly a relative contraindication. There is little doubt that women are easier to ureteroscope than men, principally because a large prostate makes access to the ureteric orifices much more difficult. Patients who have had previous lower ureteric surgery are often more difficult to ureteroscope.

# Techniques

## Patient Preparation

All patients undergoing ureteroscopy must have a preoperative intravenous urogram and urine culture. The procedure is best carried out with the patient placed on a radiological screening table under general anaesthesia with the legs in the Lloyd Davis position. We routinely cover all patients with a preoperative dose of gentamicin (80 mg) given intravenously, followed by oral antibiotics for at least one week. It is possible to use a C-arm screening unit instead of a proper uroradiological table. Endoscopy without screening (not recommended) is possible but is absolutely contraindicated when dealing with small mobile stones, which have a tendency to shoot up into the kidney, in which case immediate one-stage PCNL is indicated. Following induction of anaesthesia a diuresis should be achieved by the administration of frusemide or mannitol together with intravenous fluids. Ureteroscopy can be a prolonged and tedious procedure which may take between 5 min and 2 h or more. The operator should bear this in mind when planning cases. Initial failure to retrieve stones is not uncommon. It is therefore essential that it is explained to the patient that further endoscopic sessions or percutaneous nephrostomy may be necessary. Indeed, following failure to retrieve stones, open operation may proceed under the same anaesthetic in some cases.

## Introduction of the Ureteroscope

Prior to introducing the ureteroscope the ureteric orifice must be dilated. Conventional rigid cystoscopy is performed using a 23.5 FG (large) cystoscope. A floppy straight guide wire is introduced into the renal pelvis. Plastic, metal or balloon dilators are now passed coaxially over the guide wire. In some cases ureteral meatotomy can be performed using the purpose-designed Bischler scissors (Richard Wolf GMBH). Dilators should be radiologically screened as they are passed up the ureter to the point of interest. Care should be taken not to dislodge small stones back into the renal pelvis during dilatation. In my opinion, dilation over 16 FG is dangerous; however, some Americans are currently dilating ureters to 24 FG with balloons. Only long-term follow up will show the results of this. The Perez-Castro technique is to pass a preliminary ureteric catheter a day or so prior to endoscopy and leave it in situ. This method has much to recommend it and is ideal for rather narrow ureters which tend to dilate over the catheters, thus avoiding traumatic bouginage and haemorrhage which will spoil the view. This fact is probably responsible for the high success rate achieved at a second ureteroscopic session. It is therefore essential that if further endoscopy is planned a ureteric catheter is left in situ. Flexible metallic olivary bougies which are not perforated to take a guide wire are now obsolete and should be returned to the museum. My personal preference is for the graduated Teflon bougies which come in all the necessary sizes. The Finlayson Catheter Set (Lewis Medical Products) is not unlike the Amplatz System for PCNL (Miller et al. 1984) and consists of a series of plastic bougies which are hollow and fit over one another leaving a plastic sheath in situ. While theoretically ideal, these tubes are very difficult to insert.

Currently, we are carrying out research into a new access technique which will greatly facilitate ureteroscopy. This involves the use of a new "hydroplastic" (Aquaplastic Ltd.) material which expands and becomes slippery when wet. The material when dry is firmly adherent to an 8 FG ureteric catheter which is introduced into the ureter in the usual way. Perfusion by saline and urine causes the tube to swell, allowing the catheter to be extracted from its lumen. Ureteroscopy may then be carried out, or the tube may be left in situ to act as a stone shoot following extracorporeal shock wave lithotripsy (ESWL).

After the ureter has been dilated, endoscopy can proceed. The appropriate endoscope should be selected. The choice is between small (9 FG–10 FG) or large calibre (11.5 FG–13 FG) rigid endoscopes and the new flexible fibreoptic scopes (Keymed Ltd.), which are based on the paediatric bronchoscope. The newer shorter ureteroscopes are soon to become available. These are highly recommended and are much more manoeuvrable than their longer counterparts. It should be remembered that large scopes have better flow and allow the use of better and larger accessories. However, sometimes the ureteric calibre is insufficient for a large endoscope. The flexible endoscopes are expensive, peculiarly delicate and limited in their accessories, although the advent of laser lithotripsy may make them more useful. At present the view obtained, because of their poor irrigant flow, is not good enough to justify their expense. Normal saline at a restricted height of 80 cm above the patient is the preferred irrigant, thus diminishing the chance of a serious reaction to major retroperitoneal extravasation of fluid, which may occur if the ureter is perforated.

The operator has three choices as to the method of ureteroscopy. The ureteroscope may be introduced coaxially over the guide wire, alongside the guide wire or without a guide wire in situ. In all cases this is performed under direct vision, with screening being employed if there are difficulties. Whichever method is used the scope is gently advanced up the ureter in the same way that a sigmoidoscope is passed up the rectum. Failure to get a clear view is due to impaction of the urothelium on the end of the optic, bleeding caused by trauma, or problems with fluid flow. In all cases it is best to withdraw the ureteroscope slightly and remove all accessories from the instrument port, thus facilitating irrigant flow. Under normal circumstances it is then possible to re-establish a clearer view. Considerable patience may be required to pass the ureteroscope into the renal pelvis: force must never be used. The most difficult parts of the ureter to negotiate are the intramural portion, the pelvic brim and the PUJ. Oedema caused by stones or previous trauma makes it very difficult to obtain a clear view. If there is complete loss of view the procedure must be abandoned. In the event of a major perforation of the ureter an attempt should be made to pass a catheter or double-J stent across the defect. An 8.5 FG pigtail nephrostomy drain should be inserted as a safety valve. Further endoscopy should be delayed for at least 10 days.

## Manipulation of Calculi

Stones in the lower third of the ureter are ideally treated with the ureteroscope. Those in the middle and upper thirds are better treated by push/pull (flushing/pushing with an angiographic catheter followed by PCNL) or push/bang (in association with ESWL). Impacted stones can be very difficult to manage as they are invariably surrounded by very friable oedematous urothelium, and a clear view is extremely difficult to achieve. Ureteric perforation and damage can easily be caused by in situ disruption or attempts at extraction. The best devices at present for stone retrieval are the flat wire (Segura pattern) baskets. Alligators and triradiate forceps (rigid) newly developed by Richard Wolf (GMBH) and Karl Storz (GMBH) are useful but have a tendency to break very easily. Frequently, upper ureteric stones can be approached from the kidney. In such a case it is necessary to perform the percutaneous puncture in the middle or preferably upper caliceal group. This often involves a supra 12 puncture which requires a good deal of experience. Large stones or impacted stones are better disintegrated than retrieved. Two clinical methods exist: ultrasonic lithotripsy (USL) and electrohydraulic lithotripsy (EHL). The ultrasonic probes initially developed for ureteroscopy did not fit down the ureteroscope instrument port (Marberger and Stackl 1983). Initially, therefore, a balloon or basket was passed proximal to the stone through the instrument port of the ureteroscope. The sheath of the ureteroscope was approximated to the stone jamming it between the endoscope and the proximal balloon. The telescope was then removed and a sonotrode inserted. Disruption could then proceed under radiological control. This method can no longer be advocated. Stone disruption should always be done under direct vision using one of the larger ureteroscopes which enables the use of the sonotrode and balloon catheter or basket simultaneously. There is no doubt that fragmentation of ureteric calculi can be extremely difficult and hazardous irrespective of the disruptive modality. If EHL (5 FG or less) probes are used, single shot and minimal voltage settings are mandatory. Firing the probe at the ureteric wall directly usually results in perforation. However, the probe can be safely used providing that wall contact is avoided. A new generation of electrohydraulic probes which are very much smaller than 5 FG (2.5–3 FG) will soon be introduced. These have a lower voltage capability and are purpose built for ureteroscopic EHL. Research into pulsed focused dye lasers (G. Watson 1986, personal communication) indicates that this method is liable to provide an alternative to USL and EHL.

If a large stone is disrupted it is sometimes better to leave some small fragments in the ureter, rather than to pull out each tiny fragment, thus requiring multiple passages up and down the ureter. In such cases it is wise to leave a large ureteric catheter in situ. This causes ureteric dilatation as previously described and facilitates stone passage. In the postoperative period it may be necessary to perform a temporary percutaneous nephrostomy if the patient develops a fever. It is a good rule to leave a ureteric catheter in situ after all complex stone manipulations. Double-J stents should only be used if there is a real concern about the integrity of the ureter and a prolonged healing period is anticipated. A urethral catheter should be left in situ for 12–24 h at least following all complex stone manipulations but is generally not required if ureteroscopic inspection only has been performed.

## Resection of Ureteric Tumours

Ureteroscopy has made it possible to treat ureteric tumours under direct vision in much the same way as bladder tumours are treated (Huffman et al. 1985). The major role of ureteroscopy, however, is the diagnosis and biopsy of tumours. Low-grade superficial tumours can be treated by resection. High-grade invasive tumours still require open resection of the ureter or nephroureterectomy. Following tumour resection check ureteroscopies should be instituted exactly as for bladder tumour management. This procedure can be time consuming but, as these tumours are relatively rare, is fully justified. Recurrent superficial disease can be managed by percutaneous antegrade infusion of topical chemotherapy, but the effectiveness of this has not been satisfactorily assessed.

## Treatment of Ureteric Strictures and Division of the PUJ

Ureteric strictures can be treated endoscopically by dilatation and division, in the same way that urethral strictures are dealt with. The usual technique is to pass the endoscope up to the stricture and under direct vision pass a balloon or bougie over the guide wire across the stricture and dilate it. The stricture can now be further incised using a cold knife. Having established a good track, a double-J stent can be inserted. This should be accompanied by urethral and nephrostomy catheter drainage to ensure that refluxing vesical urine and draining urine do not extravasate alongside the stent through the previously strictured area. In a similar way it is possible to incise the PUJ. It is uncertain if merely incising the PUJ and leaving a J stent in situ is sufficient. Experience with percutaneous pyelolysis (Ramsay et al. 1984) suggests that percutaneous drainage is a prerequisite. A great deal more experience is required before such techniques can be generally recommended.

### Double-J Stent Insertion

While standard J stents do not require ureteroscopy for insertion, a frequent problem remains the curling up of the stent in the bladder. To overcome this it is often easier to insert the ureteroscope into the lower third of the ureter. The telescope can then be removed and the stent inserted through the sheath. This is particularly useful when dealing with malignant compression of the ureters, where resistance to the stent insertion can be overcome by the rigid sheath of the ureteroscope.

### Diagnostic Ureteroscopy

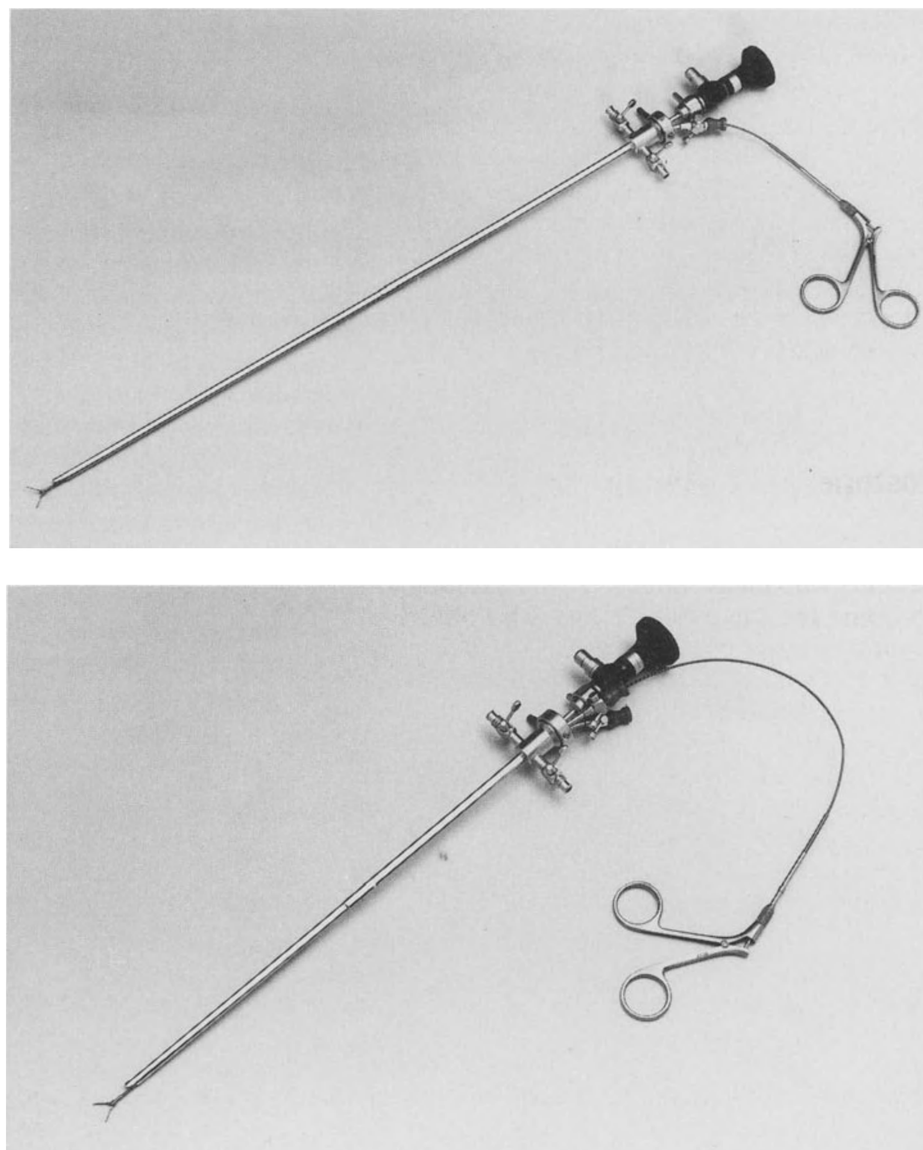
Unfortunately, rigid ureteroscopy is not a universal panacea for the diagnosis of haematuria. Commonly, having entered the renal pelvis, bleeding tissues can be identified. Biopsy usually results in loss of vision because of bleeding. A positive result is diagnostic but a negative result does not necessarily mean that the patient has not got malignant disease as the wrong area may have been biopsied. The middle and lower calyces are usually inaccessible to accessory instrumentation but can be seen with the 70° telescope of viewing ureteroscopes. In view of the possible complications of ureteroscopy, the decision to do a diagnostic ureteroscopy should not be taken lightly.

## Postoperative Management

Patients who have undergone an easy diagnostic ureteroscopy can usually go home the same day. Those who have had therapeutic manipulations should have a urethral catheter for 12–24 h at least. In addition, they may have a ureteric catheter or percutaneous nephrostomy as previously discussed. Most of the patients who have had complex manipulations or difficult ureteroscopy get considerable flank pain associated with an ileus and often with a fever. This settles within 48 h on antibiotic treatment and intravenous fluids in most cases. It is a wise precaution to check the ureter with an intravenous urogram 6–8 weeks postoperatively as strictures occasionally result from instrumentation.

## Complications

The serious complications of ureteroscopy are perforation, stricture and complete disruption of the ureter. Gram-negative septicaemia can usually be avoided by prophylactic administration of antibiotics. Perforation is dealt with endoscopically as detailed above. Complete disruption, usually a ureterovesical disconnection, occurs if large stones are trapped in a basket and pulled through a narrow ureter too hard. These require immediate open reimplantation. Strictures following ureteroscopy can be very difficult to manage. We have seen 6 in 200 cases. It is likely that they result from overstretching of the ureter with intramural extravasation, not unlike a dissection of the aorta. Another explanation is the stripping of the ureter from its retroperitoneal blood supply. These have all been managed by open ureterotomy or reimplantation.



a

b

**Fig. 3.1.** **a** Standard (long) viewing ureteroscope (Richard Wolf GMBH). **b** New short viewing ureteroscope (Richard Wolf GMBH).

## **Endoscopic Instrumentation** (Figs. 3.1–3.3)

There are two types of ureteroscope—rigid and flexible. The rigid endoscope may be small calibre for inspection (9 FG–10 FG) or wide

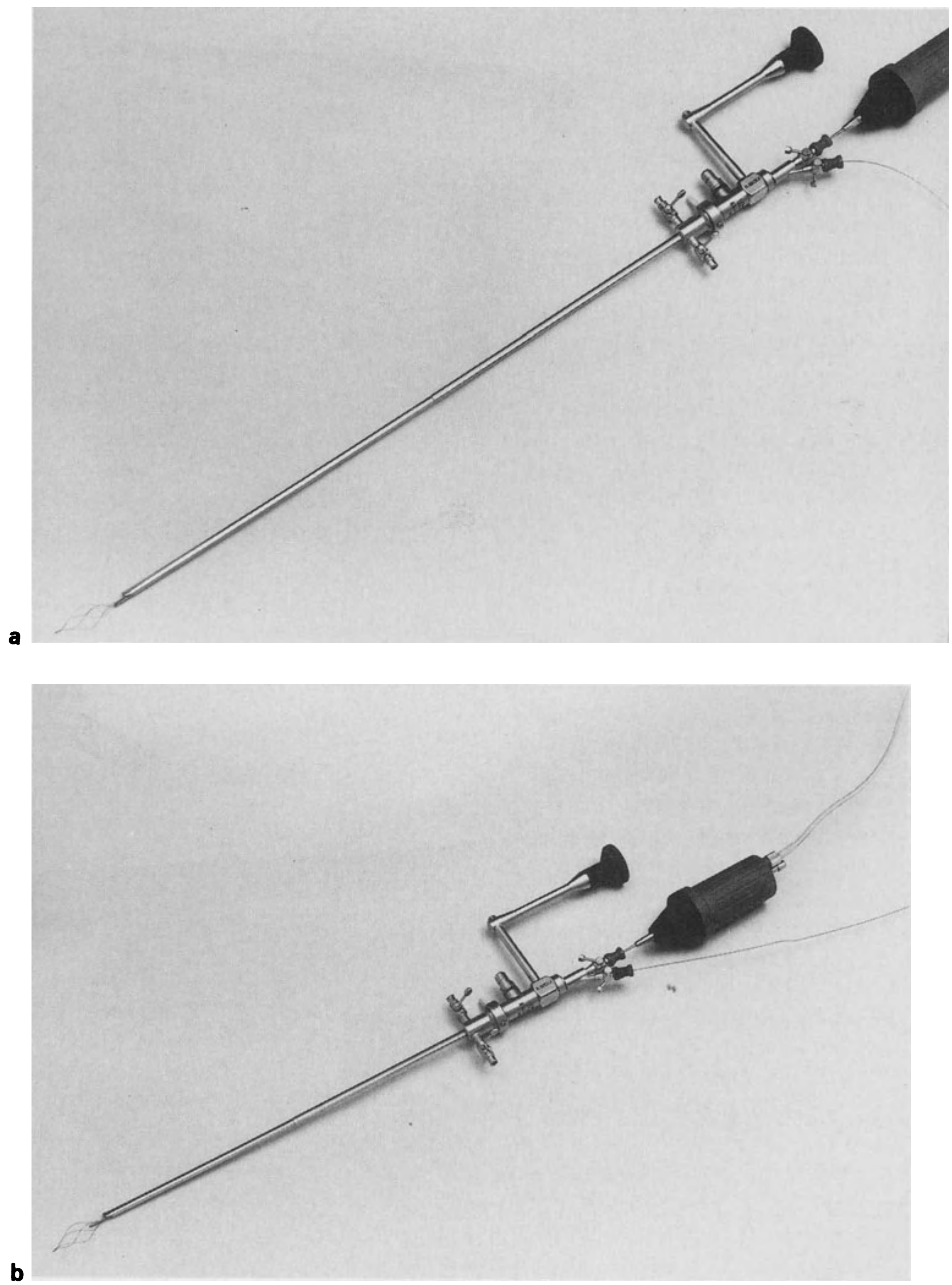


**Fig. 3.2.** **a** Interchangeable long operating scope with 90° offset telescope and ultrasound probe (Richard Wolf GMBH). **b** Short version of **a**.

calibre for operating (11.5 FG–13 FG). There is now a new range of short ureteroscopes from Richard Wolf (GMBH) and Karl Storz (GMBH) which are more manoeuvrable and robust. These are highly recommended. Viewing ureteroscopes consist of a sheath and telescope (small versions of a cystoscope elongated). The 0° (Karl Storz GMBH; ACMI), 5° (Richard Wolf GMBH; Olympus; GU) are used for inspection and operating in the ureter. The 70° telescopes are reserved for viewing inaccessible calyces from the pelvis of the kidney. The operating ureteroscopes are of two basic types: *fixed*, with oblique offset moulded telescope and instrument channel (ACMI; Karl Storz GMBH; Richard Wolf GMBH, Bischler), and *interchangeable*, where the offset (oblique, right angle) telescope can be interchanged with a forward-viewing or 70° optic (straight) for viewing. The latter has only recently been introduced. Modern ureteroscopes have a facility for a continuous flow. The ACMI operating ureteroscope incorporates a fibre viewing bundle instead of a rod lens system. This has the disadvantage of reduced resolution but does allow a relatively big instrument port while still maintaining all the advantages of the rigid system. It also enables the operator to move the telescope in any direction. A further benefit of this system is that it completely overcomes the difficult problem of "sheath bending". Rigid rod lens optics tend to lose their peripheral field when distorted. This is seen as a crescentic aberration by the operator. The Olympus optic, which incorporates a double sheath system for the optic housing, partially solves this problem, although not when the endoscope is fully stressed (Miller et al. 1986).

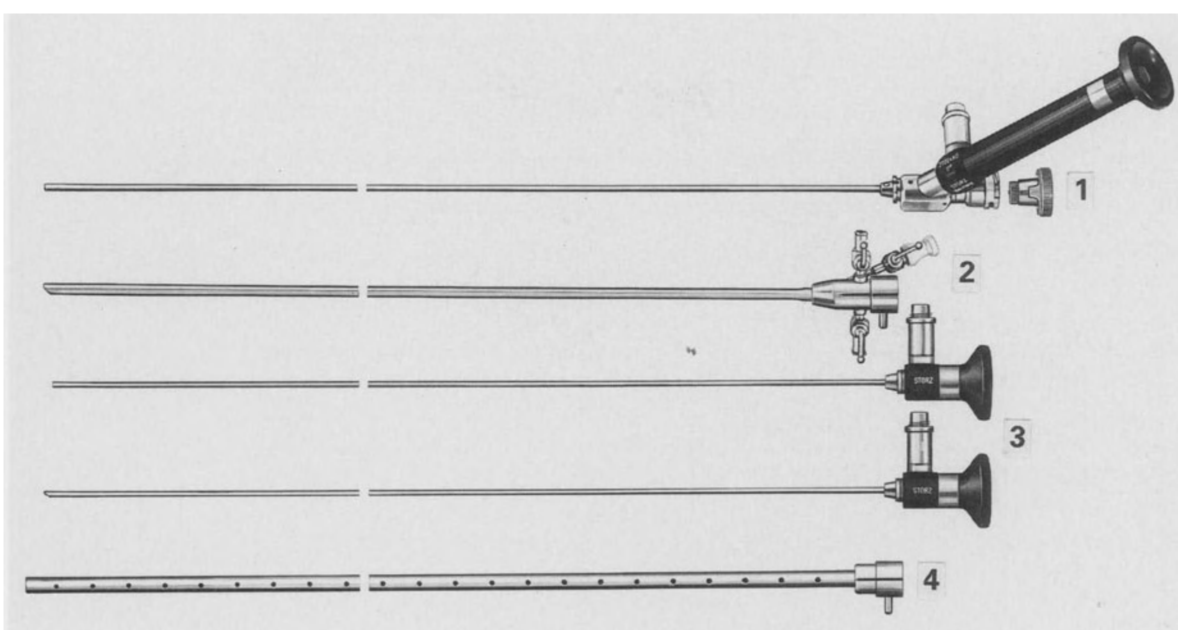



**Fig. 3.3.** Interchangeable operating ureteroscope (long) (Karl Storz GMBH): *1*, oblique offset telescope (operating); *2*, sheath; *3*, viewing telescopes; *4*, telescope protector for sterilisation.

Fibreoptic ureteroscopes (Bagley et al. 1985) are still in their infancy. Non-deflectable instruments, without an instrument channel, are of no use at all. The latest 3.6 mm endoscope (Olympus) with a 1.2 mm operating channel and deflectable tip shows some promise but in most cases cannot compare with the cheaper, more durable, rigid endoscopes with their superior illumination, resolution and irrigant flow.

## Conclusion

All urologists must master the skills of ureterorenal endoscopy. The ureteroscope may be used for diagnosis and treatment. Success depends on patience, personal skill and the level of instrumentation available. Complications can usually be dealt with endoscopically by stenting and draining, although strictures developing after instrumentation are a serious problem which sometimes require open surgery. Rigid ureteroscopes are better than their flexible counterparts. The new short operating endoscopes are particularly useful.

## References

Bagley DH, Huffman JL, Lyon ES (1985) Flexible fibreoptic ureteropyeloscopy. In: Bagley DH, Huffman ES, Lyon ES (eds) Urologic endoscopy: a manual and atlas. Little Brown, Boston, pp 207–218

Ford TF, Payne SR, Wickham JEA (1984) The impact of transurethral ureteroscopy on the management of ureteric calculi. Br J Urol 56: 602–603

Huffman JL, Lyon ES, Bagley DH (1985) Transurethral ureteropyeloscopy. In: Bagley DH, Huffman JL, Lyon ES (eds) Urologic endoscopy: a manual and atlas. Little Brown, Boston, pp 185–206

Marberger M, Stackl W (1983) New developments in endoscopic surgery for ureteric calculi. Br J Urol [Suppl on percutaneous renal surgery]: 34–40

Miller RA (1985) Role of endoscopic surgery in the management of renal and ureteric calculi. J R Soc Med 78: 1034–1038

Miller RA (1986) A review of the new methods for the treatment of renal and ureteric calculi. In: Russell RCG (ed) Recent advances in surgery 12. Churchill Livingstone, London, pp 215–230

Miller RA, Payne SR, Wickham JEA (1984) Review of accessories for percutaneous renal surgery. Br J Urol 56: 577–581

Miller RA, Eardley I, Ramsay JWA, Carter S, Wickham JEA (1986) Ureterorenal endoscopy: which instrument, what price? Br J Urol 58: 610–616

Perez-Castro Ellendt E, Martinez Pinero JA (1980) Transureteral ureteroscopy – a current urological procedure. Arch Esp Urol 33: 445–447

Ramsay JWA, Miller RA, Kellett MA et al. (1984) Percutaneous pyelolysis: implications, complications and results. Br J Urol 56: 586–588

*Chapter 4*

# Flexible Cystoscopy

*C. G. Fowler*

## Introduction

The history of urological fibreoscopy is brief. Hopkins and Kapany (1954) were the first to show that an image could be transmitted via a flexible coordinated bundle of glass fibres, using optical principles patented in the 1920s by J. L. Baird (1927). It was quickly apparent that this innovation would revolutionise medical endoscopy. The rigid gastroscope was soon obsolete and the era of gastroenterological fibreoscopy arrived.

In urology, however, the reception was cooler. Fibrelight illumination and the rod lens were already liberating urologists from the tyranny of the old distally illuminated endoscopes, whose basic design dated back to Nitze (1889). The brilliant rod lens telescope, the second of Hopkins' great boons to endoscopy (Hopkins 1959), was the central component of a whole new generation of urological instruments. The far-sighted investigations of Marshall (1964) and of Bush and Whitmore (1967) were not followed up. There seemed to be no obvious place in urology for fibrescopes with their necessarily poorer image quality and limited operative potential.

Tsuchida and Sagawara (1973) reported an early purpose-built flexible cystoscope. Their instrument had a rigid insertion tube but was equipped with a flexible tip. Once in the bladder, the tip was deflected so that the bladder neck could be visualised via a side-viewing objective. Although the views obtained with this instrument were unusual and interesting, no significant use for it was apparent and further development ceased.

It was not until the early 1980s that there was further published work on the subject. Technical improvements in fibrescope construction had answered the need for small-calibre instruments for bronchoscopy and choledochoscopy. Wilbur (1981), Burchardt (1982) and Wagenknecht (1982) demonstrated some of the many uses to which an enterprising urologist might put a choledochoscope with an external diameter of 5 mm. However, the applications which they envisaged were very highly specialised and far too limited in themselves to justify the comparatively high cost of the instrument.

A major disadvantage of the conventional rigid cystoscope is that it is rather uncomfortable to pass under topical urethral anaesthesia. The patient has to lie in the unenviable semilithotomy position while the surgeon performs the procedure between the patient's legs. The tortuous male urethra must be straightened over the instrument. Furthermore, the examination of the bladder may be inadequate, especially where the prostate is enlarged or the pelvic floor stiffened by previous surgery or radiotherapy. Although there are urologists all over the world who are happy to perform rigid cystoscopies under local anaesthesia, their patients are, in the main, less enthusiastic (Fig. 4.1). In the UK, most cystoscopies in men are performed under general anaesthesia, although the chance of finding a lesion which requires endoscopic surgery might be 50% or less. The result is a workload with which many urological departments are unable to keep pace.

By contrast, a fibrescope can be passed under topical urethral anaesthesia as easily as a latex urethral catheter. A pilot study, set up with the cooperation of KeyMed towards the end of 1982, showed that the image quality of the fibrescope was quite sufficient to demonstrate lesions within the bladder, and, when the findings on flexible cystoscopy were checked by rigid cystoscopy, there were few false negatives (Fowler 1984). Similar results were reported from the USA by Clayman et al. (1984). The advantages to the patient in terms of comfort and convenience were immediately evident.

The routine use of the flexible cystoscope to avoid unnecessary general anaesthetics and hospital admissions is attractive in a climate of

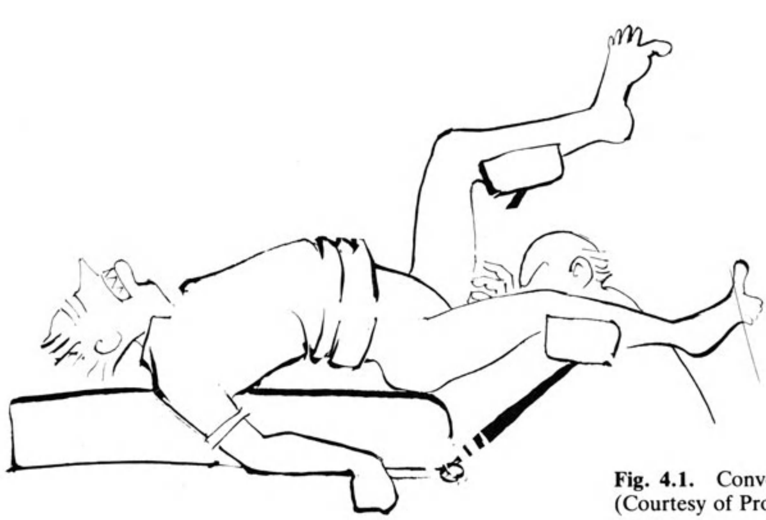


**Fig. 4.1.** Conventional cystoscopy under local anaesthesia. (Courtesy of Prof. J.P. Blandy)

increasing waiting lists and diminishing resources (Fowler et al. 1984). The simple idea that its true place was in the office or outpatient clinic provided a stimulus and justification for the development of flexible cystoscopy which has followed.

## Technique of Flexible Cystoscopy

Before the flexible cystoscopy examination begins, the patient empties his bladder fully. This removes the need to drain the bladder during the examination. The urethra is anaesthetised in the usual way by instilling 15 ml of 1% lignocaine gel. The gel is left in the urethra for a full 5 min before the examination begins.

The patient lies supine during the examination (Fig. 4.2). The operating field is isolated using a perforated water-resisting sheet. With sterile water running through the irrigation channel, the tip of the fibrescope is introduced into the external urinary meatus.

With a male patient the easiest method is for the surgeon to hold the penis between the third and fourth fingers of the non-dominant hand,

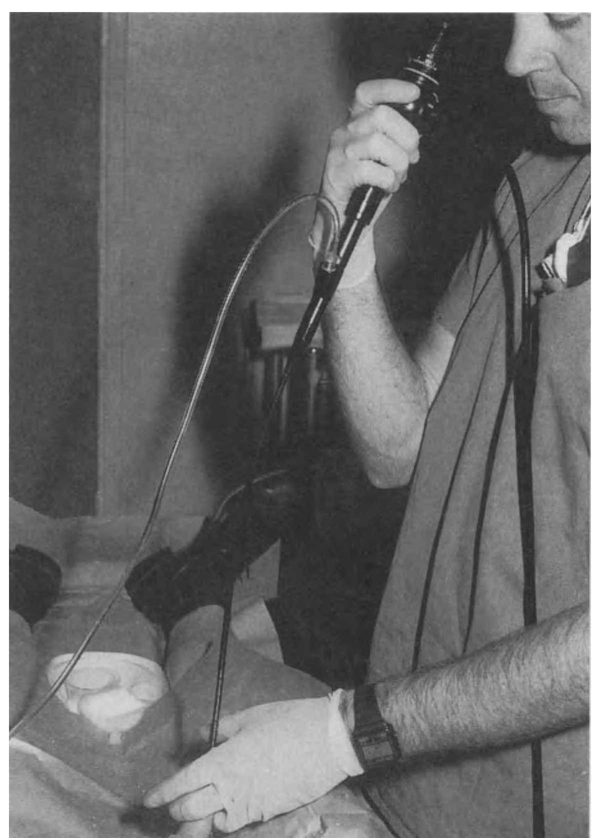


**Fig. 4.2.** Flexible cystoscopy.

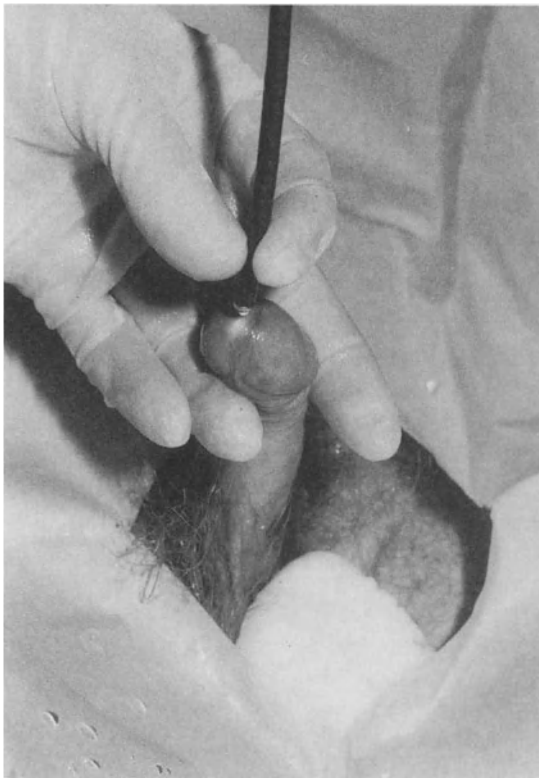


Fig. 4.3. Inserting the tip of the fibrescope into the penis.

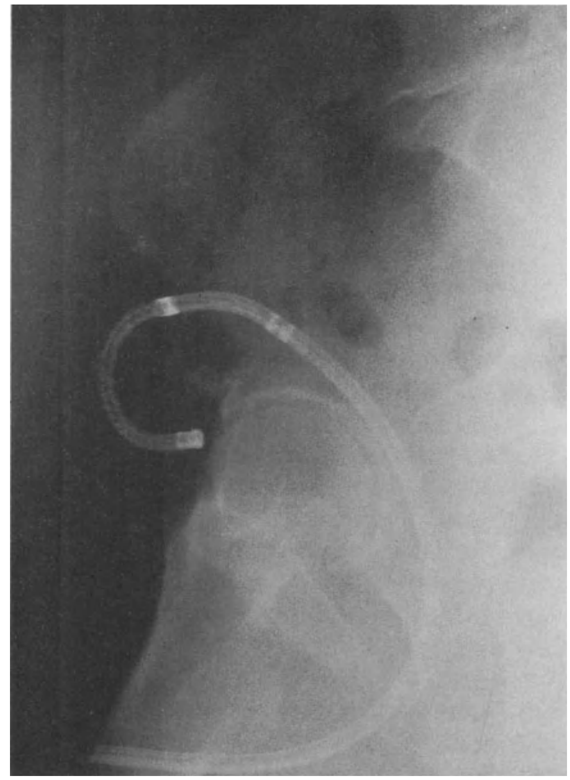


Fig. 4.4. Radiograph of flexible cystoscope performing the "antegrade" manoeuvre.

using the thumb and index to guide the tip of the fibrescope (Fig. 4.3). With a female patient, an assistant holds the eyepiece of the instrument while the surgeon passes the insertion tube into the urethra as if it were a catheter. Once the flexible cystoscope is inserted, the woman can lie comfortably with her hips extended.

The bending section of a flexible cystoscope angulates in a single plane. By a combination of angulation and axial rotation, the objective is easily steered down the male urethra. The external urethral sphincter forms an obstacle to passage of the instrument. The patient is asked to void, the sphincter relaxes and the objective can be guided gently through into the prostatic urethra. Because the tip is steerable, the prostatic urethra can be examined in great detail. The tip of the instrument is then advanced into the bladder.

Once in the bladder, a surprisingly small volume of irrigant has to be instilled to clear the view, usually less than 50 ml. If more is run in, the patient can experience an unpleasant feeling of bladder fullness. If there is blood or debris within it, the bladder can be evacuated by suction. A 50 ml syringe applied to the irrigation channel is suitable for this. However, suction is rarely necessary because the presence of blood or debris usually implies that the patient has a lesion which needs formal cystoscopy under general anaesthesia. Under these circumstances, it is usually wisest to abandon flexible cystoscopy. Suction also carries the disadvantage that the urothelium may be pulled into the open end of the irrigation channel, causing pain.

Examination of the bladder continues in the conventional way by systematic scanning using the ureteric orifices and air-bubble as landmarks. The cystoscopy is completed by deflecting the tip of the instrument from the bladder wall opposite so that the objective looks back at the bladder neck with the insertion tube passing through it (Fig. 4.4). This not only gives an extraordinary antegrade view of the trigone and internal meatus but it also allows the urothelium to be scanned tangentially from the fundus of the bladder.

With experience, a complete examination takes only a minute or two. Moffatt (1985) has emphasised the importance of explanation and reassurance during the procedure. With care and gentleness, it is usually possible to cystoscope even a tense and agitated patient without causing distress.

## Instruments

The basic technique was developed using instruments which had been designed for choledochoscopy and nephroscopy. It was soon clear that improvements were needed to provide an instrument properly suited to the special needs of flexible cystoscopy (Fowler et al. 1984; Powell et al. 1984). Several prototypes have been tested to establish optimum dimensions and bending section geometry for a dedicated flexible cystoscope (Fig. 4.5).

If the overall length of a flexible cystoscope is too long, the insertion tube may be difficult to control. Conversely, if the overall length is too short, the operator will have to stoop to carry out the examination and this will be unnecessarily uncomfortable for him.

The ideal length for the insertion tube will depend on the anthropometrics of the lower urinary tract. Measurements in patients have shown that to achieve the antegrade bladder neck view where the cystoscope is inserted to its fullest extent, an insertion tube of at least 300 mm is necessary. This presupposes a maximum tip angulation of 180° and may be reduced slightly if a passive bending section is included in the design.

By increasing the external diameter of the insertion tube to 6 mm, a larger irrigation/instrument channel of 2.6 mm can be accommodated. The result is a considerable increase in the rate of irrigant flow. However, the larger calibre instrument may cause more patient discomfort, and the increased flow rate is still insufficient to allow easy drainage of urine through the instrument. A larger irrigation channel can occasionally be a help when fluid flow is required during instrumentation. However, this is rare. In general, the smaller calibre (4.5–5 mm) prototypes tested have been easier to use and more comfortable for the patient.

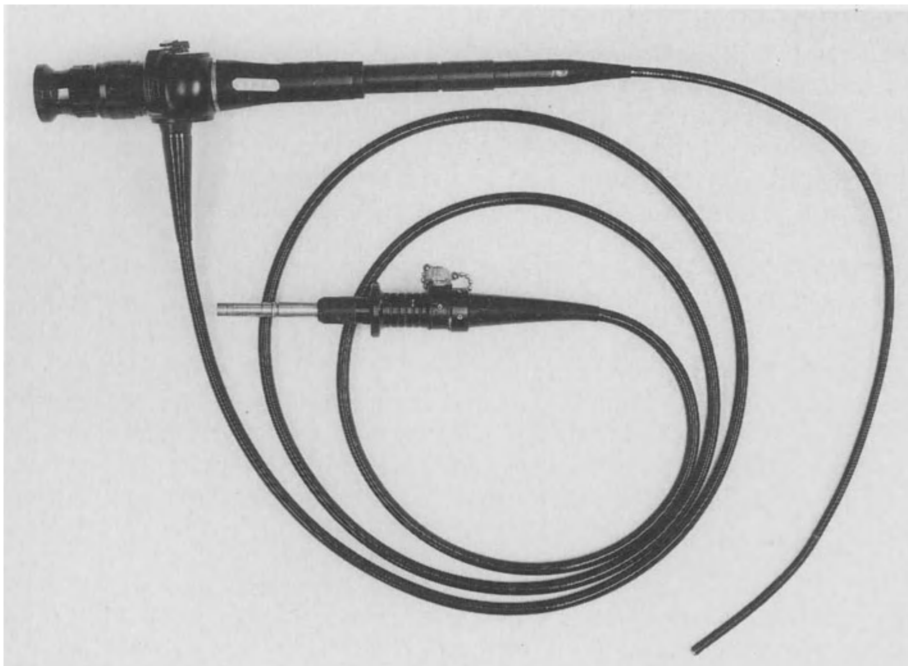


**Fig. 4.5.** A flexible cystoscope. (Courtesy of Olympus Pty)

When a fibrescope is inserted into the bladder, the insertion tube is usually held tightly by the structures of the bladder neck. The geometry of the bending section will determine the amount of access and the closeness to which the bladder wall can be approached by the objective. Choledochoscopes and nephroscopes have a short bending section which angulates in a tight curve. This permits them to operate within confined spaces. Within the bladder, a short, tight bending section is a liability because the objective can be moved close up against only a restricted region of the bladder wall (Fig. 4.6). Consequently, the flexible cystoscope needs a longer bending section with a much less tight radius of bending. This may have advantages in terms of the longevity of the

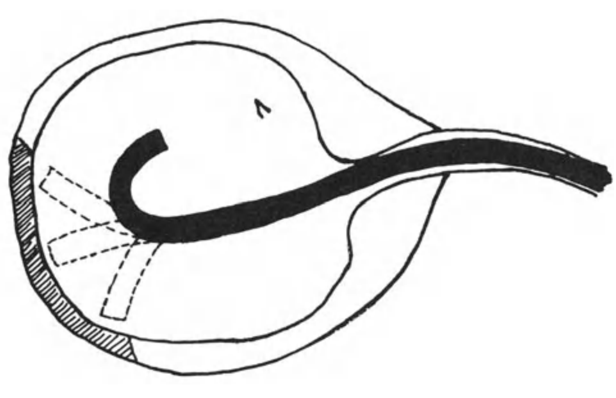


**Fig. 4.6.** A short, tight bending section allows only a small area of the bladder wall to be examined closely.

instrument because this configuration causes less stress to the fibre bundles and control wires.

## Sterility

Fibrescopes are delicate instruments which are unable to withstand sterilisation by the low-pressure steam used for rigid endoscopes. Ethylene oxide exposure, while effective, takes too long, so chemical disinfection with 2% activated glutaraldehyde has been the sterilisation method of choice. The reagent is highly irritant and must be carefully rinsed from the instrument and irrigation channel before the instrument is used.

Unfortunately, there is little clear evidence as to the length of glutaraldehyde exposure which is necessary for 100% kill of urinary tract pathogens (Babb et al. 1981). A policy of immersion of a clean instrument for 10 min before use has been adopted. Culture of postoperative midstream urine specimens has failed to show evidence of cross-infection between patients. Where mycobacterial contamination is suspected, longer immersion times have recently been advised (DHSS 1986). Further studies of infection after flexible cystoscopy are in progress.

## Clinical Application

Since 1982, when flexible cystoscopy was introduced at The London Hospital, nearly 5000 examinations have been performed. During this period, indications for flexible cystoscopy have widened so that all diagnostic cystoscopies in both sexes are performed by fibrescope unless:

1. There is a strong patient preference for general anaesthesia.
2. There is definite preoperative evidence of a lesion which will require a general anaesthetic for endoscopic treatment.
3. There is blood, debris etc. in the urine which will obscure the view.
4. A bimanual examination under anaesthetic is considered essential.

Tables 4.1 and 4.2 show the indications and outcome of 1205 flexible cystoscopies performed since these guidelines for selection were established. Exclusion of patients inappropriate for flexible cystoscopy and increasing experience with the technique have resulted in a very low rate of technical failure.

Fibrescopes are expensive to buy and maintain. Because they are relatively fragile, they need careful handling by properly trained staff. The most common problem has been with fluid leakage into instruments during disinfection when a non-immersible choledochoscope was inad-

**Table 4.1.** Indications for 1205 outpatient flexible cystoscopies

| | |
|---|---|
| Check cystoscopy for superficial bladder cancer | 470 (39.0%) |
| Investigation of haematuria | 313 (26.0%) |
| Outflow symptoms | 230 (19.1%) |
| Pain and symptoms of bladder irritation | 152 (12.6%) |
| Others | 40 ( 3.3%) |

**Table 4.2.** Outcome of 1205 outpatient flexible cystoscopies

| | | |
|---|---|---|
| No lesion found and no further procedure indicated | | 818 (67.9%) |
| Further procedure under the same LA: | | 110 ( 9.1%) |
| Urethral dilatation | 46 | |
| Biopsy | 17 | |
| Retrograde ureterogram | 12 | |
| Laser coagulation | 35 | |
| Procedure under GA indicated | | 248 (20.6%) |
| Unsatisfactory examination: | | 29 ( 2.4%) |
| Pain | 10 | |
| Poor view | 18 | |
| Anatomical difficulty | 1 | |

LA, local anaesthetic; GA, general anaesthetic.

vertently soaked without its protective devices being properly fitted. This difficulty has been resolved by the introduction of fully watertight instruments which do not need special protection before immersion. As yet, it is not possible to say what the working lifetime of a flexible cystoscope will be since no individual instrument has yet been worked to destruction.

## Instrumentation

A number of procedures can be performed under local anaesthesia using instruments passed down the instrument channel of the fibrescope. The flexible cup biopsy forceps can provide surprisingly deep specimens, including muscle. However, the samples are very small, and it is usually advisable to take several specimens from a single lesion. Cannulation of the ureter for retrograde ureterography is usually easy unless the trigone is badly distorted by an enlarged prostate (Fig. 4.7). Recently, the removal of double-J stents has been much simplified by using the flexible cystoscope. A nylon loop is used to snare the free end of the stent where it protrudes from the ureteric orifice.

Electrohydraulic lithotripsy in the bladder has been less satisfactory under local anaesthesia. Two attempts to fragment bladder stones in patients who could not tolerate a general anaesthetic failed because the patients found it uncomfortable when the electrohydraulic discharges were powerful enough to disrupt the stone. Stones lying free within the bladder tend to be blown away from the electrode by the force of the shock wave and it is difficult to break them up.

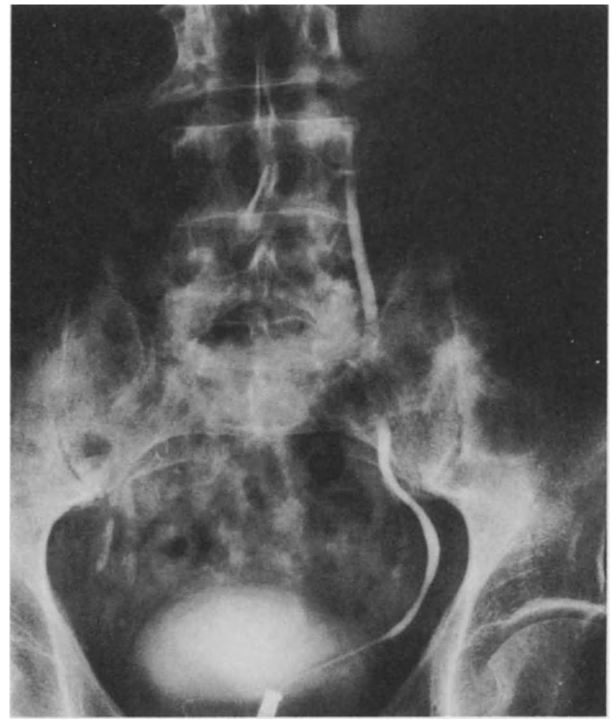


**Fig. 4.7.** Retrograde ureterography under local anaesthesia.

## Intravesical Chemotherapy

The flexible cystoscope provides a simple means to monitor the response to treatment with intravesical chemotherapeutic agents. In a recent trial, for instance, interferon was used to treat patients with superficial bladder cancer (Oliver et al. 1986). The agent was administered via the irrigation channel of a flexible cystoscope so that the state of the bladder could be assessed both visually and by biopsy as the trial progressed.

## Laser

One of the claims for neodymium-YAG laser destruction of bladder tumours is that the procedure is painless (Hofstetter et al. 1981). To date, 45 small (diameter <0.75 cm) recurrent bladder tumours in 35 patients have been treated at The London Hospital by neodymium-YAG laser irradiation delivered via a 0.6 mm irrigant-cooled quartz fibre passed through the instrument channel of a flexible cystoscope. Topical urethral anaesthesia with lignocaine was supplemented where necessary with a small dose of intravenous benzodiazepine. The patients were questioned carefully about the pain they experienced during treatment, and the effectiveness of tumour eradication was assessed by follow-up flexible cystoscopy at 1 month and subsequently.

When care was taken to avoid excessive accumulation of heat in the bladder wall, the laser caused no more than a suprapubic burning discomfort, but in two patients treatment was abandoned because of pain. The laser was easy to direct through the fibrescope, though the stiffness of the quartz fibre tended to restrict full flexion of the bending section, making access to some tumours more difficult. This problem has been surmounted by using a less stiff 0.4 mm laser guide.

Follow-up cystoscopy revealed a sharply demarcated ulcer at the site of laser irradiation. In patients who had tolerated treatment, there was complete local tumour destruction, except for one patient treated early in the series.

When patients with superficial bladder cancer are followed by regular check cystoscopy, recurrent tumours are usually small at the time of diagnosis. The number of patients suitable for laser treatment is therefore large, and there is clearly a significant potential saving in cost if they can avoid general anaesthesia and/or hospital admission. It remains to be seen whether such a saving is sufficient to offset the present high capital cost of the laser.

## Conclusion

Flexible cystoscopy has claims to be a significant advance in urological endoscopy on both humanitarian and economic grounds. The major stimulus to the development of the method and instrumentation came from the idea that it would allow painfree diagnostic cystoscopy under topical anaesthesia. That urologists have begun to appreciate the new technique is evident from the dramatic increase in sales of the purpose-designed flexible cystoscopes which are now available. Fibreoscopy requires new skills which take time to learn. As more surgeons become expert with the instruments, the pace of development will increase and the full potential of urological flexible endoscopy will be realised.

## References

Babb JR, Bradley CR, Deverill CEA, Ayliffe GAJ, Melikian V (1981) Recent advances in the cleaning and disinfection of fibrescopes. J Hosp Infect 2: 329–340

Baird JL (1927) British patent specification no. 20 969/27. HM Patents Office

Burchardt P (1982) The flexible panendoscope. J Urol 127: 479–481

Bush IM, Whitmore WF (1967) A fibreoptic ultraviolet cystoscope. J Urol 97: 156–157

Clayman RV, Reddy P, Lange PH (1984) Flexible fibreoptic and rigid-rod lens endoscopy of the lower urinary tract: a prospective controlled trial. J Urol 131: 715–716

DHSS (1986) Disinfection of endoscopes potentially contaminated with *Mycobacterium* species. (Safety information bulletin no. 28, May 1986)

Fowler CG (1984) Fibrescope urethrocystoscopy. Br J Urol 56: 304–307

Fowler CG, Badenoch DF, Thakar DR (1984) Practical experience with flexible cystoscopy in outpatients. Br J Urol 56: 618–621
Hofstetter AG, Frank F, Keiditsch E, Bowering R (1981) Endoscopic neodymium: YAG laser application for destroying bladder tumours. Eur Urol 54: 421–426
Hopkins HH (1959) British patent specification no. 954629. HM Patents Office
Hopkins HH, Kapany NS (1954) A flexible fibrescope using static scanning. Nature 173: 39–41
Marshall V (1964) Fibre optics in urology. J Urol 91: 110–114
Moffatt P (1985) A revolution in urology? Nurs Times 16 Oct: 30–31
Nitze M (1889) Lehrbuch der kystoscopie. JF Bergmann, Wiesbaden
Oliver RTD, Waxman JH, Kwok H, Fowler CG, Matthewman P, Blandy JP (1986) Alpha interferon for non-invasive bladder cancer. Br J Cancer 53: 432
Powell PH, Manohar V, Ramsden PD, Hall RR (1984) A flexible cystoscope. Br J Urol 56: 622–624
Tsuchida S, Sagawara H (1973) A new flexible cystoscope for visualisation of the bladder neck. J Urol 109: 803–804
Wagenknecht LV (1982) Inspektion der Harnwege mit flexiblen Instrumenten. Urologe 21: 112–114
Wilbur HJ (1981) The flexible choledochoscope: a welcome addition to the urologic armamentarium. J Urol 126: 380–381

*Chapter 5*

# Endoscopic Treatment of Vesicoureteric Reflux

*B. O'Donnell and P. Puri*

## Introduction

Vesicoureteric reflux is a common problem and has been shown to be present in 30%–50% of children with urinary tract infection (International Reflux Study Committee 1981). Severe vesicoureteric reflux is recognised as an important cause of end-stage chronic renal failure in early adult life (Bailey 1981; Bailey and Lynn 1984). The management of reflux is in itself controversial. It is widely agreed that reflux in undilated ureters (grade I or II in the international classification) disappears over a period of years in more than 80% of ureters (Edwards et al. 1977), though a small proportion of these kidneys may develop scarring during the regression. Until recently, patients with these lesseer degrees of reflux were managed by continuous low-dose chemoprophylaxis until the reflux had disappeared. On the other hand, higher grades of reflux in whom ureteral and pelvicalyceal dilatation is present (grades III, IV and V in the international classification) are less likely to cease refluxing spontaneously (International Reflux Study Committee 1981).

Moderate reflux (grade III in the International Classification) is controversial. Many would claim to treat such cases conservatively, but they figure largely in any published operated series. Severe vesicoureteric reflux (grade IV/V in the international classification), recurrent urinary infections while taking antimicrobial therapy ("break-through infections") and non-compliance with medical management are generally taken as indications for surgery.

Many open antireflux operations have been invented over the last 30 years, and the majority are successful in eliminating reflux. The two most commonly used are the Leadbetter–Politano technique (Politano and

Leadbetter 1958) of transvesical reimplantation of the ureters and Cohen's transtrigonal advancement technique (Cohen 1975). A success rate of 95% or more has been reported in eliminating reflux using various antireflux procedures. Few authors make any distinction between the various grades of reflux in reporting their results, and many who have been able to show 95% (and upwards) success rate do not make adequate distinction between patients with dilated ureters and those without such ureterectasia. The success rate in some reports is boosted by including the results of surgery in lower grades of reflux, and even the results of reimplanting non-refluxing ureters, where the indication for intervention has been on the contralateral side. This tactic dilutes disasters in a tidal wave of normality.

Postoperative ureterovesical obstruction is probably under reported. This is a particular hazard in thick-walled or neuropathic bladders. If the ureters are obstructed the patient is worse off than if he/she did not have any surgery, as silent destruction of renal tissue may occur. The Cohen reimplant is less likely to become obstructed than most of the other techniques, but the price paid is the relative inaccessibility of the ureteric orifice should any diagnostic or therapeutic intervention be subsequently required.

A further criticism of the various operations is that in the follow-up most surgeons perform a single micturating cystourethrogram at 3 or 6 months after surgery and if this is satisfactory it is not repeated. The test is an uncomfortable one and is avoided by patients and surgeons alike, but a realistic follow-up should include a micturating cystourethrogram 5 or 10 years following intervention. Such a routine would provide a number of surprises. This has happened in our own experience and in dealing with referred patients from other operators.

## Endoscopic Correction

The biggest trend in surgery today is towards endoscopic work. This has been particularly so in urology, where most prostatic and bladder conditions as well as intrarenal problems are being treated endoscopically. It was this trend that gave us the impetus to explore endoscopic correction of vesicoureteric reflux. The main anatomical abnormality in primary vesicoureteric reflux is deficiency or absence of the longitudinal muscle under the submucosal ureter. During filling and micturating the rise in intravesical pressure results in upward and lateral displacement of the ureteric orifice, reducing the length and obliquity of the intramural ureter. We began with the concept of putting something solid under the affected ureteric orifice to produce a support behind the refluxing intravesical ureter. We were also anxious to anchor the ureter to prevent it sliding upwards and laterally during the high intravesical pressure phases. A review of the literature revealed that there were many references to the use of Mentor Polytef paste in laryngology and urology (Arnold 1963; Lewy 1976; Politano 1982; Schulman et al. 1984;

Vorstman et al. 1985). We were impressed by the qualities of this material (polytetrafluoroethylene) and encouraged by the lack of tissue reaction, particularly in the sensitive area of the vocal cord.

The next step was to produce vesicoureteric reflux experimentally. We induced vesicoureteric reflux in piglets and then corrected it by the intravesical subureteric injection of the paste (Puri and O'Donnell 1984). Gross examination of the vesicoureteric region showed a well-circumscribed subureteric Polytef mass of firm consistency retaining its shape and position at the site of injection. Histological examination of the Polytef implant showed encapsulation by a thin layer of fibrous tissue. This provides a firm anchorage for the submucosal ureter and prevents it from sliding upwards and outwards during micturition. Moreover, it forms a floor against which the roof of the ureter can be compressed, it narrows the orifice without interfering with compliance and it produces a terminal "swan neck", all of which help to reduce reflux. We subsequently used this technique to treat primary and secondary vesicoureteric reflux in children.

## Technique: *S*ubureteric *T*eflon *Inj*ection (The Sting)

The injection of Polytef paste is carried out with a 5 FG nylon catheter onto which is swaged a 21 gauge needle with 1 cm of the needle protruding from the catheter. There is now such a needle made to our design by Karl Storz (27291 PURI). The catheter is introduced through a 14 F cystoscope. It is important to pass the catheter with the telescope removed, and only when the catheter comes through at the distal end of the cystoscope should the needle be inserted. The procedure is best carried out with the bladder almost empty. Under direct vision through the cystoscope the needle is introduced under the bladder mucosa at the 6 o'clock position 3–4 mm below the affected ureteric orifice. It is advanced about 5 mm into the space behind the submucoasal ureter and 0.3–1.0 ml of Polytef paste is injected using a 1 ml syringe with a metal sheath and piston (Karl Storz, Cat. 27200Q). The paste is put into the lamina propria between the bladder mucosa and the muscle. Recently, we have used a specially designed instrument made by Richard Wolf (Cat. 8625.31), "The Stinger", through which a rigid needle 5 FG with a 21 gauge tip is used for the injection. The paste is particularly viscid, and the high-pressure injector (Karl Storz, Cat. 27200) made for laryngology is useful. The use of a prepositioned ureteric catheter or Fogarty catheter has improved our placement of the paste in patients with large ureteric orifices. The catheter is left in situ until the injection is almost complete. The catheter is then withdrawn and the injection completed. A correctly placed injection creates the appearance of a nipple, on top of which is a slit—like an inverted crescentic orifice. This provides a firm hump against which the ureteric orifice may be compressed with rising intravesical pressure. It angles and narrows the orifice making it less likely to fall open. The uninjected roof retains its compliance while preventing reflux.

There has been no evidence of abscess formation or extrusion through the intact mucosa. Some paste may escape through a needle hole, and multiple punctures, particularly punctures of the ureter, should be avoided. Bleeding at the injection site has not been a problem. Initially, efforts were made to wash any excess paste out of the bladder, but as both the glycerine and the Polytef particles are themselves lubricants we no longer do this. We are now injecting more paste than we did in the early days, when we were concerned about the possibility of severe tissue reaction and also the possibility of circumureteric fibrosis. This has not occurred.

In two cases known to us an exaggerated response to the paste has taken place. This spread out laterally into the bladder wall, but the antireflux effect was maintained without causing obstruction. The decision to increase the paste dosage was taken because the paste is 50% glycerine, which is absorbed rapidly from the injection site. This means that the hump created by the injection becomes smaller, possibly within a week of the injection. Consequently, we now inject slightly more paste than appears absolutely necessary and we also wait for 3 months before a post-injection micturating cystogram. The maximum amount of Polytef paste injected subureterically in our cases has not exceeded 1.2 ml. Patients may be discharged from the hospital within 24 h, and a majority have been done as day cases. Co-trimoxazole is prescribed for 2 weeks following the procedure. In earlier cases a micturating cystogram was carried out on the same or the following day. Schulman carries out the procedure under fluroscopic control (C. C. Schulman 1986, personal communication). When he feels he has a good visual effect from the injection he does a cystogram under general anaesthetic to check the immediate position. In our experience, the micturating cystourethrogram is best deferred for 3 months. If there is any concern about obstruction, an ultrasound examination of the kidneys may be carried out sooner. A follow-up micturating cystogram, with an ultrasound or intravenous urogram, are obtained at 12 months.

## The Paste

Polytef paste is a suspension of biologically inert polytetrafluorethylene particles in glycerine. Glycerine comprises 50% of the paste by weight. Following injection of Polytef paste, glycerine is absorbed into the tissues and the Polytef implant achieves a firm consistency, retaining its shape and position at the injection site encapsulated by a thin fibrous layer. Injection of Polytef paste has been used since 1961 by laryngologists to enlarge displaced or deformed vocal cords in patients with dysphonia (Arnold 1963; Lewy 1976). It has been used by urologists to treat urinary incontinence (Politano 1982; Vorstman et al. 1985). No untoward side effects from the laryngological or urological use of Polytef paste have been reported in humans to date.

Recently, Malizia et al. (1984) have reported that periurethral injection of Polytef paste in continent animals was associated with distal migration of Polytef particles from the injection site. Politano, who has pioneered the use of polytetrafluoroethylene in the treatment of urinary incontinence, has not observed a single case of significant clinically documented embolisation following injection of 10–20 ml of Polytef paste periurethrally in 300 patients since 1964 (Vorstman et al. 1985). Using light and electron microscopy we failed to show evidence of migration of Polytef particles in animals followed for 3–15 months after subureteric injection of 0.1–0.4 ml of Polytef paste (unpublished data).

In our patients the amount of Polytef paste injected is so small that significant migration appears unlikely. If, on the other hand, migration of Polytef particles to regional lymph nodes does occur, it does not seem to cause any harm to the patient. The track record of the substance in laryngology and urology during the past 20 years cannot be overlooked.

**Table 5.1.** Results of endoscopic treatment of vesicoureteric reflux in 120 ureters

| | No. of ureters |
|---|---|
| Cessation of reflux after single injection of Polytef | 91 |
| No. requiring second injection for correction of reflux | 11 |
| No. requiring third injection for correction of reflux | 2 |
| No. requiring fourth injection for correction of reflux | 1 |
| Grading of reflux improved after first injection | 11 |
| No change in the grade of reflux after Polytef injection | 3 |
| Reflux deteriorated after first injection | 1 |

## Results

Table 5.1 shows the results of endoscopic correction of reflux in 120 ureters. A total of 54 patients with 83 refluxing ureters have now been followed up for periods ranging from 3 to 18 months (mean 7 months). All 54 patients had a negative micturating cystogram following endoscopic correction of reflux and have had a follow-up micturating cystogram. Of these patients, 41 have also had a follow-up intravenous urogram. There was no vesicoureteric reflux in 68 ureters. There was a recurrence of reflux in 12 (15%) and contralateral vesicoureteric reflux in 3. Of the 12 patients in which recurrence of reflux occurred, five ureters had grade I, four ureters had grade II and three ureters had grade III reflux (international classification). Recurrence of reflux is attributed to early technical difficulties and to insufficient amounts of Polytef paste used in earlier cases. Later papers (O'Donnell and Puri 1986a,b) give further details of results.

We subsequently separated out those ureters with grade IV and V reflux (international classification). While these showed a higher initial failure rate and a higher relapse rate, 80% were satisfactorily treated by injection, which was repeated if necessary. The one serious failure area has been reflux into duplex systems, where the results have been disappointing (33% success rate). Technical modifications are in progress.

The procedure has been successfully used in neuropathic bladders, mainly in patients with spina bifida (Puri and Guiney 1986). It may be difficult to find the ureteric orifices in a trabeculated succulated bladder. Once found they should be catheterised and the catheter left in situ during the injection.

## Complications

The only complications of significance have been an initial failure to correct the reflux and subsequent relapse of reflux. These problems have become less with more accurate placement of the paste and with increased dosage. Both problems are treated by reinjection.

Significant obstruction of the ureter has occurred in one patient with a neuropathic bladder and a high intravesical pressure. Sustained obstruction has not been a problem. Some patients have developed temporary nephralgia for up to 14 days following large injections (up to 1.2 ml). Ultrasound examination of the kidneys has shown some hydronephrosis in these patients. The nephralgia has disappeared and the hydronephrosis has regressed in every case. The rapid absorption of the glycerine in the paste is the likely mechanism in the relief of the obstruction.

If the obstruction were sustained we would pass one or two ureteric catheters into the affected orifice for 24–48 h. (A colleague has successfully done this in one of his cases.) A meatotomy of the ureteric orifice over an indwelling ureteric catheter could be performed if obstruction persisted. We have not had to do this.

## Summary

Our procedure has been in use for more than 3 years at the time of writing. It is safe, straightforward and effective. It needs care and attention to pinpoint the exact spot for injection. It avoids open operation. There have been no local or general complications. The only real problems have been failure of the first, and occasionally of the second, injection to stop reflux. The best results have been in patients where the terminal ureter has been raised and narrowed to produce a nipple-like appearance, on the top of which is an inverted crescentic ureteric orifice. The absence of any sustained obstruction in treating the primary refluxing ureter makes this form of management unique.

# References

Arnold GE (1963) Alleviation of aphonia or dysphonia through intrachordal injection of Teflon paste. Ann Otol Rhinol Laryngol 72: 384–395
Bailey RR (1981) End-stage nephropathy. Nephron 27: 302
Bailey RR, Lynn LK (1984) End-stage reflux nephropathy. Contrib Nephrol 39: 102–110
Cohen SJ (1975) Ureterozystoneostomie: eine neue antireflux Technik. Aktuel Urol 6: 1–9
Edwards D, Normand ICS, Prescod N, Smellie JM (1977) Disappearance of vesicoureteric reflux during longterm prophylaxis of urinary tract infection in children. Br Med J II: 285–288
International Reflux Study Committee (1981) Medical versus surgical treatment of primary vesicoureteral reflux. Pediatrics 67: 392–400
Lewy RB (1976) Experience with vocal cord injection. Ann Otol Rhinol Laryngol 85: 440–450
Malizia AA, Reiman HM, Myers RP et al. (1984) Migration and granulomatous reaction after periurethral injection of Polytef (Teflon). JAMA 251: 3277–3281
O'Donnell B, Puri P (1986a) Endoscopic correction of primary vesicoureteric reflux. Br J Urol 58: 601–604
O'Donnell B, Puri P (1986b) Endoscopic correction of primary vesicoureteric reflux: results in 94 ureters. Br Med J 293: 1404–1407
Politano VA (1982) Periurethral polytetrafluoroethylene injection for urinary incontinence. J Urol 127: 439–441
Politano VA, Leadbetter WF (1958) An operative technique for the correction of vesicoureteric reflux. J Urol 79: 932–941
Puri P, Guiney EJ (1986) Endoscopic correction of vesicoureteric reflux secondary to neuropathic bladder. Br J Urol 58: 504–506
Puri P, O'Donnell B (1984) Correction of experimentally produced vesicoureteric reflux in the piglet by intravesical injection of Teflon. Br Med J 289: 5–7
Schulman CC, Simon J, Wespes E et al. (1984) Endoscopic injections of Teflon to treat urinary incontinence in women. Br Med J 288: 192
Vorstman B, Lockhart J, Kaufman M et al. (1985) Polytetrafluoroethylene injection for urinary incontinence in children. J Urol 133: 248–250

Section III

# Ureter

# Introduction

*W. K. Yeates*

Major controversies in urology such as indications for radical prostatectomy for carcinoma do not have quite their equal in disorders of the ureter, but there are many conditions and clinical situations in which there is doubt and disagreement about the cause of symptoms or the best policy of management. At a basic level, what is the mechanism of the production of ureteric colic, spasm or distension? Is reference of pain to the "testis" anything to do with stimulation of the genitofemoral nerve by the ureter? In acute ureteric obstruction should fluid intake be increased, or is it better to reduce the pressure on the kidney by fluid restriction, even by the administration of an antidiuretic such as DDAVP? Provided that the patient is not, for example, an airline pilot, or is planning to be far from urological services, how long should a calculus causing no symptoms and no obstruction and without infection be left in the ureter? What should be the attitude to calculus extraction in the presence of various degrees of active urinary tract infection?

Endoscopic management of ureteric calculi has rapidly become the accepted preferred approach for most cases, with a natural, forecastable polarisation of upper ureteric calculi being managed from above and lower ureteric calculi from below. Problems of failure to reach or to extract the calculus or, of much more importance, problems arising from injuring the ureter by instrumentation are not insignificant but overall they compare favourably with the different complications of open ureterolithotomy.

The indications for active interference in a particular case of ureteric calculus are influenced by the availability of an appropriate operating ureteroscope and the associated experience of the urologist. On a minor point, the decision as to whether or not the ureteric orifice should be dilated largely depends on the type of beak on the particular ureteroscope. The selection of techniques of actual extraction (by forceps or basket) and fragmentation (by electrohydraulic, ultrasound or laser probes) are currently being assessed.

During the expansion of these experiences in the endoscopic management of ureteric calculi, there are controversies to be resolved within each learning urologist as well as among colleagues! The proportion of cases of ureteric calculi being treated conservatively is certainly falling. How much is this increased intervention a measure of excessive enthusiasm arising from advances in technology—an example of feasibility versus advisability? When ureterolithotomy is required, particularly in an infected case, should the ureter be left unsutured with an effective tissue drain to the site; or should it be intubated, with a cutaneous ureterostomy, or with drainage into the bladder? In renal tuberculosis with manifest involvement of the ureter, should chemotherapy be combined with steroid therapy, or only if manifest obstruction develops?

Opinions on the management of idiopathic retroperitoneal fibrosis range from immediate ureterolysis alone to steroid therapy alone, preceded, if necessary, by percutaneous nephrostomy. Some advise bilateral ureterolysis via an anterior transperitoneal approach. Others find two extraperitoneal loin incisions allow easier exposure of the dilated ureters above the obstruction. If carried out with great care, ureterolysis very rarely injures the ureter, which raises the question, does the fibrosis ever involve the wall of the ureter itself? With the advent of self-retaining (pigtail) silicone ureteric stents a new approach of long-stay ureteric intubation combined with steroid therapy is a natural development. But how long should intubation and the steroid therapy be continued? The rarity of recurrence of retroperitoneal fibrosis after ureterolysis without steroids, and the usual spontaneous subsidence of the raised ESR, have never been satisfactorily explained.

In severe structural lesions of the lower pelvic ureter with obstruction, or fistula, or both, there is little controversy about the indications for reimplantation into the bladder by some means. There may be some difference of opinion about the timing of the procedure, but only wound infections, excessive radiation reactions and the patient's poor general condition are real contraindications to early intervention. To these, in contrast, should be added, the policy of routine surgical closure, which pre-empts the spontaneous closure of a ureterovaginal fistula—a rarity but a reality in "clean" cases without obstruction.

Although there are certainly exceptions, operative injury to the lower end of the ureter frequently results in a deficiency which would allow simple direct reimplantation without tension only at the sacrifice of an adequate antireflux procedure. In these cases reimplantation by either a psoas hitch or Boari flap procedure is clearly indicated. Which, if either, procedure is the better, is a matter of controversy in most cases. However, in the rare case of excision of the lower pelvic ureter for tumour, a direct (with or without a psoas hitch) reimplantation will allow much easier cystoscopic follow-up surveillance than after a Boari flap.

Mobilisation of the bladder, a psoas hitch, and the construction of a Boari flap are, fortunately, facilitated by the thinner wall and larger bladder capacity in the female. However, in many males, but also in tuberculosis and in some Bilharzial cases, the bladder capacity may be so reduced or the bladder so thick walled that the construction of an antireflux mechanism is prevented.

The length of deficiency in the lower ureter which can be bridged by a psoas hitch or a Boari flap depends on the bladder and the experience of the surgeon. In lesions considered to be too high for direct reimplantation the choice lies between reconstruction, transuretero-ureterostomy, ureter replacement procedures and renal autotransplantation.

Opinions, and experience which might alter opinions, vary considerably and obviously influence decisions on which are the best possible methods of reconstructing the ureter. The necessary conditions for segmental resection and anastomosis—clear visualisation, certain viability of both ends, and the absence of tension—are fulfilled in only a few clinical situations, such as operative transection at the pelvic brim (without previous irradiation), some localised higher Bilharzial strictures and a short, benign polyp-bearing segment in the upper ureter. Very few urologists have significant experience of the Davis-type ureterotomy with intubation and omental wrapping or patch grafting on an omental base and would feel much more confident with alternative procedures.

Transuretero-ureterostomy is an excellent operation for a mechanical injury of the lower ureter but is not desirable in cases of calculus or urothelial tumour, or when there is a significant possibility of a subsequent lesion in the pelvis from radiation or recurrent growth affecting the lower common ureter. Both ileal replacement of the ureter and renal autotransplantation in appropriate cases are invaluable, but they are such major procedures that it is questionable whether either is justifiable when the opposite kidney is normal and is likely to remain so, and especially if the function of the affected side is equivocal. Even when the ureter itself is normal, the addition of a full-length ileal ureter from the renal pelvis and/or lower calyx is an excellent operation for recurrent renal calculi in a well-functioning kidney when the opposite kidney is not normal. This ileal stone chute originally described by Willard Goodwin seems to be a neglected procedure. Renal autotransplantation would not seem to be as reasonable a procedure as ileal replacement in calculus cases, from both the infective and calculus recurrence aspects. Its place in the management of ureteric lesions makes an interesting topic for debate.

Reimplantation of the ureter for reflux is much less frequently performed than it was a few years ago. Which are the most reliable residual indications for reimplantation: The degree of reflux on screening of the site? The situation of the ureteric orifice and/or its appearance on cystoscopy? To what extent are radioisotope and urodynamic investigations important guides for operative interference?

Should a symptomless megaureter with normal calyces be reimplanted into the bladder, or should this be done only when there are dilated calyces? Is ureteric activity on screening a guide to the operative procedure required? How much, if any, tailoring is required? Is tailoring indicated by the degree of dilatation or only by the tortuosity of the ureter?

Aortoiliac reconstructions with Dacron replacements may occasionally result in ureteric obstruction. Should the ureter be divided and reanastomosed anterior to the graft? As there is danger to both the ureter and to the vessels of a subsequent ureteric fistula in the presence of synthetic material, it is probably much more advisable to take down and reconstruct the graft behind the ureter.

These are but some examples of clinical situations where carefully considered opinions on the management of ureteric disorders still differ. While there are no raging controversies in ureteric surgery, there are sufficient points of variance to enliven many a urological meeting for the foreseeable future. These controversies are discussed in this section, which is concerned with the ureter, and in the sections which deal with endoscopic innovations (Section II) and paediatrics (Section IX).

*Chapter 6*

# Transuretero-ureterostomy

*J. C. Smith*

## Definition

The operation of transuretero-ureterostomy (TUU) is usually taken to mean the anastomosis of one ureter to its fellow across the midline. However, it can be used to describe the anastomosis of two elements of a duplex system or the joining of two ureters as part of a urinary diversion, either with a bowel conduit or a cutaneous ureterostomy (Fig. 6.1).

## Indications

The operation is indicated where the function of the lower end of one ureter is compromised and where reimplantation of that ureter into the bladder is technically difficult. The other ureter should, in most cases, be normal or at least have good drainage into the bladder with no obstruction and preferably no vesicoureteric reflux.

The most common indication for operation is when a ureter has been damaged by a surgical procedure with resulting ureteric obstruction or fistula formation. However, tumours obstructing the ureter, either primary ureteric tumours or other tumours invading the ureter, may constitute an indication for the procedure.

Although not commonly performed, the operation is simple and successful and should be part of every urologist's surgical armamentarium. One of the chief obstacles to be overcome is concern over damage to the contralateral (normal) ureter, but the reported results show this rarely occurs and it should only be a minor cause for concern. Certainly the end results amply justify the use of this procedure which should probably be used more frequently than it is at present.

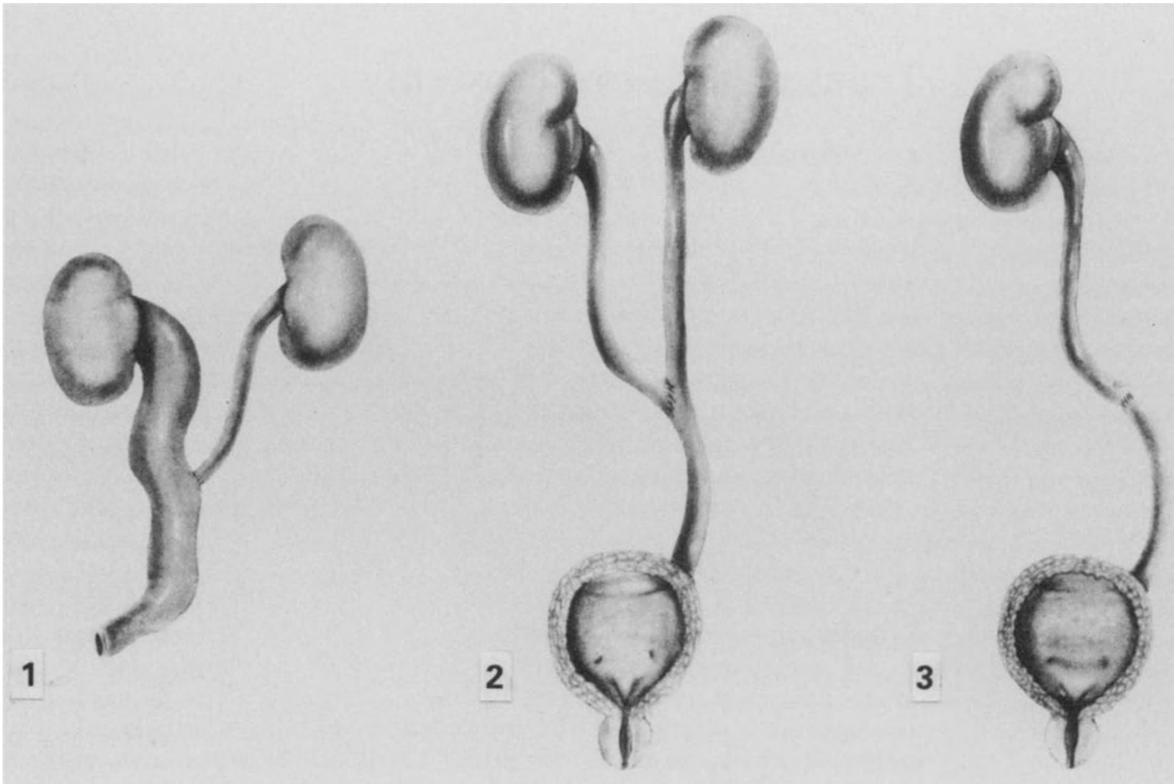



**Fig. 6.1.** *1*, Transuretero-ureterostomy to form a urinary diversion (cutaneous ureterostomy). *2*, Classic transuretero-ureterostomy. *3*, Transuretero-ureterostomy formed from right kidney and upper ureter anastomosed to the left lower ureter. [Reproduced with kind permission from Smith JC (1986) Transureteroureterostomy. In: Williams DI (ed) Operative surgery: Urology. Butterworth, London, pp 315–318 (Rob and Smith's Operative surgery, 4th edn)]

## Advantages of the Operation

The chief advantage of the procedure is the ease with which it can be performed in a difficult situation. Surgical damage of the ureter during a pelvic operation often occurs so high that reimplantation of the ureter even using procedures such as the psoas hitch or Boari flap are difficult or even impossible. Under these circumstances the only alternatives are transuretero-ureterostomy, ileal interposition or nephrectomy.

Transuretero-ureterostomy is the simplest and usually the most satisfactory of these options for the following reasons:

1. The operation site is out of the area of previous surgery: operations in the pelvis may be fraught with difficulties because of previous sepsis or irradiation damage. TUU is carried out above the brim of the pelvis, usually in a virgin surgical field.

2. The operation leaves the urinary tract lined by its natural epithelium and there are no problems associated with the contact of urine and bowel

mucosa such as fluid and electrolyte absorption and possible infective complications.

3. If the contralateral ureter and its orifice is normal then a reflux-free ureterovesical junction is present.

4. Because reported long-term results are so satisfactory, urological follow-up is unnecessary and the patient may be discharged from supervision as soon as a postoperative urogram shows satisfactory function and anatomy. This is particularly important if the original problem occurred during a surgical procedure.

5. By preserving a normal functioning kidney, subsequent litigation may be avoided. Many patients will forgive the surgeon a secondary procedure to correct damage to a ureter but will be aggrieved and take legal action if the second procedure results in the loss of a previously healthy kidney.

## Contraindications

Although there are no absolute contraindications to the use of TUU, its use is unwise in a few situations. Clearly there must be no distal obstruction in the recipient ureter or a fistula may result which fails to heal.

Where the damage to the ureter is due to irradiation of the pelvis, this may be bilateral and the operation may ultimately fail because of recurrent ureteric obstruction on the opposite side. In one of the present author's cases, the anastomosis failed because of heavy irradiation to the ureter which was brought across, and which then became necrotic because of poor blood supply.

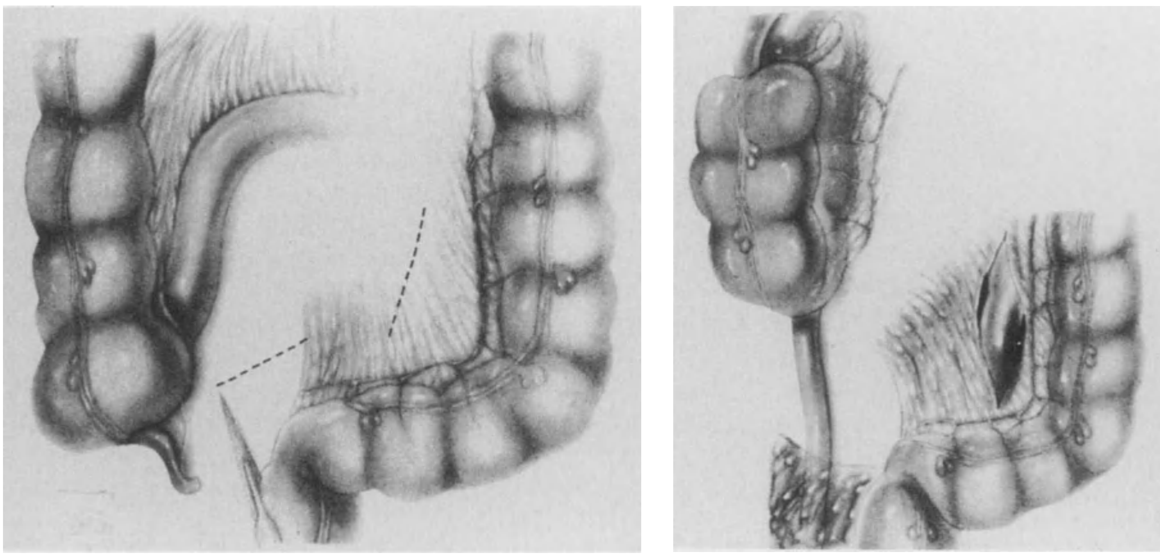
In cases of urothelial malignancy, the operation must be used with caution because of the multifocal nature of the condition. However, in some instances TUU may be preferable to nephroureterectomy.

The operation is rarely indicated in stone disease. In one of the present author's cases, a stone impacted at the anastomotic site causing some anxiety before being passed spontaneously.

Finally, it is rarely worth preserving a very poorly functioning infected kidney by anastomosing its ureter to a normal ureter on the other side. There is always the theoretical risk of infecting a previously healthy kidney, although in practice this has not caused serious problems.

## Technique

Any standard incision can be used for the operation, but if an incision has already been performed and the operation is indicated to correct surgical damage, it is usual to use the same incision for the second procedure.



a b

**Fig. 6.2 a.** Mobilisation of the right colon by incision of the posterior peritoneum below and medial to the caecum and lateral to the ascending colon. **b** Localisation of the left ureter through the left mesocolon. [Reproduced with kind permission from Smith JC (1986) Transureteroureterostomy. In: Williams DI (ed) Operative surgery: Urology. Butterworth, London, pp 315–318 (Rob and Smith's Operative surgery, 4th edn)]

However, a low Pfannenstiel's incision may make the operation difficult if high ureteric damage has occurred, and under these circumstances a second vertical incision is to be preferred.

Following incision the small intestine is lifted cranially and an incision made in the posterior peritoneum at the brim of the pelvis (Fig. 6.2a). This is extended on the right, mobilising the caecum, and the right ureter is located and mobilised. The left ureter is more difficult to locate as it lies under the sigmoid mesocolon. However, it can be found either by dissection under the mesocolon (Fig. 6.2b) or by reflecting the sigmoid medially and locating the ureter from the lateral side.

Depending on the indications for operation, an obstructed distended ureter may easily be located and traced down to the point of damage. The ureter can then be divided just above the point of obstruction and mobilised to enable it to be brought over the midline (Fig. 6.3). In such cases the wall of the ureter is thickened and vascular and there is little problem with blood supply.

In other cases, the ureter may be normal in calibre, and mobilisation across the midline must be carefully done preserving the periureteric vascular tissue as far as possible. It is an advantage that the blood supply of the upper ureter comes from its medial side and by carefully mobilising the ureter by lateral dissection it can be transposed in a medial direction and the blood supply preserved. The contralateral (recipient) ureter can then be drawn gently towards the midline using slings above and below the proposed site of the anastomosis, again carefully preserving the blood supply. The recipient ureter is then incised with a small blade and the opening enlarged with scissors to match the end of the opposite ureter,

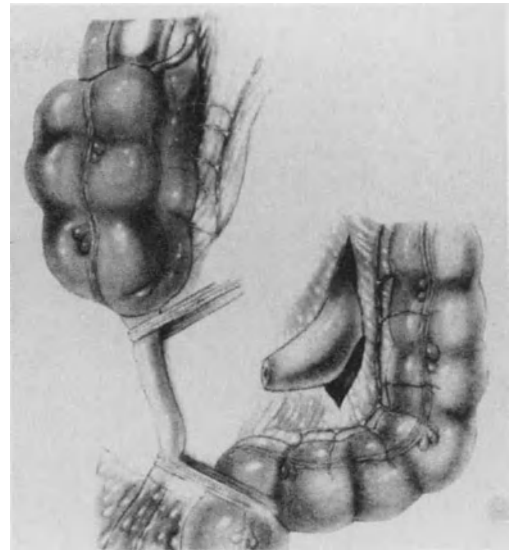


**Fig. 6.3.** Mobilisation of the divided left ureter in order that it can be anastomosed to the right ureter (held by tapes). [Reproduced with kind permission from Smith JC (1986) Transureteroureterostomy. In: Williams DI (ed) Operative surgery: Urology. Butterworth, London, pp 315–318 (Rob and Smith's Operative surgery, 4th edn)]

which is usually divided in an oblique fashion. The anastomosis is performed with 4–0 chromic catgut using fine continuous sutures and completing each end of the anastomosis over a tube passed up or down the recipient ureter (Fig. 6.4).

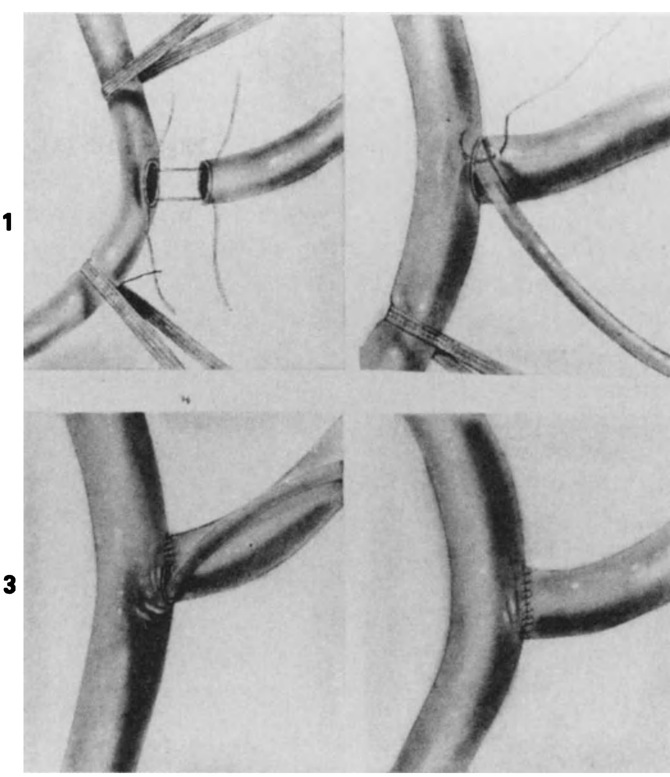



**Fig. 6.4.** *1–4* Anastomosis between cut end of left ureter and side of right ureter. [Reproduced with kind permission from Smith JC (1986) Transureteroureterostomy. In: Williams DI (ed) Operative surgery: Urology. Butterworth, London, pp 315–318 (Rob and Smith's Operative surgery, 4th edn)]

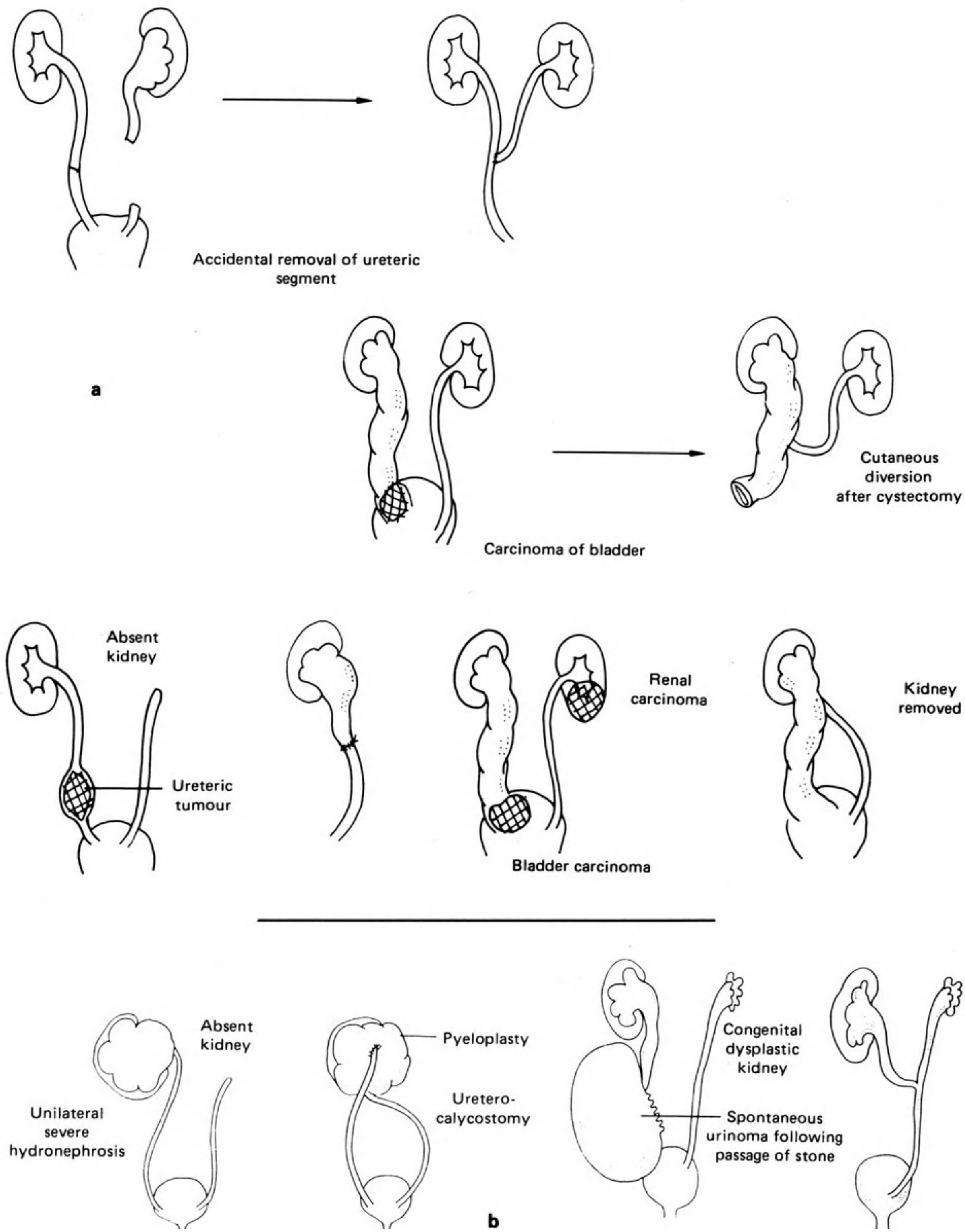



**Fig. 6.5a–c.** Pathological conditions necessitating transuretero-ureterostomy, illustrating the surgical solutions to these conditions.

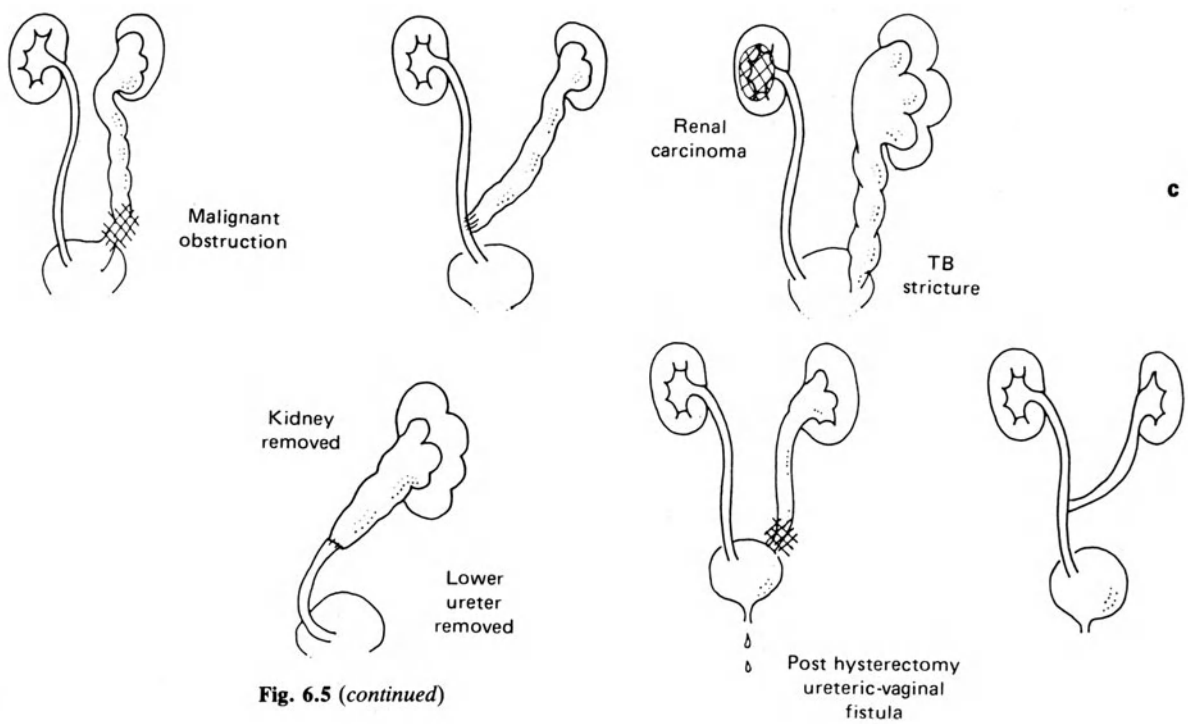



**Fig. 6.5** *(continued)*

The question of whether to splint the anastomosis or divert the urine down with a nephrostomy or ureterostomy is a difficult one and depends on the surgeon's preference and the local anatomical circumstances. The present author does not usually splint or divert unless the anastomosis is being done to drain a solitary kidney or where there are some particularly adverse local factors. A suction drain left down to the anastomosis and removed not earlier than 5 days after the operation has usually proved satisfactory. Double-J stents have been used in occasional cases in recent years but are normally not necessary.

The operation, although extremely useful, is rarely indicated. The present author has personally performed under 30 cases in more than 20 years of consultant practice. A number of different clinical situations in which the operation has been employed are illustrated in Fig. 6.5.

## Follow-up

Early postoperative intravenous urography will always show some dilatation of the (previously normal) recipient kidney. This gradually resolves, and it is therefore sensible if the postoperative course is smooth to delay radiological follow-up until 3–6 months after the procedure. Thereafter, follow-up is probably unnecessary, although ultrasound assessment to detect hydronephrosis is simply performed if indicated.

Other aspects of the follow-up may well be dictated by the underlying pathology. However, the long-term results of transuretero-ureterostomy are so satisfactory that close individual follow-up of the urinary tract is unnecessary.

## Summary

Transuretero-ureterostomy is a simple procedure with an excellent success rate. It frequently enables the surgeon (and the patient!) to overcome a difficult situation without loss of a kidney and with a very satisfactory long-term outlook. Once the surgeon has overcome the psychological aversion to interfering with a normal kidney and ureter on the other side, the results of this procedure are most gratifying.

*Chapter 7*

# Intestinal Interposition

*J. P. Blandy*

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Almost any part of the gastrointestinal tract can be used as a substitute for some part of the urinary tract, provided it has an adequate vascular pedicle. The ileum, being abundant, and relatively free from organisms, is most easy to use, but the colon, stomach and even the appendix can be employed on occasion.

## Indications

Tuberculosis was formerly a common cause of long ureteric strictures; today bilharziasis is more important. There is an increasing role for conservative surgery in well-differentiated urothelial cancers of the ureter. Until recently, iatrogenic injury of the ureter was almost confined to pelvic surgery, except for the rare damage done by a Dormia basket in removal of a ureteric calculus. Today's enthusiasm for the ureteroscope seems to be adding to the total number of damaged ureters. Finally, there may still be an occasional need to replace the ureter in recurrent staghorn matrix stones in the kidney (Goodwin and Cockett 1961).

## Technique

### Choice of the Length of Intestine

The site of the missing length of ureter may govern the selection of which part of the intestine to use. In the (rare) patient with bilharziasis whose

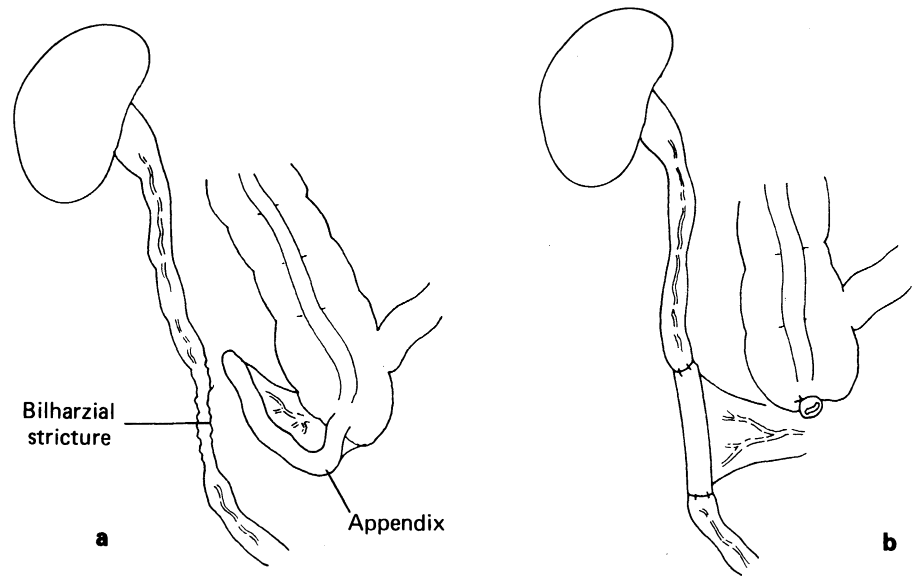


**Fig. 7.1a,b.** The appendix makes an ideal substitute for the ureter affected by bilharziasis in the appropriate segment.

stenosis is limited to the 2–5 cm of ureter adjacent to the appendix, nothing is more easy than to use the appendix on its mesentery as a substitute for the narrow part, giving a ureter indistinguishable from normal in the follow-up urogram (Fig. 7.1). On the other hand, when the left ureter has been destroyed, by whatever cause, or when it is necessary to make a wide duct for stone debris between the left kidney and the

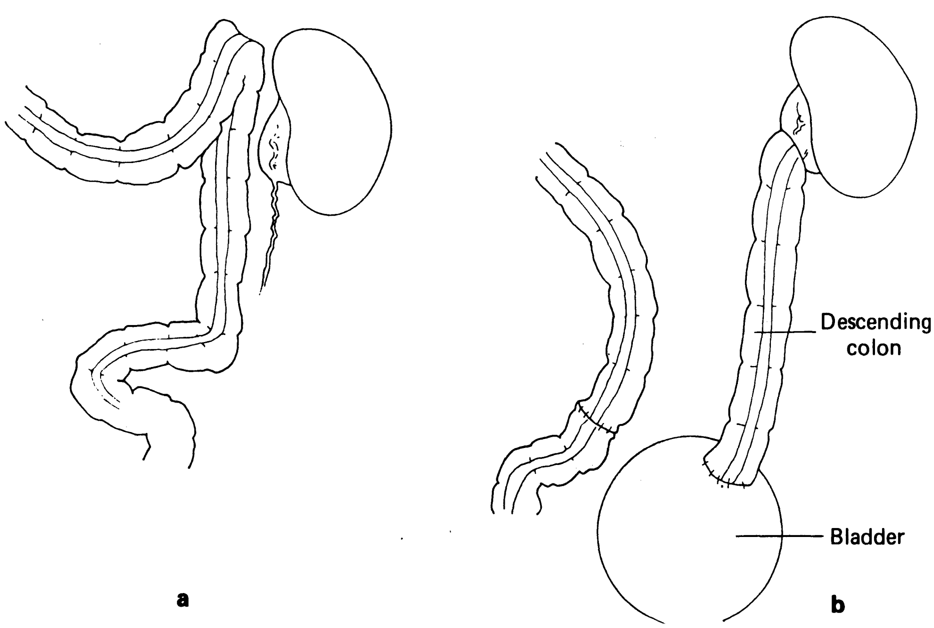


**Fig. 7.2a,b.** On the left side the descending colon is ideally situated to replace the ureter.

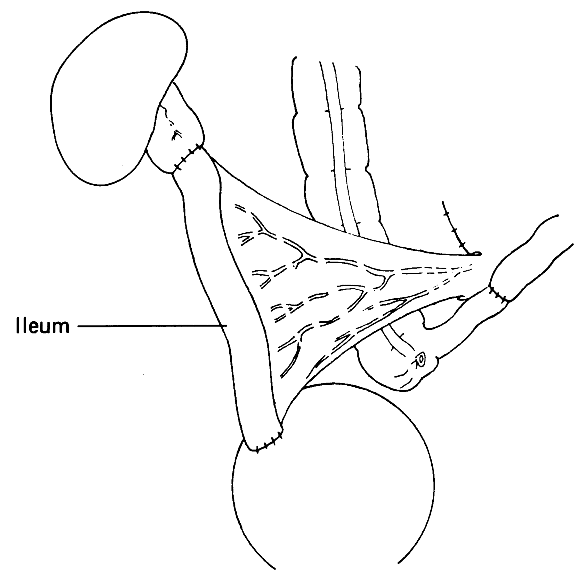


**Fig. 7.3.** On the right side an isolated segment of ileum forms a useful replacement for the ureter.

bladder, it is easy to mobilise the splenic flexure, join the transverse to the sigmoid colon, and use the descending colon as a replacement for the ureter (Fig. 7.2).

On the right side the ileum is usually the most convenient length of bowel to use as replacement for all or part of the ureter (Fig. 7.3), but it may be more convenient to utilise the sigmoid in lesions of the lower third of the ureter. The surgeon's choice may be restricted further when patients have received preoperative irradiation, and he must always be very aware that intestine which seems normal on casual inspection from the outside may be severely damaged within, often to the extent of total loss of the mucosa.

## Preparation

Mechanical cleansing of the bowel is far more important than any combination of antimicrobials, and in our unit we prepare the bowel with a high fluid sorbitol washout supplemented by neomycin and metronidazole.

## Prophylactic Antibiotics

Despite the hazards of superinfection when prophylactic antibiotics are used, there is nearly always some sound reason why they should be given: either the elderly patient suffers from chronic bronchitis with sputum that is never free from organisms, or there is a pre-existing urinary infection. It is seldom safe to omit antibiotics.

## Incision

Placing the incision will be dictated by the underlying indication for the operation, but one principle common to all cases is the need for adequate exposure. It is always necessary to get really wide exposure of the kidney when an anastomosis must be made between renal pelvis and bowel; safety demands control of the arterial supply of the kidney, and that necessitates adequate exposure. Cases which require the use of bowel as a substitute for the ureter are never straightforward, and to start with anything less than maximal exposure is the mark of inexperience. For these reasons the choice usually lies between a long midline incision or an oblique one along the line of the 12th rib, curving down towards the symphysis pubis.

## Exposure of the Kidney, Ureter and Bladder

Since intestinal substitution for the ureter is seldom needed in a patient who has not been operated on before, often many times, the peritoneal cavity is usually full of adhesions. In such cases the first step in the procedure is to perform a very cautious laparotomy with most gentle division of all the adhesions. In making this dissection, special care is taken to preserve the omentum. It is useful to lift the omentum off the transverse colon before mobilising the splenic or the hepatic flexure; this simple manoeuvre makes it much easier to mobilise the ascending or descending colon in order to display the ureter.

## Left Ureter

After the omentum has been lifted off the transverse colon, and the splenic flexure mobilised, the peritoneum on the lateral aspect of the descending colon is incised to allow the bowel to be rolled medially, exposing in turn the kidney, gonadal vein, duodenum and aorta (Fig. 7.4). Difficulty must be expected in the type of case requiring intestinal interposition, and it is seldom possible to find a ureter untouched or free from adhesions. When in difficulty, it is a good rule always to seek the ureter higher than expected, if necessary tracing it from the hilum of the kidney downwards into the mass of surrounding fibrous tissue. As the ureter is followed down it will cross anterior to the bifurcation of the common iliac artery and posterior to the superior vesical vessels, which must be divided to liberate the lower third of the ureter.

## Right Ureter

After mobilising the hepatic flexure the right colon and duodenum are swung medially, and the dissection on the right is otherwise similar to that on the left. It is equally necessary to divide the superior vesical vessels to liberate the lower few centimetres of ureter.

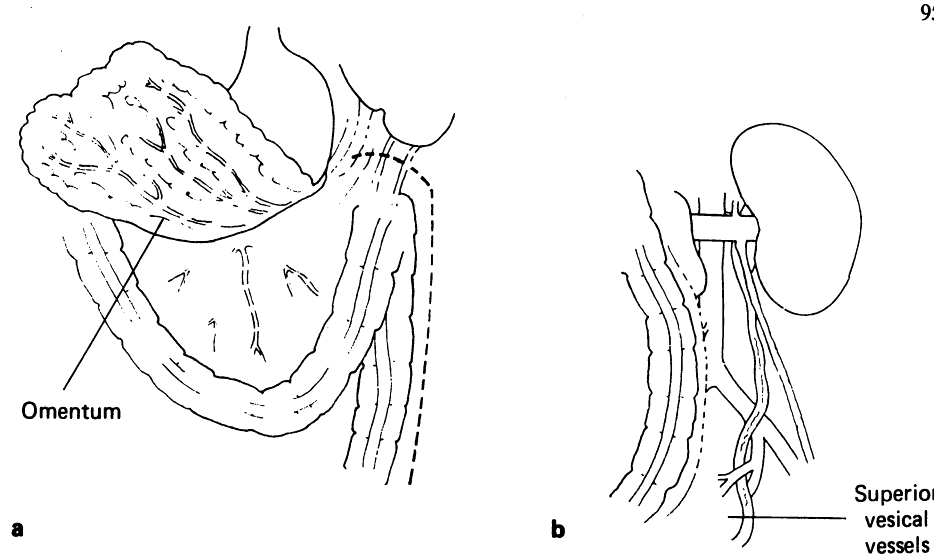


**Fig. 7.4a,b.** Exposing the left ureter by mobilising the splenic flexure and descending colon and dividing the superior vesical vessels.

# Planning the Replacement

Once the preliminary dissection has been completed, the adhesions divided and the pathology attended to as seems appropriate, there is still a gap to be bridged. How to deploy the intestine to replace the ureter is now a matter of ingenuity and common sense. The choice of procedure is guided by two simple principles:

1. In general it is best to implant ureter into intestine and intestine into bladder (Fig. 7.5). The blood supply to the lower 5 cm of the ureter is precarious, especially in elderly atheromatous patients, and the ureter is notoriously apt to slough. This is far more important than the doubtful advantage of keeping a reflux-preventing mechanism at the lower end of the ureter—at least in the adult. It is usually better to discard the lower few centimetres of ureter and join the intestine directly to the bladder.
2. When there is a choice, it is easier and safer to use small rather than large bowel.

## Preparation of a Segment of Intestine

### *Ileum*

With light shining through the mesentery, the peritoneum is gently incised along a convenient gap between the branches of the ileocolic

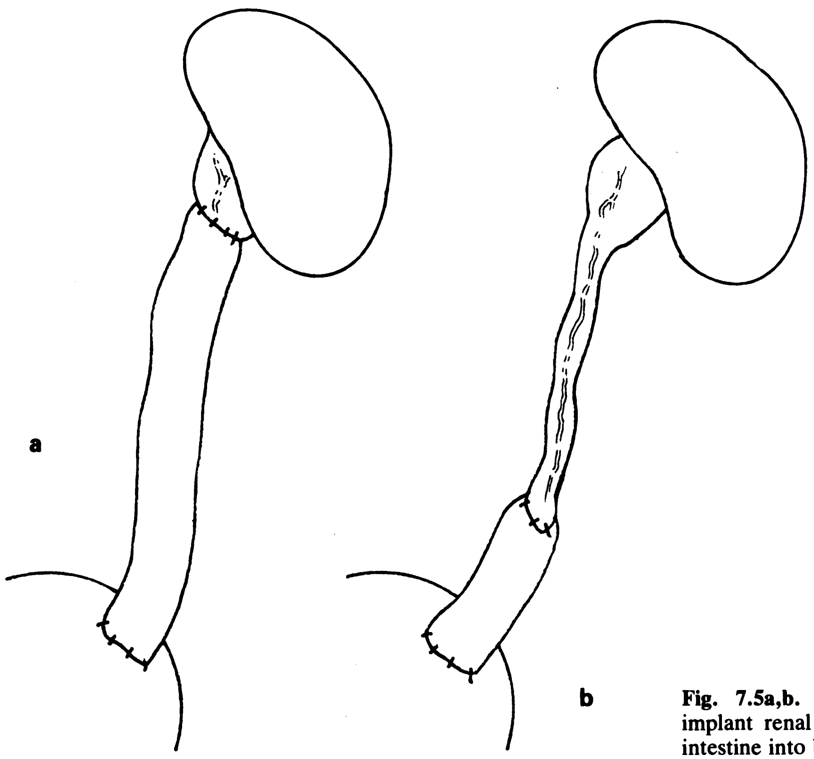


**Fig. 7.5a,b.** Principles of intestinal interposition: implant renal pelvis or ureter into intestine (**a**) and intestine into bladder (**b**).

artery first on one side of the mesentery and then on the other. The mesenteric vessels are divided between pairs of mosquito forceps and ligated with fine thread or silk. The correct length of bowel is measured by laying it into the gap that must be bridged, and then the mesentery is divided in the same way. An end-to-end anastomosis is made between the divided bowel in the surgeon's accustomed and favourite way (The present author prefers a two-layer anastomosis with 3–0 chromic catgut for the mucosa and interrupted silk or thread for the seromuscular coat.)

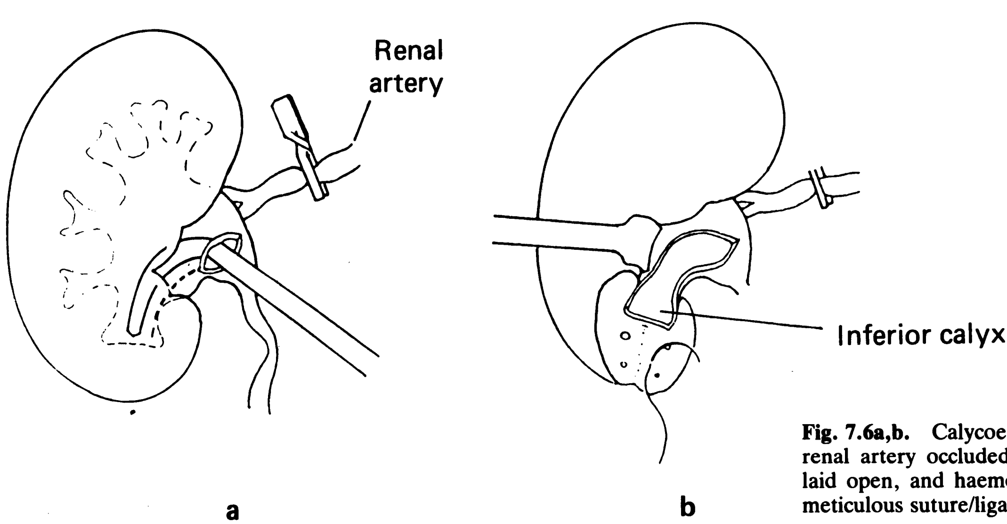


**Fig. 7.6a,b.** Calycoenterostomy: with the renal artery occluded, the lower calyx is laid open, and haemostasis is secured by meticulous suture/ligature.

### *Colon*

It matters little whether the segment of colon is ascending, transverse, descending or sigmoid provided that care has been given to careful mobilisation of the bowel to start with, with due attention to its embryological lines of adhesion and its blood supply. The colon is less well supplied with blood than the ileum, so greater care must be taken to ensure an adequate blood supply before making an isolated loop. In the elderly patient, one cannot rely on the inferior mesenteric artery, which is so often inadequate. Of the many techniques for anastomosing the large intestine, the present author prefers two layers: 3–0 chromic catgut for the mucosa and interrupted fine silk or thread for the seromuscular coat.

## Anastomoses

However the substitution is to be planned, there are only four possible anastomoses: renal calyx to bowel, renal pelvis to bowel, ureter to bowel, and bowel to bladder.

### *Renal Calyx to Bowel*

First, control of the renal artery must be achieved: without this the procedure can be bloody and dangerous. The renal pelvis is opened between stay sutures and a right-angled forceps is passed into the inferior calyx. The renal artery is occluded and the inferior calyx is laid open to its lowest part (Fig. 7.6). In the cut surfaces one can see the open ends of vessels. Each must be secured by suture ligature with 3–0 or 4–0 catgut. Only when all the visible vessels have been sutured is the renal artery released, and the remaining bleeding vessels are identified and secured with a few more sutures.

The upper end of the intestinal conduit is anastomosed to the edge of the pelvis and calyx with interrupted 3–0 chromic catgut sutures. A suitable splinting catheter is led via the renal parenchyma down through the lumen of the bowel: silicone rubber tubing provided with multiple side holes is appropriate for this purpose, the upper end being led out as a nephrostomy and secured to the skin (Fig. 7.7).

### *Renal Pelvis to Bowel*

Exactly the same anastomosis is made to the renal pelvis if it is sufficiently large and accessible. A generous elliptical incision is made in the dependent part of the renal pelvis and sutured to the upper end of the bowel over a suitable splinting catheter (Fig. 7.8). Unfortunately, under the circumstances which oblige one to replace the ureter it is seldom so easy. More often the renal pelvis is small, distorted and obscured by fibrosis.

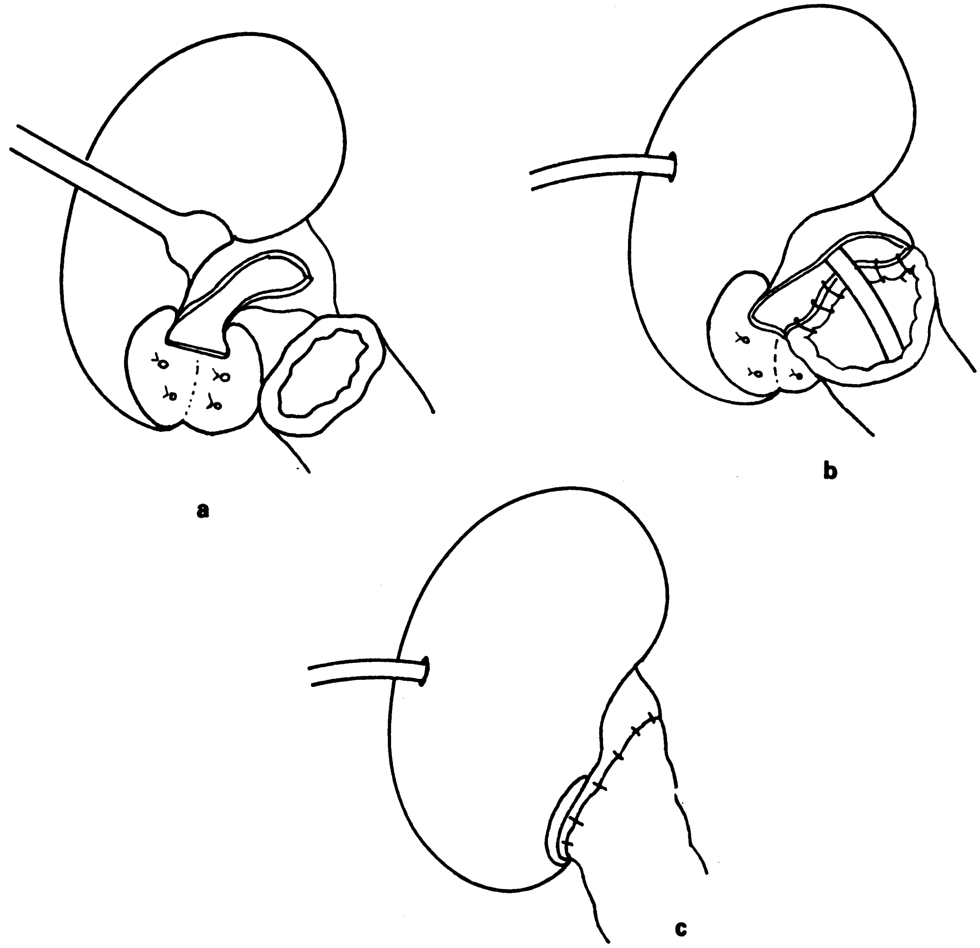

**Fig. 7.7a–c.** Calycoenterostomy: the proximal end of the segment of bowel is sutured over an appropriate stent to the mucosa of the pelvis and calyx.

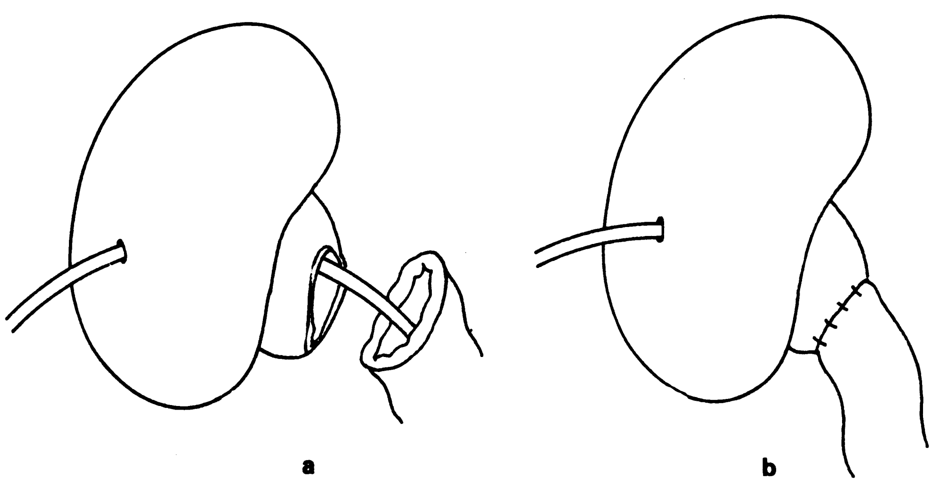

**Fig. 7.8a,b.** Pyeloenterostomy: the proximal end of the bowel is sutured to a long incision in the pelvis, over a stent.

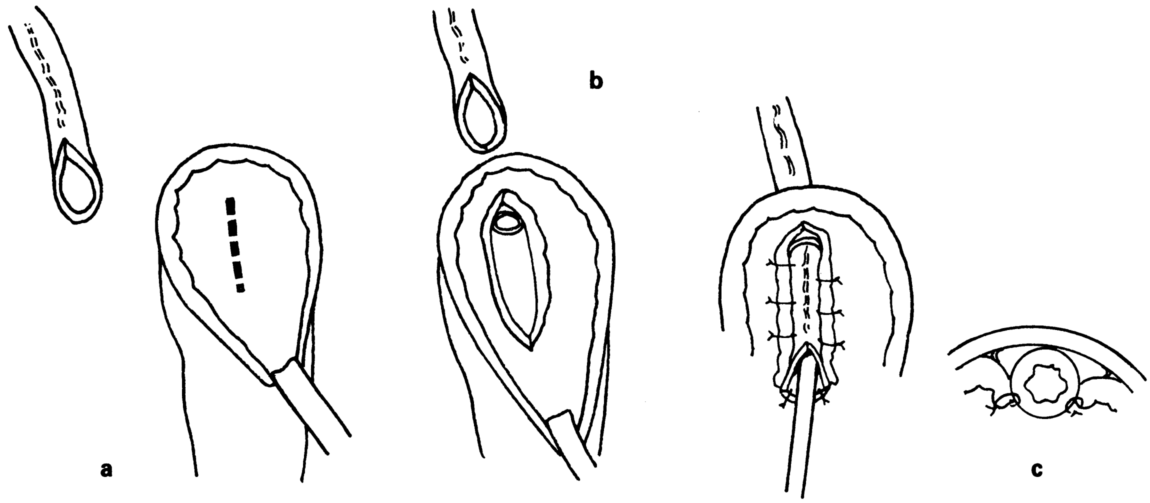


**Fig. 7.9a–c.** Antireflux anastomosis between ureter and small bowel—Camey's method: the mucosa is incised and the ureter sutured to its edges, so that the wall of the ureter acts as the valve.

### *Ureter to Bowel*

If the ureter is of large calibre, it may be joined end to end to the intestine over a suitable splinting tube, and there is little point in trying to make an antireflux anastomosis. If the ureter is of normal calibre, however, one may as well fashion an antireflux tunnel and draw the ureter under the mucosa in the colon, or, in the case of the small bowel, use Camey's method and let the wall of the ureter act as the inner layer of the valve (Fig. 7.9).

### *Bowel to Bladder*

It is helpful to fill the bladder with saline when getting ready for the anastomosis of bowel to bladder; this makes it easier to select the most convenient part of the bladder for the anastomosis. An incision is made in the muscular wall of the bladder and the lower end of the bowel loop is simply anastomosed with interrupted 3–0 chromic catgut to the wall of the bladder. The splinting catheter that leads up to, or right through the kidney is led across the bladder to emerge via a separate incision in the lower abdominal wall, rather than through the urethra. In the post-operative management it is helpful to have the ureteric splint separate from the catheter draining the bladder. The wound is closed with drainage in the usual way, avoiding the use of non-absorbable sutures.

How long the splints and catheters are left in situ is always a matter of choice. The present author leaves them in for at least 10 days, and usually 14. The wound drain is removed in stages after 5 or 6 days, when a track has formed.

## Reference

Goodwin WE, Cockett ATK (1961) Surgical treatment of multiple recurrent branched renal (staghorn) calculi by pyelo-nephro-ileo-vesical anastomosis J Urol 85: 214–222

*Chapter 8*

# Boari Flap

*J. P. Blandy*

A defect in the lower third of the ureter may result from many pathological conditions, but the most common by far is iatrogenic injury sustained in the course of hysterectomy, when the ureter has been crushed, ligated or divided. As a rule, after several days of obstruction that usually goes unnoticed, the necrotic wall of the injured ureter gives way and urine leaks through the vagina. Even then the diagnosis may be delayed by fruitless manoeuvres with methylene blue, and tampons in tandem, when the most important thing is to make sure that the fluid leaking from the vagina is urine. All that is required to confirm this diagnosis is a "blood urea" test, which can currently be performed on a drop of fluid taken up with a syringe as it pools in the vagina. Since there is no other body fluid with a urea content greater than that of blood, this simple test puts the diagnosis beyond dispute. Action should then follow without delay.

## Investigations

The first investigation is an intravenous urogram. The damaged ureter is usually a little obstructed, and appears somewhat dilated. Very occasionally, contrast can be seen to leak from the site of the injury and to pool in the vagina. However, this evidence is not enough. One must always remember that, under the circumstances that give rise to inadvertent iatrogenic injury to the ureter, not only one but both ureters may be damaged, and, furthermore, there may also be a vesicovaginal fistula. All these injuries can be repaired at one operation, and if only one fistula is corrected, the patient will have to undergo yet another operation, when the surgeon will find the operative field much more difficult to work in.

A cystoscopy should always be performed and bilateral ureterograms undertaken with a bulb-ended catheter. This investigation will reveal an unsuspected vesicovaginal fistula and show which ureter has been damaged. The opportunity should be taken to pass a catheter up the undamaged ureter, and leave it in situ, attached to the Foley catheter left in the bladder. It is usually much easier to see the ureteric orifice at cystoscopy and to catheterise it then, than when the bladder is open a few minutes later.

## Timing of Intervention

The sooner the ureter is repaired the better. If both ureters are grossly obstructed, and the patient has become anuric, it may be prudent to insert small nephrostomy catheters percutaneously into the kidneys for a few days, and if there is septicaemia secondary to infection in such an obstructed kidney, it may be profitable to leave the patient for a few days with a nephrostomy to decompress the kidney and with antibiotics to overcome the infection. However, there is no justification for delay on any other grounds, and the traditional teaching that one should wait for a certain number of weeks or months before intervening is quite invalid and is based on experience half a century ago with post-partum fistulae (which have an entirely different aetiology). There is nothing to be gained by procrastination (Flynn et al. 1979; Badenoch et al. 1986).

## Incision

When an abdominal hysterectomy has been performed, the old incision is reopened, whether Pfannenstiel or vertical: either will give adequate access. When a vaginal hysterectomy has been performed, the present author uses a Pfannenstiel incision. Since there are always adherent loops of bowel in the pelvis these must be carefully freed to reveal the back of the bladder. The damaged ureter is found after mobilising the sigmoid on the left, or the caecum on the right, and it is traced down to the site of the injury. Seldom can one be sure exactly what has gone wrong: usually the ureter disappears into a firm mass of fibrous tissue. Sometimes one can see the ligature that encircles the ureter, but far more often one must be content to note that the ureter seems to disappear into a mass of fibrous tissue. Now is the time to divide the ureter where it seems to be healthy, and ligate the distal stump. The proximal healthy ureter will be seen to retract for 2–3 cm, leaving a gap to be bridged which is a little longer than seemed at first sight (Fig. 8.1). It is perhaps for this reason more than any other that the present author has come to use the Boari flap routinely, since it overcomes any temptation to perform an anastomosis under tension. No doubt the admirable psoas hitch can achieve the same ends in the right hands, but it is a device to obviate tension, whereas with the

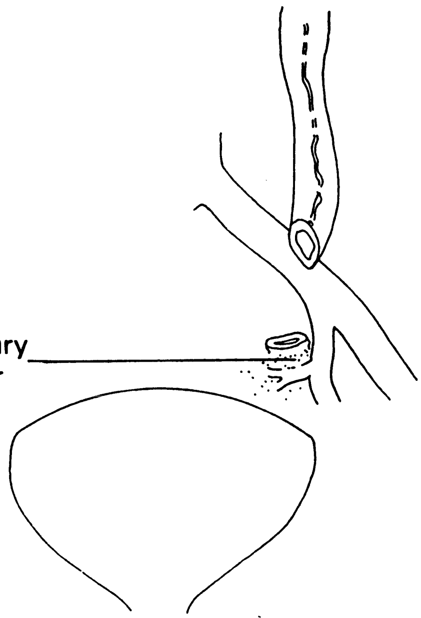


**Fig. 8.1.** After tracing the ureter down to the site of injury, it is divided just above the zone of fibrosis. It will retract, giving rise to a much longer gap than at first seems likely.

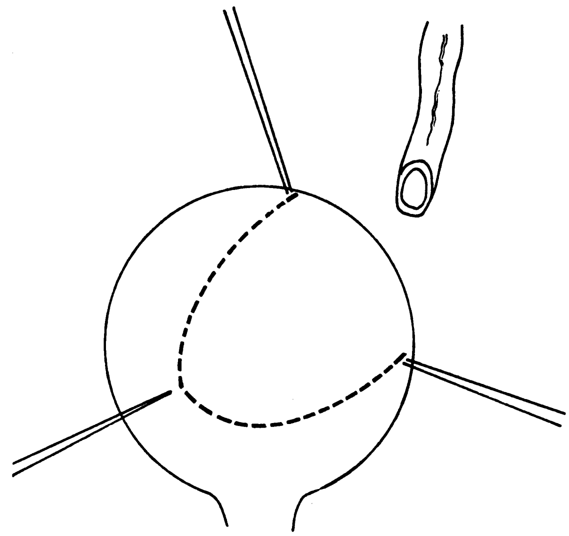

**Fig. 8.2.** Making the Boari flap: fill the bladder and mark out a broad-based flap with three stay sutures.

Boari flap, which is just as quick and easy to perform, there is never any tension (Blandy 1986).

## Marking out the Boari Flap

The bladder is filled with saline through the catheter. When it is comfortably full, a U-shaped flap is marked out with a broad base and three stay sutures (Fig. 8.2). The flap is cut out 1 or 2 cm at a time, care being taken to control the small arteries that are divided in the wall of the bladder with suture ligatures of fine catgut rather than diathermy. In making this flap it is comforting to know where the ureter lies, with the ureteric catheter that has been placed in position at the preliminary cystoscopy (Fig. 8.3).

## Ureterovesical Anastomosis

A tunnel is made in the Boari flap with scissors, and an 18 FG Jacques catheter is slipped over the end of the scissors, which are used to draw the catheter along the tunnel (Fig. 8.4). The ureter is sutured to the catheter

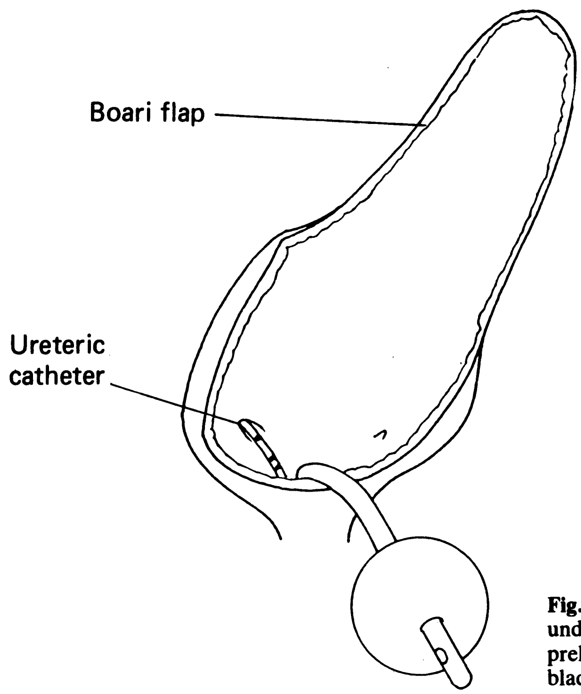


**Fig. 8.3.** The flap is formed. A catheter is now passed up the undamaged ureter, if it has not already been placed at the preliminary cystoscopy. The Foley catheter is lifted out of the bladder.

and gently drawn through the tunnel. The end of the ureter is spatulated and a cuff turned back. The edge of the ureter is sutured to the bladder with four or five 3–0 chromic catgut sutures (Fig. 8.5).

It is the present author's practice to splint these anastomoses with a Gibbon catheter which runs through the opposite side of the bladder and is sutured to the skin (Fig. 8.6). A double-J splint will serve the same purpose, but it needs another cystoscopy to take it out—and these patients have always had more than enough "operations".

The Boari flap is now folded into a tube like the finger of a glove, and sewn in two layers with 3–0 chromic catgut (Fig. 8.7). The end of the tube is attached to the ureter with a fine catgut suture, and the tube to the tendon of psoas minor or some other firm fascial band to make sure that it lies without tension in a nice easy line. In a particularly difficult case it does no harm to fold omentum around the Boari tube as an additional precaution. After removing the marker ureteric catheter from the good ureter the wound is closed with catgut in the usual way, leaving a tube drain to the prevesical space and a suitable small Foley catheter in the bladder.

## Postoperative care

The splinting Gibbon catheter is removed from the ureter after 5 or 6 days (or when it no longer drains urine), and the urethral catheter after

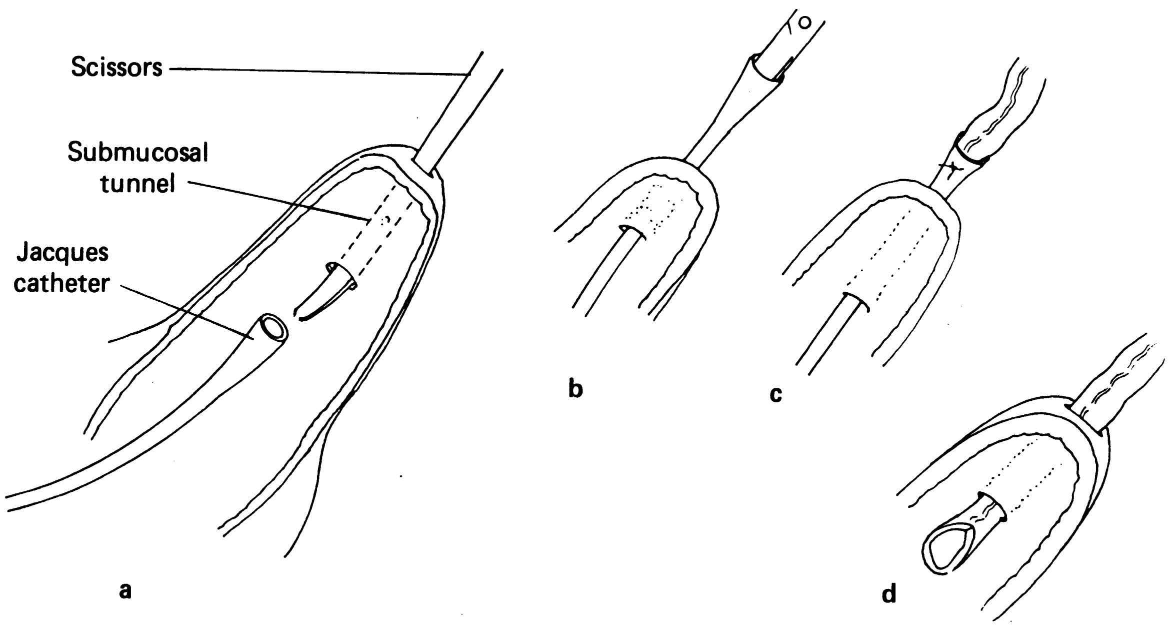


**Fig. 8.4a–d.** A submucosal tunnel is made in the Boari flap with scissors, over which a Jacques catheter is slipped and used to draw the ureter down the tunnel.

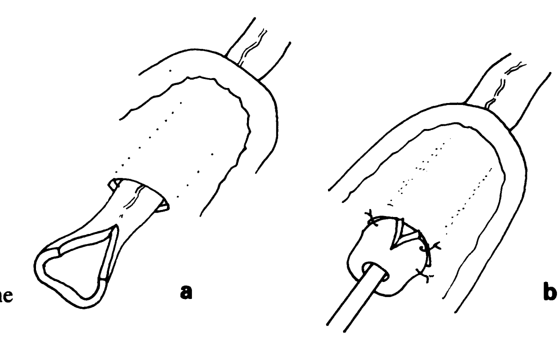


**Fig. 8.5a,b.** The ureter is spatulated, turned back and sutured to the mucosa of the bladder tube.

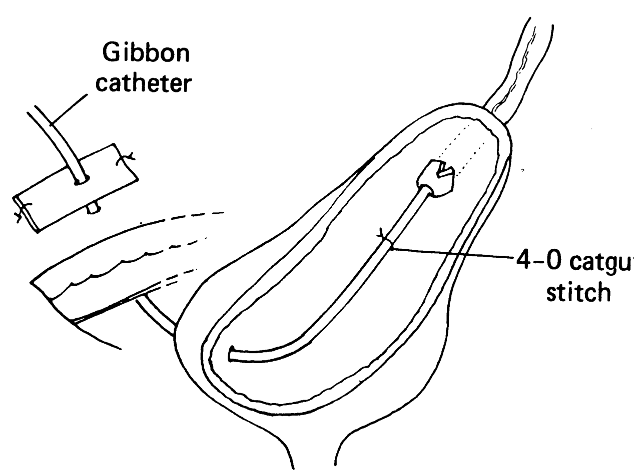


**Fig. 8.6.** The anastomosis is splinted with a Gibbon urethral catheter, the flanges of which make it easy to fix to the skin. The stent is sutured to the Boari tube with a 4–0 catgut stitch to keep it aligned and prevent kinking.

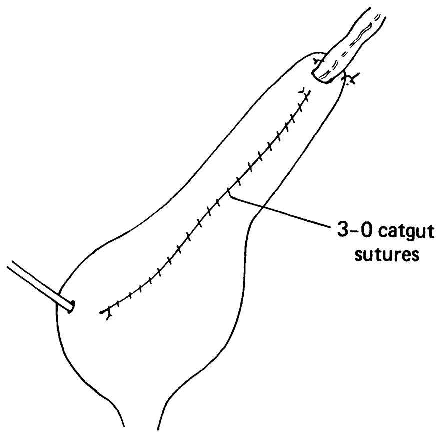


**Fig. 8.7.** The Boari flap is rolled up into a tube and sutured in two layers with 3–0 catgut. The upper end of the tube is stitched to the ureter, and when there is any suggestion of tension, the tube itself is sutured to the tendon of psoas minor or some other suitable supporting tissue.

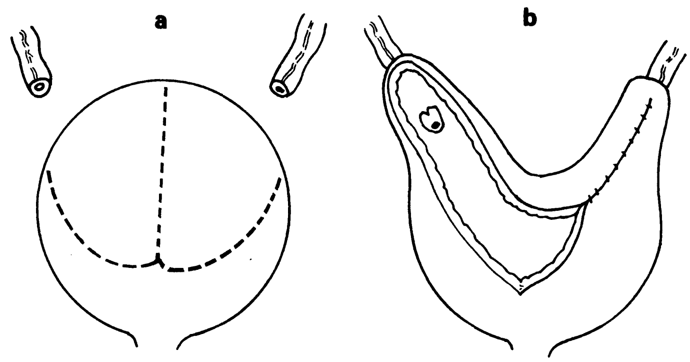


**Fig. 8.8a,b.** Double Boari flaps for bilateral ureteric injury.

12 days. A postoperative pyelogram is obtained after 3 months, by which time the appearances of the bladder are remarkably normal, and it may be impossible to guess which side has the Boari flap.

## Modifications of the Boari Flap

If both ureters have been injured, the bladder is bisected in the midline, and a Boari flap formed on each side, and splinted in the usual way (Blandy 1986). Otherwise the operation proceeds as described above (Fig. 8.8).

When a very long gap must be bridged, the flap can be elongated by using some of the posterior wall of the bladder, after first mobilising the other side of the bladder by dividing the superior vesical pedicle. In doing this one must take great care not to injure the good ureter, another reason why it is prudent to place a ureteric catheter in it at the beginning of the operation (Fig. 8.9).

When there is a vesicovaginal fistula as well as a ureterovesical one, both should be closed at the same operation. The Boari flap is marked out first. Then the medial limb of the incision is continued to bisect the bladder down to the vesicovaginal fistula, and the plane between the trigone and vagina is separated for about a centimetre (Fig. 8.10). After closing the vaginal wall with 3–0 chromic catgut sutures, it is covered with a patch of omentum. The damaged ureter is implanted into a Boari tube formed from one side of the bladder, and the other side is rotated medially to close the defect (Fig. 8.11). In these cases it is the present

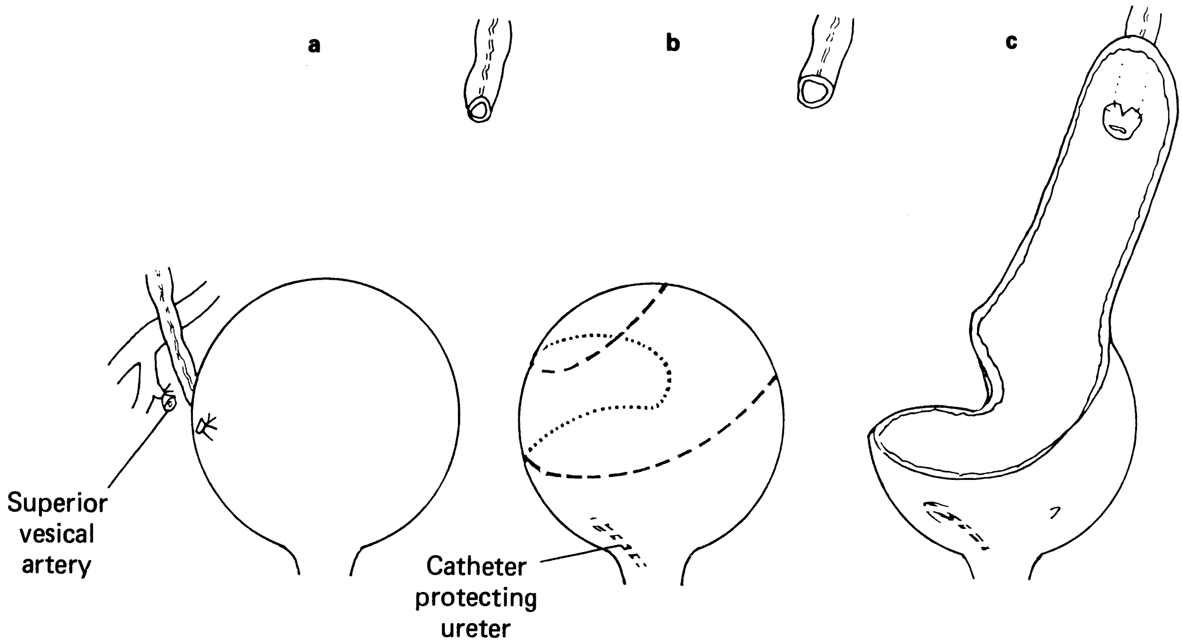


**Fig. 8.9a–c.** An extra-long Boari flap. To make the flap, the opposite superior vesical pedicle is divided between ligatures (**a**) and the flap is planned so that it can be carried on to the posterior wall of the bladder, having made certain of the position of the good ureter by placing a catheter in it (**b**). (**c**) In a patient who starts off with a large bladder, the Boari flap can be made to reach the kidney without tension.

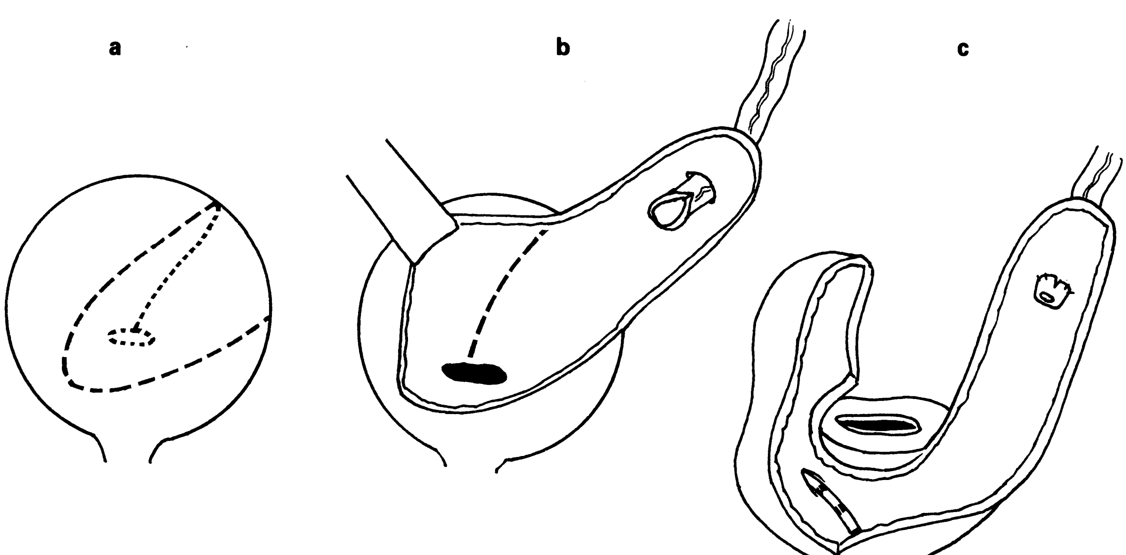


**Fig. 8.10a–c.** Ureteric fistula in the presence of iatrogenic vesicovaginal fistula. **a** The Boari flap is planned first. **b** The medial limb of the incision is carried down to the vesicovaginal fistula. **c** The trigone and margin of the bladder are separated for a full centimetre from the vagina, making sure of the safety of the undamaged ureter by its marker catheter.

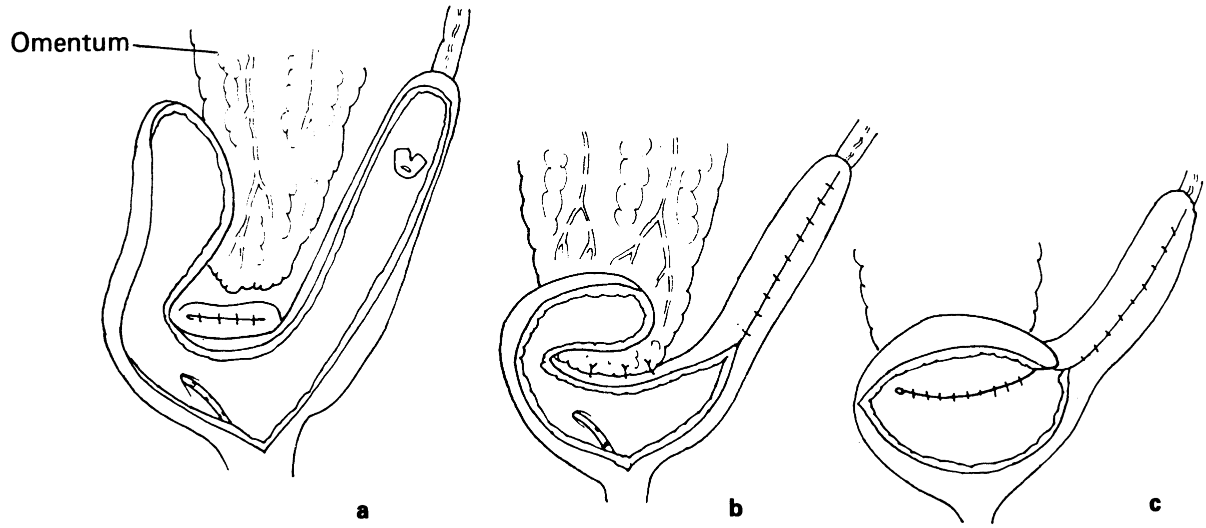


**Fig. 8.11.** **a** The damaged ureter is anastomosed to the Boari flap in the standard way. **b** The hole in the vagina is closed and sealed with a plug of omentum. **c** The other half of the bladder is rotated to cover the gap.

author's practice to leave splinting catheters in each ureter. (Gibbon's urethral catheters are very convenient because their flanges may be sutured to the skin.)

## Follow-up

The experience in the present author's department has shown clearly that early intervention in these cases of iatrogenic injury to the ureter with the aid of the Boari flap gives excellent results (Bowsher et al. 1982; Badenoch et al. 1987).

## References

Badenoch DF, Fowler CG, Thakar K et al. (1987) Early repair of accidental injury to the ureter or bladder following gynaecological surgery. Br J Urol 59: 516–518

Blandy JP (1986) Operative urology, 2nd edn. Blackwell Scientific, Oxford, pp 105–108, 182–185

Bowsher WG, Shah PJR, Costello AJ et al. (1982) A critical appraisal of the Boari flap. Br J Urol 54: 682–685

Flynn JT, Tiptaft RC, Woodhouse CRJ, Paris AMI, Blandy JP (1979) The early and aggressive repair of iatrogenic ureteric injuries. Br J Urol 51: 454–457

*Chapter 9*

# The Turner-Warwick Bladder-Elongation Psoas-Hitch Procedure for Substitution Ureteroplasty

*Richard Turner-Warwick*

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The bladder-elongation psoas-hitch (BEPH) procedure for the resolution of lower ureteric defects has many advantages over the classic Boari bladder-flap technique; not only can it reach at least as high but it is much simpler to achieve and it facilitates the reflux-preventing reimplantation of one or both ureters (Turner-Warwick and Worth 1969). It also provides the safest procedure for the reflux-preventing reimplantation of large-calibre ureters because it avoids the need for "tailoring" them (Turner-Warwick 1972, 1982; see Chap. 44).

## Principles of the Procedure

It is the correct siting of the initial incision into the bladder that enables it to be elongated so that its fundus can be anchored to the psoas muscle above the iliac vessels without either tension or significant impairment of its blood supply.

1. The transverse elongating incision into the bladder is accurately located across the middle of its anterior wall at the level of its maximum diameter, extending a little more than half way round it. When this "equatorial" incision is closed vertically it effectively elongates the anterior wall of the bladder so that its uppermost extremity can be elevated above the iliac vessels (Fig. 9.1).

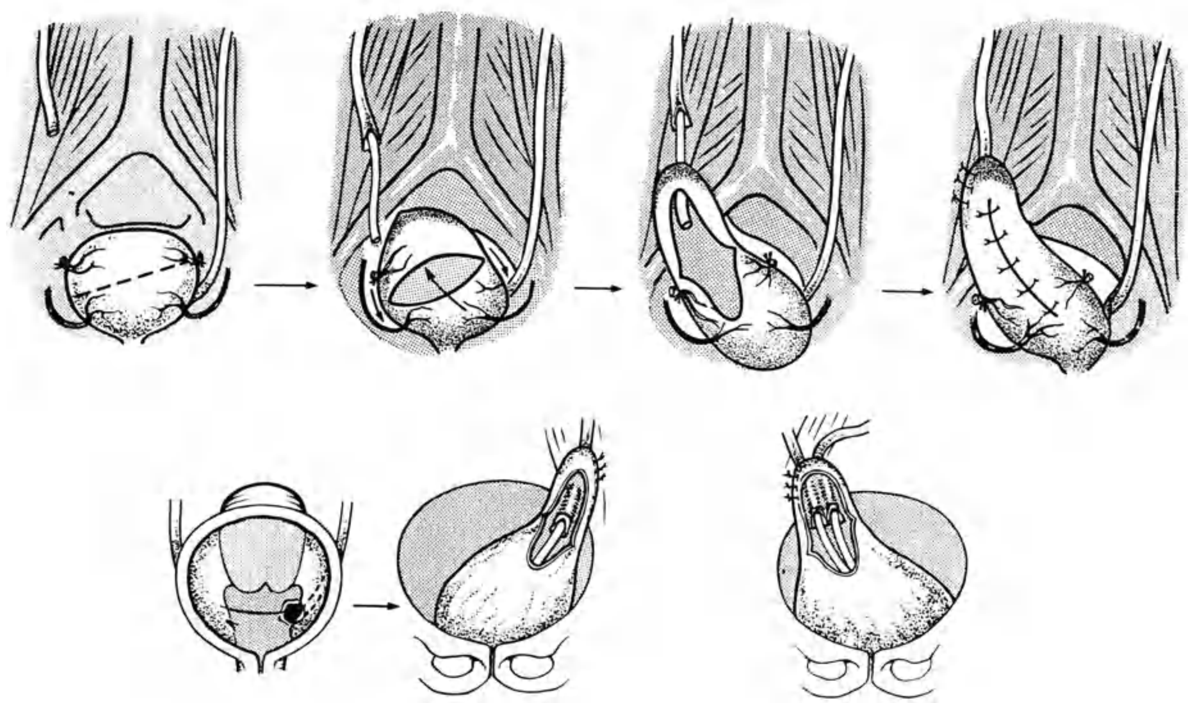

**Fig. 9.1.** The bladder-elongation psoas-hitch procedure.

2. The extent of the bladder elevation can be further increased by "double" horizontal relaxing incisions (Fig. 9.2). The effect of this is to convert the whole bladder into a wide elongated strip with maximal preservation of its blood supply.

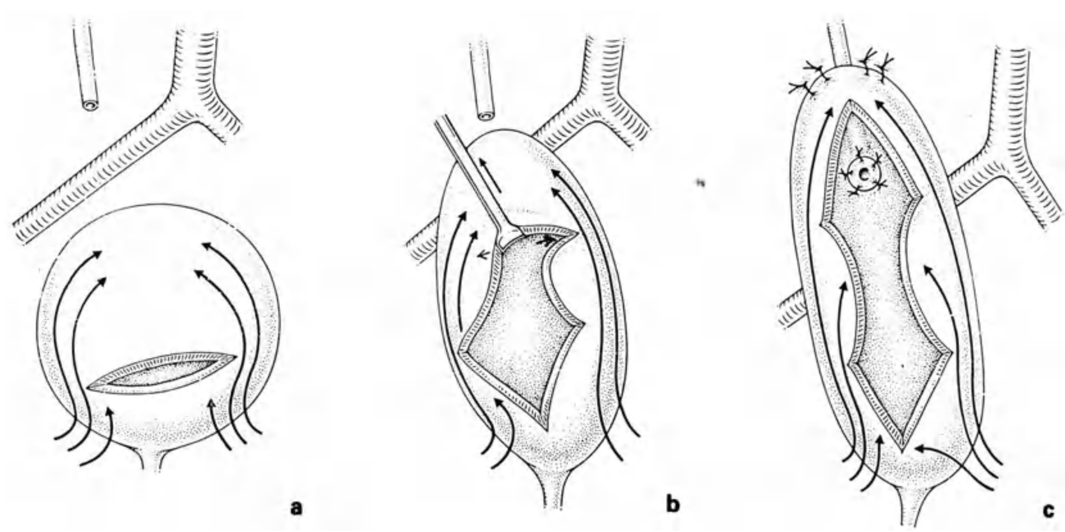


**Fig. 9.2a–c.** The "double-incision" bladder-elongation procedure.

3. Fixation of the upper apex of the bladder to the psoas muscle involves no tension, provided the bladder has been elongated by appropriate incisions. This redeployment does not prevent the detrusor contraction evacuating it completely. However, it is important to anchor the bladder firmly to the psoas muscle to prevent distraction of the ureteric reimplantation by detrusor contraction.

## Procedure

The patient is positioned supine on the operating table. Good access is provided by the suprapubic V incision (Turner-Warwick et al. 1974) or a midline incision; however, the traditional Pfannenstiel incision provides inadequate access.

1. The peritoneal reflection around the dome of the bladder is circumcised and the superior vesical vessels are divided on both sides. The lower segment of the ureter is excised and the ureterovesical stump is ligated. A fine 4–0 stay suture is inserted into the distal end of the mobilised proximal ureter, and its terminal lumen is opened by a 1.0–1.5 cm spatulating incision.

2. A 0 stay suture is inserted just above the mid point of the anterior bladder wall and the primary horizontal bladder-elongating incision is made. A single hemi-circumferential transection of the bladder in the equatorial line is usually sufficient to enable a reflux-preventing tunnel reimplantation of the ureter to be achieved above the level of the iliac vessels.

However, when maximum elongation is required to enable a somewhat smaller bladder to reach this level, or a normal bladder to reach the upper half of the ureter a "double incision" is used (Fig. 9.2): for this the primary horizontal incision is located in the lower segment of the bladder and when this is elongated vertically, secondary lateral incisions are made into its margins at its new proximal extremity. The effect of this additional procedure is to convert the whole bladder into a wide elongated strip, the length and vascularisation of which compares favourably with a Boari flap. Haemostasis of the bladder incision is achieved by fine electrocoagulating forceps.

3. A finger inserted into the fundus of the bladder elevates it to reach the psoas above the iliac vessels, where it will be firmly anchored after the reflux-preventing tunnel reimplantation of the ureter. When both ureters require reimplantation, parallel tunnels in a unilateral psoas hitch are used, one ureter being mobilised and re-routed across the midline below the root of the inferior mesenteric vessels (Turner-Warwick and Worth 1969).

To facilitate the tunnel reimplantation of the ureter 0 stay sutures are inserted on either side of the proximal margins of the elongated incision and traction maintained by appropriately placed haemostats, the tips of which are hooked under the margin of the abdominal ring retractor.

4. The length of the sub-urothelial tunnel required to prevent vesico-ureteric reflux is naturally proportional to the calibre of the ureter—a ureter of normal diameter requires a tunnel of about 3 cm. The need for "tailoring" of a large-calibre ureter 2 cm or more in diameter, and the potential complications of this procedure, can be avoided by extending the length of the implantation tunnel to 10–14 cm, from the psoas hitch down to the trigone (Turner-Warwick 1972); the calibre of even larger ureters can be reduced before implantation by a simple in-rolled plication (see Chap. 44, p. 489).

5. With the bladder-elongating incision stay-suture retracted supero-laterally the sub-urothelial ureteric tunnel is easily created with Lahey–McIndoe scissors, starting externally just behind the neo-fundus of the elongated bladder. When the scissor-blades are visualised beneath the urothelium, the tissue plane beneath it is developed into a tunnel of appropriate length and width by simple blunt dissection under direct vision using a progressive scissor-tip opening/closing manoeuvre.

At the distal end of the tunnel the scissor-tips are pushed through the urothelium and inserted into the lumen of a 20 FG catheter which is then withdrawn through the tunnel length. This ensures that a tunnel of appropriate width for the implantation of a normal ureter has been achieved, and the catheter lumen is then used as a guide for the pull-through passage of the 8 FG stenting catheter, anchored to the spatulated end of the ureter.

6. The ureter is gently pulled though its reimplantation tunnel by traction on its stenting catheter and anchor suture. The distal spatulated end of the ureter is firmly anchored to the margins of the distal end of the tunnel by interrupted 4–0 polyglycolic acid (PGA) sutures.

It is most important that the determined length of the reimplantation tunnel should be maintained by similar interrupted anchoring sutures between the adventitia of the ureter and the margins of the bladder wall at its entry site. The two anterior full-thickness sutures also include a small bite of the urothelium to ensure that full length of the sub-urothelial tunnel is maintained.

The apex of the bladder elongation is fixed to the psoas on either side of the ureteric entry with four or five interrupted 0 PGA sutures. When present, the psoas minor tendon can be used for anchorage, but otherwise large bites of the psoas muscle are taken, carefully avoiding the genitofemoral and lumbosacral nerves, with the sutures loosely tied to avoid strangulation. The psoas hitch anchorage does not create any tension on the elongated bladder; its purpose is simply to avoid distraction of the reimplantation by detrusor contraction.

A 16–18 FG Malecot catheter is inserted into the bladder before the elongating horizontal incision is closed vertically, by two layers of running 2–0 PGA sutures. The stenting catheter is usually exteriorised through the bladder and abdominal walls and a Penrose drain placed in the paravesical area. The abdominal-approach incision is closed.

## Advantages of the Psoas-Hitch Procedure

In the author's opinion the bladder-elongation psoas-hitch procedure has clear advantages over the classic Boari flap procedure:

1. A comparable elevation of the bladder is achieved by a much simpler incision in its wall.
2. The minimal incision does not impair the vascularisation of the elongated bladder. Consequently the psoas-hitch procedure can be used when the vascularity of the bladder wall is impaired by intramural pathology such as schistosomiasis or irradiation, which may preclude the raising of a long Boari flap.
3. The effective width of the elevated apex of the elongated bladder is much greater than that of a Boari flap; this greatly facilitates a reflux-preventing tunnel reimplantation of one or both ureters and even enables it to be used for the implantation of large-diameter ureters without tailoring.
4. The vertical closure of the horizontal elongating incision is simple and secure compared with the long suture line required to tubularise a Boari flap. Moreover, the closure of the "angles" at the relatively narrow base of the Boari flap is notoriously difficult.
5. Provided the bladder capacity is approximately normal, the bladder-elongation procedure can be used even when the bladder wall is grossly thickened as a result of hypertrophy, a situation which may compromise or preclude tubularisation of a Boari flap. However, gross trabeculation may preclude a submucosal tunnel reimplantation of the ureter and in such cases reflux prevention may be achieved by the Turner-Warwick split-cuff nipple procedure (Turner-Warwick and Ashken 1967; see Chap. 44, p. 491).
6. The endoscopic surveillance of the urothelium of a psoas-hitched bladder elongation is not compromised, and a rigid ureteroscope can be introduced to the in-line ureteric tunnel reimplantation without difficulty. Pan-urothelial endoscopy tends to be compromised after a Boari flap procedure, so this procedure is generally contraindicated when follow-up endoscopy and electrosurgical control of a bladder tumour is likely to be required.

## Indications

For the reasons listed above, the psoas-hitched bladder elongation is the simplest procedure for the substitution of the lower third/half of the ureter. The common indications for it are:

1. Obstruction of the lower ureter
2. Ureteric fistulae resulting from pelvic surgery

3. Vesical fistulae close to, or involving, the lower ureter
4. The resolution of persistent reflux or obstruction after previous ureteric reimplantations
5. Resection of the lower ureter for localised transitional cell tumour
6. Reimplantation of dysfunctional duplications of the upper urinary tract
7. The reflux-preventing reimplantation of large-calibre ureters without tailoring. (Turner-Warwick 1972, 1982; see Chap. 44).

## References

Turner-Warwick R (1972) Reimplantation of large calibre ureters without tailoring. Inst of Urology. Film: Br Assoc Urol Meeting, 1972

Turner-Warwick R (1982) The reflux-preventing reimplantation of large ureters without reduction tailoring. In: Proceedings of the 19th international congress of the Société Internationale D'Urologie, San Francisco. Abstract 711, p 202

Turner-Warwick R, Ashken MH (1967) The functional results of partial, subtotal and total cystoplasty with special reference to uretero-caeco-cystoplasty, selective sphincterotomy and cysto-cystoplasty. Br J Urol 39: 3–12

Turner-Warwick R, Worth PHL (1969) The psoas hitch procedure for the replacement of the lower third of the ureter. Br J Urol 41: 701–709

Turner-Warwick R, Worth PHL, Milroy EJ, Duckett J (1974) The suprapubic V incision. Br J Urol 46: 39–45

*Chapter 10*

# Double-J Stents

*J. C. Gingell and M. J. Stower*

As with many innovative developments the insertion of double-J stents has now become a standard procedure, so much so that it is difficult to remember how one managed without them. Many practising urologists have witnessed the demise of the T-tube, so frequently inserted after open ureteric surgery, and have experienced the value of the double-J stent inserted endoscopically in the management of the obstructed ureter, whether caused by stone or stricture. The immediate management of retroperitoneal fibrosis (Deane et al. 1983), acute hydronephrosis of pregnancy (Lowes et al. 1987) and ureteric obstruction caused by sloughed papillae or matrix normally with a closed renal infection are valuable applications that complement or obviate the need for percutaneous nephrostomy and, occasionally, dialysis.

The first purpose-built self-retaining stents were described by Zimskind et al. (1967) and Marmar et al. (1970), but were difficult to insert and tended to migrate (Gibbons et al. 1974). These early silicone stents were moulded with barbs and a flange at the lower end which prevented upward migration but made insertion more difficult (Gibbons et al. 1976). The development of flexible tips in the stents, however, improved the success rate of insertion (Rutner and Fucilla 1976). The modern stents are soft silicone catheters with a "self memory" J at each end which is straightened by the insertion of a guide wire (Finney 1978). The stents are usually inserted endoscopically via a catheterising cystoscope but can also be inserted at open operation and occasionally by the antegrade and percutaneous routes.

## Endoscopic Insertion (Fig. 10.1a)

It is important to select the correct length and appropriate diameter of the stent. Some "universal" stents are available which rely on the

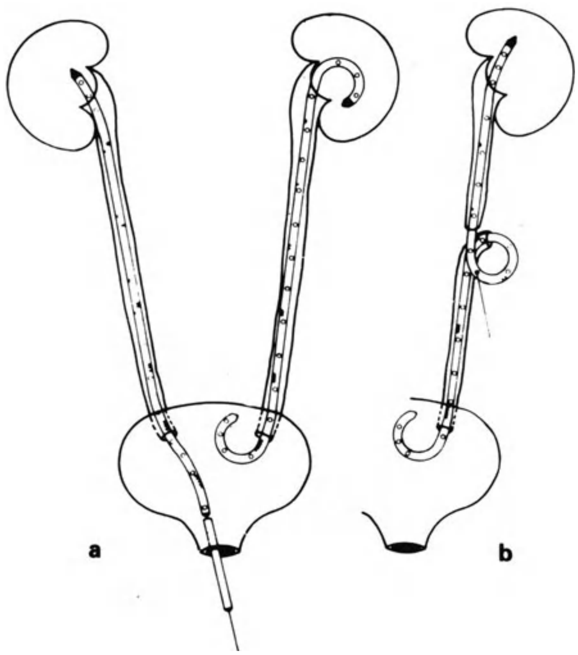


**Fig. 10.1a,b.** Insertion of double-J stent: **a** endoscopic insertion; **b** open insertion. (Reproduced by courtesy of Medical Engineering Corporation, Racine, Wisconsin)

principle of a coiled "spring-like" lower end; however, if they are used in ureters of less than average length too many coils are present in the bladder and downward migration of the stent can be a problem. The prior passage of a standard calibrated ureteric catheter gives a good guide to the length of stent required. It is not essential to use radiological screening or on-table X-ray films for the passage of ureteric stents, but if these facilities are readily available then they can be utilised and are a useful refinement. The two methods of passing a ureteric stent are described below.

## Method 1

The simplest technique is to pass the guide wire (preferably calibrated) up the ureter to the renal pelvis and then to slip the "open-ended" stent and following pusher catheter on to the guide wire. The stent and follower are then advanced over the guide wire via the cystoscope and up the ureter until the junction between the stent and following catheter is seen in the bladder several centimetres from the ureteric orifice. The guide wire is then removed by the assistant or scrub nurse while the operator holds the following catheter to prevent the stent from being inadvertently drawn down by the guide wire.

## Method 2

The "closed-ended" stent is mounted on its guide wire together with the following pusher catheter. The role of the scrub nurse or assistant is to maintain an even, steady push on the guide wire while the operator grips the junction of the pusher catheter and the stent between thumb and index finger to prevent the tip of the stent from slipping off the end of the guide wire and bending back on itself. Once the stent has been introduced into the lower ureter and the junction of the pusher catheter and stent passes through the rubber nipple into the cystoscope, the operator must now grip the distal end of the pusher catheter together with the contained guide wire and the assistant supports the pusher catheter to allow the continued passage of the stent up the ureter. It is important to avoid kinking the guide wire within the stent, which can occur if the cystoscope is not kept close to the ureteric orifice. The stent is passed until the junction of stent and pusher catheter is seen in the bladder. The pusher catheter is then held by the operator while the assistant withdraws the guide wire. As in the previous method described the lower end of the stent can then be observed to curl upwards on removal of the wire to form a curve away from the trigone. The correct position of the stent can then be confirmed by screening or by an on-table X-ray film if considered necessary.

In both methods of insertion it is advisable to use a 30° telescope and obviously a cystoscope of sufficient size to allow the passage of the stent between the sheath of the instrument and the telescope. It is important to use an Albarran bridge mechanism and to stay as close as possible to the ureteric orifice in order to be able to exert sufficient pressure to introduce the stent and pass it up the ureter without kinking the wire, which may occur if too much distance is allowed between the end of the cystoscope and the ureteric orifice. The bladder should be as empty as possible, and if irrigation is used during insertion it should be just sufficient to maintain vision.

If one is dealing with a ureteric stricture of whatever aetiology it is preferable to dilate the stricture first and not rely on the stent to do so. This is achieved by introducing the graduated flexible dilators over a guide wire, passed up the ureter, before the introduction of a ureterorenoscope. The same mechanism can be employed to disimpact a large ureteric calculus into the renal pelvis prior to the passage of a ureteric stent to prevent the stone from returning into the ureter, before extracorporeal shock wave lithotripsy (ESWL) or percutaneous removal is undertaken.

## Open Insertion (Fig. 10.1b)

In modern urological surgical practice the double-J stent has replaced the T-tube. The advantages of the double-J stent are compelling: (1) no external urinary drainage via a small tube that often became kinked, obstructed and, despite seemingly adequate fixation, displaced; (2) no increased risk of infection which accompanies external urinary drainage; and, (3) of paramount importance, better patient comfort and convenience. The only disadvantage is that the stent subsequently requires endoscopic removal, but this is a simple outpatient or day-case procedure requiring only urethral anaesthesia in the female and most male patients.

### Technique

It is not so straightforward to estimate the length of stent required at open operation as it is when placing a stent endoscopically. It is best to err on the side of generosity, as a few centimetres extra in the bladder is preferable to inserting a stent that does not enter the bladder and occupies the lower ureter. The guide wire is inserted into a side hole of the stent and passed until the proximal end is straightened. The straightened stent is then passed into the renal pelvis and the guide wire removed. The guide wire is then inserted into a side hole of the stent at the ureterotomy, and the distal portion of the stent is straightened and passed down the ureter into the bladder. The guide wire is removed and the ureter closed over the stent. A drain is always inserted down to the site of the operation.

## Antegrade or Percutaneous Insertion

Occasionally, it may be advisable to pass a double-J stent down the ureter from the renal pelvis after percutaneous manipulation, usually for stone, and particularly if the renal pelvis has been "breached". The techniques described for the more usual retrograde placement are both appropriate. Experienced "interventional" radiologists are able to manoeuvre "floppy" tipped arterial guide wires down the ureter to the bladder via needle nephrostomy and, with limited dilation over the guide wire, can then insert a double-J stent.

## Discussion

The indications and complications of the use of double-J stents in our unit in Bristol have recently been reviewed in some detail (Pocock et al. 1986).

### Indications

We have found the prompt insertion of stents to be of particular value in iatrogenic ureteric injury, retroperitoneal fibrosis and acute hydronephrosis of pregnancy. Urinary fistulae following pyeloplasty, ureteric surgery and ureteric injury have all closed within a few days of stent insertion. The role of the double-J stent is well established in the endoscopic management of ureteric calculi. Those stones too large to remove with the ureterorenoscope have been displaced back into the kidney from the ureter and a double-J stent inserted for subsequent percutaneous removal or referral for ESWL. After ureterorenoscopic removal of a ureteric calculus, if manipulation has been prolonged, a double-J stent is inserted "prophylactically".

We have found the double-J stent less successful in the management of malignant obstruction of the ureter most commonly caused by carcinoma of the prostate or bladder. Usually it is not technically feasible to identify the ureteric orifice when the intramural ureter is invaded, although some success has been obtained in malignant retroperitoneal fibrosis. In our limited experience with tuberculous ureteric strictures we have usually been unable to obtain satisfactory stent placement, which probably reflected the severity of fibrous stricturing. The use of stenting in the early inflammatory stage, however, is an attractive alternative to repeated bouginage.

## Complications

The complications of double-J stent insertion can be considered under the following headings:

### *Failure to Insert the Stent*

As with any surgical manoeuvre the success rate improves with experience. Sometimes it is easier to use the softer tip guide wire and railroading technique (method 1) and on other occasions the stent previously mounted on the stiff-ended guide wire (method 2). If a ureteric catheter can be passed to the renal pelvis then one should be able to pass a stent. If method 2 is attempted and fails, then method 1 should be tried, but the stiff-ended guide wire should not be used as it may be passed through the side wall of the ureter. If a stricture or impacted stone is being dealt with, then the tapered ureteric dilators should be used first.

### *Perforation of the Ureter*

Perforation of the ureter can largely be avoided if the above advice is followed. If X-ray control is not being used and difficulty is encountered, then undue force must not be used. Instead, an image intensifier (C-arm) should be used to obtain a bulb ureterogram to ascertain the cause of the problem. Perforation of the ureter by the stent requires its removal. On the few occasions that this has occurred in our unit no complications resulted except for pain caused by extravasation in one patient.

### *Migration of the Stent*

We have observed upward migration of the stent in 2 of 100 patients. The mechanism in one was due to surgical manipulation of a ureter during an operation for retroperitoneal fibrosis with a previously inserted stent in situ. A plain abdominal X-ray film several months after surgery showed the lower end of the stent at the pelvic brim. The stent was easily removed with the ureterorenoscope. The other patient had an acute hydronephrosis following a pyeloplasty and may not have had the stent properly sited at the original operation.

Downward migration was more common (7 of 100 patients). Of the three pregnant women, two passed their stents spontaneously after 8 and 10 weeks in situ, respectively, probably as the result of the physiological dilatation of the ureter in pregnancy. In the remaining patients the stents were either too long or of the "universal length" variety with too much redundant stent in the bladder. If the upper end of the stent is not in the pelvis then spontaneous downward migration can be expected.

### *Encrustation of the Stent*

Encrustation is a remarkably infrequent complication. It occurred in our series in only three stone formers in the presence of urinary infection (*Bacillus proteus*) and in one other non-stone former who also had infection with a urea-splitting organism. However, it is a serious complication, and precautions must be taken to prevent its occurrence. All stents must be removed at the earliest opportunity after serving their purpose. All patients must be encouraged to maintain a high fluid intake, and we advise the majority to take prophylactic antibiotic therapy (usually trimethoprim) in addition. Patients with a stent in situ must have regular mid-stream urine specimens examined for infection and plain abdominal X-ray films to detect encrustation. The latter may not be readily recognised, however, because of the low density of the calculus formation. In two of our patients the calculus formation at the upper end of the stent in the renal pelvis prevented endoscopic removal of the stent, which snapped in mid ureter on attempted removal. Percutaneous removal of the stent, together with the stone fragments, was required in one patient, and urgent open surgical removal in the other because of septicaemia.

If the stent is not removed during the patient's stay in hospital, firm arrangements must be made for subsequent removal to prevent it being overlooked. The majority of stents, however, remain encrustation free and in pristine condition when removed. We have had patients with stents in situ for as long as 2 years without any complications.

## Summary

Self-retaining double-J ureteric stents are of value in a wide range of conditions routinely encountered in urological practice. The technique of insertion is simple to follow and can be readily undertaken by anyone

experienced in the passage of ureteric catheters. Complications are relatively few and can be obviated by a careful technique and close follow-up.

## References

Deane AM, Pentlow BD, Gingell JG (1983) Ideopathic retroperitoneal fibrosis – the role of autotransplantation. Br J Urol 55: 254–256

Finney RP (1978) Experience with new double J ureteral catheter stent. J Urol 120: 678–681

Gibbons RP, Mason JT, Correa RJ (1974) Experience with indwelling silicone rubber ureteral catheters. J Urol 111: 594–599

Gibbons RP, Correa RJ, Cummings KB, Mason JL (1976) Experience with indwelling ureteral stent catheters. J Urol 115: 22–26

Lowes JJ, MacKenzie JC, Abrams PH, Gingell JC (1987) Acute renal failure and acute hydronephrosis in pregnancy: use of the double J stent. J R Soc Med 80: 524–525

Marmar JL (1970) The management of ureteral obstruction with silicone rubber splint catheters. J Urol 104: 386–389

Pocock RD, Stower MJ, Ferro MA, Smith PJB, Gingell JC (1986) Double J stents: a review of 100 patients. Br J Urol 58: 629–633

Rutner AB, Fucilla IS (1976) Flexible tip ureteral catheters in clinical practice. J Urol 115: 18–21

Zimskind PD, Fetter TR, Wilkerson JL (1967) Clinical use of long term indwelling silicone rubber ureteral splints inserted cystoscopically. J Urol 97: 840–844

*Chapter 11*

# Renal Autotransplantation

*Christine M. Evans*

## Introduction

Renal autotransplantation was first performed successfully in 1962, for the management of ureteric injury (Hardy 1963). The kidney can be removed and reinserted (usually into the iliac fossa) with or without an extracorporeal procedure (bench surgery). Since 1962 a large number of autotransplants have been reported for a greater number of reasons, with increasing enthusiasm. Many of these patients would probably be better managed by more conventional medical and surgical methods. The time has come to evaluate the role of renal autotransplantation and identify which conditions could be treated by this technique.

## Indications

### Vascular Disease

The majority of renal autotransplantations have been performed for extensive renovascular disease (Marshall et al. 1966; Belzer et al. 1970), either caused by fibromuscular dysplasia or atherosclerosis. The disease process in atherosclerosis may be confined to the renal artery but is also likely to affect the aorta itself. There is also an indication for this procedure in the management of severe aortic disease (aortic aneurysm or aortoileal occlusive disease) (Libertino et al. 1980). The need to use this procedure for renal artery occlusion in preference to conventional in situ revascularisation techniques is rare. Of more than 600 operations only 1 was managed by renal autotransplantation (Stewart et al. 1984). This patient had extensive aortic atherosclerosis with an occluded single functioning right kidney which was transplanted into a reasonable right common iliac artery leaving the ureter intact.

In the Cleveland Clinic between 1971 and 1979 10 out of 360 patients with renal artery occlusion required renal autotransplantation. Of those 10 patients, 9 were cured postoperatively (Novick and Stewart 1984).

Should surgery of any kind be contemplated for renovascular disease in the light of better medical management and percutaneous transluminal angioplasty (PTA)? A great deal of enthusiasm has greeted this latter procedure, which has a low complication rate of 5% (Grim 1981). The results of the technique vary from a 17% cure rate in patients with atherosclerotic renal disease to 67% in patients with fibromuscular disease. However, the procedure is quite easily repeated and should be considered initially in surgical management. Open surgery can always be considered later, if needed; if PTA fails it does not preclude open surgery.

The role of renal vein renin ratios in renal artery stenosis still also remains a matter of controversy. If there is no excess renin production from the affected side it does appear that the likelihood of surgery curing the hypertension is reduced. Also the persistence of hypertension following surgery is not necessarily associated with reocclusion of the vessels but may be due to irreversible renal damage, repair of a stenosis which was not the cause of the hypertension or coexistent non-hypertensive renal disease (Horvath and Tiller 1983).

However, there do appear to be guidelines for surgical intervention, which may be listed as follows:

1. If the main renal artery is involved either by fibromuscular disease or atherosclerosis and is amenable to local resection or in situ bypass, these surgical procedures are indicated.
2. If the blood pressure is very difficult to control by medical means in the presence of unilateral renal atrophy, nephrectomy is indicated.
3. If there is extensive atherosclerosis and good renal reserve, medical treatment should be continued.

As to the indications for autotransplantation with extracorporeal arterial reconstruction, it is suggested that good-risk patients with progressive disease involving segmental branches would benefit (Belzer et al. 1970). The most likely patients to require autotransplantation in terms of numbers are those with severe aortic atherosclerosis in the absence of significant iliac disease. Although the suprarenal aorta is usually less affected by the disease process and thus both splenorenal anastomosis on the left and hepatorenal anastomosis on the right offer excellent alternatives, renal autotransplant can be considered. If, in addition, aortic replacement is considered, it has been advised that a two-stage approach is considered (Libertino et al. 1980). Renal revascularisation performed at the initial operation followed 3 months later by aortic replacement has reduced the operative mortality from 40%, with the simultaneous aortic and renal reconstruction, to 4%.

The condition of middle aortic syndrome has also been treated with renal autotransplantation (Kaufman 1973). This is an entity characterised by non-stenosing arteritis and is a variant of Takayasu's disease. The aetiology is unknown but it affects young women mainly, giving rise to occlusion of the branches of the abdominal aorta with intestinal angina, hypertension (secondary to renal artery stenosis) and occasionally intermittent claudication. Because of occlusion of the coeliac axis, splenorenal or hepatorenal bypass procedures may not be possible for the treatment of the renal artery stenosis; renal autotransplantation offers a good alternative.

Thus renal autotransplantation is infrequently indicated in the surgical treatment of renovascular disease. Extracorporeal branch arterial repair is indicated if the vessels involved are less than 1.5 mm, thus making in situ repair difficult, and also if preoperative arteriography demonstrates intrarenal extension of renovascular disease. It is also indicated when renovascular occlusion is associated with abdominal aortic disease and relatively disease-free iliac arteries.

## Ureteric Disease

The first successful renal autotransplants were done for high ureteric injuries (Hardy 1963; Marshall et al. 1966). Indications have included extensive iatrogenic ureteral trauma after ureterolithotomy, left colectomy, transuretero-ureterostomy and stripping of the ureter following endoscopic stone basketing, when the site or extent of the ureteric damage has excluded reanastomosis or neo-ureterocystostomy and the method has been preferred to ileal substitution (Stewart et al. 1984). Other conditions for which this procedure has been done are multiple ureteric tumours and tuberculous ureteritis. Also this procedure has been used for persistent outflow obstruction and pain after unsuccessful pyeloplasty (Ranch et al. 1985). In addition, bilateral renal autotransplantation has also been reported (Stewart et al. 1976) as a staged procedure for retroperitoneal fibrosis and urinary fistula following diversion. Renal autotransplantation is extremely difficult in the presence of perirenal or renal sepsis or in the presence of a nephrostomy. Sepsis would make the procedure very hazardous indeed in view of the probable infection, which might occur at the vascular anastomosis, and thus increase the possibility of secondary haemorrhage.

Novick and Stewart (1984) reported on 10 renal autotransplants performed on 8 patients with extensive ureteral disease. Eight were successful. The two failures were in patients with severe perirenal inflammation and fibrosis. It would therefore appear that unilateral renal autotransplantation is not needed if the other kidney has adequate function, as nephrectomy would be safer. In bilateral disease or in the presence of a single kidney, autotransplantation may offer the best long-term solution but is not advised in the presence of sepsis.

## Renal Neoplasia

Renal adenocarcinoma in a single kidney is a good indication for considering renal autotransplantation with bench surgery, especially if the tumour is sited in the middle portion or is extensive (Calne 1971). If the tumour is sited at either pole, partial nephrectomy with or without temporary vascular occlusion should give adequate resection. Stewart (1984) reported on 17 patients with a tumour in a single kidney over a period of 20 years. One patient underwent partial nephrectomy with bench surgery and autotransplantation, and two others, before the advent of extracorporeal perfusion techniques, would have benefited from the same technique. It is a probable estimate that 20% of patients with a carcinoma of the solitary kidney should be considered for autotransplantation.

### Renal Calculous Disease/Renal Trauma

Extensive renal nephrolithiasis has been considered an indication for bench surgery (Gil-Vernet et al. 1975). In situ anatrophic nephrotomy (Smith and Boyce 1968) will allow for the removal of even the most extensive renal calculi, and thus it is unlikely that autotransplantation still needs to be considered for renal calculi.

More controversial is the problem of autotransplantation and pyelocystostomy for recurrent intractable ureteric colic from the passage of renal calculi down the ureter requiring both excessive analgesia and repeated ureterolithotomy. Again, newer techniques of stone removal, including rigid ureteroscopy, percutaneous nephrolithotomy and extracorporeal shock wave lithotripsy, will treat most patients.

The haematuria/loin pain syndrome has also been treated by autotransplantation (Sheil et al. 1985). The rationale for this could be the reduction in colic from the passage of small clots or renal denervation. This is a non-life-threatening condition and, although it is difficult to treat, renal autotransplantation seems difficult to justify.

Following trauma, the technique involving removal of severely damaged kidneys, repair of the damage and organ perfusion has been reported. Autotransplantation as a secondary procedure when the patient has stabilised is then performed (Corman et al. 1973). The need for this procedure would be extremely rare, arising only in the case of life-threatening haemorrhage from the trauma in the presence of a single kidney.

The reconstruction of donor kidneys with vascular anomalies, either from cadavers or live relatives, although included in articles on autotransplantation, is really a separate issue and is a procedure frequently undertaken in the practice of renal transplantation.

## Methods of Autotransplantation

Evaluation preoperatively should include renal and aortic arteriography. Patients for surgery should not have extensive cardiovascular/pulmonary problems, and those with solitary kidneys should be informed of the possiblity of postoperative renal replacement therapy, e.g. haemodialysis.

The kidney will benefit from a good diuresis during the time of surgery prior to clamping of the vessels.

The operative methods will differ if extracorporeal repair (bench surgery) is required. In patients with ureteric lesions or renal artery lesions confined to the main renal artery, the removed kidney is perfused with chilled perfusate (intracellular solutions: Collins, Marshalls, Sacks) until the effluent from the renal vein is clear. Anastomosis of the renal artery and vein to the prepared iliac vessels is then performed. The vein is anastomosed end-to-side to the external iliac vein. The renal artery is anastomosed either end-to-end to the internal iliac artery or end-to-side to the external iliac artery. The time between clamping and cooling is important, but once the kidney is chilled time is less important. The kidney should start functioning immediately after it has been reanastomosed. In the presence of renovascular disease the ureter can be left untouched, and although it is rather long and redundant it drains adequately. In the presence of ureteric disease urinary continuity can be restored by uretero-neocystostomy or uretero-ureterostomy. (Fig. 11.1).

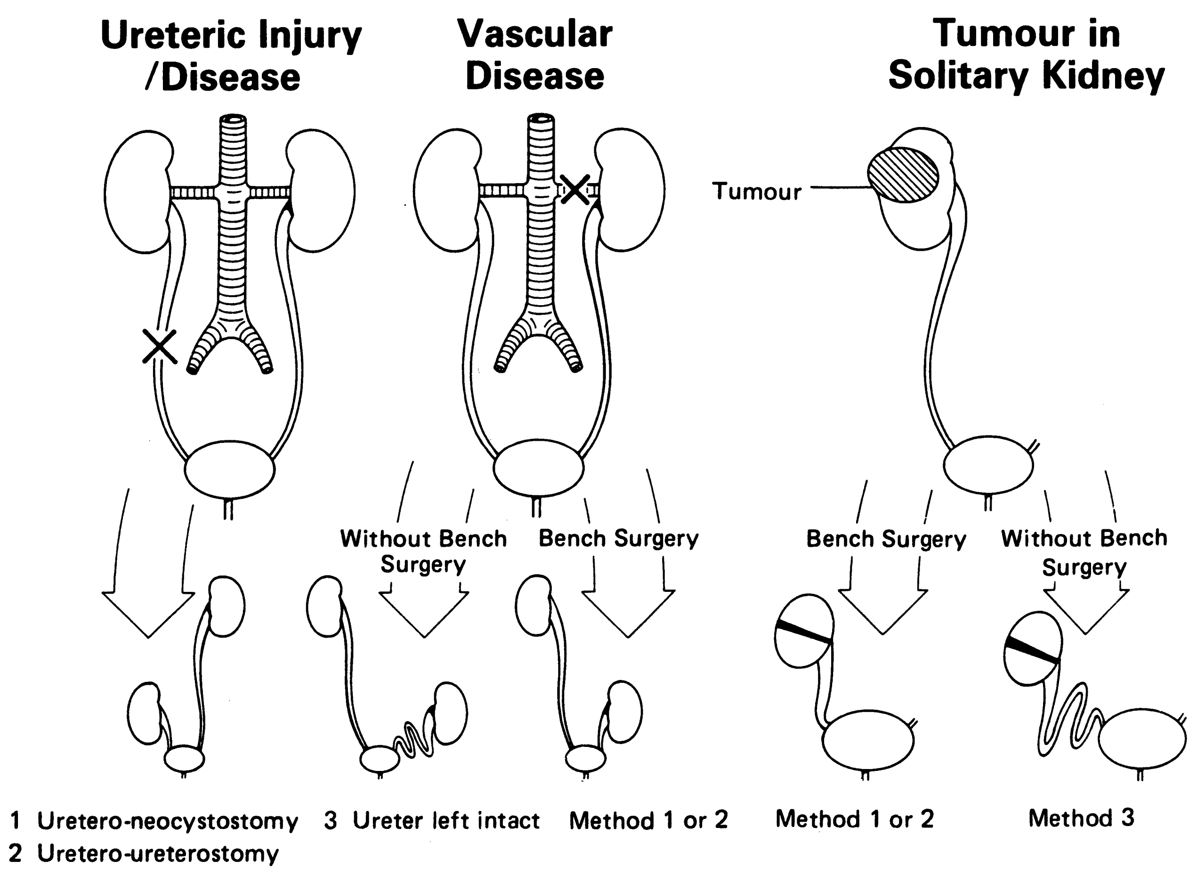


**Fig. 11.1.** Methods of autotransplantation.

If extracorporeal surgery is required, as in removal of a tumour, radical nephrectomy is performed and the kidney perfused as above. If possible the ureter is left intact, as the collateral blood supply to the renal remnant will be improved. This means that the kidney perfusion and partial nephrectomy will need to be performed on the anterior abdominal wall. Dissection of the tumour should begin at the hilus; arteries and veins to the tumour should be ligated but those to normal kidney remain untouched. The tumour should be removed with a 2 cm margin. In order to ensure the tumour has been cleared, tumour-free margins can be checked by frozen section. The capsule is then closed and the kidney reinserted as above.

When performing bench surgery for renal revascularisation it is advisable to remove the kidney entirely and work on a separate bench as this method is less cumbersome and magnification techniques easier to apply. Pre-fashioned saphenous vein grafts, vein patches or branched internal iliac artery autograft are the best materials to use for vascular reconstruction. It is recommended that after the arterial repair is completed, before autotransplantation, the kidney is placed on a pulsatile perfusion unit at systolic pressure where anastomotic leaks can be identified. Also, indigo carmine can be perfused to indicate patency of the branch vessels. The kidney is then reinserted as above with reimplantation of the ureter.

## Conclusion

Indications for renal autotransplantation are few but include renovascular disease with or without aortic atherosclerosis, partial nephrectomy for tumours in solitary kidneys and extensive ureteric disease in the absence of sepsis. A surgeon trained in transplantation techniques may well consider autotransplantation in preference to small bowel substitution in the case of ureteric damage, as it is certainly no more hazardous. It is important to determine that the operation is necessary and to ensure that it is not embarked upon lightly.

## References


Belzer FO, Keaveny TV, Reed TW, Pryor JP (1970) A new method of renal artery reconstruction. Surgery 68: 619–624

Calne RY (1971) Tumour in a single kidney, nephrectomy excision and autotransplantation. Lancet II: 761–762

Corman JL, Anderson JL, Taubman JT, Stables J et al. (1973) Perfusion arteriography and autotransplantation procedures for kidney salvage. Surg Gynecol Obstet 137: 659–665

Gil-Vernet JM, Caralps A, Revert L et al. (1975) Extracorporeal renal surgery. Urology 5: 444–451

Grim CE (1981) Percutaneous transluminal dilatation: the treatment of choice for renal artery stenosis causing hypertension. Am J Kidney Dis 1: 186–187

Hardy JD (1963) High ureteral injuries. Management by autotransplantation of the kidney. JAMA 184: 97–101

Horvath JS, Tiller DJ (1984) Indications for renal artery surgery: a review. J R Soc Med 77: 221–226

Kaufman JJ (1973) The middle aortic syndrome: report of a case treated by renal autotransplantation. J Urol 109: 711–715

Libertino JA, Zinman L, Breslin DJ, Swinton NW, Merle A (1980) Renal artery revascularization: restoration of renal function. JAMA 244: 1340–1342

Marshall VF, Whitsell J, McGovern JH, Miscall BG (1966) The practicality of renal autotransplantation in humans. JAMA 196: 138–140

Novick AC, Stewart BH (1984) Indications for renal autotransplantation. In: Whitehead E, Leiter E (eds) Current operative urology. Harper and Row, Philadelphia, pp 204–214

Ranch T, Brynger H, Granerus G, Henriksson CH, Nilson AE, Petterson S (1985) Function of human autologous kidney grafts after extracorporeal perfusion with Sacks 11 solution. Br J Urol 57: 380–385

Sheil AGR, Ibels LS, Thomas MAB, Graham JC (1985) Renal autotransplantation for severe loin pain/haematuria syndrome. Lancet II: 1216–1217

Smith MJV, Boyce WH (1968) Anatrophic nephrotomy in plastic calyrhaphy. J Urol 99: 521–527

Stewart BH, Hewitt CB, Banowsky LH (1976) Management of extensively destroyed ureter. Special reference to renal autotransplantation. J Urol 115: 257–261

Stewart BH, Banowsky LH, Hewitt CB, Straffon RA (1984) Renal autotransplantation: current perspectives. In: Whitehead E, Leiter E (eds) Current operative urology. Harper and Row, Philadelphia, pp 197–204

*Chapter 12*

# Omento-ureteroplasty and Omento-skin-patch Substitution Ureteroplasty

*Richard Turner-Warwick*

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The results of ureteric surgery are often compromised by the characteristics of the surrounding fatty tissue, which is poorly vascularised and resists infection badly. Consequently, almost any healing reaction tends to result in fibrosis, which often forms a dense frozen mass around a ureterotomy or a reconstruction. This may compromise its urodynamic mobility and function.

Although the macroscopic appearances of the omentum have a general resemblance to peri-ureteric fat, it is in fact the only body tissue that is specifically developed for the resolution of inflammatory processes—a function which is as much dependent upon its highly developed lymphatic drainage system as its blood supply, because it is this that ensures the efficient transportation of inflammatory debris and macromolecular exudates that would otherwise accumulate and form pus (Turner-Warwick et al. 1967).

However, although long since emphasised (Turner-Warwick 1976), the additional "urodynamic value" of a pedicled omental graft wrap in functional reconstructions is not as widely recognised and used as perhaps it should be. Quite unlike peri-ureteric fat, the omentum regains its suppleness after the resolution of a local inflammation, thus preventing immobilisation by fibrosis and preserving the freedom of the urodynamic excursion of a reconstructed ureter or sphincter mechanism and the natural expansion and contraction of the bladder. Consequently, in addition to its value as a supporting wrap an omental pedicle graft is an integral component of many functional reconstructions of the urinary tract.

## Indications for the Use of the Omental Wrapping

### Retroperitoneal Fibrosis

Although the ureteric obstruction resulting from idiopathic retroperitoneal fibrosis can sometimes be resolved by simple full-length ureterolysis and lateral transposition, the vascularisation of such a mobilised ureter is precarious and omental wrapping is strongly advocated (Turner-Warwick et al. 1967; Turner-Warwick 1976); indeed the success of a remobilisation procedure after a previous surgical failure is virtually dependent on this.

### Intubated Ureterotomy

The development of intubated ureterotomy by Davis (1943) was a milestone in the surgical management of ureteric strictures. However, the results were often compromised by the characteristic fibrotic healing reaction of the peri-ureteric fat. Undoubtedly the results of simple ureterotomy procedures can be improved, not only by the addition of omental wrapping, but also by the use of a *fenestrated* ureteric stent which drains the peri-catheter space and prevents the development of a "urinoma" resulting from the extravasation of peri-catheter urine in the proximal ureter by peristalsis (Turner-Warwick 1976).

### Other Indications

Other specific indications for omento-ureteric wrapping are the resolution of coincident inflammatory responses associated with ureteroplasty for tuberculosis and adjacent aortic-graft surgery etc. It is also useful as a prophylactic procedure for reducing the natural incidence of complications associated with uretero-ureterostomy, uretero-conduit anastomosis and surface ureterostomy stenosis (Turner-Warwick 1976).

## Substitution Ureteroplasty

The substitution of the lower third of the ureter rarely presents a problem because it is simply achieved by reimplanting the ureter into a psoas-hitched bladder elongation, which, with the extended procedure, can often reach the upper half of the ureter (see Chap. 9, p. 109).

However, substitution/reconstruction of the middle third of the ureter often presents a surgical challenge when a lesion is too extensive for restoration of continuity by a simple spatulated overlap anastomosis.

A pedicled urothelial-island bladder patch, freely mobilised on the basis of the superior vesical vascular pedicle, is sometimes a valid alternative to a bladder-elongation procedure (Turner-Warwick 1972), and the appendix can also be mobilised as a pedicled substitution for the mid-segment of both the right and the left ureter.

## Omento-skin-patch Ureteroplasty

We have used a free full-thickness skin graft supported by an omental pedicle graft on five occasions, both as a hemi-substitution patch to complete the epithelialised circumference of a ureterotomy or a partial circumference anastomosis and as a circumferential tube graft substitution of a ureteric segment (Fig. 12.1). Naturally the augmenting patch graft procedure is preferred to the tube graft when possible, because the hemi-substitution principle is generally more reliable.

One of our five cases developed a short-segment re-stenosis within 2 months which was satisfactorily resolved by redeployment of the proximal uretero-graft anastomosis; this re-exploration was greatly facilitated by the characteristic ease with which the tissue planes of an

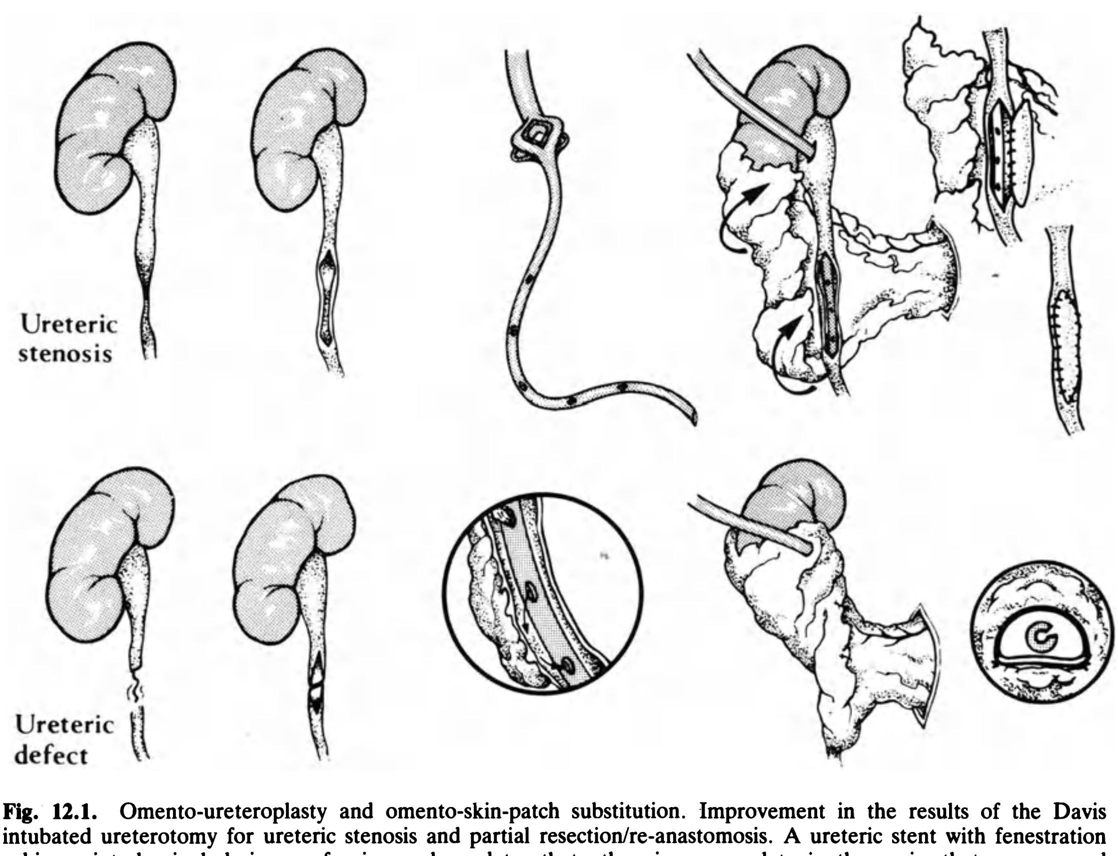
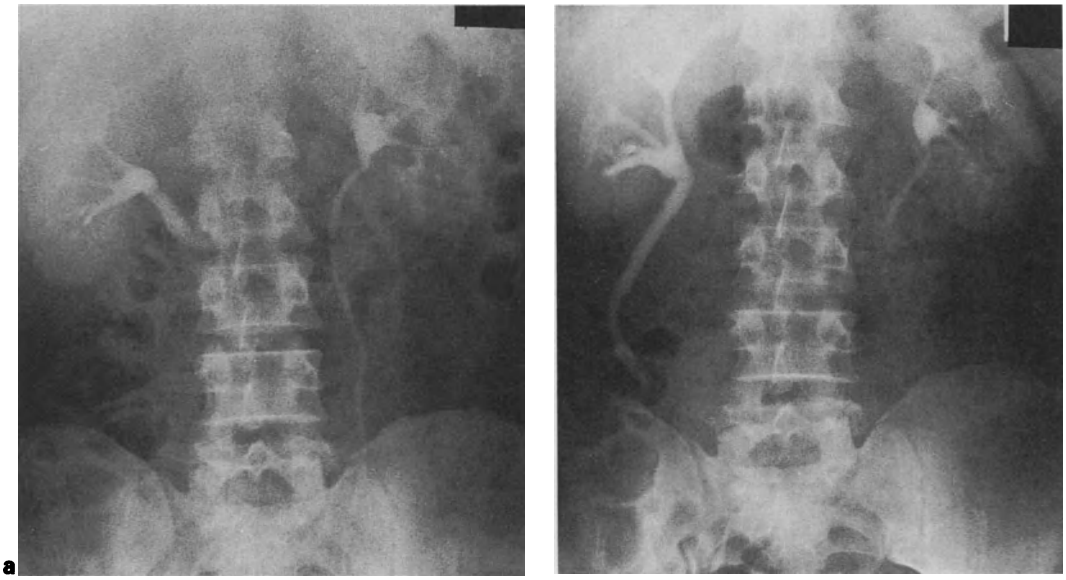



**Fig. 12.1.** Omento-ureteroplasty and omento-skin-patch substitution. Improvement in the results of the Davis intubated ureterotomy for ureteric stenosis and partial resection/re-anastomosis. A ureteric stent with fenestration achieves intraluminal drainage of urine and exudates that otherwise accumulate in the peri-catheter space and extravasates through the suture line. Omental wrapping provides a supple vascular support with efficient physiological lymphatic drainage of exudates. Augmentation of a partial ureteric defect or circumferential segmental replacement can be provided by a full-thickness skin graft from the labia or distal penile/foreskin.



a b

**Fig. 12.2a,b.** Intravenous urograms showing 7-year follow-up appearances of free-draining omentum-supported full-thickness skin graft substitution of right ureteric segment in a patient with a retrocaval ureter with a 9 cm atretic segment. **a** Preoperative urogram; **b** postoperative urogram.

omental pedicle graft support can be separated. Three of the patients died as a result of tumour but with freely draining ureteric reconstructions. The two remaining ureteric grafts are functioning satisfactorily after 4 and 7 years, respectively (Fig. 12.2).

Naturally graft failure tends to be rapidly revealed by early re-stenosis, but, once established, an omentum-based free full-thickness graft seems likely to prove stable and stricture free in the long term.

In all cases we specifically chose a "wet skin" donor site, either the foreskin or the labial skin. Our experience with full-thickness skin graft bulbo-penile urethroplasty indicates that grafts of foreskin or labial and buccal epithelia are preferable for urinary tract substitution to those derived from "dry-skin" areas such as the groin, the inner arm and especially the scrotum, which are poorly adapted to a moist environment (Turner-Warwick 1985).

## References

Davis DM (1943) Intubated ureterotomy: a new operation for ureteral and ureteropelvic stricture. Surg Gynecol Obstet 76: 513–523

Turner-Warwick R (1972) The use of pedicle grafts for the repair of urinary tract fistulae. Br J Urol 44: 644–656

Turner-Warwick R (1976) The use of the omental pedicle graft in urinary tract reconstruction. J Urol 116: 341–347

Turner-Warwick R (1986) The principles of urethral reconstruction. In: Williams DI (ed) Operative surgery: urology. Butterworth, London, pp 480–520 (Rob and Smith's Operative surgery, 4th edn)

Turner-Warwick R, Wynne EJC, Ashken MH (1967) The use of the omental pedicle graft in the repair and reconstruction of the urinary tract. Br J Surg 54: 849–853

Section IV

# Surgical Management of Stress Incontinence

# Introduction

*Paul Abrams and Richard Turner-Warwick*

Stress incontinence is a common condition, the prevalence of which seems highest amongst women in the so-called developed world. However, incontinence has historically carried a severe social stigma, which persists in many societies. Fortunately, in the western world, women are now more prepared to seek help with this condition which often leads to social isolation.

Formerly the assessment of patients with incontinence was by symptoms alone. However, as most women also complain of symptoms other than stress incontinence, such as urgency, frequency and perhaps urge incontinence, symptoms alone rarely allow an accurate diagnosis. In recent years it has become apparent that the selection of patients on symptoms alone is inadequate. This applies equally to the selection of patients prior to surgery as it does to the evaluation of surgical procedures designed for the cure of incontinence.

Hence the introduction of appropriate urodynamic evaluation has led to considerable changes in the treatment of female urinary incontinence, i.e. urodynamics have led to the development of new surgical procedures based on a better understanding of the relevant physiological and pathological factors that lead to incontinence.

## Anatomy of the Sphincter Mechanism

Contrary to prevalent gynaecological concepts the pelvic floor of the female, anterior to the vagina, is devoid of muscle relating to the urethra. A "urogenital diaphragm" containing muscle around the distal sphincter-active urethra is as fictitious in the female as it is in the male. (Chilton and Turner-Warwick 1981).

The sphincter mechanism of the bladder neck is formed by extension of cholinergic smooth muscle detrusor fibres lying concentrically around the internal meatus, together with the proximal fibres of the striated urethral muscle. The intrinsic urethral sphincter is thicker in the anterior urethral wall; posteriorly on the vaginal aspect it is relatively thin. As in the male, it is composed of two layers, the inner smooth muscle and the outer striated muscle. However, unlike that of the male, the striated muscle extends throughout the length of the sphincter-active urethra, as far as the internal meatus, to form a considerable functional component of the bladder neck sphincter.

## Physiology of Continence

Videocystography shows that continence can be maintained either by the bladder neck or by the urethral sphincter, but very rarely between these levels. Continence is maintained despite marked fluctuations in intravesical pressure during periods of stress. Continence during stress depends on the intra-abdominal position of the proximal urethra and bladder neck and on the intrinsic urethral sphincter mechanisms. The question as to whether reflex contraction of the pelvic floor during stress is also important is explored in the chapter on the Stamey procedure (p. 153).

Idiopathic sphincter weakness in young women is not uncommon: 10%–15% of nulliparous women have occasional stress incontinence (J. Osborne 1979, personal communication). Bladder neck incompetence is also common in the asymptomatic older woman: Versi et al. (1986) showed that 50% of such women had an open bladder neck on videourodynamics.

For involuntary urine leakage to occur there must be both bladder neck *and* urethral incompetence. In the "normal" woman the urethral sphincter mechanism alone should be able to resist pressure changes caused either by stress or detrusor contractions. Leakage may result from a combination of descent of the proximal urethra and urethral sphincter weakness, in which case the incontinence is *stress* in type. However, leakage also occurs if a normal bladder neck/urethra reflexly opens in response to strong unstable detrusor contractions, when the incontinence will be *urge* in type.

It is established that urethral relaxation is the first event in normal voiding preceding the onset of the detrusor contraction (Asmussen and Ulmsten 1976). Inappropriate urethral relaxation, in the absence of a detrusor contraction, is an uncommon third cause of urinary leakage —the so-called unstable urethra (James 1979). The finding of fluctuations in urethral pressure during filling is common in both symptomatic and asymptomatic women. In most women these fluctuations are not associated with leakage and are of uncertain clinical significance.

## Significance of Unstable Detrusor Behaviour and the Maximum Detrusor Pressure

A patient's continence is at risk from involuntary bladder contractions (detrusor instability), because this not only opens the bladder neck, but also raises the intravesical pressure. Treatment of incontinence is consequently less satisfactory when associated with unstable detrusor activity. It is even less satisfactory when unstable contractions create abnormally high pressures (Turner-Warwick and Brown 1979).

However, when conservative treatment of unstable stress incontinence fails, patients with low-pressure instability (less than 35 $cmH_2O$) have a fair chance of improvement after a single repositioning procedure. Many females with idiopathic detrusor instability do not leak because the urethra can contain the intravesical pressure rise. Consequently, a marginal improvement of impaired urethral function achieved by repositioning of a prolapsed urethra, may prove sufficient.

Some of our North American colleagues have given a picture of postoperative bliss for women with preoperative bladder instability. This is not our experience, and certainly women with urgency and urge incontinence as well as stress incontinence prior to surgery should be warned of the uncertain effect of surgery on these symptoms. This discrepancy in views can partially be explained by the variable use of the term "detrusor instability". For example, in McGuire and Savastano's paper (1985) there are substantial deviations from the International Continence Society's definition of detrusor instability. This gives a falsely high incidence of instability which, not surprisingly, reduces significantly after surgery. McGuire and Savastano include patients with urgency or fluctuations in urethral pressure as being unstable, despite the lack of phasic contractions on filling cystometry.

## Relationship between Vaginal Prolapse, Vesicourethral Descent and Sphincter Competence

Vesicourethral descent is best identified by videocystography. It may, or may not, result in impaired function of the bladder neck and urethral sphincter. Vesicourethral descent does not necessarily correlate with clinical assessment of anterior vaginal wall laxity. Urodynamically significant descent may be associated with a vault prolapse, which is difficult to assess clinically in the absence of lower vaginal wall laxity.

The evidence from videocystographic studies of more than 6000 females (Turner-Warwick and Whiteside 1982) confirms that many patients with severe vesicourethral descent are continent, either at bladder neck or at urethral level. Furthermore, many patients who have no significant descent have stress leakage. It seems clear that prolapse/descent of a normally functioning bladder neck and/or urethral mechanism does not cause incontinence. The majority of parous women are perfectly continent in spite of an obvious anterior vaginal wall laxity. On the other hand, prolapse/descent of an intrinsically weak bladder neck/ urethral sphincter is commonly associated with stress leakage.

## Patient Assessment

The discussion as to the most appropriate therapy for stress incontinence has been clouded for many years by the difficulty of comparing the results of different techniques performed by different surgeons in different centres. Most authors reporting the effects of their favourite surgical procedure have not adequately categorised their patients in terms of diagnosis and severity of incontinence. The most frequent failures have been that of grading the severity of incontinence and the importance of associated urge incontinence caused by bladder instability.

### Symptoms

Incontinence can usefully be graded from symptoms by the use of a frequency/volume chart to record the number of leaks per day and the number of incontinence pads required to deal with that leakage. (Incontinence can also be graded according to the findings on video-urodynamics: Blaivas 1985).

In mixed incontinence (urge and stress) it is vital to assess the most troublesome type of leakage and to treat it accordingly. The patient with severe bladder instability and stress incontinence that occurs once a year, when she has a cold, is unlikely to be helped by surgery for her stress incontinence.

### Physical Examination

The observation of instantaneous cough/leak when the patient's bladder is full is a valid finding. In patients without urgency or urge incontinence (suggestive of detrusor instability) such observations are probably adequate for the decision to proceed with surgery. However, recent work suggests that even patients who have the symptom of stress incontinence without other complaints should be urodynamically assessed (Byrne et al. 1987). The prognostic values of the Q tip test and the Bonney Marshall test are poor.

### Urodynamic Evaluation

Urine flow studies are useful to the extent that low flow may indicate relative outflow obstruction caused by detrusor underactivity or urethral obstruction. Patients with detrusor underactivity need to be counselled that surgery may result in some voiding difficulty. However, it is probably better that such a patient should be further evaluated by cystometry.

The filling and voiding cystometry not only allows the clinician to confirm stress incontinence but also to assess coexisting detrusor instability and to estimate the detrusor contractility during voiding, by the stop test. There is evidence that the patient with an underactive detrusor showing a small isometric rise (or no rise) in pressure on interruption of the urinary stream will have voiding problems after stress incontinence surgery.

Urethral pressure profilometry, by both static and stress methods, is of some value in assessing the stress incontinent patient. However, these tests must be performed with meticulous technique and interpreted with caution.

Video-urodynamics, if readily available, is the best method of assessment, allowing the visualisation of the lower urinary tract at the same time as pressure and flow measurements are recorded. The technique is particularly important in the patient with recurrent stress incontinence as it may give some clue as to whether the persistent leak is due to a repositioning failure or is a reflection of the intrinsic weakness of the urethral sphincter mechanism. In this way, video-urodynamics may guide the surgeon to a particular therapeutic solution.

## Surgical Treatment of Stress Incontinence

A further problem in comparing one study with another is the variable reliance placed on adjunctive forms of therapy. In some centres physiotherapy is used in a routine manner, as we believe it should be. However, other centres fail to use physiotherapy at any stage in patient management. This is despite the fact that some 40% of new patients with stress incontinence will be improved to the extent that surgery is no longer desired. One imagines that by operating on such patients the surgeon can achieve his dream of near 100% success rates: such rates are quoted in some papers, to the astonishment of most surgeons.

In this section a variety of procedures is described by authors with extensive experience of "their" operations. In most instances these procedures have been subjected to critical postoperative urodynamic review.

As we have already discussed, the two main mechanisms of continence are the intra-abdominal proximal urethra and an adequate intrinsic urethral sphincter mechanism. In patients with stress incontinence the urethra and bladder neck have usually escaped the closure mechanism resulting from their normal intra-abdominal position. In such patients, who have an adequate intrinsic urethral sphincter mechanism, repositioning of the bladder neck and proximal urethra usually restores continence. However, if there is a severe weakness of the intrinsic urethral sphincter mechanism, repositioning may not be adequate in itself. In these patients compression of the urethra may be necessary to achieve continence. An alternative approach would be reduction urethroplasty.

Hence operations for stress incontinence may use repositioning of the urethra, compression of the urethra or both. We do not yet know how to select a particular operation for a particular patient, based on objective measurement. All of us involved in stress incontinence surgery tend to use one or, at most, two procedures. Perhaps this is incorrect. Most urodynamically trained uro-gynaecologists/gynae-urologists no longer perform the anterior repair (anterior colporrhaphy) for the treatment of stress incontinence, as we believe it to be a difficult method of obtaining repositioning of the proximal urethra and bladder neck. However, a minority of our colleagues perform this operation and achieve superior results to those quoted in the literature by Stanton et al. (1985).

Two of the procedures described in this section, Teflon injection and the Stamey procedure, have significant advantages for patients as they carry less morbidity than the suprapubic procedures described. Teflon injection is regarded with scepticism by many and has still not undergone the fullest urodynamic evaluation. It is undoubtedly a simple technique, but how does it work? Does Teflon obstruct the urethra? Could Teflon reposition the urethra and bladder neck? If it has only average results, is it still worth considering if it does not prejudice further surgery?

The Stamey procedure has achieved much wider acceptance both in its original form and in the modified technique described by Raz (1981). Its proponents claim that it is a simple repositioning procedure and its detractors say it is obstructive. However, it probably has elements of both effects, although its obstructive effect is dependent on how tightly the sutures are tied.

The colposuspension and vagino-obturator-shelf procedures have become the "Gold Standards" of operations for genuine stress incontinence. Both procedures, performed with meticulous technique, enjoy high success rates: both are repositioning techniques.

Sling procedures, depending on their precise technique, may be intended as compressive or repositioning. In the technique described by Stanton (see p. 178) a sling can be used to reposition the urethra where vaginal rigidity prevents a colposuspension procedure.

The levatorpexy technique represents a novel and somewhat different approach to stress incontinence. Levatorpexy is based on an anatomical assessment of the defects that lead to stress incontinence in the individual patient. Levatorpexy is a repositioning operation in which the technique can be adapted according to the anatomical characteristics of the patient. The precise place of this innovative procedure remains to be defined.

The essence of the good clinical treatment of incontinence is a satisfied patient. Superficial postoperative questioning by the enthusiastic surgeon gives spuriously high success rates. Close questioning, and even the simplest of objective evaluation, shows that a considerable proportion of patients who claim to be dry (postoperatively) do still leak (Turner-Warwick and Brown 1979). Therefore, it is essential to perform an objective urodynamic assessment in the evaluation of any technique designed to cure urinary stress incontinence. The discerning reader will note that in some of the following accounts the period of postoperative follow-up is short. It should further be stated that no stress incontinence operation can be properly assessed until a careful evaluation has been performed many years after the original procedure.

## References

Asmussen M, Ulmsten U (1976) Simultaneous urethrocystometry with a new technique. Scand J Urol Nephrol 10: 7–11

Blaivas JG (1985) Pathophysiology of lower urinary tract dysfunction. Urol Clin North Am 12: 215–224

Byrne DJ, Hamilton Stewart PA, Gray BK (1987) The role of urodynamics in female urinary incontinence. Br J Urol 59: 228

Chilton CP, Turner-Warwick R (1981) The relationship of the distal sphincter mechanism to the pelvic floor musculature. Communication to the annual meeting of the British Association of Urological Surgeons, London, July 1981

James ED (1979) Continuous monitoring. Urol Clin North Am 6: 131

McGuire EJ, Savastano JA (1985) Stress incontinence and detrusor instability/urge incontinence. Neurourol Urodyn 4: 313–316

Raz S (1981) Modified bladder neck suspension for female stress incontinence. Urology 18: 82–84

Stanton SL, Chamberlain GVP, Holmes DM (1985) Randomised study of anterior repair and colposuspension operation in the control of genuine stress incontinence. Communication to the 15th annual meeting of the International Continence Society, London, September 1985

Turner-Warwick R, Brown ADG (1979) A urodynamic evaluation of urinary incontinence in the female and its treatment. Urol Clin North Am 6: 213

Turner-Warwick R, Whiteside CG (1982) Urodynamic studies and their effect on management. In: Chisholm GD, Williams DI (eds) Scientific foundations of urology, 2nd edn. Heinemann, London, pp 442–457

Versi E, Cardozo LD, Studd JWW et al. (1986) Internal urinary sphincter in maintenance of female incontinence. Br Med J 292: 166–167

*Chapter 13*

# Periurethral Teflon Injections

*R. C. L. Feneley*

## Introduction

Periurethral polytetrafluoroethylene (Polytef, Teflon) injections were first introduced for the treatment of urinary incontinence over 20 years ago and the results have shown that the method has an accepted place amongst the extensive repertoire of operative procedures that have been described. This technique is simple to perform, only briefly extending the length of a routine cystoscopic examination. The period of hospitalisation is short, approximately 2–4 days and no serious complications have been reported. The injection may be repeated and, if subsequent surgery is necessary, the Teflon deposits do not prejudice the operation. Age and obesity do not present contraindications.

Berg (1973) described "Polytef augmentation urethroplasty" for women whose incontinence had failed to respond to conventional surgery and he gave details of three women who had been cured following five, three and two unsuccessful conventional operations, respectively. Politano (1982) must be acknowledged for promoting this approach to treatment in both incontinent men and women, with an overall success rate of 70%. Schulman et al. (1983) reported results of a series of 56 women with stress incontinence who were treated by this method: 70% were completely cured and 16% greatly improved. Their results attracted particular attention.

Urinary continence ultimately depends on adequate urethral closure to provide a watertight seal. The necessary compression of the soft mucosal folds of the urethra is sustained within the sphincter-active zone of the urethra by the active and passive properties of the structures between the proximal sphincter mechanism at the bladder neck and the distal mechanism at the level of the pelvic floor musculature. Periurethral Teflon injections aim to give additional passive compression of the mucosa within the proximal urethra. Various substances have been used by injection, in an attempt to control urinary incontinence by this means. Murless (1938) used a sclerosant, sodium morrhuate, which he injected into the anterior vaginal wall, and Sachse (1963) injected another sclerosant, Dondren, which was successful but was complicated by evidence of small pulmonary emboli. Quackels (1955) used paraffin in two reportedly successful cases. Teflon attracted interest following the report of Arnold (1962), who used the material by injection into the paralysed vocal cord in cases of dysphonia. The paste is a suspension of polytetrafluoroethylene particles in glycerin and polysorbate and marketed as Polytef by Ethicon. The particles are relatively inert, but stimulate a fibroblastic response. Histiocytes phagocytose the particles and foreign body giant cells are formed. The chronic inflammatory reaction results in fibrous tissue encapsulation of the particles.

## Technique of Injection

Polytef paste is a highly viscous material and thus difficult to inject by means of a conventional intravenous syringe and needle. The injection techniques fall into two main categories. The paste may be injected into the submucous and periurethral tissue either via a perineal approach or through a needle designed for passage through the sheath of a panendoscope. In recent years the development of endoscopic equipment specifically designed for the purpose has greatly facilitated the procedure. Visual control of the injection is an important feature, whichever route is used. The patient is prepared as for a conventional cystoscopic examination under general or regional anaesthesia, with full aseptic precautions, and placed in a modified lithotomy position. Preliminary urethroscopic and cystoscopic examination is undertaken, to exclude any associated pathology. The sheath is then withdrawn into the urethra and, using a 0° telescope, the bladder neck and proximal urethra are observed while the paste is being injected, to ensure visual occlusion of the urethral mucosa.

If the perineal approach is chosen, a needle is advanced from a midline point between the external urethral meatus and vagina, in the space between the two viscera, until the tip lies just below the bladder neck mucosa. Politano used a 17 gauge needle (outside diameter of 1.4 mm), and in our series a 1.7 mm intravenous Medicut needle with cannula was employed, removing the needle prior to the injection. The syringe is loaded with Polytef and, because of the force that is required to inject the material, a syringe with a metal sheath is an advantage. Between 3 and 5 ml of the paste is injected to raise a prominent part of the 6 o'clock

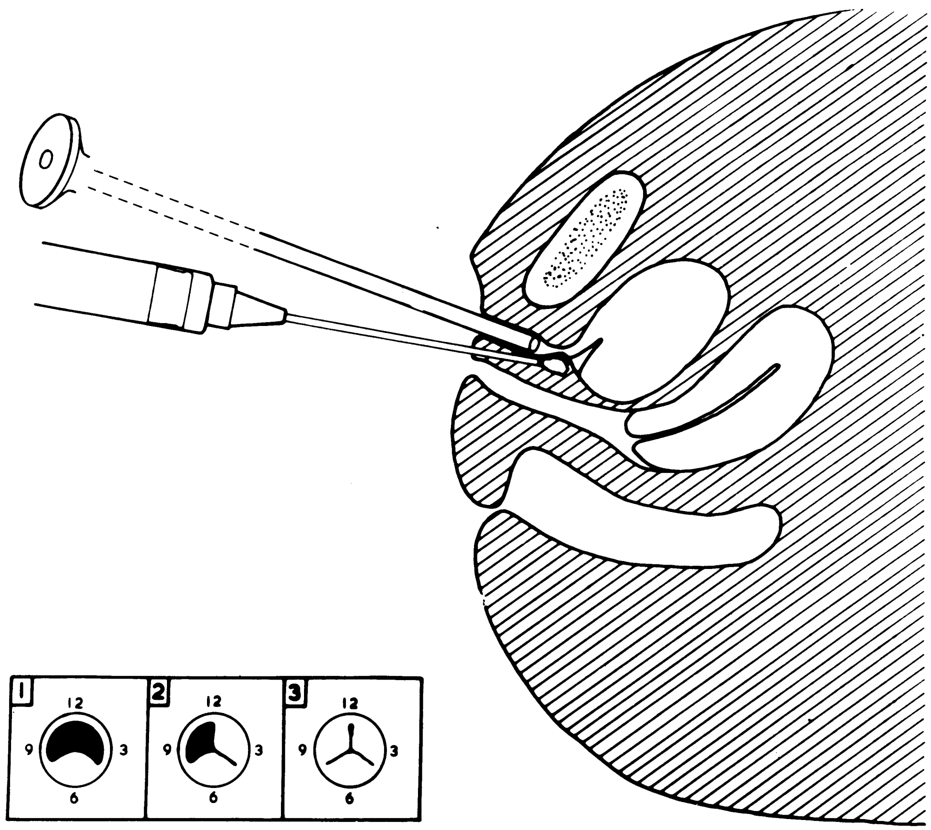



**Fig. 13.1.** Injection of Teflon paste at the bladder neck under endoscopic control.

position at the bladder neck, which appears similar to a middle lobe of the prostate. The injection is continued as the needle or cannula is withdrawn to the mid-urethral position. Further injections are then sited at the 3 and 9 o'clock positions at the bladder neck, until the mucosa is approximated and the lumen closed (Fig. 13.1) The paste can be recognised when it enters the submucosa, and care must be taken to avoid breaching the surface.

The alternative method employs a needle designed to pass through the sheath of a panendoscope. Schulman et al. (1983) used an 8 FG polyethylene catheter with a needle at its tip, which passes through a sheath of 23.5 FG. The needle can be directed by the Albarran device to penetrate the urethral wall about 1 cm below the bladder neck. Injections were given at the 3, 6 and 9 o'clock positions around the bladder neck, using a small syringe with a metallic sheath and piston (Karl Storz). A specific cystoscopic Teflon injector, designed and manufactured by Richard Wolf, has facilitated the accuracy and ease of the endoscopic procedure, using a foot pedal to control the introduction of the Teflon paste (Fig. 13.2).

A total of 10–15 ml of Teflon are normally used and this creates a resistance to the passage of the endoscope. When the bladder has been

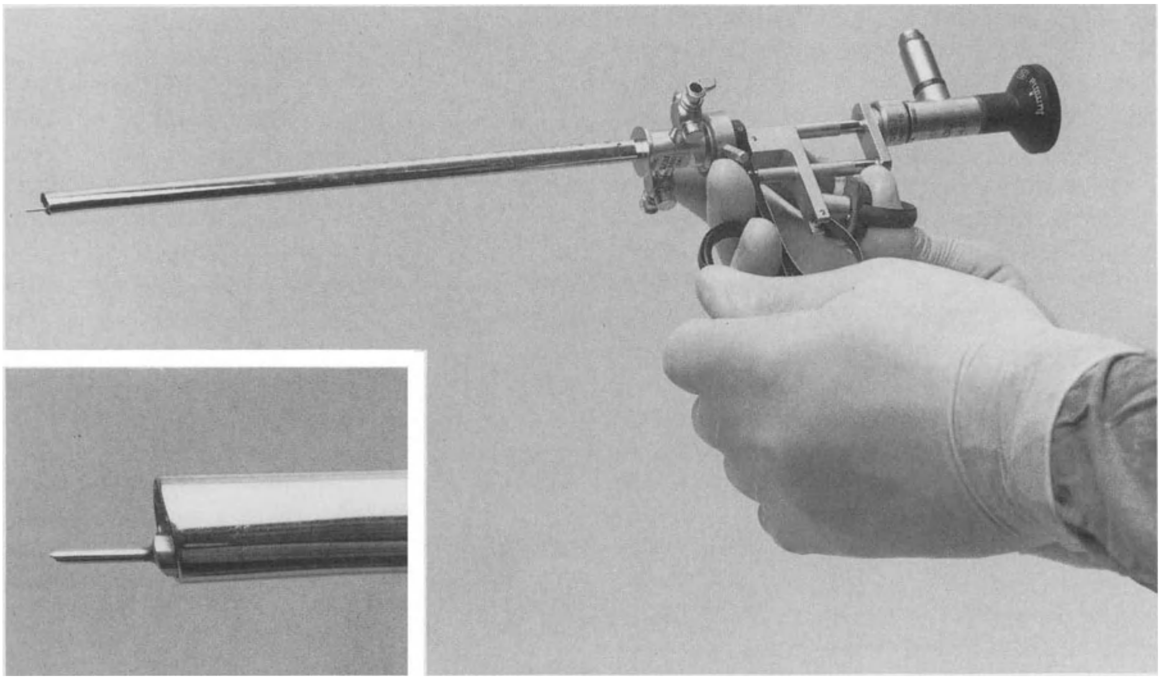


**Fig. 13.2.** Teflon injector manufactured by Richard Wolf.

filled with irrigant, the panendoscope can be removed and occlusion of the urethra can be checked by application of manual suprapubic pressure. A bladder washout with an evacuator should be performed to make sure that no paste is left within the bladder.

A catheter may be left in situ for 24 h postoperatively. Alternatively, intermittent catheterisation is used, if retention of urine should occur. Catheterisation is often necessary during the first 24 h, and in a few patients during the first 3 days. An oral broad-spectrum antibiotic is advisable during the first 2 weeks following the procedure. A low-grade pyrexia may be evident during the first 24 h. Urethritis is the common postoperative complication, which normally settles within 7–10 days. No cases of abcess formation have been reported in women.

# Results

The results of treatment depend on the initial assessment and selection of patients. Periurethral Teflon injections were initially reserved for those women in whom conventional operative treatment failed to control their incontinence. In Politano's series, only 13 of the 54 women had stress incontinence, and thus a heterogeneous group had been selected for this treatment. Of his patients, 51 were available for review: 26 were fully continent by day and night, 10 experienced a good response requiring only minimal protection and 15 had little or no improvement. The follow-up ranged from 6 months to 16 years (Politano 1982).

Schulman et al. (1983) selected 56 women with stress incontinence with an age range between 30 and 60 years (mean 59 years). Urodynamic investigations were performed in a majority of the cases. Initially the technique was used for women who had undergone several previous operations that had proved unsuccessful. The results were encouraging and led to primary treatment in women for whom conventional surgery would otherwise have been performed. A total of 39 patients were cured. Of these, eight received two injections and three had three injections. Nine patients experienced marked improvement of their incontinence and eight failed to respond, despite up to four injections. The follow-up ranged from 3 months to 25 months.

In our series (Lim et al. 1983), there were 28 patients with an age range between 20 and 84 years (mean 57 years). Twenty-six patients reported a history of previous failed surgery; this was a major indication for the selection of this method of treatment. Six patients were cured and 9 were improved. Only one injection was attempted, and this probably accounted for the disappointing results.

The results of these three published series are summarised in Table 13.1. Excellent results refer to complete cure, good results to a substantial reduction in the severity of incontinence requiring minimal protection which was acceptable to the patient.

**Table 13.1.** Results of three series of patients treated with Teflon injections

| Reference | No. of patients | Cured | Improved | Failed |
|---|---|---|---|---|
| Politano et al. (1982) | 51 | 26 (51%) | 10 (20%) | 15 (29%) |
| Schulman et al. (1983) | 56 | 39 (70%) | 9 (16%) | 8 (14%) |
| Lim et al. (1983) | 28 | 6 (21%) | 9 (33%) | 13 (46%) |

Failure of this therapy may be related to an inadequate amount of the paste being injected. Politano noted that early failures had received 4–5 ml of paste, while in his latest series approximately 10–15 ml were used. Schulman et al. used approximately 10 ml. Some patients may respond to a second or third injection, and it has been suggested that these are repeated at 3- to 6-monthly intervals.

Age, obesity and the duration of incontinence are not considered to be contraindications to treatment. The period of hospitalisation following treatment is usually 3–4 days.

Patients with detrusor instability received little benefit in our series: 7 of the 8 patients with evidence of this failed to respond. Lewis et al. (1984), on the other hand, have published a small series of six women with "neurogenic" bladder disorders who achieved complete urinary control following periurethral Teflon injections. All the patients had detrusor hyper-reflexia, and anticholinergic and sympathomimetic drugs were used in varying combinations to control this. If the incontinence persisted, the Teflon was injected to occlude the urethra, and a regime of intermittent self-catheterisation (ISC) was then instituted. Five of the patients developed complete urinary retention, which was controlled by regular ISC, and the sixth patient could maintain continence for 2–3 h.

## Discussion

When periurethral Teflon injections were first introduced, the selection of patients for treatment was essentially empirical. Politano (1982) mentioned that some of his patients were "doomed to failure". On the other hand, in their published series, Schulman et al. (1983) restricted this approach to women with stress incontinence and performed urodynamic investigations in the majority of their cases before and after treatment. Although Politano has recorded satisfactory results in the treatment of men with distal urethral sphincter damage following prostatic surgery, experience with its use in this group has not been encouraging (personal communications). Theoretical considerations and practical application indicate the value of Teflon injections in women with urinary stress incontinence.

Genuine stress incontinence (GSI) has been defined as the involuntary loss of urine when intravesical pressure exceeds the maximum urethral pressure in the absence of detrusor activity (Bates et al. 1979). The condition thus excludes those patients with detrusor instability. Urethral incompetence in patients with GSI is associated with a failure of both proximal and distal sphincter mechanisms. The response of the structures within the sphincter-active zone to a sudden rise in intra-abdominal pressure has been the subject of detailed investigation. By simultaneous measurement of the intravesical and urethral pressures, Hilton and Stanton (1983) confirmed Enhorning's thesis (1961) that intra-abdominal pressure is transmitted to both bladder and proximal urethra. The debate centres on whether this pressure transmission is purely a passive mechanical effect or an active reflex contraction of the pelvic floor musculature (Heidler et al. 1979). Hilton and Stanton (1983) confirmed that the urethral pressure and the urethral closure pressure (intravesical pressure minus abdominal pressure) decreased with age and that, furthermore, in women with stress incontinence, the urethral closure pressure on coughing was significantly lower in comparison with symptom-free women.

Periurethral Teflon injections impart an additional passive compression to the mucosa within the proximal urethra. Schulman et al. (1983) showed that successful treatment was associated with an increased functional length of the urethra, which is presumably related to the inflammatory reaction that results from the injection therapy. In patients with mild or moderate stress incontinence, this contribution to the proximal urethral pressure may be sufficient to prevent stress incontinence. The presence or absence of adequate urethral support, however, is a critical factor. Deficient support, particularly from the posterior pubourethral ligaments, may be evident on clinical examination as marked laxity of the anterior vaginal wall or an obvious cystocele. In the absence of any medical contraindication, reconstructive surgery is indicated in such cases. Successful operative correction for GSI has been shown to improve the transmission of abdominal pressure to the proximal urethra. Failed conventional surgery, however, is not uncommon, and the causes have been summarised by Stanton (1985) to be related to:

1. Failure to elevate the bladder neck
2. Failure to approximate and align the urethra to the posterior superior aspect of the symphysis pubis
3. Lack of support to the posterior aspect of the proximal urethra and bladder
4. Creation of a rigid and functionless urethra as a result of postoperative fibrosis (the frozen urethra).

In such cases the injection of Teflon in and around the proximal urethra may provide a simple and effective method of curing the continued stress incontinence. Concern has been expressed that Teflon injections can cause urethral obstruction, but Schulman et al. (1983) showed that the urine flow rate following treatment decreased by approximately 5 ml/s. A second or third injection may be introduced if necessary, and they do not appear to compromise conventional operative techniques, if these are eventually required.

Following injection, Teflon particles have been shown to migrate, both to local and distal sites. Boedts et al. (1967) reported Teflon particles in the local lymph glands following laryngeal injection of Teflon paste. In a post-mortem study in a male patient following suicide, Teflon granulomas were found in the lungs after he had received two periurethral injections, 2 years and 1 year, respectively, before his death (Mittleman and Marraccini 1983). Malizia et al. (1984) performed detailed studies on the migration of Polytef particles in animals (using dogs and monkeys) and showed that migration took place not only to the local lymph glands but also to the lungs, spleen and kidneys. They concluded that Teflon paste should not be given to children or young adults with a normal life expectancy, until the long-term effects have been more fully evaluated.

In summary, there is now ample evidence to justify the use of periurethral Teflon injections in the treatment of women with GSI. More specific indications would be helpful to select those patients most suitable for this form of treatment. In the reported series, Teflon injections were initially used for patients who had failed to respond to conventional operative procedures, and only after achieving satisfactory results in this group was the technique considered as a primary form of treatment. The principle of injecting Teflon paste to promote passive compression of the urethra has not been universally accepted and there are potential long-term complications. These points would perhaps explain why there have been no reports of larger series of patients treated by this method as a primary procedure.

# References

Arnold G (1962) Vocal rehabilitation of paralytic dysphonia. IX. Technique of intracordal injection. Arch Otolaryngol 76: 358–368
Bates P, Bradley WE, Glen E et al. (1979) The standardization of terminology of lower urinary tract function. J Urol 121: 551–554
Berg S (1973) Polytef augmentation urethroplasty. Correction of surgically incurable urinary incontinence by injection technique. Arch Surg 107: 379–381
Boedts D, Roels H, Kluyskens P (1967) Laryngeal tissue responses to Teflon. Arch Otolaryngol 86: 562–567
Enhorning G (1961) Simultaneous recording of intravesical and intraurethral pressure. A study on urethral closure in normal and stress incontinent women. Acta Chir Scand [Suppl] 276: 1–68
Heidler H, Wolk H, Jonas U (1979) Urethral closure mechanism under stress conditions. Eur Urol 5: 110–112
Hilton P, Stanton SL (1983) Urethral pressure measurement by microtransducer: the results in symptom-free women and in those with genuine stress incontinence. Br J Obstet Gynaecol 90: 919–933
Lewis RI, Lockhart JL, Politano VA (1984) Periurethral polytetrafluoroethylene injections in incontinent female subjects with neurogenic bladder disease. J Urol 131: 459–461
Lim KB, Ball AJ, Feneley RC (1983) Periurethral Teflon injection: a simple treatment for urinary incontinence. Br J Urol 55: 208–210
Malizia AA, Reiman HM, Myers RP et al. (1984) Migration and granulomatous reaction after periurethral injection of Polytef (Teflon). JAMA 251: 3277–3281
Mittleman RE, Marraccini JV (1983) Pulmonary Teflon granulomas following periurethral Teflon injection for urinary incontinence. Arch Pathol Lab Med 107: 611–612
Murless BC (1938) The injection treatment of stress incontinence. J Obstet Gynaecol Br Emp 45: 67–73
Politano VA (1982) Periurethral polytetrafluoroethylene injection for urinary incontinence. J Urol 127: 439–442
Quackels R (1955) Deux incontinences après adenomectomie gueries par injection de paraffine dans le perinée. Acta Urol Belg 23: 259–262
Sachse H (1963) Treatment of urinary incontinence with sclerosing solutions: indications, results, complications. Urol Int 15: 225–244
Schulman CC, Simon J, Wespes E, Germeau F (1983) Endoscopic injection of Teflon for female urinary incontinence. Eur Urol 9: 246–247
Stanton SL (1985) Stress incontinence. Why and how operations work. Urol Clin North Am 12: 279–283

*Chapter 14*

# Stamey Endoscopic Bladder Neck Suspension

*P. Abrams and S. D. Yande*

## Mechanism of Continence During Stress

A plethora of surgical techniques has been designed for the treatment of stress incontinence. Uro-gynaecologists favour operations that seek to reposition the bladder neck and proximal urethra within the abdominal cavity. The theoretical basis of repositioning operations is the intra-abdominal position of the proximal urethra. The intra-abdominal proximal urethra acts as a "flutter valve". Although there are large alterations in intravesical pressure during straining and coughing (pressures rising up to 200–300 cm$H_2O$) we are protected from leakage. The increased intravesical pressure will try to force open the bladder neck. In a flutter valve mechanism an equal and opposite pressure attempts to maintain lateral compression on the urethra, negating the intravesical force attempting to open it. Stress urethral pressure profilometry shows how these increases in intravesical pressure are matched by equal transmission of intra-abdominal pressure to the proximal urethra (Fig. 14.1, "Post-op" trace). It has been disputed whether the intra-abdominal position of the proximal urethra is the only mechanism preventing stress incontinence. Several workers have suggested that there is also a pelvic floor reflex contraction that is important in maintaining continence (Heidler et al. 1979).

To test this theory we investigated 20 women undergoing Stamey procedures for genuine stress incontinence. These patients had stress urethral pressure profiles (SUPPs) prior to surgery. The SUPP was repeated with the patient breathing spontaneously under minimal anaesthesia prior to the commencement of the operative procedure. A cough profile was mimicked by the surgeon pushing suprapubically, using

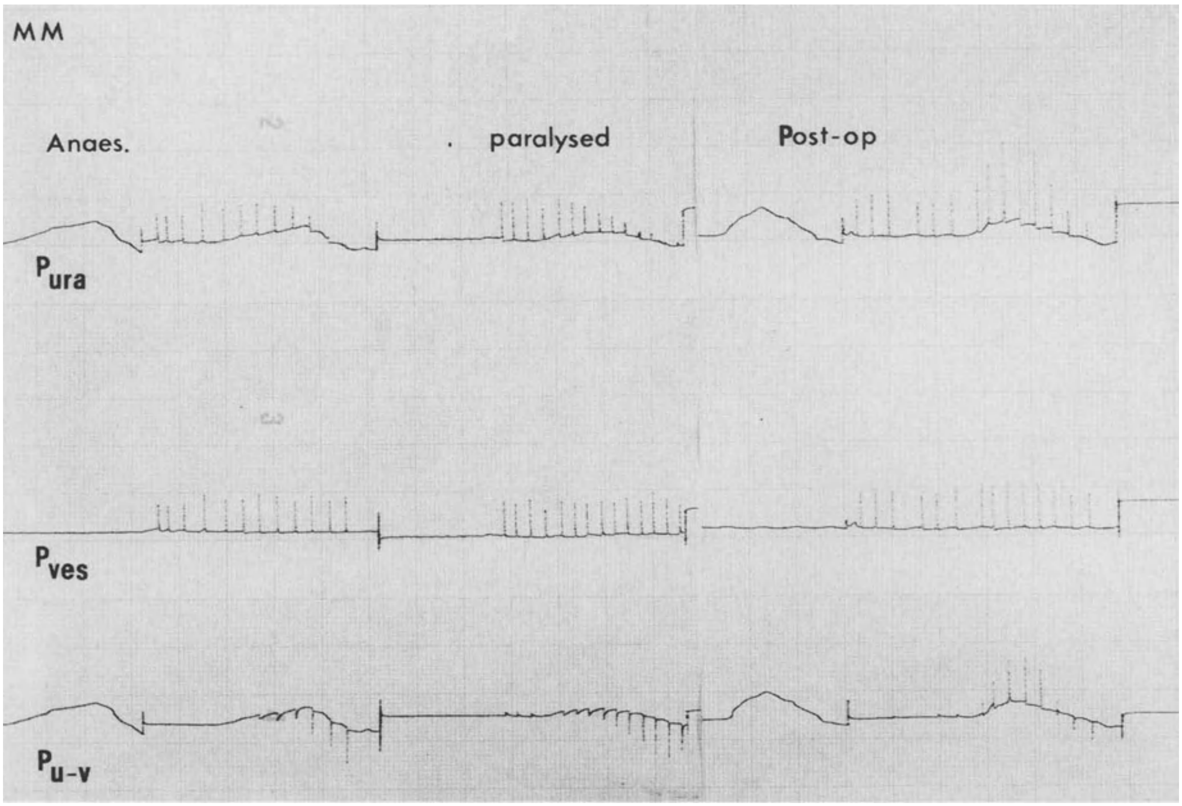



**Fig. 14.1.** Stress urethral profiles on a patient before (*Anaes.* and *paralysed*) and after (*Post-op*) Stamey procedure. The Post-op trace shows that the urethral closure pressure is enhanced at "coughing" by transmission of greater than 100%.

the flat of his hand. This method produced an identical trace to that seen in a normal SUPP with intermittent coughing (Fig. 14.1, "Anaes." trace). The patient was then paralysed and ventilated in the standard way. The SUPP was then repeated. Table 14.1 shows that no significant differences could be seen in any of the SUPP parameters. In five of the patients pelvic floor and urethral muscle electromyography (EMG) was measured before and after muscle paralysis. Bipolar electrodes were passed into the pelvic floor and into the intraurethral striated muscle (Fig. 14.2). There has always been considerable controversy as to

**Table 14.1.** The effect of paralysing agents on the urethral pressure profile. No significant differences are seen

| | Functional urethral length (cm) | Maximum urethral closure pressure ($cmH_2O$) | Transmission ratio (%) | |
|---|---|---|---|---|
| | | | Presphincteric | Sphincteric |
| Light anaesthesia | 2.7 | 42 | 106 | 67 |
| Paralysed | 2.7 | 34 | 108 | 63 |

**Fig. 14.2.** An EMG electrode passed under EMG control into the intraurethral striated muscle from a point 0.5 cm anterior to the external urinary meatus.

whether the intraurethral striated muscle EMG can be measured. However, the anatomical studies of Chilton and Turner-Warwick (1985) have shown the absence of pelvic floor musculature anterior to the urethra. Therefore, striated muscle EMG recorded anterior to the urethra, at the mid-urethral point, can be assumed to be from the intraurethral striated muscle. Location of this muscle was aided by the auditory transduction of electromyographic signals. In every case paralysis produced electrical silence. We could therefore be sure that no pelvic floor reflex was active during the SUPP recorded after paralysis. This work appears to show that there is no pelvic floor contraction during stress, and that continence is maintained by the position of the proximal urethra.

Immediately after tying the Stamey sutures the urethral pressure profile (UPP) and SUPP were repeated. As has been shown previously, significant changes were seen in the SUPP, with the urethral length over which a positive pressure was maintained being increased.

## The Stamey Procedure

The Stamey procedure was described by Stamey (1973) as a modification of the Pereyra technique (Fig. 14.3). Stamey added endoscopy to

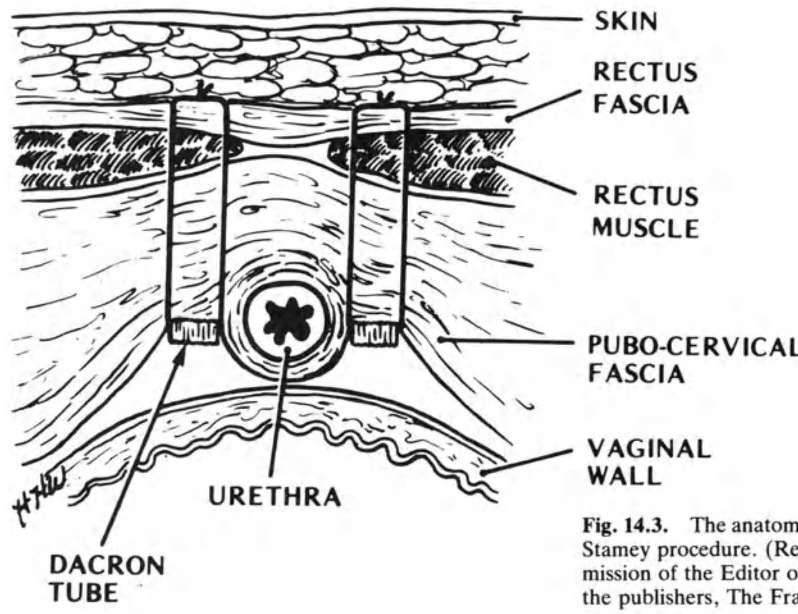



**Fig. 14.3.** The anatomical relationships of the sutures used in the Stamey procedure. (Reproduced from Stamey 1973 by kind permission of the Editor of *Surgery, Gynecology and Obstetrics* and the publishers, The Franklin H. Martin Memorial Foundation).

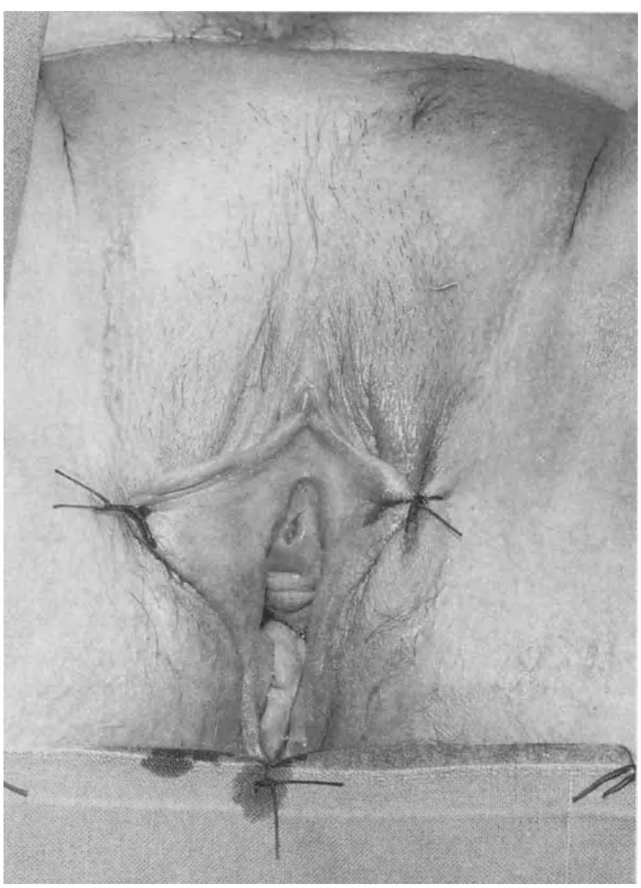


**Fig. 14.4.** "Towel" arrangement for Stamey procedures.

visualise the bladder, bladder neck and urethra during surgery for three main reasons:

1. To ensure that the needle, on which the nylon thread was to be mounted, had not passed into the bladder.
2. To assess the needle's position in relation to the bladder neck.
3. To assess the alteration of bladder neck shape as the sutures were tied.

We have followed Stamey's described technique in most respects.

## Patient Inclusion

Only in patients with genuine stress incontinence, as shown during filling cystometry (filling rate 60 ml/min, water/contrast media), was the procedure performed.

## Operative Technique

Intravenous antibiotic (gentamicin) is given with induction. The patient is placed in the lithotomy position and the vagina and suprapubic area prepared with aqueous iodine solution. Sterile drapes are positioned and sewn to the perineal body (Fig. 14.4). A preliminary endoscopy using the 30° cystoscope is carried out and a Foley catheter passed into the bladder (14 FG size, 5 ml balloon).

Two small incisions (1–1.5 cm in length) are made on either side of the bladder neck (Fig. 14.5). The bladder neck is localised by gentle traction on the Foley catheter, feeling the junction between the shaft of the catheter and the balloon. The medial ends of the incisions are approximately 1 cm lateral to the midline. Using McIndoe's scissors, dissection is carried out creating a small space beneath the vaginal mucosa. This space is just sufficient to allow the tip of the index finger to palpate the tip of the Stamey needle when pushed from above. The space is also just large enough to accept the Silastic tube buttress that is used during the procedure. We consider that it is important to minimise the dissection done in the vagina as excessive dissection may weaken the very support upon which the success of the suspension depends—the endopelvic fascia.

Two suprapubic incisions are made in the skin crease one to two finger breadths above the pubis (Fig. 14.6). These incisions are short, of sufficient length to allow the sutures to be tied down to the rectus sheath over a 1 cm Silastic tube buttress. Care is taken to ensure that the fascial layer between the two fat layers of the anterior abdominal wall is broken down. If this is not done and the suture is tied against the fascia, we believe that the suture is likely to cut through to the anterior rectus sheath postoperatively and loosen the nylon loop.

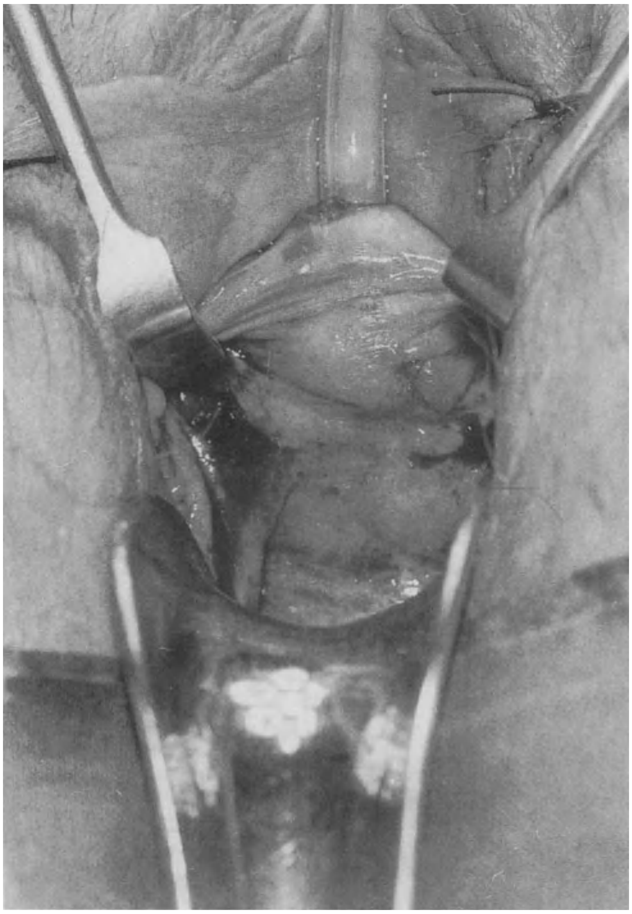


**Fig. 14.5.** Short transverse anterior vaginal incisions made on either side of the bladder neck: defined by the balloon on the Foley catheter.

The straight Stamey needle is then passed from the medial edge of one of the two suprapubic wounds. The initial needle position is vertical in order to pass the needle through the rectus sheath (Fig. 14.7). Once through the rectus sheath the needle is then laid horizontally on the abdominal wall. The needle is passed on until the tip of the needle is felt to hit the back of the pubis (Fig. 14.8). Using short jabbing movements, the needle tip is "walked" down the posterior aspect of the pubis until it passes under the pubic arch.

The index finger is then introduced into the ipsilateral vaginal incision. The catheter is palmed (Fig. 14.9) and gentle traction applied to the catheter shaft. At this point the needle is advanced by pressure from the abdominal hand. The index finger can then feel the catheter balloon medially and the tip of the needle on the pulp of the finger. The needle tip is guided as close as possible to the bladder neck/urethral junction. We believe that precise placement of the needle at the bladder neck is most easily achieved when the Stamey needles are passed from above downwards. Mundy (1983) has pointed out that the operation can be

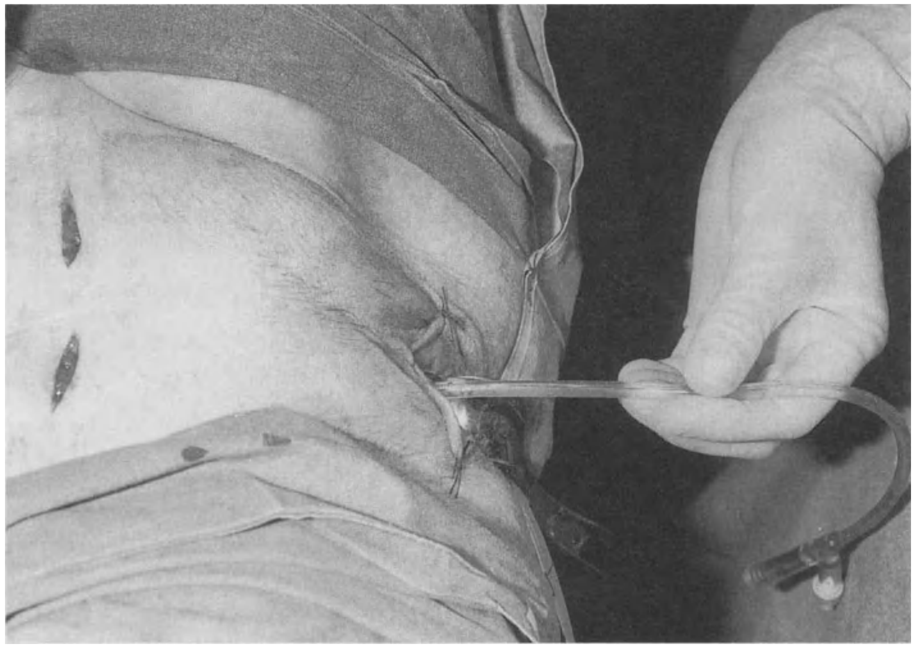


**Fig. 14.6.** Twin suprapubic incisions.

performed more quickly if the needles are passed from below upwards. However, when we have had to use this modification, for example in very obese patients, we have felt that precise placement of the needle at the bladder neck was compromised. We would therefore recommend adherence to this aspect of Stamey's original technique.

Having passed the needle and delivered the tip through the vaginal incision into the vagina (Fig. 14.10), the catheter is then removed and the bladder/urethra inspected endoscopically. Should the needle have been passed into the lower urinary tract, it is removed, the catheter replaced and the procedure attempted again. When the needle is outside the bladder, as the bladder fills, the needle can be seen to produce a ridge along the ipsilateral anterior bladder wall. If the endoscope is withdrawn to the distal urethra whilst the bladder neck is visualised, then medial pressure on the needle should move the lateral aspect of the bladder neck and proximal urethra.

Once the surgeon is happy with the placement of the needle the nylon suture (No. 2 nylon) is passed through the eye of the needle and the needle withdrawn suprapubically. The nylon is then held medially and the needle repassed through the lateral end of the first abdominal incision.

The needle should be introduced 1–2 cm lateral to the point of the first passage of the needle. The needle is passed in the same way until the vaginal finger can feel the needle tip as far laterally as possible. The needle tip is then advanced through the vagina into the vaginal canal. The inexperienced surgeon should check the bladder once more: if the

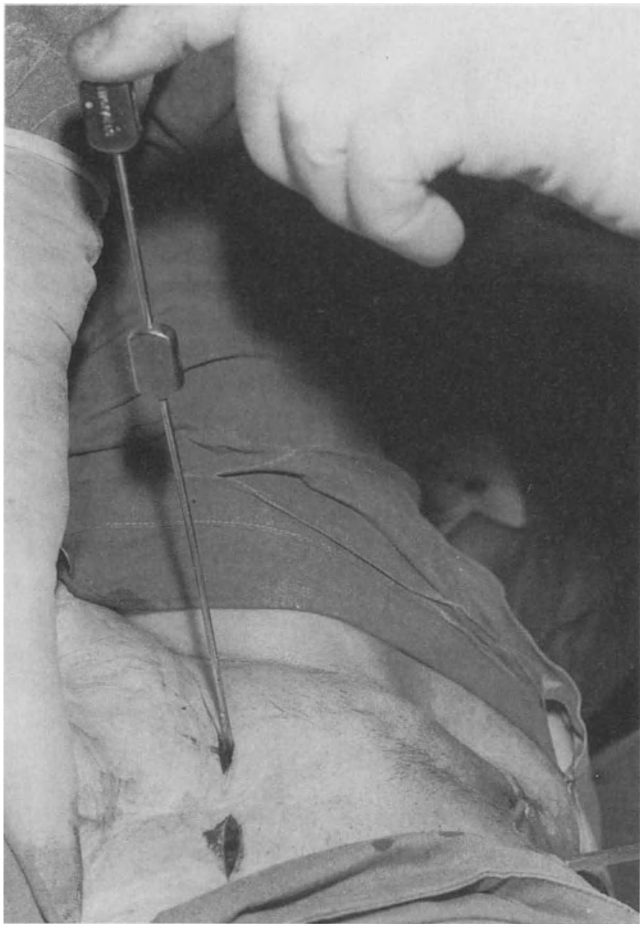


**Fig. 14.7.** Vertical position of Stamey needle for passage through the anterior rectus sheath.

second needle passage has been extravesical, the vaginal end of the nylon suture is passed over a 1 cm Silastic buttress and then through the eye of the Stamey needle (Fig. 14.11). Taking care not to twist the nylon loop, the needle is withdrawn suprapubically, thus completing the sling on one side. A Silastic buttress is also passed over one of the two ends of the loop as it emerges from the suprapubic wound. A second loop is introduced on the opposite side of the urethra using an identical technique.

Inadvertent passage of the needle into the bladder is of no importance. In one patient the needle was passed into the bladder six times before an extravesical route could be found behind the pubis. Obviously this is more likely to occur in patients who have had previous surgery or radiotherapy. The use of the angled Stamey needles (either 15° or 30°) can facilitate the passage of the needle without entering the bladder in difficult cases.

With both loops in a satisfactory position the bladder is filled. When the cystoscope is removed a jet of irrigation fluid comes from the urethra

**Fig. 14.8.** Horizontal position of Stamey needle as the needle is "walked" down the inner aspect of the pubis.

**Fig. 14.9.** While the needle is being advanced beneath the pubis the index finger of the surgeon's left hand is in the left vaginal incision feeling for the needle tip and simultaneously feeling the bladder neck identified by the Foley balloon, which is being gently pulled down.

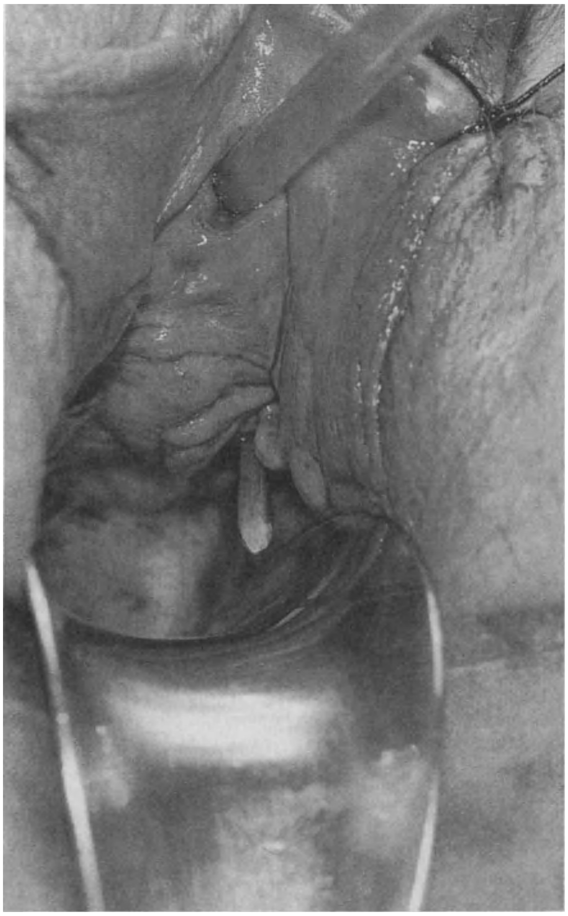


**Fig. 14.10.** The needle tip is shown as it emerges from the left vaginal incision.

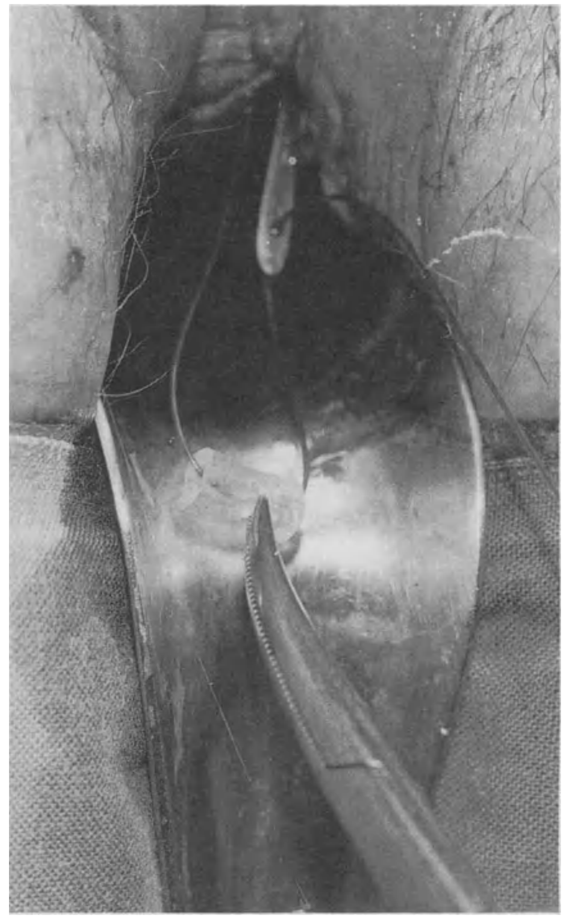


**Fig. 14.11.** After the second passage of the needle (lateral to the first passage) the nylon suture with Silastic tube (in forcep) is shown in position prior to the needle being withdrawn suprapubically.

(Fig. 14.12). By smoothly increasing the tension on the loops this leakage should be easily controlled. Failure to control the "incontinent" jet may reflect malpositioning of one or both loops. Repositioning one of the loops may improve control. A failure to control the incontinent jet may also reflect a lack of mobility of the tissues around the bladder neck/proximal urethra. With experience the operator can usually be confident about the position of the loops, and failure to achieve total control of the incontinent stream does not mean that the operation will be unsuccessful. It is now unusual for us to reposition a loop.

Prior to tying the loops the anterior vaginal incision must be closed. If closure is attempted after loop tying it is most difficult (if not impossible) as the anterior vaginal wall is drawn anteriorly behind the inferior border of the pubic symphysis. If one of the loops cuts through, it should be replaced, if possible. Occasionally, the tissues on one side of the bladder

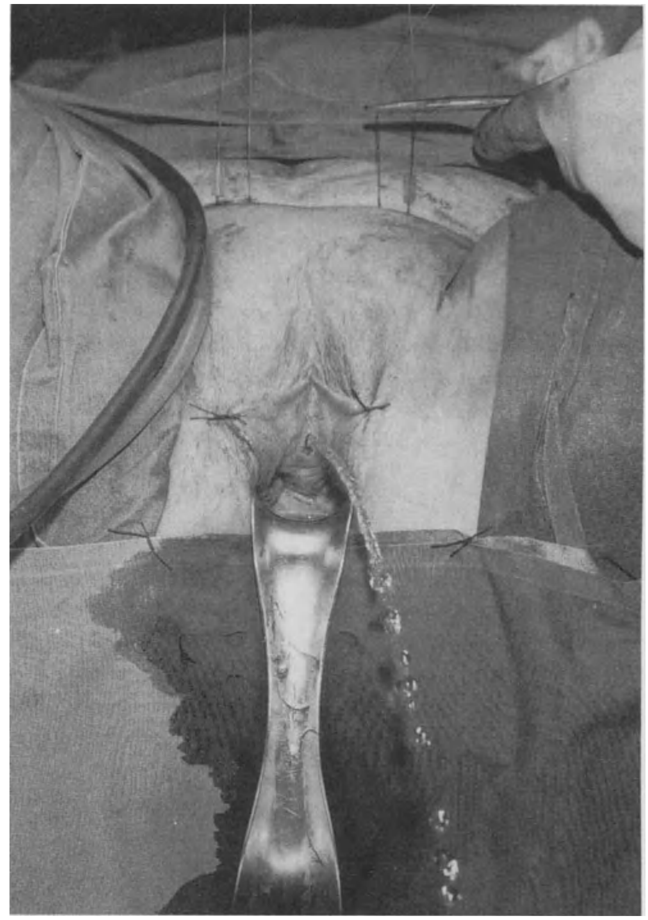


**Fig. 14.12.** With the bladder filled, and after removal of the cystoscope an "incontinent" stream is obtained. The free ends of the two loops (*left* and *right*) are pulled to stop the leak.

neck/urethra are too weak to hold the loop. At this point the surgeon should not despair as a single loop appears sufficient to maintain postoperative continence.

Once the vagina is closed, the bladder is refilled. Again, withdrawal of the cystoscope leads to an incontinent jet. One of the loops is tied down with sufficient tension to just stop leakage. The bladder is then refilled and the second loop tied just tightly enough to stop leakage again.

A narrow suprapubic catheter (8 FG) is passed. If there has been any bleeding during the procedure then a wider bore catheter (12 FG) is used. The wounds are sprayed with antiseptic and closed in two layers. A vaginal pack is left in situ for 24 h.

Postoperatively the suprapubic catheter is clamped as soon as the patient can move freely, usually on the second or third postoperative day. The residual urine levels are checked and the catheter removed when the residual urine is less than 50% of the bladder capacity (voided volume + residual urine). The patient is allowed home as soon as she voids after catheter removal.

## Results

A total of 100 patients aged 17–88 years were operated on for genuine stress incontinence in the period 1982–1986. All patients had a minimum follow up of 6 months. Two patients were young women who had a neuropathic urethra secondary to meningomyelocele, and two patients had surgery in an attempt to prevent them expelling indwelling catheters. The remaining patients were typical of those seen in gynaecology and urology clinics with stress incontinence. Incontinence was confirmed as being due to sphincter weakness by urodynamic studies. Any coexisting detrusor instability was noted.

Eighty patients were cured. "Cure" is a symptomatic definition: the patient states that she is never wet, wears no pads and does not need to change underwear. Occasionally, we were able to show stress incontinence during follow-up urodynamic studies even though the patient said she was cured. In this situation leakage occurred at capacity and not at lower volumes.

Nine patients were improved, in that the frequency of leakage and pad usage was reduced. This category was further defined as the use of a maximum of one pad per day (two patients) or the need to change underwear on an occasional basis because of stress incontinence (seven patients).

Eleven patients had an unsatisfactory result from surgery. In one patient this was due to persistent severe detrusor instability without stress incontinence, and a second developed a vesicovaginal fistula probably secondary to radiotherapy. However, nine patients had significant recurrent stress incontinence.

## Complications

There were few complications. No cases of haemorrhage or haematuria were seen. One patient, an old woman whose Stamey procedure was intended to prevent her from expelling her urethral catheter, developed infection and required suture removal. As with all series some patients required prolonged catheter drainage. However, only three patients were catheterised for longer than 3 weeks. Six patients use intermittent self-catheterisation (ISC), of whom two are the young women with meningomyelocele. All but one of the remaining four void normally most of the time.

## Failures and Their Treatment

As mentioned above, nine patients had an unsatisfactory result from surgery because of recurrent stress incontinence. In such circumstances

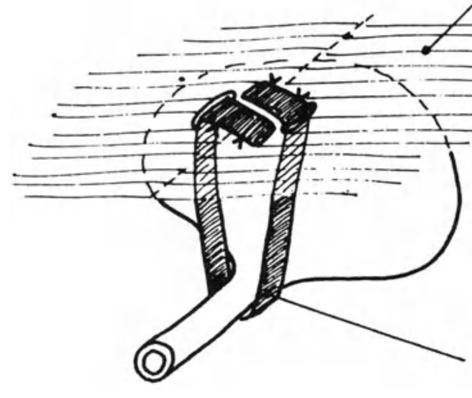



**Fig. 14.13.** The anatomical relationships of the sling procedure.

the surgeon attempts to find the contributory factors (excluding his own technique!) that may have led to such failures. In this series there appear to be three main factors:

1. Poor intrinsic sphincter mechanism
2. Chronic cough
3. Previous treatment with radiotherapy.

Previous surgery did not seem to be a significant cause of failure. (Chronic cough and previous radiotherapy were found to be further poor predictive indications.)

Six of the nine failures have now had further surgery. The Stamey procedure has been repeated in two patients and was successful in one. One patient had a successful colposuspension (Burch procedure). In four patients a new sling procedure has been used (Fig. 14.13). (Each patient was shown to have recurrent genuine stress incontinence.)

## Sling Procedure

### *Technique*

The patient is prepared for surgery in the same manner as described for the Stamey technique. A short suprapubic incision is made (10 cm long) and deepened until the anterior rectus sheath is seen. The sheath is cleared of fat over an area measuring 6 cm × 3 cm. Two vertical incisions are made through the sheath 2 cm on either side of the midline. Using McIndoe's scissors a tunnel is made from the vertical incision through the rectus muscle to the level of the extraperitoneal fat.

A vertical vaginal incision 4 cm long is made in the anterior wall. This incision should be across the bladder neck/urethral junction as defined by the balloon on the Foley catheter. Using McIndoe's scissors blunt dissection is carried out on either side of the bladder neck. The tip of the scissors are aimed at the patient's ipsilateral shoulder tip.

The 15° Stamey needle is then passed from below. The needle is kept as close to the underside and posterior aspect of the pubis as possible and brought out through the ipsilateral vertical incision in the rectus sheath. The bladder and urethra are checked endoscopically to make sure that the needle passage is extravesical.

The flattened tip of the Stamey needle is gripped using a Fraser–Kelly forcep. Using a push (on the forcep) and pull (on the needle) technique the forcep is drawn down the path of the needle until the tip of the forcep emerges from the vaginal incision. The bladder is once more checked endoscopically. The forcep with the Stamey needle still grasped in its teeth is drawn back upwards through the retropubic channel. The Fraser–Kelly forcep is then replaced with a thicker Nelson–Roberts forcep. Using a similar push/pull technique this is delivered to the vagina. The Stamey needle is then released from the jaws of the forcep, which are then used to grasp the end of the Silastic sling. The Silastic sling measures 0.8 cm × 20 cm and is of a sandwich composition. The centre of the sling is made of woven Dacron. This is then coated with Silastic to give an entirely smooth outer surface. Along one side of the sling is embedded a copper wire. This copper wire aids orientation of the sling and allows its position to be checked radiographically.

The Silastic sling is drawn upwards by traction through the retropubic tunnel created by the Stamey needle and the two forceps. Little resistance is met at this stage of the procedure.

The same procedure is adopted on the other side of the urethra to create a similar retropubic tunnel. Once the larger forcep has appeared on the contralateral side of the bladder neck, in the vagina, the vaginal end of the sling is grasped and pulled through to the suprapubic incision. Extreme care is taken not to twist the sling, and we use the convention of keeping the copper on the medial side of the sling.

One end of the Silastic sling is then secured by four sutures of Prolene mounted on a J needle. Each suture passes through the sling and takes a good bite of the anterior rectus sheath (Fig. 14.14). The bladder is then filled and an incontinent stream produced. The second end of the sling is then smoothly tightened until the leakage stops. This tension is maintained and the second end of the sling secured, both to the rectus sheath and also to the first end of the sling. As in the Stamey procedure, the anterior vaginal incision must be closed *before* the sling is finally secured.

The suprapubic wound is sprayed with antiseptic and closed in two layers. A suprapubic catheter is passed, as in the Stamey procedure.

Postoperatively, the regime adopted is similar to that used after the Stamey procedure. However, the incidence of postoperative voiding difficulties is much higher in the group of patients with a sling in situ. For this reason all patients are taught ISC prior to surgery. If a patient is unable to void quickly following operation then the suprapubic catheter is removed and the patient is discharged home on ISC. When home, patients are instructed to attempt to void when they have a normal desire and then to catheterise themselves. Once the residual is less than 50% of

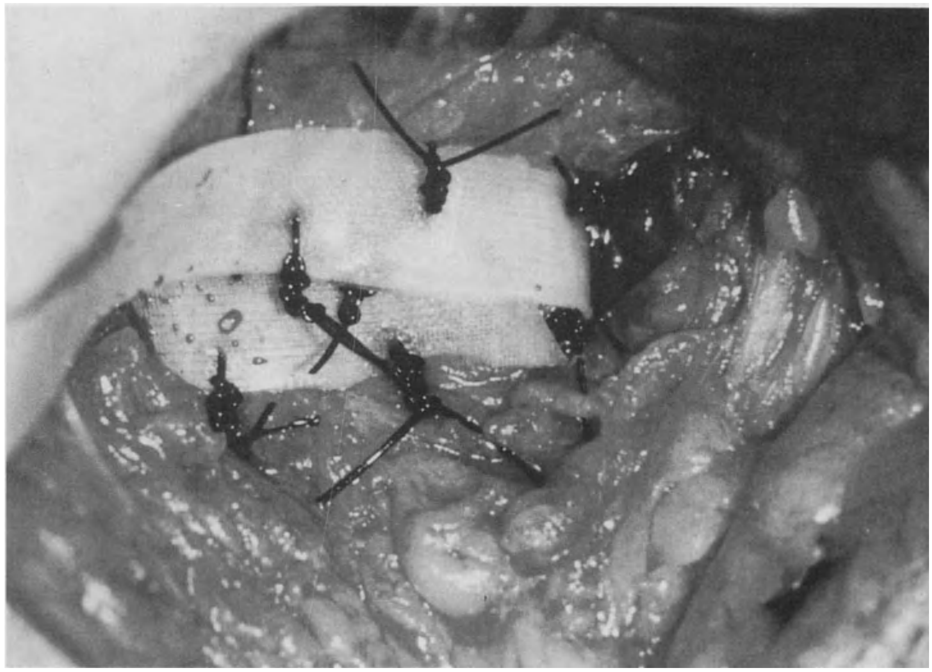


**Fig. 14.14.** The two ends of the sling are shown sewn to each other and to the anterior rectus sheath.

the bladder capacity they are asked only to catheterise twice a day. Once the residual is less than 100 mls they are instructed to cease ISC.

Postoperative voiding problems may be helped by advising the patients to press very firmly over their scar and hence relax their sling.

### *Results*

All four patients treated with a sling are dry. However one patient's sling is infected. The infection developed 6 weeks after surgery. At the time of writing, the wound is being irrigated daily with antibiotics. Both the urethra and vagina are intact.

### *Discussion*

This sling procedure was devised because it appeared to offer several substantial advantages in comparison with sling procedures and with the artificial urinary sphincter. The procedure can be carried out very simply and quickly. One great advantage is the fact that the surgeon need not enter the retropubic space. In most patients who have had previous gynaecological or urological surgery this is a considerable advantage.

Silastic is used to encourage the body to form a fibrous sheath around the Silastic sling. In the one patient who has needed sling adjustment this proved extremely easy because of the presence of this fibrous sheath through which the Silastic slid most smoothly. The third theoretical advantage of the Silastic sling technique is that, should the insertion of an artificial sphincter be necessary, then the sphincter cuff can be easily passed around the urethra using the Silastic sling fibrous sheath. In most sling procedures either fascia or a synthetic woven material is used. These materials are incorporated into the connective tissue around the bladder neck and urethra and any subsequent dissection of this area becomes extremely difficult.

## Conclusions

In our hands the Stamey procedure has given good results. Formerly, in 1982, we used the technique only in the elderly and after previous failed surgery. Since that time our results have given us the confidence to use this procedure in all patients, that is, for either the initial operation or the subsequent operation in patients with previous failed surgery.

The hospital stay is short with low morbidity. Nevertheless, it is wise to advise the patient to take the same precautions, in respect of heavy lifting, as would be advised after a procedure such as the Burch colposuspension.

Our final verdict on the Stamey procedure must await a longer term follow-up. For this reason detailed results have not been presented in this chapter. Similarly, the sling procedure must be judged with suitable reservations.

## References

Chilton CP, Turner-Warwick R (1981) The relationship of the distal urethral sphincter to the pelvic floor musculature. Communication to the annual meeting of the British Association of Urological Surgeons, London, July 1981

Heidler H, Wolk H, Jonas U (1979) Urethral closure mechanism under stress conditions. Eur Urol 5: 110–112

Mundy AR (1983) A trial comparing the Stamey bladder neck suspension with colposuspension for the treatment of stress incontinence. Br J Urol 55: 687–690

Stamey TA (1973) Endoscopic suspension of the vesical neck for urinary incontinence. Surg Gynecol Obstet 136: 547

*Chapter 15*

# Colposuspension and Slings

*S. L. Stanton*

## Introduction

Of the many suprapubic operations for the control of genuine stress incontinence (urethral sphincter incompetence, sphincter weakness incontinence), the colposuspension and sling operations are well established and effective, though not necessarily without complication or side effect. This chapter will critically review the similarities between these procedures.

## Historical Origins

Von Giordano (1907) is credited as being the first to describe the sling operation and he used gracilis muscle. He was followed by Goebell (1910), who used pyramidalis muscle, subsequently modified by Frangenheim (1914) and again by Stoeckel (1917), who combined the sling with bladder neck plication—the technique now being known by the triple eponym of Goebell–Frangenheim–Stoeckel. The sling technique fell into abeyance for a while, because of complications such as abcess formation in the paravaginal space, and was then revived by Aldridge (1942), who used rectus fascial strips, originating from the midline and united below the bladder neck. Studdiford (1944) modified this, using a continuous fascial support anchored at the lateral edge of the rectus sheath and reunited with the sheath after its passage below the bladder neck. Up to that time all slings were organic in nature. Shortly afterwards, Anselmino (1952) used Perlon, and since then many other clinicians have used a variety of inorganic tissues, namely Moir (1968)—polyethylene (Mersilene), Morgan and Farrow (1977)—polypropylene (Marlex). More recently there has been a brief return to the use of organic tissues, e.g. lyophilised dura (Havlicek 1972), fascia lata (Beck and Lai 1982) and porcine skin (Jarvis and Fowlie 1985).

The disadvantages of organic tissue are (1) variation in tensile strength and (2) difficulty in obtaining a sufficient and satisfactory sling if the rectus sheath has already undergone surgery. Fascia lata may be used but that entails a further incision for the patient. The advantage of organic tissue is the lack of adverse host reaction.

Inorganic tissue, whilst strong, inert and readily available, has a tendency to become incorporated in body tissues, producing fibrosis and making subsequent sling removal extremely difficult. The ideal sling should be inert, strong, readily available and easily adjustable for removal. Medical grade Silastic most readily approaches these criteria and has been used clinically (Stanton et al. 1985). Its main advantage lies in easy removal should erosion or recurrent incontinence occur; where appropriate, the cuff of an artificial urinary sphincter can be inserted in its place with little extra dissection.

The most notable of the urethrovesical suspension procedures is the Marshall–Marchetti–Krantz (MMK) operation (1949). Dissatisfied by this procedure because "the MMK is not always easy to perform, the field is often deep and bloody, the edges of the urethra are difficult to define and the periosteum of the posterior aspect of the symphysis is far from ideal as a holding structure", Burch (1961) devised the urethrovaginal fixation procedure. Initially, he used the origin of the levator ani from the white line of the pelvis, but after discovering that this had the same disadvantage as the periosteum, he used the ileopectineal or Cooper's ligament. The term "colposuspension" was coined in 1970 by Turner-Warwick and Whiteside. In the USA Tanagho (1976) preferred the term "colpocystourethropexy" and Hodgkinson (1978) preferred "retropubic urethropexy".

## Mechanism of Surgery

Elevation of the bladder neck within the pelvis is certainly the prime aim of most continence procedures. Whether surgery succeeds because, according to Enhorning's theory (1961), elevation brings the proximal urethra into the zone of transmission of intra-abdominal pressure change and therefore maintains the positive pressure gradient between urethra and bladder or because the proximal urethra is kinked during elevation and this is responsible for urethral closure is debatable. Continence by obstruction certainly seems to be the mechanism with some operations,

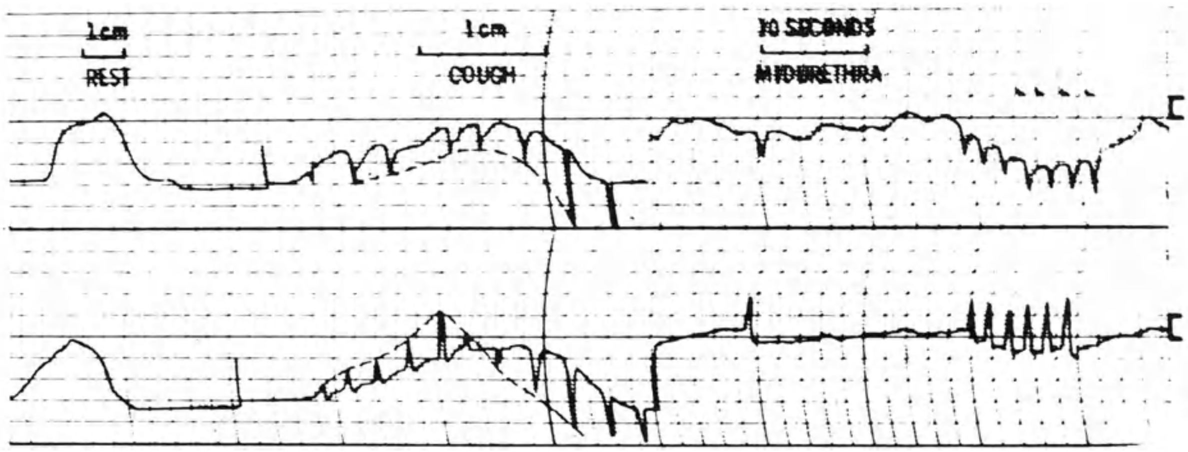



**Fig. 15.1.** Urethral pressure profile before (*top*) and after (*bottom*) successful colposuspension. (Reproduced from Hilton and Stanton 1983 by kind permission of Hilton and the Editor of *British Journal of Obstetrics and Gynaecology*)

but not all, and not consistently with any one type of procedure (except for the sling when used under marked tension).

It is likely that the colposuspension works on the principle of enhanced intra-abdominal pressure transmission to the proximal urethra (Hilton and Stanton 1983; Fig. 15.1). Continence may be further enhanced by relative outflow obstruction (indicated by a decrease in peak flow rate for an increase in maximum voiding pressure) in some patients. Sling procedures may produce continence in the following ways:

1. Marked tension of the sling will produce obstruction leading to retention which can then be relieved by clean intermittent self-catheterisation (CISC).
2. Less marked tension may elevate the bladder neck and proximal urethra and produce continence without obstruction, as described above (Fig. 15.2).
3. Kinking of the proximal urethra may occur.
4. The sling may act as a stable object, posterior to the proximal urethra or bladder neck, against which the urethra may be compressed by an increase in intra-abdominal pressure during straining (Fig. 15.3).

## Preoperative Investigations

The basic investigation includes history and clinical examination with demonstration of stress incontinence. It is important to detect symptoms of prolapse, detrusor instability and voiding difficulty. A past history should include previous bladder neck, pelvic and spinal operations. Examination includes a neurological assessment of the sacral outflow and

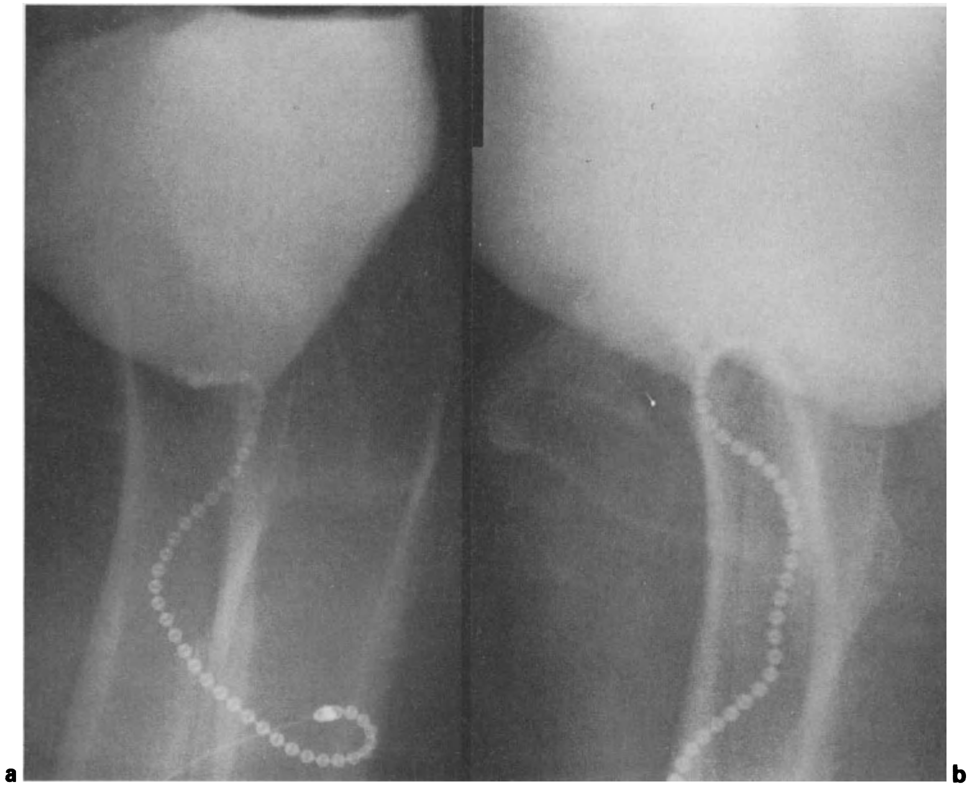



**Fig. 15.2a, b.** Lateral straining chain cystourethrogram before (**a**) and after (**b**) successful Silastic sling procedure. The degree of elevation and alignment to the symphysis pubis is shown.

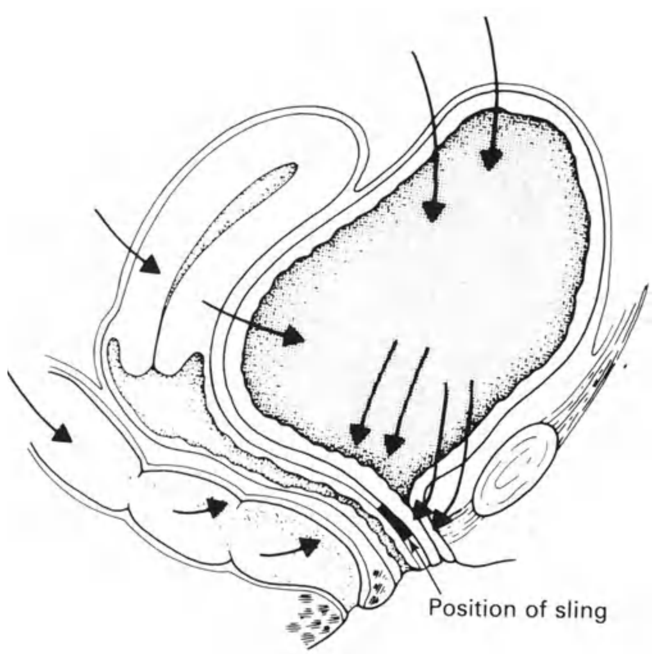



**Fig. 15.3.** Forces resulting from straining and the presence of a sling. (Reproduced from Asmussen and Miller 1983 by kind permission of the publishers, Blackwell Scientific Publications, Oxford)

**DEMENTIA SCORE**

1. Age.
2. Time (to nearest hour).
3. Address for recall at end of test – this should be repeated by patient to ensure it has been heard correctly: 42, West Street.
4. Year.
5. Name of hospital.
6. Recognition of two persons (doctor, nurse etc.).
7. Date of birth (day and month sufficient).
8. Year of first World War.
9. Name of present Monarch.
10. Count backwards 20 – 1.

3b. Recall of address.

DEMENTIA SCORE = /10

**Fig. 15.4.** Dementia score, completed by the doctor or nurse at the first visit.

a pelvic examination to detect residual urine, stress incontinence and genital prolapse, including bladder neck descent. Vaginal mobility and capacity should be assessed to determine whether a colposuspension is technically feasible. Significant genital prolapse indicates that repair surgery may be required. In the case of colposuspension, it is important to correct an enterocele or rectocele at the same time, as these will be made worse by the colposuspension. If the patient is elderly or mentally frail, a dementia score (Fig. 15.4) is completed; if there is limitation of mobility, this should be assessed objectively.

A mid-stream specimen of urine is sent for culture and sensitivity. Urodynamic assessment is necessary to confirm the cause of the stress incontinence and to detect conditions prejudicial to the success of surgery, namely detrusor instability and voiding difficulty. If there are no symptoms of voiding difficulty and no past bladder neck surgery, then twin channel subtraction cystometry with uroflowmetry should be sufficient. If there is doubt about bladder neck position, a lateral strain chain cystourethrogram is performed (see Fig. 15.2). However, if there has already been one failed operation to cure stress incontinence, videocystourethrography (VCU) will give additional and useful information about the sphincter mechanism and activity of the pelvic floor. Cystoscopy is performed if indicated by symptoms and if there has been past bladder neck surgery, to exclude significant intravesical pathology, e.g. calculus around a suture (Fig. 15.5).

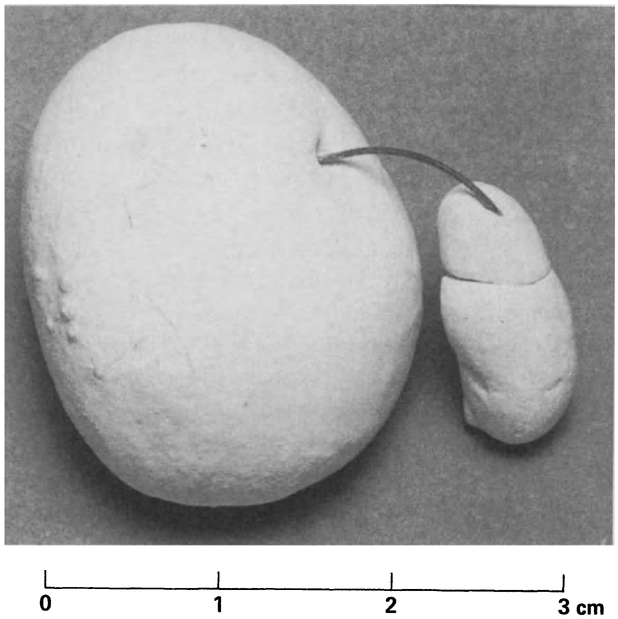



**Fig. 15.5.** Vesical calculus around a nylon suture.

## Patient Selection and Exclusion

The selection criteria for both operations are:

1. Absence of voiding difficulty.
2. Preferably a stable bladder: if detrusor instability coexists, it should be therapeutically controlled, with contractions or a systolic pressure rise of less than 25 $cmH_2O$.
3. Family complete: if not, and if the incontinence is very severe, then the patient should be counselled that a caesarian section may be appropriate for the next delivery.
4. Absence of urinary tract infection.
5. Mentally alert and aware of the need to be dry.

For the colposuspension, which is my initial preference for the surgical correction of uncomplicated genuine stress incontinence, there should be adequate vaginal mobility and capacity to allow each lateral vaginal fornix to be approximated to the ipsilateral ileopectineal ligament. If vaginal mobility or access is limited, then a sling procedure is the preferred operation. Significant cystourethrocele may be adequately corrected by colposuspension. In addition, there should be some descent of the bladder neck: if the bladder neck is well elevated, it is unlikely that the colposuspension will confer any additional benefit. Coexistent uterine descent, enterocele or rectocele will need correction, and this may be achieved by an abdominal hysterectomy, closure of the pouch of Douglas (Moschowitz operation) or posterior repair, respectively.

For the sling procedure, which is usually a secondary procedure, I have the following criterion for selection: poor posterior support to the proximal urethra or bladder neck, which may either be well elevated but not aligned to the anterior-superior border of the symphysis pubis, or may be poorly elevated. Usually the patient has reduced vaginal mobility and capacity because of previous vaginal surgery which has produced scarring, and there is little prolapse to be corrected.

## Operative Techniques

No special preparation is required for either operation apart from an abdominal and perineal shave. If the patient is at risk of deep thrombosis, 5000 IU calcium heparin is given subcutaneously with the premedication and then twice daily until the patient is fully mobilised (usually day 5). Cephradine 500 mg is given with the premedication and then 6-hourly for 48 h as chemoprophylaxis. If a posterior repair is performed, a 1 g rectal suppository of metronidazole is given with premedication.

The patient is placed in the horizontal lithotomy position with the legs abducted and supported in Lloyd-Davies or similar stirrups. The abdomen, vaginal and perineal regions are cleansed and draped. A transurethral resection drape is placed over the perineum to allow sterile access to the vagina during the operation by means of the attached condom. A 14 FG Foley urethral catheter is inserted to allow free urine drainage and to delineate the bladder neck and subsequently allow bladder filling after the operation to insert the suprapubic catheter. A low Pfannenstiel incision, to obtain maximum access to the bladder region, is made approximately one finger breadth above the symphysis pubis. If there has been previous lower abdominal surgery, a Cherney incision is used, which gives excellent exposure without risk of entering the peritoneal cavity. Should an abdominal hysterectomy or Moschowitz procedure be required, they are performed before the colposuspension or sling and without using a Cherney incision.

A Denis-Brown four-bladed ring retractor gives good exposure: the bladder is carefully dissected off the symphysis and the space of Retzius is exposed by a combination of scissor and blunt finger dissection.

### Colposuspension

The surgeon places a forefinger in the vagina and elevates one or other lateral vaginal fornix (Fig. 15.6). From above, the upward pressure cone is readily identified visually and by palpation. Using either a swab on a holder or a Lahey dab, the abdominal hand carefully dissects the bladder base medially off the paravaginal fascia (Fig. 15.7), using scissors where undue resistance is found. Large perivesical veins may be encountered; these should be moved to one side and diathermied or ligated with the

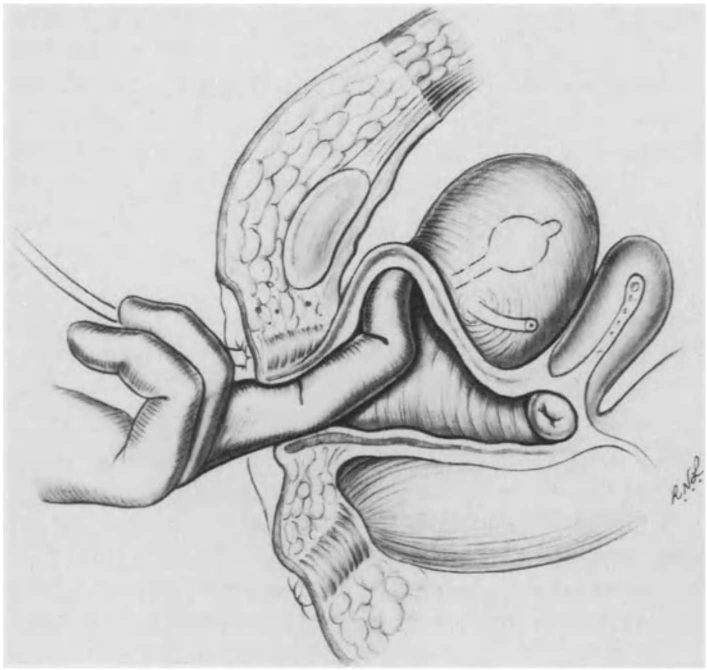


**Fig. 15.6.** Colposuspension: sagittal section demonstrating upward pressure in a lateral vaginal fornix, to aid in the abdominal dissection. [Reproduced from Stanton SL and Tanagho E (1986) Surgery of female incontinence, 2nd edn. Springer, Berlin Heidelberg New York London]

**Fig. 15.7.** Colposuspension: with the operator's finger still in the vagina and elevating the lateral vaginal fornix, the bladder base is dissected medially off the paravaginal fascia. [Reproduced from Stanton SL and Tanagho E (1986) Surgery of female incontinence, 2nd edn. Springer, Berlin Heidelberg New York London]

ensuing suture. The paravaginal fascia is recognised as white tissue, and no sutures should be placed in it until it is clearly visible. Two sutures of either No.1 polyglycolic acid (PGA; Dexon or Vicryl) or No.1 unabsorbable polybutylate-coated polyester (Ethibond) are inserted into the paravaginal fascia, opposite the bladder base on one side and separated by about 1 cm. The suture is tied to produce haemostasis and to avoid seesawing of the suture through the fascia. Next, the lateral fornix is elevated to the ipsilateral ileopectineal ligament. The suture is then inserted through the ligament and held. The second suture is similarly placed. At this stage, the Foley catheter is gently pulled down and a third suture may be inserted on the same side if the second suture is not already at the level of the bladder neck. It is important to avoid placing sutures distal to the bladder neck because of the risk of producing postoperative voiding difficulties: the procedure is then repeated on the other side (Fig. 15.8).

Once the sutures are in position and haemostasis is complete, they are tied, so approximating the paravaginal fascia to the ileopectineal ligament. To do this, the operator holds taut that limb of the suture passing through the ileopectineal ligament (which will elevate the fascia to the ligament) and then ties the remaining limb around it. I usually tie the most distal or caudal suture, moving alternatively from side to side to ensure even bladder neck elevation (Fig. 15.9). Some "bow stringing" of the distal sutures may occur as the fascia fails to approximate to the ileopectineal ligament. Although this looks surgically inept, as long as some fascia approximates to the side wall of the pelvis, it does not seem to affect the result adversely. The alternative procedure of suturing the paravaginal fascia to the internal obturator fascia is less satisfactory, as obturator fascia is not as strong as the ileopectineal ligament. If the

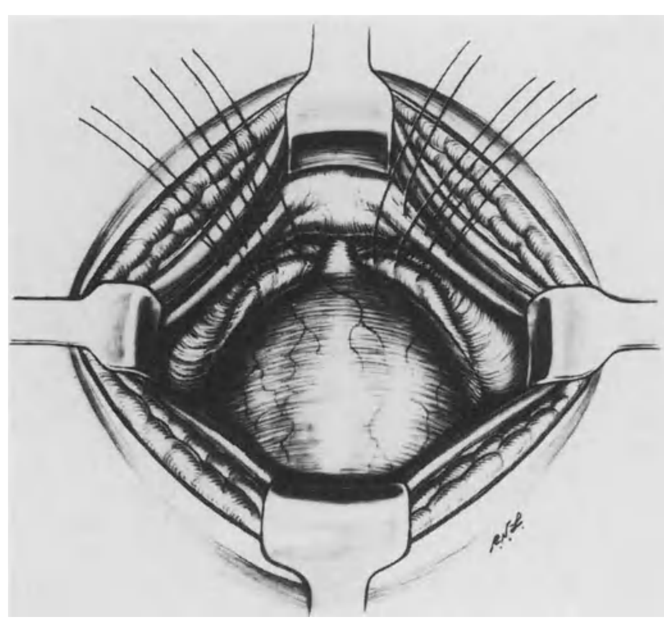


**Fig. 15.8.** Colposuspension: the three pairs of sutures are in place but not tied. [Reproduced from Stanton SL and Tanagho E (1986) Surgery of female incontinence, 2nd edn. Springer, Berlin Heidelberg New York London]

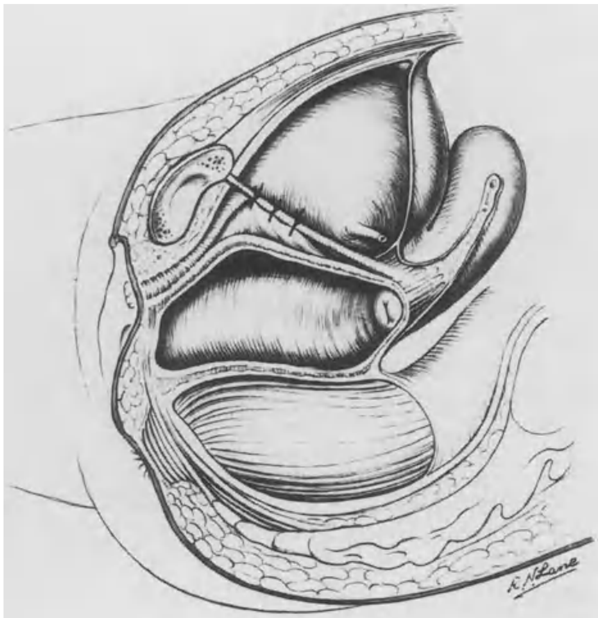


**Fig. 15.9.** Colposuspension: sagittal section showing elevation of the bladder neck and bladder base on a shelf of paravaginal fascia, sutured to an ileopectineal ligament. [Reproduced from Stanton SL and Tanagho E (1986) Surgery of female incontinence, 2nd edn. Springer, Berlin Heidelberg New York London]

paravaginal fascia will not approximate at all to the ileopectineal ligament, then the colposuspension is an inappropriate procedure and a sling or Stamey operation may be more satisfactory.

A suction drain is left in the space of Retzius and the wound closed. If a Cherney incision has been performed, this is closed using nylon. The bladder is filled via the urethral catheter and the suprapubic catheter is inserted.

## Sling

There are many variations on this procedure. It is undoubtedly easier to carry out a simultaneous vaginal and suprapubic dissection to expose the bladder neck and place the sling in the correct position. However, using inorganic material, there is always a risk of infection from the vaginal incision. I prefer the suprapubic approach only, with the creation of a tunnel underneath the bladder neck into which the sling is placed (Millin and Read 1948).

The bladder neck and proximal urethra are approached in the same way as the colposuspension. Gentle scissor dissection proceeds at the level of the bladder neck to create a suburethral tunnel (Fig. 15.10). This is continued on the other side of the bladder neck and by "rolling" the bladder neck from side to side the dissection meets in the midline. To aid the abdominal dissection, it is helpful to have a finger in the vagina within the TUR drape. Once continuity has been established (Fig. 15.11), the sling (Fig. 15.12) is pulled through and sutured to each ileopectineal ligament. Since Silastic does not bond to body tissues, unabsorbable suture material (e.g. Ethibond No.1) must be used. To avoid obstruc-

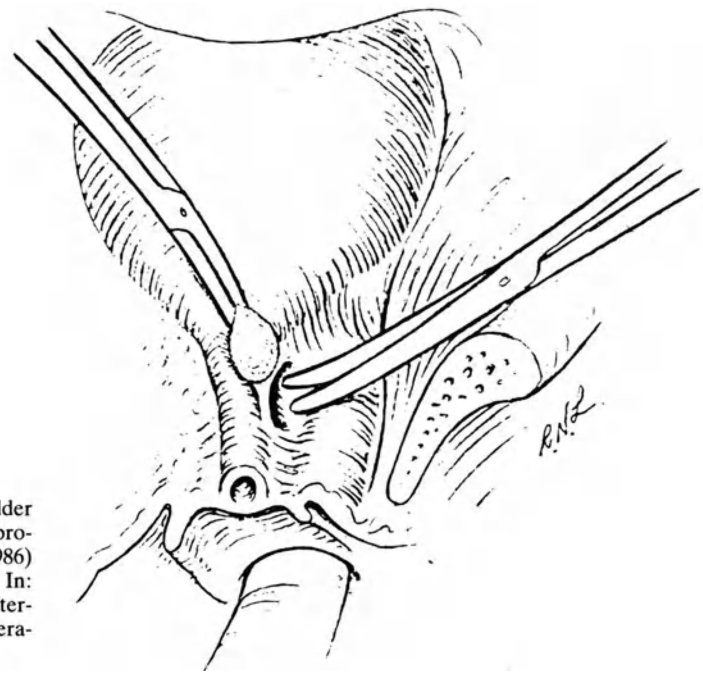


**Fig. 15.10.** Sling: creation of a suburethral/bladder neck tunnel by scissor and blunt dissection. [Reproduced with kind permission from Stanton SL (1986) Operations for incontinence of urine in the female. In: Williams DI (ed) Operative surgery: Urology. Butterworth, London, pp 625–642 (Rob and Smith's Operative surgery, 4th edn)]

tion, I suture the sling under *minimal* tension. By that, I mean just sufficient to support the bladder neck away from the underlying paravaginal fascia but still leaving the sling somewhat slack. (This is necessarily a subjective description, as at present there is no objective measure of sling tension.) If the patient were to be cystoscoped at this

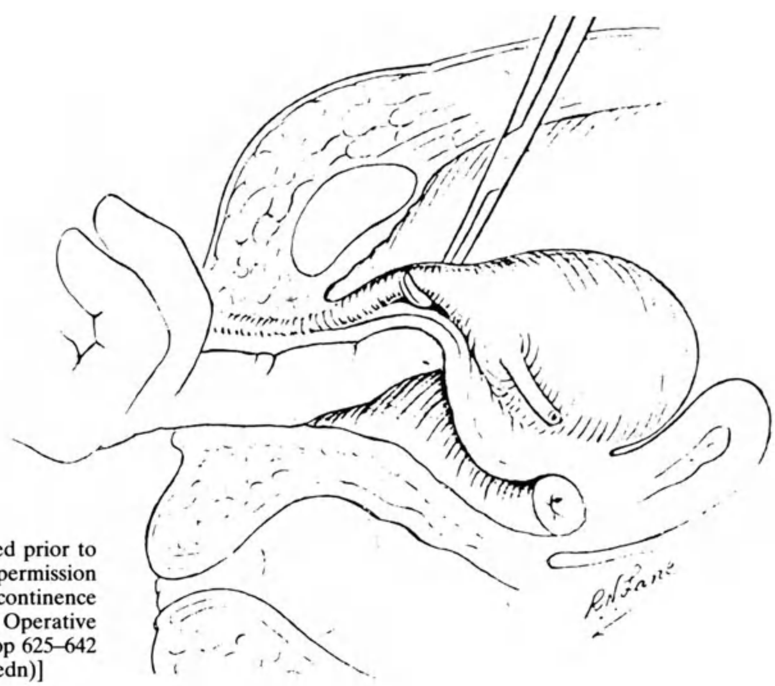


**Fig. 15.11.** Sling: the tunnel is established prior to sling insertion. [Reproduced with kind permission from Stanton SL (1986) Operations for incontinence of urine in the female. In: Williams DI (ed) Operative surgery: Urology. Butterworth, London, pp 625–642 (Rob and Smith's Operative surgery, 4th edn)]

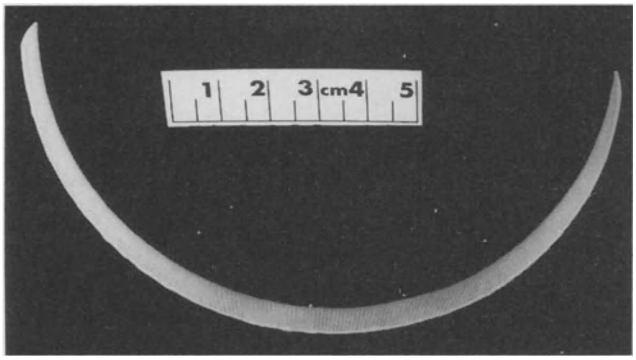



**Fig. 15.12.** Silastic sling which may be cut to length.

stage, the urethral axis would be horizontal: excess tension would result in a more vertical urethral axis.

After haemostasis, a suction drain is inserted and the wound closed. A suprapubic catheter is inserted.

## Postoperative Management

Patients at risk of deep venous thrombosis continue to have 5000 IU of heparin until full mobilisation (day 5). Cephradine is continued for 48 h. The patient is encouraged to drink between 2 and 2.5 litres a day, and an accurate intake and output chart is maintained. Mobilisation commences on day 1, and the suprapubic catheter is clamped on day 2 and the patient encouraged to void spontaneously every 2–3 h. If she fails to do so, the catheter is unclamped. The residual urine is measured at the end of the day by unclamping the suprapubic catheter for 30 min. Once the residual urine is less than 150 ml and the patient is voiding amounts greater than 200 ml, the catheter is clamped overnight. She is then woken once or twice by the nursing staff and encouraged to void. The morning residual urine is measured in the same fashion, and, provided the patient voids at least 200 ml and neither develops retention nor incontinence and the residual does not exceed 300 ml, the catheter may be removed. The final catheter specimen of urine is sent for culture and sensitivity testing. Montz and Stanton (1985) showed that early catheter clamping after colposuspension resulted in 65% of patients voiding by day 3 and 39% of patients having the catheter removed by day 5. The patient can then be discharged home as early as day 6 or 7.

After a colposuspension, the patient is advised to avoid heavy lifting for at least 2 months and preferably, if feasible, for ever. Intercourse should be deferred for 2 months because the altered axis of the vagina and prominence of a web of rectovaginal fascia on the posterior vaginal wall may cause dyspareunia. After a sling, strenuous lifting should be avoided for about a month.

## Complications

Intraoperative complications of both operations include urethral and bladder injury during the initial dissection and during insertion of the sling. Ureteric injury can occur during colposuspension as a result of inadequate dissection and ligation of the ureter adjacent to the ureterovesical junction. Management entails recognition of these injuries (some clinicians operate with the bladder partially filled with dye or sterile milk) and their repair. Venous haemorrhage is managed by diathermy, ligation with sutures or Liga clips and haemostatic aids such as Oxycel. Venous bleeding ultimately stops when the lateral vaginal fornices are elevated. Arterial haemorrhage is rare and requires diathermy or ligation.

Postoperative complications include urinary tract infection, which is partially avoided by suprapubic catheterisation and prophylactic antibiotic cover.

Voiding difficulties are well documented following colposuspension. They may be anticipated by preoperative urodynamic testing: repeated peak urine flow rate below 15 ml/s and a low isometric contraction pressure during voiding are adverse factors. Dundas et al. (1982) analysed the aetiology of voiding difficulties following colposuspension and found them to be due to reduced mobility and excess elevation of the bladder neck. Voiding difficulty and a large residual urine are known hazards of sling operations; indeed, they are so common that Beck (1978) includes them under routine postoperative care. Undue sling tension and dissection around the bladder neck are the likeliest causes.

Detrusor instability can be encountered after both procedures. It was first reported after colposuspension by Cardozo et al. (1979), when 5% of patients were found to have developed detrusor instability. Subsequent follow-up to 5 years by Steel et al. (1986) of a group of 24 women with instability showed that 14 (58%) were symptomatic, of whom 4 were improved by drug therapy. Instability has also been encountered following sling surgery and artificial urinary sphincter implantation. The aetiology is obscure: it is not due to obstruction (in the female). It may be due to latent instability, which is made obvious by more effective occlusion of the bladder neck, or may be a sequel to single or repeated dissection around the bladder neck.

Other complications following the sling include sling erosion into the urethra or vagina. Recurrent incontinence can occur following either procedure; its management will depend on its severity and the results of the urodynamic studies.

## Literature and Personal Results

Until recently, results quoted for incontinence surgery were largely subjective and often 5%–10% more optimistic than real. Table 15.1 shows the published results for colposuspension.

**Table 15.1.** Results for colposuspension operation

| Reference | No. of patients | Surgery $1^y$ or $2^y$ | Follow-up (months) | Cure rate |
|---|---|---|---|---|
| Burch (1968) | 143 | mixed | 2–60 | 93% subjective |
| Morgan (1973) | 51 | $1^y$ | 6–60 | 90% subjective |
| Walter et al. (1982) | 38 | $1^y$ | 12–30 | 84% subjective<br>71% objective |
| Mundy (1983) | 25 | mixed | 12– | 89% subjective<br>73% objective |
| Gillon and Stanton (1984) | 35 (elderly) | mixed | 36–60 | 89% objective |

$1^y$, no previous surgery; $2^y$, previous surgery.

My own series of colposuspension with pre- and post-urodynamic studies is now 525. A 5-year follow-up of some 40 patients undergoing primary surgery and using No.1 PGA sutures showed that 90% were cured subjectively and 75% cured objectively. For those undergoing secondary surgery, the subjective and objective cure rates over 5 years were 64%. In an effort to improve the cure rate, a trial of unabsorbable suture material, namely No.1 Ethibond was begun 4 years ago. The 2-year objective cure rate of a group of 25 patients treated with Ethibond sutures was 84%, compared with 70% for a group of 51 patients treated with PGA sutures. However, for secondary surgery, the objective cure rate at 2 years was 87% (15 patients) for Ethibond and 42% (19 patients) for PGA.

The results for sling procedures are shown in Table 15.2. The main variable factor is the type of material used.

**Table 15.2.** Results for sling procedures

| Reference | Sling material | No. of patients | Surgery ($1^y$ or $2^y$) | Follow-up (months) | Cure rate |
|---|---|---|---|---|---|
| Morgan and Farrow (1977) | Polypropylene (Marlex) | 127 | $2^y$ | – | 93% subjective |
| Beck and Lai (1983) | Fascia lata | 88 | $2^y$ | 2–24 | 89% objective |
| Kersey (1983) | Polyethylene (Mersilene) | 103 | mixed | 6–108 | 68% subjective |
| Petri et al. (1983) | Rectus fascia | 106 | mixed | 6–144 | 52% subjective |

$1^y$, no previous surgery; $2^y$, previous surgery.

Our results for Silastic sling (Stanton et al. 1985) relate to 30 patients, 23 of whom had undergone previous bladder neck surgery. The follow-up was between 3 months and 2 years. The overall subjective and objective cure rates were 83%. At 1 year (for 22 patients) only one patient was subjectively and objectively wet. However, these figures are small, and a more complete follow-up is needed. At sling insertion, two patients had a vaginal entry and two patients had a bladder or urethral entry. One of the latter two patients subsequently developed a urethrovaginal fistula. The sling was removed and the fistula was closed. Five patients required removal of the sling for voiding difficulties; this was easily accomplished through two small groin incisions. The voiding difficulty resolved in three of them. Sling removal does not always lead to a recurrence of stress incontinence.

## Future Modifications

The main disadvantages of both procedures are

1. Recurrent incontinence
2. Detrusor instability
3. Voiding disorders.

Recurrent incontinence indicates that there is much about the mechanism of continence and its surgical treatment that still eludes us. To improve the cure rate we need to (1) know how each operation works, (2) have knowledge of the precise factors responsible for sphincter incompetence in the individual patient and (3) know how to match the clinical and urodynamic features of the patient with the appropriate operation. Further understanding is sought from conventional investigations, and there is a need to develop more sophisticated tests to measure urethral function.

Detrusor instability is undoubtedly aggravated by, and even caused by, these operations, and some patients are more prone to develop it. It is necessary to understand more about its aetiology and have more effective treatment of the established condition.

To reduce postoperative voiding difficulties, some objective method of intraoperative measurement is required to regulate the amount of (1) elevation of the bladder neck at colposuspension and (2) sling tension, both of which contribute to subsequent voiding difficulty. At present, both are dependent upon the particular skills of the surgeon.

## References

Aldridge A (1942) Transplantation of fascia for relief of urinary stress incontinence. Am J Obstet Gynecol 44: 398–411

Anselmino K (1952) Eine neue Schlingeroperation zur Behandlung der hochgradiger Urinkontinenz des Weibes. Geburtshilfe Frauenheilkd 12: 277

Asmussen M, Miller A (1983) Clinical gynaecological urology. Blackwell Scientific, Oxford

Beck RP (1978) The sling operation. In: Buchsbaum HJ, Schmidt J (eds) Gynecologic and obstetric urology. Saunders, Philadelphia, pp 223–244

Beck RP, Lai AR (1982) Results in treating 88 cases of recurrent urinary stress incontinence with Oxford fascia lata sling procedure. Am J Obstet Gynecol 142: 649–651

Burch J (1961) Urethrovaginal fixation to Cooper's ligament for correction of stress incontinence, cystocele and prolapse. Am J Obstet Gynecol 81: 281–290

Burch J (1968) Cooper's ligament urethrovesical suspension for stress incontinence. Am J Obstet Gynecol 100: 764–772

Cardozo LD, Stanton SL, Williams JE (1979) Detrusor instability following surgery for genuine stress incontinence. Br J Urol 51: 204–207

Dundas D, Hilton P, Williams J, Stanton SL (1982) Aetiology for voiding difficulties post colposuspension. In: Proceedings of 12th annual meeting of International Continence Society, Leiden, p 132

Enhorning G (1981) Simultaneous recording of the intravesical and intra-urethral pressures. Acta Chir Scand [Suppl] 276: 1–68

Frangenheim P (1914) Zur operativen Behandlung der Inkontinenz der männlichen Harnöhre. Verh Dtsch Ges Chir 43: 149–154
Gillon G, Stanton SL (1984) Long-term follow-up of surgery for urinary incontinence in elderly women. Br J Urol 56: 478–481
Goebell R (1910) Zur operativen Beseitigung der angeborenen Incontinentia vesicae. Z Gynaekol Urol 2: 687–690
Havlicek S (1972) Schlingoperationen mit Lyoduraband bei rezidivierden Harinkontinenz der Frau. Geburtshilfe Frauenheilkd 32: 757
Hilton P, Stanton SL (1983) A clinical and urodynamic evaluation of the Burch colposuspension for genuine stress incontinence. Br J Obstet Gynaecol 90: 934–939
Hodgkinson CP (1978) "Recurrent" stress urinary incontinence. Am J Obstet Gynecol 132: 844–860
Jarvis G, Fowlie A (1985) Clinical and urodynamic assessment of the porcine dermis bladder sling in the treatment of genuine stress incontinence. Br J Obstet Gynaecol 92: 1189–1191
Kersey J (1983) The gauze hammock sling operation in the treatment of stress incontinence. Br J Obstet Gynaecol 90: 945–949
Marshall V, Marchetti A, Krantz K (1949) The correction of stress incontinence by simple vesico-urethral suspension. Surg Gynecol Obstet 44:509–518
Millin T, Read C (1948) Stress incontinence of urine in the female. Postgrad Med J 24: 51–56
Moir JC (1968) The gauze hammock operation. Br J Obstet Gynaecol 75: 1–9
Montz F, Stanton SL (1985) Suprapubic bladder catheterisation: use and management in the gynecologic patient. Contemp Obstet Gynecol 25: 31–46
Morgan JE (1973) The suprapubic approach to primary stress urinary incontinence. Am J Obstet Gynecol 115: 316–320
Morgan JE, Farrow GA (1977) Recurrent stress urinary incontinence in the female. Br J Urol 49: 37–42
Mundy AR (1983) A trial comparing the Stamey bladder neck suspension procedure and colposuspension for the treatment of stress incontinence. Br J Urol 55: 686–690
Petri E, Beckhaus I, Frohneburg D, Thuroff J (1983) Inguino-vaginal sling according to Narik and Palmrich – indications, problems, long-term results. Aktuel Urol 14: 286–290
Stanton SL, Brindley G, Holmes D (1985) Silastic sling for urethral sphincter incompetence in the female. Br J Obstet Gynaecol 92: 747–750
Steel SA, Cox C, Stanton SL (1986) Long-term follow-up of detrusor instability following the colposuspension procedure. Br J Urol 58: 138–142
Stoeckel W (1917) Ueber die Verwendung der Musculi Pyramidalis bei der operativen Behandlung der Incontinentia urinae. Zentralbl Gynaekol 41: 11–19
Studdiford W (1944) Transplantation of abdominal fascia for relief of urinary stress incontinence. Am J Obstet Gynecol 47: 764–775
Tanagho E (1976) Colpocystourethropexy: the way we do it. J Urol 116: 751–753
Von Giordano (1907) Sling procedures. Quoted by Hohenfellner and Petri. In: Stanton SL, Tanagho E (eds) 1986 Surgery of female incontinence, 2nd edn. Springer, Berlin Heidelberg New York, pp 105–112
Walter S, Olesen K, Hald T, Jenson H, Pedersen P (1982) Urodynamic evaluation after vaginal repair and colposuspension. Br J Urol 54: 377–380

*Chapter 16*

# Levatorpexy—Transperitoneal Levator Muscle Repair

*C. Frimodt-Møller*

## Introduction

Urodynamic and radiological investigations of the bladder and its outlet in females with urinary incontinence have provided us with improved knowledge of the cause of incontinence. Thus, we are now able to distinguish between bladder neck suspension defects, pelvic floor deficiency and/or detrusor instability. The importance of distinguishing between the different causes of incontinence is to enable the urologist/gynaecologist to choose between a series of treatment modalities, thereby improving the success of the method chosen. Micturating cystourethrography (MCUG) provides excellent information regarding the distinction between bladder neck suspension defect and pelvic floor deficiency (Fig. 16.1; Olesen 1983).

It is impossible from the patient's symptoms to classify their suspension defects (Stanton 1978). On the other hand, uroflowmetry may indicate whether there is an anterior suspension defect, since the flow curve demonstrates a normal curve with a peak flow. In patients with posterior suspension defects the flow curve is usually obstructed and often intermittent (Frimodt-Møller 1978). The cystometrograms are similar in both types of suspension defect.

Anterior suspension defects with high peak flow rates are usually best treated with a urethrosuspension. However, in patients with posterior suspension defects with obstructed flow the treatment must avoid obstructing the flow. Usually a posterior vaginal repair including a lower levatorpexy is recommended. Since the cause of this suspension disorder is due to an insufficient pelvic floor, another type of repair has been developed: the transperitoneal levatorpexy (Kielmann et al. 1986). Details of this repair procedure are given in this chapter.

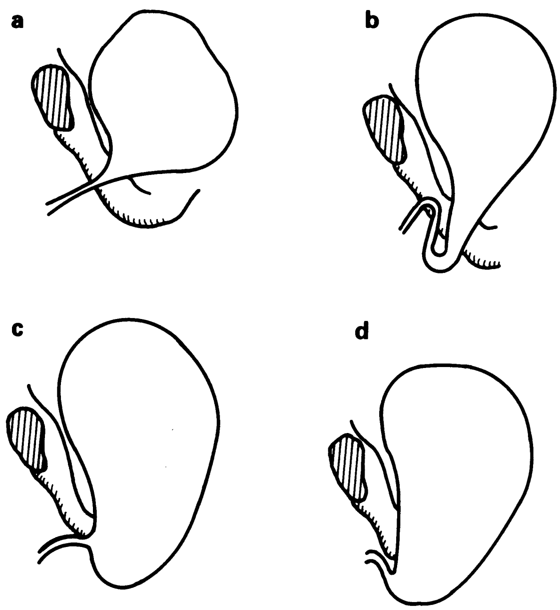



**Fig. 16.1.** **a,b** Anterior bladder suspension defects: **a** bladder base insufficiency; **b** anterior bladder descent. **c,d** Posterior bladder suspension defects: **c** trigonocele; **d** posterior bladder descent.

# Operative Method

The operation is performed as a laparotomy with the patient in the supine position. An indwelling catheter in the bladder ensures that the bladder is drained during operation. In patients who have had previous pelvic surgery it is advisable to introduce bilateral ureteric catheters in order to safeguard the position of the lower ureters. A rectal tube is inserted into the rectum to mark the position of the rectum. If hysterectomy has been performed, a similar tube is inserted into the vagina to mark its location.

A lower midline or transverse incision is used. The small gut is packed off into the upper abdomen, giving good access to the pelvis. The vesicovaginal pouch is opened through a transverse incision, and the anterior vaginal wall is freed from the urethra down to the lower edge of the pubis. At this level the relatively thick muscular fibres of the pubococcygeus muscles are identified (Fig. 16.2). By pulling these muscles medially with an Allis forceps it is easy to feel in the lateral part of the pelvis that traction is performed at the anterior part of the pelvic floor. Three or four resorbable sutures (Dexon No. 0) are inserted to the left and right pubococcygeus muscles, the anterior suture being placed just behind the bladder, and the most posterior suture just in front of the vagina (Fig. 16.3).

Through a transverse incision of the peritoneum in the pouch of Douglas an easy dissection can be performed down the posterior wall of the vagina, especially when the rectum can be localised by the rectal tube in situ. The puborectalis muscle fibres are closely adjacent to the peritoneum and, in contrast to the anterior part of the pelvic floor the

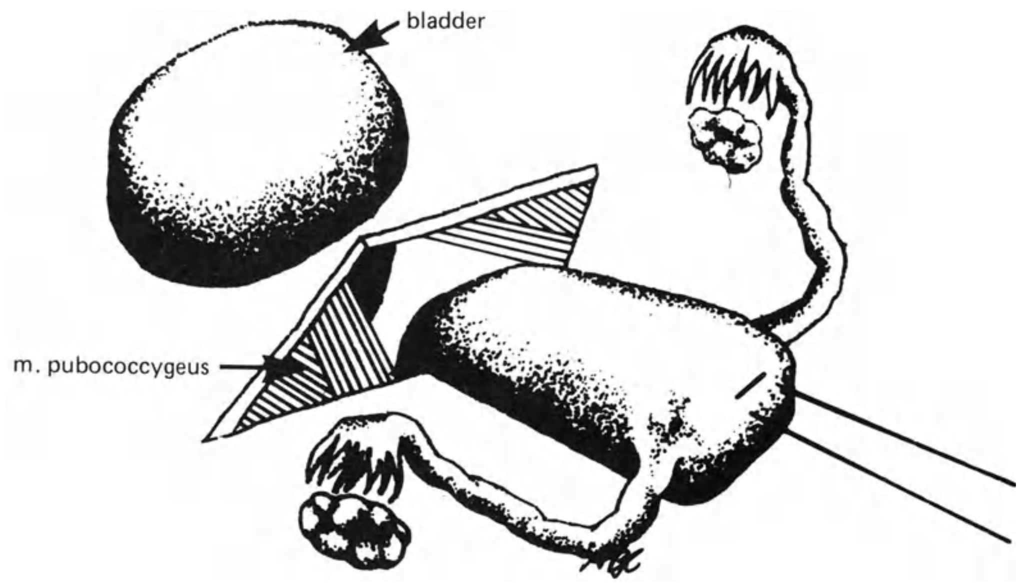



**Fig. 16.2.** Section of the pelvic floor showing the transverse incision of the peritoneum in the vesicovaginal pouch with the pubococcygeus fibres of the levator muscle present.

muscle fibres are sparse and not so easily defined (Fig. 16.4). On the other hand, traction of the muscle when palpating laterally in the pelvis may facilitate identification of the correct muscle. Two or three resorbable sutures are then placed in each muscle (Fig. 16.5). No suction tubes are necessary.

Postoperatively the patient is left with an indwelling catheter for 5 days. She is mobilised immediately, and pelvic floor training is usually commenced on the seventh day after operation.

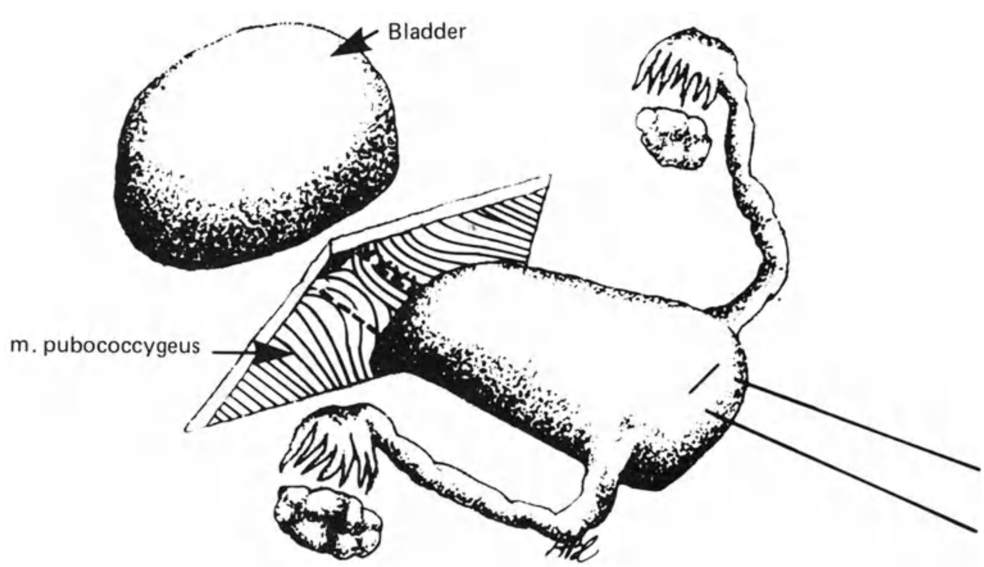



**Fig. 16.3.** Dexon sutures in the levator ani muscles.

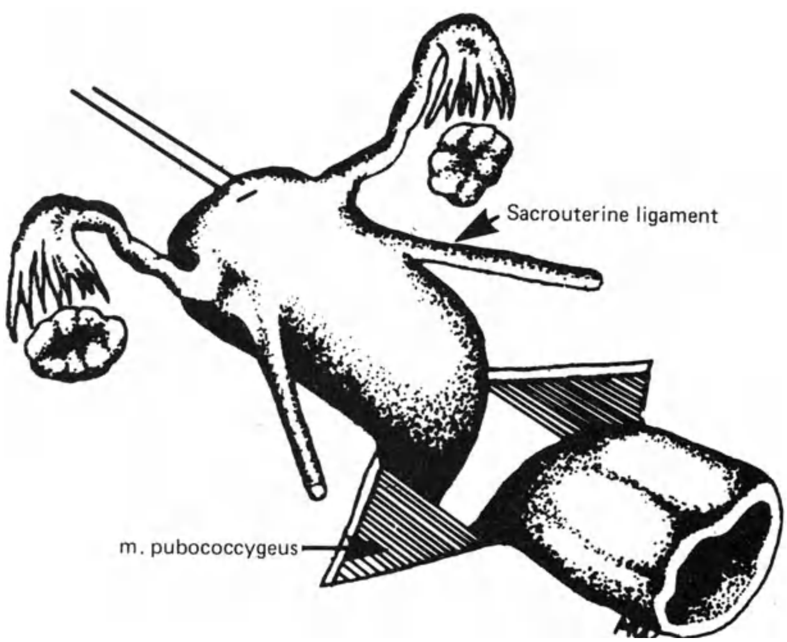



**Fig. 16.4.** The uterus displaced anteriorly and a transverse incision of the peritoneum in the rectovaginal pouch.

## Material and Method of Investigation

At the introduction of this new operative treatment for urinary incontinence the operation was offered to all stress-incontinent women regardless of their cause of incontinence (Kielmann et al. 1986). The present study included 68 women referred for treatment with stress or mixed stress/urge incontinence during the years 1979–1984. The inclusion

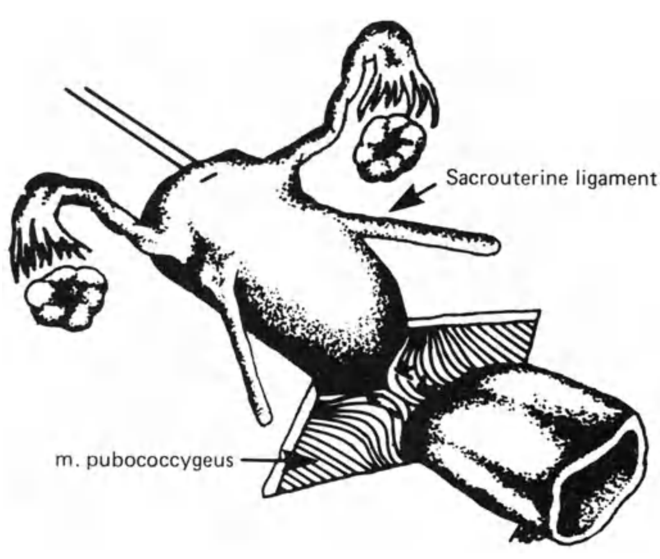



**Fig. 16.5.** Dexon sutures in the pubococcygeus muscles.

criteria were stress-incontinent women with posterior suspension defects, anterior bladder descent (see Fig. 16.1), patients following previous pelvic surgery, patients with detrusor instability, and patients with impaired flow. Excluded were obese patients (>30% over standard weight).

**Table 16.1.** Age and symptoms in 68 incontinent women according to their radiological classification

| | No. of patients | Age (years) | Stress | Urge | Continuous |
|---|---|---|---|---|---|
| *Anterior suspension defect* | | | | | |
| Bladder neck insufficiency | 28 | 50 (31–66) | 28 | 10 | 4 |
| Anterior descensus | 29 | 51 (32–69) | 29 | 16 | 3 |
| *Posterior suspension defect* | | | | | |
| Posterior descensus | 8 | 48 (31–66) | 8 | 8 | 1 |
| Trigonocele | 3 | | 3 | | 1 |

Table 16.1 depicts the age of the incontinent women, their symptomatology and the number of patients in each of the radiologically classified groups (see Fig. 16.1). The distribution of women with anterior and posterior suspension defects reflects the normal distribution seen in our institution, where 78% of women have anterior suspension defects, 15% posterior suspension defects and 7% are unclassified.

The severity of stress incontinence was graded according to Ingelmann-Sundberg (1953) and consisted of two patients with grade I, 50 patients with grade II and 16 patients with grade III incontinence. All but five women were multiparous, with a mean of 2.4 deliveries per patient. Fifteen of the patients (20% of all patients) were obese, with an average of 17% excess over standard weight (range 7%–31%%). Seventeen patients had had operations previously for incontinence (13 vaginal repairs and 4 colposuspensions), while 15 had been hysterectomised (12 because of menorrhagia and 3 because of genital prolapse).

Urodynamic investigation revealed peak flow rates ranging from 1 to 50 ml/s at volume rates of 120–990 ml, mean peak flow rate 25 ml/s. Six patients had typical obstructed flow curves. At cystometry 14 patients presented with detrusor instability. Ten patients had residual volumes exceeding 100 ml. MCUG was performed according to Olesen and Walter (1977), and the distribution of patients into the four subgroups (see Fig. 16.1) is listed in Table 16.1.

## Results

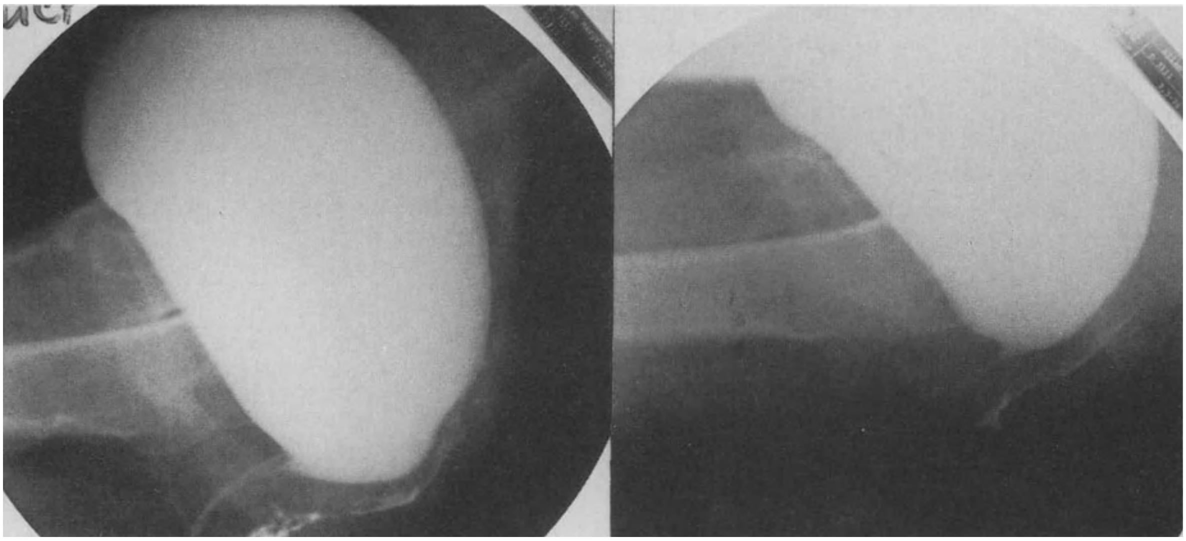
During the early years ureteric catheters were not used routinely and this probably accounts for three complications, including one peroperative ureteric lesion that was dealt with immediately and two postoperative ureteric obstructions. After 3 days of drainage by percutaneous nephrostomies the oedema causing the obstruction had disappeared and a  b

**Fig. 16.6a,b.** MCUG of a 50-year-old female with urinary stress incontinence caused by a posterior bladder descent. **a** Before and **b** after the levatorpexy.

the renal function was restored. Since the introduction of ureteric catheterisation no ureteric problems have occurred.

In 14 cases a simultaneous hysterectomy was performed. In such cases it was feasible to place the levator sutures first but not to tie them till after the hysterectomy. Blood transfusion was required in 14 patients (median

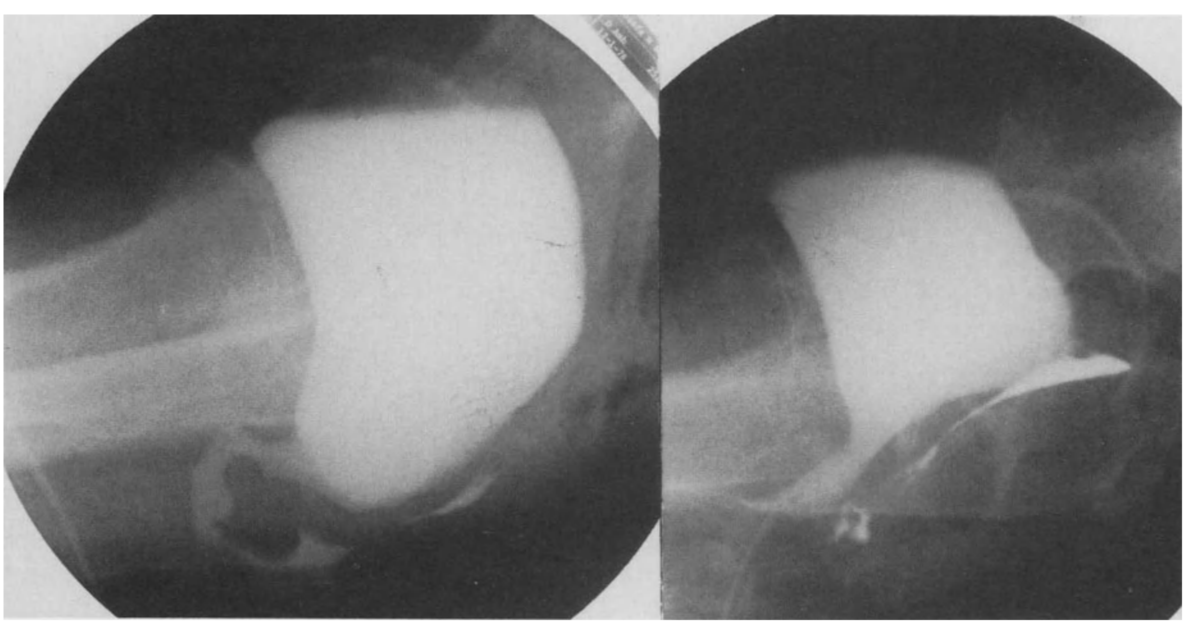
a  b

**Fig. 16.7a,b.** MCUG of a 61-year-old female with urinary stress incontinence caused by posterior bladder descent. **a** Before and **b** after the levatorpexy.

1 litre), the cause being simultaneous hysterectomy in 5 patients, previous operation with scarring in another 5, and difficulty in dealing with the venous plexus close to the bladder neck in the remaining 4 patients.

The bladder catheters were removed on the fifth postoperative day and all patients were able to void at once without any residual volumes. The patients were referred for pelvic floor exercises conducted by physiotherapists for a period of 2–3 months. Thereafter they were encouraged to continue the exercises themselves.

Six months after the operation MCUG was repeated and a clinical examination was performed (Figs. 16.6, 16.7). In cases with recurrent incontinence a full urodynamic investigation was undertaken. A clinical follow-up including a questionnaire, voiding chart and uroflowmetry was performed at an average of 2 years postoperatively (12–72 months). The results at the 6 months review revealed 36 totally cured patients, 13 improved and 19 patients with unchanged incontinence. At the long-term follow-up, however, the results had improved, demonstrating 46 totally cured patients, 11 patients improved but still occasionally wet and 11 patients with unchanged incontinence.

**Table 16.2.** Symptoms of stress incontinence before and 2 years after transperitoneal levatorpexy

| Preoperative staging of stress incontinence | Postoperative staging of incontinence | | | | |
|---|---|---|---|---|---|
| | 0 | Grade I | Grade II | Grade III | Total |
| Grade I | 1 | 1[a] | | | 2 |
| Grade II | 33 | 8[b] | 9[a] | | 50 |
| Grade III | 12 | 1[b] | 2[b] | 1[a] | 16 |
| Total | 46 | 10 | 11 | 1 | 68 |

[a]Unchanged: $n$=11.
[b]"Improved" (staging of urinary incontinence down-staged: $n$=11).

Table 16.2 demonstrates the results in relation to pre- and postoperative symptoms. It seems as if the severely incontinent women (grade III) did benefit more than the moderately incontinent women. The long-term results did not show any significant changes when correlated with the radiological classification, although there was a tendency towards poorer results in patients with bladder neck insufficiency. The presence of detrusor instability did not influence the results since 9 of the 14 patients with detrusor instability were in the "cured" group. The group of patients with failure of the levatorpexy were closely studied. Among the 11 patients 7 had bladder neck insufficiency, which confirms the hypothesis that it is probably not the correct indication for this type of operation; 6 patients were obese, and 2 had had four previous operations performed for incontinence. Of the 11 patients, 9 accepted another operative treatment: an endoscopic urethrosuspension was performed in 6 and a colposuspension in 3. All the patients were cured after the second operation.

## Discussion

From an anatomical and a physiological point of view the type of incontinence benefiting from the levatorpexy should be the posterior suspension defect, described as a deficiency of the muscular sling consisting of pubococcygeus muscle fibres surrounding the pelvic organs such as the urethra, the vagina and the rectum, giving way for a descent of the bladder (Olesen and Grau 1976). The solid muscular sling is sutured by the anterior correction of the levatorpexy. Anterior suspension defects have been reported as being due to a weakness in the ligamentous suspension apparatus (Olesen 1983) indicating that an operation aiming at a muscular plastic repair should be worthless. This has also been demonstrated in a study on the effect of the levatorpexy versus colposuspension (Mouritsen et al. 1986). There were significantly less operative successes in patients with anterior suspension defects treated with the levatorpexy than with the colposuspension (50% versus 81%). (Table 16.3). The same poor results could be demonstrated in the present study, where only 75% of patients with bladder neck insufficiency were cured or improved. However, the results of the levatorpexy in patients with an anterior bladder descent did show acceptable figures: 93% cured or improved. This might indicate that the causative factor leading to an anterior descent is not just a ligamentous deficiency but rather a deficiency of the puborectalis muscles as suggested by Bonnesen et al. (1985).

**Table 16.3.** Clinical results 2 years after transperitoneal levatorpexy according to radiological classification. Additional information is included to show the influence of preoperative detrusor instability on the long-term results

| | No. of patients | Preoperative instability | Cured | Improved | Unchanged |
|---|---|---|---|---|---|
| Bladder neck insufficiency | 28 | 7 | **** 18 | 3 | *** 7 |
| Anterior descent | 29 | 5 | **** 21 | * 6 | 2 |
| Posterior descent + trigonocele | 11 | 2 | * 7 | 2 | * 2 |
| Total | 68 | 14 | 46 | 11 | 11 |

*Denotes a patient with preoperative detrusor instability.

The operative method is more time consuming than the urethrosuspension operations, there is a risk of bleeding from the venous plexes at the bladder neck junction, and in inexperienced hands damage to the ureter(s) may occur, although ureteric catheters are safeguards against this complication. On the other hand, the levatorpexy is able to restore normal anatomical and physiological function without interfering with the bladder neck or the urethra. Several patients with posterior suspension defects and impaired flow and/or detrusor instability may thus be treated without the risk of postoperative voiding problems. This is contradictory to usual recommendations (McGuire 1981; Hodgkinson and Stanton 1980). Usually patients awaiting incontinence surgery are offered preoperative pelvic floor exercises. They often complain of difficulty in performing the exercises because of malfunction of their pelvic floor. However, after the levatorpexy it is the rule that patients suddenly become aware of their pelvic floor and can cooperate more easily with the physiotherapist. If some type of urethrosuspension has been performed (colposuspension, endoscopic urethrosuspension), patients do not experience any change of sensation in their pelvic floor muscles. In contrast to other types of incontinence operation, none of our patients have complained of dyspareunia. It is striking to realise how much the patients with operative failures benefited from a second-stage urethrosuspension, since all the patients became continent. This contradicts the usual concept that almost 50% of patients do not benefit from a second-stage operation.

## Conclusion

The levatorpexy is a newly described method of treating patients with posterior suspension defects and anterior bladder descent. The method offers a reasonably good long-term result of 90% cured or improved, and since it does not interfere with the bladder neck it is suitable in patients with obstructive outflow and/or detrusor instability.

The major advantage of the levatorpexy in comparison with the usual urethrosuspension is the restoration of normal anatomy and normal voiding and pelvic floor function. In patients with anterior suspension defects, especially bladder neck insufficiency, a urethrosuspension is the treatment of choice, while patients with trigonoceles are offered a vaginal repair.

However, the levatorpexy method is more difficult to manage than the traditional urethrosuspensions, and obesity and multiple pelvic surgery are serious contraindications for this procedure.

## References

Bonnesen T, Kielmann J, Frimodt-Møller C (1985) Anal profilometry correlated to colpo-cysto-urethrography in female urinary bladder suspension defects. Dan Med Bull 32: 131–134

Frimodt-Møller C (1978) Investigation of the lower urinary tract. Clin Obstet Gynaecol 5: 27–39

Hodgkinson CP, Stanton SL (1980) Retropubic urethropexy or colposuspension. In: Stanton SL, Tanagho EA (eds) Surgery of female incontinence. Springer, Berlin Heidelberg New York, pp 55–58

Ingelmann-Sundberg A (1953) Urininkontinens hos kvinnan. Nord Med 50: 1149–1152

Kielmann J, Nielsen EL, Frimodt-Møller C, Bonnesen T, Mortensen S (1986) The levator-muscle repair – a new method in the treatment of female urinary incontinence. World J Urol 4: 32–37

McGuire EJ (1981) Causes of involuntary urinary loss and ways to recognize them. In: McGuire J (ed) Urinary incontinence. Grune and Stratton, Orlando, Florida, pp 1–27

Mouritsen L, Petersen JH, Folke K, Frimodt-Møller C, Berget A (1986) Colposuspension compared with levator ani muscle repair for correction of female stress urinary incontinence. World J Urol 4: 38–40

Olesen KP (1983) Descent of the female urinary bladder. A radiological classification based on colpo-cysto-urethrography. Dan Med Bul 30: 66–84
Olesen KP, Grau V (1976) The suspensory apparatus of the female urinary bladder neck. Urol Int 31: 33–37
Olesen KP, Walter S (1977) Colpo-cysto-urethrography. Dan Med Bull 24: 95–101
Stanton SL (1978) Surgery of urinary incontinence. Clin Obstet Gynaecol 5: 83–108

*Chapter 17*

# Turner-Warwick Vagino-Obturator Shelf Urethral Repositioning Procedure

*Richard Turner-Warwick*

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The vagino-obturator shelf (VOS) urethral repositioning operation (Turner-Warwick 1969, 1986) was a urodynamically conceived procedure (Turner-Warwick et al. 1974; Turner-Warwick 1978) designed to reposition the urethra and the bladder neck sphincter mechanisms most efficiently, but leaving them free-lying in an elevated position without compromising their occlusive function by fixation or paraurethral tethering. Furthermore, the development of secondary retropubic fibrotic adhesions is positively prevented by interposing a supple omental pedicle graft between the back of the pubis and the urethra; this not only ensures the mobility of the functional movements of the intrinsic sphincter mechanisms in the long term but ensures the circumferential transmission of intra-abdominal pressure changes to the urethra.

The basic principle of the procedure is that the vaginal wall is simply prolapsed through a definitive incision in the para-urethral fascia on both sides of the urethra and firmly anchored to the internal obturator muscle on either side by large-bite tissue-approximating sutures.

It is fundamentally important to appreciate that only the lower 4–5 cm of the vaginal wall relates to the urethra and the bladder neck so it is only this part that is used for the vagino-obturator shelf support: above this the anterior vaginal wall relates to the posterior bladder wall and descent of this may create voiding problems, particularly when the detrusor is underactive (Farrar and Turner-Warwick 1979). Thus the vagino-obturator shelf procedure additionally involves a transperitoneal vaginal vault suspension procedure and an occlusion of the rectovaginal pouch to prevent a subsequent enterocele.

Thus the vagino-obturator shelf procedure can be regarded as a "urodynamically pure" procedure because it achieves most effective repositioning of the bladder neck and urethra in an elevated free-lying position specifically avoiding any fixation of the para-urethral fascia that might compromise the functional movements of its intrinsic sphincter mechanisms *without introducing any element of passive urethral compression*.

The vagino-obturator shelf procedure was originally described as a "colposuspension" (Turner-Warwick 1969); however, this term has been generally adopted to include other procedures such as the Burch suspension operation, the principle of which is distinctly different in as much as the sling sutures which suspend the vaginal wall from Cooper's ligament anterolaterally on the pelvic brim include para-urethral fascial fixation and commonly have to be "bow-strung" when the tissue bites are insufficiently lax to be suture-approximated. Traction on the para-urethral fascia introduces an additional lateral tethering effect; this may or may not compromise urethral sphincter function and may introduce an element of passive bladder outlet occlusion which, while it may marginally improve the leak-proof success of the procedure, may increase the incidence of postoperative voiding inefficiency (Turner-Warwick and Brown 1979; Turner-Warwick and Whiteside 1982).

Because the vagino-obturator shelf procedure simply repositions the urethra without any element of compression it rarely causes difficulty with voiding postoperatively and sometimes even improves a pre-existing voiding inefficiency associated with vesico-urethral descent. Thus it may be particularly appropriate for the treatment of patients whose vesico-urethral descent is associated with both stress incontinence and with a significant volume of post-voiding residual urine.

The potential of sphincter-function impairment by retropubic tethering is readily apparent in the male after pelvic fracture injuries of the sub-prostatic urethra, which almost always destroys the functional competence of the distal sphincter mechanism. In such cases the commonest cause of an associated incompetence of the only residual sphincter mechanism at the bladder neck is its tethering-open by the retraction of an extensive haematoma-fibrosis surrounding it; its competence, and consequently continence, can often be restored by simple lysis and replacement of the resected fibrosis by a supple omental graft. This calls to question the principle of achieving vesico-urethral repositioning by the definitive retropubic cystourethropexy procedure of Marshall–Marchetti–Krantz.

## Operative Method

1. The patient is positioned on the operating table for a synchronous abdomino-vaginal approach.

2. A wide exposure of the pelvis and lower abdomen is required: a Pfannenstiel incision is quite inadequate; a suprapubic V exposure (Turner-Warwick et al. 1974) or a midline incision is appropriate. Ring retraction is most effective.

3. The retropubic space is developed, the anterior wall of the lower segment of the bladder and urethra exposed and the position of the bladder neck identified with a balloon catheter in the urethra (Fig. 17.1a).

4. The para-urethral fascia is incised lateral to the urethra and bladder neck on both sides. No para-urethral musculature is encountered in this area because the urogenital hiatus in the pelvic levator diaphragm is wide. Bleeding from the para-urethral venous plexus is primarily controlled by upward pressure by a finger in the vagina. Definitive haemostasis is achieved with broad-tipped electrocoagulating forceps (Fig. 17.1b).

5. The long Turner-Warwick electrocoagulating scissors are particularly helpful for haemostasis during the development of the incision and the paravaginal tissue-plane that enables the vaginal wall to be prolapsed through the incision to reach the inner margin of the internal obturator muscle (Fig. 17.1c,d).

6. The plane between the vagina and the urethra may be more difficult to develop when there are adhesions resulting from previous surgery; in such cases the plane of scissor dissection should be close to the finger in the vagina to avoid injury to the urethral musculature. A small perforation of the vagina wall is of no consequence. A small volume of blue dye introduced into the bladder gives early warning of the thinning of its wall in the process of separating secondary adhesions in this area.

7. The mobilised lower anterior vaginal wall is prolapsed through the retropubic para-urethral incisions and anchored to the obturator internus muscle with three or four large-bite polyglycolic acid (PGA) sutures (Fig. 17.1e). The laterally located obturator nerve and vessel tunnel are easy to identify and to avoid.

8. The mobility of the urethra elevated by the vagino-obturator shelf is checked to ensure that there are no residual lateral tethering adhesions.

9. A suprapubic catheter is simply inserted by pulling it into the bladder with a pair of forceps thrust through a double fold of the vault of the bladder and a simple purse-string suture around the opposing forceps-hole.

10. The peritoneum is opened above the bladder and the bowel retracted by the deep blades of the ring retractor to expose the whole of the pelvic floor. It is sometimes necessary to relax the utero-sacral folds, or fibrosis resulting from previous pelvic surgery, to enable the vaginal vault to come forward (Fig. 17.1f).

11. The vault of the vagina is elevated to ensure that there is no residual vault prolapse. This can sometimes be achieved by elevating the uterus by one of its round ligaments and suture-anchoring it to the inner surface of the anterior abdominal wall on one side (not both because this can reduce the bladder capacity by incarceration). When the uterus is insufficiently mobile to enable the anterior vaginal wall to be elevated by traction upon it, or after a previous hysterectomy, the vaginal vault can be elevated by suturing the divided ends of both round ligaments to it directly (Fig. 17.1g).

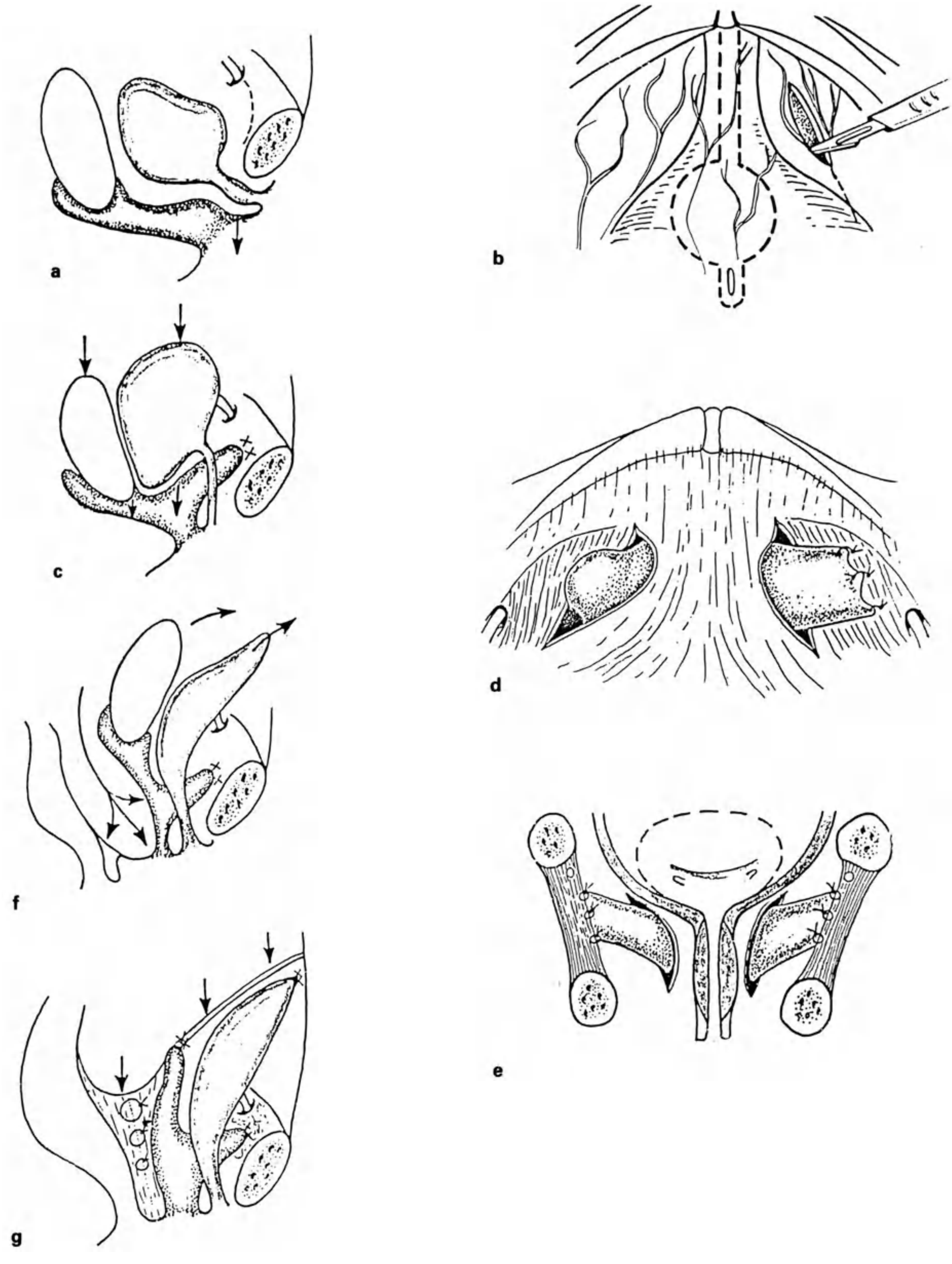


**Fig. 17.1a–g.** The Turner-Warwick vagino-obturator shelf procedure for urethral repositioning (see text for details).

12. Anterior suspension of the vaginal vault increases the exposure of the posterior vaginal wall to the intra-abdominal pelvic floor pressure, and it is generally advisable to plicate the rectovaginal peritoneal pouch by a series of occlusive purse-string Moscovitch sutures taking care to avoid distorting the ureters with the upper sutures. Although the peritoneal approximation involved in this procedure may appear somewhat tenuous it is remarkably effective.

13. The omental apron is mobilised from the transverse colon and mesocolic mesentery and, if necessary, by division of some of its left pedicle vessels. The lower margin of its apron is repositioned into the retropubic space and suture-anchored there to prevent immobilisation of the vagino-obturator shelf-elevated urethral sphincter mechanisms by secondary fibrotic adhesions.

14. It is generally wise to drain the retropubic space, although the lymphatic drainage of the repositioned omentum provides remarkably effective physiological drainage of macromolecular exudates.

15. The preoperative urethral catheter is removed and the suprapubic catheter placed on free drainage for 4–5 days, after which it is trial-clamped and finally removed when measurements of the post-voiding residual urine show that the volume is acceptably small.

## Conclusion

Follow-up videocystourethrography shows that the vagino-obturator shelf provides very effective urethral elevation repositioning in the long term. The persistence of the firm attachments of the vaginal wall to the obturator on either side of the urethra is easy to confirm by simple palpation with a finger in the vagina; its spontaneous separation is a rare event. A cystoscope or sound passed urethrally into the bladder with the patient in the supine position cannot be elevated much above the horizontal because of the internal support of the bladder base by the vagino-obturator shelf.

## References

Farrar D, Turner-Warwick R (1979) Outflow obstruction in the female. Urol Clin North Am 6: 217–225

Turner-Warwick R (1969) The management of bladder neck dysfunction. In: Riches E (ed) Modern trends in urology. Butterworth, London, pp 295–311

Turner-Warwick R (1978) Impaired voiding efficiency and retention. Clin Obstet Gynecol 5: 193–207

Turner-Warwick R (1986) The Turner-Warwick vagino-obturator shelf urethral repositioning procedure. In: Debruyne FMJ, Van Kerrebroeck PEV (eds) Practical aspects of urinary incontinence. Martinus Nijhoff, Dordrecht, pp 100–104

Turner-Warwick R, Brown ADG (1979) The urodynamic evaluation of urinary incontinence in the female and its treatment. Urol Clin North Am 6: 203–216

Turner-Warwick R, Whiteside CG (1982) Urodynamic studies and their effect upon clinical management. In: Chisholm GD, Williams DI (eds) Scientific foundations of urology. Heinemann, London, pp 442–445

Turner-Warwick R, Worth PHL, Milroy EJG Duckett J (1974) The Suprapubic V incision. Br J Urol 46: 39–45

Section V

# The "Neuropathic" Bladder

# Introduction and Patient Selection for Surgery

*A. R. Mundy*

With currently available treatment modalities it is possible to replace the entire urinary tract. The only requirement is a functioning kidney. The ureter and bladder can be replaced by gut, the urethra by skin and the sphincter mechanisms by an artificial device (for example). Fortunately, such extensive surgery is rarely required, but the fact remains that it is possible to make anybody continent, regardless of the nature of their problem. The questions that have to be answered for each individual patient are:

1. What is required to restore or produce continence and adequate voiding with respect to the patient's adequately evaluated and objectively demonstrated urodynamic abnormalities?
2. Is the surgical intervention required justifiable with regard to the patient's general condition, circumstances and motivation?

Given that, in general, a patient with neuropathic dysfunction has more than one urodynamic abnormality and will usually therefore need more than one kind of treatment, the process of selection of patients for surgery involves an initial selection of patients in whom such surgery is warranted, then a decision as to which abnormalities require surgical intervention and, finally, a decision as to which procedure or procedures will be needed to correct those abnormalities.

## Initial Selection of Patients

Surgical intervention is usually required either for preservation or restoration of renal function, for incontinence, or for a combination of both problems. Other indications include recurrent, severe urinary tract infection (UTI) and the medically and socially undesirable effects of previous treatment whether initially appropriate or inappropriate. An example in the second of these two categories is the patient, diverted in early life with a satisfactory result, who wishes to be undiverted to be rid of the "stigma", real or imagined, of a surface diversion.

Intervention for surgically correctable causes of impaired renal function or recurrent UTI is usually a straightforward decision. In both instances the usual cause is outflow obstruction, which is usually easily corrected by sphincterotomy. Selection is more difficult when incontinence is the problem or, as in the case of sphincterotomy, when correction of the cause of impaired renal function is likely to make incontinence worse. In such situations the patient's general condition, circumstances and motivation assume much greater importance.

Motivation is usually the most important factor. There is no point in trying to persuade a patient to have an operation for incontinence; the patient must persuade the surgeon that he or she is prepared to put up with the pain and inconvenience of what may be two or three surgical procedures, staged over several months, in order to achieve continence and relatively normal urethral voiding. If there is any doubt in the patient's mind then it is best to wait until further discussion or stronger motivation have removed these doubts.

The questions concerning the patient's general condition relate principally to intelligence and any associated neurological disability, particularly if manipulative skills and mobility are impaired. A surgical procedure that will leave the patient dependent on an artificial urinary sphincter (AUS) or clean intermittent self-catheterisation (CISC) is clearly inappropriate in a patient who lacks the necessary manipulative skills. Equally, irrespective of any anatomical factors which may influence the decision to operate on a patient who is restricted to a wheelchair existence (for example, gross obesity or lack of space between xiphisternum and the pubis in a youngster with spina bifida), lack of mobility places special demands on continence. Whereas hourly voiding (with continence) may be an acceptable result of surgery in a fully mobile patient who can get to and from an ordinary toilet with ease, it is not acceptable to a wheelchair-bound patient who may need a substantial part of that hour to gain access to a special toilet and then transfer from the wheelchair on to the toilet and back again afterwards.

The question of circumstances is often closely related to the question of motivation. Two common reasons for referral for the treatment of incontinence are the desire or need for continence so that a child can go to a normal school and a similar need so that a young adult can go on to further education or take up certain kinds of work. Such reasons, particularly the former, may push the surgeon into a decision to treat the patient when otherwise he might have decided to postpone such a decision.

In summary, selection at this stage involves the decision as to whether the patient has (or is at risk of developing) impaired renal function, or incontinence, or both, and the subsequent decision, when incontinence is the problem, or a substantial part of it, as to whether the patient's general condition, circumstances and motivation warrant surgical intervention.

## Defining the Urological Problems

As patients do not die from incontinence but may die from impaired renal function, upper tract screening takes priority in the investigational sequence. An intravenous urogram (IVU) provides a general morphological survey and is often all that is required beyond a simple estimation of the serum creatinine. After the initial IVU, ultrasound studies are perfectly adequate for follow-up. If the IVU is abnormal, then a $^{99m}$Tc-DTPA renal scan will usually confirm or exclude obstruction as the cause, and if the abnormal study returns to normal after a period of indwelling catheterisation, then reversible outflow obstruction, usually at the level of the distal sphincter mechanism (see below) is confirmed. Further investigations if the IVU is abnormal should include the measurement of glomerular filtration rate to determine total renal function and a $^{99m}$Tc-DMSA scan to determine differential function.

Lower tract problems are defined by video-urodynamics. Whereas there is debate as to the necessity of synchronous video studies with urodynamic studies in patients without neuropathic problems, there is general agreement that full video-urodynamic studies are essential in patients with neuropathic dysfunction.

This is not the place to discuss video-urodynamic evaluation in detail. Suffice it to say that in general there are three main types of dysfunction: contractile, intermediate and acontractile.

### Contractile Dysfunction

In the group of patients with contractile dysfunction, contractile activity of both the bladder and the distal sphincter mechanism (DSM) are both relatively well preserved, although they may be, and often are, entirely involuntary and, in patients with suprasacral cord lesions, uncoordinated the one with the other. Nonetheless, detrusor contractions are capable, by their amplitude and duration, of giving a useful degree of bladder emptying if the frequently associated sphincteric obstruction is eliminated. Equally, the DSM is usually competent so that sphincter weakness incontinence does not occur during filling, although 50% of patients with suprasacral cord lesions have incompetence of the bladder neck. Bladder compliance is also usually normal. During a detrusor contraction in a patient with a suprasacral cord lesion, the DSM also contracts—so-called detrusor/sphincter dyssynergia (DSD)—although the detrusor contraction usually produces a pressure rise in excess of the urethral resistance so that voiding occurs.

Thus patients with suprapontine lesions have detrusor hyper-reflexia but appropriate DSM behaviour (because their lesions are above the level at which detrusor and sphincter behaviour are coordinated), whereas those with suprasacral cord lesions have detrusor hyper-reflexia and DSD causing high-pressure outflow obstruction. In both groups bladder compliance is normal and sphincter weakness incontinence does not occur unless caused by a coexisting abnormality. The patients with suprasacral cord lesions who have a contractile type of vesicourethral dysfunction are usually those with relatively high or discrete lesions.

## Intermediate Dysfunction

Intermediate dysfunction is only seen in patients with suprasacral cord lesions which are usually extensive and, by contrast with the contractile group, relatively low. In this type, detrusor contractile activity is of high frequency, low amplitude and short duration, incapable of giving useful emptying but restrictive to bladder filling. Poor compliance is a usual and potentially serious associated finding as this may lead to persistently elevated intravesical pressures which may lead, in turn, to upper tract obstruction. The bladder neck is always incompetent at usual bladder volumes, and the DSM, which, like the detrusor, is relatively unchanging, has a more or less fixed resistance. Thus, when the bladder pressure exceeds DSM resistance, sphincter weakness incontinence occurs, and when bladder pressure is less than DSM resistance the distal sphincter is obstructive—so-called static distal sphincter obstruction.

## Acontractile Dysfunction

Acontractile dysfunction may be seen in two situations: either in patients with cord lesions, in which case it appears to be a low-pressure variant of intermediate dysfunction (with respect to both the detrusor and the DSM) in most instances, or in patients with peripheral lesions affecting the pelvic parasympathetic nerves and pelvic plexuses. In either case the bladder is more or less acontractile and bladder compliance is usually within normal limits. The bladder neck is incompetent at usual bladder volumes and, as in the intermediate group, the DSM is of fixed resistance so that it is both incompetent and obstructive depending on intravesical pressure; however, because DSM resistance is usually lower than in the intermediate group, the obstructive element in those with cord lesions is often of no clinical importance, although it may well be so in those with peripheral lesions.

Thus the urodynamic problems to be treated may be:

| | |
|---|---|
| 1. *Suprapontine lesions* (contractile dysfunction): | Detrusor hyper-reflexia |
| 2. *Suprasacral cord lesions*: | |
| Contractile dysfunction | Detrusor hyper-reflexia<br>Detrusor/sphincter dyssynergia |

| | |
|---|---|
| Intermediate dysfunction | Low-amplitude detrusor hyper-reflexia<br>Poor compliance<br>Static distal sphincter obstruction<br>Sphincter weakness incontinence |
| Acontractile dysfunction | Acontractile detrusor<br>Sphincter weakness incontinence<br>Static distal sphincter obstruction |
| 3. *Peripheral lesions* (acontractile dysfunction): | Acontractile detrusor<br>Sphincter weakness incontinence<br>Static distal sphincter obstruction |

## Selecting the Surgical Procedure

Patients with suprapontine lesions rarely require surgical intervention because (1) age and general health are contraindications (as in patients with cerebrovascular disease or Parkinson's disease) and (2) loss of sensory appreciation or social awareness are often dominant factors and these are not amenable to surgical correction.

Patients with peripheral lesions are often asymptomatic or only have recurrent UTIs which are controllable with prophylactic antibiotics. In these patients nothing further is indicated. If UTIs are a problem or there is significant incontinence, CISC is the best form of treatment, if the patient can perform it, as the incontinence is usually of the overflow type in such patients associated with a significant degree of outflow obstruction; reduction of sphincter resistance by sphincter rebalancing procedures often improves emptying at the expense of worsening incontinence.

In neither of the above groups are patients at risk of high-pressure outflow obstruction or poor compliance, which are the two factors that lead to impairment of renal function. However, patients with suprasacral cord lesions are at risk for these very reasons: those with contractile dysfunction because of DSD and those with intermediate dysfunction because of poor compliance or static distal sphincter obstruction or a combination of the two. Vesicoureteric reflux and recurrent UTI, if present, although rarely risk factors alone, act to compound the risks that outflow obstruction and poor compliance engender. The usefulness of separating out the acontractile group of patients with suprasacral cord lesions, although pathophysiologically their condition appears to be just a low-pressure variant of the intermediate type, lies in the ability to distinguish these patients as a group which is not at risk of renal impairment as the intermediate and contractile groups are. However, experience shows that the implantation of an AUS in this group, by augmenting outflow resistance, often leads to a change in detrusor behaviour from acontractile to intermediate in type.

Thus, in general, surgical intervention in a patient with a suprasacral cord lesion may need to be considered for impaired renal function or

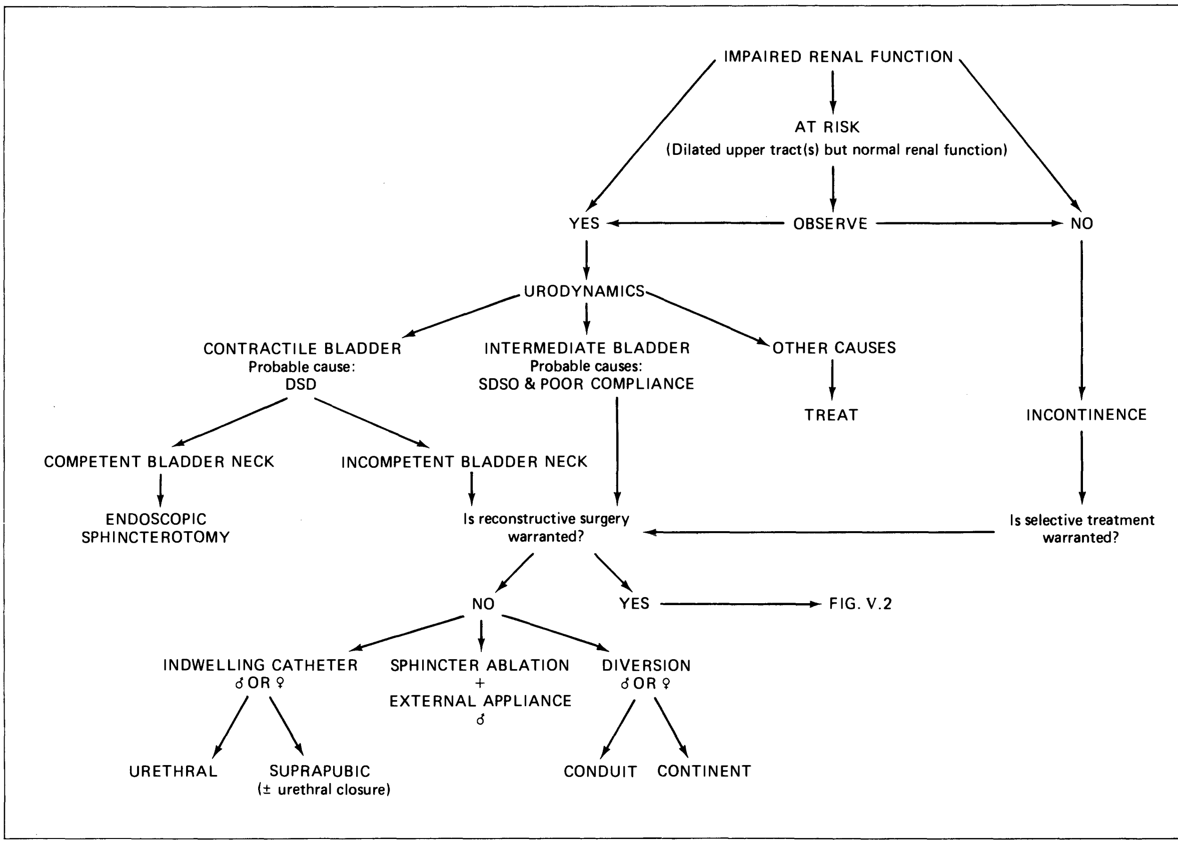



**Fig. V.1.** Investigation and management of the neuropathic bladder. (*DSD*, detrusor/sphincter dyssynergia; *SDSO*, static distal sphincter obstruction)

incontinence, or both, and will often involve correction of one or more abnormalities. Sometimes one will have a patient with a contractile dysfunction who has a dangerous level of outflow obstruction because of DSD but a competent bladder neck who can therefore be treated by endoscopic sphincterotomy alone, relying on his or her bladder neck competence for continence thereafter. It is hoped that the detrusor hyper-reflexia in such a patient will be controlled by anticholinergic medication. Equally, in the patient with an acontractile bladder who has sphincter weakness incontinence, implantation of an AUS alone may give a satisfactory result, although a preoperative sphincter ablation would be advisable to eliminate the obstructive element of the DSM dysfunction.

More often, however, the patient with a contractile dysfunction has detrusor hyper-reflexia that is not responsive to anticholinergic drugs, or has bladder neck incompetence, thereby precluding a sphincterotomy (unless it is intended that an appliance is to be used thereafter) as total incontinence would result. In such patients it is better not to resort to surgery but to rely on drug treatment or catheterisation until or unless the surgeon and patient are prepared to consider a combined attack on both the bladder and sphincter problems. This would require a cystoplasty (see Chap. 18) and either CISC or sphincter ablation and

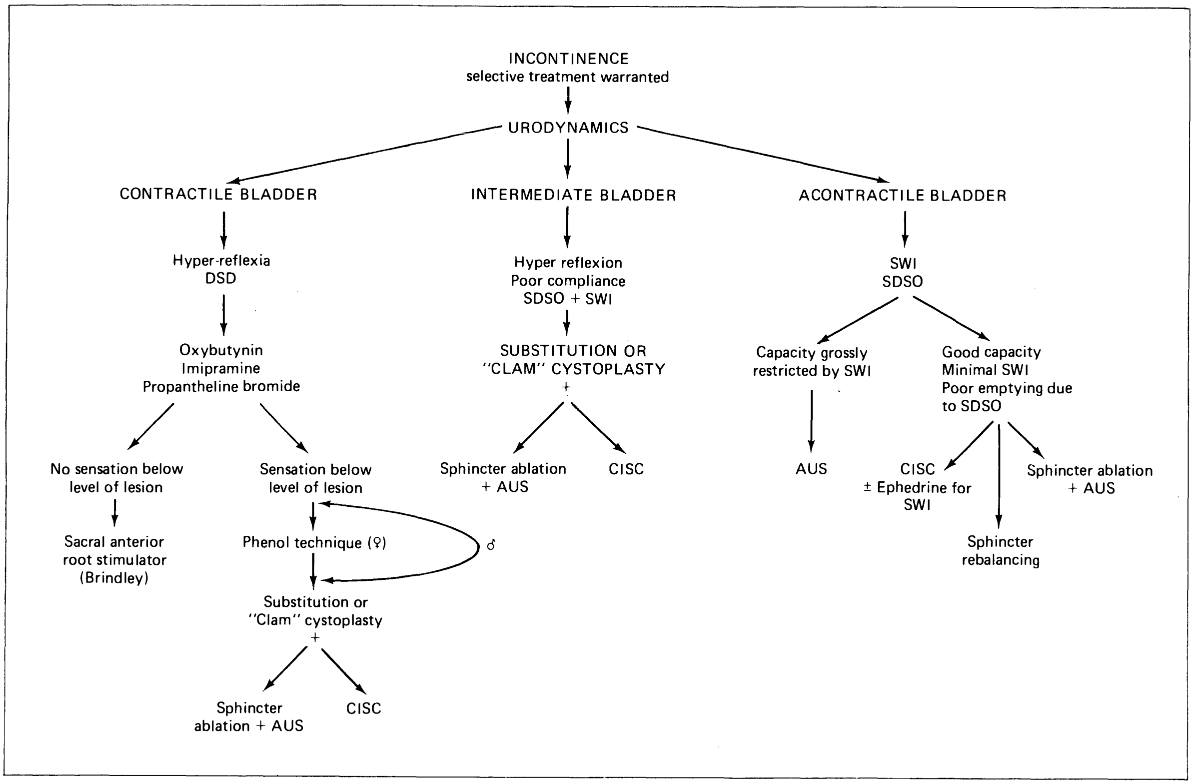



**Fig. V.2.** Selective treatment of the neuropathic bladder. (*DSD*, detrusor/sphincter dyssynergia; *SDSO*, static distal sphincter obstruction; *SWI*, sphincter weakness incontinence)

implantation of an AUS (see Chap. 20). The same approach will be necessary for patients with the intermediate type of dysfunction.

Fortunately, patients with contractile dysfunction caused by multiple sclerosis or related conditions tend to suffer less, in both degree and frequency of incidence, from DSD than do patients with spina bifida or spinal cord injury. For this reason correction of detrusor hyper-reflexia as an isolated abnormality is feasible. Often this is achieved with anticholinergic medication. If this fails, transvesical injection of the pelvic plexuses with phenol is successful in over 75% of cases, particularly in those with the worse degrees of dysfunction. In those patients who are unresponsive to phenol, augmentation ("clam") cystoplasty may be considered, although these patients will often need to use CISC afterwards for emptying.

Another group of patients with contractile lesions, namely those with a functionally complete spinal cord transection, may also be applicable to a specific form of treatment. Such patients who have viable root nerves below the level of the lesion and no sensory appreciation may be candidates for the Brindley sacral anterior root stimulator (see Chap. 21).

Finally, there is the patient for whom surgery is necessary for uncontrolled incontinence (not amenable to indwelling catheterisation) or for obstructive uropathy, but who is not a candidate for reconstructive surgery. Some patients may be controlled by permanent suprapubic catheter with or without formal bladder neck closure (Feneley 1983). Others will require a suprapubic diversion, particularly female patients for whom there is no appropriate external appliance available. When a diversion is being considered a continent diversion such as the Kock pouch (see Chap. 23) or Mainz pouch (see Chap. 24) may be more acceptable than a standard surface diversion.

My current scheme of management is shown diagramatically in Figs. V.1 and V.2.

Patients with neuropathic bladders who are being considered for undiversion are not really any different from those who have already been considered as above, except that consideration has also to be given to bridging the gap between the upper and lower urinary tracts and to the correction of the effects of other surgical procedures, such as the Spence procedure, which pose their own problems. This is beyond the scope of this introduction, and the interested reader is referred elsewhere (Mundy 1987).

## References

Feneley RCL (1983) The management of female incontinence by suprapubic catheterisation, with or without urethral closure. Br J Urol 55: 203–207

Mundy AR (1987) Refunctional urinary tract surgery with particular reference to undiversion. In: Hendry WF (ed) Recent advances in urology/andrology 4. Churchill Livingstone, Edinburgh, pp 147–168

*Chapter 18*

# Which Cystoplasty?

*T. P. Stephenson*

## Introduction

Bowel segments have been used for reconstruction of the bladder since the turn of the century (von Mikulicz 1899). Subsequently various authors reported the use of ileum and colon for bladder augmentation. The early results were generally disappointing, partly because most of the procedures were performed for the contracted tuberculous bladder prior to the introduction of successful antituberculous therapy and partly because intact bowel segments anastomosed to the opened dome of the bladder, the "bull-horn" cystoplasty, tended to act as a diverticulum, especially where relative outflow obstruction existed because of reduced voiding efficiency.

*Substitution* caecocystoplasty was first used by Couvelaire in 1950 and introduced the concept of excision of the diseased portion of the bladder but retention of the trigone to preserve bladder sensation. Subsequently Gil Vernet et al. (1962) demonstrated that upper tract function could be preserved by the ileocaecal valve if the ureters were implanted into the ileal tail. Turner-Warwick and Ashken (1967) indicated the fundamental importance of sphincter balancing procedures to achieve efficient voiding and described the use of split cuff nipples to achieve reflux prevention. However, despite this accumulating evidence that substitution cystoplasty might be functionally preferable to augmentation, the latter continued to be the procedure of choice in patients with the small contracted bladder of whatever cause, though these and other authors found that nocturnal and, to a lesser extent, diurnal enuresis was a significant problem (Dounis et al. 1980).

Few attempts were made to reconstruct the neuropathic bladder until intermittent catheterisation became established. The pool of potentially suitable patients subsequently enlarged with the advent of a reliable artificial urinary sphincter. These innovations plus increased understanding of the lower urinary tract both before and after reconstruction have led to a flurry of publications on the surgical correction of functional lower urinary tract abnormalities resulting from overt congenital and acquired neuropathy, occult neuropathy (and recalcitrant detrusor instability which may or may not have a neuropathic basis). The considerable expansion in the use of bowel segments has led to a fairly critical analysis of the dynamic behaviour of such isolated bowel segments in their new environment.

## Overview of the Selection of Bowel Segments

Segments of bowel for bladder reconstruction have been taken from virtually every part of the gastrointestinal tract. In general terms small intestine forms a more docile storage system than large bowel, and caecum is more docile than sigmoid. This somewhat simplistic generalisation might be expected, since small bowel motility is peristaltic, whereas large bowel, especially sigmoid, contracts by mass contraction to propel formed stool. Thus Hradec (1965), using intact bowel segments, found that ileocystoplasties generated pressures 10 $cmH_2O$ lower than colocystoplasties. Kuss et al. (1970) found that there was a higher morbidity using colon, but both these workers demonstrated reduced voiding efficiency using ileum with greater frequency and nocturia and higher residual urine volumes.

Since those early days every surgeon involved in reconstruction of the bladder has faced this difficulty of striking a balance between the advantages of intact large bowel segments—greater capacity and voiding potential—against their major disadvantage—high pressure contractions between voiding attempts—and the more reliably docile behaviour of either intact small bowel segments or large bowel segments in which disruption of the circular muscle layer has been achieved, but in which the voiding efficiency is (further) compromised. Virtually all the patients in the early published series were reconstructed for benign non-neuropathic disease, principally for tuberculous cystitis or interstitial cystitis; once adequate antituberculous therapy was established, the subjective success rate, whatever technique was used, was high (Shirley and Mirelman 1978; Dounis et al. 1980).

The presence of normal sphincter innervation, normal patient mobility, normal upper tracts and ureters and "normal" bowel in non-neuropathic disease mitigated major problems, though Turner-Warwick and Ashken (1967) underlined the necessity for sphincter balancing procedures to reduce outflow resistance in most males and many females, after augmentation or substitution cystoplasty. Gleason et al. (1972) underlined the "diverticulum effect" of the bowel segment effectively creating outflow obstruction. Koskela and Kontturi indicated (1982) that the detrusor/sphincter remnant can act dyssynergically, especially if much of the bladder is left. Most of the long-term problems encountered in our practice, where augmentation cystoplasty was instituted 25 years ago, have been related to outflow obstruction and the complications thereof: infection, stasis, renal impairment and, on three occasions, tumours at the vesicointestinal anastomosis (Stone et al. 1987).

In our personal experience (substitution) cystoplasty was restricted almost entirely to non-neuropathic disease, mainly interstitial cystitis and selected cases of carcinoma of the bladder, until 7 years ago, when the poor results of diversion stimulated the beginning of the undiversion programme. Two years later the introduction of the more reliable artificial sphincter greatly enlarged our potential pool of patients with neuropathic bladders suitable for reconstruction. Since then there has been a continuous evolution of technique with a leaning towards the use of small bowel, further encouraged by the introduction of the "clam" procedure in selected cases. The following text presents current philosophies, which will inevitably alter further with the passage of time.

## Choice of Cystoplasty Technique

### "The Occult Neuropath"

There has been considerable interest and research in the past 3 years in patients with functional disturbance of the lower urinary tract, urodynamic abnormalities, but no obvious neurological deficit measured by standard neurological techniques. Further evaluation of such patients by sacral evoked responses (SER; Bilkey et al. 1983; Galloway and Tainsh 1985) and by analysis of individual motor units from the rhabdosphincter (Fowler et al. 1984) have suggested that a neurological deficit may be present in many of these patients. Thus, for example, in 100 patients with urinary incontinence (Galloway and Tainsh 1985), 43 had minor sacral bony abnormalities, 72 had phasic detrusor contractions on filling and 42 had a degree of outflow obstruction, and all but 10 had abnormal SERs. Many of these patients either have life-long symptoms and phasic contractions early in filling (Fig. 18.1) or acquired incontinence in which reduced compliance and phasic contractions may coexist (Fig. 18.2) which often dates from pelvic surgery, usually hysterectomy. Both these groups of patients are extremely resistant to conservative measures such as bladder training, drugs or phenolisation, and surgery is often indicated for those with severe symptoms. Such surgery is rarely if ever indicated in the older patients with "degenerative" instability (Fig. 18.3).

The procedure of choice when surgery is indicated is the "clam" procedure, the technique of which has been described in detail (Bramble 1982; Stephenson and Mundy 1985). Some points and aspects need emphasising. The procedure is a simple one with a low morbidity. The bladder is opened in the coronal plane and the incision may be carried down either to just above the ureteric orifices or to 2 cm above the bladder neck. If the latter is chosen it is important to ensure that the

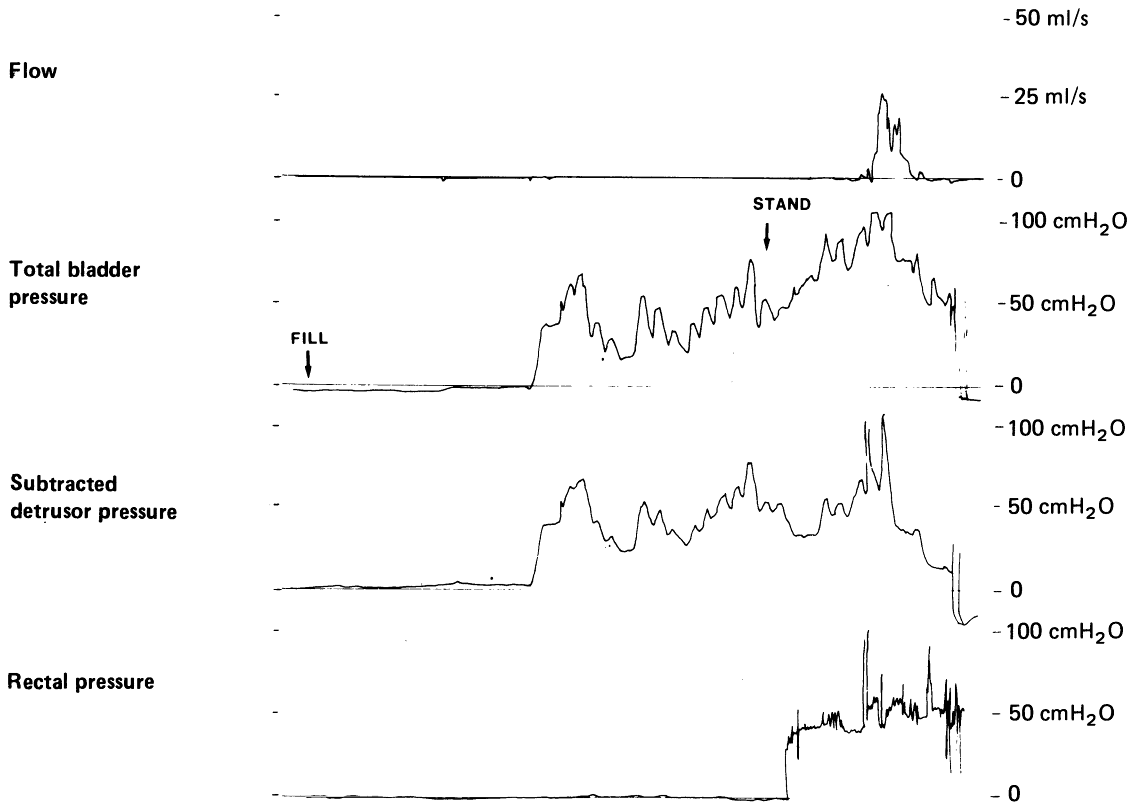



**Fig. 18.1.** Phasic contractions of the "congenital" type.

anterior "half" is of similar size to the posterior (Fig. 18.4); it is a common mistake to make it too small. In those patients with severely reduced compliance, careful assessment of the naked eye appearance of the bladder is desirable since a severe degree of thickening and fibrosis would favour substitution rather than augmentation. Substitution is also preferable where the voiding phase of micturition on urodynamics is abnormal, although in the great majority of these patients the voiding phase is normal. In general, if the voiding phase *is* normal, (the "worse" the urodynamic behaviour on filling), the greater the length of segment of ileum needed. Although there is not yet solid evidence for this premise, it seems probable that the longer the segment the more certain the control of the symptoms of urgency and urge incontinence but the more likely the disturbance of voiding function and the requirement of intermittent self-catheterisation (ISC). If the voiding phase *is* disturbed preoperatively, ISC is almost certain to be necessary, and the patient should be both warned accordingly and trained in the technique if female. In the male, where ISC may be less acceptable, the possibility of subsequent bladder neck incision and the attendant risk of retrograde ejaculation or even the possibility of sphincter ablation and replacement with a prosthesis *must* be discussed with the patient before embarking on any surgery.

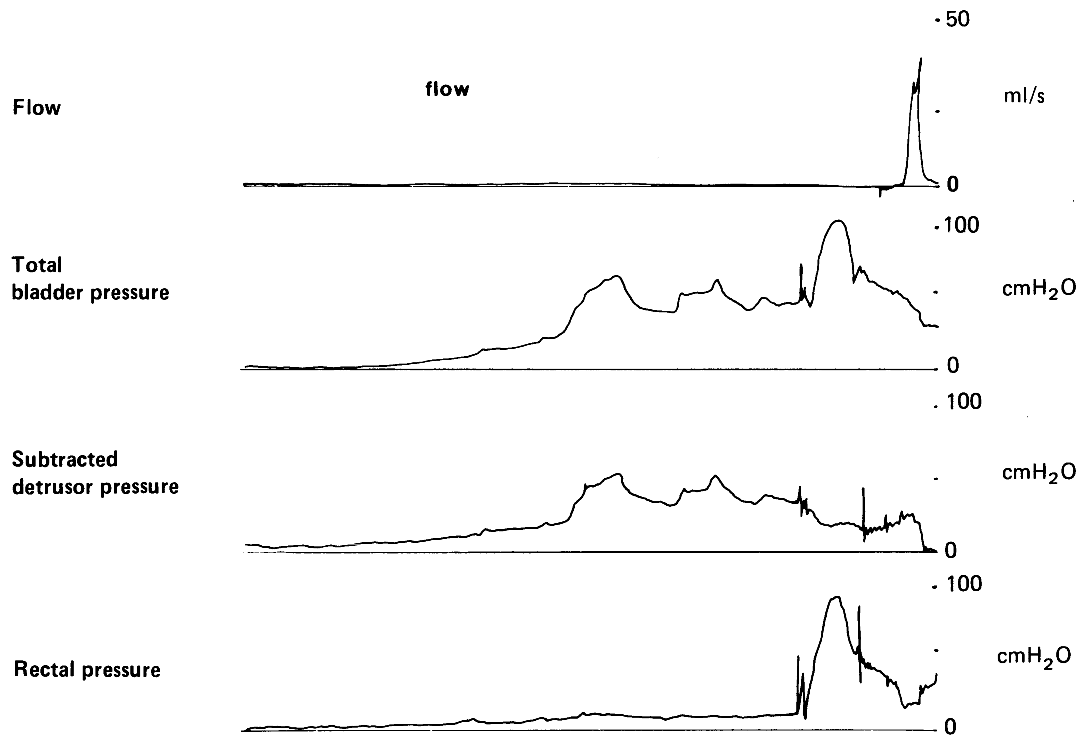



**Fig. 18.2.** Reduced compliance and instability of idiopathic or acquired type.

Nevertheless, the "clam" has an established and increasing part to play in the treatment of the "occult neuropath" and also the established neuropath where the bladder is the main or only deficit. The change in objective (and subjective) behaviour is usually dramatic (Fig. 18.5). The "clam" procedure may be of particular value also in patients with small poorly compliant bladders who are being considered for undiversion and who have at least a neuropathic element, usually in conjunction with the artificial sphincter.

## Overt Neuropathic Bladder

The choice of segment, the planning of the surgical technique, the treatment of the upper tracts, and the method of achieving continence depend upon a number of fundamental factors. The most important factors in planning reconstruction are:

1. *The mobility of the patient.* If the bladder is the main or only organ neurologically disturbed, as is quite common in patients with spina bifida, central disc protrusions and transverse myelitis, then substitution cystoplasty on to the bladder neck is preferred. If the patient is paraplegic and chairbound, reconstruction is often contraindicated, although a continent surface diversion may be the procedure of choice.

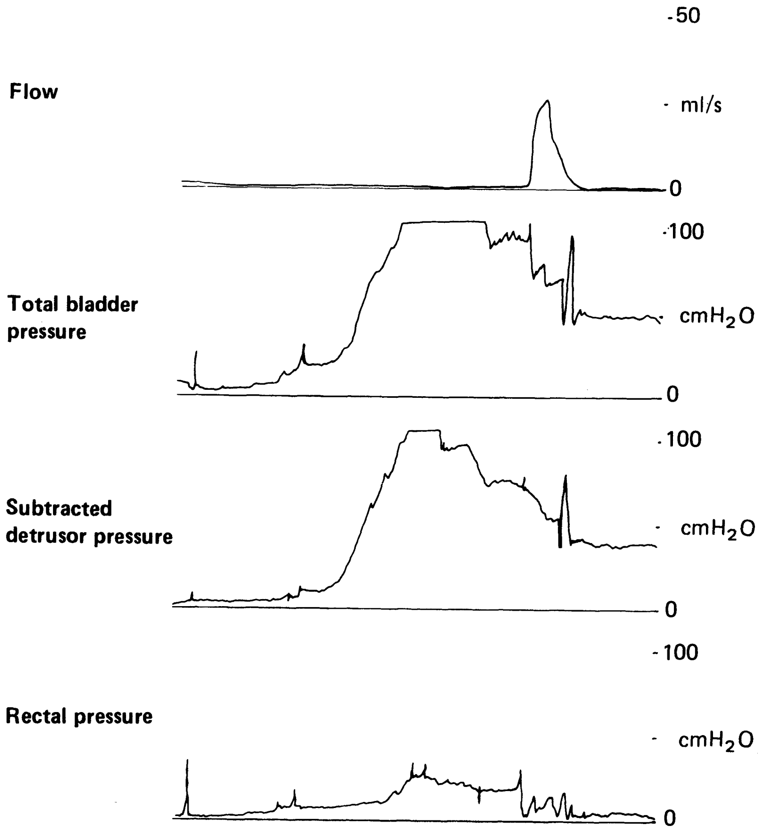


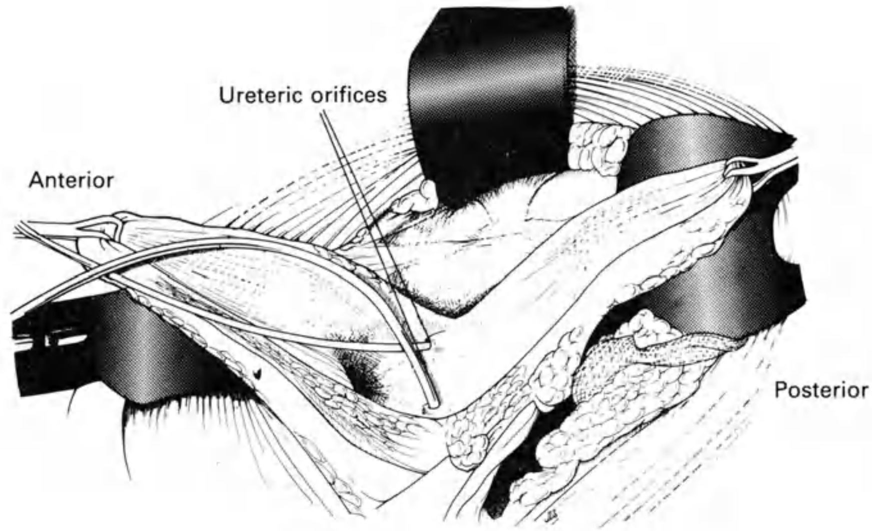

**Fig. 18.3.** High-pressure "degenerative" type instability.

2. *The size, functional behaviour, and the degree of fibrosis of the bladder and, if diversion has previously been performed, the gap between ureters and bladder.* These factors all have a bearing on the choice of segment, and the final decision may sometimes have to be taken at the time of surgery.

3. *The status of the upper tracts.* Almost exactly one-third of the patients with overt neuropathy reconstructed over the past years (Stephenson and Mundy 1985) have had impaired renal function. The combination of impaired renal function and "ureteric failure" is the central issue in the choice of segment and technique used in this difficult group.

4. *The sex of the patient.* Since almost all these patients have "static" distal sphincter obstruction, with outflow obstruction as well as a variable degree of sphincter weakness, the decision about whether to undertake sphincterotomy and insertion of an artificial sphincter needs to be taken before the major reconstruction is carried out. Although these techniques are virtually routine in the male, substitution cystoplasty with ISC may be preferable in the female.

With these ground rules it is possible to plan the surgical approach in most instances, though it should be reiterated that some of the technical decisions have to be taken or altered during the surgical procedure(s).



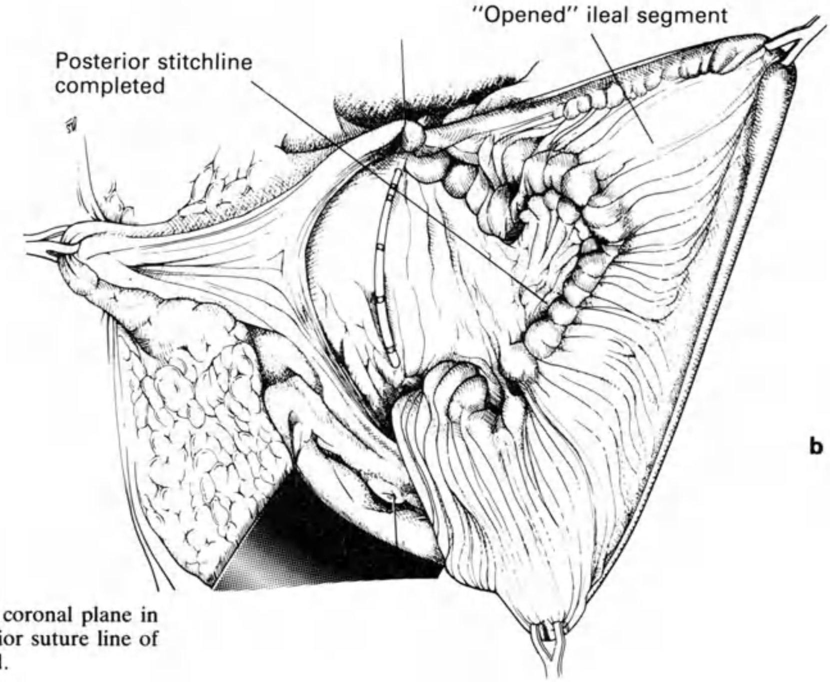




**Fig. 18.4.** **a** Bladder opened in the coronal plane in preparation for the "clam". **b** Posterior suture line of the ileovesical anastomosis completed.

## Surgical Technique for Mobile Patients with Hyper-reflexia, and/or Impaired Compliance with Normal Renal Function and Normal or Adequate Ureteric Function

One group of patients forms about half the total of neuropathic bladders that are suitable for reconstruction: most have hyper-reflexia, incontinence, an inadequate voiding phase with a static and obstructive rhabdosphincter. Many of the older patients develop poor compliance

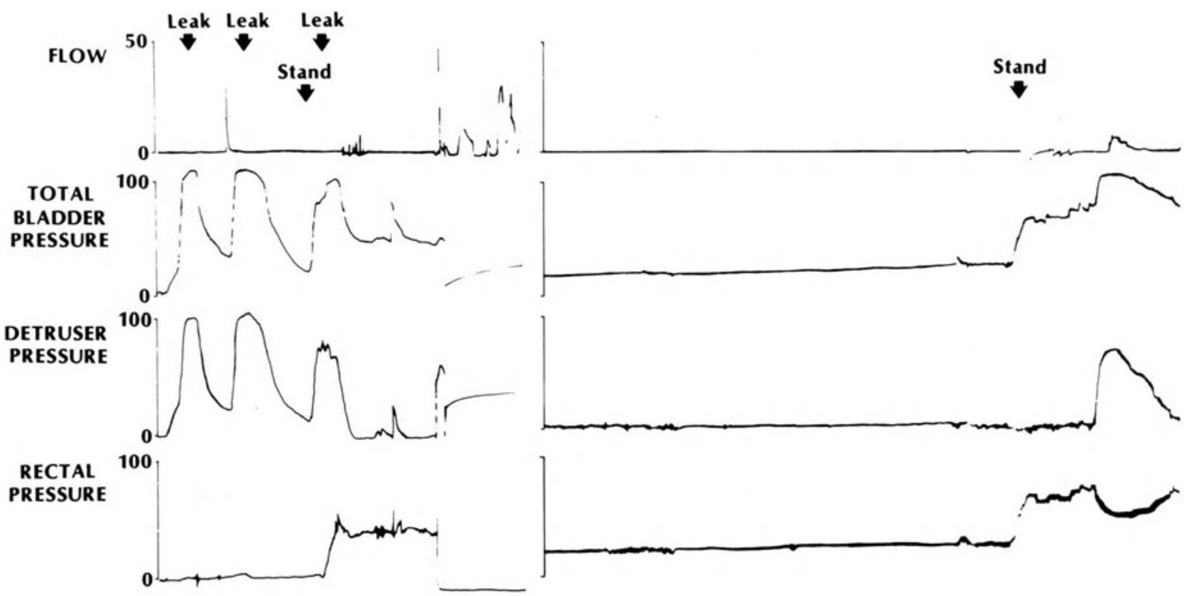



**Fig. 18.5.** Preoperative (*left*) and post "clam" urodynamics (*right*).

early in filling, which represents the greatest threat to the upper tracts (Fig. 18.7).

In the male patients, bladder neck incision and external sphincterotomy is undertaken as a first stage and a month or so later

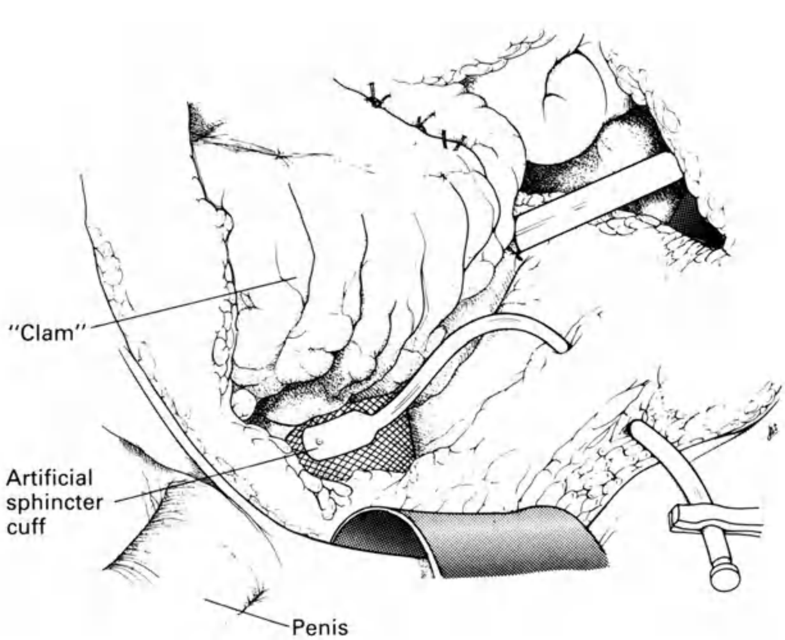



**Fig. 18.6.** "Clam" and artificial sphincter in a boy with a traumatic neuropathy.

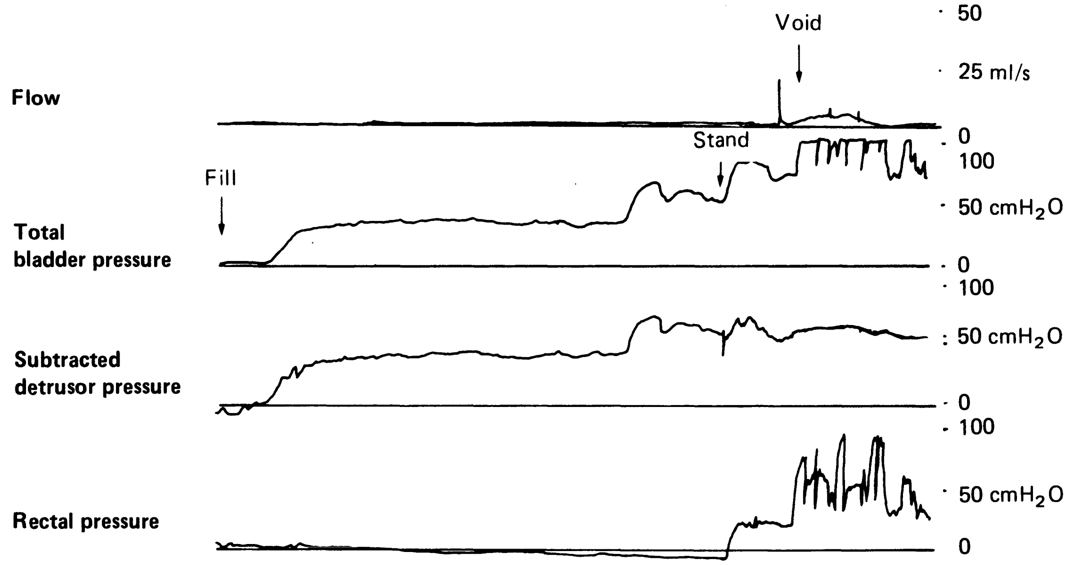



**Fig. 18.7.** Poor compliance early in filling.

substitution cystoplasty is undertaken. All but a cuff of bladder neck is excised and the bladder is reconstructed using a double segment of ileum (Fig. 18.8) into which the ureters are nippled and splinted (Fig. 18.9) on each side. The pelvis is then flushed with antibiotic solution, the cystoplasty wrapped in omentum (Fig. 18.10) and a suitable sized artificial sphincter cuff inserted around the bladder neck remnant (Fig. 18.11): in this case a caecocystoplasty. It is also routine to insert a suitable pressure reservoir retroperitoneally and bring the tubing of both into the subcutaneous space in the left groin. If the surgery has been uneventful and the bowel segment clean and well prepared, an AS 800 pump control mechanism is placed in the left hemiscrotum and connected to the cuff and reservoir tubing, but deactivated. In the female, an exactly similar procedure is followed in terms of the treatment of the bladder reconstruction. However, a policy decision preoperatively must be made whether to ablate the patient's rhabdosphincter with a view to insertion of an artificial mechanism or whether to achieve voiding by ISC postoperatively. It is currently commoner to undertake sphincterotomy and insert an artificial sphincter. Again, if the procedure has been surgically "clean", the whole sphincter mechanism is implanted, but the older model (AS 792) is used since the much smaller pump fits more comfortably in the labium. The mechanism is deactivated by plugging the reservoir tubing and the reservoir part of the control mechanism. In both sexes activation is carried out 6–8 weeks later.

In the immediate postoperative period the reconstruction is gently flushed, via a urethral and suprapubic catheter 12 hourly to avoid mucous retention. The ureteric splints are removed between 10 and 12 days and the urethral catheter at 2–3 weeks prior to a cystogram via the suprapubic catheter to check for anastomotic leaks and the absence of reflux. There is no merit whatsoever in undertaking radiological investigation of the

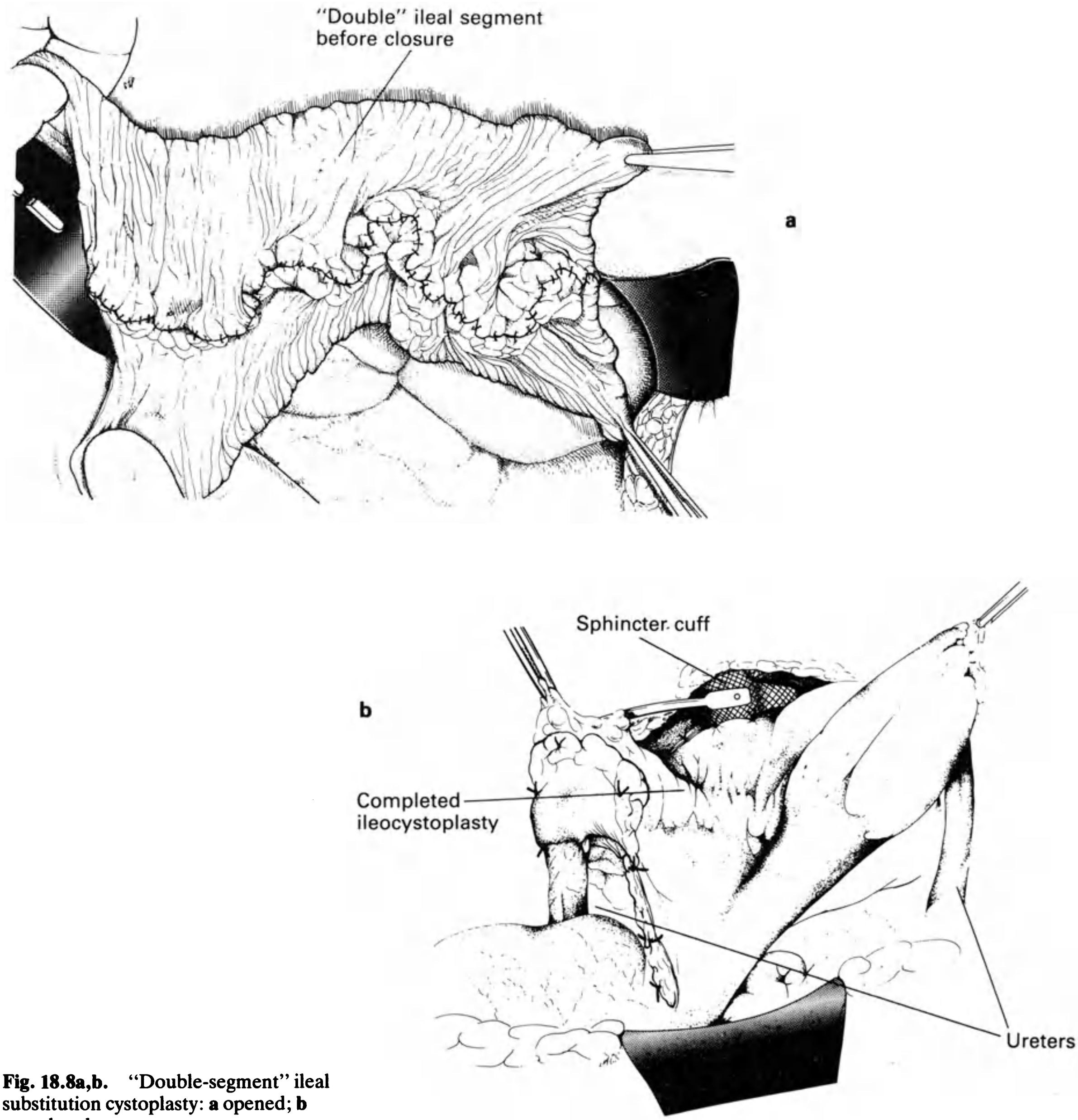



**Fig. 18.8a,b.** "Double-segment" ileal substitution cystoplasty: **a** opened; **b** completed.

reconstruction before this time since extravasation at the ileovesical anastomosis runs a significant risk of infecting the sphincter cuff.

The question of bowel preparation and antibiotic cover is largely dependent on personal choice and of lesser importance where small bowel is used. We prefer to administer oral sorbitol for 3 days preoperatively and mezlocillin with anaesthetic induction and for 24 h post-operatively. Probably of greater importance is meticulous surgical

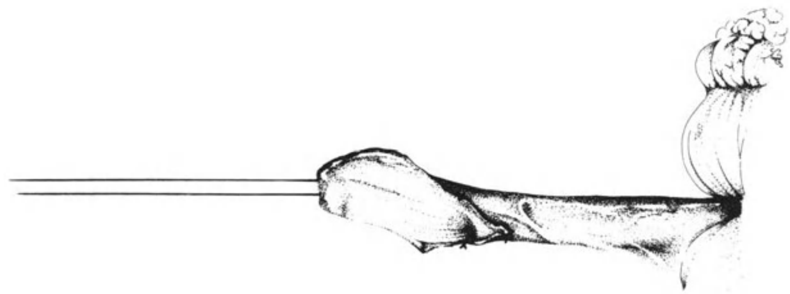


Fig. 18.9. Normal ureter splinted, with split-cuff nipple technique.

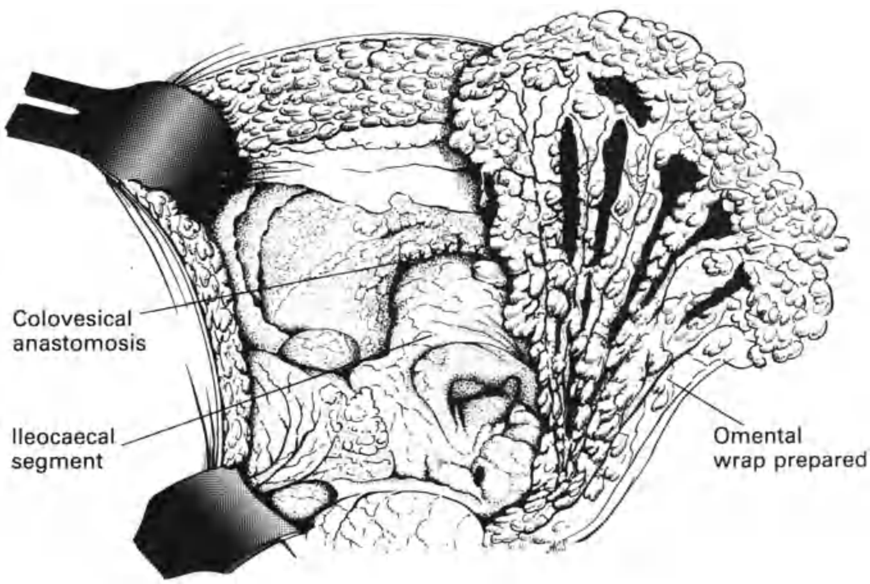



Fig. 18.10. Cystoplasty with omental wrap prepared in situ.

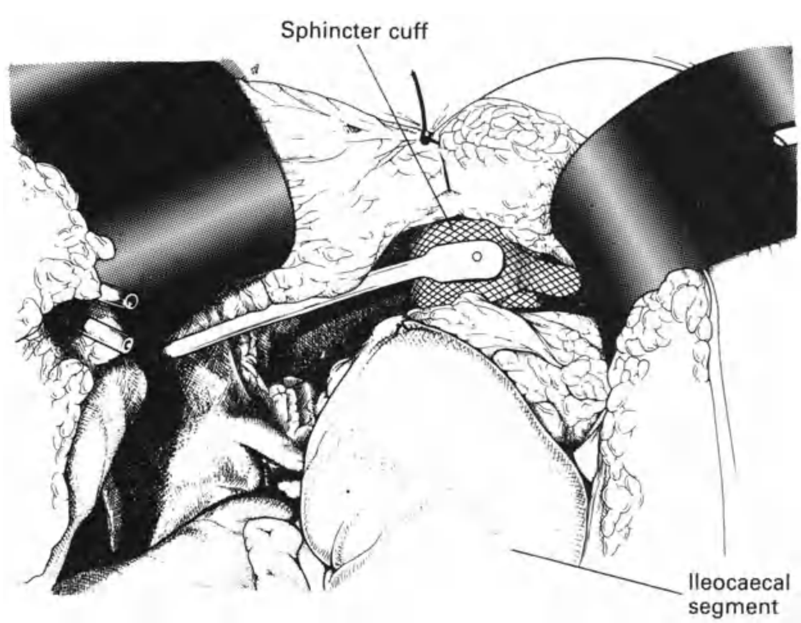



Fig. 18.11. Cystoplasty with sphincter cuff round bladder neck.

technique and the use of preoperative lavage with antibiotic solutions such as tetracycline at regular intervals, particularly after closure of the bladder reconstruction itself, though this is a disputed area (Sauven et al. 1986).

Occasionally, in patients in whom the voiding phase is impaired but adequate, minimal fibrosis of the detrusor has occurred and urge incontinence and enuresis are the main symptoms the "clam" procedure alone may be sufficient surgical intervention, but it must be reiterated that drug treatment with oxybutynin or propantheline bromide should be the first line of treatment. Sphincter weakness in this (small) group is not a contraindication to consideration of the "clam" alone, since it may resolve after surgery.

## Surgical Technique for Mobile Patients with Hyper-reflexia (and Often Reflux) or Poor Compliance and Severely Impaired Ureteric (and Usually Renal) Function

Mobile patients with hyper-reflexia or poor compliance and severely impaired ureteric function (who make up nearly one-third of the neuropathic referrals) form the most difficult group to achieve a satisfactory long-term result, almost entirely because of the virtual impossibility of achieving reflux prevention without obstruction of the adynamic ureter. The only (inefficient) reflux-preventing mechanism which is completely safe for the totally acontractile ureter is the ileocaecal valve. Much has been written about the efficiency of the ileocaecal valve and its ability to prevent reflux with reinforcement (Gittes 1977) and without (Rendleman et al. 1958). The latter group demonstrated that the ileocaecal valve is incompetent in 25% at a pressure of 25 $cmH_2O$ and in 75% at 50 $cmH_2O$. In our own experience the valve is very variable, but incompetence tends to increase with time. It has been clearly demonstrated that reinforcement of the valve (which has been widely practised) may not hold (Skinner 1982), and a variety of techniques have been employed to maintain the nipple (Hendren 1982; King et al. 1985). In our own practice, nippling of the adynamic ureter itself has long since been abandoned as obstruction can occur, even though it was often possible to pass a finger comfortably through the nipple at the time of surgery. Reinforcing the valve and separating off the ileal tail and nippling it into the anterior wall of the caecum have been tried, and although these techniques may be useful where the ureters are dilated but still contractile, they *all* cause obstruction in the totally acontractile ureter. It is therefore current practice to "trouser leg" such ureters into the ileal tail and use a large segment of the right half of the colon. This method has been fully described elsewhere (Mundy 1988). It is routine practice to divide the right colic vessels (and if necessary the right branch of the middle colic) to facilitate the ease of dropping the divided transverse colon down to the bladder neck (Fig. 18.12). It has the additional advantage of making the mobilisation of the omentum much easier (Fig. 18.13). Furthermore, there is no doubt that the use of such a

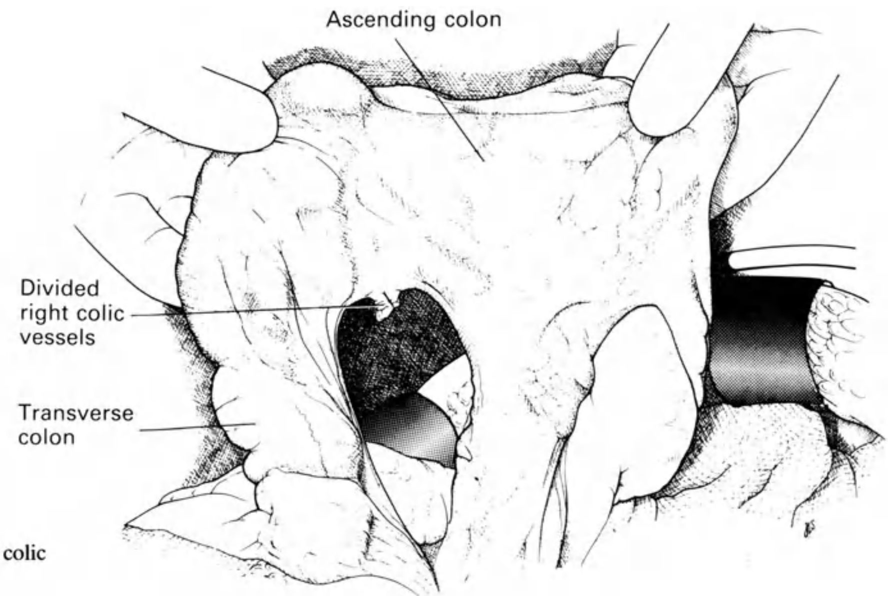



**Fig. 18.12.** Division of the right colic vessels after mobilisation of the ascending colon.

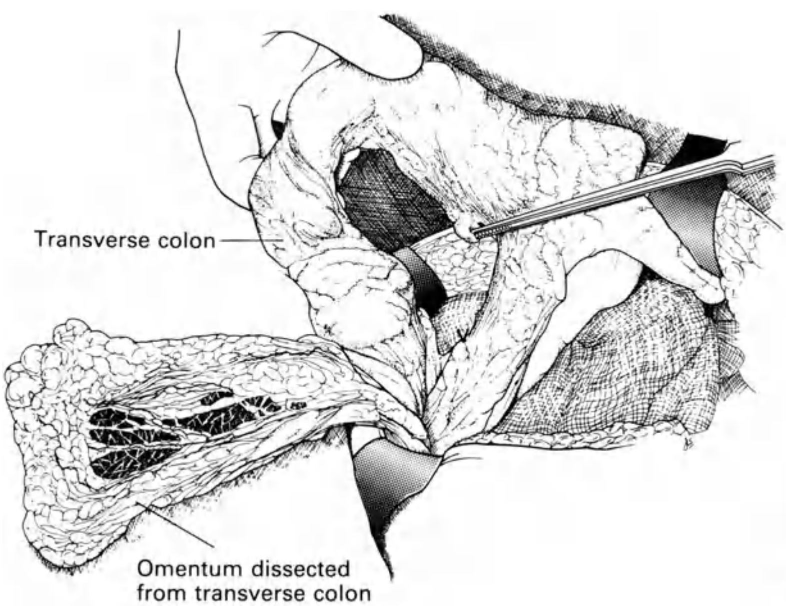



**Fig. 18.13.** Omental mobilisation facilitated by extensive mobilisation of the right colon.

large segment reduces nocturnal incontinence (but does not by any means prevent it). It is widely reported that the tubular caecal segment varies in behaviour from very docile (Fig. 18.14) to very aggressive (Fig. 18.15), and there is no doubt that such very high pressures are more likely in the more severely generally incapacitated spina bifida patients, although the reasons for this are unclear. This problem has led to the development of a number of techniques to disrupt the circular muscle

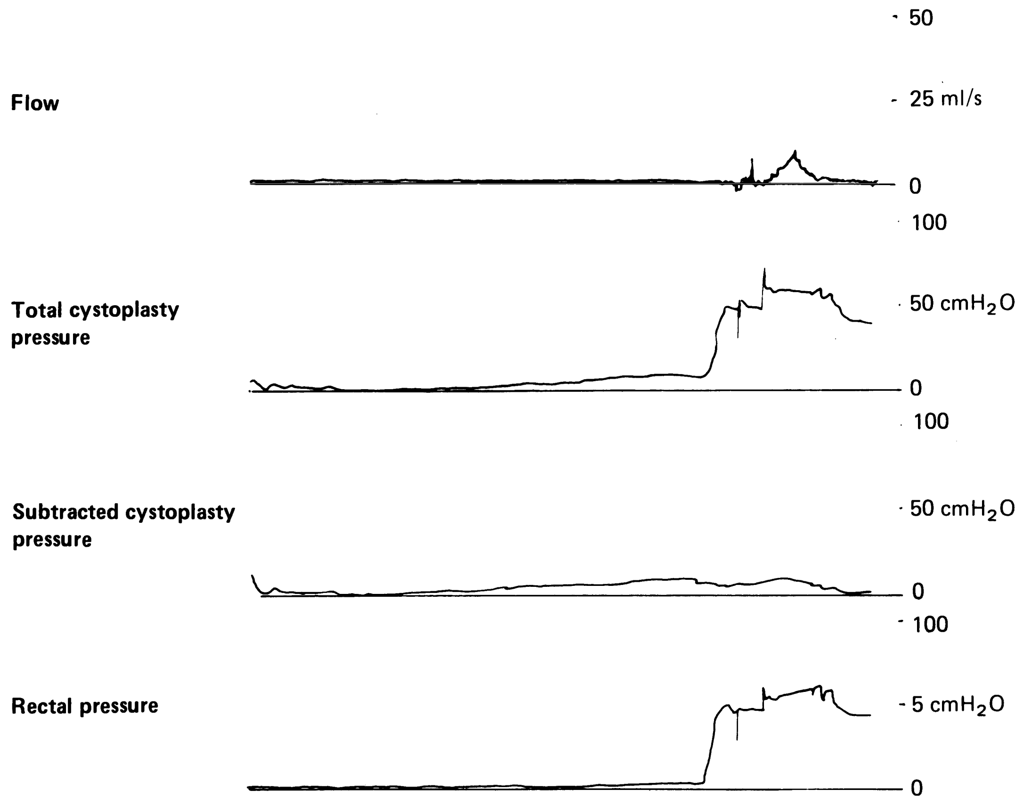



**Fig. 18.14.** "Docile" cystoplasty.

layer of the bowel, such as the Mainz pouch (Thüroff et al. 1987). Although our own preference remains the use of small bowel where possible, there is no perfect answer to the problem of maintaining some expulsive properties and the avoidance of unwanted contractions.

## Surgical Technique for Mobile Patients Requiring Undiversion

Clearly the only special consideration in choice of segment of bowel when undiverting patients with neuropathy is bridging the gap between the ureter(s) and the reconstruction. However, it should be reiterated that about 25% of those patients diverted at a young age for upper tract compromise have no obvious neuropathy—the "unexplained" group — and in our hands they are routinely reconstructed by substitution cystoplasty unless urodynamics after bladder cycling militate strongly against this, which is very rare. Since undiversion is now much less common than primary reconstruction (Fig. 18.16), most of our patients have been undiverted using the ileocolic segment when this was the rule, and there is considerable advantage in the use of the ileal tail for bridging the gap. Furthermore, since many of the patients are undiverted for deteriorating renal function and have poor ureteric function, the ileocolic

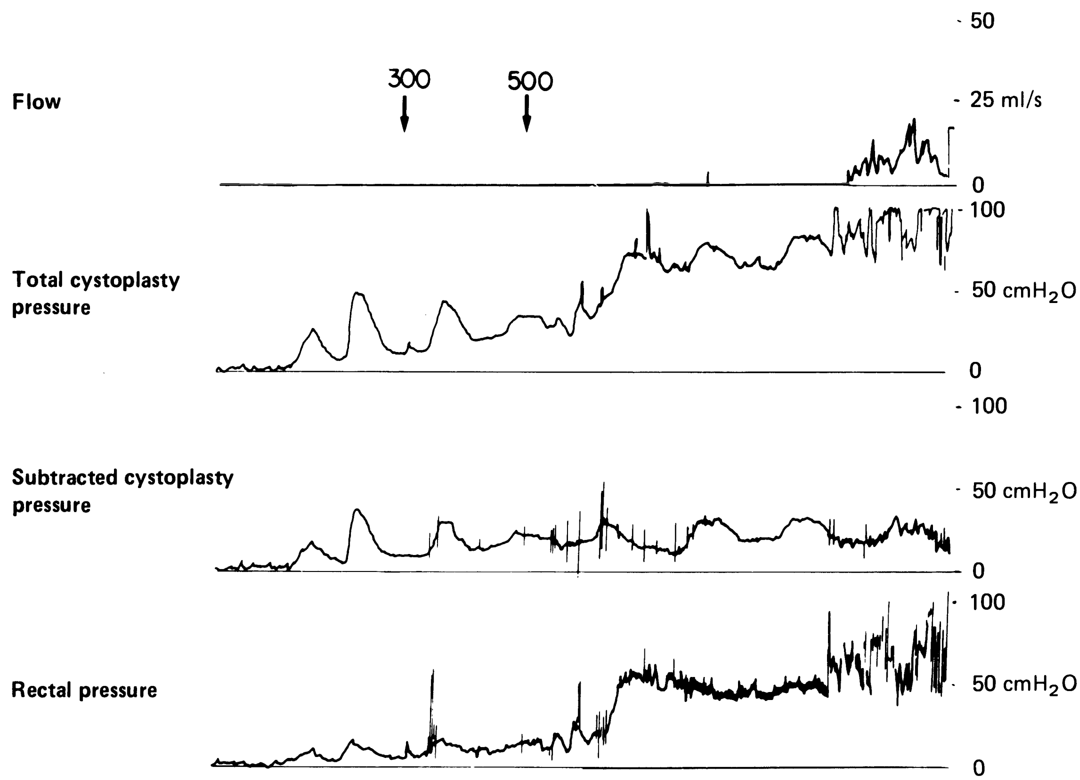



**Fig. 18.15.** "Aggressive" cystoplasty with contractions early in filling.

segment may be indicated anyway, and the ileal tail can be made to reach the renal pelvis if required, and the adynamic ureter discarded. If the patient has had an ileal loop diversion, the loop itself is occasionally useful for a "Hendren" reimplant (Hendren 1973). In patients with end-stage renal failure in whom a transplant is planned, the end of the loop and one ureter may be preserved and attached to the ileal tail of the cystoplasty to facilitate uretero-ureterostomy at the time of transplantation (Stephenson 1987).

When the patient has been diverted by a colonic loop, it is unwise to use the tubular colonic segment since the chance of undesirably high pressures and incontinence occurring is so high. Currently, if the patient has normal upper tracts and the ureters are too short to reach an ileal substitution cystoplasty, the Mainz pouch or the similar technique described by Goldwasser and Webster (1986) is indicated.

## Surgical Technique for Paraplegic Patients

The philosophy of whether to perform undiversion or reconstruction surgery in a patient (usually with spina bifida) who is paraplegic varies considerably in different units, especially in the USA. In my view,

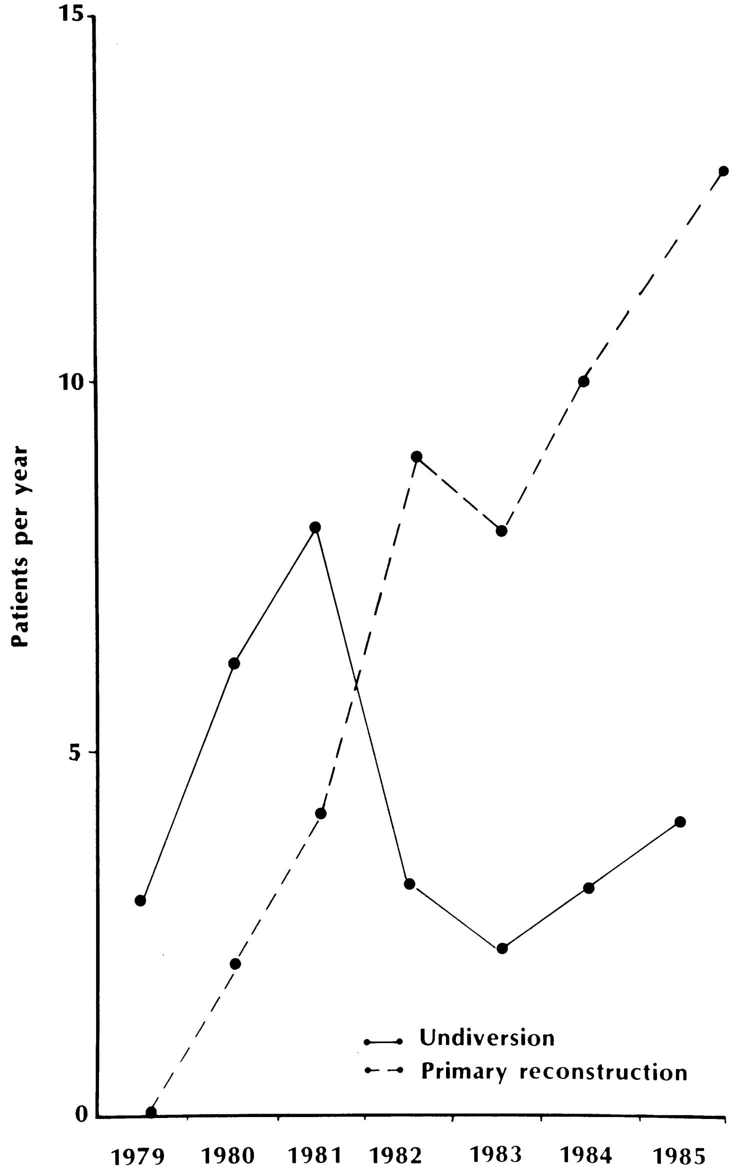



**Fig. 18.16.** Numerical comparison between undiversion and primary reconstruction between 1979 and 1985.

patients should only be considered for reconstruction if serious stomal problems or deteriorating renal function are present. It is just as important to achieve continence in patients confined to a wheelchair as in mobile patients, not least in the male, because the penis is often of a configuration that a condom cannot be relied upon to stay in place. If an artificial sphincter is used it is unwise to place the pump in the scrotum or labium as erosion through the skin is such a significant risk.

Commonly it is inappropriate to perform reconstruction to the bladder neck, sometimes because of anatomical problems such as urethral strictures in the male, or previous perineal pressure sores, but usually because of the configuration of the pelvis and abdomen. Occasionally a non-refluxing colon conduit is considered and may well be a reasonable approach (though it has not actually been used over the past 7 years). However, the preference in our unit is to construct a continent diversion using the ileocaecal segment with the ureters implanted into the ileal tail by one of the techniques described above, depending on the size and contractility of the ureters. The colon is mobilised exactly as for substitution cystoplasty and the bowel exteriorised on the right side of the abdomen and an artificial sphincter cuff placed round the bowel subcutaneously. A low-pressure reservoir is also implanted intraperitoneally, but not the pump or control mechanism since the cuff alone may be sufficient to create continence. If necessary, the cuff may be activated at a later date. The patients always have to catheterise the stoma, often only two or three times daily as the colonic segment will usually hold up to 1000 ml. We have not employed other techniques such as the Kock pouch or invagination of the appendix to achieve continence. Certainly, if a continent "diversion" is chosen it is often much easier for the paraplegic patient to catheterise via the abdomen than via the urethra. Furthermore, although a non-refluxing colon conduit may be safe, the abdominal configuration of some of these patients may make the maintenance of ileostomy bag application unsatisfactory.

## Summary

Overall, the neuropathic group who require reconstruction of the lower urinary tract is the most difficult (and most rewarding) of patients with detrusor/sphincter dysfunction. The choice of segment and techniques used have changed considerably over the past 5 years, and the current trend of disruption of the continuity of the muscle layers of the bowel segments are promising, but need careful long-term evaluation. All these patients need meticulous urodynamic, bacteriological and upper tract assessment on a regular basis. Undoubtedly, further refinements of technique will occur over the next few years.

## References

Bilkey WJ, Awad EA, Smith AD (1983) Clinical application of sacral reflex latency. J Urol 129: 1187–1189

Bramble FJ (1982) The treatment of adult enuresis and urge incontinence by enterocystoplasty. Br J Urol 54: 693–695

Couvelaire R (1950) La petite vessie des tuberculeaux genito-urinaires. Essai de classification place et varientes des cysto-intestino-plasties. J Urol (Paris) 50: 381

Dounis A, Abel BJ, Gow JG (1980) Caecocystoplasty for bladder augmentation. J Urol 123: 164–167

Fowler CJ, Kirby RS, Harrison MJG, Milroy EJG, Turner-Warwick RT (1984) Individual motor unit analysis in the diagnosis of disorders of urethral sphincter innervation. J Neurol Neurosurg Psychiatry 47: 637–641

Galloway NTM, Tainsh J (1985) Minor defects of the sacrum and neurogenic bladder dysfunction. Br J Urol 57: 154–155
Gil Vernet JM, Escarpenter JM, Perez-Trujillo G et al. (1962) A functioning artificial bladder: results of 41 consecutive cases. J Urol 87: 825–836
Gittes RF (1977) Bladder augmentation procedures. In: Libertino JA, Zinman L (eds) Reconstructive urologic surgery: paediatric and adult. Williams and Wilkins, Baltimore, pp 216–226
Gleason DM, Gittes RF, Bottacini MR, Byrne JC (1972) Energy balance of voiding after cecal cystoplasty. J Urol 108: 259–264
Goldwasser B, Webster GD (1986) Augmentation and substitution enterocystoplasty. J Urol 135: 215–224
Hendren WH (1973) Reconstruction of previously diverted urinary tracts in children. J Pediatr Surg 8: 135–150
Hendren WH (1982) Editorial comment. J Urol 128: 256
Hradec EA (1965) Bladder substitution: indications and results in 114 operations. J Urol 94: 406–417
King LR, Robertson CN, Bertram RA (1985) A new technique for the prevention of reflux in those undergoing substitution or undiversion using bowel segments. World J Urol 3: 194–196
Koskela E, Kontturi M (1982) Function of the intestinal substituted bladder. Scand J Urol Nephrol 16: 129–133
Kuss R, Bitker M, Camey M, Chatelain C, Lassau JP (1970) Indications and early and late results of intestinocystoplasty: a review of 185 cases. J Urol 103: 594–597
Mundy AR (1988) Cystoplasty. In: Mundy AR (ed) Current operative surgery: urology. Baillière Tindall, London, pp 140–159
Rendleman DF, Anthony JE, Davis CJ et al. (1958) Reflux pressure studies on the ileocecal valve of dogs and humans. Surgery 44: 640–643
Sauven P, Playforth MJ, Smith GMR, Evans M, Pollock AV (1986) Single dose antibiotic prophylaxis of abdominal surgical wound infection: a trial of preoperative latamoxef against preoperative tetracycline lavage. J R Soc Med 79: 137–142
Shirley SW, Mirelman S (1978) Experiences with colocystoplasties, caecocystoplasties and ileocystoplasties in urologic surgery. J Urol 120: 165–168
Skinner DG (1982) Further experience with the ileocecal segment in urinary reconstruction. J Urol 128: 252–256
Stephenson TP (1987) Undiversion and transplantation. In: King LR, Stone AR, Webster GD (eds) Bladder reconstruction and continent urinary diversion. Year Book Medical Publishers, Chicago, pp 154–161
Stephenson TP, Mundy AR (1985) Treatment of the neuropathic bladder by enterocystoplasty and selective sphincterotomy or sphincter ablation and replacement. Br J Urol 57: 27–31
Stone AR, Stephenson TP, Davis N (1987) Carcinoma associated with augmentation cystoplasty. Br J Urol 60: 236–238
Thüroff JW, Alken P, Engelmann U, Riedmiller H, Jacobi GH, Hohenfellner R (1987) The Mainz pouch (Mixed augmentation ileum 'n zoecum) for bladder augmentation and continent diversion. In: King LR, Slone AR, Webster GD (eds) Bladder reconstruction and continent urinary diversion. Year Book Medical Publishers, Chicago, pp 252–268
Turner-Warwick R, Ashken MH (1967) The functional results of partial, subtotal and total cystoplasty with special reference to uretero-caecocystoplasty, selective sphincterotomy and cystocystoplasty. Br J Urol 39: 3–12
Von Mikulicz J (1899) Zur Operation der angeborenen Blasepalte. Zentralbl Chir 20: 641–643

*Chapter 19*

# Bladder Transection

*K. F. Parsons*

## History

To transect the bladder as a deliberate procedure in order to reduce irritative symptoms was first tried in 1967 on a 58-year-old female patient with interstitial cystitis. The operation attempted to achieve a supratrigonal denervation by dividing all the intramural neurons in the transection line and all the inferior lateral communications just outside the bladder. This, it was thought, would leave trigonal and bladder neck sensation intact yet reduce sensory appreciation and abnormal bladder contraction. Indeed, in the case reported the aim was achieved and bladder spasms eradicated, but at the cost of efficient voiding so that an appropriate selective sphincterotomy was required (Turner-Warwick and Ashken 1967).

To avoid the undesirable effect of bladder atony, Yeates proposed that bladder transection alone, omitting the inferior neurotomies, would be sufficient to reduce abnormal contractility during storage yet leave the micturition phase unaffected. He tried this modified operation on two patients with the enuretic syndrome and found the effect on storage to be satisfactory and voiding to be unaffected (Yeates 1970). Encouraged by these results other surgeons adopted open bladder transection for the treatment of the intractible enuretic in whom conservative therapy had failed.

## Operative Technique—the Open Operation

There are minor modifications in the procedures reported, but in essence the open operation is as follows:

Ureteric catheters are passed either at preliminary endoscopy or after the bladder is opened. The bladder is exposed through a Pfannenstiel incision, and the transection started anteriorly 2 cm proximal to the bladder neck. The incision is continued circumferentially, with the aim of dividing the bladder 2 cm above the trigone. Division of the bladder at the back is carried out from within the bladder with dissecting forceps and scissors into the extravesical plane, which is easily recognisable. The posterior and lateral lines of section are then joined above the ureteric orifices, with the juxtavesical part of the ureter, easily recognisable when catheterised, being displaced downwards and backwards. Complete separation of the two parts is ensured by stripping the bladder upwards for about 1 cm from underlying tissues and dividing any remaining connecting strands. The ureteric catheters are removed and the bladder is reconstructed using a single layer of continuous 2–0 chromic catgut starting in the midline posteriorly on either side, avoiding the mucosa, and extending up the lateral walls to join in the midline anteriorly. The extravesical space is drained and an indwelling catheter left in situ for 7–10 days.

## Effect of Open Bladder Transection

Most authors (Essenhigh and Yeates 1973; Gibbon et al. 1973; Parsons et al. 1977; Hindmarsh et al. 1977; Janknegt et al. 1979; Mundy 1980) who have reported their results of open bladder transection have adhered to the technique described and used the operation for generally similar cases, the majority of which have been patients with the enuretic syndrome. There has been a relative consistency in the results that have been achieved. Some 80% of patients have shown symptomatic improvement, and of these a little over 50% were cured. The difficulty has been in predicting which patients might be expected to benefit the most. There has been no single urodynamic parameter to predict a successful result. Instability, when present, is not necessarily changed at all by the operation, even though a symptomatic cure might be achieved. In general a shift to the right of the filling cystometrogram is found, with a delay in onset of unstable contractions. Those cases with a stable bladder and primary enuresis have similarly shown a 50% cure rate, though there are only eight well-documented cases. Neuropathic cases seem not to benefit.

Modifications of the "standard transection" have been advocated. Following a report by Mahoney and Laferte (1972), in which multiple detrusor myotomies cured detrusor hyperactivity in a 4½-year-old girl, this simple addition was tried but found to confer no additional benefit (Parsons et al. 1977). Mundy (1983) has used "bladder transection", but as a procedure to facilitate access to the inferior neural plexus, which he divides outside the bladder, which itself is only partially transected. This transvesical neurotomy cannot strictly be compared with transection. Yet the results achieved seem remarkably similar, thus begging the question whether it is the partial transection or the neural division which produces the effect.

## Experimental Evidence

Surprisingly, there has been, until recently, virtually no experimental evidence to determine precisely the effect of bladder transection. The assumption has been that a cholinergic denervation is produced, and this was partially reinforced in an experimental study in dogs which showed a highly significant reduction in the maximum pressure achieved within the partially transected bladder in response to tetanic stimulation of the parasympathetic nerves and an associated increased capacity and lower voiding pressures. However, Gibbon et al. (1973) considered the neural interruption in the bladder wall to be "incidental", citing the preservation of normal detrusor voiding function to be evidence against denervation being a significant factor. They speculated that interruption of the muscular integrity of the detrusor may be of prime importance.

In an attempt to define precisely the effect of bladder transection, Staskin et al. (1981) devised an experimental model in rabbits and dogs which matched standard transection, transection with additional peripheral denervation and peripheral denervation alone in humans. They investigated the effect of these procedures on detrusor function, autonomic receptor status and microneuroanatomy of the bladder. The results in the operation that mimicked bladder transection in humans showed there to be only a relatively minor change in the density of cholinergic neurons above the line of transection. Cholinergic innervation was sustained by the presence of ganglia within the bladder wall, and by extramural preganglionic neurons. On the other hand, the adrenergic innervation was abolished completely. This indicated that there are no sympathetic ganglia within the bladder wall and implied that adrenergic neurons ran from trigone to fundus and are entirely intramural. Furthermore, a spatial separation of the adrenergic and cholinergic systems, hitherto unrecognised, seemed evident. Finally, the addition of a peripheral denervation to the standard operation added little to the effects observed, and peripheral denervation alone produced hardly any change.

The reason why these intramural neuroanatomical changes may be of importance relates to the dual innervation of the bladder seen at least in animals, in whom the cholinergic ganglia have a profuse *adrenergic* afferent supply (Fig. 19.1). The supposition is that this cholinergic transmission is modulated by the adrenergic system. Section of these afferent adrenergic neurons will render the ganglia supersensitive to circulating catecholamines, which will have the effect of inhibiting cholinergic transmission. In man, however, it is difficult to find any adrenergic intramural neurons, but it is possible that a modulating system does exist, perhaps a neuropeptide, and that inhibition of cholinergic transmission might be produced by a similar sensitising phenomenon produced by transection.

It was realised that were transection to produce an effect as a result of the intramural neurotomy then this could readily be produced by an endoscopic operation, which would also disrupt the myoelectrical and anatomical integrity of the detrusor syncytium.

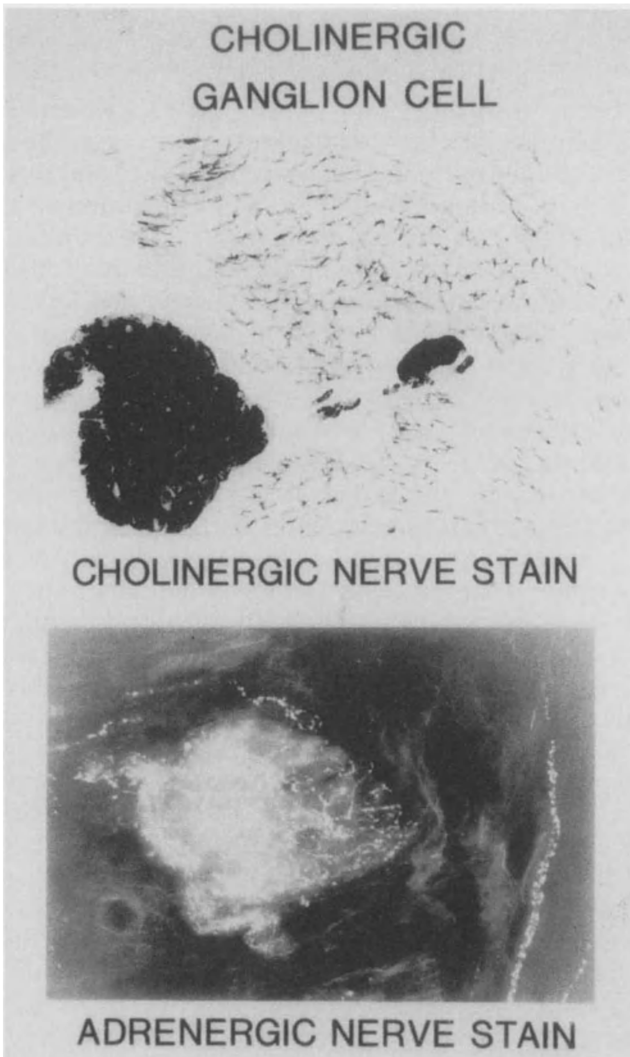



**Fig. 19.1.** Adjacent sections of ganglion stained to show cholinergic nerve (*above*) and adrenergic nerve (*below*) in close approximation.

## Operative Technique—Endoscopic Bladder Transection

The technique of endoscopic bladder transection is simple (Parsons et al. 1984). After endoscopy of the lower urinary tract each ureteric orifice is catheterised to identify the course of the submucosal intravesical ureter so that damage to it can be avoided. Using an irrigating resectoscope with a Collins knife, the bladder volume is set and held constant by adjustment of the inflow and outflow valves. The proposed line of transection is then mapped using a series of small mucosal cuts. The line is positioned approximately 2 cm above the interureteric bar posteriorly and extended round on each side to a point roughly 2 cm proximal to the bladder neck anteriorly. The incision is then started in the midline posteriorly, cutting through mucosa and muscle until extravesical fascia and fat are seen, and extended laterally up the side of the bladder to the anterior midpoint. To complete the circumferential transection it is easier to return to the posterior midpoint and to incise across the back above the interureteric bar, and finally up the side to meet the contralateral incision at the front. Both marking and incising the front are facilitated by reducing the bladder volume, and when the incision is completed, increasing the volume widens the cut and allows individual detrusor fibres which remain intact to be identified and divided carefully. Haemorrhage is minimal, perhaps because the transection line is aimed to be in the watershed between the inferior and superior arterial supply and can readily be controlled by pinpoint coagulation. Careful attention to prevention of bladder overdistension during the operation ensures that extravasation is slight. A 22 FG irrigating catheter is used to drain the bladder for 8 days, and during this time antibacterial therapy is administered.

The use of endoscopic bladder transection has been limited to patients with urodynamically proved bladder instability, usually in association with nocturnal enuresis. There has been a symptomatic improvement in some 80% of cases, with a little over 50% being cured. In particular, bed wetting ceases.

Perhaps the most encouraging feature is that no patient has had symptoms worsened by the operation. As with the open procedure, improvement is not necessarily predicted by the preoperative urodynamic assessment, nor is a symptomatic improvement accompanied by a return of a normal urodynamic trace, though a "shift to the right" is often seen. Morbidity is low and there has been no mortality, an ever-present risk with major abdominal surgery. The threshold for performing an endoscopic transection can thus perhaps be lowered.

## Conclusion

The fact that results of open bladder transection can be matched by a closed procedure probably renders the former obsolete. The difficulty still remains in predicting which patients will benefit from transection, and in placing the operation in the schema of treatments for the unstable bladder. Its use should be restricted to patients with symptoms associated with unstable detrusor activity, and not for primary enuresis, or for sensory urgency, where detrusor function is usually normal. Those who have had a failed trial of drug therapy and whose symptoms are severe should be candidates for the operation (Lancet Editorial 1984), and a cure rate of some 50% can be anticipated, with 80% of patients gaining symptomatic benefit. The low morbidity and lack of adverse effects would suggest that endoscopic bladder transection should be tried before proceeding to a more major cystoplasty.

# References

Choudhary A, Mittra S (1980) Transection denervation of the urinary bladder. Br J Urol 52: 193–195

Essenhigh DM, Yeates WK (1973) Transection of the bladder with particular reference to enuresis. Br J Urol 45: 299–305

Gibbon NOK, Jameson RM, Heal MR, Abel BJ (1973) Transection of the bladder for enuresis and allied conditions. Br J Urol 45: 306–309

Hindmarsh JR, Essenhigh DM, Yeates WK (1977) Bladder transection for adult enuresis. Br J Urol 49: 515–521

Janknegt RA, Moonen WA, Schreinemachers LMH (1979) Transection of the bladder as a method of treatment in adult enuresis nocturna. Br J Urol 51: 275–277

Lancet Editorial (1984) Denervation of the bladder. Lancet II: 1106–1107

Mahony DT, Laferte RO (1972) Studies of enuresis. IV. Multiple detrusor myotomy: a new operation for the rehabilitation of severe detrusor hypertrophy and hypercontractibility. J Urol 107: 1064–1067

Mundy AR (1980) Bladder transection for urge incontinence associated with detrusor instability. Br J Urol 52: 480–483

Mundy AR (1983) Long term results of bladder transection for urge incontinence. Br J Urol 55: 642–644

Parsons KF, O'Boyle PJ, Gibbon NOK (1977) A further assessment of bladder transection in the management of adult enuresis and allied conditions. Br J Urol 49: 509–514

Parsons KF, Machin DG, Woolfenden KA et al. (1984) Endoscopic bladder transection. Br J Urol 56: 625–628

Staskin DR, Parsons KF, Levin RM, Wein AJ (1981) Bladder transection – a functional, neurophysiological, neuropharmacological and neuroanatomical study. Br J Urol 53: 552–557

Turner-Warwick R, Ashken MH (1967) The functional results of partial, subtotal and total cystoplasty with special reference to ureterocystoplasty, selective sphincterotomy and cysto-cystoplasty. Br J Urol 39: 3–12

Yeates WK (1970) Selective denervation of the bladder. Urologists' Correspondence Club, Newsletter, 12th June

*Chapter 20*

# The AS 800 Artificial Urinary Sphincter: Surgical Technique and Troubleshooting

*J. K. Light*

## Introduction

The first artificial urinary sphincter was implanted in June 1972. Since then, significant advances have been made in both the design and reliability of the device. Faulty patient selection and/or surgical technique have now replaced mechanical problems as the most common cause of device failure. The current model, the AS 800, together with the improved silicone-coated cuff, has a low failure rate. A detailed description of patient selection is beyond the scope of this chapter. Briefly, however, the success with the artificial urinary sphincter in obtaining continence is definitely influenced by the presence of any bladder pathology. A "normal" bladder or detrusor areflexia with unaltered compliance is consistently associated with a high degree of success, approaching 90%. However, the presence of detrusor hyperreflexia, e.g. following spinal cord injury, or diminished compliance results in a much lower success rate of approximately 68% and 50%, respectively. Careful urodynamic evaluation is therefore essential to establish the bladder response to filling. It should be remembered that the artificial urinary sphincter substitutes for sphincteric incompetence and should not therefore be used solely to control aberrant detrusor behaviour. The decision as to whether to ablate any bladder outflow resistance rests with the implanting surgeon. The present author routinely performs a sphincterotomy in males or a bladder flap urethroplasty in females if outflow obstruction is documented on preoperative urodynamic evaluation. It is felt that the ability to urinate per urethra without having to resort to intermittent catheterisation achieves improved overall patient rehabilitation.

## Surgical Technique

The artificial urinary sphincter is designed to be placed around either the bladder neck or bulbous urethra. The former applies to patients of both sexes, while the latter is obviously restricted to male patients. The bladder neck is the position of choice for the cuff unless previous trauma has rendered the tissue unsuitable, e.g. transurethral resection of the prostate (TURP), carcinoma of the prostate, or fractured pelvis. In this instance the cuff is placed around the bulbous urethra. However, there is a higher incidence of stress incontinence in the latter situation. The usual precautions when handling the device are strictly adhered to during the operation. Urine sterility is mandatory at the time of surgery.

### Bladder Neck Approach

Male patients are placed in the supine or lithotomy position, while female patients are placed in the lithotomy position with thighs parallel to the floor to allow access to the vagina during the surgical procedure. A low Pfannenstiel skin incision together with transection of the recti muscles as described by Cherney is used to gain access to the retropubic space. Exposure of the bladder neck following dissection in the prevesical space is a simple procedure in those patients who have not undergone any previous retropubic surgery. Palpation of the balloon from a transurethral catheter allows identification of the bladder neck area (Fig. 20.1a).

#### *Male Patients*

At this point the tissue posterior to the catheter balloon is grasped between the thumb and second finger. Three distinct structures can readily be palpated; the vas deferens posteriorly, the trigone, and lastly the catheter itself lying anteriorly. Incision of the endopelvic fascia at the level of the bladder neck at the 3 and 9 o'clock positions may be necessary to allow the structures to be palpated clearly (Fig. 20.1a). Dissection around the bladder neck must be done between the bladder neck, identifiable by the catheter and trigone, and the accessory sex structures identifiable by the vas deferens. To accomplish this the trigone is held between the thumb and second finger allowing the vas deferens to drop posteriorly (Fig. 20.1b). At this stage there should be a minimal amount of tissue between the tips of the thumb and finger. Holding the tissues in this position, dissection is commenced using a right-angled pair of scissors placed in close apposition to the fingers (Fig. 20.1d). A combination of sharp and blunt dissection is required to create a tunnel between the trigone and vas deferens. In those patients where the three important structures can readily be palpated, the relatively blind

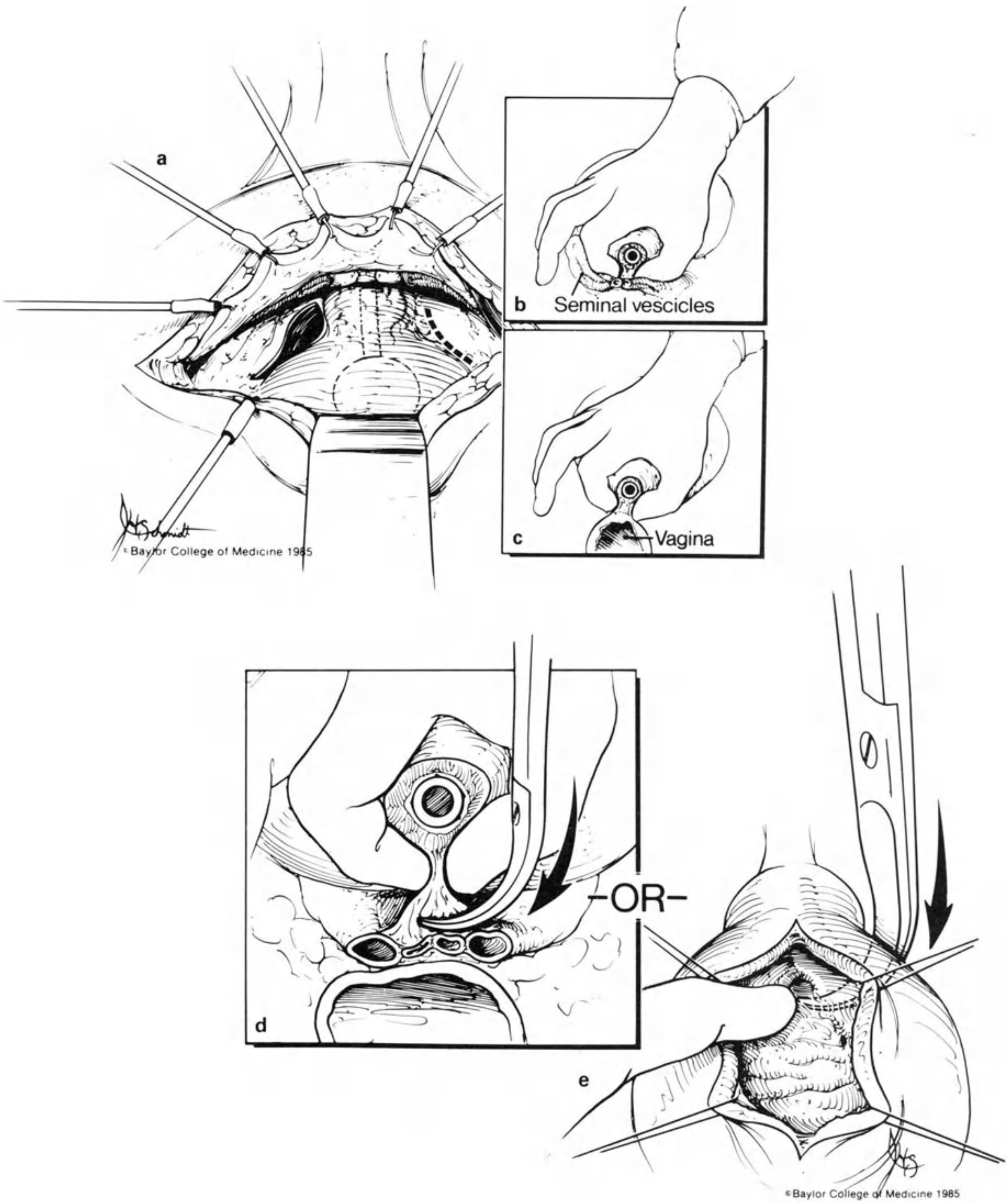
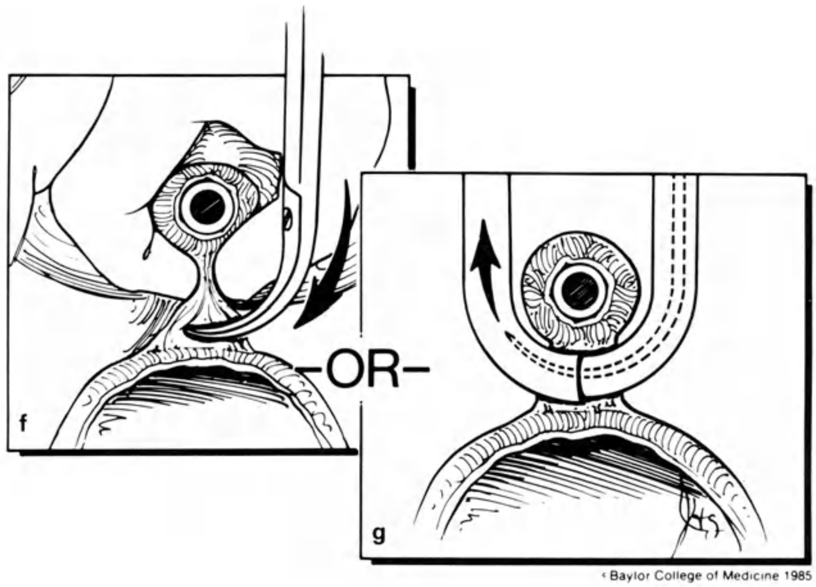



**Fig. 20.1a–n.** Surgical technique for implanting artificial sphincter—bladder neck approach. **a** Anatomy of the retropubic space showing the location of the balloon from a transurethral catheter to aid in identification of the bladder neck by palpation together with incision of the endopelvic fascia. Note the exposure obtained by transection of the recti abdominal muscles. **b** Position of the finger and thumb for digital separation of the posterior aspect of the trigone anteriorly from the vas deferens posteriorly. **c** Position of the finger and thumb in a female patient separating the posterior aspect of the trigone from the anterior wall of the vagina. Note that there is no recognised surgical plane in this area. **d** Position of right-angled dissecting scissors creating the tunnel between the trigone and the vas deferens by blunt dissection. **e** The bladder has been opened to facilitate dissection of the subtrigonal tunnel with the aid of inspection and intravesical palpation.



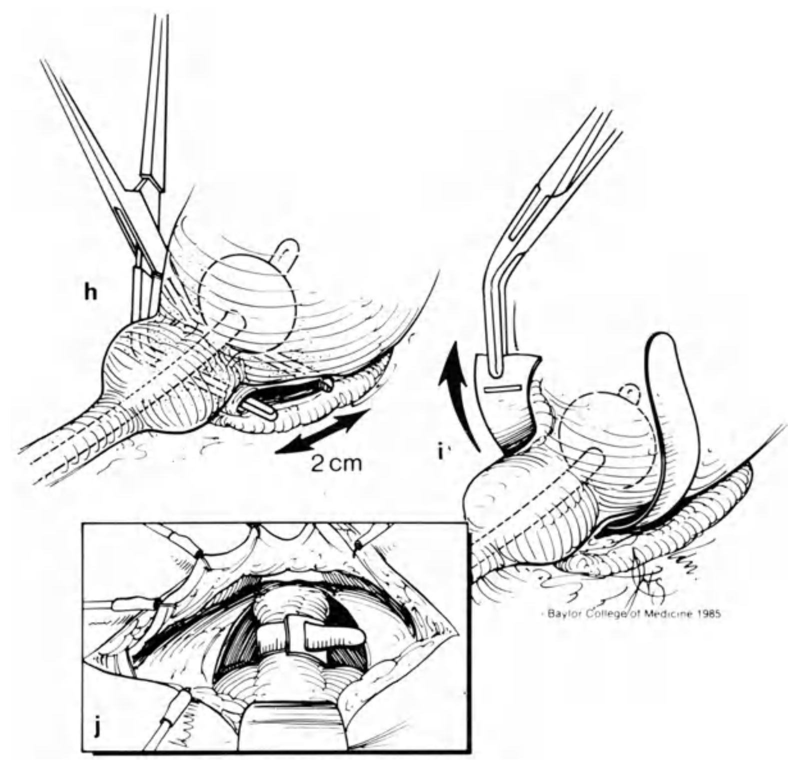




**Fig. 20.1** *(continued)* **f** Creation of the subtrigonal tunnel in a female. **g** Use of the cutter clamp to achieve the subtrigonal tunnel. **h** Subtrigonal tunnel is gently dilated with a right-angled clamp to accept the 2 cm cuff. **i** The cuff sizer is pulled through the subtrigonal tunnel with the aid of the right-angled clamp. **j** Cuff sizer in position to measure cuff length. Note bilateral incisions of the endopelvic fascia.

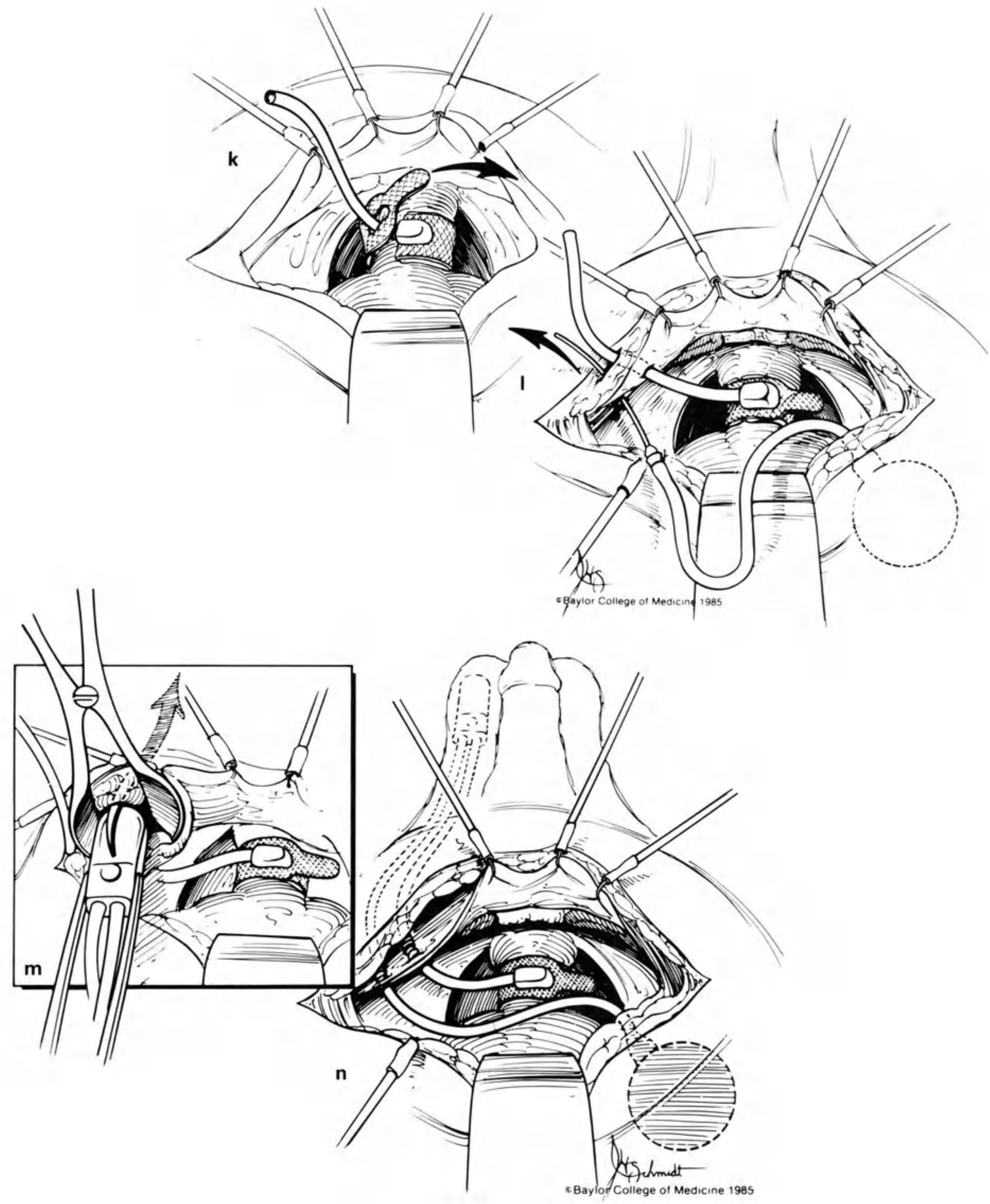



**Fig. 20.1** (*continued*) **k** Cuff in position around bladder neck. **l** Cuff snapped into position. Tubing from cuff has already been passed through the full thickness of the lower abdominal wall. Note the balloon in a submuscular extraperitoneal position with the tubing being passed by means of a tubing passer through the full thickness of the abdominal wall on the inferior aspect of the incision. **m** Following dissection of a subdartol pouch, the pump is passed with the aid of an extended nasal speculum inferiorly, using vascular forceps. **n** Entire device in position with connections lying in the subcutaneous plane to one side of the incision.

dissection to create the subtrigonal tunnel will proceed without incident. If, however, the subtrigonal plane cannot be readily identified, it is strongly recommended that the bladder be opened at this point. Care should be taken to do this in a manner such that the incision is well above the cuff site. With a combination of inspection and palpation from inside the bladder, the appropriate dissection can be accomplished with relative ease (Fig. 20.1e). Indeed, it is recommended that the novice implanter proceed in this manner until confidence is obtained in distinguishing the structures by palpation only. A large right-angled clamp is then placed through this tunnel before the right-angled scissors are removed. The tunnel is then gently dilated with the right-angled clamp to accept the 2 cm cuff (Fig. 20.1h).

### *Female Patients*

The tissue is similarly grasped with the thumb and second finger, as described in the male, except that on this occasion the structure lying posteriorly is the vagina (Fig. 20.1c). No packing is inserted into the vagina, to allow easy access during the dissection if required. In the absence of any previous anterior vaginal wall surgery, this plane is created relatively easily with the right-angled scissors, as described in the male (Fig. 20.1f). Vaginal examination can be performed at any stage during this procedure to ensure that the dissection is proceeding in the correct plane without any vaginal perforation. If the latter should inadvertently occur, the perforation should immediately be repaired before continuing with the operation. If previous surgery has obliterated this plane, use of the cutter clamp is recommended (Fig. 20.1g). The use of this instrument has already been described.

### *Continuation of Procedure for Both Sexes*

The right-angled clamp is then used to grasp the cuff sizer, which is pulled through the previously dissected tunnel (Fig. 20.1i). The cuff sizer is used to measure the bladder neck diameter and thus the cuff size (Fig. 20.1j). The present author, however, prefers to use a 0 Prolene and umbilical tape which are pulled simultaneously through the previously dissected tunnel. It is frequently necessary to secure haemostasis by using interrupted sutures of catgut at the level of the cuff dissection. Bleeding from underneath the tunnel usually ceases following insertion of the cuff. To confirm that the posterior trigone is intact, the retropubic space is filled with fluid and air injected through the urethral catheter. The escape of bubbles into the retropubic area indicates a perforation through the trigonal area which will require repair. This method has been found to be more accurate than the insertion of fluid into the bladder to observe for a leak in the retropubic space. The umbilical tape is then used to measure the cuff size by clamping it so as to be relatively snug against the tissues.

The excess tape is then excised immediately above the clamp and the length measured. Estimation of cuff size may be a problem as it should neither be too large nor too small. The adult male bladder neck generally requires an 8–10 cm cuff, while in the adult female a 7–9 cm cuff is sufficient. A bladder neck diameter of 11 cm or greater usually indicates that too much soft tissue has been included in the dissection around the bladder neck. Again, to aid the novice implanter it is suggested that the bladder is opened and the tip of the fifth finger placed into the internal meatus. Admission of the tip only indicates that the cuff sizing is correct. The appropriate sized cuff is then tied on to the 0 Prolene suture to aid in pulling it through the subtrigonal tunnel. Care should be taken that the cuff does not twist during this manoeuvre. The cuff is snapped into position (Fig. 20.1k).

A space is then bluntly dissected on one or other side of the prevesical space for placement of the balloon. The balloon should lie in the submuscular extraperitoneal plane in such a manner that the tubing assumes a gentle curve (Fig. 20.1l). Using the conventional method the balloon is filled to 18 ml and connected directly to the cuff by means of a straight connector. The balloon is then held at the level of the pubic symphysis and the cuff allowed to fill. Following this, the balloon is disconnected and refilled to a precise volume of 16 ml. It is essential that the fluid be isotonic as the silicone acts as a semipermeable membrane. A radiopaque dye is frequently added for convenience to visualise the components in the postoperative period. The present author, however, dispenses with the previous manoeuvre and fills the balloon directly to 20 ml while maintaining an empty cuff. The tubing from the cuff and balloon are then brought separately, with the aid of a tubing passer, through the appropriate side of the incision so that the tubing exits through the full layer of muscles to enter the subcutaneous area (Fig. 20.1l). A space in the subcutaneous area is dissected to accommodate the connectors. With the aid of a large clamp or long scissors a space is dissected in the subdartol area of the appropriate hemiscrotum or labium. The pump is inserted into this area with the aid of an extended nasal speculum to lie in a position where it will be easily accessible to the patient (Fig. 20.1m). The tubing is then cut to the appropriate length and connections made (Fig. 20.1n). At present the plastic connectors are doubly ligated with 3–0 Prolene ties. The recent introduction of "quick connects", however, will probably replace the conventional method. All the tubing is then checked to confirm that there are no kinks present, especially as the tubing traverses the muscle fascia. The fascia is then closed by using a running horizontal mattress suture of a monofilament absorbable suture. This will allow for visualisation of the prosthesis components at all times and thus avoid inadvertent puncturing during closure. Haemostasis is exceedingly important as no drains are used. Following closure of the rectus fascia the device is manipulated again to ensure that kinking of the tubing has not occurred as a result of the fascial closure. The subcutaneous tissue is closed in layers followed by the skin. Final manipulation of the device confirms normal function before deactivation is performed by pressure on the poppet valve. A Foley catheter is left indwelling at the completion of the surgery.

## Bulbous Urethral Approach

The patient is placed in the lithotomy position for access to the perineum. A midline perineal incision is made over the distal bulbar urethra (Fig. 20.2a). A catheter may be placed into the urethra to allow for easier identification of this structure. The bulbocavernosus muscles are divided vertically in the midline and retracted laterally (Fig. 20.2b). The urethra is easily dissected until the 12 o'clock position is reached. Care is taken at this point to avoid inadvertent damage to the urethra. Should perforation of the urethra inadvertently occur, immediate repair is recommended with the cuff being placed at a different site if possible. The device is then implanted but not pressurised until healing has occurred. In contradistinction to the dissection around the bladder neck, the dissection around

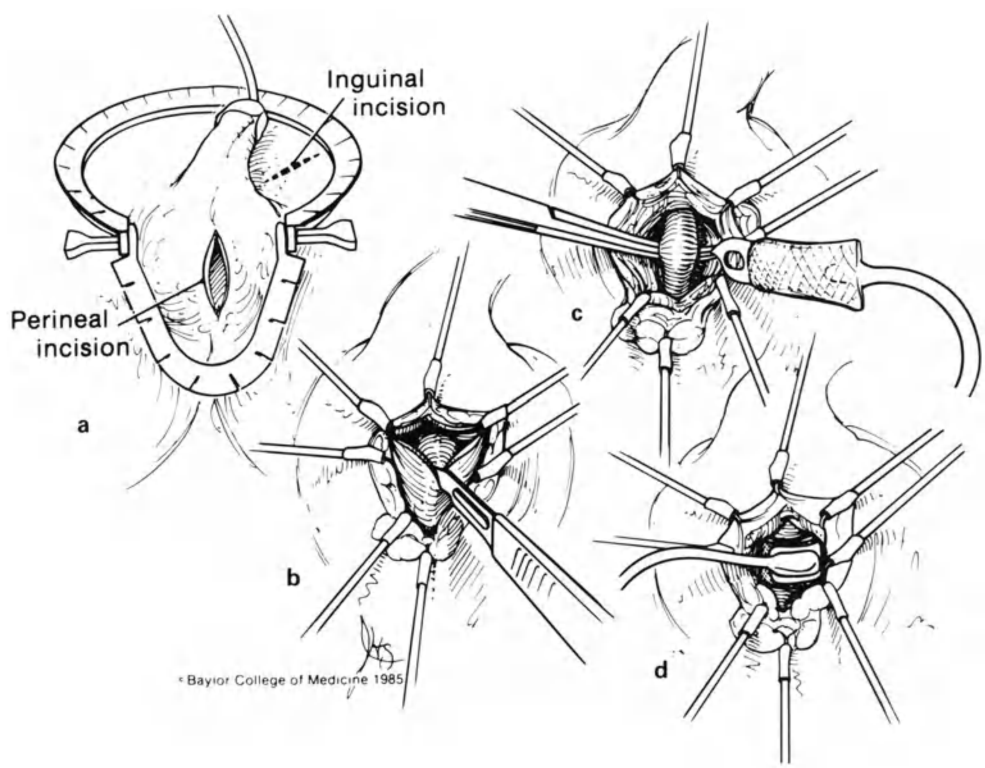
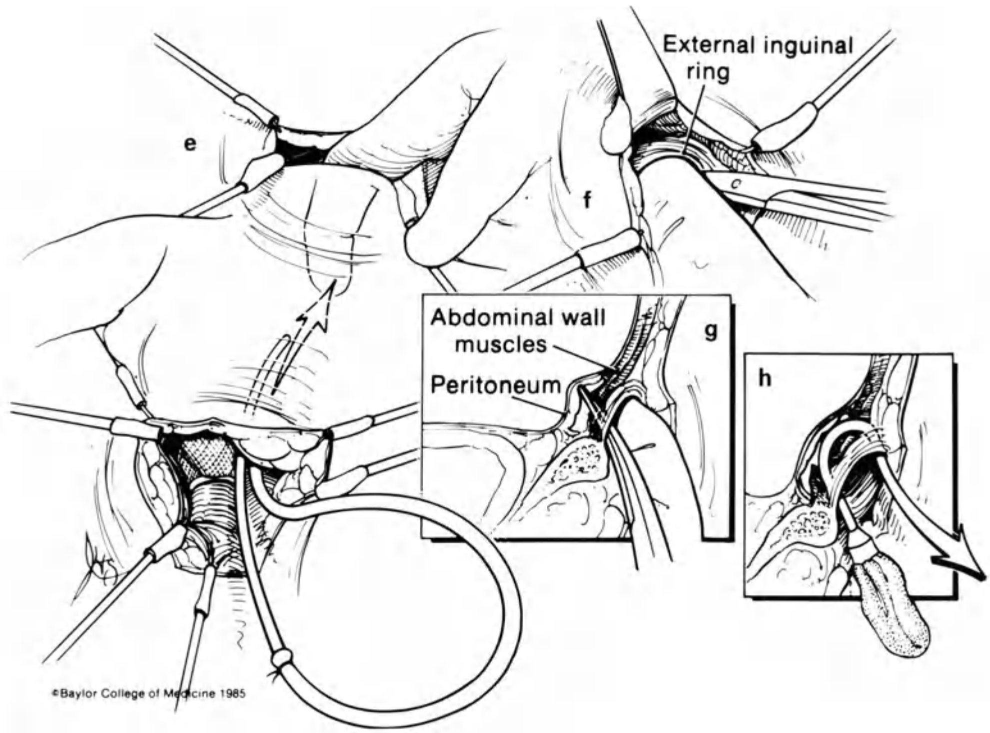



**Fig. 20.2a–j.** Surgical technique for implanting artificial sphincter—bulbous urethral approach. **a** Perineal incision over distal bulbar urethra shown together with proposed site for the inguinal incision. **b** Division of the bulbocavernosus muscle in the midline. **c** Circumferential dissection of the urethra has been completed and the cuff is now being pulled through to encircle the urethra. **d** Cuff in position around bulbar urethra. **e** Index finger is inserted inferiorly in the subcutaneous plane through a previously made incision to meet a tubing passer attached to the cuff tubing. The cuff tubing will exit in the subcutaneous plane through the inguinal incision. **f** The index finger of one hand is shown in position through the external inguinal ring palpating the posterior floor. Scissors are introduced between the finger and the inferior pubic tubercle. **g** Sagittal section demonstrating perforation of the inguinal canal floor so as to enter the retropubic space. **h** The balloon is being placed in the previously dissected retropubic space by passing through the external inguinal ring. **i** Pump placement in the left hemiscrotum using the extended nasal speculum and vascular forceps for manipulation of the pump. **j** Completed operation showing the balloon in the extraperitoneal submuscular plane, the cuff lying around the proximal bulbar urethra and the pump in the hemiscrotum. Note gentle curvature of the tubing leading from the cuff to the pump. Connections lie in the submuscular plane at the level of the inguinal incision.



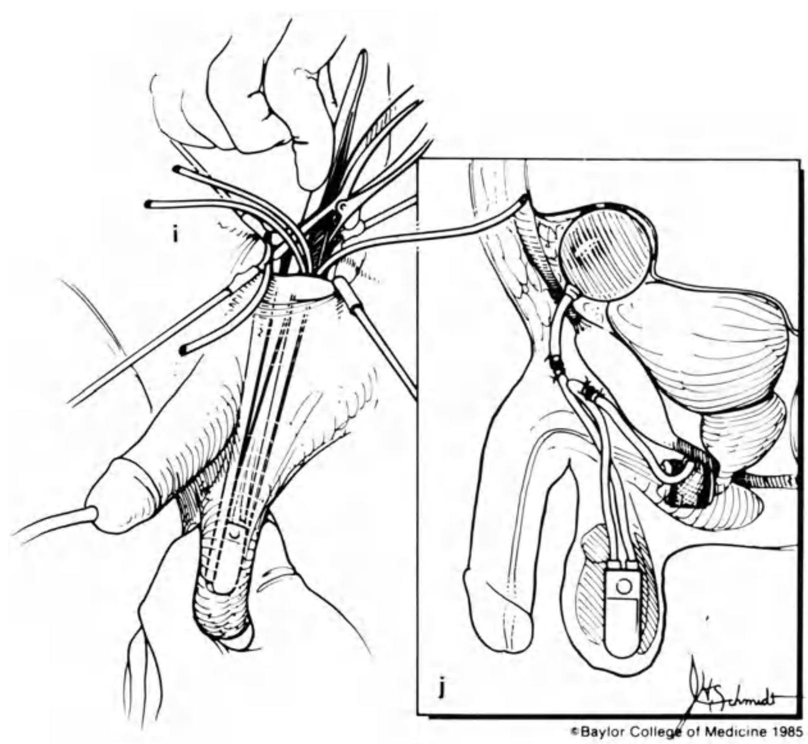




**Fig. 20.2** (*continued*)

the bulbar urethra can be performed under direct vision. Measurement of the cuff size is performed in a similar manner to that described under bladder neck approach. A 4.5 or 5 cm cuff commonly fits the male urethra. The cuff is pulled in position with the aid of a right-angled clamp and snapped into the closed position in the routine fashion (Fig. 20.2c,d). The use of a malleable metal protector which fits around the cuff is optional. The protector prevents the patient expressing fluid out of the cuff in the sitting position, resulting in incontinence when the patient stands. The present author routinely uses the metal cuff protector. A small incision is now made directly over the external inguinal ring (Fig. 20.2a). The dissection is deepened down to the level of the external oblique fascia. A finger is then inserted subcutaneously downward towards the cuff site. The cuff tubing, with the aid of a tubing passer, is now guided by the finger to exit through the inguinal incision (Fig. 20.2e). The tip of a forefinger is then placed through the external inguinal ring and with the aid of Mètzenbaum scissors, the floor of the inguinal canal is perforated (Fig. 20.2f,g). This allows access to the retropubic space. Using gentle finger dissection a space is created for the balloon. A tubing passer with an empty balloon attached is then placed through the external inguinal ring to exit again approximately 2 cm above the apex of the external inguinal ring (Fig. 20.2h). The empty balloon is thus pulled through the perforated inguinal floor into the retropubic space so that the nipple of the balloon comes to lie in the direct submuscular plane. With this manoeuvre herniation of the balloon through the external inguinal ring is avoided. The balloon is then filled with 18 ml of the appropriate solution. The pump is then implanted into the scrotum in a similar fashion to that described under the bladder neck approach (Fig. 20.2i). Routine connections are made at the subcutaneous level between the appropriate tubing (Fig. 20.2j). A right-angled connector may be used between the cuff and pump if required. The device is then manipulated to ensure proper function. Both incisions are then closed in layers without drains.

## Balloon Pressures

A choice of balloon pressures is available, ranging from 50 to 90 $cmH_2O$. The cuff pressure should not exceed the diastolic blood pressure as otherwise erosion may occur. The closing pressure of the cuff is dependent on the balloon pressure. Since the introduction of the different balloon pressures, cuff erosion from pure pressure necrosis in normal vascularised tissue is extremely rare. Certain factors, however, do interfere with local tissue perfusion, e.g. radiotherapy, previous surgery or trauma, and increase the risk of erosion.

Generally, in the adult male with normal tissues a 71–80 cm balloon is used for the bladder neck and a 61–70 cm balloon for the bulbous urethra. In the adult female a 51–60 or 61–70 cm balloon is used around the bladder neck. If the local tissue perfusion is diminished, the lowest pressure balloon should be used. Even then, erosion may occur if the balloon pressure of 51–60 $cmH_2O$ (36–44 mmHg) exceeds the blood pressure of the pudendal artery. This applies particularly to patients who have undergone a full course of pelvic radiotherapy.

## Troubleshooting the Device

An understanding of the device mechanism is important when considering causes of malfunction. The control-pump assembly contains the fluid resistors, one-way and poppet valves. The balloon pushes fluid across the resistors to first fill the pump and then the cuff. On squeezing the pump, fluid passes easily and immediately to the balloon. On releasing the pump, fluid is sucked from the cuff to refill the pump immediately. When the cuff is empty, the pump no longer re-expands and therefore stays "flat". Gradual refilling of the pump and then the cuff occurs as the cycle is repeated. The following clinical and surgical protocol is used by the present author to diagnose complications resulting from the artificial sphincter.

### **Clinical Protocol** (Fig. 20.3)

A urine culture is performed to ensure that the urine is sterile. If not, the appropriate antibiotic treatment is given. Examination and manipulation of the pump is the single most important aspect of the clinical

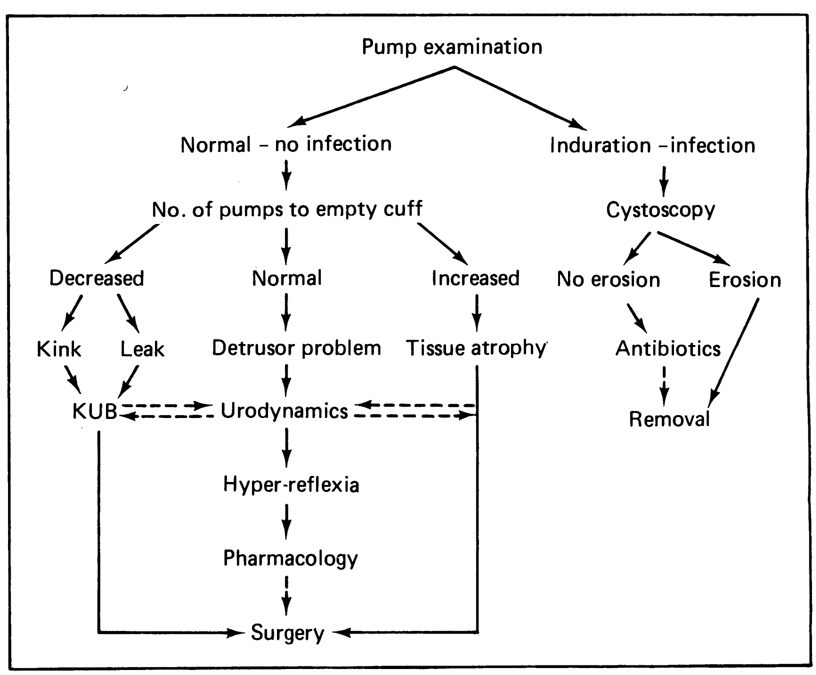



**Fig. 20.3.** Clinical protocol for diagnosis of complications resulting from the artificial sphincter.

examination. The AS 800 control-pump assembly expresses approximately 0.75 ml with each pump. This is in contrast to the AS 791/2, which has a pump volume of 0.5 ml. Assuming there is no leak, by counting the number of pumps required to empty the cuff a reasonably accurate estimate regarding cuff volume can be made. The residual balloon volume can now be estimated by subtracting this cuff volume from the original balloon volume. Generally, a snug-fitting cuff will contain 0.75–2 ml, depending on the position, i.e. bulbous urethra or bladder neck, respectively. A cuff volume of 6 ml or greater (bladder neck), or 3 ml (bulbar urethra), usually indicates that the cuff is too large. This can be determined clinically by counting the number of pumps required to empty the cuff. Induration and/or hyperaemia surrounding the pump suggest underlying infection, with the possibility of cuff erosion. This will be discussed later (see p. 251). However, the most common problem which occurs postoperatively is urinary incontinence. There are two basic causes for persistent or recurrent urinary incontinence following insertion of the artificial sphincter. The first involves the device itself and the second is related to abnormal tissues, usually the bladder.

### *Causes of Device Failure*

The most frequent complication involving the device is a decrease in the closing pressure of the cuff. The two most common causes for this are a leak in the device and pressure atrophy of the tissue beneath the cuff. Other problems include tube kinks, debris in the system and a restrictive sheath around the reservoir.

*Leak in the Device.* The fluid loss may be gradual or sudden, depending on the size of the leak, and may occur at any stage following implantation of the device. Characteristically the patient states that the number of pumps required to empty the cuff has decreased from that observed previously or that the pump does not fill, i.e. stays "flat". This can easily be confirmed on clinical examination of the pump. A KUB X-ray film of the pelvis may show an alteration or decrease in the balloon shape, but it should be remembered that a balloon volume of only 10 ml may look radiologically normal. A balloon which appears normal on the X-ray film therefore does not exclude a slow leak. The cuff has been the most common site for a leak, followed by the balloon. In previously reported series where repeat surgery was required for a mechanical problem, a cuff leak was responsible in 56% of instances and balloon leak in 13%. The introduction of the new silicone-coated cuff, however, is expected to result in a sharp drop in the incidence of cuff leaks by preventing friction between the inner soft and outer firm backing of the cuff. The site of the leak is determined at surgery.

*Pressure Atrophy.* A variable degree of pressure atrophy inevitably occurs beneath the cuff, the severity of which is related to the balloon pressure. This problem is becoming recognised more frequently and

**Table 20.1.** Inefficient cuff—guidelines

| Cuff length | Cuff volume | No. of pumps | |
|---|---|---|---|
| | | 791/792 | 800 |
| 5.0 | 1.5 | 3 | 2 |
| 6.0 | 2.0 | 4 | 2 |
| 7.0 | 2–3 | 4 | 3 |
| 8.0 | 3.5 | 6 | 4 |
| 9.0 | 4.5 | 8 | 5 |
| 10.0 | 5 | 10 | 6 |

results in the cuff volume increasing at the expense of the balloon volume (Table 20.1). Clinical examination reveals that the number of pumps required to empty the cuff has increased. The pressure/volume relationship on the deflated curve of the balloon is sigmoid shaped (Fig. 20.4). The pressure therefore will drop sharply for a relatively small decrease in volume below a critical balloon volume of approximately 14 ml. Significant pressure atrophy will decrease the cuff closing pressure by "siphoning" fluid from the balloon. Other factors, however, play a part when considering an incompetent cuff, including cuff size, tissue compliance and the shape the cuff assumes on inflation.

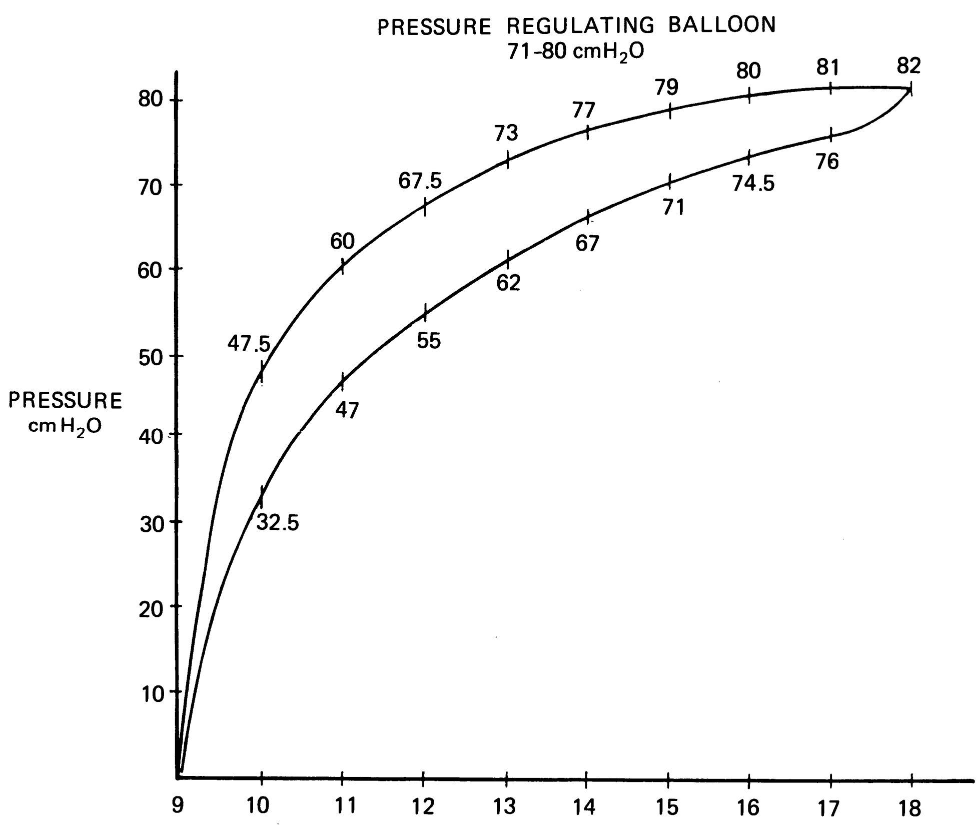



**Fig. 20.4.** Pressure/volume relationship on the deflated curve of the balloon is sigmoid shaped.

In a recently reported series the above two problems, i.e. a leak in the device and pressure atrophy, were responsible for 88% of the malfunctions that required repeat surgery following insertion of the artificial sphincter. It is therefore possible to diagnose 88% of the possible mechanical malfunctions that require further surgery simply by clinical examination of the pump. If doubt is still present, urodynamic evaluation can be performed to confirm that the cuff is inefficient.

*Debris.* Occasionally, debris within the system can simulate a leak. However, the patient usually reports that the number of pumps required to empty the cuff varies, as does the continence status, because of the intermittent obstruction to the resistors by the debris. This obstruction prevents full cuff pressurisation. Primary malfunction of the control assembly is extremely rare, and it follows therefore that the introduction of debris occurs at the time of surgery or following a leak.

*Kink.* A kink in the tubing may also simulate a leak because of incomplete refilling of the cuff. A straightforward X-ray film of the pelvis will often identify the site of the kink in addition to showing dye within the system. The specific abnormality found on pump manipulation will depend on the site of the kink. If this occurs between the cuff and pump, extremely slow refilling of the pump occurs following the first manipulation. However, if the kink lies between the pump and balloon, difficulty will be experienced in pumping the device with the very first manipulation.

*Restrictive Reservoir Sheath.* Occasionally, a restrictive sheath forms around the reservoir postoperatively. This results in inability of the reservoir to distend to accept all the fluid from the cuff. Characteristically the first couple of pumps are easy, followed by a progressive increase in the resistance as the elasticity of the sheath is exceeded. The significance of a restrictive reservoir sheath is that it may prevent cuff deflation and therefore interfere with adequate urination. Urinary incontinence associated with this type of problem is usually an overflow-type of incontinence secondary to incomplete bladder emptying. This can be avoided by ensuring that the patient completely empties the cuff on a frequent basis in the postoperative period.

### *Abnormal Tissues*

If there is no change in the pumping characteristics of the device, i.e. the cuff volume has remained the same, the reason for the incontinence usually lies with bladder behaviour. Detrusor hyper-reflexia or poor bladder compliance are two common causes. Both conditions result in an increase in intravesical pressure at variable volumes. If this exceeds the cuff pressure, fluid will move out of the cuff, resulting in a decrease in the closing pressure and therefore urinary leakage. Urodynamic evaluation is essential in this situation. Cystometry is routinely performed postoperatively to categorise bladder type. Frequently, preoperative hyper-reflexia is aggravated or detrusor instability precipitated by the surgery. This is treated initially with anticholinergics. A flow rate and post-void residual are also performed to exclude the presence of an outflow obstruction and/or inefficient bladder emptying. An overflow-type incontinence can thus be excluded. Static urethral pressure profilometry with the cuff open and closed adds a further dimension to the evaluation. Because of the cuff efficiency, the intraurethral pressure beneath the cuff generally closely approximates or exceeds that of the balloon pressure. If the problem lies with the bladder, the maximum urethral pressure obtained with the cuff closed will be close to or exceed the balloon pressure. If the maximum urethral pressure is significantly lower than the balloon pressure, the cuff is inefficient. Profilometry with the cuff open is a general measure of outflow resistance and may indicate an inadequate sphincterotomy or poor cuff opening. Pressure/flow studies with simultaneous video-cystourethrography performed transurethrally are an excellent means of confirming abnormal detrusor function or outlet obstruction as a cause for the urinary leakage.

## **Surgical Protocol** (Fig. 20.5)

The first step is to perform retrograde gas sphincterometry to determine the "opening pressure" of the cuff. This measures essentially the same parameters as the urethral pressure profilometry but is more accurate than the latter in assessing cuff efficiency. The "opening pressure" of the cuff should normally be equal to or greater than the stated balloon

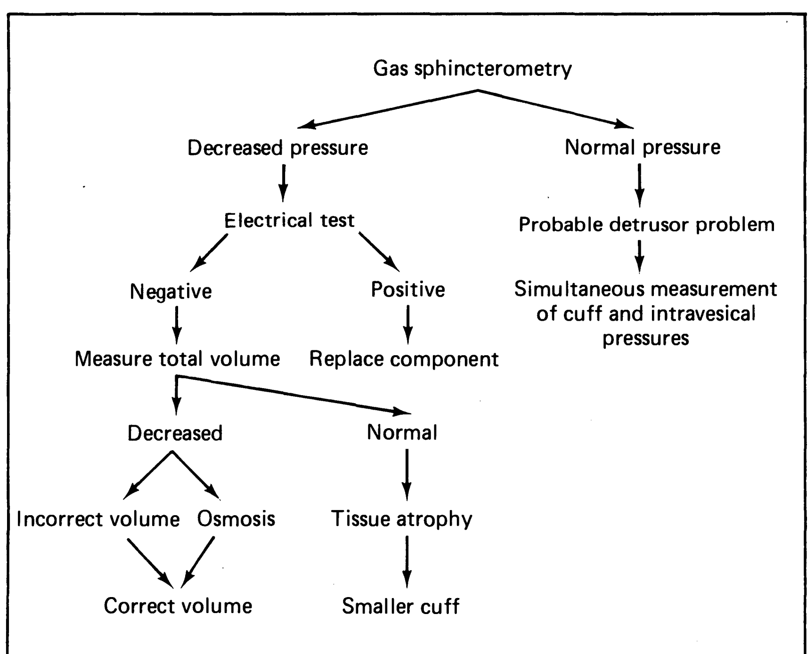



**Fig. 20.5.** Surgical protocol for diagnosis of complications resulting from the artificial sphincter.

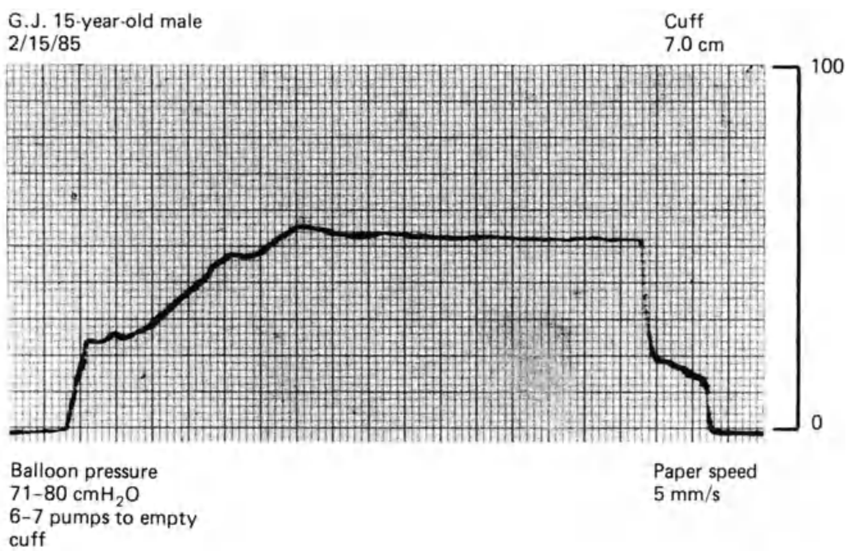



**Fig. 20.6.** Preoperative sphincterometry measurement to assess efficiency of AS 792 cuff. Low opening pressure—cuff inefficient.

pressure. This measurement also serves as a baseline to compare with following "corrective" surgery (Fig. 20.6). Cystoscopy is performed to assess the cuff site and exclude an erosion.

The electrical test is performed following exposure of the connectors to determine the presence or absence of a leak. If a leak is found, the damaged component is exchanged and the system refilled. In the absence of a leak, the balloon volume is measured. With significant pressure atrophy around the bladder neck, this volume will be 14 ml or less. Finally, the cuff volume is measured. The total volume of the cuff and balloon should add up to the original volume inserted if the inefficient cuff is secondary to pressure atrophy. A smaller cuff will correct the

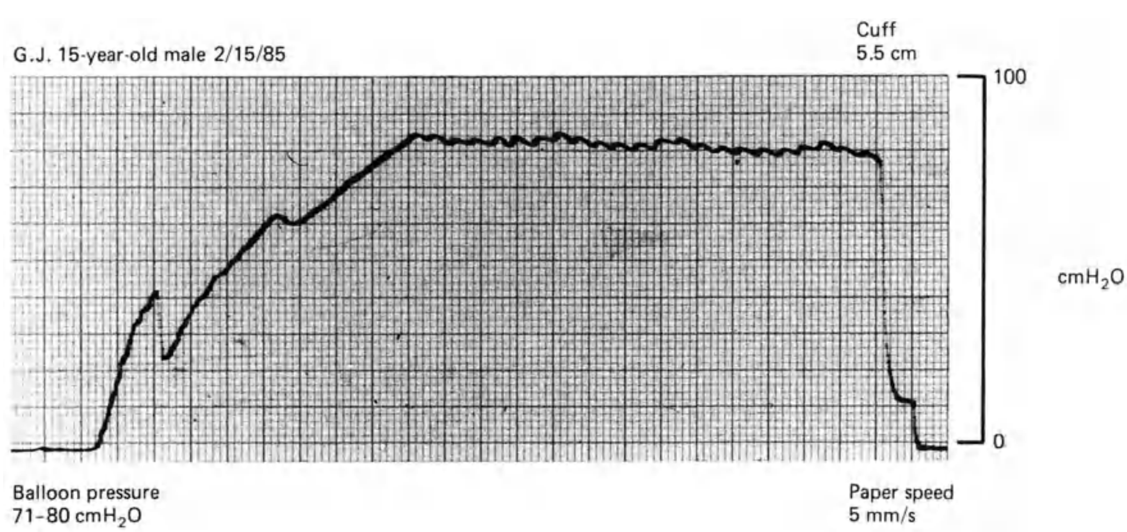



**Fig. 20.7.** Postoperative sphincterometry measurement shows increase in cuff opening pressure following repair surgery.

problem and repeat gas sphincterometry will show the expected increase in the "opening pressure" (Fig. 20.7). Rarely, the total volume will have decreased in the absence of a leak. Original insertion of an incorrect volume is one possibility, while fluid loss secondary to osmosis from a hypo-osmolar mixture is another. Replacement of the fluid will solve the problem. In the event that the opening pressure is normal, the problem will usually be in the tissues at the cuff site. However, this should have been suspected on preoperative evaluation. In this instance, it may be necessary to measure simultaneous pressures of the cuff and bladder to confirm poor tissue compliance as the cause of the incontinence. If the problem lies with poor tissue compliance beneath the cuff, fluid will leak past the cuff with detrusor pressures lower than the cuff pressure. However, this test is only rarely necessary. A higher pressure balloon is inserted to overcome poor tissue compliance of the cuff area, while an augmentation cystoplasty may be necessary with poor bladder compliance.

## Infection

Infection involving the artificial sphincter is a serious complication, as removal of the device is inevitable. Any induration around the pump, local skin hyperaemia or pain with manipulation suggests infection. The sudden onset of pain and swelling around the pump suggests cuff erosion. In addition, a persistent, burning type of pain in the perineum in the presence of a bulbar cuff points to an impending cuff erosion. In the presence of a suspected infection, exclusion of a cuff erosion is imperative. This is best done with a cystoscopy in the operating room, with arrangements being made to proceed with removal if necessary. A urethrogram is contraindicated as this may contaminate a sterile erosion or fail to show extravasation if the erosion is small. In the case of a sterile erosion of the bladder neck, the cuff only may be removed, or relocated, if possible with a bulbar sphincter. Removal of the entire device is necessary, however, in the case of erosion in the presence of infected urine. Cystoscopy may reveal mucosal oedema at the cuff site without an apparent erosion. In this situation the device should be deactivated and a full course of intravenous and then oral antibiotics given. Repeat cystoscopy should be performed 6 weeks later to ensure that a small erosion has not been missed. The device may then be reactivated if the mucosa overlying the cuff site appears healthy.

Patients with an infected device rarely present with the usual systemic signs of an infection, e.g. leucocytosis or fever. The key symptoms and signs are usually confined to the pump area and have been enumerated above. If the infection is left untreated, eventual erosion of the pump or cuff will occur.

Several methods have been tried to salvage a known infected device, including long-term antibiotic treatment, irrigation of the prevesical space with the appropriate antibiotic solution and exchanging the infected device. However, the present author has not succeeded in salvaging a known infected device using all three of the above methods and therefore has abandoned this approach for the artificial sphincter. An infected device which does not respond to antibiotic treatment as outlined above or is associated with erosion of the cuff or pump is therefore synonymous with removal.

## Conclusion

The patient with urinary incontinence has a far greater chance of achieving continence now than ever before. The surgical procedure to be performed must be meticulously chosen after due consideration of all the complications and success rate.

## Further Reading

Holm-Bentzen M, Klarskov P, Opsomer R, Maegaard EM, Hald T (1985) Objective assessment of urinary incontinence after successful implantation of the AMS artificial urethral sphincter. Neurourol Urodynam 4: 9–13

Light JK (1985) The artificial urinary sphincter in children – experience with the AS800 series and bowel reconstruction. Urol Clin North Am 12: 103–109

Light JK, Scott FB (1983a) Use of the artificial urinary sphincter in spinal cord injury patients. J Urol 130: 1127–1129

Light JK, Scott FB (1983b) Complications of the artificial urinary sphincter in pediatric patients. Urol Clin North Am 10: 551–555

Light JK, Scott FB (1984) The artificial urinary sphincter in children. Br J Urol 56: 54–57

Light JK, Scott FB (1985) Use of the artificial urinary sphincter in stress incontinence. J Urol 134: 476

Scott FB, Bradley WE, Timm GW (1973) Treatment of urinary incontinence by implantable prosthetic sphincter. Urology 1: 252–259

Scott FB, Light JK, Fishman IJ (1983) Postprostatectomy incontinence. The artificial sphincter. In: Hinman F Jr. (ed) Benign prostatic hypertrophy. Springer, Berlin Heidelberg New York, pp 1008–1022

Webster GD, Sihelnik SA (1984) Troubleshooting the malfunctioning Scott artificial urinary sphincter. J Urol 131: 269–272

*Chapter 21*

# Nerve-stimulating Implants for Bladder Control in Patients with Spinal Cord Injury or Disease

*G. S. Brindley*

This chapter is mainly about the merits, defects and range of application of one type of implant, the sacral anterior root stimulator (Brindley et al. 1986; Herlant and Colombel 1986). Some related devices will be discussed briefly.

## Types of Bladder Disorder in Patients with Spinal Cord or Cauda Equina Lesions

We need to distinguish three kinds of lesion:

1. *Lesions that have destroyed the efferent innervation of the detrusor.* These lead to complete areflexia of the bladder. Sacral anterior root stimulators are clearly useless because the fibres that they are designed to stimulate have been destroyed, and it is unlikely that any other kind of electrical implant will be useful.

It should not be assumed that detrusor areflexia as shown in cystometry necessarily implies loss of efferent innervation. If ankle jerks, the bulbocavernosus and anal skin reflexes and reflex erection are absent in a patient with detrusor areflexia, one can safely presume that the bladder is de-efferented; but if these sacral cord reflexes are present, further testing by transrectal stimulation of the pelvis splanchnic nerves (Brindley 1981) will probably show that efferent innervation of the bladder survives, and good voiding with low residual volume may be achievable by sacral anterior root stimulator.

2. *Complete cord transections that leave the sacral segments of the cord intact or nearly so.* Provided that 2 months or more have elapsed since the

injury or other cause, patients with such lesions typically have reflex micturition. This is almost always inefficient, leaving a residual urine volume of 50–500 ml, and unpredictable, causing incontinence. The incompleteness of emptying is usually due partly to insufficient duration of the reflex detrusor contractions, and partly to detrusor/sphincter dyssynergia. Most patients with complete cord transections who have inefficient reflex bladders are suitable for treatment by sacral anterior root stimulator.

3. *Incomplete cord lesions*. Patients with stationary incomplete lesions who have inefficient reflex voiding and no pelvic pain sensitivity are as suitable for sacral anterior root stimulators as they would be if their lesions were complete. Patients with preserved pelvic pain sensitivity present special problems, which will be considered later. Patients with slowly progressive lesions, especially multiple sclerosis, can be suitable, but experience with them is small.

## Use of Sacral Anterior Root Stimulators

### Purpose and Method of Stimulation

Sacral anterior root stimulators were originally designed and developed, using baboons as experimental animals, as devices that would activate either the bladder or the striated sphincter and pelvic floor, according to the stimulus parameters used (Brindley 1973, 1977). It was originally expected that many patients would use both the bladder-emptying mode to lower the residual volume and the sphincter-activating mode to assist continence. In practice, the bladder-emptying mode has been of great value, but very few patients use the sphincter-activating mode. Appropriate stimulation through the implant will also activate the smooth muscle of the colon and rectum, and cause penile erection. Both of these actions are of great value to some patients.

The stimulator consists of a pair of electrode mounts, called "books", implanted in the subarachnoid space at the level of the 5th lumbar vertebra and last intervertebral disc, joined by three cables to an array of three passive radio receivers implanted over the left lower ribs. The S-2 and S-3 anterior roots are placed between the pages of the upper book and the S-4 roots between the covers of the lower book, which has only a single slot between its covers. Stimulation is achieved by holding an array of three radio transmitters over the receivers for micturition or defecation. For sphincter activation or to achieve prolonged erection for coitus, patients glue or tape the transmitter block over the implanted receivers. Typically, weak continuous S-3 stimulation activates the pelvic floor and rhabdosphincter without affecting the bladder, and strong intermittent S-3 stimulation gives a controllable large rise in bladder pressure with alternating contraction and relaxation of the striated closing muscles. Strong continuous S-4 or S-3 stimulation raises the rectal pressure, and strong continuous S-2 stimulation at a lower frequency gives erection. The control box that drives the radio transmitters has a three-position switch on its outer casing. By adjusting internal controls, the three positions of the switch can be set to give any three of the above four modes, or variants that may be needed because of unusual anatomical or pathological states.

The operation of implanting the electrodes provides the opportunity of cutting posterior roots to deafferent the bladder and thus abolish reflex detrusor contractions and the reflex component of any lack of compliance. This is very advantageous in avoiding reflex incontinence and (probably) back-pressure damage to the kidneys. It can also abolish pre-existing detrusor/sphincter dyssynergia. These advantages have to be weighed against the disadvantages of impairing reflex erection and, in patients with incomplete lesions, of causing sensory loss.

As far as we have been able to detect, deafferentation by section of posterior roots or accidental damage to them is absolutely permanent. The cut fibres may regenerate, but presumably fail to make connections in the spinal cord. In contrast, accidentally damaged anterior roots in our experience always recover some function, and often the recovery seems complete.

## Achievements

Up to the end of March 1987, 140 intradural sacral anterior root stimulators had been implanted in 21 centres. One patient has been using his implant for 9 years, and four others for 8 years. One patient who used her implant successfully for 3 years is dead from suicide, and one from a coronary occlusion after only 6 months' use of the implant. Four implants are not in use and are unlikely ever to be used. Eight are not yet in use but are likely to be in the future. A total of 109 are known to be now in use for micturition. Of these, at least 22 are also used to assist defecation. At least 11 are in regular use for coitus, and only one for continuous sphincter activation. Nearly all female users and the majority of male users have become fully continent and do not need urine-collecting devices. Those men who are not fully continent are all more nearly continent than they were. Postoperative residual volumes are less than half the preoperative volumes in almost all patients, and less than one-tenth in the majority. Symptomatic urinary infections have become less frequent in almost all patients. In implant-driven voiding, the voiding pressure can be regulated by adjusting the stimulus parameters. By this, and by the reduction in reflex detrusor activity from posterior root section, ureteric reflux has been abolished in five of eight patients who showed it at preoperative examination.

## Disadvantages and Complications

The operation to implant a sacral anterior root stimulator is a long one, usually taking between 4 and 5 hours.

Leakage of cerebrospinal fluid has occurred in 18 patients. In all but one of these it tracked along the cables, forming a fluctuant swelling around the receiver block. In 10 of these patients surgical repair of the leak was needed, and in 8 the leakage stopped spontaneously.

Ten patients have needed to have parts of their implants replaced because of engineering failures; however, the implants have now been through several stages of improvement, and such failures are likely to be much less common in future.

Some damage has been done to roots at operation in about 30 patients, and in 8 of these it was severe enough to make the implant useless for several months. From such damage, anterior root action on the bladder and pelvic floor always recovers well.

Section of posterior roots or accidental damage to them entails irreversible loss of some or all genital sensation if this was present preoperatively, and it impairs or abolishes reflex erection. Reflex ejaculation may also be lost. These disadvantages have to be weighed against the very great benefits of posterior root section in increasing bladder capacity and compliance.

One tetraplegic patient found that attempts to use the implant caused severe autonomic dysreflexia, and three patients with incomplete lesions found that such attempts were painful.

An increase in spasticity and sweating is common during the first few weeks after the operation. It rarely continues for more than 6 months, and in our experience never for more than a year.

In four patients the space around the receiver block has become infected, and it has been necessary to remove the receiver block and parts of the cables. In two of these patients the removed block has now been replaced, and in the other two it probably will be. In no patient among the first 140 has infection been detected around the intradural part of the implant.

## Selection of Patients

It is necessary that the patient has enough surviving efferent supply to the detrusor to allow good implant-driven micturition. Systolic increases in detrusor pressure during cystometry by 50 $cmH_2O$ in a man or 35 $cmH_2O$ in a woman, or similar increases provoked by transrectal stimulation, suffice as evidence.

Prospective patients must want an implant, having been told what they may gain and lose by it, and the balance of likely gain against possible loss must also be such as would satisfy a reasonable person other than the patient. Continence is a very great benefit to a woman, whether paraplegic or tetraplegic, and women with complete lesions have nothing to lose on the sexual side except perhaps reflex vaginal lubrication. On the other hand, a man with sterile urine and years of trouble-free experience of using condom drainage who has excellent reflex erections may think continence an insufficient benefit to justify even a small risk of losing the erections. Reflex erections that consistently and easily suffice for coitus are not common in men with complete cord transections. A man whose erections, though reaching full stiffness, cannot be sustained for long, is likely to gain sexually by having a sacral anterior root stimulator, because implant-driven erection adequate for intromission and sustainable for as long as stimulation continues is achieved in more than 50% of cases.

Of 19 patients with preserved pain sensitivity in the S-2 to S-4 dermatomes, 3 have found the use of a sacral anterior root stimulator too painful to be tolerated. This is a disturbingly high failure rate, even though the other 16 benefited greatly. Extensive use of sacral anterior root stimulators in patients with preserved sacral-segment pain sensitivity will not be justified until methods of avoiding such failures have been developed.

## Other Nerve-stimulating Implants for Bladder Control

Direct bladder stimulators (Merrill 1979) and stimulators of the conus medullaris of the spinal cord (Nashold et al. 1982) are probably now entirely obsolete. Stimulators of spinal segmental nerves, trapped extradurally, were used by Habib (1967) in three patients, with some short-term success. Their use was not reported again until, in 1982, Dr E. Tanagho of San Francisco described at a meeting three patients with extradural sacral nerve stimulators. The electrodes were placed on the segment between the exit from the dural theca and the posterior root ganglion. The connective tissue sheath was opened, and the anterior and posterior roots separated within it. The stimulating electrode was placed to surround the anterior root only. The electrode was unipolar, so it must presumably have stimulated posterior as well as anterior root fibres. Since 1982, more such devices have been implanted in San Francisco and described at meetings, but it seems that the only publication is that of Schmidt (1986). From this paper it appears that in later San Francisco implantations the posterior root has been cut within the short segment of sacral nerve between dural exit and ganglion, and the electrode placed around the connective tissue sheath and surviving anterior root.

Drs D. Sauerwein and P. Ingunza of Bad Wildungen (Federal Republic of Germany) have confirmed that extradural access and extradural posterior root section is practicable and can give good results. They use it only in a minority of patients, where there are clear contraindications to the intradural approach.

Much simplified sacral root stimulators have been implanted into three paraplegic patients (G. S. Brindley, D. G. Thomas, D. Packham and B. Gardner, unpublished work). The stimulating electrode is inserted through the sacral hiatus and lies extradurally at the level of the first sacral foramina. The single-stage operation takes less than an hour. The implant is suitable only for patients with no pelvic pain sensitivity, no autonomic dysreflexia, and areflexic bladders.

Conditional pudendal nerve stimulators (Brindley and Donaldson 1986) have been implanted into three patients, all with multiple sclerosis. These implants are controlled by an applanation tonometer capsule sewn on to the wall of the bladder and stimulate the pudendal nerves only when the bladder contracts. They seem likely to prove useful in treating incontinence caused by detrusor instability, but are suitable only for patients who void easily with low residual volume.

## References

Brindley GS (1973) Emptying the bladder by stimulating sacral ventral roots. J Physiol (Lond) 237: 15P–16P

Brindley GS (1977) An implant to empty the bladder or close the urethra. J Neurol Neurosurg Psychiatry 40: 358–369

Brindley GS (1981) Electroejaculation: its technique, neurological implications and uses. J Neurol Neurosurg Psychiatry 44: 9–18

Brindley GS, Donaldson PEK (1986) Electolytic current-control elements for surgically implanted electrical devices. Med Biol Eng Comput 24: 439–441

Brindley GS, Polkey CE, Rushton DN, Cardozo LD (1986) Sacral anterior root stimulators for bladder control in paraplegia: the first 50 cases. J Neurol Neurosurg Psychiatry 49: 1104–1114

Habib HN (1967) Experience and recent contributions in sacral nerve stimulation for voiding in both human and animal. Br J Urol 39: 73–83

Herlant M, Colombel P (1986) Electrostimulation intra-durale des racines sacrées antérieurs chez les paraplégiques. Historique, resultats, indications. Annales de Réadaptation et de Médecine Physique 29: 405–411

Merrill DC (1979) Electrical vesical stimulation. Acta Urol Belg 47: 110

Nashold BS, Friedman H, Grimes J (1982) Electrical stimulation of the conus medullaris to control the bladder in paraplegia: a ten-year review. Appl Neurophysiol 45: 40–43

Schmidt RA (1986) Advances in genitourinary neurostimulation. Neurosurgery 18: 1041–1044

Section VI

# Continence after Cystectomy

# Introduction

*P. Abrams*

Radical surgery for bladder cancer has been based on the skin surface diversion (ileal or colonic conduit) or, in countries where a stoma is unacceptable, a ureteric or rectal bladder diversion.

As experience of reconstructive surgery in neuropathic bladder/urethral dysfunction has increased, urologists have tried to develop methods of restoring continence after cystectomy. In this section three techniques are described which achieve this aim. The Kock pouch and the Mainz pouch incorporate a method for producing a leak-proof valve, one end of which can be brought to the skin as a continent stoma. The Mainz pouch can also be used as a bladder augmentation/substitution technique with anastomosis to the urethra. Mundy describes using a caecoplasty to replace the bladder after cystectomy.

The use of these techniques to preserve urethral micturition after cystectomy for cancer will cause some controversy. Preservation of the sphincteric (sub-prostatic) urethra may cause problems with tumour recurrence if field change leads to new urethral tumours. However, this complication may be predicted by taking preoperative urethral biopsies and excluding those patients who show severe atypia or carcinoma in situ. Long and close follow-up will define the precise place of these techniques. The importance of these innovative procedures is that the patient now has greater choice over the type of operation performed, particularly for bladder cancer.

*Chapter 22*

# Cystectomy and Substitution Cystoplasty with Particular Reference to Bladder Cancer

*A. R. Mundy*

## Introduction

There are certain conditions such as the small contracted bladder, caused by diseases such as interstitial cystitis, post-radiotherapy cystitis and tuberculosis, and the more severe examples of detrusor dysfunction in which the bladder dysfunction is so severe that a urinary diversion may be considered. Equally, in bladder cancer the need for cystectomy to control the disease makes a diversion seem a necessity. In fact it is almost always possible, in all of these situations, to remove the diseased bladder (where indicated) and restore continent urethral voiding using current surgical techniques.

The use of cystoplasty techniques and of the artificial urinary sphincter in patients with neuropathic vesicourethral dysfunction have been described in Chapters 18 and 20. However, as a general rule it may be said that for non-malignant bladder conditions an augmentation cystoplasty (so-called clam cystoplasty) may be used when the bladder capacity is not too small, the bladder wall not too thick and there is no vesicoureteric junction obstruction; if any or all three of these conditions is not satisfied then a subtotal cystectomy, leaving the bladder neck and trigone intact, and substitution cystoplasty is indicated. Sphincter dysfunction in these patients may require either clean intermittent self-catheterisation or sphincter ablation and substitution with an artificial sphincter, although some patients may be able to achieve a normal voiding pattern with a simple sphincter rebalancing procedure or sometimes with no treatment at all.

The situation is somewhat different for bladder cancer, for three reasons: (1) because the average age of the patients is substantially higher, (2) because of the need to perform an adequate "cancer-type" cystectomy, and (3) because a total cystectomy (or cystoprostatectomy in the male patient) will necessarily remove the bladder neck sphincter mechanism and may well compromise the function of the distal sphincter mechanism.

The question is therefore, is it possible to perform an adequate "cancer operation" and yet restore continent urethral voiding? The answer is yes, although sometimes a second operation a few months later, usually to implant an artificial sphincter, may be necessary to achieve total continence. In any case, for many men urethral incontinence requiring a penile sheath and a leg bag may be more acceptable than an ileal conduit with an abdominal stoma and an ileostomy bag. In practical terms the choice is between a standard procedure with an ileal conduit, which can be expected to be a single operation, and a reconstructive procedure, which may require a second operation 3 months or so after the main event to restore complete continence. The main criteria for adopting the reconstructive approach are the patient's general condition and motivation, assuming that disease considerations allow urethral preservation.

In terms of magnitude of the procedure there is little to choose between the operations. In both there is a cystectomy (although perhaps with differences in technique in the reconstructive approach) and in both there is the isolation of a gut segment, to one end of which the ureters are joined. The only real differences are the choice of the gut segment and the site of anastomosis of the distal end of that segment.

## Technique

The key to the technique of the cystectomy is the preservation of as much as possible of the distal sphincter mechanism along with its blood supply and innervation. If these aims are achieved, then, in the male, the nerves responsible for potency will be preserved.

The patient is admitted to hospital 4 days preoperatively for assessment of his or her cardiorespiratory status and for bowel preparation, which is both mechanical and microbial. Four units of cross-matched blood are prepared, a parenteral antibiotic (or antibiotics) is given with the premedication and subcutaneous heparin is used to reduce the risk of postoperative thromboembolic problems.

The technique described here is the one the present author uses routinely (as far as possible) in male patients and owes much to the pioneering work of Walsh in the development of his technique of radical prostatectomy. It takes the present author about 4 h to perform. Postoperatively a gastrostomy is used in preference to a nasogastric tube, and parenteral nutrition is employed routinely.

The patient is placed in the supine position with a Foley catheter in the bladder to keep the bladder empty and to facilitate the identification of the sub-prostatic urethra. A midline incision is made from the pubis to the point halfway between the umbilicus and the xiphisternum to allow adequate access at the upper end to the middle colic artery, which will subsequently be an important landmark when mobilising the gut segment for the cystoplasty.

The incision is deepened to the peritoneum, where the urachus and the obliterated umbilical arteries are identified just below the umbilicus. These are clamped and ligated. The peritoneum is then incised just lateral to the obliterated umbilical arteries on each side down to the points where they are crossed by the vasa. These are then clamped and divided. The peritoneal incision is then continued around the posterior margin of the bladder, keeping lateral and then posterolateral to the line of the vas on each side. The posterior part of this peritoneal incision is then opened up and deepened, using the ligated proximal vas segments as guides, so that the posterior aspect of the bladder and subsequently the ampullae and the seminal vesicles and then the upper margin of the prostate can all be identified in turn between the two lateral pedicles.

Having identified the lateral pedicles on their posteromedial aspects, their anterolateral aspects are defined by opening up the retropubic space fully on the anterior and lateral aspects of the bladder. The subperitoneal fascial wing on either side which connects the bladder to the pelvic brim is then divided, securing where necessary the small vascular branches that run within it.

In this way the lateral pedicles are clearly defined down to the pelvic floor anterolaterally and down to the upper posterior margin of the prostate posteromedially. The upper parts of each pedicle, including the superior vesical vessels and the ureter, are then divided. The pelvic nerves to the distal sphincter and corpora run in relation to the rectum and the prostate and therefore are not at risk of damage until the inferior vesical vessels are divided.

It is usual at this stage in a standard cystectomy to continue with the division of the lateral pedicles by ligating and dividing the inferior vesical vessels; however, to reduce damage to the pelvic nerves to a minimum this is best left until later.

The next step is to expose the sub-prostatic urethra and then to mobilise the prostate. Having already opened the retropubic space fully, the fascial covering of the pelvic floor should be clearly visible on either side of the lateral visible margin of the prostate. The fatty tissue in the midline between the pubic symphysis and the anterior surface of the prostate should be divided, with careful diathermy control of the veins that run within it, clearing as much as possible from the pubic symphysis so that it is not left hanging down to obscure the view of the urethra subsequently. Having done that, the puboprostatic ligaments should be clearly visible with the superficial branch of the dorsal vein complex running between them on to the anterior surface of the prostate. Just lateral to the puboprostatic ligament on each side there is usually a hiatus in the fascial covering of the pelvic floor, close to the side wall of the pelvis. This serves as a useful starting point from which to incise the fascia, keeping as close to the side wall of the pelvis as possible, from the lateral margin of the pubourethral ligament anteriorly to the base of the anterolateral aspect of the lateral pedicle posteriorly. If this incision is kept as close as possible to the side wall of the pelvis, the veins on the lateral aspect of the prostate which lie immediately deep to this fascial layer will not be damaged and there should therefore be little or no bleeding.

The pubourethral ligaments should be divided next, once again keeping as close to the side wall of the pelvis as possible to reduce the risk of damage to the prostatic venous complex, which in this situation means incising the ligaments at their site of origin from the pubis on each side.

The next step is to divide the dorsal vein complex which lies on the anterior surface of the sub-prostatic urethra and the apex of the prostate and which fans out into the rich complex of veins on the anterior and lateral aspects of the prostate. Having divided the pelvic floor fascia and the pubourethral ligaments, it should be possible to identify the dorsal vein complex on the surface of the sub-prostatic urethra before it fans out on to the lateral aspects of the prostate (Fig. 22.1). The urethral catheter often facilitates this stage by making the sub-prostatic urethra palpable; maximal posterior displacement of the prostate is also very helpful. The dorsal vein complex is then ligated at this point and divided above the ligature. It is rarely, if ever, possible (never in the present author's experience) to double clamp the complex, then divide it between the clamps and then to ligate each side. It is often not even possible to place two ligatures and divide between without the distal (and important) ligature subsequently falling off, which leads to heavy bleeding and often a great deal of difficulty in securing haemostasis. In fact, if the distal end of the dorsal vein complex is completely and securely ligated in the correct place there is usually very little back bleeding from the proximal cut end, and what bleeding occurs is usually easily controlled.

Once the dorsal vein complex has been divided, the anterior aspect of the apex of prostate and the sub-prostatic urethra is exposed with a band of tissue on either side. These bands of tissue contain the neurovascular bundles which supply the distal sphincter mechanism and the corpora. If these bands of tissue are clearly seen, a sling can be passed gently around the sub-prostatic urethra before the urethra is divided; if not, the anterior aspect of the urethra is incised transversely at the apex of the prostate, exposing the Foley catheter (Fig. 22.2). Approximately 2–5 cm of the catheter is then hooked out of the urethra and then clamped and cut, thereby keeping the balloon inflated, so that the proximal part of the catheter can be used to provide upward traction of the apex of the prostate. The rest of the urethral wall is then divided under direct vision, preserving the neurovascular bundle on either side.

Having divided the urethra at the apex of the prostate and defined the neurovascular bundle on each side, the next step is to separate the more proximal part of each bundle from the lateral aspect of the prostate to which it is bound by an anterior layer of fascia and by capsular branches to the prostate from the neurovascular bundle itself. The fascial layer is anatomically the same layer of the pelvic floor fascia which was earlier divided close to the side wall of the pelvis, which is continuous over the surface of the prostate with the fascia on the other side.

The neurovascular bundles are separated from the lateral aspect of the prostate by insinuating a pair of right-angled forceps between the bundle and the prostate, first on one side, then on the other, and then by

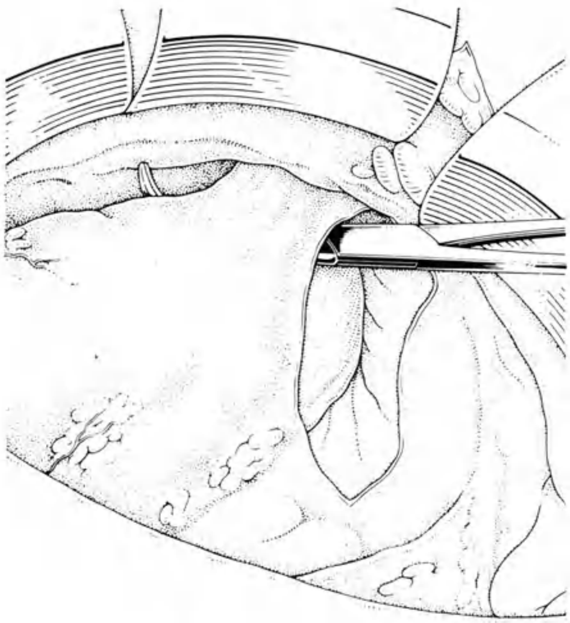


**Fig. 22.1.** The endopelvic fascia has been divided on the right-hand side and digital palpation has revealed the plane of cleavage between the apex of the prostate/membranous urethra and the dorsal vein complex. A long curved forceps has been passed through this plane prior to ligating the dorsal vein complex.

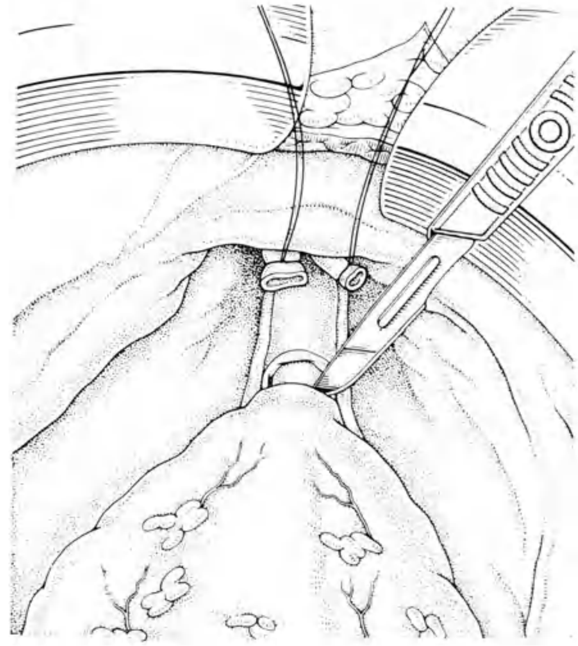


**Fig. 22.2.** The dorsal vein complex has been ligated and divided, and the sub-prostatic urethra is being incised with a scalpel to reveal the Foley urethral catheter within it. The neurovascular bundles are visible on either side of the urethra.

dividing the fascial and fine vascular attachments between the two as far anteriorly as possible, starting at the apex of the prostate and working progressively along the lateral margin of the prostate on each side to the bladder neck (Fig. 22.3).

This stage is made easier by upward traction on the Foley catheter, which also facilitates the division of the few posterior attachments of the prostate which represent fibromuscular bundles of the rectourethralis.

Now that the bulk of the prostate has been mobilised from below it should now be possible to enter from below the plane lying behind the ampullae and the seminal vesicles, between the lateral pedicles, which was previously opened up from above, earlier in the procedure. It should therefore be possible to define clearly the remaining inferior part of the lateral pedicle which has yet to be divided on each side to complete the cystoprostatectomy. For this reason it should be relatively simple to divide these remaining attachments as close to the bladder and prostate as possible, thereby keeping any damage to the neurovascular bundles to a minimum.

Even if the constraints of achieving a satisfactory "cancer operation" mean that the neurovascular bundles have to be sacrificed, this technique of cystoprostatectomy still has the advantage of reducing to a minimum the risks of haemorrhage from the dorsal vein complex, of traction injury to the sphincter-active urethra and of rectal damage.

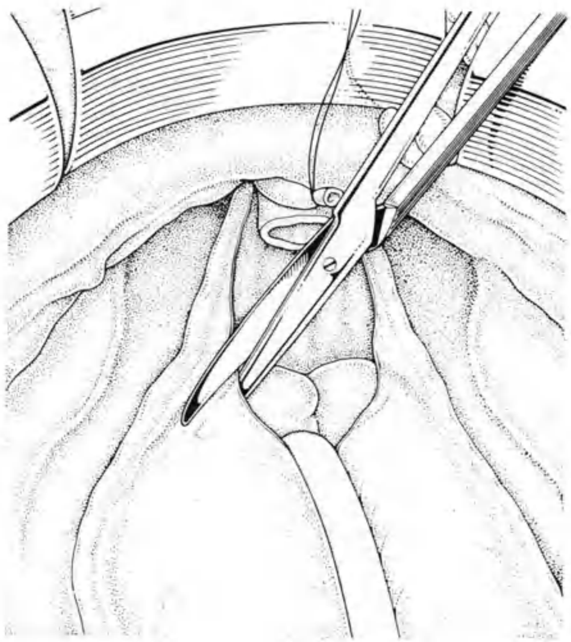


**Fig. 22.3.** The urethra has been divided and the Foley catheter pulled through, and the catheter is now being used for upwards traction. The fascia over the anterior and lateral aspects of the prostate is being carefully divided to allow separation of the prostate from the neurovascular bundles, which are visible on either side of the posterolateral aspect of the prostate.

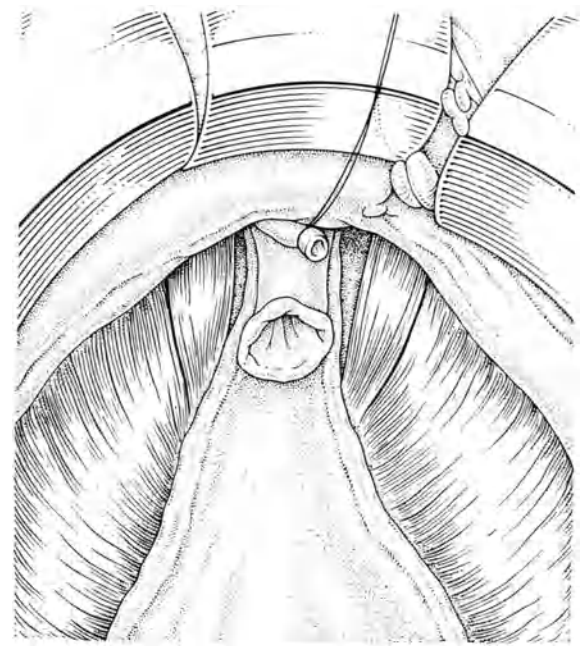


**Fig. 22.4.** After the cystoprostatectomy has been completed, the dorsal vein complex, the membranous urethra and the neurovascular bundles are visible within the pubourethral and puborectal slings.

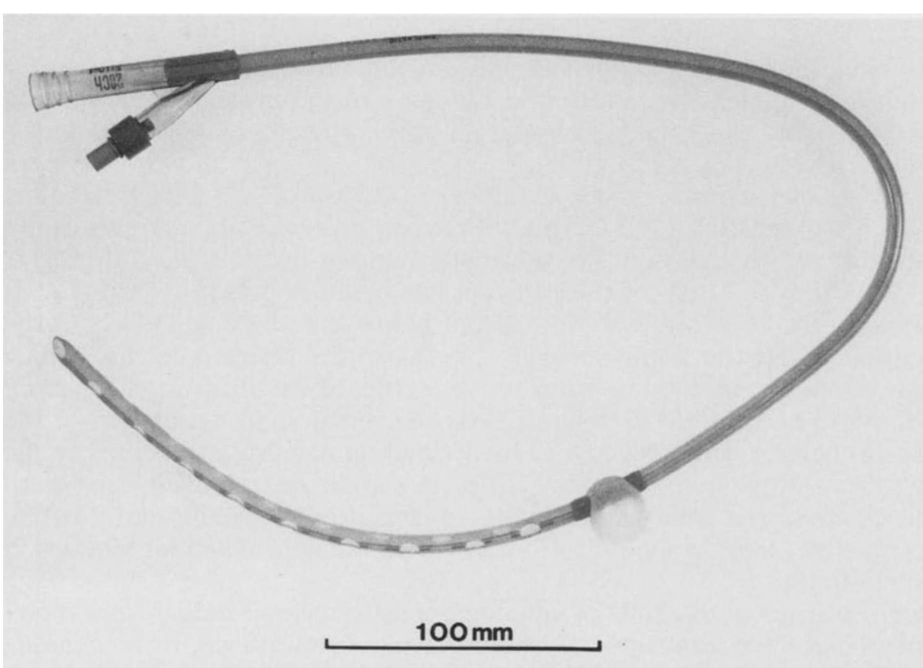



**Fig. 22.5.** The author's cystoplasty catheter with multiple eye holes above the small retaining balloon to allow free drainage of mucus.

When the bladder and prostate have been removed the pelvic floor musculature should be clearly visible (and undamaged) and there should be 0.5–1 cm of sphincter-active urethra (also undamaged) with the neurovascular bundle on each side of it protruding through the pubourethral sling (Fig. 22.4).

With the cystoprostatectomy complete, the substitution cystoplasty is performed. The terminal 5 cm or so of the ileum, the caecum, ascending colon and the right half of the transverse colon as far as the middle colic artery are fully mobilised on their vascular pedicle, which consists of the ileocolic, right colic and marginal vessels. The gut segment is then isolated and intestinal continuity is restored, anterior to the isolated segment, by a two-layer ileotransverse anastomosis with closure of the mesenteric defect.

The ureters are then juxtaposed on one side of the great vessels, usually the right, above the common iliac vessels, and a side-to-side anastomosis is performed with 3–0 Vicryl. A 6 FG infant feeding tube is passed up each ureter to serve as a ureteric stent. The cystoplasty segment is then rotated through 180° so that the ileal tail can be anastomosed to the common ureteric orifice with one layer of 3–0 Vicryl. The infant feeding tubes (ureteric stents) are brought out through the stump of the appendix alongside a special "cystoplasty catheter" (Fig. 22.5).

All that remains is to anastomose the colonic end of the cystoplasty segment to the urethra (Fig. 22.6). To reduce the difference in size between the two ends, the last 5–7 cm of the colon is tailored on its antimesenteric border (which should now be anterior) to an appropriate calibre for an end-to-end anastomosis. Six 3–0 Vicryl sutures are then

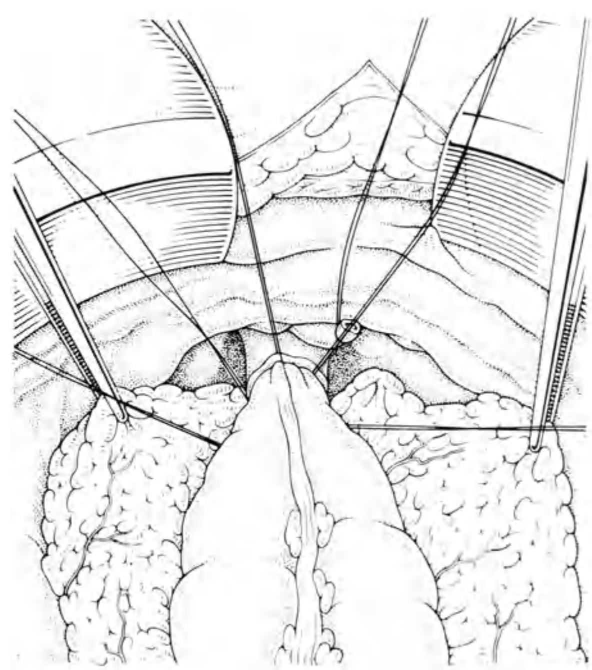


**Fig. 22.6.** The omentum has been mobilised and deployed behind the anastomosis between the tailored colon and the membranous urethra. The colon is anastomosed to the urethra with six or eight interrupted Vicryl sutures, great care being taken to ensure mucosal apposition. The anastomosis is then wrapped with omentum.

placed equidistant around the circumference of each end before pushing the colonic end down on to the urethra, sliding it along the sutures, and then tying the knots.

To complete the procedure the defect between the cystoplasty segment and the side wall of the pelvis is closed and the two anastomoses, particularly the colourethral, are wrapped with omentum. A tube drain is left in the pelvis and another alongside the ureteroileal anastomosis.

In female patients the procedure is similar, except that the plane of posterior mobilisation is between the bladder and the anterior vaginal wall, and the urethra is divided just below the bladder neck.

## Postoperative Management

The ureteric stents are removed on the eighth postoperative day, or thereabouts, and the cystoplasty catheter is clamped for a trial of voiding 2 or 3 days later. If this trial has a reasonably satisfactory result over a 24-h period, a cystogram is performed to check that there is adequate emptying and no leaks (see Fig. 22.5). If there are any problems it is the present author's usual practice to send the patient home with the catheter on free drainage for 2–3 weeks to recover further from the operation and then to readmit him or her for a further 24-h trial of catheter clamping. If there is still a problem it is usually with continence. In that case, female patients are left with their catheters until 3 months have elapsed, at which time an artificial sphincter is implanted. Male patients have their catheters removed and are provided with a sheath and leg bag during this interim period.

In those patients who look as though they will need an artificial sphincter it is always worth reassessing "bladder" function before making a final decision to implant, as some will gain adequate, if not complete, control during this 3-month period. Similarly, in the occasional patient with incomplete emptying it is worth waiting a similar period before considering sphincter rebalancing to allow for spontaneous improvement. Obviously all such patients require careful and lifelong follow-up both because of their underlying disease and for careful monitoring of cystoplasty function.

*Chapter 23*

# The Continent Ileal Reservoir (Kock Pouch) in Urinary Diversion

*L. J. Norlén, B. M. Philipson and N. G. Kock*

For more than a century surgeons have tried to devise an ideal method for urinary diversion. The ideal urinary diversion should substitute for the functions of the lower urinary tract without jeopardising the integrity of the upper urinary tract. Thus, the following requirements should be fulfilled:

1. Collection and storage of urine should occur under low pressure.
2. The substitute should provide continence and be easy to empty at convenient intervals.
3. Reflux to the upper urinary tract must be avoided.
4. Storage of urine should not imply metabolic disturbances.

Previously Kock's team (Ekman et al. 1964) described a new type of ileal bladder substitute which accomplished daytime and night-time continence. Long-term results were favourable (Faxén et al. 1973); the pouch had adequate capacity and only slow increase in basal pressure was noted during filling. Later this pouch was utilised when Kock (1969) introduced the continent ileal reservoir for diversion of intestinal contents. Urinary diversion via the continent ileal reservoir is a logical development of the continent ileostomy.

## Experimental Studies

Experimental studies in dogs proved that the reservoir was also feasible in urinary diversion (Kock et al. 1978a). Volume/pressure recordings in the reservoirs indicated an increased volume and a decreased pressure with time (Norlén and Trasti 1978). Also, shifts of water and solutes occurred across the mucosa (Jagenburg et al. 1978), and morphological changes were observed in the mucosa of the pouch (Hansson et al. 1978).

## Clinical Material

Owing to favourable results with the continent ileostomy and encouraging experimental results with the continent urostomy the method was adopted in the clinic in 1975 (Kock et al. 1978b). In the beginning only patients seriously disabled after urinary diversion by other methods were elected for conversion; later the method was the primary procedure of diversion. During the period 1975–1985 the ileal pouch was employed in 40 patients, 28 women and 12 men, with a mean age of 42 years (range 20–68 years) at operation. The mean follow-up time was 3.5 years (range 3 months to 11 years). Indications for urinary diversion are given in Table 23.1. The diversion was a primary procedure in 15 patients and a secondary conversion in 25 patients (Table 23.2) who experienced problems with their previous types of diversion or substitution or came to us merely wishing for a better kind of diversion. Construction of the pouch was combined with cystectomy in four patients, with excision of malfunctioning caecocystoplasty in two and with restoration of normal colorectal function in two.

**Table 23.1.** Indications for urinary diversion

| Indication | No. of patients |
|---|---|
| Neurogenic bladder (multiple sclerosis 4) | 19 |
| Bladder carcinoma | 8 |
| Congenital anomaly | 6 |
| Chronic prostatitis and incontinence | 2 |
| Interstitial cystitis | 2 |
| Radiation cystitis (gynaecological Ca) | 2 |
| Vesicovaginal fistula (rectal Ca) | 1 |

Ca, carcinoma.

**Table 23.2.** Previous diversion or substitution

| Previous procedure | No. of patients |
|---|---|
| Ileal conduit | 14 |
| Ureterosigmoidostomy | 4 |
| Cutaneous ureterostomy | 2 |
| Isolated rectal bladder | 2 |
| Permanent pyelostomy | 1 |
| Caecocystoplasty | 2 |

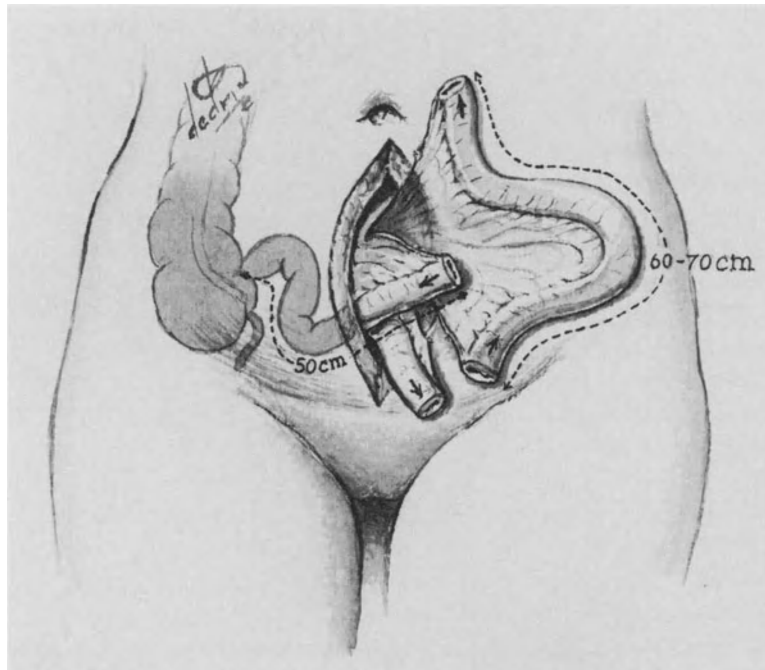



**Fig. 23.1.** The ileal segment is isolated.

## Surgical Procedure

Through a low midline incision an ileal segment of approximately 70 cm is isolated 50 cm proximal to the iliocaecal valve (Fig. 23.1). Next, 15 cm of the proximal and distal parts of the segment are preserved for inlet and outlet segments and the future nipple valves (Fig. 23.2). Peritoneum and fat are stripped off the mesentery supplying parts intended for intussusceptions. In order to further minimise the bulk of mesentery supplying the intussusceptions a small triangular window is opened in the mesentery. The mid portion of the isolated ileal segment is then opened along its antimesenteric border by electrocautery (Fig. 23.2). The opened section is folded into a U, the legs of which are joined together with a continuous 4–0 polyglycolic acid (PGA) suture (Fig. 23.3). The incision is made 2–3 cm longer in the proximal leg in order to separate the outlet from the inlet when the reservoir is closed.

The valves are constructed by grasping bowel wall through the open lumen to the unsplit segments, which are intussuscepted partly into the lumen of the future reservoir (Fig. 23.4). The intussuscepted valves (5 cm long) are maintained by application of four rows of staples (TA 55 stapler instrument and 4.8 mm staples), one on each side of the mesentery and the remainder in the other two quadrants. The important staples for maintaining the intussusception are those at the base of the nipple valve, while those at the tip of the valve are unimportant and may cause a nidus for stone formation and may further cause tip necrosis. Thus, the 10 most proximal staples are removed from the loading unit before application.

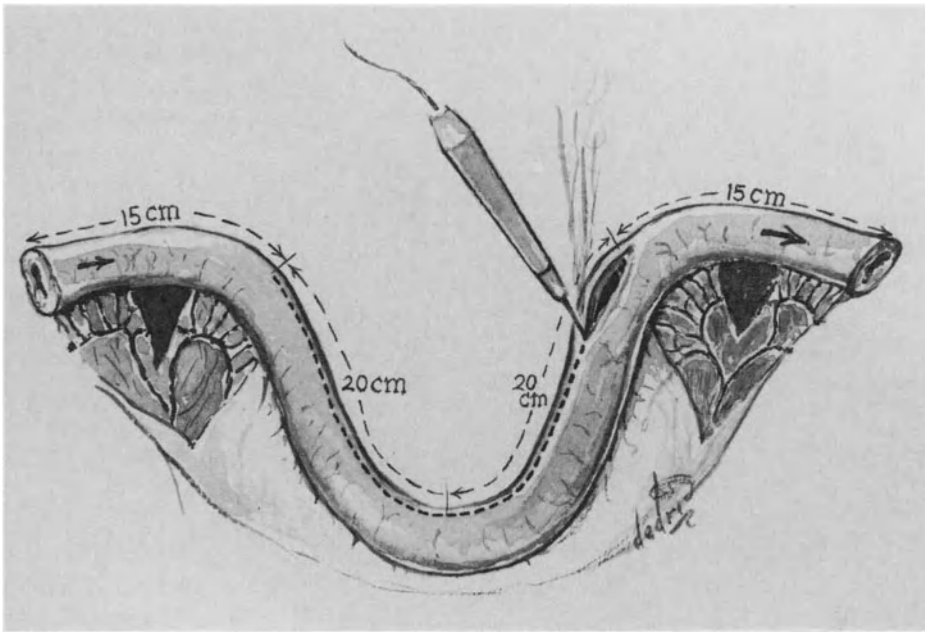



**Fig. 23.2.** Peritoneum and fat are stripped from the mesentery supplying the future intussusceptions, and small triangular windows are opened in the mesentery. The mid portion of the segment is split open at its antimesenteric border.

The valves are further secured from desusception by suturing the wall of the reservoir to the outlet and inlet respectively over the base of the valve by 4–0 PGA sutures. Recently, we also started to anchor both valves to the wall of the pouch by means of a row of staples. Prior to stapling, the mucosa of the surface of the valves and also of the wall of the pouch is electrocauterised along the site of the future anchoring row of staples.

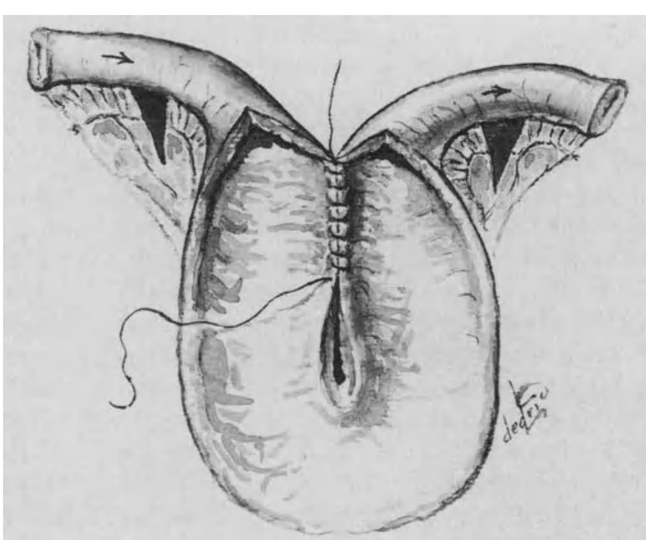


**Fig. 23.3.** The intestinal plate is formed by uniting the two legs of the U with a running stitch.

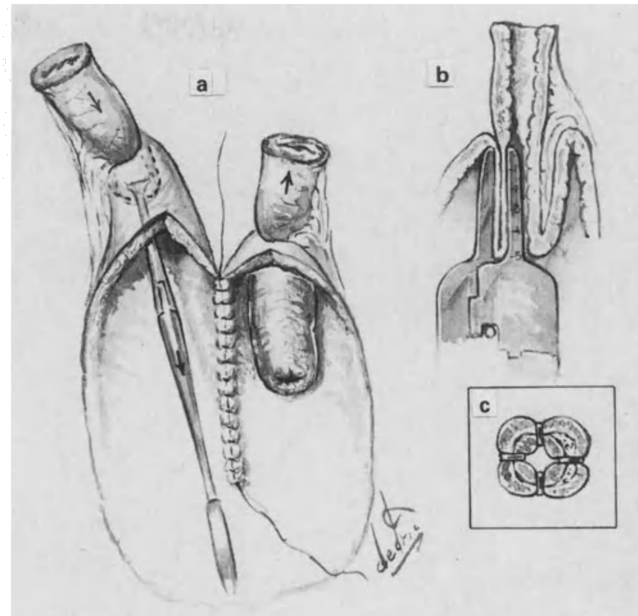



**Fig. 23.4a,b.** The bowel wall is grasped through the opened lumen and the unsplit ileal segments are intussuscepted partly into the lumen of the future reservoir (**a**). The intussuscepted position is maintained by application of staples (**b**) and (**c**).

Thus, the bulk of tissue to be stapled is reduced and the denudation of muscularis promotes firmer healing.

The intestinal plate is folded up and the pouch closed with a single layer of running inverting 4–0 PGA sutures (Fig. 23.5a). The corners of the pouch are pushed between the mesenteric leaves and thus the posterior aspect of the reservoir is brought to an anterior position (Fig. 23.5b). The manoeuvre permits the later positioning of the reservoir in the pelvic cavity. The competence of the valves and suture lines are tested by injection of air into the reservoir. The ureters are anastomosed to the proximal end of the inlet segment by an open technique (Fig. 23.5c) and stented with infant feeding tubes.

An opening two fingers wide is made in the abdominal wall through the rectus muscle just above the pubic hairline. The reservoir is attached to the abdominal wall on the lateral side by interrupted 3–0 PGA stitches taken through the seromuscular layer of the reservoir and through the rectus muscle (Fig. 23.6a). After the outlet has been pulled through the channel in the abdominal wall the medial aspect of the reservoir is anchored in the same way taking care not to strangulate the vascular supply to the nipple and/or outlet. An almost flat stoma is constructed (Fig. 23.6b). Before the wound is closed, a catheter (Medena urostomy catheter, M 8724[1]) is inserted through the stoma and the outlet for drainage of the reservoir. A drain is positioned along the afferent segment and the reservoir and brought out via a separate incision.

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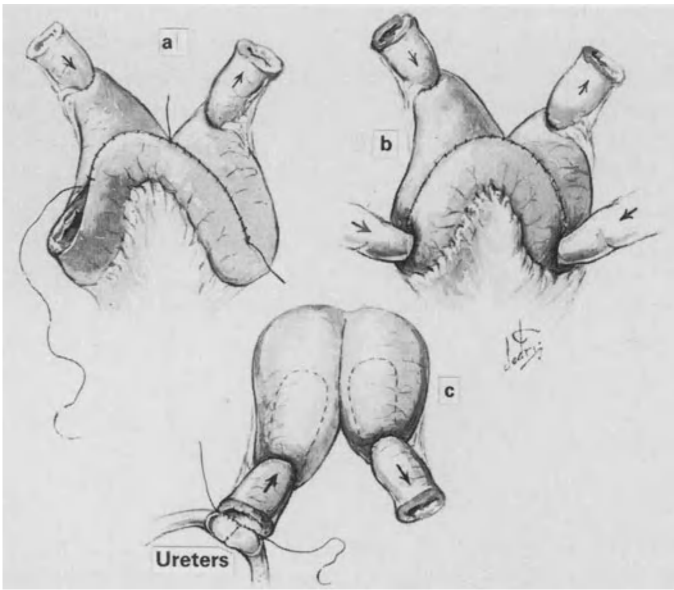



Fig. 23.5a–c. The reservoir is closed (a) and brought into final position by pushing the corners of the reservoir downwards between the mesenteric leaves (b). The ureters are anastomosed to the afferent segment (c).

When an ileal conduit is converted into an ileal reservoir, the preexisting conduit with the previous ureteral implantation(s) is anastomosed and used as an inlet segment.

## Postoperative Management

General principles for postoperative management are followed. Antibiotics are administered intravenously preoperatively and during the

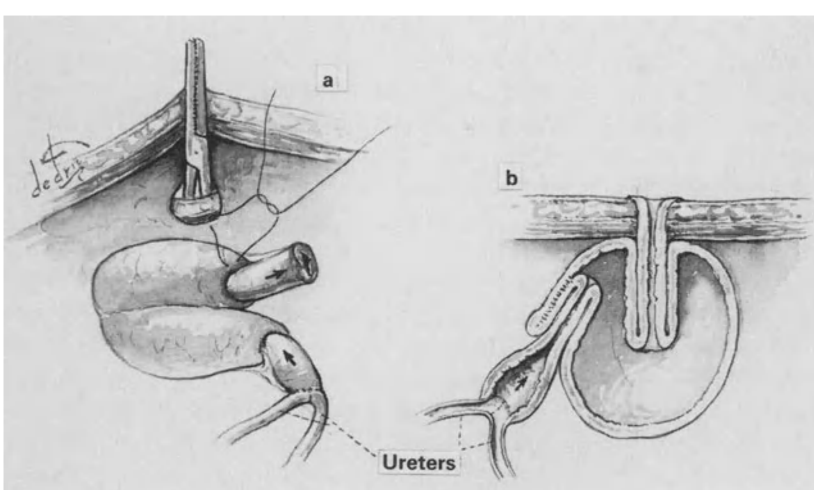



Fig. 23.6a,b. The reservoir is attached to the rectus muscle in the channel through the abdominal wall (a) and an almost flat stoma is constructed (b).

immediate postoperative days. Ureteral stents are removed after 5–10 days and the drain is removed after a few days if no leakage is encountered. The Medena tube is left open for continuous drainage of the pouch during 2 weeks. The catheter is clamped intermittently for 1 h during the third week and for 2 h during the fourth postoperative week; during the night the catheter is left open. Then under supervision the patient is instructed to self-catheterise the pouch. When the patient is discharged he is encouraged to prolong intervals gradually between emptying. A minimum of four emptyings per day is recommended. Patients use specially designed (Medena M 8724) clean but not sterile catheters. Between emptyings the stoma is covered by a small pad.

## Complications and Their Management

A full account of the management of complications after construction of a continent ileal reservoir is given by Kock et al. (1985b).

### Early Complications

There was no operative mortality. Anastomotic leakage and necrosis of the afferent segment, respectively, necessitated laparotomy in two patients. These complications manifest themselves by leakage of urine, and thus creatinine concentration of the fluid accumulated from the drain is checked. The complications were managed by additional sutures of the anastomotic dehiscence and by replacing the necrotic part with a new ileal segment. Other possible early complications which we have so far not encountered are necrosis of the outlet segment and/or necrosis of the nipple valves. These complications do not require immediate surgery but the reservoir catheter should be left until revision is performed at a convenient time. We have encountered no early complications from the ureteroileal anastomosis, although these have been reported by others (Skinner et al. 1984).

### Late Complications

Late complications from the reservoir have not been observed. In some of our earlier cases the most frequent complication was malfunction of the nipple valves with consequent leakage and, in a few cases, reflux. However, during the course of time the technique for construction of nipple valves has been modified (Kock et al. 1978b, 1982; Skinner et al. 1984; Kock et al. 1985a), and one may expect this distressing complication to be largely avoided in the future. To prevent sliding, a collar of Marlex mesh was previously applied around the base of the nipple valve. However, the mesh has been reported to erode the intestinal wall (Skinner et al. 1984; Kock et al. 1985b), and thus the Marlex collar has not been used since 1982. Revisional surgery for sliding of nipple valves in general requires construction of a new valve from a transposed ileal segment. Prolapse of the nipple valve has occasionally occurred, resulting in leakage and intubation difficulties. This complication was managed by stapling the nipple valve to the wall of the reservoir, which is now a routine procedure.

Parastomal hernia may develop if the outlet channel through the abdominal wall becomes too wide and is most often repaired from the exterior simply by approximating the rectus muscle and fascia around the outlet with a few stitches. Stoma strictures may often be corrected under local anaesthesia. Stricture of the ureteral implantations occurred in three patients and required surgical correction.

## Follow-up Studies

During the observation period no progressive deterioration of renal function was observed when studied by serum creatinine, $^{51}$Cr-EDTA clearance or excretion studied by radiorenography and urography. Serum concentration of electrolytes and arterial acid–base status was normal even under loading conditions (Jagenburg et al. 1978). Serum levels of vitamin $B_{12}$ and folic acid remained normal. No signs of outflow obstruction or progressive dilatation of the upper urinary tracts were recorded. Patients use clean but not sterile catheters for emptying. In spite of this precaution, one-third of the patients have negative urine cultures, and the remaining two-thirds have intermittent or constant bacteriuria. We do not treat asymptomatic bacteriuria. One patient with ureteral implantation stricture and one patient with malfunction of a reflux-preventing valve had pyelitis before revisional surgery.

## Structure of Reservoir Mucosa

Constant exposure to urine leads to slow but progressive mucosal changes (Hansson et al. 1978; Philipson et al. 1982; Philipson et al. 1983; Höckenström et al. 1986; Philipson et al. 1986.) In spite of a normal endoscopic appearance, biopsies 1 month after construction already showed reduction of villus height and increase in crypt depth and a number of mucus-storing goblet cells. These changes became more apparent later: after 2 years and onwards endoscopic examination showed that parts of the reservoir mucosa closely resembled urinary bladder mucosa in some patients. However, interspersed in these smooth areas there were islands with preserved intestinal appearance. Microscopic examination of biopsies from these islands showed variability of villus shapes and a slight oedema with mild inflammatory reaction of lamina propria. The enterocytes appeared normal, whereas metabolic activity of the microvillus layer was greatly reduced as reflected by enzyme histochemistry. Biopsies from the smooth avillus areas showed the greatest alterations. Crypts were less disseminated and in some areas totally absent. Enterocytes in luminal position were cuboidal or flattened, and the number of microvilli and other cell organelles of the enterocytes were greatly reduced. Histochemically the enzyme activity of the microvillus layer was almost absent. No signs of fibrosis, foreign body reaction or dysplasia were encountered. The ileum seems to adapt both structurally and functionally to exposure to urine.

## Reservoir Capacity and Function

Immediately after construction the reservoir volume is approximately 100 ml, increasing to approximately 700 ml during the first year, a capacity at which the basal pressure reached approximately 10 cm $H_2O$; superimposed pressure waves (motor activity) occurred towards the later part of the filling period (Berglund et al. 1987). These results were compared with recent observations in the continent ileal and continent caecal reservoirs for intestinal diversion (Berglund et al. 1984, 1986). The ileal reservoirs for intestinal and urinary diversions had larger volumes, lower basal pressure and less motor activity than the caecal reservoir for intestinal diversion. Also, intraluminal pressures were higher and of longer duration in the caecal reservoir for urinary diversion (Hedlund et al. 1984) than in the ileal pouch for urinary diversion (Norlén and Trasti 1978; Berglund et al. 1987). Plain radiography after catheterisation disclosed no significant residual urine.

## Functional Results

Patients empty four to five times daily but not during the night. The time required for emptying is 3–4 min. Since the patients do not experience urge, they are instructed to develop a routine suiting their social and vocational activities and not to exceed 5 h between emptying at daytime. All patients were satisfied with the present type of urinary diversion, especially those seriously disabled by other types of diversion where conversion made rehabilitation possible. Stomal and peristomal skin problems were eliminated and were not encountered in any patients after conversion, not even in two patients with serious skin disease (pemphigoid and bullous epidermeolysis, respectively), where the ileal pouch was the sole solution.

One patient had uneventful pregnancies followed by normal vaginal deliveries of two healthy babies. One patient died in an accident and another from spread of his bladder carcinoma.

## Discussion

The caecal reservoir is stated to have the advantage of being a readymade reservoir in comparison with the ileal pouch (Ashken 1982; Månsson 1984). However, construction of the ileal pouch is not particularly time consuming (Skinner et al. 1984; Kock et al. 1985a). The major problem has been the instability of the nipple valves. The construction of these valves requires time and a careful technique. However, this is also the case in the caecal reservoir. With the present technique for construction of nipple valves, complications should be largely avoided.

The excellent functional results obtained with urinary diversion via a continent ileal reservoir and the absence of harmful side effects in patients now observed for up to 11 years postoperatively are justification for recommending the procedure in patients who need supravesical urinary diversion. However, a meticulous technique and special care in construction of the valves is necessary. It is particularly important that the vascular supply of any part of the whole construction is not compromised in any way. The margin for technical error is small and surgeons contemplating this procedure should be prepared to encounter complications and be aware of how they should be managed (Kock et al. 1985b).

## References

Ashken MH (1982) Urinary diversion. Springer, Berlin Heidelberg New York

Berglund B, Kock NG, Myrvold HE (1984) Volume capacity and pressure characteristics of the continent ileostomy reservoir. Scand J Gastroenterol 19: 683–690

Berglund B, Kock NG, Myrvold E (1986) The volume capacity and pressure characteristics of the continent cecal reservoir. Surg Gynecol Obstet 163: 42–48

Berglund B, Kock NG, Norlén L, Philipson BM (1987) Volume capacity and pressure characteristics of the continent ileal reservoir in urinary diversion. J Urol 137: 29

Ekman H, Kock NG, Jacobsson B, Sundin T (1964) The functional behaviour of different types of intestinal urinary bladder substitutes. Congr Soc Int Urol 2: 213–217

Faxén NA, Kock NG, Sundin T (1973) Long-term functional results after ileocystoplasty. Scand J Urol Nephrol 7: 127–130

Hansson HA, Kock NG, Norlén L et al. (1978) Morphological observation in pedicled ileal grafts used for construction of continent reservoirs for urine. Scand J Urol Nephrol [Suppl] 49: 49–61

Hedlund H, Lindström K, Månsson W (1984) Dynamics of a continent caecal reservoir for urinary diversion. Br J Urol 54: 505

Höckenström T, Kock NG, Norlén L, Åhrén C, Philipson BM (1986) Morphologic changes in ileal mucosa after long-term exposure to urine. A study in patients with continent urostomy (Kock pouch). Scand J Gastroenterol 21: 1224–34

Jagenburg R, Kock NG, Norlén L, Trasti H (1978) Clinical significance of changes in composition of urine during collection and storage in continent ileum reservoir urinary diversion. Scand J Urol Nephrol [Suppl] 49: 43–48

Kock NG (1969) Intra-abdominal "reservoirs" in patients with permanent ileostomy. Preliminary observations on a procedure resulting in fecal "continence" in 5 ileostomy patients. Arch Surg 99: 223–231

Kock NG, Nilson AE, Norlén L, Sundin T, Trasti H (1978a) Changes in renal parenchyma and the upper urinary tracts following urinary diversion via a continent ileum reservoir. Scand J Urol Nephrol [Suppl] 49: 11–22

Kock NG, Nilson AE, Norlén L, Sundin T, Trasti H (1978b) Urinary diversion via a continent ileum reservoir: clinical experience. Scand J Urol Nephrol [Suppl] 49: 23–31
Kock NG, Nilson AE, Nilsson LO, Norlén LJ, Philipson BM (1982) Urinary diversion via a continent ileal reservoir: clinical results in 12 patients. J Urol 128: 469–475
Kock NG, Norlén L, Philipson B, Åkerlund S (1985a) The continent ileal reservoir (Kock pouch) for urinary diversion. World J Urol 3: 146–151
Kock NG, Norlén LJ, Philipson BM (1985b) Management of complications after construction of a continent ileal reservoir for urinary diversion. World J Urol 3: 152–154
Månsson W (1984) The continent caecal reservoir for urine. Scand J Urol Nephrol [Suppl] 85: 1–137
Norlén L, Trasti H (1978) Functional behaviour of the continent ileum reservoir for urinary diversion. Scand J Urol Nephrol [Suppl] 49: 33–42
Philipson BM, Nilsson LO, Norlén L, Kock NG, Åhrén C (1982) Mucosal adaptation in ileum after long-time exposure to urine: a study in patients with continent urostomy. In: Robinson JWL, Dowling RH, Riecken EH (eds) Mechanisms of intestinal adaptation. MTP Press, Lancaster, pp 613–620
Philipson BM, Kock NG, Jagenburg R et al. (1983) Functional and structural studies of ileal reservoirs used for continent urostomy and ileostomy. Gut 24: 392–398
Philipson BM, Kock NG, Norlén L et al. (1986) Ultrastructural and histochemical changes in ileal reservoir mucosa after long-term exposure to urine. A study in patients with continent urostomy (Kock pouch). Scand J Gastroenterol 21: 1235–1244
Skinner DG, Boyd SD, Lieskovsky G (1984) Clinical experience with the Kock continent ileal reservoir for urinary diversion. J Urol 132: 1101–1107

*Chapter 24*

# The Mainz Pouch for Continent Urinary Diversion, Bladder Substitution and Augmentation

*U. Engelmann, J. W. Thüroff, P. Alken, G. H. Jacobi, H. Riedmiller and R. Hohenfellner*

## Introduction

The work of Kock and his associates on continent ileostomies (Kock 1973) and later on the application of their continent ileal pouch for continent urinary diversion has stimulated considerable interest in this field. A variety of procedures were investigated experimentally and were clinically applied for bladder augmentation, substitution or for continent diversion. It soon became evident that urinary reservoirs constructed from isolated bowel segments should fulfill the following criteria:

1. Adequate storage capacity and compliance.
2. A low pressure system without excessively high pressures caused by peristaltic contraction waves.
3. A reliable method of antirefluxive ureter implantation.

Each of the different procedures was almost exclusively used for one indication, for instance the ileal pouch for continent diversion (Kock et al. 1982), the Camey procedure for bladder substitution (Camey 1985) and the "clam" procedure for bladder augmentation (Mundy and Stephenson 1985).

Based on our own animal experiments with various types of urinary reservoirs and on the good clinical experiences reported on the ileal pouch (Kock 1986), an ileocaecal pouch using caecum, part of the ascending colon and terminal ileum was constructed. It combines the advantages of an ileal pouch but also allows implantation of the ureters by submucosal tunnelling. Implantation of the ureters by the "open-end technique" has proved reliable in preventing reflux and obstruction in large series of colonic conduits (Wilbert and Hohenfellner 1984) and psoas hitch procedures (Riedmiller et al. 1984). Since our initial reports (Thüroff et al. 1985, 1986) the technique has been modified slightly to improve continence mechanism, catheterisation and cosmetic appearance in continent diversions.

This report is based on 97 adult patients who received the Mainz pouch as a continent urinary diversion, bladder substitution or bladder augmentation. The indications, technique and results of the procedure in children will be presented in Chapter 25.

## Material and Methods

We operated on 97 patients with a mean age of 44 years (range 18–65 years). The original diagnosis with which the patients presented is given in Table 24.1. Infiltrating bladder carcinoma requiring radical cystectomy and urinary diversion or bladder replacement represented the underlying disease in most cases. Of the 97 patients, 48 received a Mainz pouch as a continent urinary diversion, 34 as bladder augmentation and 15 for bladder substitution.

**Table 24.1.** Indications for Mainz pouch procedure in 97 patients

| Indication | No. of patients |
|---|---|
| Bladder carcinoma | 44 |
| Functional or morphological bladder loss | 47 |
| Otherwise untreatable incontinence | 6 |

## Surgical Technique

For all applications of the Mainz pouch isolation of the bowel segments and construction of the pouch is basically the same. Caecum and ascending colon are mobilised by incision of the lateral peritoneal flexure. A length of caecum and ascending colon of 15 cm and a corresponding segment of terminal ileum of about 30 cm is isolated. For construction of the intussusception valve an additional segment of ileum of sufficient length needs to be taken. Bowel continuity is restored by an ileoascendostomy using either an end-to-end anastomosis with single-layer seromuscular interrupted sutures or a mechanical end-to-side anastomosis with a stapler.

The isolated segment is then opened along the antimesenteric border starting at the ileum and leaving the ileocaecal valve intact. After opening the ascending colon and caecum along the taenia libera the posterior wall of the pouch is constructed. The free medial border of the colon is joined to the adjacent border of the terminal ileum and the remaining borders of the ileum to each other. The most time-saving suturing technique proved to be a single-layer through and through running suture with 4–0 polyglycolic acid (PGA) sutures and a straight needle. Before closing the resulting flat plane of bowel into a spherically shaped reservoir, anastomosis of the pouch to the bladder remnant or urethra (in cases with augmentation or substitution) and ureter implantation has to be performed.

## Augmentation

For augmentation the fundal area of the bladder is subtotally excised, removing part of the trigone including both ureteral orifices so that the bladder remnant has a diameter of less than 3 cm. If the vascular pedicle of the pouch is long enough the pouch can be anastomosed to the bladder without rotation. In cases with a short mesentery the pouch has to be rotated 180° counterclockwise.

## Substitution

In bladder substitution, after radical cystectomy has been done, a buttonhole incision is made at the lowest intact part of the caecum to which the urethra is anastomosed with four to six interrupted sutures, first placing the sutures and tying them after insertion of the indwelling catheter.

## Continent Urinary Diversion

In a continent urinary diversion the pouch is formed in the same way and is combined with an ileal intussusception valve for continence. The nipple was initially constructed by multiple seromuscular sutures and seromuscular scarification as described by Månsson et al. (1984), combined with anchoring Dexon mesh collars at the nipple base, as proposed by Skinner et al. (1984), who used Marlex mesh. However, the results were unreliable with regard to continence and easy catheterisation. Currently we use the following procedure: An area of 7–8 cm of ileal mesentery is transsected leaving a rim of approximately 1 cm at the bowel, thus preserving the mesenteric vessels immediately adjacent to the bowel wall. Two Allis clamps are introduced into the ileum and grasp the terminal ileum from inside (Fig. 24.1). The ileum is pulled into the pouch and the nipple is then secured with two rows of TA 55 metal staples and with an additional row that also ties the invaginated nipple within the ileocaecal valve (Figs. 24.2, 24.3). The mucosa of the nipple tip and the corresponding interior surface of the ileocaecal valve is

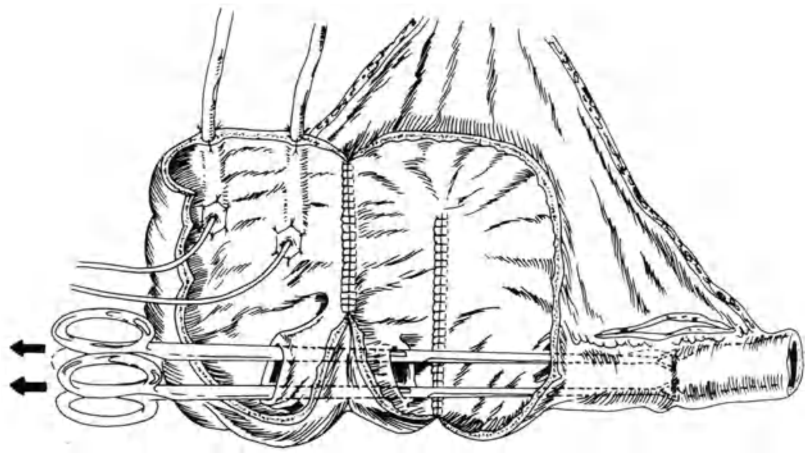


**Fig. 24.1.** Construction of a continent Mainz pouch: the mesenteric slit has been performed and the terminal ileum is prepared for the intussusception.

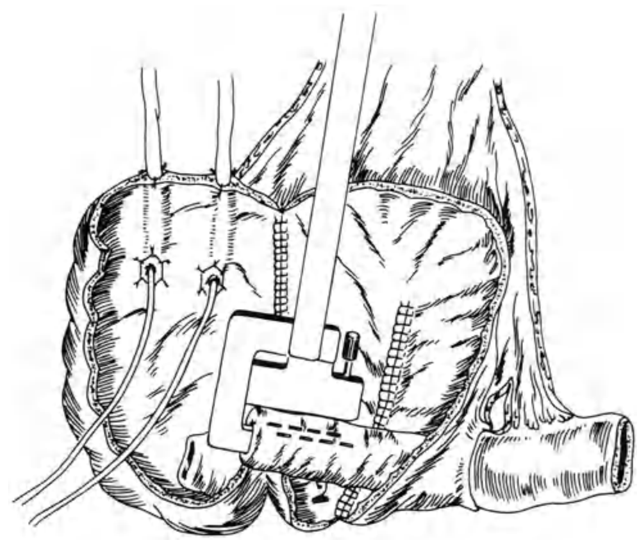


**Fig. 24.2.** The nipple has been performed and will be pulled through the ileocaecal valve, which is intact.

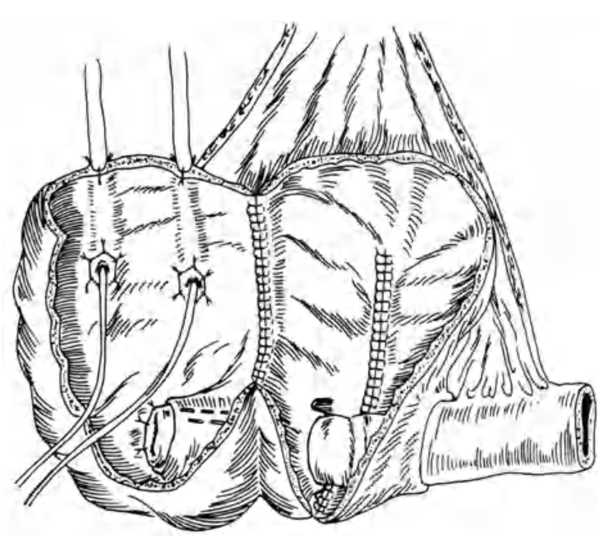


**Fig. 24.3.** The intussusception valve has been completed.

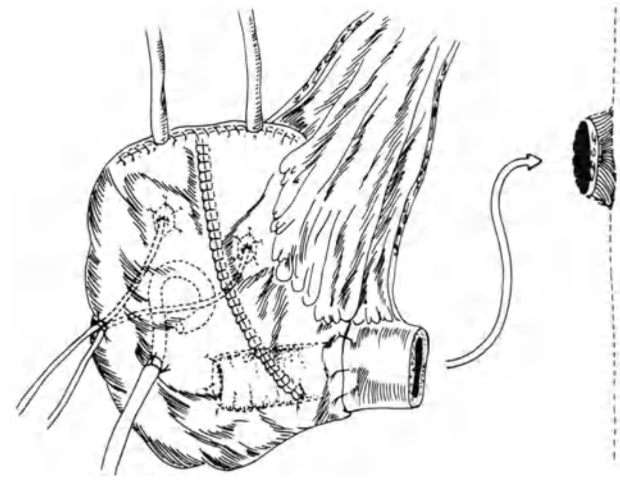


**Fig. 24.4.** The pouch is closed with a running suture and catheters are inserted for drainage.

removed in a circular way and adapted with 4–0 interrupted sutures. Both ureters are implanted into the large bowel segment using separate submucosal tunnels of 4 cm length. The ureters are spatulated and anchored to the muscular wall of the colon by 5–0 PGA sutures. Mucosal adaptation is done by 6–0 interrupted sutures of the same material. The ureters are stented with 6–8 FG catheters. The pouch is then closed in a single-layer fashion. For drainage a 20–26 FG catheter and a 10–15 FG cystostomy tube with multiple perforations are introduced into the pouch. The cystostomy tube leaves the pouch through a separate incision (Fig. 24.4). In the current technique all tubes are placed through the stoma.

For a better cosmetic appearance the stoma is placed into the umbilicus. Therefore the umbilicus is incised at its base, the efferent loop is pulled through a fascial incision, and the cutaneous funnel of the umbilicus is anastomosed to the efferent loop (Fig. 24.5). The reservoir is anchored to the abdominal wall assuring a straight and short course for catheterisation later on.

## Postoperative Care

The reservoir is flushed daily to remove mucus that has a tendency to clot the catheter. The ureter stents are removed after 10 days, but the catheter and the cystostomy tube are left in place for 2–3 weeks. After removal of the catheter, patients with a continent urinary diversion are instructed to empty their reservoir by clean intermittent self-catheterisation (CSC) every 4–6 h during daytime, and those with a bladder augmentation or substitution void by abdominal straining. Hyperchloraemic acidosis initially needs correction with alkalising drugs until control of acid–base balance shows normal values.

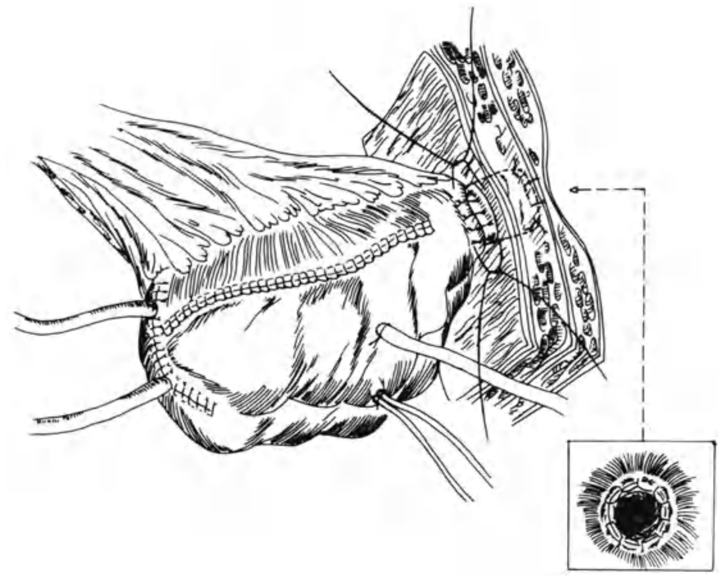


Fig. 24.5. Placement of the stoma into the umbilicus.

# Results

The average operating time is now 5–6 h, which includes all additional procedures, i.e. cystectomy, that might be necessary. Blood loss caused by the construction of the pouch is minimal, and patients tolerate the relatively long and extensive procedure well. The average duration of hospitalisation is 14 days.

We observed seven *perioperative* complications in seven patients that required three operative interventions. Perioperative mortality was nil. The most frequent complication was bowel obstruction in three patients (Table 24.2).

**Table 24.2.** Perioperative complications

| Complication | No. | Operative intervention |
|---|---|---|
| Bowel obstruction | 3 | 2 |
| Bowel fistula | 1 | – |
| Erosive gastritis | 1 | – |
| "Laparotomy dehiscence" | 1 | 1 |
| Tamponade of the pouch | 1 | – |
| Total | 7 | 3 |

During *follow-up* 14 operative revisions—not counting 3 procedures during the perioperative period (Table 24.2)—had to be performed. The most frequent cause was the prolapse of the intussusception valve in seven cases. These valves had all been secured by sutures without the application of staples. At the time of writing, the revised stapled valves are competent. Voiding difficulties with a high residual urine and a weak stream had to be treated twice by bladder neck incision and once by dilatation. In another case with unchanged frequency of voiding a secondary continent diversion with an abdominal stoma had to be performed (Table 24.3).

**Table 24.3.** Operative revisions during follow-up

| Complication | No. | Procedure | No. |
|---|---|---|---|
| Nipple prolapse | 7 | Revision | 7 |
| "Voiding difficulties" | 4 | Bladder neck incision | 2 |
| | | Dilatation | 1 |
| | | Continent diversion | 1 |
| Abscess | 1 | Drainage | 1 |
| Ileus | 1 | Laparotomy | 1 |
| Hernia | 1 | Closure | 1 |
| Total | 14 | | 14 |

The mean duration of follow-up at the time of writing is 21 months. Of 34 patients with a bladder augmentation, 29 are continent during day and night with normal micturition intervals and without requiring any medication so far. Three patients are on CSC because of residual urine, and one out of two patients with postoperative urgency obviously caused by a large bladder remnant underwent secondary continent diversion. Of 48 patients with a continent diversion, 45 are continent; one patient is awaiting revision of the nipple. The remaining patients in this group are completely dry. Seven patients reported discharge of bowel mucus which required changing of the stomal dressing. Incontinence requiring a bag was never reported in these cases.

Comparison of creatinine levels preoperatively and during the last follow-up showed identical mean values. The dilatation of upper urinary tracts as shown in the intravenous pyelogram (IVP) was graded according to Emmet's classification or was measured ultrasonically. Eleven renoureteral units improved postoperatively, and in nine kidneys (all with a short follow-up of less than 6 months) a slight dilatation was seen in the postoperative period; the remainder showed no change.

## Urodynamic Findings

The urodynamic findings during follow-up are summarised in Table 24.4. Continent diversions had a mean capacity of 622 ml, and augmented or substituted bladders 510 ml. The capacity increased during follow-up, probably depending on catheterisation intervals. Mean residual urine in patients who emptied by abdominal straining was 94 ml. The compliance of augmented/substituted bladders was a mean 35 ml/cm$H_2O$. Continent diversions showed an even higher compliance of 43 ml/cm$H_2O$. Pressures at 50% capacity in augmented/substituted bladders were 33 cm$H_2O$ (mean value) and 41 cm$H_2O$ at 100% capacity compared with 23cm$H_2O$ and 31 cm$H_2O$ for continent diversions.

**Table 24.4.** Urodynamic findings

| | Bladder augmentation/ substitution | Continent diversion |
|---|---|---|
| Capacity (ml) | 510 | 622 |
| Residual urine (ml) | 94 | 10 |
| Compliance (ml/cm$H_2O$) | 35 | 43 |
| Pressure at 50% capacity (cm$H_2O$) | 33 | 23 |
| Pressure at 100% capacity (cm$H_2O$) | 41 | 31 |
| Onset of contraction waves at (ml) | 221 | 290 |
| Duration of waves (s) | 13 | 22 |
| Maximum amplitude (cm$H_2O$) | 14 | 12 |

## Discussion

Reconstruction of the lower urinary tract has received new interest by introduction of continent urinary diversion. The general concern today about body image means that "... public as well as physician awareness has increased the demand for these techniques ..." (Rowland 1986). The criteria stated at the beginning—adequate storage capacity, good compliance and a reliable method of antireflux ureter implantation—are fulfilled by the Mainz pouch, as the results in our series of 97 patients show. The operative technique has been refined, it is now standardised and the complication rate relating to the pouch itself is low. Loss of renal function was not seen and more patients showed improvement of the upper urinary tract than dilatation.

The continence mechanism has to be reliable and easy to catheterise. Although intussusception valves were competent, they caused a significant number of revisions, which is also reflected by the initially frequent changes in technique. Our current modification of the isoperistaltic ileoileal intussusception valve has been secured with three rows of mechanical staples and additionally has been pulled through the ileocaecal valve to which it is attached. This not only seems to prevent slipping effectively, but also facilitates catheterisation of the pouch, as kinking and "dead" efferent loops are avoided. By shortening the efferent loop as much as possible the area of intussusception comes into close proximity to the abdominal wall, resulting in a short and straight passage for CISC. Placement of the stoma into the umbilicus conceals the stoma well, and these patients do not even have to wear a dressing to cover the abdominal stoma. Patient satisfaction is high, and despite the sometimes necessary reoperations none of the patients with a well-functioning continent diversion would choose a wet stoma if he were given the choice again.

However, long-term follow-up in patients with a continent urinary diversion is still limited (Kock et al. 1985), and frequent modifications of the continence mechanism have been needed (Skinner et al. 1984; Kock et al. 1985). Until sufficient data is available on the long-term outcome, continent urinary diversion has to be regarded as an innovative procedure which has to be proposed and applied with great care.

The advantage of the "Mainz pouch" is that it can be used not only for diversion but also for substitution and augmentation, and even in combination with other reconstructive procedures in the genital area. Techniques which do not interrupt muscular integrity of the bowel segment will generally result in contraction waves of varying degree. In cases of bladder substitution/augmentation this may lead to mass contractions or peristaltic waves requiring medication and still lead to incontinence. Contrary to Mitchell et al. (1986), we believe that the bowel segment chosen for augmentation/substitution plays an important role, as does the shape of the cystoplasty (Goldwasser and Webster 1986; Gonzalez et al. 1986; Sidi et al. 1986). The Mainz pouch, with its spherical shape and the incorporation of small bowel, can absorb contraction waves, and medication such as oxybutynin or dicyclomine were not needed.

Intussusception valves used as continence mechanisms on the efferent side of a continent urinary diversion experienced a significant rate of failures and revisions. The same type of valve is used by others as an antireflux mechanism in bladder augmentation/substitution. Again, long-term results on the reliability in large numbers of patients are missing. Antireflux ureter implantation into ileal segments has been difficult to obtain, as is nicely illustrated by the variety of procedures recommended, although it seems to function well with the Camey procedure (Camey 1985). In long-term results in large numbers of patients the "open-end technique" used in the Mainz pouch has been shown to prevent reflux and obstruction reliably (Riedmiller et al. 1984; Wilbert and Hohenfellner 1984).

Thus the Mainz pouch has proved to be a standardised procedure which is suitable for various indications and can be universally applied not only for continent diversion but also for bladder augmentation and substitution. As with other new techniques, careful selection of patients and a diligent long-term follow-up are needed before it can be recommended as a common procedure.

## References

Camey M (1985) Bladder replacement by ileocystoplasty following radical cystectomy. World J Urol 3: 161–166

Goldwasser B, Webster GD (1986) Augmentation and substitution enterocystoplasty. J Urol 135: 215–224

Gonzalez R, Sidi AA, Zhang G (1986) Urinary undiversion: indications, technique and results in 50 cases. J Urol 136: 13–16

Kock NG (1973) Continent ileostomy. Prog Surg 12: 180–201

Kock NG (1986) Urinary diversion via a continent ileal reservoir (Kock pouch) (John K. Lattimer Lecture). In: Proceedings of the 79th annual meeting of the AUA, Anaheim, 6–10 May 1986

Kock NG, Nilson AE, Nilsson LO, Norlén J, Philipson BM (1982) Urinary diversion via a continent ileal reservoir: clinical results in 12 patients. J Urol 128: 469–475

Kock NG, Norlén L, Philipson BM, Åkerlund ST (1985) The continent ileal reservoir (Kock pouch) for urinary diversion. World J Urol 3: 146–151

Månsson W, Colleen S, Sundin T (1984) Continent caecal reservoir in urinary diversion. Br J Urol 56: 359–365

Mitchell ME, Kulb T, Backes DJ (1986) Intestinocystoplasty in combination with clean intermittent catheterization in the management of vesical dysfunction. J Urol 136: 288–291
Mundy AR, Stephenson TP (1985) "Clam" ileocystoplasty for the treatment of refractory urge incontinence. Proceedings of the 15th annual meeting of the International Continence Society, London, 3–6 September 1985, pp 276–277
Riedmiller H, Becht E, Hertle L, Jacobi G, Hohenfellner R (1984) Psoas-hitch ureteroneocystostomy: experience with 181 cases. Eur Urol 10: 145–150
Rowland RG (1986) Continent urinary diversion. J Urol 136: 76
Sidi AA, Reinberg Y, Gonzalez R (1986) Influence of intestinal segment and configuration on the outcome of augmentation enterocystoplasty. J Urol 136: 1201–1204
Skinner DG, Boyd StD, Lieskovsky G (1984) Clinical experience with the Kock continent ileal reservoir for urinary diversion. J Urol 132: 1101–1107
Thüroff JW, Alken P, Engelmann U, Riedmiller H, Jacobi GH, Hohenfellner R (1985) Der Mainz-Pouch zur Blasenerweiterungsplastik und kontinenten Harnableitung. Aktuel Urol 16: 1–10
Thüroff JW, Alken P et al. (1986) The Mainz pouch (mixed augmentation ileum and cecum) for bladder augmentation and continent diversion. J Urol 136: 17–26
Wilbert DM, Hohenfellner R (1984) Colonic conduit, preoperative requirements, operative technique, postoperative management. World J Urol 2: 159–164

*Chapter 25*

# Bladder Augmentation, Undiversion and Continent Urinary Diversion in Children Using the Mainz Pouch Technique

*M. Stöckle, J. W. Thüroff, H. Riedmiller, P. Alken and R. Hohenfellner*

## Introduction

Encouraged by the low morbidity and high degree of subjective contentedness achieved in adult patients who had undergone bladder augmentation or continent urinary diversion using the Mainz pouch, we began applying the same technique with increasing frequency in children. Initial disease in a series of 11 children treated with this technique consisted of functional or morphological iatrogenic bladder loss in 6, neurogenic bladder dysfunction caused by myelomeningocele in 4 and failed reconstruction of bladder exstrophy in 1. Of these, seven children received bladder augmentation, combined with undiversion in two cases. The remaining four children, who had suffered from appliance problems related to a wet stoma (ureterocutaneostomy, three; colonic conduit, one), received a Mainz pouch to create a continent urinary diversion. The main reasons for reoperation in this patient group were incontinence or problems with the care of a wet urostomy. In six patients, hydronephrosis, reflux or recurrent pyelonephritis had already involved the upper urinary tract. The preoperative details of the 11 children are summarised in Table 25.1. To illustrate the problems found in these children, two patients are described in detail:

1. *Patient M.B. (Case No. 2)* Male child born 1981, who developed spastic diplegia of the lower limbs after postnatal sepsis following premature birth. In his home country, a transuretero-ureterocutaneostomy had been performed for an unknown indication shortly after birth. Some months later the left ureter was reimplanted into the bladder using the Politano–Leadbetter technique leaving the ureteroureterostomy in place. The patient developed bilateral reflux (see Fig. 25.1a: case no. 4), hydronephrosis and a shrunken bladder with permanent incontinence (see Fig. 25.1b). After bladder augmentation in 1986 the patient was continent and learned to void his bladder

**Table 25.1.** Preoperative details of a series of 11 children treated with the Mainz pouch

| Patient no. | Age and sex | Initial disease | Pre-existing urinary diversion | Preoperative problems | Operation |
|---|---|---|---|---|---|
| 1 | 14 years Male | Failed bilateral antireflux operations | Colonic conduit | Psychological problems of urostomy | Undiversion by augmentation |
| 2 | 5 years Male | Failed bilateral antireflux operations | – | Bilateral hydronephrosis and reflux, incontinence | Bladder augmentation |
| 3 | 5 years Male | Subtotal bladder loss during herniorrhaphy | Colonic conduit | None | Undiversion by augmentation |
| 4 | 9 years Female | Shrunken bladder after surgery and chemoradiotherapy for gluteal sarcoma | – | Bilateral reflux and hydronephrosis, incontinence | Bladder augmentation |
| 5 | 3 years Male | Bladder necrosis after ether instillation for removal of a blocked catheter | – | Bilateral hydronephrosis, incontinence | Bladder augmentation |
| 6 | 12 years Male | Bladder necrosis after postnatal trisbuffer injection into the left umbilical artery | – | Incontinence, increasing bilateral hydronephrosis, sphincter weakness | Bladder augmentation |
| 7 | 17 years Female | Neurogenic bladder dysfunction caused by myelomeningocele, no diplegia | – | Incontinence | Bladder augmentation |
| 8 | 8 years Female | Myelomeningocele, diplegia | Transuretero-ureterocutaneostomy | Hydronephrosis, recurrent pyelonephritis, renal stones. Permanently wet because of appliance problems | Continent diversion |
| 9 | 16 years Male | Myelomeningocele, diplegia | Colonic conduit | Recurrent pyocystis. Frequently wet because of stomal position | Continent diversion, subtotal bladder resection |
| 10 | 15 years Female | Myelomeningocele, diplegia | Double midline ureterocutaneostomy | Recurrent pyelonephritis, reduced function of the left kidney. Sometimes wet because of stomal position | Continent diversion |
| 11 | 12 years Male | Bladder exstrophy, status after two failed bladder reconstructions | Midline transuretero-ureterocutaneostomy | Permanently wet because of stomal position | Continent diversion |

without residual urine. Postoperative intravenous pyelogram (IVP) showed a significant decrease in renal dilatation (see Fig. 25.1c).

2. *Patient L.J. (Case No. 11)* A 12-year-old male born with bladder exstrophy. Bladder reconstruction immediately after birth had failed. After another bladder reconstruction at the age of 3 years the patient developed bilateral hydronephrosis, which was treated by transuretero-ureterocutaneostomy some months later. Stomal position was in the midline of the lower abdomen. An adequate appliance of this urostomy had never been possible, and the patient had worn nappies constantly. Reoperation to change the transuretero-ureterocutaneostomy to a continent ileocaecal pouch was perfomed in June 1986. Three weeks after the operation the patient learned to empty the continent pouch by self-catheterisation without problems.

## Operative Technique

The principles of the operation have been detailed in the preceding chapter. Regarding operative technique and postoperative treatment, there is no difference between adults and children. In two of the four children who underwent continent urinary diversion, the stoma was placed into the umbilicus, rendering it invisible and providing an excellent cosmetic result (Fig. 25.2).

## Early Complications

One boy underwent operative revision because of ileal invagination which had occurred far from the operative site; resection of ileum was not necessary. The same boy later developed a thrombosis of the subclavian vein as a complication of the central venous catheter. This resolved completely under conservative treatment. No other serious complications were encountered.

## Late Results

In the group with bladder augmentation, six of seven children are completely continent at the time of writing. One boy with a preoperatively known sphincter weakness still suffers from slowly decreasing nocturnal incontinence. Of special interest is the fact that urge incontinence caused by autonomous contractions of the intestinal segments used in the procedure did not occur in any of the children. Those children with continent diversion had no difficulty learning self-catheterisation. Complications of the continent nipple, especially nipple sliding, have not been observed in children after continent urinary diversion.

Gross preoperative renal dilatation improved significantly after the operation in all cases. Three children with normal upper urinary tracts preoperatively showed slight renal dilatation (Emmett II) in the

a

Fig. 25.1a–c. Case no. 4: shrunken bladder, reflux and hydronephrosis following radiotherapy. a Reflux cystogram; b IVP preoperatively; c IVP 4 weeks postoperatively.

b

c

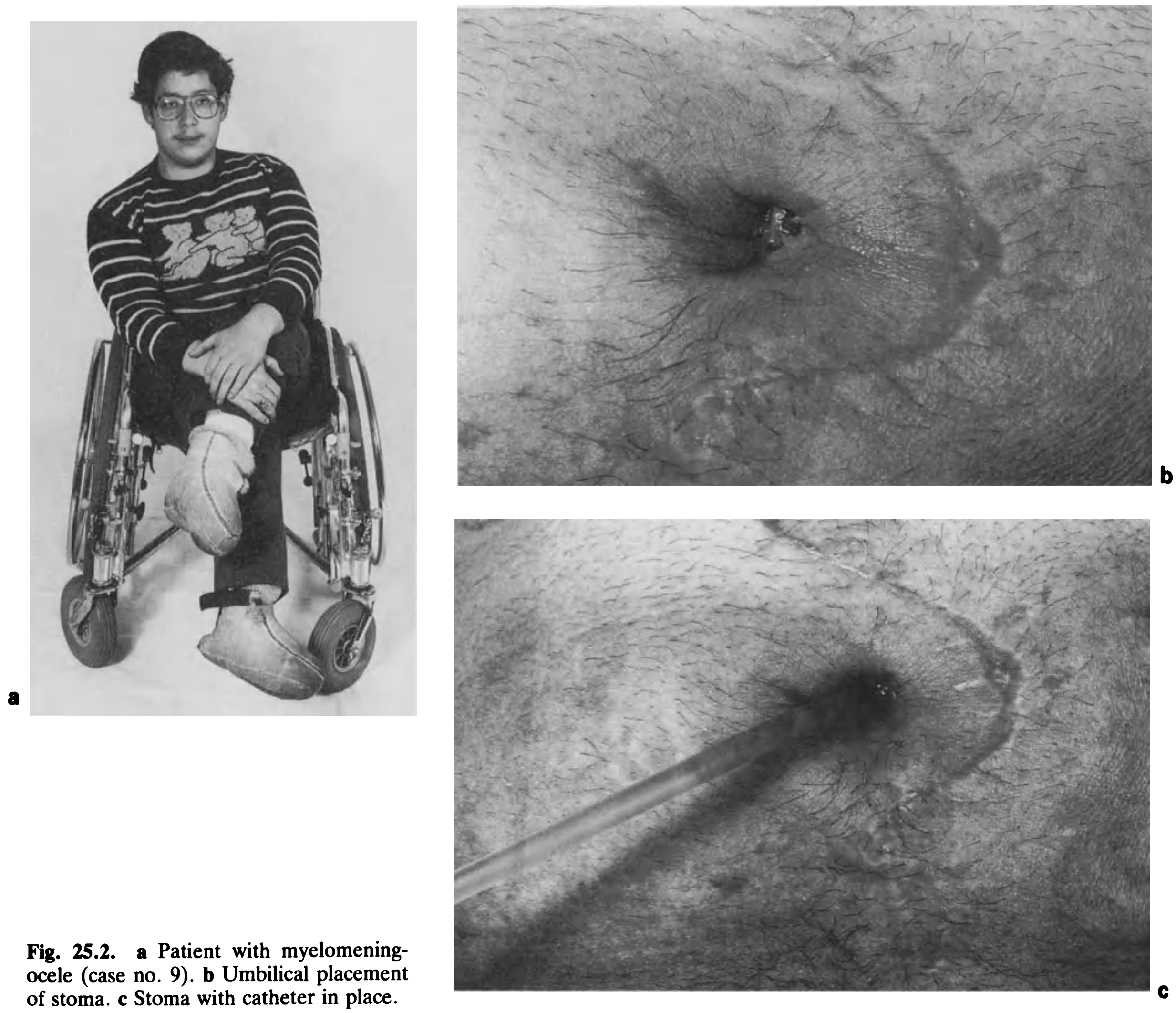


**Fig. 25.2.** **a** Patient with myelomeningocele (case no. 9). **b** Umbilical placement of stoma. **c** Stoma with catheter in place.

postoperative IVP. For compensation of resorptive acidosis, 4 of our 11 children require oral base substitution. No other drug is necessary in any of the children. No subjective complaints related to the loss of the bowel segment taken for pouch construction have been reported. Of particular interest is that diarrhoea resulting from a lack of biliary acid resorption was not observed in any of these 11 children. The postoperative details of the 11 children in this series are summarised in Table 25.2.

## Discussion

The children of this series can be divided into two main groups. The *first group* consists of children with iatrogenic functional or morphological

**Table 25.2.** Postoperative details of a series of 11 children treated with the Mainz pouch

| Patient no. | Follow-up period | Upper urinary tract | Continence | Self-catheterisation |
|---|---|---|---|---|
| 1 | 20 months | Emmett II in periods of maximal filling of the pouch | + | – |
| 2 | 5 months | Decreasing dilatation | + | – |
| 3 | 16 months | Normal | + | – |
| 4 | 8 months | Decreasing dilatation | + | – |
| 5 | 20 months | Decreasing dilatation, reflux grade II right kidney | + | – |
| 6 | 4 months | Emmett II | Nocturnal incontinence with decreasing tendency | – |
| 7 | 21 months | – | + | + |
| 8 | 3 months | Emmett II, no change | + | + |
| 9 | 2 months | – | + | + |
| 10 | 1 month | Emmett II | – | + |
| 11 | 2 months | Emmett II | + | + |

bladder loss of different aetiologies (case nos. 1–6). Iatrogenic bladder loss in children is a rare but well-known and catastrophic complication of medical or surgical treatment (Reifferscheid et al. 1973; Colodny 1974; Mihatsch et al. 1974; Redman et al. 1985; Fig. 25.1). Incontinence, social problems, urinary diversion and renal insufficiency often characterise the late fate of the children concerned. All six children in this group underwent bladder augmentation to avoid or reverse urinary diversion (Hendren 1978; Amis et al. 1981).

The technique presented here for intestinal cystoplasty and continent diversion (Thüroff et al. 1985) ideally combines the essential requirements for all types of bladder substitutes: ureter implantation into the colonic segment using a well-established antireflux technique (Altwein and Hohenfellner 1975) and low pressure of the reservoir guarantee the preservation of kidney function. Furthermore, low pressure—which is achieved by splitting the circular muscles and utilising the elastic property of the ileal section to buffer pressure peaks caused by contractions of the colonic section—is basic for continence.

The *second group* of children consists of patients with a congenital bladder dysfunction (Linder et al. 1983) or bladder exstrophy (case nos. 7–11). With the exception of case no. 7, all these children underwent a continent urinary diversion. All of them use clean intermittent self-catheterisation (CISC) to empty the pouch. The girl who underwent bladder augmentation because of a neurogenic bladder dysfunction caused by myelomeningocele (case no. 7) also needs self-catheterisation for emptying of the pouch because of sphincter dyssynergia. Having suffered from permanent incontinence before bladder augmentation, she is highly satisfied with her present status. The reason why this girl, in contrast to all other children with myelomeningocele, received bladder augmentation instead of continent diversion was the fact that she has no diplegia. As she is able to walk, she has no problems catheterising the urethra. The three other children with myelomeningocele are diplegic. Confined to a wheelchair, they are not able to use lavatory facilities without assistance. It is therefore difficult to conceive that bladder emptying via the urethra, either by CISC or by the use of an artificial sphincter (Light et al. 1983), could be a better solution for these severely disabled patients than continent diversion.

Specific metabolic disturbances resulting from the use of the ileocaecal segment have not been observed. The need for oral base substitution was comparable with that after colonic conduit or ureterosigmoidostomy (Hohenfellner and Marberger 1976a,b). As a decrease in serum cobalamines has been described in cases of ileocaecal urinary diversion (Månsson et al. 1984) as a late complication occurring 2–5 years after ileum loss, further evaluations will be necessary in our children.

Urge incontinence caused by autonomous contraction of the pouch has never been observed in any of our patients. Consequently, antispasmodic drugs, which are known to be imperative for continence in many other forms of bladder augmentation (Whitmore and Gittes 1983), were not necessary. All of these six children who have normal sphincter function successfully achieve complete emptying of the augmented bladder. Technical devices such as self-catheterisation are not necessary. YV-plasty, whose importance for bladder emptying after augmentation has been emphasised by other authors (Chan et al. 1980), did not prove necessary in our experience.

## Conclusion

An important advantage to the surgeon of the Mainz pouch technique is the fact that the ileocaecal pouch can be used for various indications and various types of operations with slight operative modifications. In addition to the continent urinary diversion and bladder augmentation described here, the technique can serve as a total bladder replacement after radical cystoprostatectomy for the treatment of bladder cancer. Although the results are still of a preliminary nature, and late results—especially in children—must be awaited, the Mainz pouch appears to offer a perfect bladder substitute in terms of preservation of the upper urinary tract, continence and patient satisfaction.

## References

Altwein JE, Hohenfellner R (1975) Use of the colon as a conduit for urinary diversion. Surg Gynecol Obstet 140: 33–38

Amis ES, Pfister RC, Hendren WH (1981) Radiology of urinary undiversion. Urol Radiol 3: 161–169

Chan SL, Ankenman J, Wright JE, McLoughlin MG (1980) Cecocystoplasty in the surgical management of the small contracted bladder. J Urol 124: 338–340

Colodny HC (1974) Bladder injury during herniorrhaphy manifested by ascites and azotemia. Urology 3: 89–90

Hendren WH (1978) Some alternatives to urinary diversion in children. J Urol 119: 652–659

Hohenfellner R, Marberger M (1976a) Colon conduit. In: Bergsma D, Duckett WD (eds) Urinary system malformation in children. Proceedings of the international pediatric urological seminar, Philadelphia, 1976. Alan R Liss, New York

Hohenfellner R, Marberger M (1976b) Open transcolonic ureterosigmoidostomy. In: Bergsma D, Duckett WD (eds) Urinary system malformation in children. Proceedings of the international pediatric urological seminar, Philadelphia, 1976. Alan R Liss, New York

Light JK, Flores FN, Scott FB (1983) Use of the AS792 artificial sphincter following urinary undiversion. J Urol 129: 548–551

Linder A, Leach GE, Raz S (1983) Augmentation cystoplasty in the treatment of neurogenic bladder dysfunction. J Urol 129: 491–493

Månsson W, Colleen S, Sandin T (1984) Continent caecal reservoir in urinary diversion. Br J Urol 56: 359–365

Mihatsch MJ, Ohnacker H, Herzog B, Goldschmidt H (1974) Bladder necrosis caused by use of THAM in a newborn infant. J Urol 111: 835–837

Redman JF, Jacks DW, O'Donnell PD (1985) Cystectomy: a catastrophic complication of herniorrhaphy. J Urol 133: 97–98

Reifferscheid R, Eckstein HB, Flach A, Rager K (1973) Wandnekrosen der Harnblase des Neugeborenen als Komplikation eines Nabelkatheters. Dtsch Med Wochenschr 98: 727–731

Thüroff JW, Alken P, Engelmann U et al. (1985) The Mainz pouch (Mixed augmentation ileum 'n zecum) for bladder augmentation and continent urinary diversion. Eur Urol 11: 152–160

Whitmore WF, Gittes RF (1983) Reconstruction of the urinary tract by cecal and ileocecal cystoplasty. Review of a 15-year experience. J Urol 129: 494–498

Section VII

# Urethral Strictures and Fistulae

# Introduction

*A. R. Mundy*

## Urethral Strictures

In relation to the long history of the treatment of urethral strictures, the use of any modality other than dilatation is a comparatively recent innovation. Dilatation, or bouginage, usually monthly and for decades, was the rule for centuries. During the last century an internal or transperineal open urethrotomy was occasionally performed for an impassable stricture, but only (usually) with the intention of establishing a channel that could subsequently be managed by dilatation. Nonetheless, although some patients were plagued by haemorrhage, septicaemia and a worsening of their stricture, many men have been happily treated by regular dilatation, and dilatation is the yardstick against which the effectiveness of other treatment modalities must be judged.

In the last 30 years or so there have been two aetiological and two therapeutic developments that have affected the way strictures are treated. Aetiologically, there has been a substantial increase in the number of iatrogenic (mainly catheter-related) strictures and a relative increase in the number of membranous urethral strictures as distinct from bulbar urethral strictures. The latter increase is due to the increase in the number of pelvic fracture injuries of the urethra as a result of road traffic accidents and the reduction in the number of untreated cases of gonococcal urethritis with the introduction of antibiotic medication. Therapeutically, there has been the introduction of visual internal urethrotomy and of urethroplasty. As a result, there is a greater variety of types of stricture and a greater choice of treatment modalities; this has led to a more critical approach to treatment but a somewhat more confusing range of choices of treatment.

It is fair to say that most interested surgeons would elect to treat most pelvic fracture strictures of the membranous urethra by urethroplasty, most post-transurethral resection sphincter strictures by dilatation, most bulbar and penile strictures by visual internal urethrotomy, and most meatal or fossa navicularis strictures by meatotomy or meatoplasty (except those following instrumentation, when a trial of dilatation would usually be opted for). Urethroplasty for bulbar or penile strictures would in most instances be reserved for those who failed to respond to a reasonable trial of instrumentation. There are exceptions, of course. One occasionally sees a short post-traumatic stricture of the membranous urethra that is amenable to endoscopic surgery and a short post-traumatic stricture of the bulbar urethra which is probably best treated by excision and anastomotic urethroplasty. Moreover, in general, most surgeons would agree that after a failed trial of endoscopic techniques a refractory stricture should be considered for urethroplasty.

Thus the approach to the treatment of urethral strictures is relatively uncontroversial; indeed, there is little controversy in the detailed technique for the repair of post-traumatic membranous strictures or penile strictures. However, there is considerable debate as to the best technique for the resolution of bulbar strictures.

Excluding short strictures which are amenable to excision and end-to-end anastomosis, two questions arise. Firstly, should the stricture be excised so that any repair consists *entirely* of healthy epithelium, or is this unnecessary; and secondly, what tissue should be used as a substitute for the urethra, either for part or all of its circumference?

The first of these questions has not been widely discussed, and it is not therefore clear whether the total excision of the stricture reduces the recurrence rate following urethroplasty or not, although theoretically at least it should do so. The second question as to the preferred tissue for the urethral substitution principally relates to whether a free graft or pedicle graft should be used, and the specific controversy concerns the relative merits of free preputial grafts against pedicled scrotal grafts. Other free grafts include the mesh skin graft described by Schreiter (see Chap. 28) and the bladder urothelial graft. The principal application so far of the latter graft has been for hypospadias repair, but it shows promise (in the present author's experience) in the repair of urethral strictures also. Other pedicle grafts include pedicled preputial or penile skin, which is the present author's own favourite.

The considerable advantage of pedicle grafts is that they take more predictably; the advantage of free grafts is that they are generally easier to harvest and prepare. On the other hand, the advantage of preputial skin is that it is "wet" skin, i.e. it is used to being moist, and therefore tolerates the passage of urine much better than does scrotal skin. The disadvantage is that it is in somewhat limited supply. The advantage of scrotal skin is that it is in much more profuse supply. The disadvantage is that it sometimes develops a rather soggy eczematous reaction to the passage of urine over it, it is hairy and it is difficult to size during the urethroplasty procedure because it is thermosensitive.

It is probably fair to say that most of the established techniques for urethroplasty work well and with a low complication rate in the hands of those who perform the procedure sufficiently frequently to be adept in its practice. The present author, however, would feel rather uneasy about using a free graft of any sort in urethral repair because of the generally lower take rate of free grafts and because of their general proneness to contracture.

## Fistulae

Fistulae are the plague that gynaecologists visit upon urologists. It is probably the complication that gynaecologists fear more than anything else except death (their own or their patients!). There are essentially two types of fistulae: simple fistulae and complex fistulae. In the developed world (for want of a better description), simple fistulae occur after obstetric or gynaecological surgery, and complex fistulae are made complex by virtue of radiotherapy.

On the whole, simple fistulae are easy to repair if one follows the general principles closely. This is not to underestimate the importance of the general principles; they are indeed extremely important. However, by excising the fistula, undermining the edges on both sides of the fistula, bringing the freshened edges together without tension and repairing them with adequate suturing techniques a successful resolution can be guaranteed. If additionally some extraneous tissue such as labial fat pad or omentum is interposed between the two suture lines a successful result can almost be guaranteed. Failure in such instances is usually because there was tension of the suture line or operative trauma to the coapted edges, resulting in ischaemia and breakdown of the closure.

Repair of complex fistulae may be extremely difficult because of the surrounding fibrosis and the impaired vascularity of the bladder and vagina (and rectum where relevant) resulting from the radiotherapy and because of the larger size of the fistula (usually), all of which reduce the surgeon's ability to bring together without tension the edges of the defect with sufficient vascularity to ensure their proper healing.

Thus it is common to find in practice that a considerable bulk of extraneous tissue will need to be brought into the pelvis for a satisfactory resolution of the fistula. If indeed the fistula can be closed, then the omentum (as described in Chap. 26 by Turner-Warwick) will need to be brought in to wrap and protect the closure and separate it from the other suture lines to prevent a recurrence. Sometimes it may be necessary only to plug the defect with omentum, particularly the vaginal defect. In more extreme cases it may be necessary in addition to use bladder, vaginal or rectal substitution procedures to repair the defects. Nevertheless, omental "redeployment" will still be necessary to support the repair, hence the importance of Turner-Warwick's contribution.

*Chapter 26*

# The Omental Repair of Complex Urinary Fistulae

*Richard Turner-Warwick*

## Introduction

It is almost always possible to close urinary vaginal and rectal fistulae. Meticulous technique is naturally essential, but success with the more complicated problem is dependent upon the ability of the surgeon to select the procedure that is best suited to the particular clinical situation and, furthermore, to vary it according to the findings in the course of the operation on the basis of a wide personal experience.

Simple fistulae can often be resolved by simple closure in layers. However, because even complex fistulae associated with tissue loss and irradiation are almost invariably reparable by the addition of a vascularised omental interposition graft, it follows that almost *any* recurrent fistulae after a layer-closure procedure should cause the surgeon to reflect both upon the technique and the choice of the procedure (Turner-Warwick 1986a,b). Thus a recurrent fistula after a vaginal-approach procedure indicates that an abdominal-approach repair should have been used, and a recurrence after an abdominal-approach layer-closure repair indicates that an additional omental interposition procedure was required.

## The "Perineo-abdominal Progression-approach"

An "exaggerated lithotomy" position is commonly used for vaginal- and rectal-approach repairs; the disadvantage of this is that it does not offer the facility of extension to a synchronous abdominal exploration, and consequently it is generally inappropriate unless the surgeon is certain that perineal-approach repair will be sufficient—a conviction which sometimes proves questionable. Thus the principle of the synchronous perineo-abdominal progression-approach (PAPA) procedure is advocated for the resolution of all pelvic fistulae, irrespective of whether a dedicated perineal-approach procedure or an abdominal-approach procedure is envisaged preoperatively (Turner-Warwick et al. 1967; Turner-Warwick 1973).

The patient is placed on the operating table in a flat, slightly head-down position and the legs are widely abducted with only a moderate degree of hip-flexion. This position gives good access for both perineal and abdominal surgery (Fig. 26.1). The patient is draped so that both the abdomen and the perineum are included in a single operating field. "Committee surgery" has its shortcomings: pelvic surgery is best regarded as a "horizontal specialty" requiring a surgeon with appropriate training in both urology and colo-rectal surgery (Turner-Warwick 1986a, 1987, 1988). Thus it is rarely necessary to have two surgeons for a synchronous approach because the interchange is simple when the patient is positioned for a progression-approach procedure.

**Fig. 26.1.** The Turner-Warwick perineo-abdominal progression-approach (PAPA) procedure for the resolution of complex fistulae and pelvic fracture urethral distraction defects (PFUDDs), according to the findings at operation.

When the perineal-approach repair proves difficult or inappropriate, the surgeon simply walks round to the abdominal-approach position and the scrub-nurse repositions the instrument table between the patient's legs. Furthermore, if appropriate ring retraction is used, one assistant is more than enough; certainly no one should intervene between the surgeon and the instrument table/scrub nurse.

For the perineal proceedings the surgeon is seated with the scrub-nurse and the instrument table immediately to the right (or left if left handed). The bundle of suction tube, fibrelight and diathermy cables is arranged over the patient's leg on the side opposite the scrub-nurse. If a foot-control is used to operate the diathermy (as it has to be if the Turner-Warwick insulated diathermy knife/forceps/scissors set-up is used), the cable should be tracked around the head-end of the operating table pedestal and back to the surgeon's right foot so that minimal movement enables it to be moved and operated with the same foot when the surgeon moves back and forth from the perineal- to the abdominal-approach position.

## Closure of Complex Fistulae by Interposition Grafts

The healing potential of the tissue margins of a fistula may be compromised by scarring as the result of infection, by previous attempts at repair or by irradiation. Consequently the success rate of simple layer-closure falls abruptly so that some form of additional vascularised tissue interposition graft is required; the advisability of this is generally predictable at operation, so that almost any incidence of recurrent fistulae after a simple layer-closure technique is unacceptable.

Sizeable flaps of parapelvic peritoneum sometimes provide sufficient additional support for a layer-closure, but these are generally inappropriate when they are also affected by the local pathology, especially irradiation. Pedicled muscle grafts such as gracilis can be used as a simple tissue-bulk interposition, but skeletal muscle is ill-adapted to resist infection and inflammation and it contributes little to the local healing reaction; its vascular response is primarily exercise related, and ultimately inactivity results in disuse atrophy and fibrosis.

## Omental Interposition Repair

The omentum is uniquely adapted for the resolution of local inflammatory processes, not only on account of its blood supply, but also because of its abundant lymphatic drainage, which reabsorbs inflammatory cell debris and macromolecular protein exudates that would otherwise result in purulent accumulations. Thus, quite apart from its value in closing complex fistulae associated with irradiation, the omentum has a well-established place in complex urinary tract reconstructions in general. Furthermore, once an inflammatory situation has resolved, vascularised omentum regains its suppleness and consequently any reconstruction that is wrapped in it does not become incarcerated in the secondary fibrosis that commonly develops in peri-ureteric and para-renal fat. Thus, omental wrapping is often fundamental to the functional success of complex urodynamically orientated reconstructions, especially those involving sphincter activity.

The reliability of an omental pedicle graft fistulae repair depends upon achieving a large interpositional bulk with a wide lateral overlap of the closure suture lines; it should not be regarded as a simple "omental plug". Thus, for the closure of a complex vesical or rectal fistula the basic essential is to achieve a wide lateral overlap by developing an abdomino-perineal interposition tunnel that is three to four fingers wide and to mobilise a sufficient bulk of the omental apron to fill it.

## Principles of Omental Repositioning

The lower margin of the omental apron is long enough to reach the pelvic floor and the perineum without mobilisation of its vascular pedicle in about 30% of patients; however, it should always be separated from its natural adhesion to the transverse colon and mesocolon to avoid dislocation of the interposition graft by postoperative gaseous bowel distension (Fig. 26.2).

In about 30% of patients sufficient elongation of a moderate-length apron can be achieved by dividing the left gastroepiploic pedicle from the splenic vessels which contribute only a small proportion of its blood supply. Meticulous full-length mobilisation of the whole length of the right gastroepiploic vascular pedicle is required to enable the omentum to reach the pelvis in about 40% of patients (Turner-Warwick et al. 1967; Turner-Warwick 1976).

## Blood Supply of the Omentum

The preservation of the "magic" of the omentum during its mobilisation is dependent upon preservation of the "pulsating efficiency" of its vascularisation and naturally therefore upon an accurate knowledge of the anatomical features.

1. The blood supply of the omentum is derived from vertically running vessels arising from the gastroepiploic arcade arising from the gastro-duodenal vessels on the right and the splenic vessels on the left. The distal arcade communications between these vertical vessels in the lower part of the omental apron are tenuous; thus when providing omental support for an upper urinary tract reconstruction the two halves of the omental apron can often be separated in the midline without dividing any blood vessels sufficiently large to require ligation.

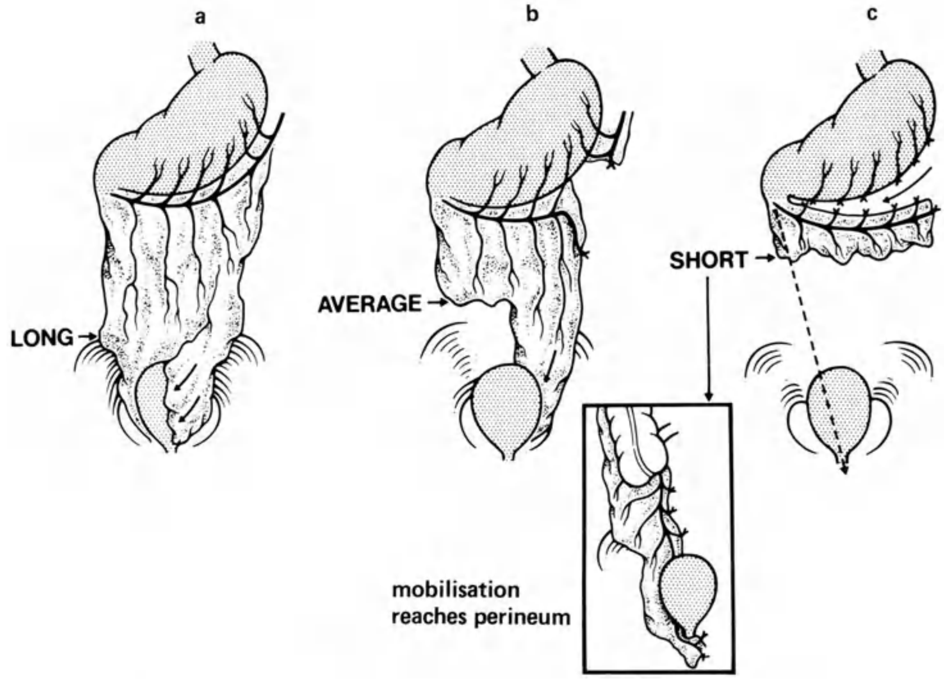



**Fig. 26.2a–c.** The three varieties of mobilisation required to enable the omental apron to be used to support a complex surgical reconstruction in the pelvis: **a** Long aprons simply require separation from the transverse mesocolon. **b** Additional division of the left gastroepiploic pedicle may enable an average-length omentum to reach adequately. **c** A short apron requires meticulous mobilisation of the whole length of the right gastroepiploic pedicle from the stomach.

It follows that elongation of the omental apron by horizontal incision below the gastroepiploic arcade involves the division of a number of its vertical vessels, which, to some extent, impairs the efficiency of the extremity of the graft (Fig. 26.3b).

2. The right gastroepiploic pedicle vessels are always larger than those on the left and these directly vascularise more than two-thirds of the omental apron. It follows that the mobilisation of a short apron is best based on the right gastroepiploic pedicle, not the left (see Fig. 26.2). This is fortunate for mechanical reasons because the origin of the right gastroepiploic vessels is lower in the abdomen than that of the left so that, when the full length of the gastroepiploic arcade is mobilised from the greater curvature of the stomach by meticulous individual ligation/division of its 30–40 short gastric branches after division of its left pedicle, its extremity is long enough to reach the pelvis irrespective of the vertical length of the apron; thus the omentum can be used in children when the apron is undeveloped.

3. However, the junction between the right and left gastroepiploic vessels that usually completes the arcade is deficient in about 10% of cases at a point towards the left side of the greater curvature of the stomach (Fig. 26.3a). While it is technically possible to mobilise a satisfactorily vascularised omentum on the basis of its smaller left pedicle when the arcade is complete, where it is deficient this naturally results in impaired vascularisation of its extremity (Fig. 26.3c).

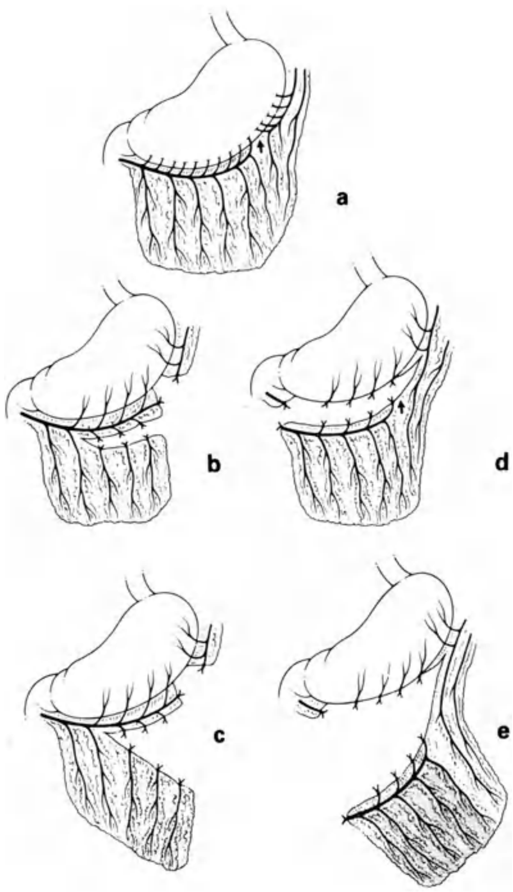



**Fig. 26.3.** **a** In 10% of patients the right and left gastroepiploic vessels do not anastomose to form an "arch". **b,c** The omentum should never be mobilised by a horizontal incision across the apron below the gastroepiploic arch which divides its vertical branches because the distal communications between these are poor. **d,e** The right gastroepiploic vessels almost invariably vascularise more than two-thirds of the omental apron; mobilisation of the omentum on the basis of the left gastroepiploic pedicle may result in ischaemia if the gastroepiploic arcade is incomplete.

## Technical Details of Omental Mobilisation

1. A midline abdominal wall incision should always be used because an upward extension to the xiphisternum is often necessary to provide the appropriate surgical access to the greater curvature of the stomach for the meticulous mobilisation of its right gastroepiploic vascular pedicle when this is necessary to enable a short apron omentum to reach the perineum.

2. The universal Turner-Warwick abdomino-perineal ring retractor provides maximum retraction and pelvic floor exposure without additional assistant-retraction. The abdominal ring is retained in position by four, fully curved, abdominal-wall retractor blades of appropriate size; additional blades between these retract the abdominal contents efficiently, and a sliding clip that engages the inner margin of the ring locks them down to prevent them from "lifting" (Fig. 26.4). A particular advantage of a ring retractor is that appropriate directional tension on *elevating traction stay sutures* can be achieved by haemostats with their tips hooked under the margin of the ring.

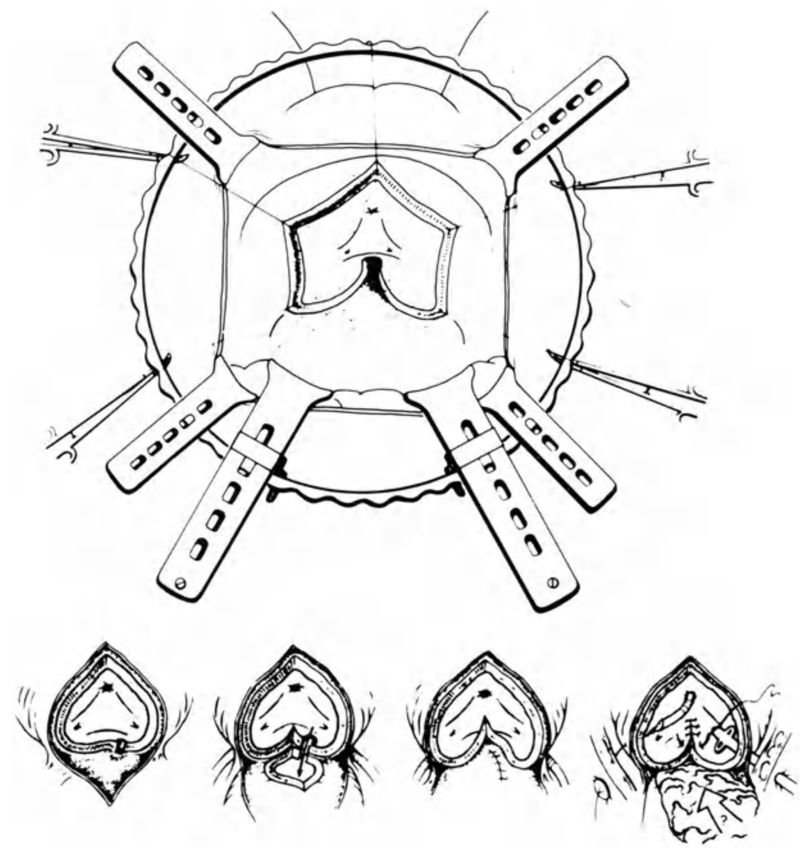


**Fig. 26.4.** The Turner-Warwick abdominal ring retractor and particular advantages of elevating traction stay sutures by ring-margin haemostats for pelvic fistula repair.

3. Mobilisation of the right gastroepiploic pedicle vessels requires the individual ligation of the 20–40 short gastric branches with absorbable suture material; the technique of this must be meticulous:

a) Bunch ligation of the short gastric vessels foreshortens the pedicle and adds to the risk that one may escape and bleed.

b) Non-absorbable sutures should never be used on an omental pedicle graft because any of them could come to lie exposed within a urinary fistula and result in calculus formation.

c) The proximal end of the short gastric vessels should be ligated in continuity, before division, *not between haemostats*, because vessel-escape commonly results in the rapid development of an interstitial haematoma, and great care is then necessary to retrieve the bleeding end for secure re-ligation without damaging the main pedicle vessels (Fig 26.5). Haemostat ligation can be used for the gastric end, which is easy to retrieve in the case of slip-off.

d) Once started, mobilisation of the gastroepiploic arch should be completed to its gastroduodenal origin, otherwise there is a risk that traction on the pedicle may tear the last undivided branch.

4. The initial course of the slender, mobilised, right gastroepiploic pedicle vessels to a pelvic redeployment of the omentum should be protected by relocating it behind the mobilised ascending colon.

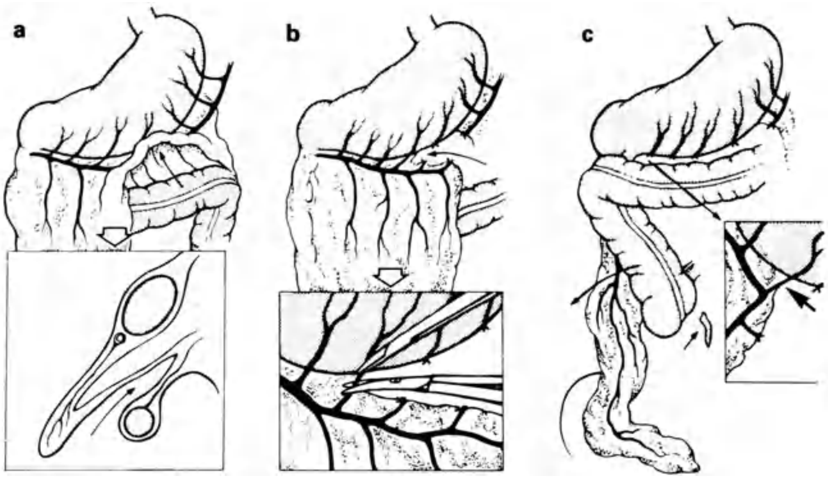



**Fig. 26.5a–c.** Mobilisation of the right gastroepiploic pedicle of the omentum requires meticulous vascular technique. **a** Separation of the transverse mesocolon by development of the avascular tissue plane is always advisable to prevent postoperative displacement of the redeployed omentum by gaseous bowel distension. **b** Ligation in continuity reduces the risk of developing an interstitial haematoma; ligation between haemostats risks vessel-escape. Absorbable ligature material should always be used. **c** Once started, mobilisation of the right gastroepiploic vessels from the stomach should be extended to their gastroduodenal origin, otherwise tension on the pedicle at the point of the last undivided branch may rupture it.

5. A prophylactic appendicectomy is generally advisable to avoid the risk of surgical damage to the pedicle as a result of a subsequent fortuitous acute appendicectomy immediately adjacent to it.

6. Gastric suction is often required for 4–5 days after an extended mobilisation of the gastroepiploic pedicle for the management of a reactionary intestinal ileus. Gastrostomy tube drainage is a humane alternative to a nasogastric tube and, because the stomach has already been exposed, this is not a difficult procedure; however, because a simple gastrostomy can leak after removal of the catheter, an appropriate invaginated tunnel procedure must be used.

7. It is fundamentally important to remember that there is only one omentum and that it is a major disaster for the patient if the blood supply of this is damaged by surgically incompetent mobilisation of its vascular pedicle.

## Failure of Omental Pedicle Graft Repairs

The reliability of an omental pedicle graft fistula repair can and should be very high. Thus, it is generally possible to attribute a failure to one or two of three shortcomings:

1. Failure to develop a sufficiently wide abdomino-perineal interposition tunnel
2. Failure to mobilise an adequate bulk of omentum

3. Impairment of the blood supply of the omentum by inappropriate mobilisation of its vascular pedicle (see Fig. 26.3).

## "Space-occupying" Caecocolo-vaginoplasty

A caecocolo-vaginoplasty is sometimes valuable as a space-occupying procedure in pelvic surgery when, even after meticulous mobilisation of its pedicle, there is an insufficient bulk of the omentum to fill a "dead space" in the pelvis (Turner-Warwick 1986a) (Fig. 26.6). In such cases the well-vascularised wall of the inverted caecal segment provides a mucosal lining for the "vaginal" cavity which creates only a minimal and inoffensive mucus discharge. This procedure is particularly useful in the resolution of complex irradiation vesico-vagino-rectal damage requiring the extensive resection of the fibrosis of a "frozen" pelvis, the stenotic and restoration of bowel continuity by colo-anal anastomosis.

Furthermore, the value of this procedure is not confined to the female; it is a valuable alternative to wound-space packing after an abdomino-perineal resection of the rectum in the male, and it is particularly

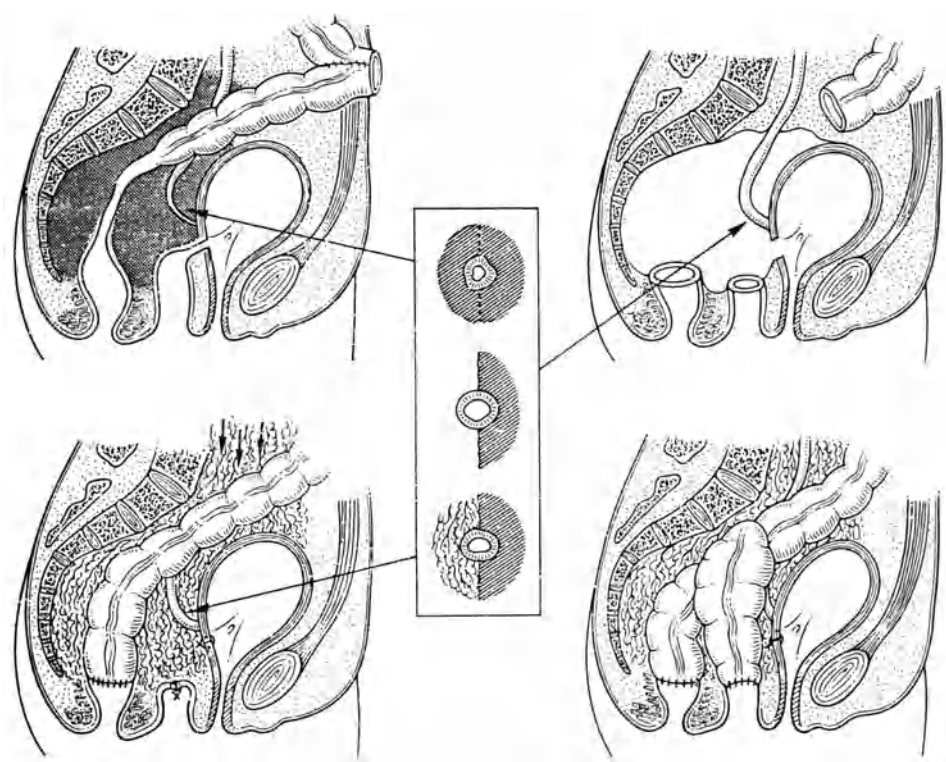


**Fig. 26.6.** The resection and replacement of irradiation fibrosis—"the frozen pelvis". Extensive resection of the fibrosis results in rigid-walled cavity. Restoration of bowel continuity by colo-anal anastomosis is usually possible and "hemi-liberation" of obstructive ureteric encasement avoids the risk of necrosis resulting from circumferential mobilisation. The pelvic dead-space is best filled by mobilised omentum when sufficient is available, otherwise the caecum can be used as a space-occupying procedure.

indicated for this after a preoperative course of irradiation that can otherwise delay the natural granulation-occlusion of the cavity indefinitely.

## Repair of Vesico-vaginal Fistulae

It is always advisable to use Turner-Warwick's PAPA procedure for the repair of a vesico-vaginal fistula because it enables the procedure to be appropriately adapted to the findings at the time of operation (Turner-Warwick et al. 1967, Turner-Warwick 1986b).

### Vaginal Approach

Because the vaginal approach to a vesico-vaginal fistula is inherently somewhat restricted, the widest possible retraction and stay suture traction exposure is important. The Turner-Warwick perineal ring retractor, with appropriate deep blades and stay-suture-traction guide-knobs, provides much better exposure for the repair of these than the traditional gynaecological weighted Auvard retractor.

### Abdominal approach

The abdominal approach can be used for the repair of any vesico-vaginal fistula, high or low, and many urological surgeons find it technically easier than the vaginal approach; certainly it is much more reliable for the repair of difficult fistulae and it is essential for the repair of complex fistulae that require an interpositional omental graft and for those involving the ureter. However, even when the need for an abdominal approach is a foregone preoperative decision, the PAPA procedure is still advisable because it not only enables a finger in the vagina to be used as a guide to facilitate the development of the vesico-urethral/vaginal tissue plane but it is also essential for the development of an abdomino-perineal tunnel for an interpositional omental pedicle graft and its distal vaginal anchorage (Fig. 26.7).

### Transperitoneal Supra-vesical Fistula Exposure

The transperitoneal posterior vesical approach is always preferable for the abdominal repair of vesico-vaginal fistulae; the traditional anterior transvesical approach provides a relatively poor exposure. The initial intraperitoneal incision is made in the vesico-vaginal peritoneal fold and the posterior wall of the bladder is opened in the midline just above the fistula. The separation of the vagina from the bladder around the fistula is

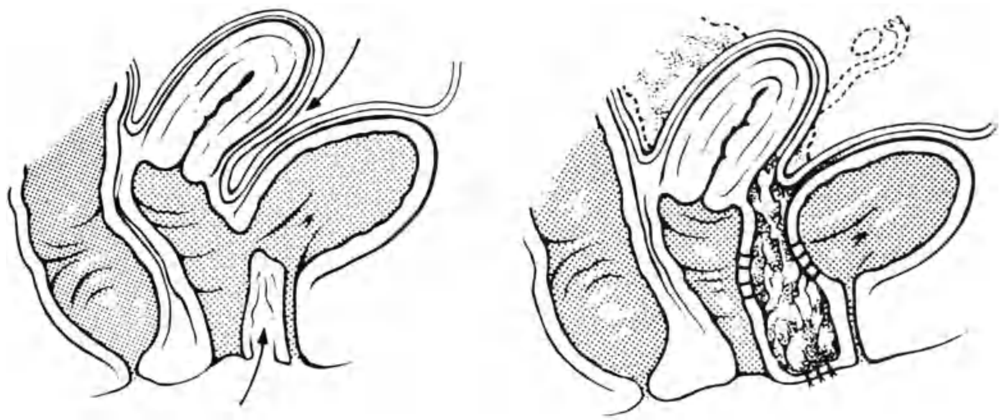


**Fig. 26.7.** Omental interposition for a complex vesico-vaginal fistula after the creation of a wide intervening abdomino-perineal tunnel.

facilitated by an orientating finger in the vaginal vault. The vaginal vault and the bladder are closed with 3-0 polyglycolic acid (PGA) sutures. A wide exposure of the fistula area is thus provided and a direct extravesical exposure of the terminal ureter is easily obtained if its reimplantation into the bladder is indicated. Efficient retraction is maintained by the elevating stay sutures. The transperitoneal supra-vesical approach to a fistula is also basic to the creation of the abdomino-perineal tunnel when this is required for an interpositional omental pedicle graft to support the closure of a complex fistula.

However, when the posterior wall of the bladder is indurated and fibrotic, as it often proves to be in irradiated fistulae, it is important that the fistula-exposing incision in the posterior wall of the bladder should not be midline but curved laterally as far as possible to achieve a tension-free suture line closure of the fistula by rotating the eccentric bladder flap: under such circumstances, a vertical incision in a scarred posterior bladder wall sometimes proves difficult or impossible to close.

## Omental-Interposition Repair of Vesico-vaginal Fistulae

The omentum can be used to repair extensive tissue-loss and post-irradiation vaginal fistulae extending into the rectum (Figs. 26.8, 26.9). Such complex fistulae are most commonly the result of trauma or the treatment of carcinoma of the cervix by the combination of a radical hysterectomy and irradiation.

It is essential for omental-interposition repair that a wide abdomino-perineal tunnel that will accept four fingers in the adult is created in the tissue plane between the vagina and the bladder. The bladder and vagina are closed with interrupted PGA sutures; the knots of these lie within the respective lumina as far as possible, so that eventually their summated bulk becomes detached and voided, thus reducing the tissue reaction to a minimum. The bulk of omental graft is interposed and its distal margin included in the introital skin sutures (see Fig. 26.7).

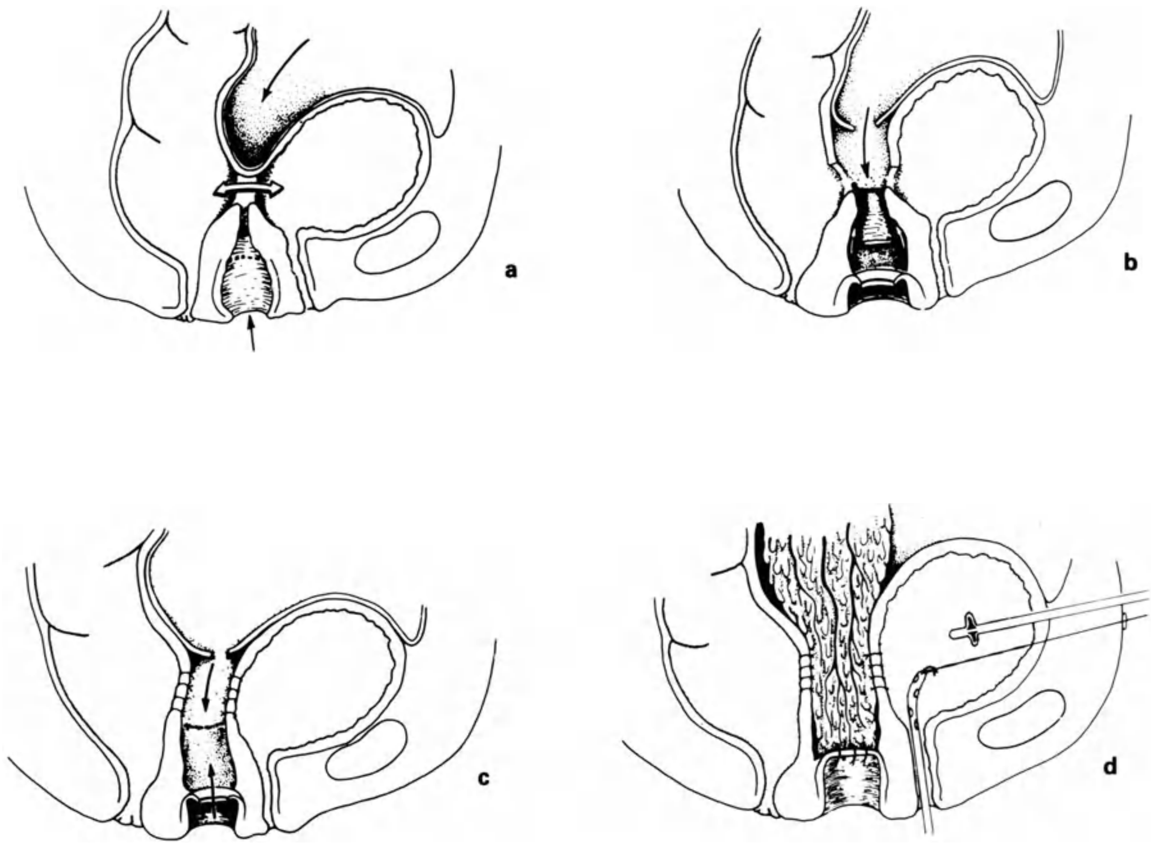


**Fig. 26.8a–d.** The closure of a complex vesico-vagino-rectal fistula achieved by **a,b** excising the stenotic vault of the irradiated vagina to create **c,d** the wide abdomino-perineal omental-interposition tunnel.

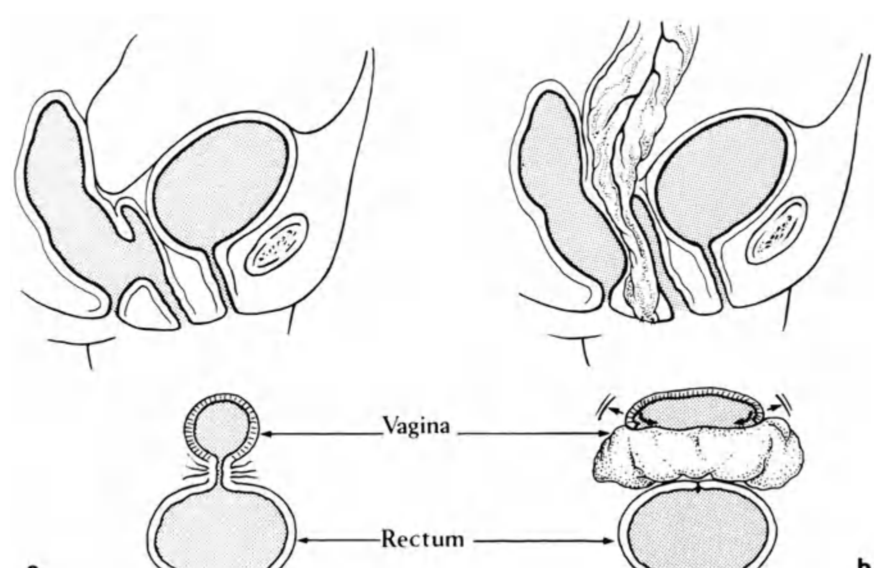



**Fig. 26.9a,b.** **a** Complex neo-vaginal rectal fistula after skin graft vaginoplasty for atresia closed by **b** separation lateral fixation of the neo-vaginal strip and omental interposition, the exposed surface of which re-epithelialises.

Provided there is an adequate bulk of well-vascularised omental graft with a good lateral overlap of the suture line, the recurrence of a urinary fistula is exceedingly unlikely; even if the suture line of a heavily irradiated bladder breaks down, the omentum exposed to the lumen of the bladder rapidly urothelialises.

After irradiation the vault of the residual vagina is usually stenosed and surrounded by dense irradiation fibrosis. The simplest way of resolving this situation is to circumcise the lower vagina, removing its scarred vault and interposing the bulk of the omentum between the fistula closure suture lines of the bladder and the rectum. It is particularly important that the width of the abdomino-perineal tunnel should extend across the full width of the pelvic cavity: the creation of this often involves extensive resection of the irradiation fibrosis of a "frozen" pelvis laterally.

## Irradiation Fistulae and Residual Tumour

There is always a possibility that there are residual tumour cells in the fibrosis associated with an irradiation fistula, even when a preliminary biopsy proved negative and even if the treatment was concluded 10 or 20 years previously. The presence of microscopic tumour in dense irradiated fibrosis is not necessarily a contraindiction to the omental closure of a fistula; however, this situation requires thoughtful qualification and considered clinical judgment.

It is clearly inappropriate to attempt to close a fistula when the bulk of the induration associated with it is active, recurrent macroscopic tumour. However, when a representative biopsy simply shows a few residual cells in extensive irradiation fibrosis, this may indicate that the local tumour situation is relatively quiescent; under these circumstances, because the prognosis is consequently poor, it is all the more important to resolve the incapacitating incontinence as swiftly and as efficiently as possible. Closure of the fistula with omental support is not only a considerably simpler surgical procedure than a uretero-ileal surface conduit but it offers patients a good chance of normal urinary voiding and control for their remaining months.

## Postoperative Urinary Drainage

Suprapubic urinary catheter drainage should be used as a routine postoperative procedure after any vesical fistula repair: it is efficient, reliable, and less uncomfortable than a urethral catheter. Furthermore, at the conclusion of the drainage period it is easy to verify the restoration of voiding efficiency by clamping the suprapubic drainage and checking the post-voiding residual urine volumes before removing it; this compares favourably with the emotionally charged situation which arises when a urethral catheter has to be re-inserted repeatedly—the "yo-yo catheter".

An additional urethral catheter may be advisable; however this must be retained by a sling suture with a button on the abdominal wall. A balloon-retained urethral catheter is most inadvisable because inadvertent traction upon it can be disastrously disruptive.

Suction urinary drainage systems are unnecessary. Unfortunately, however, the calibre of the connecting tube of many standard drainage bag systems is so large that they have a tendency to retain air bubbles, and fluid levels in a hanging loop at the bedside create a positive hydrostatic pressure resistance to the flow of urine. If the internal diameter of the connecting tubing is not much larger than the lumen of the catheter it is draining, it remains bubble free and creates a natural syphonic suction. However, unobstructed urinary drainage is all that a fistula repair requires; hence the added safety of using both suprapubic and urethral catheter drainage.

## Timing of a Fistula Repair

It is impossible to generalise usefully about the timing of a fistula repair; this is determined by clinical estimation of the healing potential of the local tissues of a particular patient in relation to the proposed procedure. In general, a multi-procedural repair is somewhat easier in the female than in the male because both the abdominal and the perineal access is better: a rectal-closure covered by defunctioning loop ileostomy is simple; a urethral closure generally involves a reduction sphincteroplasty (Turner-Warwick 1976); and the omental-interposition graft, extending down to the lower segment of the vaginal suture line, may or may not be combined with a caecolo-vaginoplasty (Turner-Warwick et al. 1967) (see Fig. 26.6).

If a repair is to be entirely dependent upon a layer-closure it is obviously very important that the local tissue be in the best possible condition. It is generally preferable to resolve the problem of a simple traumatic or postoperative fistula by early exploration, within a few days, before a compromising degree of tissue healing reaction has developed. However, once this is established, it is usually better to wait several months until the local inflammatory response has stabilised as much as possible.

Although it is obviously important to ensure that any acute inflammatory element or haematoma is resolved, the timing of a fistula repair is relatively less critical when the success of the procedure is largely dependent upon an interposed omental pedicle graft; not only has this procedure enabled us to repair fistulae caused by permanent severe tissue damage or loss resulting from infection, trauma or irradiation that were far beyond the potential of a layer-closure procedure, but the timing and the repair can be less critical.

The timing of a repair must be considered carefully in relation to each individual fistula. It is generally unjustifiable to use a relatively major abdomino-perineal procedure involving a full-length median incision for the repair of a simple fistula when, by waiting a few months, this can be simply repaired by a vaginal-approach layer-closure procedure. However, there are occasions when the ultimate repair is clearly going to require the omental position, so that, provided any coincident infection has been reduced to a minimum and there is no haematoma mass, it may be unnecessary to wait for maximal resolution of the local tissue reaction.

## Recto-urethral Fistulae

The PAPA procedure is equally important for the resolution of recto-urethral fistulae in the male. With appropriate ring retraction (see Fig. 26.1) it provides good exposure for a simple perineal layer-closure procedure when this proves appropriate, and it is essential for complex cases, which invariably require a synchronous abdomino-perineal approach because it is impossible to achieve adequate exposure of the back of the prostate from an abdominal approach alone.

### Procedure Options for the Repair of Recto-urethral Fistulae

With the exception of the congenital variety, it is rarely appropriate to endeavour to close a recto-urethral fistula by simple separation and layer-closure; this is because the majority are either associated with a tissue deficiency, which precludes a sutured overclosure of the prostatic or membranous urethra, or an aetiological abnormality of the local tissue healing, resulting from infection, irradiation or colitis etc.; thus reliable success commonly depends upon an appropriate interpositional tissue inlay.

In addition to the creation of an interposition tissue-bulk that effectually reconstructs the recto-urethral septum, the natural vascularisation and healing characteristics of an omental pedicle graft combine to make it the most reliable procedure for closure of complex recto-urethral fistulae, especially when the local tissue healing is compromised as a result of infection, irradiation or conditions such as Crohn's disease or colitis. For less complicated fistulae a relatively simple interposition may be sufficient, and this can be achieved by an inlay of the subcutaneous tissue of the scrotum using the drop-back procedure primarily designed for scroto-urethral inlay urethroplasty (Turner-Warwick 1968). When a midline perineal incision is closed horizontally the scrotum drops back towards the anal margin so that a good bulk of the intertesticular subcutaneous tissue can be inlaid up to the level of the upper border of the prostate and sutured in position without significantly invaginating the scrotal skin itself. When a larger bulk of interpositional tissue is required the gracilis muscle can be mobilised on its pedicle and inlaid. However, skeletal muscle interposition is relatively unsuitable for situations associated with infection, which it resists relatively poorly.

## Technical Aspects

The separation of the anterior wall of the rectum from the back of the prostato-membranous urethra by a perineal approach is by no means an easy procedure, even when the tissue layers are normal; the endeavour must be to stay as close to the rectal wall as possible to avoid increasing the existing injury to the urethral mechanism and the nervi erigentes.

The dissection through a midline perineal incision is greatly aided by a finger in the rectum; this ensures that the plane of sharp dissection is close to its wall. An additional hole in the rectum is of no consequence when the repair is covered by a temporary proximal loop-ileostomy. The anterolateral wall of the rectum is mobilised into a supple plane so that it drops back when the defect in it is closed either vertically or horizontally, as appropriate.

However, if the induration associated with the fistula extends upwards, an early extension of the procedure to a synchronous abdomino-pelvic approach is advisable to define the appropriate layer of separation from above. The secret of finding the recto-vesical tissue plane in the abdomino-pelvic approach is finger-tip dissection behind the seminal vesicles after the incision of the pelvic floor peritoneum. It is usually possible to develop this incision down to mid-prostatic level without sharp dissection and thus "seek out" the layer of fascia in front of the rectum by synchronous abdomino-perineal palpation.

The common problem presented by a prostato-rectal fistula is lack of sufficient residual tissue on the back of the prostate to enable the urethra to be overclosed; any lateral dissection endeavouring to achieve this greatly increases the risk of injury to the nervi erigentes and subsequent impotence. Hence, the extremely reliable omental-interposition procedure is generally preferable to an attempt at a two-layer closure, the urethra being left open with simple fenestrated urethral catheter drainage.

## Congenital Recto-urethral Fistulae

For many years congenital recto-urethral fistulae have been treated by separation and a rectal pull-through in infancy. However, the results of many of the early operations often left much to be desired: sometimes there was a persistent fistula, sometimes an extensive posterior urethral diverticulum with a bowel lining, and sometimes a grossly patulous and incontinent asensory perineal colostomy. Consequently "retrievoplasty" procedures are often required, involving:

1. Trimming of the urethral diverticulum or fistulous orifice to create a posterior urethra of normal and even calibre.
2. Reconstruction of a recto-urethral septum by an appropriate interposition graft.
3. A revision anoplasty, commonly involving a posterior repositioning of the bowel in relation to any potentially functional element of the

puborectal levator musculature. The inlay of a posteriorly based inverted V-shaped flap of perineal skin into the neo-anal canal in an endeavour to create an element of faecal passage sensation, and an anterior neo-anal calibre-reducing resection/reconstruction.

## Perineal Lacerations

Extensive perineal lacerations commonly result either from road traffic accidents or gunshot injuries. Loss of perineal skin is commonly associated with avulsion of the posterior bulbar and sometimes the membranous urethral sphincter (but usually with preservation of the bladder neck mechanism). The anal sphincter mechanism is often avulsed, or detached and dislocated, and this can result in a cloacal recto-urethral fistula.

It is generally possible to achieve:

1. Restoration of perineal bowel opening in relation to a reconstruction of any surviving pelvic floor levator and anal sphincter musculature.
2. Restoration of urethral continuity by one of the augmented roof-strip procedures (Turner-Warwick 1973, 1983).
3. Reconstruction of the recto-urethral septum by an omental pedicle graft (Turner-Warwick 1973).
4. Overclosure by appropriately redeployed pedicled skin flaps.

## Surgical Injuries in the Male

### *Transurethral Resection Recto-urethral Fistulae*

In the absence of complicating factors such as carcinoma of the prostate or rectum, rectal fistulae resulting from transurethral prostatic resection tend to be associated with minimal damage to the surrounding tissues. A tissue-loss defect of the posterior prostatic capsule precludes its closure, although the small fistulous orifice in the rectum is easy to mobilise and close by a simple perineal-approach procedure.

When a satisfactory urethral overclosure cannot be achieved by suture approximation of the prostatic capsular margins an interposition graft certainly reduces the incidence of fistula recurrence. For such cases a major extension of the procedure to obtain an omental or gracilis muscle graft may not be appropriate unless the fistula is recurrent after a previous repair failure. However, the simple interposition of the bulk of the inter-testicular scrotal tissue, is redeployed by a horizontal closure of the midline perineal-approach incision – after the principle of the Turner-Warwick drop-back scrotal-inlay urethroplasty procedure (Turner-Warwick 1968, 1983) – is often effective.

### *Rectal Surgery Injuries*

Surgical injuries to the posterior urethra are not uncommon in the course of operations involving the separation of the natural adhesions of the anterior rectal wall to the perineal body and the posterior surface of the prostate; these may result in the development of a urinary fistula, either of the perineum into the rectum, or, if this has been removed, into the consequent excisional cavity. When they persist, the choice of a definitive closure procedure is naturally dictated by the availability of layer-closure tissue, but when this is deficient an interposition graft is commonly required. An omental pedicle graft is particularly reliable, but when this is not available the alternatives of gracilis muscle or a bowel-lined "vaginal" cavity have to be considered (see Fig. 26.6).

### *Impotence after Recto-urethral Fistula Repair*

Erection failure, usually resulting from injury to the nervi erigentes lying posterolateral to the prostato-membranous urethra, is a potential complication of the surgical dissection behind and lateral to the prostate that is required to mobilise the margins of a prostato-urethral fistula for a layer-repair overclosure procedure. The nervi erigentes are particularly vulnerable in a perineal-approach procedure because they tend to be embedded in the fibrosis of the "perineal body" and, especially when this is augmented, they are virtually impossible to visualise from this aspect without injury.

While it is generally impossible to guarantee that impotence will not result from surgical closure of a recto-urethral fistula, the best chance of avoiding this complication is by:

1. The avoidance of a lateral, and especially anterolateral dissection immediately behind the prostato-membranous junction in the course of a layer-closure procedure.
2. The use of an interpositional omental pedicle graft procedure in which the width of the abdomino-perineal closure is obtained by bilateral dissection in a *posterolateral* direction as close as possible to the anterior rectal wall (facilitated by scissor-dissection guided by a finger in the rectum), limiting the anterior dissection of the urethral

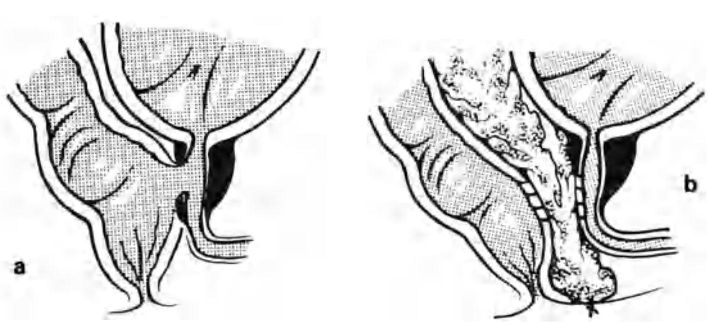


**Fig. 26.10a,b.** **a** Prostato-rectal fistula closed by **b** abdomino-perineal separation tunnel and omental interposition.

orifice of the fistula to a midline de-epithelialisation of its lumen, which is left unclosed

In our series of recto-urethral fistula repairs, a particular endeavour to avoid the complication of impotence has been the reason for selecting a procedure relying upon simple interposition graft in some cases that were otherwise potentially suitable for a simple two-layer closure operation (Fig. 26.10).

## Pelvic Fracture Urethral Injuries

The urethra is damaged in about 10% of pelvic fracture injuries and only about 10% of these result in the development of a complex as opposed to a "simple" stricture (Turner-Warwick 1973, 1983, 1988). However, because of the selection inherent in the referral of patients, some 250 of our series of more than 450 pelvic fracture urethral distraction defects (PFUDDs) proved to be complex; coincident recto-urethral injury or fistulae were present in about 15% of these.

When a rectal fistula complicates a pelvic fracture urethral distraction injury the fistulous track is usually very narrow and surrounded by dense haematoma fibrosis so that after a perineo-transpubic-approach restoration of urethral continuity by a spatulated bulbo-prostatic anastomosis, the fistulous track is occluded, without an attempt at formal closure, by the omental pedicle graft that we routinely use to obliterate the fibro-osseus dead-space surrounding the anastomosis (Fig. 26.11) (Turner-Warwick 1973, 1983).

Thus, the closure of a coincident rectal fistula in the course of a definitive one-stage multi-procedural reconstruction of a complex pelvic fracture urethral distraction injury does not complicate it significantly (Turner-Warwick 1973, 1983). In practice, the fistulous track into the rectum is usually narrow and one of many ramifying in the mass of subprostatic haematoma-fibrosis so that after the synchronous abdomino-perineal excision of the bulk of this and the restoration of urethral continuity by bulbo-prostatic anastomosis, the omental pedicle graft which we routinely use to support the urethral repair and to fill the surrounding dead-space automatically occludes the short residual fistulous track into the rectum without the need for any suture closure of it; however, in such cases the procedure is of course covered by a proximal loop-ileostomy (which is generally preferable to a colostomy) (Turner-Warwick 1968, 1983).

## Gunshot Wounds

Penetrating gunshot wounds involving a localised injury of the rectum and the posterior urethra ultimately result in a wide variety of complex recto-urethral fistulae, usually associated with extensive scarring and tissue loss. While it is almost always possible to restore both bowel and

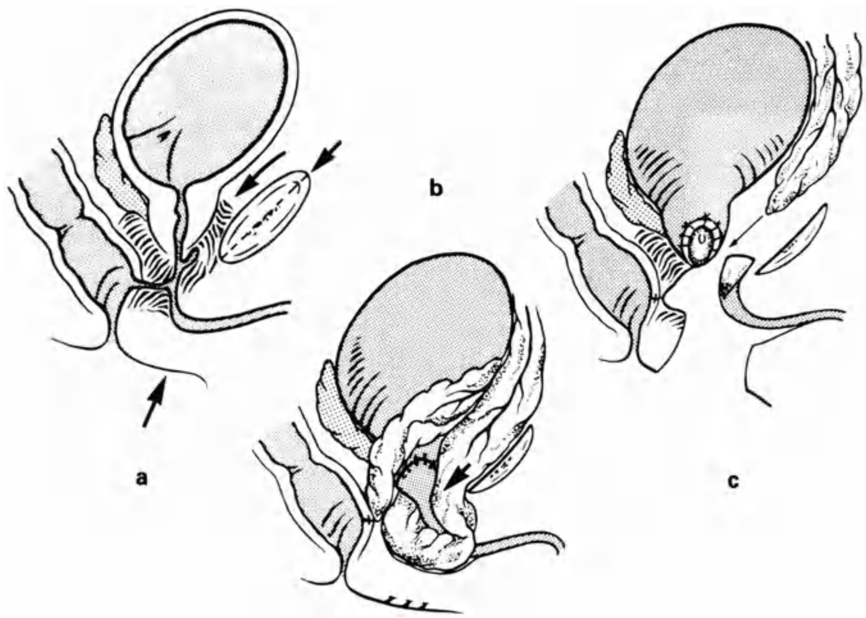



**Fig. 26.11a–c.** **a** A prostato-rectal fistula associated with a pelvic fracture urethral distraction defect is reliably resolved by **b,c** the Turner-Warwick omentum-supported bulbo-prostatic anastomotic repair.

urethral continuity after a localised defect, and to achieve satisfactory healing of these reconstructions if an omental pedicle graft is available, the functional result of both is naturally dependent upon the survival of the anal sphincter and of either the bladder neck or the distal urethral sphincter mechanisms.

# References

Turner-Warwick R (1968) The repair of urethral strictures in the region of the membranous urethra. J Urol 100: 303–314

Turner-Warwick R (1973) Observation on the treatment of traumatic urethral injuries. Br J Surg 60: 775–781

Turner-Warwick R (1976) The use of the omentum in urinary tract reconstructions. J Urol 116: 341–347

Turner-Warwick R (1983) Urethral stricture surgery. In: Glenn J, Boyce G (eds) Urologic surgery, 3rd edn. Lippincott, Philadelphia, pp 689–719

Turner-Warwick R (1986a) The repair of urinary tract fistulae. In: Williams DI (ed) Operative surgery: urology. Butterworth, London, pp 374–391 (Rob and Smith's Operative surgery, 4th edn)

Turner-Warwick R (1986b) The repair of vesico vaginal fistulae. In: Walsh PC et al. (eds) Campbell's urology, 5th edn. Saunders, New York, pp 2718–2738

Turner-Warwick R (1987) Pelvic surgery – a horizontal speciality. Gordon Taylor Lecture (to be published)

Turner-Warwick R (1988) Urethral stricture surgery. In: Mundy AR (ed) Current operative surgery: urology. Baillière Tindall, pp 160–218

Turner-Warwick R, Wynne ECJ, Ashken MH (1967) The use of the omental pedicle graft in urinary tract reconstruction. Br J Surg 54: 849–853

*Chapter 27*

# Transpubic Urethroplasty

*A. R. Mundy*

## Introduction

"Transpubic urethroplasty" is the term generally applied to the operative correction of post-traumatic strictures of the membranous urethra, particularly those following pelvic fractures; thus the term "pelvic fracture stricture" is a useful specific descriptive term. There are three basic types of pelvic fracture stricture: strictures without urethral disruption, in which case the stricture behaves much the same as other "sphincter strictures"; strictures where there has been urethral disruption but no distraction of the two ends; and strictures in which there has been urethral distraction to a considerable degree, or which are associated with other complications.

The aim of treatment of sphincter strictures is to preserve the function of the sphincter as far as possible. If the bladder neck is competent, sphincter damage may in fact go unnoticed, as the bladder neck should maintain continence unless there is coincident detrusor instability. Sphincter strictures are therefore best treated by dilatation as far as possible. Because of the generally small associated tissue damage around the stricture any post-traumatic "sphincter stricture" that does not respond to dilatation alone can be treated by a simple transperineal excision and end-to-end bulboprostatic anastomosis.

Strictures with urethral disruption but no significant distraction may also be amenable to endoscopic treatment—in this case by visual urethrotomy—because the characteristic deformity is for the proximal end of the bulbar urethra to come to lie in front of the distal end of the prostatic urethra producing an inferior shelf on endoscopic view rather than a true stricture which may be amenable to direct incision. Again, if endoscopic treatment is unsuccessful in resolving the stricture then the comparatively minor degree of associated tissue damage means that a transperineal excision of the stricture and end-to-end bulboprostatic anastomosis will usually resolve the problem adequately.

It is the more complex stricture problems involving distraction of the two ends and other associated complications that generally require the so-called transpubic urethroplasty approach. It has to be said that a considerable mystique has developed around the subject of transpubic urethroplasty, and this mystique distracts from the important points in technique. The actual bulboprostatic anastomosis is in fact remarkably easy to perform. What is difficult is the mobilisation required to allow the anastomosis to take place. This mobilisation is complicated when there are problems other than the distance between the two ends of the urethra such as massive fibrosis, fistulae, abscesses, stones, false passages, bladder neck incompetence or associated bulbar strictures.

Such a complex reconstruction may take four to six hours and the blood loss during mobilisation may be considerable. Two days preoperative assessment are usually necessary to be sure that the patient is fit for surgery (although they are usually youngish men) and to ensure, more importantly, that the urine is sterile and that adequate blood is cross matched. Four units of blood are usually adequate, at least in the first instance.

## Operative Technique

The patient is placed in the low lithotomy position and draped to allow a full exposure of the abdomen and perineum. A preliminary urethroscopy is performed to ensure the normality of the bulbar urethra. The importance of this cannot be overemphasised as the success of bulboprostatic anastomosis is dependent upon the normality of the bulbar urethra. Even if the bulboprostatic anastomosis itself were to prove satisfactory, then the presence of associated bulbar abnormalities at the time of transpubic repair is likely to be complicated by postoperative bulbar strictures.

It is also important to emphasise that a radiologically normal urethra may be endoscopically abnormal as the radiology only shows the calibre of the urethra and the smoothness of the urethral wall. On the other hand, radiology demonstrates false passages and communications proximal to the stricture that may not be seen by endoscopy.

The operation begins with a midline lower abdominal incision down from the umbilicus well over the anterior aspect of the pubis. Subsequently, the incision may need to be extended upwards to allow omental mobilisation, which is a crucial factor at the end of the operation in reducing the long-term complication rate. At the early stage of the procedure, however, only the lower half of this wound need be opened and this reduces peroperative fluid loss and makes wound retraction easier by keeping the peritoneal contents out of the way.

The incision is deepened to expose the bladder extraperitoneally, and an adequate retractor (in the present author's opinion only a ring retractor is adequate) is inserted. Fibrous tissue on the anterior and lateral aspects of the bladder neck and prostate is then excised. This is easy to say; it is not so easy to do, particularly as it is important not to damage the bladder, bladder neck or prostate during excision of the fibrous tissue. It is therefore important to keep close to the pelvic side walls during the mobilisation and excision of the fibrous tissue thereby taking best advantage of any tissue planes that still exist. It is also an advantage to open the dome of the bladder at an early stage of the procedure so that by feeling the inside of the bladder the risk of damaging the bladder neck area may be reduced to a minimum. Early inspection of the inside of the bladder also allows identification of any false passages. Once the fibrous tissue has been mobilised off the pelvic side wall and pubic symphysis down as far as the upper limit of the stricture, this tissue can then be dissected off the bladder, bladder neck and prostate till only healthy tissue is left.

After the fibrous plaque has been excised, the apex of the prostate and the subprostatic stricture segment are exposed; this is usually obscured by the overhanging convexity of the posterior aspect of the pubis. For this reason, the posterior aspect of the pubis needs to be removed, and this is best achieved by chiselling it away with either a gouge or a chisel, cutting a trench approximately 5 cm wide through the posterior aspect of the pubis. It should be emphasised that it is the posterior aspect of the pubis that needs to be removed, not the superior aspect.

When chiselling through the pubis for the first time the surgeon tends to worry about the chisel slipping at the lower end of the trench and causing torrential bleeding from damage to the dorsal vein complex and further damaging the urethra on either side of the stricture. In point of fact this never happens, because the dorsal vein complex is usually thrombosed off as a result of the original injury and because the periosteum at the lower end of the trench usually holds up the gouge when the bone itself has been cut through. Usually, the final stages of clearing a trench requires the use of bone nibblers and the cutting diathermy to excise fibrous tissue from around the lower end of the "trench". To help identify the upper end of the stricture, which is the lower end of the normal urethra, a metal sound passed down through the prostatic urethra from above is helpful. The next step is to open up the apex of the prostate where the sound is palpable and then to cut away some of the apex of the prostate, preserving the urothelium so that the urothelium can then be tacked outwards to produce a sufficiently wide distal prostatic urethral end for subsequent anastomosis to the bulbar urethra (Fig. 27.1).

Any false passages anterior or lateral to the bladder neck will usually have been excised with the fibrous tissue earlier on in the procedure and all that remains at this stage is to "clean" the entry point into the bladder and to suture the entry point. Posterior false passages between the

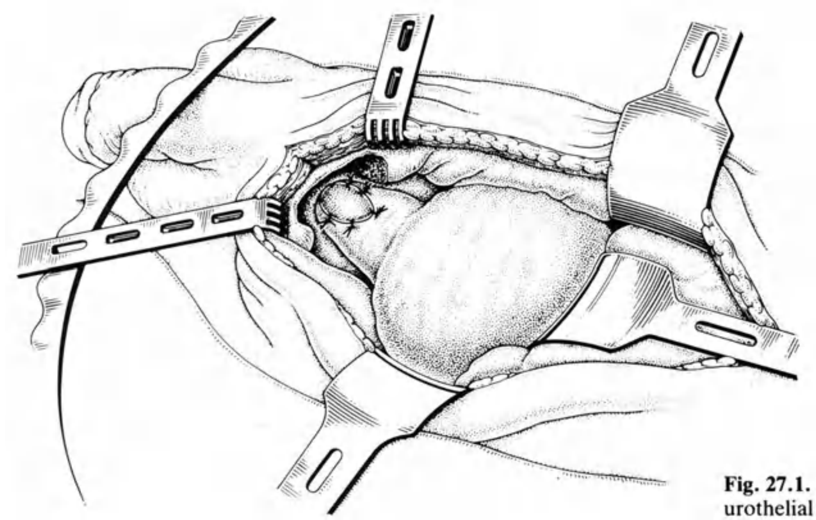


**Fig. 27.1.** Urethra divided at apex of prostate with urothelial sutures in situ.

prostate and the rectum can normally be dealt with by curettage and closure, although in some instances it is necessary to open the plane formally between the bladder/prostate and the rectum transperitoneally and then to plug this defect subsequently with omentum.

Next the bulbar urethra is exposed through a midline perineal incision. This incision is deepened down to the bulbospongiosus muscle, which is divided in the midline all the way back to the perineal body and reflected laterally. The bulbar urethra is then mobilised from the underlying corpora cavernosa by division of the midline raphe between the corpus spongiosum and the corpora. This mobilisation should be throughout the length of the bulbar urethra from the penoscrotal junction up as far as the lower end of the stricture and the fibrous tissue that surrounds it (Fig. 27.2). The bulb of the urethra is then mobilised posterolaterally from its vascular attachments and in the posterior midline from the perineal body, again going up as far as the lower end of the stricture.

When the bulbar urethra has been fully mobilised it is divided just below the stricture. Once the upper healthy end of the bulbar urethra has been defined from below and the lower end of the healthy prostatic urethra from above, all that now exists between the perineal incision and the retropubic dissection is the stricture itself and the surrounding fibrosis within the confines of the inferior pubic arch. Assuming there has not been too much bony displacement, it is usually possible to create a channel of adequate calibre through the inferior pubic arch through which the mobilised bulbar urethra can be passed with a bulboprostatic anastomosis. If the inferior pubic arch is somewhat narrow, then bone can be chipped away from between the diverging corpora cavernosa to gain some extra space. Indeed, the corpora themselves may be separated for a centimetre or two to gain some extra length, although this is often a fairly bloody procedure.

In general, if there is any extensive posterior fibrosis this should not be excised, unless it is known beyond a shadow of a doubt that the patient is

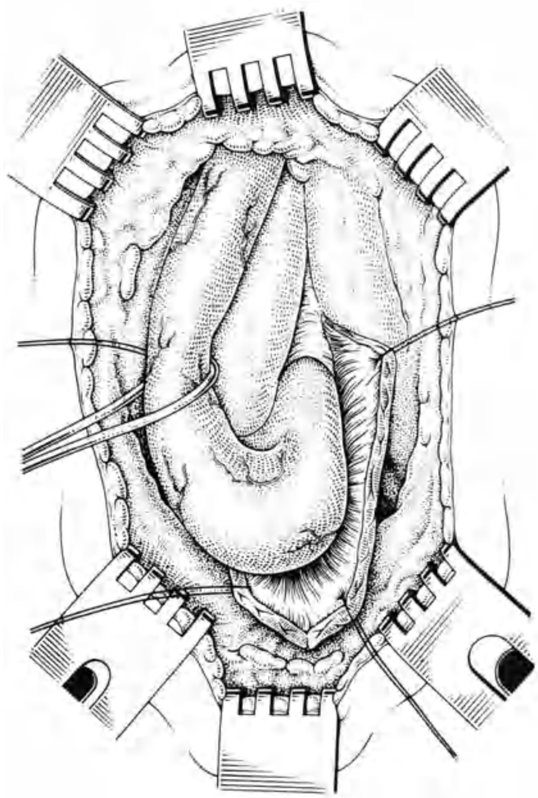


**Fig. 27.2.** Bulbar urethra mobilisation from corpora cavernosa after division of bulbospongiosus muscle.

already impotent; this is because the nerves that supply the corpora cavernosa and are responsible for erection lie on the posterolateral aspect of the prostate. If there is extensive fibrosis limiting the size of the channel that can be created to pass the bulbar urethra through to the prostate and the patient is known to be potent, then it is safest to incise this fibrous tissue keeping strictly in the midline down on to the anterior surface of the rectum, at which point the fibrous tissue will usually spring apart almost magically. A finger in the rectum during this incision is a simple precaution. Having created an adequate channel for the bulbar urethra to pass through without tension and without kinking from the inferior margin of the cut pubis one is at last ready to perform the bulboprostatic anastomosis itself.

First of all the vascularity and urothelial integrity of the cut end of the bulbar urethra must be checked; if this is healthy, an estimate is made as to whether it will reach to the spatulated prostatic urethra without difficulty. If there is any suggestion of tension with the urethra in its normal axis of rotation then extra apparent length may be gained by rotating the urethra through 180° so that the bulb comes to lie anteriorly. When the best lie is achieved the end of the urethra is spatulated so that it is of the same size as the spatulated prostatic urethra above.

Eight sutures of interrupted 3–0 Vicryl are used for the anastomosis. The first three are put in posteriorly and the knots are tied on the inside

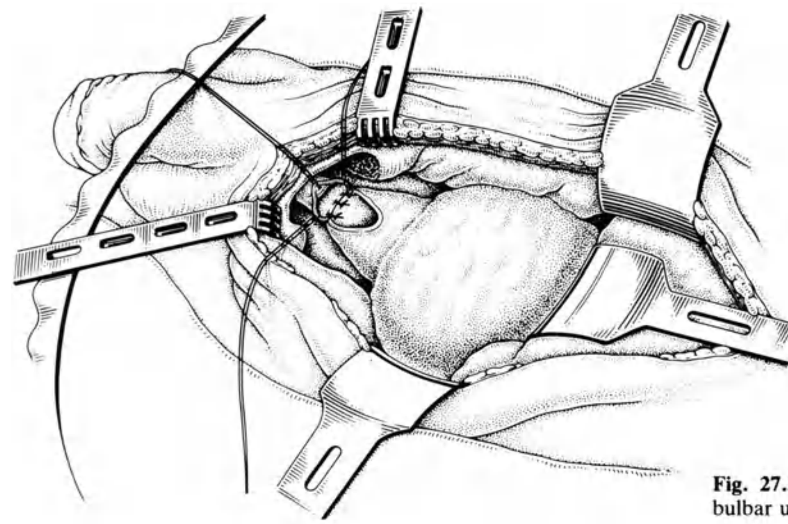


**Fig. 27.3.** Anastomosis of cut end of mobilised bulbar urethra to spatulated prostatic urethra.

(Fig. 27.3). The first one is placed in the midline and the next two 0.5 cm on either side. A suture is then placed on each side in the mid lateral point with the knots on the outside, and the final three are placed anteriorly again with the knots on the outside. By far the most important factor when placing these sutures is to ensure that there is direct mucosal apposition with each stitch.

At the end of the anastomosis a 16 FG catheter is placed to splint the anastomosis and a suprapubic catheter is placed to provide urinary drainage. A wound drain is placed in the retropubic space. Before closing the perineal wound the spongiosus is tethered to the cavernosus with a series of interrupted sutures so that if a postoperative erection occurs there is no distraction on the anastomosis. The bulbospongiosus mucle is then carefully closed over the urethra and the perineal wound is closed with a series of full-thickness interrupted mattress sutures. A gauze dressing with a pliable adhesive strip is then applied.

It is important to wrap the bulboprostatic anastomosis with omentum, and preferably also the bladder neck area, for the following reasons: firstly, and most importantly, to keep the anastomosis away from the raw bone cut in the posterior aspect of the pubis and to fill this trench; and secondly, to fill any dead space that is left in the area as far as possible. This may be possible with little or no omental mobilisation but may require full mobilisation of the omentum and retrocolic tunnelling of the omentum down into the pelvis to achieve a satisfactory lie. Tedious as it may be at the end of a long and difficult urethroplasty to spend time carefully ligating each individual branch of the gastroepiploic arcade, the importance of preventing the adhesion of the anastomosis to the raw bone of the pubis cannot be overemphasised.

## Postoperative Management

The wound drain is removed when it ceases to function—usually after a few days. It is a wise precaution to use prophylactic antibiotics, starting with the premedication and continuing for the first 5 postoperative days. After 3 weeks it can be assumed that the anastomosis has healed, provided that there has been no complication during the early postoperative period; however, before allowing full normal voiding it is wise to perform a gentle urethrogram whilst removing the urethral catheter under X-ray control. If this shows no evidence of extravasation a retrograde urethrogram is performed; if this shows no extravasation the bladder is filled with contrast through the suprapubic catheter and a voiding cystogram is performed. If this is satisfactory the catheter is then clamped for 24 h and removed when voiding is deemed to be satisfactory by patient and doctors.

A satisfactory radiological appearance 3 months postoperatively usually means that all will be well for the future. However, it is never safe to assume this, and it is wise to follow the patient up for 5–10 years, albeit on only an occasional basis.

*Chapter 28*

# Meshgraft Urethroplasty

*F. Schreiter*

## Introduction

The treatment of complicated urethral strictures presents a considerable surgical challenge to the urologist. Recurrence of the stricture, hair in the reconstructed urethra and the consequences of inflammation and stone formation often make reintervention necessary.

One of the main causes of a relatively high failure rate of between 20% and 40% is the growth of hair in the neourethra when scrotal skin is used for urethral reconstruction. Also, a lack of sufficient suitable epithelium for the repair leads to early recurrence of stricture (Bressel 1976).

Complicated recurrent strictures in patients who have had multiple previous operations and have a urethra which is completely obliterated by scar tissue formation because of chronic infection, often in the presence of stones and abscesses, cannot be effectively treated by a one-stage procedure. The classic Johanson procedure (Johanson 1953) has the disadvantage of using scrotal skin, which leads to a high failure rate of about 30% in the long-term follow-up. I have therefore developed a method of reconstruction that creates a sufficiently large area of hairless epithelium that can be fashioned into a neourethra at a second stage.

Since 1977 I have used a free foreskin transplant in a two-stage procedure for reconstruction of complicated strictures of the urethra. When preputial skin is not available, for example in circumcised patients, a 0.1 mm thin split-skin graft transplantation is performed. This split-skin graft is cut so thinly that the cut surfaces are located above the hair follicles lying deep in the epidermis. A commercially available split-skin dermatome, driven by compressed air, is used to obtain the graft.

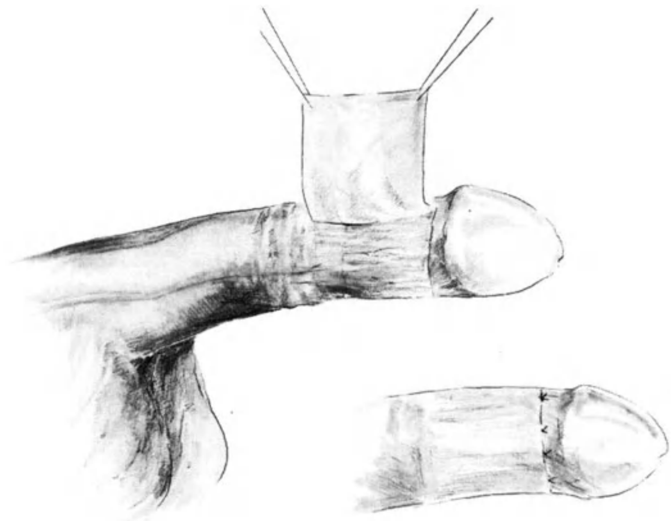


**Fig. 28.1.** Circumferential excision of retracted foreskin.

# Operative Technique

## First Stage

In an extensive circumcision, the amount of preputial skin obtained is approximately 50–60 $cm^2$ (Fig. 28.1). The inner sheet of the prepuce offers ideal conditions for a free transplant. It has a minimal tendency towards keratinisation, it is elastic and soft, and it provides enough epithelium for the new urethra.

The preputial transplant is mounted on a cork-board and the subcutaneous tissue is carefully and completely removed with scissors until the foreskin appears translucent (Fig. 28.2). If no foreskin is available, such as in circumcised patients, or if it is not large enough for long strictures, a split-skin graft is excised from the inner side of the thigh.

While removing the split-skin graft, it is important to cut the transplant thinly enough, so that the dermatome cuts the skin above the hair follicles. The slice setting on the dermatome should not be deeper than 0.1 mm. The depth is correct when the transplant shows no tendency to curl and is semitransparent.

The full-skin preputial transplant or the split-skin transplant are converted into a network by a meshgraft dermatome (Fig. 28.3). This enlarges the surface by 50%–100%, so that, as a rule, about 100–120 $cm^2$ of foreskin are available for transplantation.

The meshgraft transplant adapts ideally to the usually uneven tissue base and can be stretched in all directions. The mesh network produced

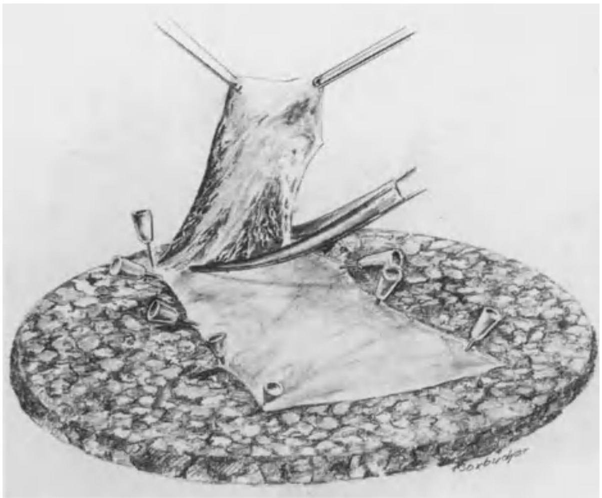


**Fig. 28.2.** Excision of subcutaneous tissue from excised foreskin.

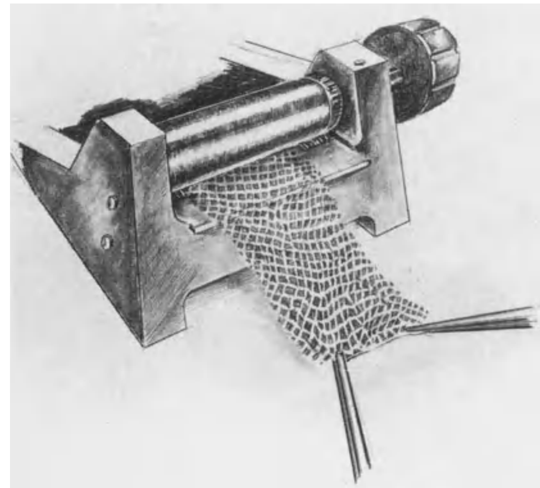


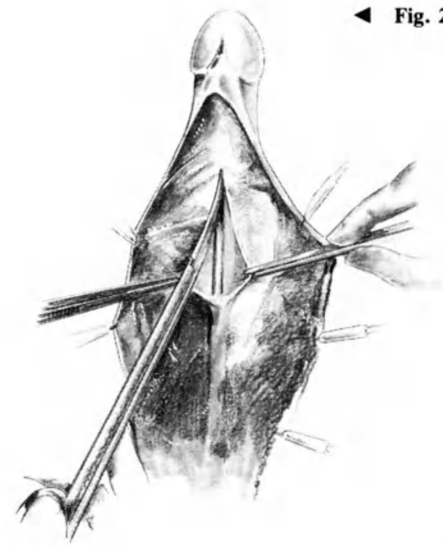
**Fig. 28.3.** Conversion of foreskin or split-skin graft into a mesh.

by the dermatome provides optimal drainage conditions for wound secretion and blood in the first postoperative phase of healing and is the single most important reason for the reliability and success of this method of reconstruction. Closed transplants, such as the unilateral free transplant patch techniques, are only perforated full-thickness skin patches (Devine et al. 1963; De Sy 1981). They often result in retention of wound secretions and blood in the early phase of healing, making revascularisation more difficult and resulting in shrinkage and restricturing of the neourethra. For this reason we prefer a two-stage procedure in which the open and dry skin graft is first transplanted, complete healing is achieved, and then, in the second stage, urethral reconstruction is undertaken. This staged reconstruction is the key to the excellent long-term results achieved by this method.

The strictured urethra is opened over a metal bougie and the entire stricture is split (Fig. 28.4). In long strictures running over the length of the urethra, the scrotum is divided at the raphe and sutured laterally over the testes. The stricture is opened, and the urethra dissected into healthy tissue.

The mesh transplant is cut into strips and adapted to the size of the tissue defect. It is sutured between the incised urethral stricture and the skin edge, using 5–0 interrupted running Monofil resorbable sutures (Fig. 28.5). The meshgraft adapts ideally to the irregular underlying tissue, achieving the tissue contact necessary for rapid revascularisation and problem-free healing of the transplant.

After completion of the sutures the transplant is covered with paraffin gauze and an absorbant but loosely applied compression dressing. This gently presses the transplant against the underlying tissue. The dressing is not removed before the fifth postoperative day in order to avoid endangering the healing process.



◄ **Fig. 28.4.** Incision of strictured penile urethra.

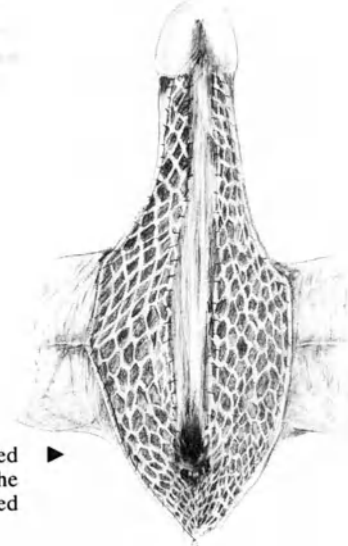
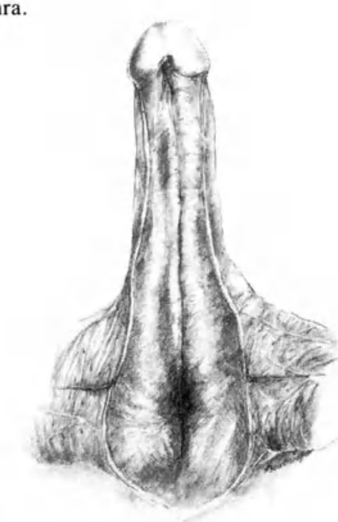


**Fig. 28.5.** Meshed skin transplant sutured between the incised urethral stricture and the skin edge. The divided scrotum is sutured laterally to cover the testes. ►



▲ **Fig. 28.6.** Appearance before commencing the second stage of the operation.

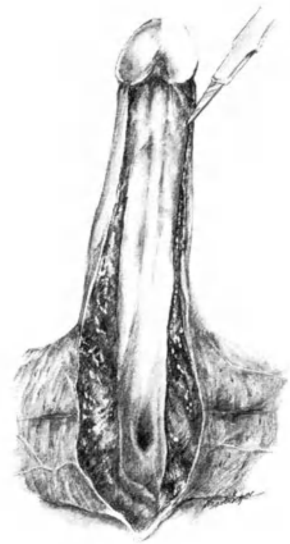
## Second Stage

Reconstruction of the urethra from the completely healed network transplant should not be undertaken before a period of 8 weeks has elapsed. The tissue defect has by then become completely epithelialised, circulation has been established in the transplant, and it is soft, free of hair and offers ideal conditions for the reconstruction of the urethra (Fig. 28.6). A large amount of tissue is always available, so that the urethra can be made as wide as desired without stretching and tension.

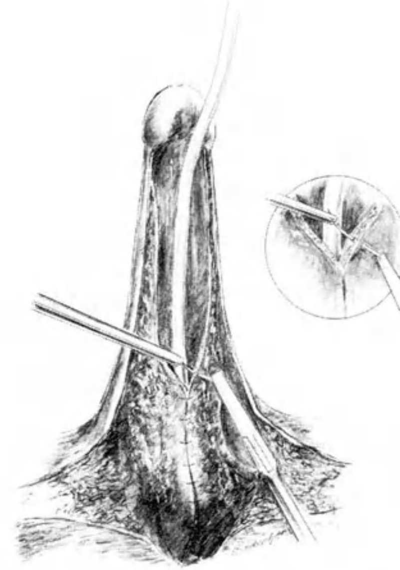
The first step of the second stage consists of performing a sufficiently wide incision around the perimeter of the transplant (Fig. 28.7). However, the epithelium should be trimmed closer at the proximal end of the new urethra, to avoid later development of a sack-like diverticulum.

To reconstitute the normal anatomy the laterally fixed scrotum is divided and dissected (Fig. 28.8). The new urethra is formed over a 24 FG catheter using inverted interrupted running sutures which do not penetrate the epidermis to prevent fistula formation (Fig. 28.9).

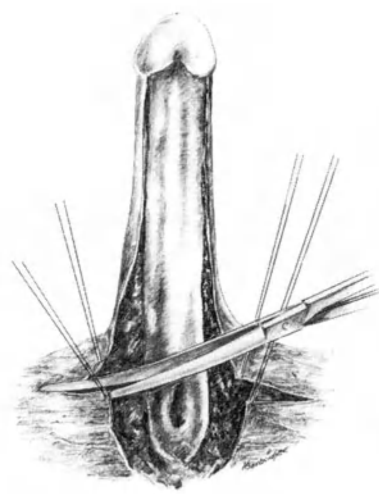
After trimming the meatal edges of the glans penis, the skin defect is covered by an asymmetric displaceable flap, using the technique of Byars (1955) and Marberger and Bandtlow (1976). The scrotal suture, which was placed during the first stage of the operation for coverage of the



◄ **Fig. 28.7.** Incision around perimeter of skin transplant.



▲
**Fig. 28.9.** Construction of neourethra over a 24 FG catheter, using invaginating sutures.



◄
**Fig. 28.8.** Division and dissection of laterally fixed scrotum.

◄ **Fig. 28.10.** Skin closure after trimming meatal edges of glans penis.

testes, is opened, and both scrotal halves approximated in the midline at the end of the procedure (Fig. 28.10). The catheter is then removed and a light compression dressing applied.

## Postoperative Measures

Urinary drainage after both stages is achieved by *suprapubic cystostomy.* The compression dressing, especially after the first stage (the free meshgraft transplantation), should not be removed before the fifth postoperative day as this may lift the transplant from the underlying tissue, thereby interfering with the healing process and possibly resulting in rejection of the graft. For the same reason the patient should not have bowel movements during the first 5–7 days (pre- and postoperative astronaut diet and immobilisation of the bowel with opium tincture). Heparinisation, in a low dose of 2 × 500 units of heparin per day, is routinely administered as a general thrombosis prophylaxis and does not lead to haemorrhagic complications.

Beginning on the seventh postoperative day after the first operative stage, the patient should take a daily sitz bath. To prevent scar tissue formation and bridges in the area of the transplant surface, a loose paraffin gauze dressing is applied between the transplant surfaces.

On the seventh day, at the earliest, after urethral reconstruction (second stage), a micturition cystourethrogram is performed via the suprapubic cystostomy. If the urethral suture proves to be watertight, the cystostomy catheter is removed.

## Long-term Results

Between 1977 and 1985, 78 patients with urethral stricture were treated operatively. The procedure was successful in 77 cases (Table 28.1). It is striking that a total of 23 patients had multiple previous operations. One of these patients, from the hypospadias group, had been treated 14 times for recurrence. Another one from the iatrogenic group was treated 11 times for recurrence.

**Table 28.1.** Results of meshgraft urethroplasty in a series of 78 patients

| | No. of patients | Successful | Failure |
|---|---|---|---|
| *Aetiology of the stricture* | | | |
| Iatrogenic | 32 | 32 | – |
| Paraplegic | 18 | 17 | 1 |
| Trauma | 13 | 13 | – |
| Inflammatory | 8 | 8 | – |
| Hypospadias | 7 | 7 | – |
| *Location* | | | |
| Distal urethra | 29 | 28 | 1 |
| Anterior urethra | 27 | 27 | – |
| Extensive stricture | 22 | 22 | – |
| Total | 78 | 77 | 1 |

In our series, there was a high incidence rate of long strictures (22 patients). All patients who had experienced no additional disturbance of micturition preoperatively had a normal urine flow postoperatively and were free of infection and a residual urine.

The long-term results determined by urethrography show no tendency to contraction of the surgically reconstructed urethra, even in the early cases treated 5–8 years ago. Our results are based on at least 2 years of repeated follow-up examinations, including retrograde urethrogram, micturition urethrogram, uroflowmetry and urethrocystoscopy. The follow-up periods vary between 2 months and 8 years postoperatively. Most cases have been followed up for longer than 2 years.

We considered a result to be good and successful when the radiological and functional results were good, that is, when a flow of at least 15 ml/s was registered and when there was no residual urine, except for the paraplegic patients; when a uniform urethra of sufficient size was seen; and when the patients were free of infection. Subjectively, the patients reported no complaints and catheterisation or urethral dilatation has not been necessary. We have not seen any case of hair in the urethra.

## Complications

The complication rate was low and not serious (Table 28.2). The operation was unsuccessful in only one paraplegic patient, who had been treated in the early stage of our experience. In this patient, the second operative stage was performed too soon after the previous split-skin transplantation, before complete epithelialisation of the transplant was achieved. In three cases meatotomy had to be performed to treat meatal stenosis, in two cases there was postoperative fistula and in five cases a supplementary transplantation had to be done because the meshgraft transplant was partially rejected after the first procedure as the result of a local wound infection or early removal of the dressing.

**Table 28.2.** Postoperative complications in a series of 78 patients treated with meshgraft urethroplasty

| | |
|---|---|
| Urethral fistula | 2 |
| Meatal stenosis | 3 |
| Supplementary transplantation | 5 |
| Complete obliteration | 1 |

## Summary

In conclusion, the meshgraft urethroplasty offers the following advantages over all available methods of open, reconstructive urethral surgery.

1. The two-stage meshgraft urethroplasty is a very reliable procedure that also assures good results in the most complicated cases, such as paraplegic patients or those who have had frequent operations, and in long, scarred strictures. The previously dreaded recurrent stricture, especially in those patients who have already undergone multiple operations (the typical stricture cripple) have not been seen at our hospital since the introduction of the meshgraft method.

2. There is no lack of skin for the reconstruction of the urethra as enough foreskin is usually available. If not, then sufficient split-skin can be obtained. A sufficiently large urethra can be created without difficulty.

3. As both foreskin and split-skin cut thinly above the hair follicles heal without hair, hair growth in the newly formed urethra has never been observed. Therefore, urinary infections can be cleared, and restricturing, stone and diverticular formation are no longer encountered.

4. The two-stage procedure guarantees optimal healing of the free transplant and abundant, elastic tissue with good circulation for the neourethra. This makes the method reliable and simplifies reconstruction. In contrast to the unilateral free transplanted patch technique and use of scrotal skin, shrinkage of the graft and restricturing are avoided.

In the course of 8 years, not one stricture recurrence was seen in the treatment of 77 of 78 patients. This is proof of the superiority and safety of this method as a two-stage procedure over all other procedures, especially for the treatment of complicated urethral strictures. The Johanson procedure has never been used in our department since the meshgraft urethroplasty was introduced.

## References

Bressel M (1976) Harnrohrenplastik mit freiem Vorhauttransplantat. Vortrag Norddeutscher Urologenkongress, Malente, 1976

Byars LT (1955) A technique for consistently satisfactory repair of hypospadias. Surg Gynecol Obstet 100: 184–186

De Sy WA (1981) Le traitement du retrecissement de furetre masculin. Acta Urol Belg 49: 93–97

Devine PC, Horton CE, Devine CJ et al. (1963) Use of full thickness skin grafts in repair of urethral strictures. J Urol 90: 67–71

Johanson B (1953) Reconstruction of the male urethra in strictures. Acta Chir Scand [Suppl] 176: 1–103

Marberger H, Bantlow KH (1976) Ergebnisse der Harnrohrenplastik nach Johanson. Urologe [A] 15: 269–272

*Chapter 29*

# The Island Patch

*J. P. Blandy*

## Introduction

Although musculocutaneous skin grafts are now widely used by plastic surgeons, they were introduced to urology by the Leadbetters (1962), Yaxley (1967) and Orandi (1968), who utilised a pedicle of the well-vascularised dartos muscle to transfer an overlying island of scrotal skin into a defect in the urethra. Since there is nearly always an abundance of scrotal skin, and since it is completely lined by dartos, there is no limit to the length or site of the urethral defect that can be enlarged or even completely replaced.

The two main advantages of using scrotal skin on a dartos pedicle are:

1. It is freely available.
2. It has such a reliable blood supply that there is little risk of the skin graft undergoing necrosis—the major hazard of free skin grafts.

There are three disadvantages:

1. It is difficult to judge the size of patch to use, because the scrotal skin is so elastic, and one may easily make the patch too big, resulting in a pouch in which urine may stagnate.
2. The hairs of the scrotal skin keep on growing. Since each hair arises from a little battery of follicles, preoperative depilation would have to be repeated many times to be complete.
3. A kind of dermatitis may develop in the skin lining the urethra, which may undergo contracture with recurrence of the stricture.

It is important not to exaggerate these disadvantages. One may avoid too large a patch by cutting the skin graft precisely to a tinfoil template

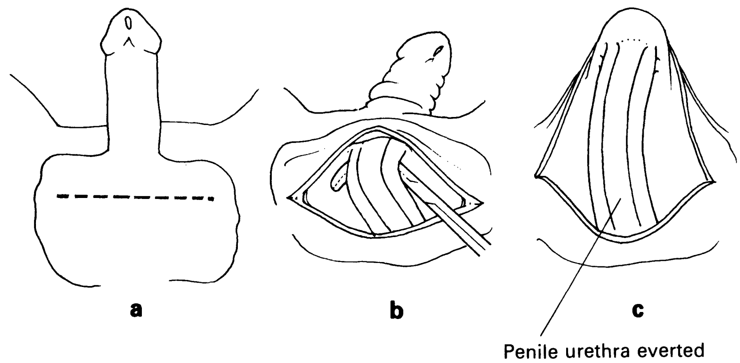



**Fig. 29.1a–c.** Exposure of the anterior urethra. A transverse incision is made in the scrotum (**a**), the shaft of the penis is mobilised (**b**) and drawn out of its sheath of penile skin as if taking a finger out of a glove (**c**). Sometimes it is helpful to circumcise the penile skin at the corona.

fitting the urethral defect, and in any case, a urethra that is slightly too large causes no trouble. Stones form on the hairs very uncommonly—in less than 1:20 of the writer's series—and when they do form they are usually easy to remove through a urethroscope. Eczema in the skin patch still proves an enigma, but fortunately is very rare, and is of course a difficulty common to any urethroplasty that incorporates skin into the urethra. It can be mitigated by instillation of hydrocortisone cream, but not entirely, for the skin changes seem very similar to those seen in balanitis xerotica obliterans, which is equally intractable.

## Anterior Urethra

Exposure of the anterior urethra is best achieved by withdrawing the penis from its shaft, as in removing one's foot from a sock (Fig. 29.1). This preserves the thin skin of the penile shaft, which is notoriously prone to fistulae after urethral surgery. If necessary, this exposure of the anterior urethra may be facilitated by a circular incision at the coronal sulcus.

### Stricture

For a stricture, the urethra is laid open, carrying the incision well into healthy corpus spongiosum at each end of the stricture (Fig. 29.2). With a 24 FG bougie as a guide a tinfoil template made from a catgut packet is cut to the right size for the skin patch. The outline of the template is traced with a skin pencil on to the scrotal skin stretched out with skin hooks or fine sutures (Fig. 29.3). The dartos pedicle is now carefully planned so that the island patch of skin may be drawn under the penile skin without tension (Fig. 29.4).

Dissecting in the plane between skin and dartos, the island of skin and its dartos pedicle are defined (Fig. 29.5). The island patch is sewn into the defect with interrupted 3–0 chromic catgut sutures over a 16 FG silicone

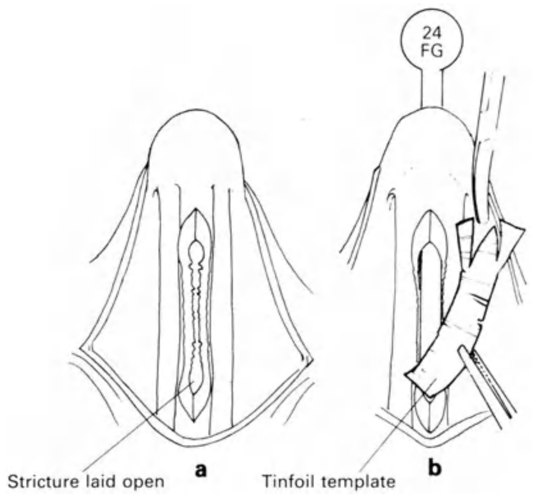



**Fig. 29.2a,b.** Stricture of the penile urethra. The stenosed part is incised well into healthy urethra at either end (**a**). To measure how large a patch is needed, a template of tinfoil from a catgut packet is made using a 24 FG bougie as a guide (**b**).

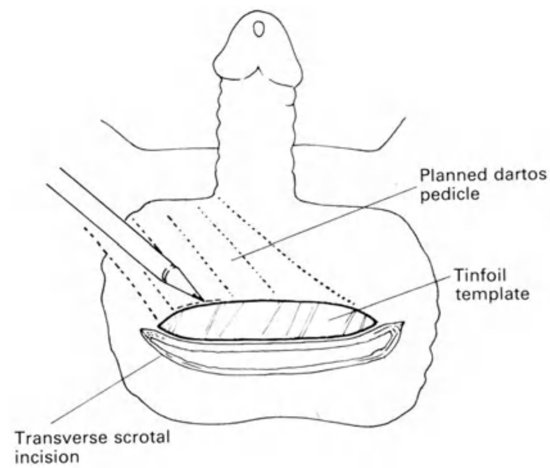



**Fig. 29.3.** Stricture of the penile urethra. The patch is marked out from the tinfoil template, and the dartos pedicle is planned so that it can easily swing up into the penis.

rubber Foley catheter. The penis is replaced in its shaft skin and the scrotum closed with fine interrupted Prolene sutures (Fig. 29.6).

## The Hypospadiac Cripple

Exactly the same procedure is followed in order to deliver the penis from its skin sheath, care being taken not to buttonhole the delicate and

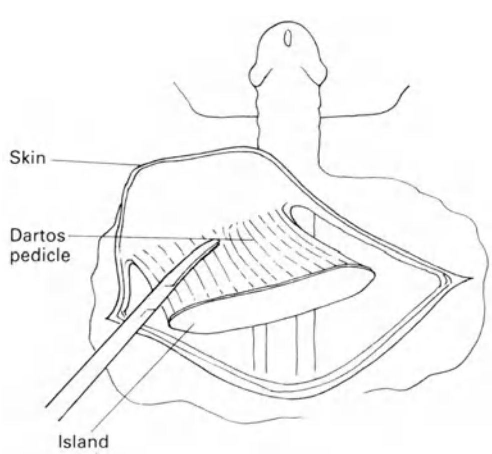



**Fig. 29.4.** The plane between dartos and skin is opened to make a pedicle for the patch of skin.

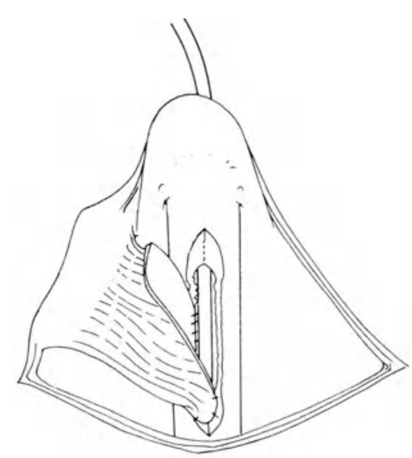


**Fig. 29.5.** With the penis withdrawn from its sheath of skin, the patch is sewn into the defect over a 16 FG silicone rubber catheter.

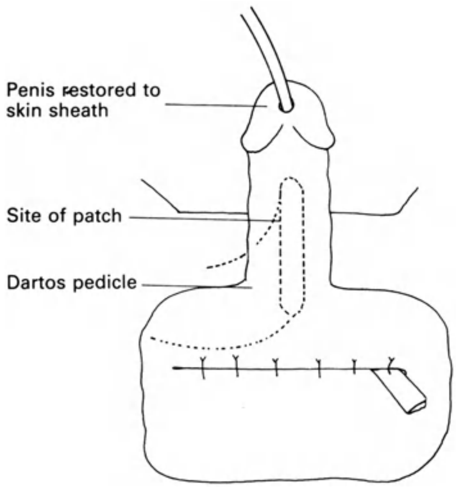



**Fig. 29.6.** The penis is restored to its normal position, and the pedicle lies without tension. There is no risk of fistula because the penile skin has not been breached.

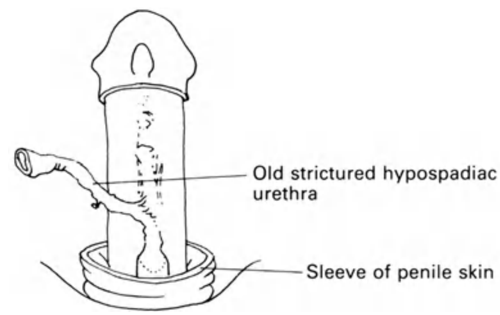



**Fig. 29.7.** The hypospadiac cripple. He has a stricture, chordee and often several fistulae. All the old "urethra" is removed along with its fibrous tissue. Correction of the chordee is confirmed by means of an artificial erection.

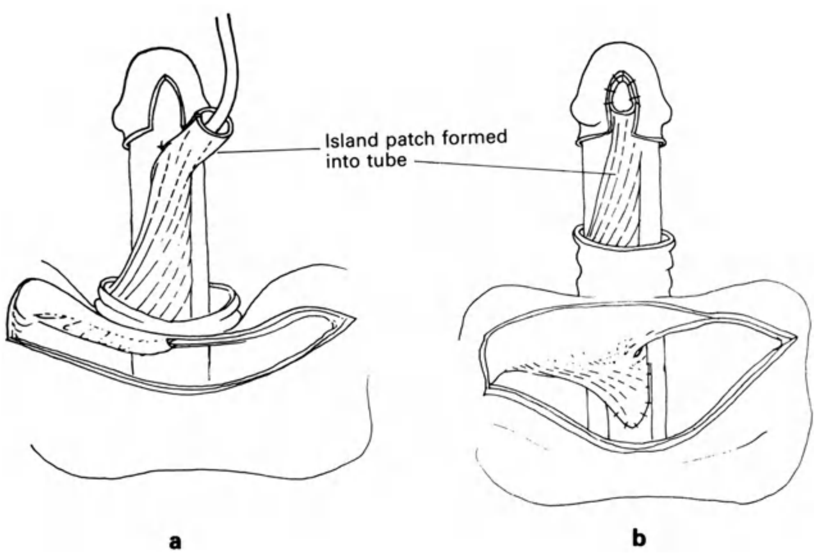



**Fig. 29.8a,b.** The dartos-pedicled patch is made long and wide enough to replace the penile urethra; it is sewn into a tube (**a**) and brought to the tip of the glans (**b**).

much-scarred skin of the shaft of the penis, though existing fistulae must be divided. The old urethra is excised with all the fibrous tissue until correction of the chordee has been confirmed by an artificial erection with saline (Fig. 29.7).

A skin patch of the appropriate length and width is marked on the scrotum: it must be the length of the erect penis and about 24 mm wide. The dartos pedicle is carefully planned so as not to tether the penis later on.

After the island patch has been sewn into a tube over a 16 FG silicone rubber catheter (Fig. 29.8) it is attached to the midline of the penis with a

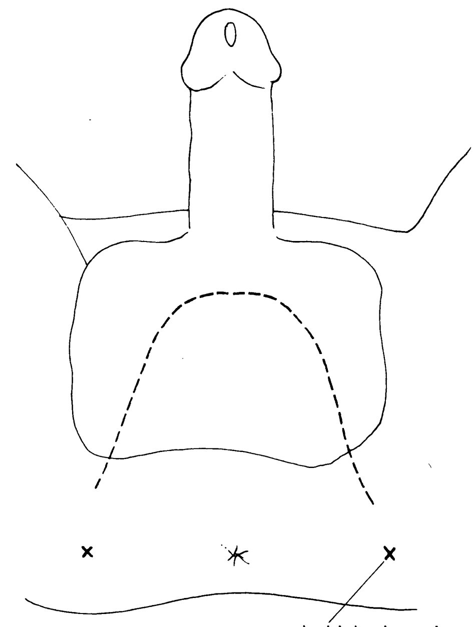



**Fig. 29.9.** Exposure of the posterior urethra through a scrotal flap approach.

few catgut sutures. The distal end is carefully sewn to the glans penis to provide a normal-looking meatus and the proximal end anastomosed to the healthy proximal urethra. Finally, the penis is restored to its skin sheath.

## Posterior Urethra

The posterior urethra is approached through a ∩-shaped scrotal flap (Fig. 29.9). The apex of the flap must be in the loose skin of the scrotum, not the taut skin of the perineum, or else it is impossible to make an adequate dartos pedicle.

After the bulbospongiosus muscle has been reflected, the strictured urethra is opened out well into healthy corpus spongiosum at each end. The cut edge of the corpus spongiosum is closed with running 4–0 chromic catgut to obtain complete haemostasis. A tinfoil template is made over a 24 FG bougie and traced on the apex of the skin flap (Fig. 29.10) to raise a dartos pedicle. The patch is sewn into the defect, and five sutures are placed before tying any of them. Having straightened the shank of the 3–0 chromic catgut needle, it is passed through the skin island, under the edge of the urethra, and then carried on and up towards the bladder, until it is free and can be retrieved. (Fig. 29.11; Blandy 1986).

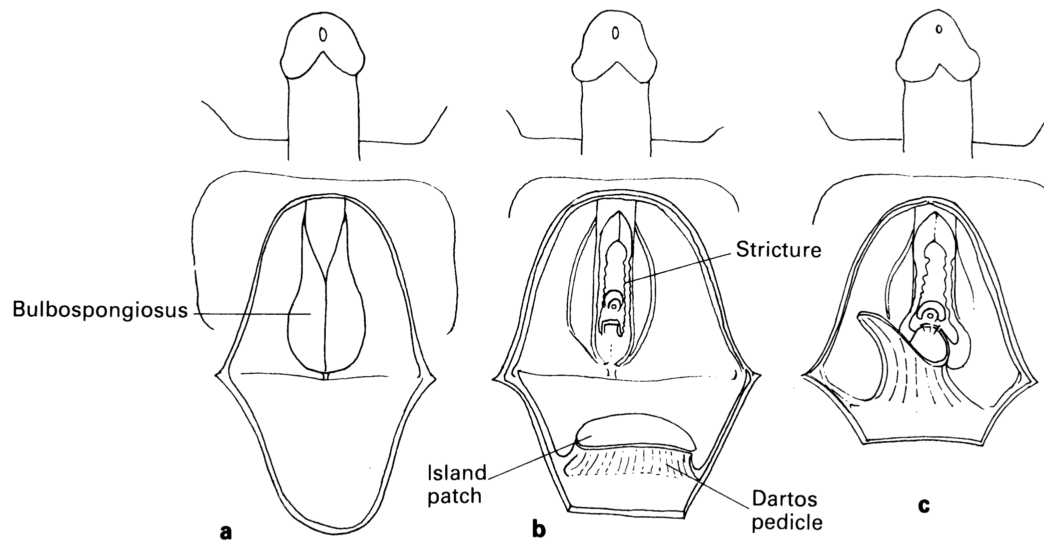
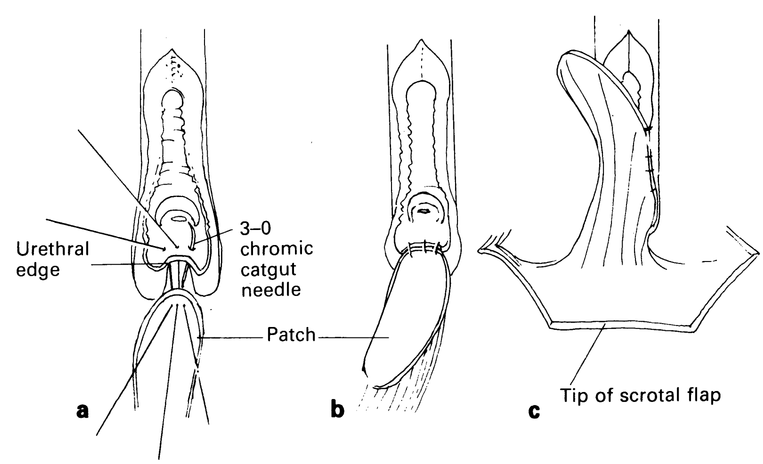



**Fig. 29.10a–c.** **a** The bulbar urethra is exposed. **b** The bulbospongiosus muscle is divided, and a patch measured with a tinfoil template is raised from the apex of the flap. **c** The patch is sutured into the narrow part of the urethra.

**Fig. 29.11a–c.** The uppermost stitches are placed first (**a**) and then tied (**b**), and the patch is then sutured into the defect over a 16 FG silicone rubber catheter (**c**).



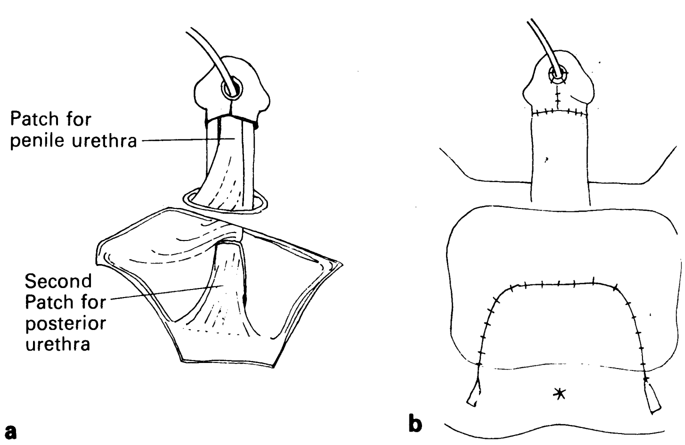




**Fig. 29.12a,b.** By using a combination of the two patches described in the text the entire length of the urethra may be enlarged or even entirely replaced.

## Full-length Strictures

There is no limit to the length of the urethra that may be enlarged or replaced with dartos-pedicled skin. Two patches are usually enough, one for the penile urethra, made in the way described above, and a second from the apex of the scrotal flap for the posterior urethra (Fig. 29.12). Occasionally, there may be a stenosis at the junction between them, but this is easily remedied by incising the stricture longitudinally and sewing it up in the transverse axis.

## After-care

All these operations are protected by metronidazole and a penicillin to prevent spore-bearing and anaerobic infection in the perineum. Penrose drains are removed after two days. The splinting catheter remains for 14 days. Urethrograms are obtained at 3 and 12 months.

All these patients are followed by flow studies and (if necessary) urethroscopy, for the remainder of their lives. It is wise to remember the dictum "Once a stricture always a stricture", and one must anticipate occasional failures and disappointments. The longer patients are followed after any type of urethroplasty the more late failures are seen, including inexplicable late stenosis and an occasional hair-ball stone. Indeed, in a 12-year-follow-up the present author found that about 15% needed some further intervention, e.g. dilatation, removal of a calculus or internal urethrotomy. Put another way, 85% have had successful long-term results which bear comparison with any other treatment for urethral strictures.

## References

Blandy JP (1986) Operative urology, 2nd edn. Blackwell Scientific, Oxford, pp 206–227
Leadbetter GW, Leadbetter WF (1962) Urethral strictures in male children. J Urol 87: 409–415
Orandi A (1968) One-stage urethroplasty. Br J Urol 40: 717–719
Yaxley RP (1967) One-stage urethroplasty. Aust NZ J Surg 36: 332–334

Section VIII

# Male Genitalia—Infertility and Impotence

# Introduction

*J. P. Pryor*

The past decade has seen many changes in the surgery of the male external genitalia, and many of these are described in this section. Patients are now more likely to seek advice for sexual dysfunction, and this has led to an increase in our knowledge of the mechanisms for erection, to improved diagnosis of organic impotence and to new methods of treatment.

The aetiology of Peyronie's disease remains obscure and is multifactorial in origin. The initial management is conservative and vitamin E, possibly because of its antiprostaglandin activity, is not only the cheapest and best tolerated drug, but also the most effective in relieving the discomfort on erection. Surgery is indicated once the disease process has stabilised, after about 1 year, to correct an erectile deformity that is sufficient to prevent or severely hinder coitus. The early attempts to excise the fibrous scar were unsuccessful, but scar excision and replacement of the tunica albuginea with a dermal graft sometimes gives satisfactory results, particularly for small lesions which do not involve the underlying cavernous tissue. Excision of more extensive lesions tends to cause erectile impairment, and Yeates describes an ingenious method of overcoming this by the insertion of a silicone prosthesis. The Nesbit operation would seem to be the best way of correcting the erectile deformity of Peyronie's disease, and a technique for this operation is described. The insertion of a penile prosthesis in Peyronie's disease is reserved for those patients whose erectile dysfunction is due to impaired blood supply; this may be confirmed by the intracavernous injection of papaverine or by nocturnal penile tumescence testing.

The surgical treatment of impotence has become established, and it is now more important to decide which patients with organic impotence should not have a penile prosthesis inserted. It has been estimated that there are 10 million impotent men in the USA—half of these with organic impotence. On this basis there would be 1.2 million impotent men in the UK. The urologist should be aware of impotence surgery. Arterial reconstruction is of value for those patients with major vessel disease but has little role to play for those men with small vessel disease. Venous leaks are easy to diagnose but difficult to identify with precision, and the results of surgery are variable; therefore the implantation of a prosthesis is the mainstay of surgical management. The selection of patients for operation is the key to a successful outcome, and some psychosexual counselling is necessary, even if provided by the urologist. The semi-rigid/malleable prostheses are easy to implant and give satisfactory results. The operation is more difficult following a priapism and some useful aids are discussed. The inflatable prostheses are now much more reliable but remain expensive. Their main advantage is that they provide greater flaccidity and are also less of a hindrance should the patient require endoscopic procedures. The self-contained inflatable prostheses (Hydroflex and Flexi-flate) are worthy of consideration in this respect as they combine ease of implantation with some flaccidity.

Arguments about the surgical correction of epididymal and vasal obstruction focus on how much improvement in results may be obtained with the use of an operating microscope. The pathological cause for the obstruction is a major determinant of success: Failure is almost inevitable following epididymo-vasostomy for congenital obstruction at the junction of the caput and corpus epididymis, and success follows the operation for vasectomy reversal or post-gonococcal obstruction. The microscopic technique of tubulovasostomy is time consuming but allows more accurate construction of a mucosal anastomosis; this undoubtedly gives improved patency rates.

The difference between patency and conception rates is dependent on many factors, not least those occurring in the partner, but the failure of spermatozoa from the caput epididymis to fertilise the heterologous (hamster) and homologous oocytes emphasises the importance of epididymal function and pathology to success. The role of antisperm antibodies in obstruction also remains to be resolved. The presence of significant antisperm antibodies in the seminal plasma after vasectomy reversal may prevent conception, although the number of patients with such antibodies is not high.

The management of transsexual patients is often difficult, and surgery should only be performed when these unfortunate people have had skilled counselling, preferably by doctors with a special interest and experience in the problem. Many transsexuals are well adapted to their new gender role and these patients benefit greatly from surgery. Unfortunately, some patients are less well adapted and these need careful selection. The technique for gender conversion in the male to female transsexual is clearly described, and the results may be spectacular. Surgery for the female to male transsexuals is much less satisfactory, as was penile reconstruction in exstrophy. The construction of a urinary conduit alone is not sufficient as erectile function is of great importance to these men. Woodhouse has evolved a good technique for correcting the short curved penis and it can be recommended without hesitation.

Professor Brindley has two useful contributions on erectile and ejaculatory disturbances. The magic of evoking an erection by the intracorporeal injection of papaverine has captured the attention of both medical and lay persons alike. Intracavernous papaverine is a valuable diagnostic tool but its therapeutic role remains uncertain. The risks of a iatrogenic prolonged erection are small and easily reversed, but the longer term risks remain uncertain although cavernous fibrosis is not uncommon. Metaraminol (or norepinephrine) has been used in idiopathic priapism since 1983 with variable results. It is more effective in the venous outflow type of priapism than in the high flow form where leakage of the metaraminol into the circulation occurs. Urologists should also be aware of the possibilities for the management of ejaculatory failure by the use of drugs, vibrators or electroejaculation.

Ejaculatory failure is of obvious importance with regard to fertility. Sperm retrieved from the urine may be used for artificial insemination; however, there remains a small group of men in whom this is unacceptable, and some of these demand bladder neck reconstruction. One such technique is described. Retrograde ejaculation is common after prostatectomy, and increasing numbers of patients are seeking legal redress for not having been forewarned of this alteration in their sexuality. The incidence of retrograde ejaculation is less after bladder incision, but Edwards does not rely upon this to extol the merits of such surgery. Bladder outflow obstruction is the basis of most urological practice and it is significant that changes are occurring even in such a traditional area.

The omissions in this selection are of interest and reflect the speed with which change has occurred in andrology over the past decade. It has taken a decade to recognise that prophylactic irradiation is unnecessary for all testicular tumours, but what now of the role for nodal dissection and how should testicular carcinoma in situ be managed? The retrieval of spermatozoa from the epididymis and vas for artificial insemination or in vitro fertilisation has introduced new hope for the infertile and basic questions for the physiologists. What now is the function of the prostate and seminal vesicles in fertility?

Our knowledge of the mechanisms of erection increases each year, but often as each new piece is fitted to the jigsaw of knowledge, the size of the jigsaw is increased. Vasointestinal polypeptides (VIP) may still play an important role in erection, but how important are venous leaks and what is the role for dynamic cavernosography? The scope of uroandrology is expanding rapidly and these chapters should prove useful to practising urologists.

*Chapter 30*

# Peyronie's Disease

*W. K. Yeates*

## Introduction

Not only is the pathogenesis of Peyronie's disease still obscure, but also the clinical features vary with the site of the plaque and the patient's erection ability. The most frequent site, which is in the dorsal part of the septum, between the corpora cavernosa and their adjacent sheaths, results in dorsal concavity on erection. The deformity may not be symmetrical, resulting also in some lateral deviation. Occasionally, both dorsal and ventral plaques of equal deforming potential are present and balance each other, the plaque being noticed just as a hardness by the patient or by the doctor.

Deficiency of erection in association with Peyronie's disease may be of independent origin, especially in older patients; it may have been induced by prolonged coital difficulties; or it may be caused by the constrictive effect of the plaque, with the patient describing the penis as being flaccid distal to the plaque.

The present author's experience of the natural history of the disease corresponds to that of Williams and Thomas (1970). Usually the condition reaches its plateau within a few weeks of the onset so that the maximum deformity is present by the time the patient is seen in consultation. The degree of interference with intercourse ranges from minimal and tolerable to coitus being physically impossible. Spontaneous improvement may occur slowly over a few years; similar improvement may occur during the administration of drugs of doubtful efficacy.

Surgical procedures for Peyronie's disease aimed at correcting the deformity are not consistently satisfactory. Their success rates are much less than operations for impaired erection alone. They can in fact worsen the situation, particularly with regard to potency.

## Indications for Correction

Indications for operative treatment for the deformity should include significant disability persisting for about a year. Where deficient erection is a major feature, the prognosis is particularly unfavourable, and early operation aimed at correcting the deficient erection is usually requested and is reasonable.

## Surgical Procedures for Peyronie's Disease

The surgical procedures can be simply classified into:

1. Excision of the plaque with replacement of the deficiency in the sheath with a dermal graft (Horton and Devine 1973; Wild et al. 1979), dura (Kelami 1977) or synthetic material (e.g. silicone) sheet.
2. Combining excision of the plaque with replacement of its deep portion with a solid prosthesis (Loeffler et al. 1964).
3. Compensating the curvature on one aspect by plicating the opposite aspect of the sheaths of the corpora cavernosa—Nesbit's operation (Pryor and Fitzpatrick 1979; Frank et al. 1981; Lemberger et al. 1984).
4. Insertion of prostheses throughout the lengths of the corpora cavernosa as for cases of impotence, combined if necessary with incision or excision of the plaque (Raz et al. 1977; Melman and Holland 1978; Carson et al. 1983).

Not surprisingly, excision of the plaque in the septum between the corpora and the associated involved part of the sheaths of the corpora cavernosa and replacing them only with a thin sheet of material is reported to be associated with a high incidence of local defective rigidity on erection in many cases (Melman and Holland 1978; Pryor and Fitzpatrick 1979; Frank et al. 1981).

### Excision of Plaque Combined with Silicone Prosthesis

Based on the technique of Loeffler et al., who used an acrylic prosthesis, the present author has combined excision of the plaque with replacement of it with a specially made moulded rod of silicone (Fig. 30.1) to compensate for the loss of erectile tissue at the site of excision of the plaque.

If the patient has been circumcised the plaque is exposed by a circumferential incision about 5 mm from the glans for about three-quarters of the dorsal and lateral circumference. If the patient has not been circumcised a simple dorsal longitudinal incision is quite satisfac-

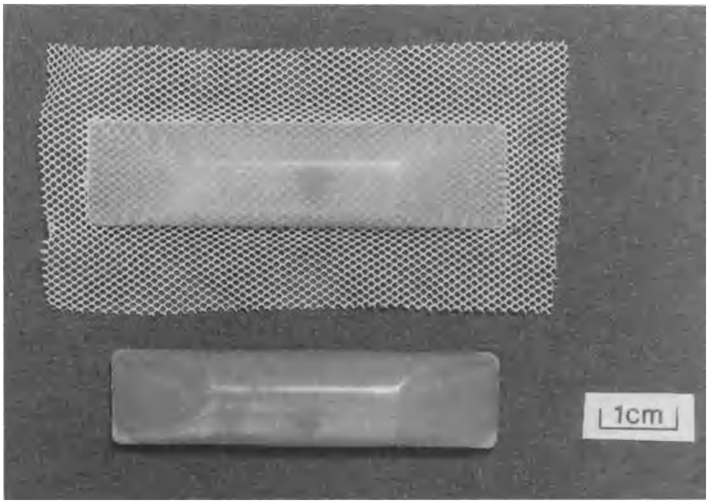



**Fig. 30.1.** Silicone prostheses for replacing plaque. Upper model has Teflon fringe which can be trimmed as required for fixation to inner aspects of corpora.

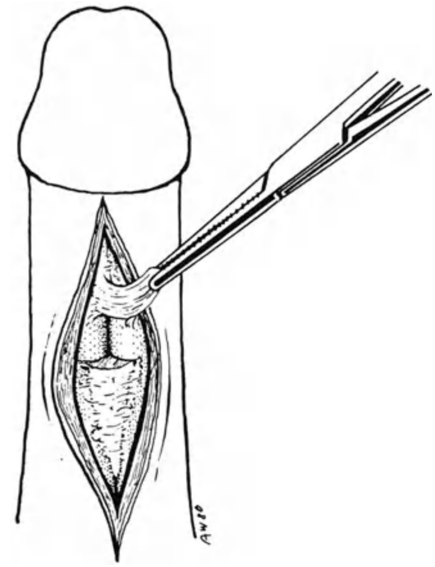


**Fig. 30.2.** Exposure and excision of plaque by initially dividing it transversely and then excising the anterior and posterior parts.

tory; a circumferential incision in uncircumcised men has usually to be combined with a circumcision, which seems to be an unnecessary addition.

The plaque is identified by palpation and a midline longitudinal incision is made into the overlying—and usually involved—sheaths of the corpora. The ease with which the sheaths can be dissected from the plaque depends on their involvement in the fibrosis (Smith 1966). The dorsal nerves of the penis are avoided by deepening the dissection of the flaps into the erectile tissue about 5 mm from the midline.

The plaque is divided transversely and each strip of the involved septum is then excised proximally and distally (Fig. 30.2). Complete proximal excision is probably unnecessary. The margins of the incision in the sheaths of the corpora are notched for a few millimetres about every 3–4 mm to allow some elongation during closure.

A silicone prosthesis corresponding to the length of the excised plaque is inserted into the deficiency of the septum made by the excision of the plaque, making sure the distal end of the prosthesis reaches under the corona (Fig. 30.3). The dorsal flaps of the sheaths of the corpora are then closed with 3–0 Dexon over the prosthesis (Fig. 30.4). The most recent model of the prosthesis has a frill of Teflon, which is used to fix the prosthesis to the inner aspects of the sheaths of the corpora before closure.

This technique has the advantage of correcting the deformity without a decrease in the penile length. It was found to be highly successful in four of six cases. In the other two cases the dorsal tilting on erection was not satisfactorily corrected, apparently on account of inadequate excision of the dorsal parts of the sheaths of the corpora; these patients were treated by the ventral insertion of Jonas prostheses combined with removal of the original prosthesis through a very short dorsal incision.

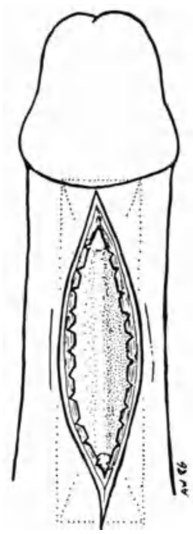


**Fig. 30.3.** Prosthesis lying in site of bed of excised plaque. Note that the anterior end of the prosthesis extends under the corona. The edges of the incision into the sheaths of the corpora have been notched to increase length on closure.

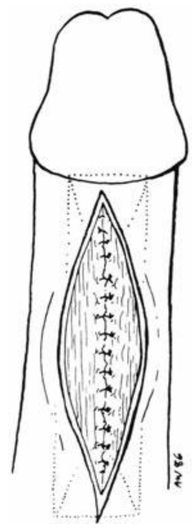


**Fig. 30.4.** Incision closed over prosthesis.

## Nesbit's Procedure

Nesbit's procedure of plicating the sheaths of the corpora cavernosa on the opposite side to the concavity on erection was originally devised for congenital curvature of the penis (Nesbit 1965). Its use in cases of Peyronie's disease was first reported by Pryor and Fitzpatrick in 1979. It is certainly the procedure with the least complications, though it does cause some shortening of the penis. It is the only satisfactory procedure for a ventral plaque with downward deformity on erection.

The present author has found the following modifications of the procedure to be helpful:

1. As the plaque is usually dorsal, the plication is on the ventral surface of the corpora cavernosa.
2. A size 16 FG catheter is passed and left indwelling.

### *Incision*

As noted in the previously described procedure, a circumferential incision either over the ventral three-quarters, or completely, depending on the extent of exposure required, is usually recommended; however, this has to be combined with a circumcision if the patient has not already been circumcised. A simple ventral incision has been found to be entirely satisfactory both for the exposure and postoperatively.

The severity of the deformity is demonstrated by the usual technique of producing an artificial erection by the application of a tourniquet and the injection of saline into one corpus, which of course diffuses across the septum and distends the opposite corpus. Although it is usual to mobilise the corpus spongiosum completely from the undersurface of the corpora cavernosa, this is not really necessary; the corpus spongiosum can be retracted to the opposite side very satisfactorily by the use of one or two pairs of Babcock's forceps.

### *Present Author's Technique for Planning the Sites and Extent of Plication*

One essential site to plicate is of course opposite the main concavity of deformity on erection. Usually this requires to be supplemented by a proximal and distal site on each side.

The method of plication which the author has found to be most satisfactory is a cruciate incision, each limb being 1 cm long, which, by undermining, results in four equal flaps (Fig. 30.5). The extreme ends of the longitudinal incisions are approximated so that two flaps on either side come into apposition when the ends of the longitudinal incision are approximated. Each lateral flap is then maintained in position by a mattress suture as shown in Fig. 30.5c.

The sites and numbers of these cruciate incisions required can be planned by inserting marker sutures of fine Dexon initially at three sites on each side, the middle pairs being opposite the site of greatest convexity produced by the artificial erection. The other two sites are about 5 mm distal and proximal respectively to the middle one.

The marker sutures at each end of the proposed longitudinal limb of the cruciate incision are approximated and held together with fine haemostatic forceps on each side, and the artificial erection is recreated (Fig. 30.6). This demonstrates what would be the effects of actually creating the cruciate incisions with plication before any incisions are

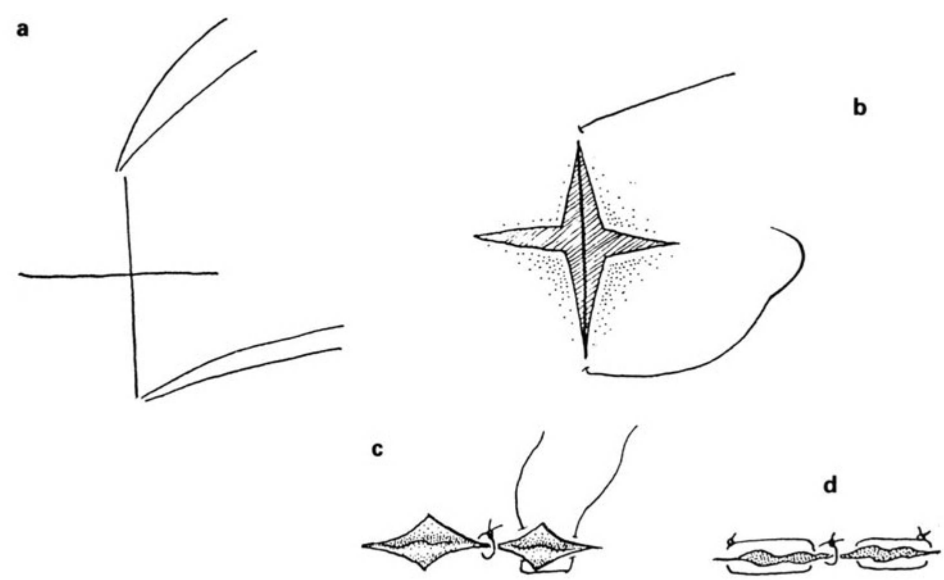



**Fig. 30.5a–d.** Plication by cruciate incision. **a** Cruciate incision. The ends of the vertical limb extend between markers previously inserted during planning (see Fig. 30.6). **b** Flaps undermined. Marker sutures removed. Initial closure suture inserted. **c** Initial closure suture tied. Mattress suture inserted to appose everted flaps. **d** Closure completed.

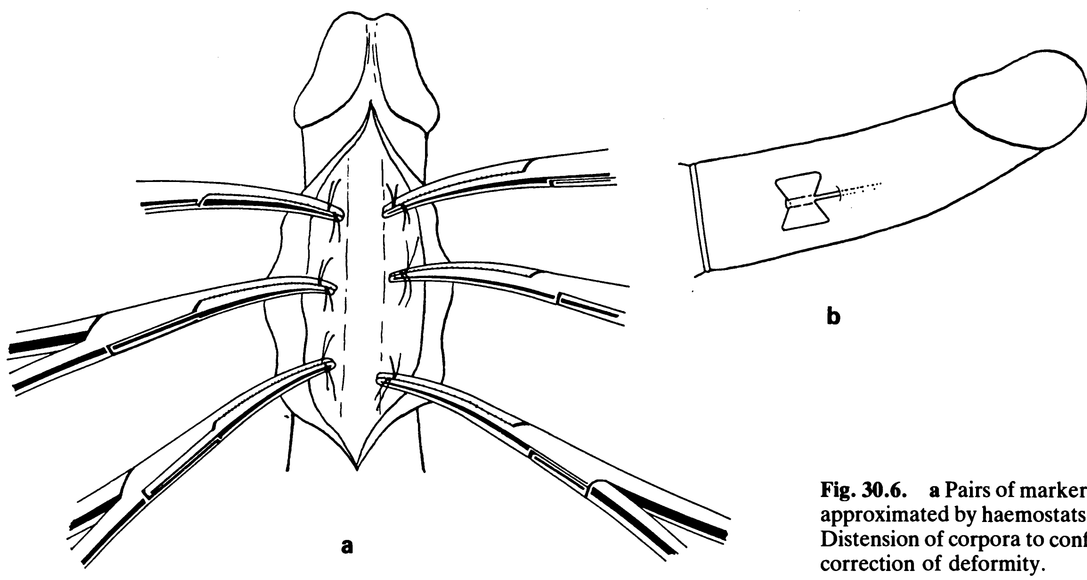



**Fig. 30.6.** **a** Pairs of marker sutures approximated by haemostats. **b** Distension of corpora to confirm correction of deformity.

actually made. This has the great advantage that leakage through the marker suture holes is minimal, in contrast to the effect of distending the corpora after excision or incision of the sheaths, when gross leakage usually occurs to such an extent that it reduces the value of reconstituting the erection. It can thus be planned whether only one, two or three cruciate plication sites are required, and, in cases with asymmetrical deformity, whether the same number of sites is required on each side.

## Peyronie's Disease Associated with Impotence

Where the deformity on erection is associated with deficiency of erection the most satisfactory procedure is the insertion of a solid prosthesis into each corpus cavernosum. The present author has found the easiest approach is through a ventral penoscrotal incision with lateral retraction of the corpus spongiosum. The incision, dilatation and "sizing" of the corporal bodies are carried out as usual, but with the following modifications, which the present author can strongly recommend:

1. The distal ends of the corpora can be prepared for the reception of the prostheses most safely by excavating them with a sharp spoon.
2. Each corpus is dilated as usual, but with minimal force being applied to its distal end.
3. A sharp spoon of the same diameter as the largest of the dilators accommodated is then passed along the corpus and rotated in its extremity in the glans.

After this procedure (which has no risk of injuring the urethra), the appropriate size of prosthesis can be easily passed for the full length of each corpus. (Following the success of this technique the present author had an orthopaedic sharp reamer specially adapted with a long handle to rotate in the distal end of the corpus, but it was not so effective as the sharp spoon). The incisions in the corpora are closed with continuous 2–0 Dexon.

Usually no procedure is required on the plaque itself, but where the dorsal deformity is reproduced by the insertion of the prosthesis, the plaque can be exposed through a separate dorsal circumferential incision (or dorsal longitudinal incision) and incised transversely with a diathermy needle. When indicated, this results in a dramatic gaping of the incision with straightening of the corpora. No suturing is possible, or appears to be necessary.

### Completion of All Procedures

In all incisions on the shaft of the penis the most satisfactory closure is with continuous 6–0 Dexon in the dartos and interrupted 6–0 plain catgut sutures in the skin.

In all these procedures a 16 FG Foley catheter is left indwelling until the following morning. This allows a firm dressing to be applied without concern over impeding micturition.

## References


Carson CC, Hodge GB, Anderson EE (1983) Penile prosthesis in Peyronie's disease. Br J Urol 55 (4): 417–421

Frank JD, Mors B, Pryor JP (1981) The surgical correction of erectile deformities of the penis of 100 men. Br J Urol 53: 645–647

Horton CE, Devine CJ (1973) Peyronie's disease. Plastic and reconstructive surgery. 52: 503–509

Kelami A (1977) Surgical treatment of Peyronie's disease using human dura. Eur Urol 3: 191–192

Lemberger RJ, Bishop MC, Bates CP (1984) Nesbit's operation for Peyronie's disease. Br J Urol 56: 721–723

Loeffler RA, Sayegh S, Lash H (1964) The artificial os penis. Plast Reconstr Surg 34: 71–74

Melman A, Holland TF (1978) Evaluation of the dermal craft inlay technique for the surgical treatment of Peyronie's disease. J Urology 120: 421–422

Nesbit RM (1965) Congenital curvature of the phallus: report of 3 cases with description of corrective operation J Urol 2: 230–232

Pryor JP, Fitzpatrick JM (1979) A new approach to the correction of the penile deformity in Peyronie's disease. J Urol 122: 622–623

Raz S, DeKernion JB, Kaufman JJ (1977) Surgical treatment of Peyronie's disease: a new approach. J Urol 117: 598–601

Smith BH (1966) Peyronie's disease. Am J Clin Pathol 45: 670–678

Wild RM, Devine CJ, Horton CE (1979) Dermal graft repair of Peyronie's disease: survey of 50 patients. J Urol 121: 47–50

Williams JL, Thomas GG (1970) The natural history of Peyronie's disease. J Urol 103: 75–76

*Chapter 31*

# Penile Prostheses

*J. P. Pryor*

## Introduction

The implantation of a penile prosthesis is a simple method of restoring a man's ability to have sexual intercourse. The patient should accept that he cannot become normal, but the operation does give him the ability to obtain vaginal penetration. He will continue to ejaculate, depending on the cause of his erectile dysfunction, and both patient and partner can obtain sexual satisfaction. The operation may be performed on all men with organic impotence (diagnosed from the history, intracavernous injection of papaverine or nocturnal penile tumescent testing) and for selected men with psychogenic impotence. Special care is necessary with the latter group of patients; they should all have received psychosexual counselling by at least two practitioners.

There is a wide variety of implants available, and the initial choice is between the simple malleable implants and the more expensive inflatable models. The latter type used to be unreliable, but mechanical failure is now unusual and this factor need not enter into the decision making. There is probably not a great deal of difference in the sexual performance with the different prostheses, but those patients who have experience of both types prefer the inflatable prosthesis. The American Medical Systems (AMS) multipart IPP 700 prosthesis (Fig. 31.1) is of proven reliability, gives good increase in penile girth and excellent flaccidity. The self-contained inflatable prostheses are much easier to implant but less versatile. The Hydroflex prosthesis (Fig. 31.2) is delivered ready for implantation, whereas the Flexi-flate prosthesis requires filling at the time of operation. Inflatable prostheses are preferable in patients who

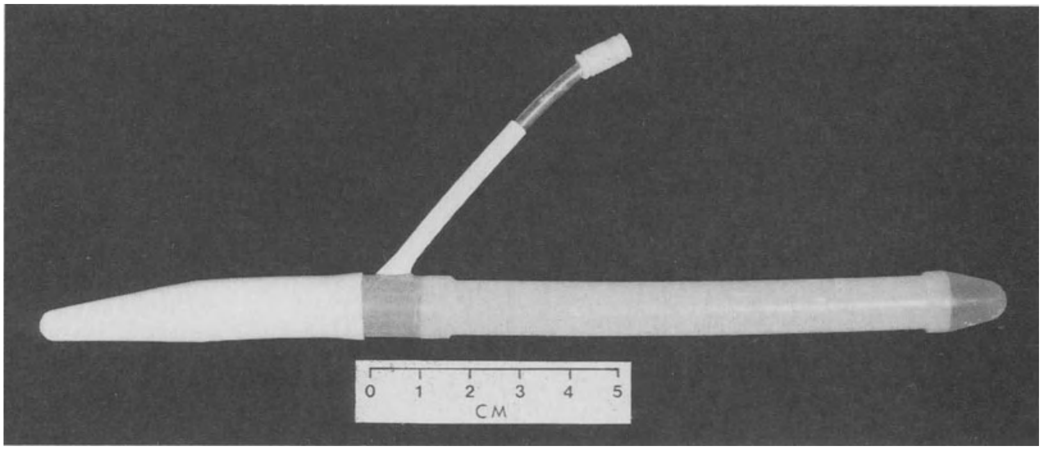



**Fig. 31.1.** IPP 700 multipart inflatable penile prosthesis. This prosthesis requires a separate pump mechanism, which is inserted in the scrotum, and a reservoir, situated in the extraperitoneal tissues. The prosthesis is of proven reliability and gives good flaccidity and rigidity.

may require repeated endoscopy and for paraplegics, although these may be managed by the injection of intracorporeal papaverine. Diabetics may also benefit from the inflatable prosthesis as those with erectile dysfunction caused by an autonomic neuropathy may also have bladder problems. There is also a suggestion that postoperative pain, infection and pressure necrosis are more common after the implantation of a

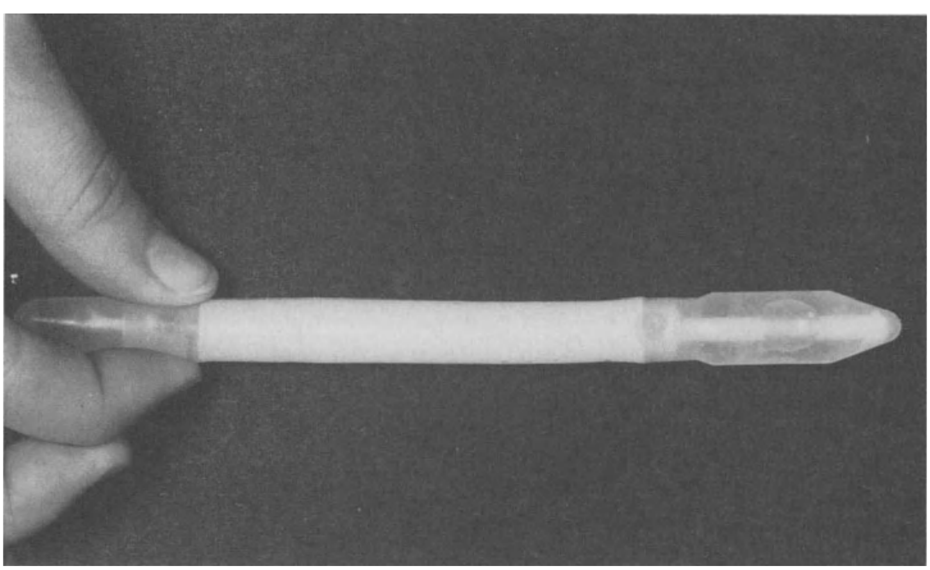


**Fig. 31.2.** Hydroflex prosthesis. This prosthesis gives some degree of flaccidity, but the range of rigidity is much less than the multipart inflatable prostheses (Fig. 31.1). The deflation valve is shown being compressed.

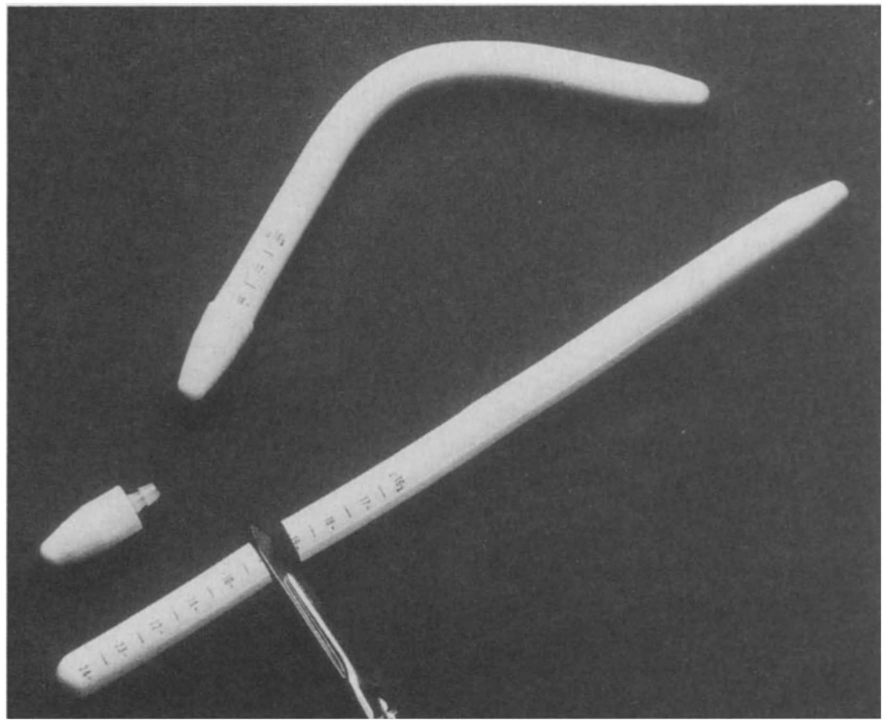


**Fig. 31.3.** Mentor malleable prosthesis. This prosthesis has a malleable distal part which fits within the penile shaft and a more flexible proximal part which may be trimmed to the correct length at the time of operation.

semi-rigid prosthesis into diabetic patients. It is probably better to avoid the inflatable prosthesis in patients with priapism because it is difficult to find a space within the corpora.

The Small Carrion prosthesis is the standard semi-rigid prosthesis; it is easy to implant and relatively free of complications. The recent developments in prosthetic design have enabled the implantation of a less obtrusive prosthesis and have reduced the stock required to cover all possible sizes. The choice between the AMS 600, Mentor malleable (Fig. 31.3) and Flexirod prostheses depends to a large extent upon availability, personal preference of the surgeon and back-up provided by the manufacturing company.

## Preoperative Considerations

Careful selection of the patient, after discussion with a partner, is essential. Some psychosexual counselling is always required and this may be given by the surgeon in some cases. Any focus of infection must be eliminated, and it is also wise to correct any urinary outflow obstruction, particularly if a semi-rigid prosthesis is to be implanted. Prophylactic antibiotics (cephalosporin and metronidazole) are given for a minimum of 48 h, commencing with the premedication. The infecting organism in prosthetic surgery is usually *Staphylococcus albus*, and a low-grade infection may not be recognised for many months.

## Operating Room Considerations

The prevention of infection is of prime importance, and movement in the operating theatre should be kept to a minimum. It is preferable to shave the lower abdomen and scrotum when the patient arrives in the operating room and the skin should be thoroughly cleansed with povidone-iodine. The patient is placed on the operating table with the legs slightly apart. The operation is usually performed under a general anaesthetic, but this is unnecessary. Some surgeons in the USA will even implant an inflatable prosthesis as an outpatient office procedure.

## Operation

The following description is for the implantation for semi-rigid or malleable prostheses. The most versatile incision is a longitudinal one approximately 5 cm long at the penoscrotal junction. The skin and underlying subcutaneous tissue are incised down to the fascia overlying the corpus spongiosum; if there is any doubt about the anatomical landmarks it is easy to insert a urethral catheter. The tunica albuginea is exposed on either side of the urethra and stay sutures inserted. Longitudinal corporotomies are performed using a scalpel. Whilst obtaining experience, it is helpful to insert stay stitches through the cut edge of the tunica albuginea as this facilitates measuring the correct size for the prosthesis to be inserted. The corporotomy should be approximately three times as long as the diameter of the prosthesis (3–4 cm). A space is created within the corpora by gentle dilatation with a measuring tool or Hegar's dilator. The dilatation is kept to the minimum that is required to receive the prosthesis, and it is important to ensure that the prosthesis will fit to the end of the corpora cavernosum and can be felt beneath the glans penis.

It is important to obtain an accurate measurement of the internal length of the corpora, and the marker suture provides a fixed point for all measurements. A short prosthesis results in the ST or concord deformity with a drooping glans and makes penetration difficult. An overlong prosthesis causes more postoperative pain and may lead to pressure necrosis and extrusion of the prosthesis. The diameter of the prosthesis is of less importance, but it is advisable to implant the thickest prosthesis that will fit the corpus. This is particularly important in those patients with a long penis as the pencil-like appearance of a very long thin penis is less than satisfactory. The AMS 600 prosthesis has the advantage of having an outer skin that may be peeled off should the 13 mm diameter prosthesis be too large for the patient. Once the size of the prosthesis has been chosen by careful measurement, it is always advisable to double-check the fit. The final length may be adjusted in some prostheses by trimming the tail (Flexirod, Subrini or Mentor) or by adding rear tip extenders (AMS 600). It is most uncommon for the length of prosthesis inserted into each corpora to differ more than 1 cm.

The second prosthesis is fitted into the opposite corpus cavernosum in the same manner as the first. The operation to insert the penile cylinders of an inflatable prosthesis is very similar to the above description. An additional aid is found in the Hydroflex and AMS 700 prostheses, which have a suture placed through the tip which facilitates traction of the flaccid prosthesis down to the subglandular region. With these prostheses it is convenient to insert the inflated prosthesis first into the crura. The self-contained inflatable prostheses (Hydroflex or Flexi-flate) are simple to insert and offer an inflatable prosthesis. They do not give such good rigidity or flaccidity but are a useful addition to the range of prostheses. A description of the insertion of the pump mechanism and reservoir is not given as this should only be performed by surgeons having observed the technique.

The corporotomies are closed with interrupted synthetic absorbable sutures, as are the subcutaneous tissues and the skin. A urethral catheter is left in the bladder overnight when the operation is performed in the late afternoon. A dry dressing is applied to the wound, and the penis is kept against the anterior abdominal wall in the early postoperative period.

## Postoperative Course

The patient is mobilised next morning and discharged from hospital as soon as comfortable. Coitus is prohibited until the wound has healed and the patient is pain free—usually 3–6 weeks.

## Special Considerations

### Peyronie's Disease

Implantation of the prosthesis is rarely difficult in patients with Peyronie's disease as the fibrosis is usually associated with the tunica albuginea. Cavernous fibrosis is rarely extensive and can be overcome by the dilatation or by direct incision. The choice of prosthesis is more difficult to answer; the present author's preference is for semi-rigid or malleable prostheses as these are sufficiently rigid to overcome the deformity without any additional surgery.

### Priapism

Post-priapism impotence may be a result of psychological factors, a patent shunt or cavernous fibrosis. It is essential to determine the cause, and a penile prosthesis is reserved for those patients with extensive fibrosis. In some patients the cavernous tissue is completely replaced by fibrous tissue, and calcification is not uncommon. Implantation of a prosthesis can then be very difficult, and it is helpful to perform cavernosography to define the extent of the fibrosis. Patent shunts are also identified by cavernosography, and the remaining areas of erectile cavernous tissue demonstrated, which is useful when it comes to the time of implantation.

The prosthesis should always be inserted through a ventral penoscrotal incision and the corpora are exposed in the usual manner. It may not be possible to dilate the corpus in order to form the space for the implant, and in these circumstances it is often sufficient to implant a single prosthesis. This may be carried out by excising a gutter of fibrous tissue throughout the penile part of the corpus, laying a prosthesis in the space and closing the tunica over the top. An alternative approach is to try and core out a cylinder of fibrous tissue with a modified apple corer. On some occasions there is a vascular space beneath the tunica albuginea and it may be possible to disect out the fibrous tissue in this plane. It may be necessary to invaginate the penis into the wound in order to obtain sufficient access to the cavernous tissue. Finally, Dacron may be used to close the defect over the implant, or alternatively the implant may be placed within a sleeve of Dacron.

## Operative Complications

Operative complications usually occur during the dilatation and rarely occur in the patient with normal corpora. The dilatation should be performed gently and the surrounding erectile tissue disturbed as little as possible. The Hegar's dilators should be directed away from the urethra and in the anatomical direction of the corpus, particularly for the crural dilatation. Perforation of the tunica albuginea is of little importance provided that it is recognised and the prosthesis is positioned within the corpus. Perforation of the urethra is more difficult to manage and is recognised by the appearance of blood at the external urethral meatus. It is safer not to proceed with the implantation but on some occasions this is not practicable. Under these circumstances it is best to perform a suprapubic cystotomy for 7 days and to continue with antibiotics until 48 h after the catheter is removed.

## Postoperative Complications

### Urinary Retention

Catheterisation is avoided whenever possible and any outflow obstruction should have been corrected before the operation. Urethral catheterisation may be kind if the operation is performed in the late afternoon, and the catheter is removed the next morning. Should a patient develop postoperative retention then a stab suprapubic cystostomy is the method of choice for managing this complication.

### Haematoma Formation or Penile Oedema

Some bruising may occur but it is rarely severe enough to warrant any specific measures. Penile oedema is not uncommon following the insertion of the self-contained inflatable prosthesis and is more likely if there have been repeated attempts at inflation and deflation of the prosthesis. Care should be taken to avoid a constricting dressing around the penis as this may lead to gangrene. This is particularly likely to occur if the dressing has become soaked in blood and hardened and the tissues are compressed between the dressing and the prosthesis. The presence of a urethral catheter is an additional hazard as it permits the passage of urine without inspection of the penis. The glans penis should always be visible, and the use of constricting tape should be avoided.

### Pain, Infection and Extrusion

The complications of pain, infection and extrusion are often related and infection is the biggest postoperative complication. Every attempt should be made to prevent contamination at the time of surgery, and it is for this reason that prophylactic antibiotics are used.

Postoperative pain may be associated with a subclinical infection and it may be many months before the prosthesis is extruded. This is more likely to occur in diabetics; the hyperglycaemia and poor blood supply are additional factors which lead to necrosis of the erectile tissue. Postoperative pain is more common in those patients who have a prosthesis which is a little long and this may lead to pressure necrosis. The difficulties of the prosthesis which is too short have been overestimated and it is advisable to insert a shorter malleable prosthesis than one of the semi-rigid models. Such considerations do not apply to the inflatable prosthesis. Many men find a single prosthesis gives sufficient rigidity, and the loss of a single implant is not necessarily an indication for further surgery.

## Conclusions

The selection and preoperative counselling of patients is of the utmost importance and a major factor in ensuring a trouble-free postoperative course. Patients with false expectations tend to become very bitter when minor, let alone major, complications occur. Despite these words of caution, the satisfactory implantation of a penile prosthesis may do more to restore a man's health than most surgical procedures and, in addition, the patient's partner and family may also reap the benefits.

*Chapter 32*

# Vaso-vasostomy and Epididymo-vasostomy

*W. F. Hendry*

## Introduction

Vaso-vasostomy (vas-vas.) and epididymo-vasostomy (ep-vas.) are the standard methods of joining parts of the male genital tract to overcome obstruction of the outflow from the testicles. Experience with vasectomy reversal has shown that, with a careful vas-vas. technique, very successful results can be obtained, restoring fertility in a high proportion of cases. With ep-vas., on the other hand, results have generally been rather poor, even discouraging. These two procedures are technically different, but it is probably a mistake to assume that failure after ep-vas. is necessarily due to surgical problems alone. Instead, the surgeon should consider the underlying pathological conditions that necessitated the operation, which are different in the various parts of the male genital tract, and which are probably more important as the fundamental causes of treatment failure.

Although there are differences between vas-vas. and ep-vas., both technically and pathologically, there are similarities which perhaps may be considered together. Both operations, by definition, are dealing with obstructed testicles, and immunological or other consequences of the obstruction may influence the success of either procedure. It is well known that testicular obstruction leads to sperm antibody (SAb) formation, and there is good evidence that these antibodies can impair fertility. Although, superficially, it might be thought that SAb would adversely affect both vas-vas. and ep-vas. equally, in fact it appears that the cause of the obstruction affects the nature and class of the antibody response, which may in turn influence the clinical significance of the SAb.

Clearly, there is a lot to learn about the surgery and pathology of testicular obstruction, far beyond the technical details of these two operations. In this chapter a start is made with the simplest procedure, vasectomy reversal, and then attention is turned to the surgery of obstructive azoospermia. The significance of unilateral testicular obstruction, and the role of vas-vas. and ep-vas. in its treatment must be considered, as this seems to be an important and yet treatable cause of male infertility. Finally, consideration must be given to the immunological consequences of testicular obstruction, since it seems clear that SAb can be a potent cause of failure of restoration of fertility by vas-vas. and ep-vas.

## Vasectomy Reversal

The increasing popularity of vasectomy as a method of birth control has lead inevitably to an increased demand for reversal, which probably occurs in 1%–3% of the vasectomised population for a variety of reasons, including remarriage, death of children, change of heart or altered financial circumstances. Howard (1982) has studied the question "Who asks for vasectomy reversal and why?", and found that over half were divorced or separated from their wives, and felt disadvantaged in courtship or remarriage by being infertile: amongst those that had remarried, many of their wives were said to be desperate for a pregnancy. Most requests for reversal came from men who had been under 35 years of age at the time of vasectomy, and many had decided to have the operation done at a time of emotional crisis.

There is no fundamental reason why fertility should not be restored by reconnection of the testes after vasectomy: sperm production is well maintained in most animal species, with the possible exception of rabbits and guinea pigs. Certainly, normal spermatogenesis has been observed in testicular biopsies taken from men 1 month to 10 years following vasectomy (Bagshaw et al. 1980). In fact, technical difficulties with vas anastomosis, secondary changes in the epididymis and, in some cases, the immunological reaction provoked by the spermatozoa make the chances of successful restoration of fertility by vasectomy reversal only about 50:50.

### Surgical Technique

For vasectomy reversal, an oblique incision is made on the lateral aspect of the scrotum, so that it can be extended up to the inguinal region to obtain more length of vas if this should prove necessary. The superior end is identified first, cleaned of surrounding adhesions and mobilised enough to allow it to meet the inferior end without tension. The inferior end is then identified and cleaned. Once the mobilisation is completed, an 0.5 cm linear incision is made in the inferior end of the vas just below the point of transection, and the tail of the epididymis is squeezed to express milky fluid from the vas. The superior end is similarly incised and

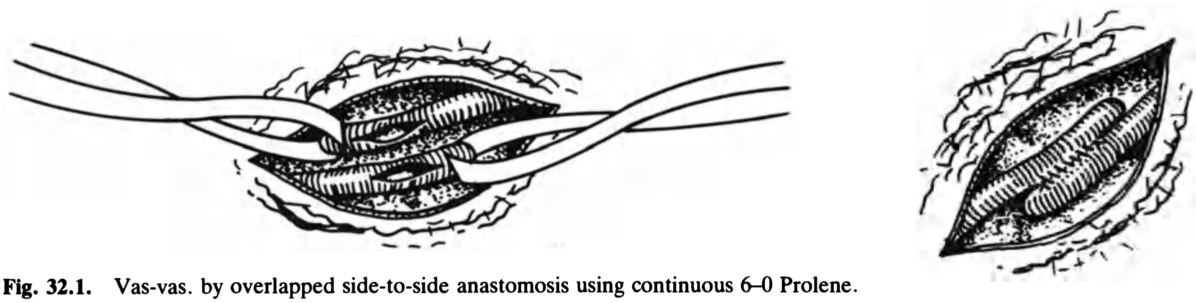


**Fig. 32.1.** Vas-vas. by overlapped side-to-side anastomosis using continuous 6–0 Prolene.

the lumen defined with a no. 1 nylon probe. The two ends are then overlapped and joined together by side-to-side anastomosis using 6–0 Prolene and no splint (Fig. 32.1). Care should be taken to ensure that the anastomosis is as leak-proof as a vascular anastomosis, to prevent spermatozoa from extravasating into the tissues and causing a granuloma.

Alternatively, an end-to-end anastomosis may be done, but the fine bore of the lumen, and the disparity that often exists between the diameter of the upper and lower ends, requires a two-layer microsurgical technique using the operating microscope (Silber 1977) if an accurate union is to be obtained.

## Results

The results of vasectomy reversal have improved significantly in recent years. A collective review of 13 papers by Hulka and Davis in 1972 showed very variable results, with normal sperm counts reported in 37%–92% (average 60%) of cases, and pregnancies in 10%–60% (mean 44%) of the wives. In another collective review of 20 papers by Wicklund and Alexander in 1979, 49% of 2685 cases showed return of spermatozoa to the ejaculate, with 21% of the wives of 2177 men becoming pregnant. By contrast, having pioneered a two-layer non-stented microscopic technique of end-to-end anastomosis, Silber (1978) reported a pregnancy rate of 71% in the first 42 patients followed for 15 months. Cos et al. (1983) have reviewed the results of 943 vaso-vasostomies performed by 19 surgeons using 6 techniques, reported between 1978 and 1983. The overall patency rate was 81.5%, with a pregnancy rate of 53.5%. Although the best technical results (90% patency) were obtained with the microscopic two-layer unstented technique, there was no difference in the pregnancy rates (56%–62%) between the microscopic and loupe magnification, stented or unstented techniques. However, considerably lower pregnancy rates (41%–44%) were recorded with macroscopic methods. The present author favours the overlapped side-to-side anastomosis done with loupe magnification and no splints. Not only is a large opening obtained between the two parts of the vas, but the use of a continuous Prolene suture produces a water and sperm-tight anastomosis, which discourages leakage from the anastomosis and hence reduces the tendency towards granuloma formation. Furthermore, the use of a side-to-side technique eliminates any technical difficulties resulting from differences in the calibre of either end of the vas.

Several other factors have been shown to have an influence on the likelihood of success. The finding of spermatozoa in the fluid from the testicular end of the vas indicated a favourable prognosis, whereas the absence of such spermatozoa was associated with an increasingly poor prognosis with lengthening time since vasectomy. Overall, the likelihood of regaining a normal sperm count fell from 91% within 10 years of vasectomy to 35% after more than 10 years (Silber 1977). This may have been due to the development of secondary changes in the epididymis. Vasectomy increases the pressure in the testicular end of the vas, which is transmitted to the epididymis. Rupture of the tubules in the epididymis may produce granulomas and secondary epididymal obstruction. Granuloma formation at the cut testicular end of the vas, however, is associated with reduction in dilatation of the vas, and better quality vas fluid has been observed in the absence of such dilatation, possibly as a result of protection against back pressure (Silber 1977). Vasectomy can also damage the nerves lying adjacent to the vas (Pabst et al. 1979), and degenerative changes have been described in the alpha-adrenergic nerve supply to the testicular end of the vas and the cauda epididymis; these nerves regenerated slowly after vas-vas. and this may account for the slow recovery of normal ejaculate content after vasectomy reversal (Alexander et al. 1979).

## Failed Vasectomy Reversal

With a good surgical technique, vasectomy reversal should successfully restore a man's fertility in around 50% of cases. If the operation is unsuccessful—if spermatozoa appear in the ejaculate only transiently or not at all—the scrotum should be re-explored: the results in 23 such cases are summarised in Table 32.1 (Royle and Hendry 1985).

**Table 32.1.** Results of re-exploration of scrotum in 23 patients who remained azoospermic after vasectomy reversal[b]

| Category | Treatment | No. | Follow-up sperm counts | | | Pregnancies[a] |
|---|---|---|---|---|---|---|
| | | | 0 | <20 | ≥20 | |
| 1. Blocked vas | Redo vas-vas. | 12 | 1 | 3 | 7 | 5/8 (62%) |
| 2. Epididymal block | Ep-vas. | 4 | 1 | | 3 | 2/4 (50%) |
| 3. Antisperm antibodies (≥1024) | Surgery + prednisolone | 7 | 1 | 3 | 3 | 0/7 |
| | | | | | Total | 7/19 (37%) |

[a]Couples trying to conceive for 6 months or more.
[b]Reproduced from Royle and Hendry (1985) by kind permission of the Editor of *British Journal of Urology*.

There appear to be four distinct causes of failure of vasectomy reversal. The commonest by far, which should be anticipated in about half of these patients, is due to stenosis or blockage of the previous vas-vas. It is known that spermatozoa tend to leak out of the anastomosis when vas-vas. is done, and these may produce local granulomas. Hagan and Coffey (1977) showed that the presence of spermatozoa at the site of anastomosis led to sperm granuloma formation and that this appeared to be an important cause of failure of vas-vas. In 1977, Silber showed that good results can be obtained by carefully re-doing the vas-vas., with most satisfactory results in terms of restoration of normal sperm counts and a high incidence of pregnancy in the wives. The success rate in this group is equivalent to that obtained on first doing vas-vas. (Table 32.1).

The second most common cause is epididymal blockage, presumably caused by back pressure from the site of the vasectomy, leading to rupture of the epididymal tubules with local sperm granuloma formation within the epididymis. Histological examination of a section of epididymis removed at the time of ep-vas. will often demonstrate rupture of an epididymal tubule with surrounding sperm granuloma formation (Fig. 32.2) which leads to the secondary blockage in the epididymis upstream of the original site of the vasectomy. The present author has confirmed that excellent results can be obtained following ep-vas. in these cases, although restoration of normal sperm count generally takes rather longer than following vas-vas. (Royle and Hendry 1985).

The problem of the patient who develops very high antisperm antibody response to his vasectomy continues to defy successful treatment. In previous studies (Parslow et al. 1983) the present author and his colleagues showed that pregnancy was possible despite high antisperm

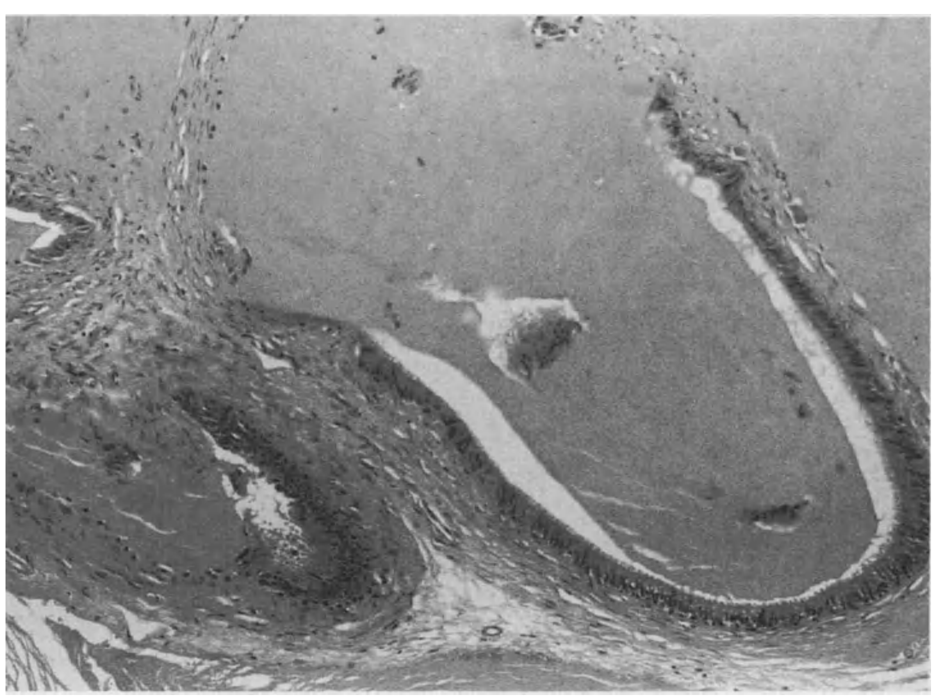


**Fig. 32.2.** Ruptured epididymal tubule with granuloma formation in a man who had had four previous unsuccessful attempts at vasectomy reversal. Following ep-vas. above this block by the technique shown in Fig. 32.6, spermatozoa returned to the ejaculate and pregnancy was produced.

antibody titres; however, they have defined a small sub-population of patients in whom, despite re-exploration of the scrotum and prednisolone therapy (Hendry et al. 1986), restoration of fertility does not seem to be possible, apparently because of the immunological response to the spermatozoa. This problem continues to present a significant therapeutic challenge (see p. 388).

Finally, spermatogenesis may have ceased. The present author's studies, and those of Bagshaw et al. (1980), showed by testicular biopsy that significant impairment of spermatogenesis following vasectomy was in fact extremely uncommon. Nevertheless, the possibility should be considered amongst this population of patients, many of whom are entering middle life at the time when this surgery is carried out.

## Surgery for Obstructive Azoospermia

The outflow passages from the testicle can become obstructed at a number of different sites as a result of a variety of aetiological factors, and yet the exact site involved is generally related to the underlying cause (Fig. 32.3). As a result, it is possible to classify descriptively testicular obstruction according to the site of the blockage, and still take into

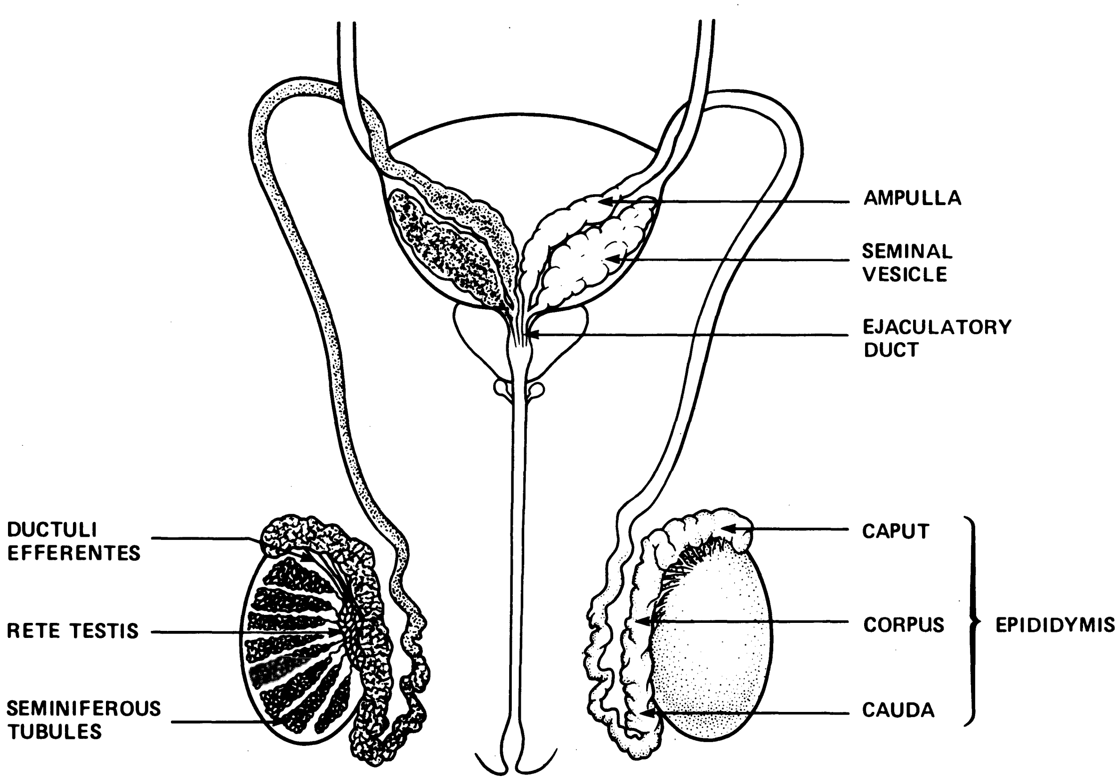



**Fig. 32.3.** The efferent passages of the male genital tract.

account the different pathophysiological processes involved. This is of practical importance, since supplementary medical treatment may be required in addition to surgery. A classification based upon the findings at exploratory scrototomy in 168 patients with azoospermia and normal serum follicle-stimulating hormone (FSH) levels (Hendry et al. 1983) is shown in Table 32.2. The incidence of each type of obstruction is shown, together with the findings on testicular biopsy and vasography. The commonly related aetiological factors are indicated. In some cases the lesions were asymmetrical, and this is emphasised when it appears to be a common feature. Although this descriptive classification was worked out in patients with azoospermia, it is equally applicable to unilateral testicular obstruction since its basis is anatomical. The cases are stratified according to:

1. The external appearances of the epididymis when examined with magnifying spectacles or operating microscope.
2. The findings on vasography.
3. The results of testicular biopsy.

**Table 32.2.** Classification of testicular obstruction based on the findings in 167[a] azoospermic males with normal serum FSH levels[b]

| Site of obstruction | No. of cases (%) | Spermatogenesis | Vasogram | Aetiological factors |
|---|---|---|---|---|
| Empty epididymis | 8 (5%) | Absent | Not done | Sertoli cell only |
| | 14 (8%) | Impaired | Not done | Maturation arrest |
| | 2 (1%) | Normal | Not done | Immune orchitis |
| Caput epididymis | 48 (29%) | Normal | Normal | Usually Young's syndrome |
| Cauda epididymis | 34 (20%) | Normal | May be abnormal | Post-infective |
| Blocked vas | 23 (14%) | Normal | Abnormal | Traumatic, infective |
| Absent vas | | | | |
| bilateral | 29 (17%) | Normal | Not possible | Congenital |
| unilateral | 8 (5%) | Normal | Various | Various (Contralateral testis) |
| Ejaculatory duct | 1 | Normal | Dilated | Congenital, traumatic |

[a]The series also included one unclassifiable patient who had had both epididymides excised as treatment for epididymal cysts.
[b]Reproduced from Hendry et al. (1983) by kind permission of the Editor of *British Journal of Urology*.

## Classification of Testicular Obstruction

*Empty Epididymis.* In the vast majority of these cases, there is absent or impaired spermatogenesis which has not been reflected by elevation of serum FSH levels. Occasionally, there is gonadotrophin deficiency, which may respond to medical therapy. Rarely, there is normal spermatogenesis associated with very high antisperm antibody titres (1024 or greater); testicular biopsy may show focal mononuclear cell infiltrates, indicating that this is a form of cell-mediated immune orchitis, which may respond to prednisolone therapy (see p. 389).

*Caput Epididymis.* This is the largest single group encountered in the UK, comprising 29% of all cases in my experience. In three-quarters of these patients there is coexisting sinusitis, bronchitis or bronchiectasis, an association first noted by Young (1970). The distension of the epididymal tubules is confined to the head of the epididymis, and light microscopy shows that this coincides with the ductuli efferentes, where the epithelium is ciliated; the tubules are filled with inspissated masses of spermatozoa and lipid. Electron microscopy shows that the cilia have the normal 9+2 arrangement of microtubules and that dynein arms are present (Hendry et al. 1978). Lung mucociliary clearance is impaired (Pavia et al. 1981), even though ciliary beat frequency measured by the technique of Rutland and Cole (1980) is normal (P. Cole 1983, personal communication). Despite intensive further studies, the aetiology of Young's syndrome remains obscure (Neville et al. 1983; Handelsman et al. 1984). The results of ep-vas. are generally poor.

*Cauda Epididymis.* This is the appearance commonly seen following infection, which may be gonococcal, chlamydial, resulting from urinary infection or smallpox, or associated with a variety of esoteric conditions such as sandfly fever or Bornholm disease (Jameson 1985). Typically, the tubules within the epididymis are uniformly distended down to its tail; of course, a similar appearance is seen when the vas is blocked, causing back pressure on the epididymis, and a vasogram is mandatory to ensure that it is clear, or to localise coexisting vasal blocks which may also require surgical correction. After bilateral ep-vas. about 50% of patients in this category regain normal sperm counts, although this may take a year or more from the time of surgery (Hendry 1981). A unilateral caudal block may be found not uncommonly; the appearances at exploratory scrototomy are characteristic and easy to recognise (Fig. 32.4).

*Blocked Vas.* This occurs in its simplest form after vasectomy. Vasal blocks may also occur following infection, such as gonorrhoea, when they may coexist with a caudal epididymal block, either on the same or on the other side. Ipsilateral caudal block is excluded by finding a good flow of milky fluid on incising the vas. The most common sites affected are the neck of the scrotum and the internal inguinal ring, where the vas changes direction sharply. Totally impenetrable blocks are occasionally encountered, which generally turn out to be tuberculous. The vas may also be obstructed following groin surgery such as hernia repair in infancy or childhood. The level of the block may be defined by vasography, which should also confirm patency of the vas beyond the block.

*Absent Vas.* Bilateral absence of the vas was found in 17% of patients with azoospermia and normal FSH levels. If the seminal analysis indicates that this is the likely diagnosis (low pH, absent fructose) and the vasa are impalpable, the patient can be spared surgical exploration. Unilateral absence of the vas was found in 5% of the present author's patients with azoospermia, associated with a variety of other problems on the contralateral side such as testicular atrophy, post-infective blocks or

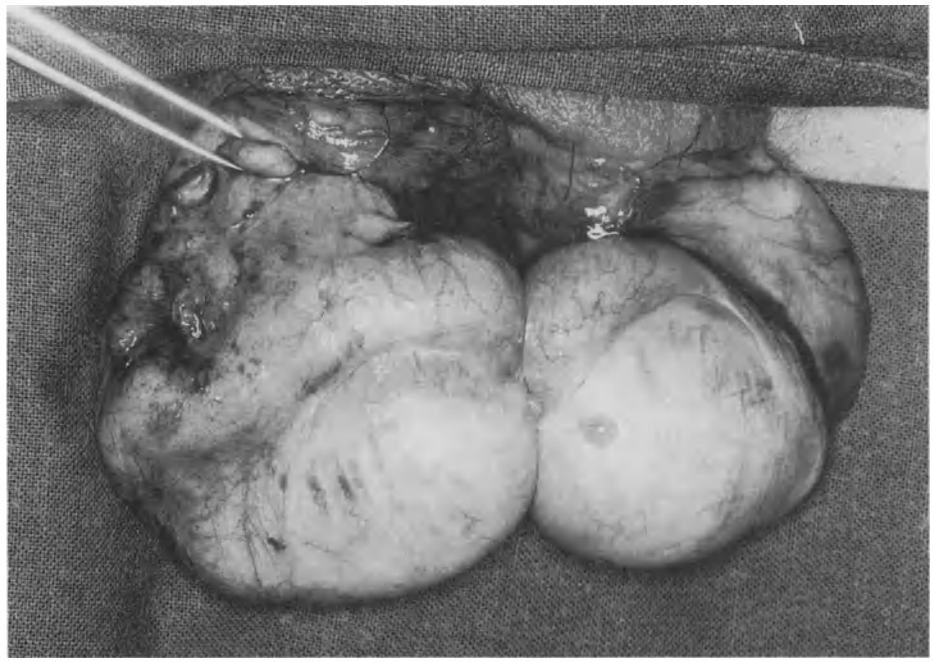


**Fig. 32.4.** Unilateral caudal block. Note the difference in the appearances of the obstructed right side (with tissue forcep) compared with the normal left side.

other congenital anomalies. Surgical reconstruction was successful in 50% of cases. Associated urological abnormalities such as pelvic kidney or renal agenesis were commonly present.

*Ejaculatory Duct.* Obstruction at this level is rare, but examples have been seen with congenital anomalies such as Mullerian duct cysts or malformations of the ampullary part of the vas and seminal vesicle; obstruction may also occur after excision of the rectum, or following surgery for imperforate anus.

## Surgical Technique

### *Exploratory Scrototomy*

Surgery for male subfertility should always be done with good operating facilities and a general anaesthetic if possible; it is important to recognise that conditions which may be appropriate for vasectomy are generally not adequate for corrective or reconstructive surgery on the male genitalia. Special facilities will be needed, such as fine instruments for microsurgical anastomoses, an operating microscope or magnifying spectacles, and equipment to allow X-ray films to be taken on the operating table. A microscope will be required to examine fluid obtained from the epididymis or vas for the presence of spermatozoa. These

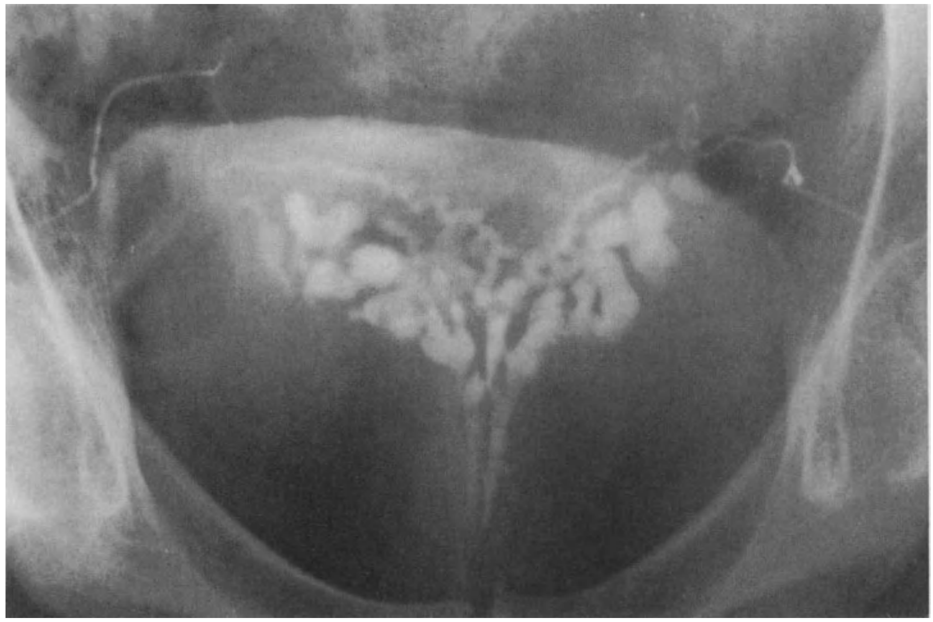


**Fig. 32.5.** Normal vasogram. Note that the ejaculatory duct is clearly shown by directing the X-ray 20° down towards the feet—the so-called open-pelvis view.

should be prepared in advance, so that they are readily available at the time of surgery.

The scrotum is opened through a short midline incision, and the testicles are delivered. The tunica vaginalis is opened on both sides and the epididymides are examined for evidence of obstruction. If distended tubules are seen, the radiographer is notified that a vasogram will be required.

Whether or not there is evidence of obstruction, a testicular biopsy is taken next. A nick is made in the tunica albuginea, and a small piece of testicular tissue (about 2 mm diameter) is extruded and removed with scissors. This tissue is immediately fixed in Bouin's solution (*not* formalin), and may be sent for cytogenetic processing to study the meiotic chromosomes (Hendry et al. 1975). The tunica albuginea is closed with a horizontal mattress suture of 3–0 chromic catgut. If the epididymides are empty, nothing further is done.

If there is evidence of obstruction, vasography is done either by puncturing the vas with a fine needle, or by making an 0.5 cm, longitudinal incision in the vas immediately adjacent to the lowest part of the epididymis that contains dilated tubules, and introducing a 2 FG Portex polythene cannula. About 5 ml of radiopaque contrast medium such as 25% Hypaque are injected up each side and an X-ray film is taken (Fig. 32.5).

Following the completion of reconstructive surgery the tunica vaginalis is closed on each side and the testes are returned to the scrotum. After applying a little antibiotic spray, the dartos layer is closed with continuous catgut, and the skin with a subcuticular nylon or Vicryl suture. The scrotum is wrapped in cotton wool, and placed in a scrotal support, which should remain dry and undisturbed for 7 days.

*Ep-vas.*

After careful examination with the operating microscope or magnifying spectacles, the lowest part of the epididymis that contains dilated tubules is incised, and the fluid which runs out is examined immediately for the presence of spermatozoa. Once their presence has been confirmed, the incisions in the vas and the epididymis, which should lie together without tension, are united. This can be done most conveniently using double-ended 6–0 Prolene, starting inferiorly. The posterior edges are joined with a continuous suture and the anastomosis is continued up to and around the critical superior end; the vasography cannula may be left in while this part of the anastomosis is done. Once it is certain that the lumen of the vas is not narrowed by the suture, the cannula is removed and the anterior part of the anastomosis is completed.

Alternatively, the epididymis may be carefully mobilised by dissection from the body of the testis and then transected (Fig. 32.6). This can be repeated until free efflux of milky fluid is obtained, and then the epididymis is anastomosed end-to-side or end-to-end to the vas deferens. Ideally, the tubule exuding milky fluid is joined to the vas, mucosa-to-mucosa, using an operating microscope (Schoysman 1982; Silber 1984).

*Vas-vas.*

If a vasal block is found in the patient with obstructive azoospermia in the course of exploratory scrototomy, it is generally best to make a counter incision in the groin to provide wide exposure of the vas so that the site of obstruction can be clearly defined with a view to reconstruction by vas-vas. However, if there is a coexisting caudal epididymal block on the opposite testicle, or if that testis is atrophic, an alternative approach is

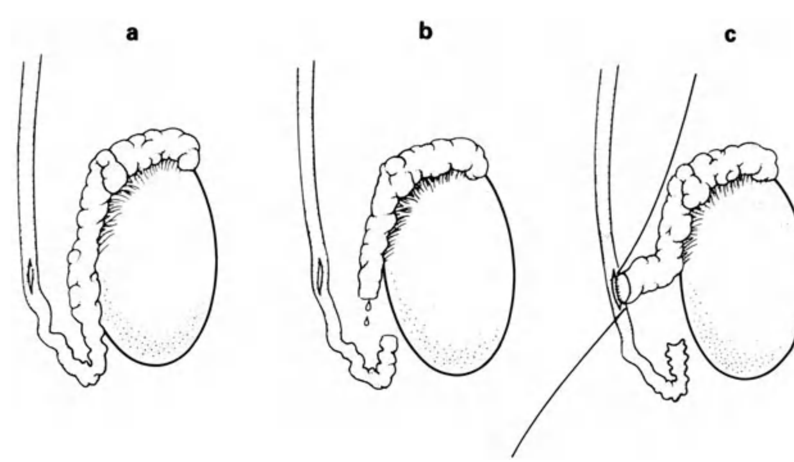



**Fig. 32.6a–c.** Ep-vas. procedure. The epididymis is mobilised off the body of the testicle and transected. Serial transection of the epididymis continues until a good flow of milky fluid is obtained from the epididymis. It is then anastomosed to the vas end-to-side.

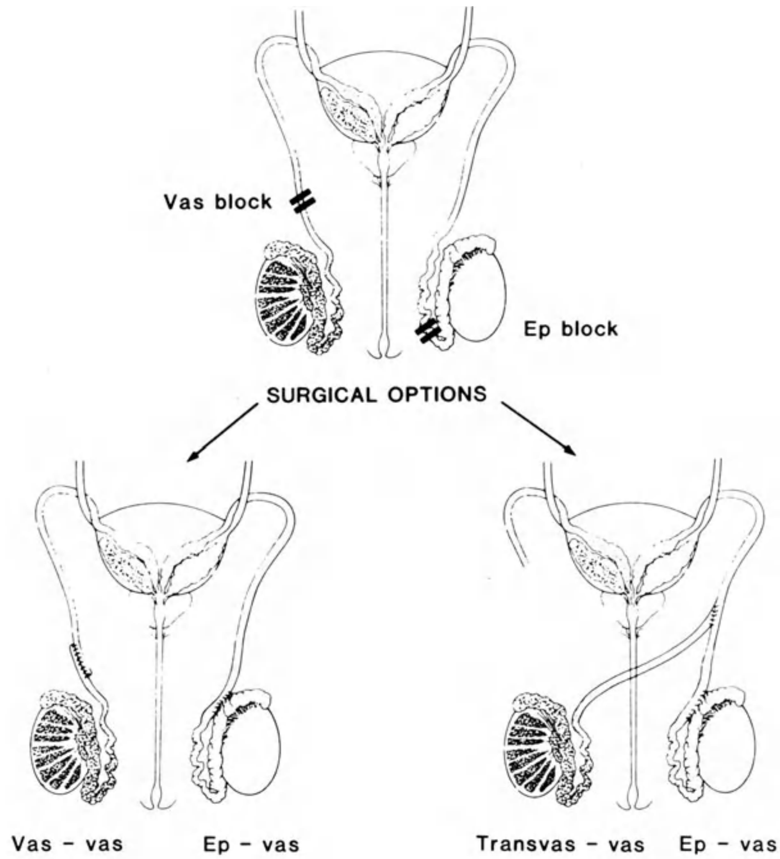



**Fig. 32.7.** When there is a high vasal obstruction on one side and a low epididymal block on the other side, the surgeon can choose between total reconstruction by vas-vas. and ep-vas., or the technically simpler transvas-vas.

transvas-vas. (Fig. 32.7). However, this procedure has given rather disappointing results in the present author's hands.

## Ejaculatory Duct Obstruction

Surgical correction of ejaculatory duct obstruction is difficult, since the area is very inaccessible. However, endoscopic incision in the prostatic urethra can open into the ejaculatory duct, which may be more obvious if it has previously been filled with methylene blue at the time of vasography. Ejaculatory duct cysts may bulge into the prostatic urethra and cause urinary difficulty or even retention: it can be easily recognised endoscopically and de-roofed with the resectoscope, or deeply incised with the Colling's diathermy knife. Follow-up exploratory scrototomy and vasograms may be necessary if azoospermia persists (Fig. 32.8).

Alternatively, patients with high vasal blocks, and those with failure of ejaculation resulting from paraplegia or following retroperitoneal node dissection, can be treated by implantation of specially designed sperm reservoirs (Fig. 32.9), from which spermatozoa can be aspirated for insemination. The vasa deferentia are cannulated in the inguinal canal, and the reservoirs are sited under the deep fascia of the anterior

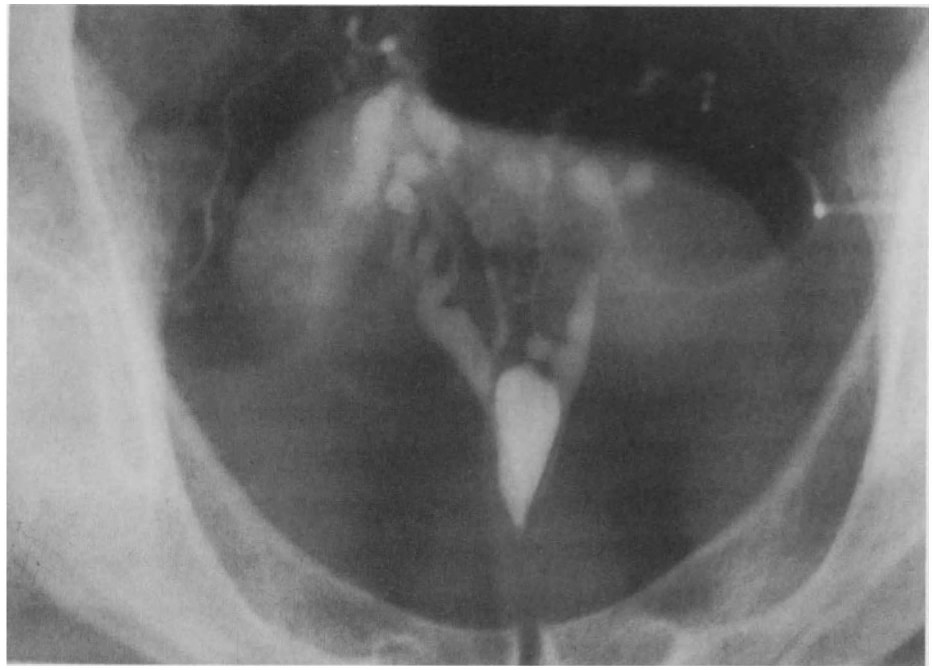


**Fig. 32.8.** Vasogram showing ejaculatory duct cyst after transurethral incision. Note that there is some dye in the bladder indicating that patency has been restored.

abdominal wall just above and lateral to the internal inguinal ring. The reservoir has a self-sealing membrane in front to allow repeated needle puncture, and a rigid back plate and rigid side walls. In early studies by the present author and his colleagues, motile spermatozoa were recovered in 8 of 12 cases and 2 pregnancies were produced (Brindley et al. 1987).

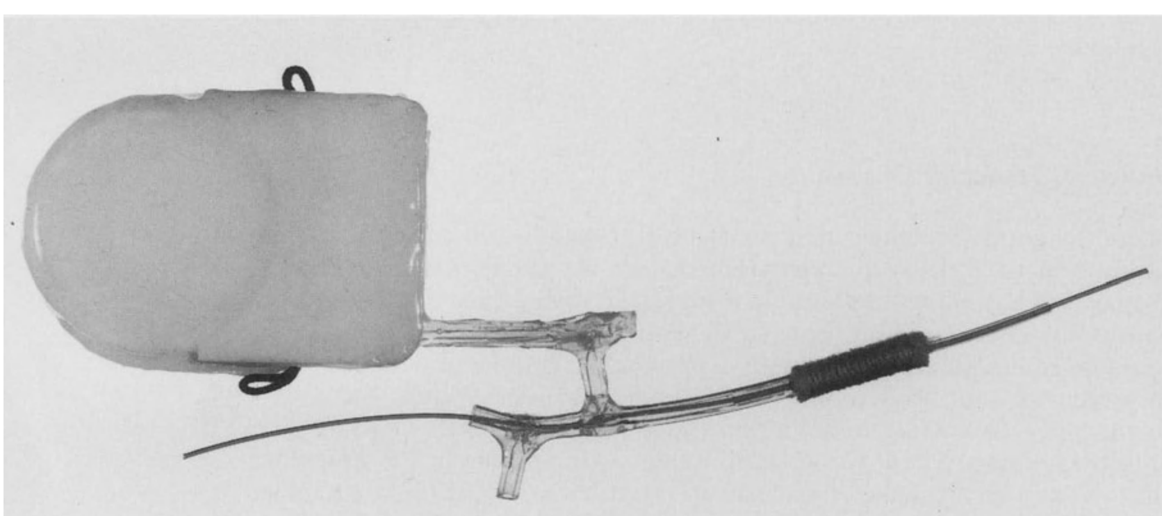


**Fig. 32.9.** Sperm reservoir for high vasal block or failure of ejaculation. The cannula is inserted into the vas deferens in the inguinal canal, and the reservoir lies subcutaneously. Spermatozoa are obtained by needle puncture.

## Results of Surgery for Testicular Obstruction

### *Obstructive Azoospermia*

In 66 (39%) of 168 patients with obstructive azoospermia, acquired blocks of the cauda epididymides, vasa or ejaculatory duct were found which were potentially suitable for surgical correction (Hendry et al. 1983). Overall, spermatozoa returned to the ejaculate in 27 (41%) of these cases after surgery: excluding the 15 lost to follow-up, sperm counts of 10 million per millilitre or more were produced by 23 (45%) of 51 patients in these categories. Eleven wives became pregnant: 21.5% of patients with adequate follow-up, 17% of all patients in these categories, and 6.5% of the whole series of 168 patients (Hendry et al. 1983). These figures may be compared with those of 51% patency and 21% pregnancy reported from 291 patients with adequate follow-up by Schoysman (1982), and 55% patency and 29% pregnancy in 24 patients with a history of epididymitis (Dubin and Amelar 1982). On the other hand, the present author and his colleagues had no success, apart from a few spermatozoa in the ejaculate, in any of the patients with blocks in the caput epididymis. The results, therefore, confirmed the conclusions of Hanley (1955) that post-inflammatory lesions are amenable to surgical repair, whereas congenital defects are seldom correctable.

The association between chest disease and blocks in the caput epididymis (Young's syndrome) suggests that a defect in mucociliary function is the basic problem in this group of patients. Since the cilia are ultrastructurally and functionally normal in these patients (see p. 380), the present author and his colleagues have assumed, until the precise underlying defect is defined, that the fluid within the epididymal tubules and the respiratory tree must be excessively viscous, and they have empirically given these patients a mucolytic agent (carbocysteine) for 1 year from the time of surgery. Since then, some patients have achieved good sperm counts postoperatively, and one pregnancy has been obtained.

### *Unilateral Testicular Obstruction*

There is good evidence that unilateral testicular obstruction causes diminution of fertility in mice (Kessler et al. 1985). Once unilateral obstruction has been diagnosed in a subfertile male, it may be possible to correct the obstruction in some cases, and in others the obstructed testis could be removed and replaced by a prosthesis. Rumke and Titus (1970) showed that antibody stimulation tended to cease and titres fell significantly following removal of the obstructed testis in rats. The present author studied 32 subfertile males with sperms in the ejaculate and unilateral testicular obstruction (Hendry et al. 1982): the past medical history gave relevant information in 27 (84%) and useful findings were made on clinical examination in a further 3 cases. Since then, this experience has been extended to 80 spontaneously infertile males, in whom the presence of unilateral testicular obstruction has been confirmed by exploratory scrototomy. Forty (50%) had severe oligozoospermia with sperm counts of less than 5 million per millilitre, even though testicular biopsies showed adequate spermatogenesis, and despite the presence of an unobstructed contralateral testis. The sperm count was normal (greater than 20 million per millilitre) in only 21. Sixty-one patients (75%) had serum antisperm antibodies, presumably provoked by the testicular obstruction. The most common sites of obstruction were at the tail of the epididymis, or in the vas deferens (Table 32.3).

**Table 32.3.** Sites and probable causes of unilateral obstruction in 80 subfertile males[a]

| | Post-infective | Surgery/injury | Congenital | Cause unknown |
|---|---|---|---|---|
| Upper epididymis | | 5 | | 6 |
| Tail of epididymis | 25 | 6 | | 9 |
| Vas deferens | 8 | 12 | 4 | |
| Ejaculatory duct | 1 | 2 | 1 | 1 |
| Total | 34 | 25 | 5 | 16 |

[a]Reproduced from Hendry (1987) by kind permission of the Editor of *British Journal of Urology*.

Corrective surgery was done by ep-vas. or vas-vas. whenever possible, but in 11 cases when repair was impossible the obstructed testis was removed and replaced with a prosthesis. Steroid treatment for antisperm antibodies was given when appropriate. So far, 19 (32%) of 60 patients with adequate follow-up successfully impregnated their female partners. Paradoxically, the best results occurred in 30 men who started with sperm counts of less than 5 million per millilitre; 12 (40%) of whom were successful (Table 32.4).

**Table 32.4.** Pregnancies produced/number treated in 60 patients with adequate follow-up related to initial sperm counts and surgical treatment[a]

| Surgical treatment | Initial sperm count M/ml | | | Totals |
|---|---|---|---|---|
| | ≤5 | 6–20 | >20 | |
| Ep-vas. | 7/18 | 1/10 | 2/5 | 10/33 (30%) |
| Vas-vas. | 2/5 | | 1/1 | 3/6 (50%) |
| Orchidectomy | 1/2 | 0/2 | 1/6 | 2/10 (20%) |
| None (steroids) | 2/5 | 1/2 | 1/4 | 4/11 (36%) |
| Totals | 12/30 (40%) | 2/14 (14%) | 5/16 (31%) | 19/60 (32%) |

[a]Reproduced from Hendry (1987) by kind permission of the Editor of *British Journal of Urology*.

Clinical history, physical examination and serum antisperm antibodies, especially if head-to-head agglutinins are present, can suggest the possibility of unilateral testicular obstruction, but confirmation of the diagnosis requires exploratory scrototomy. It is clear that unilateral obstruction is a correctable cause of male infertility that should be recognised and treated.

## Antisperm Antibodies and Testicular Obstruction

After experimental vasoligation in animals, testicular lymph and regional lymph nodes consistently contain spermatozoa (Ball and Setchell 1983), and spermatozoa have been found in a para-aortic lymph node 1 year after vasectomy in a man undergoing laparotomy (Ball et al. 1982). It is therefore not surprising that antisperm antibodies develop in the serum of 60%–80% of men following vasectomy (Hellema and Rumke 1978; Rose and Lucas 1979).

**Table 32.5.** Incidence of pregnancy in spouse 1 year or more after vasectomy reversal related to serum TAT titre[a]

| Serum TAT titre | Total no. | Information available | Sperm count | | | ? Pregnancy | |
|---|---|---|---|---|---|---|---|
| | | | 0 | <20 | ⩾20 M/ml | Trying | Success |
| ⩽16 | 40 | 32 | 5 | 7 | 20 | 29 | 15 (52%) |
| 32–256 | 40 | 36 | 1 | 14 | 21 | 32 | 17 (53%) |
| ⩾512 | 41 | 31 | 2 | 9 | 20 | 28 | 7 (25%) |

TAT, tray agglutination test.
[a]Reproduced from Parslow et al. (1983) by kind permission of the Editor of *American Journal of Reproductive Immunology*.

The present author and his colleagues measured antisperm antibodies in serum and seminal plasma in 130 males before and after vasectomy reversal, and the occurrence of pregnancy was analysed in those partners who were trying to produce a pregnancy. All patients were followed for at least 1 year. Sperm agglutinating antibodies were found in the serum of 79% of patients; seminal plasma antibodies were present in only 9.5% before reversal, and this rose to 29.5% afterwards (Parslow et al. 1983). Overall, pregnancies occurred in the partners of 44.6% of those men who were trying to produce children. Production of pregnancy was significantly less likely when the preoperative serum antisperm antibody titre was 512 or more, but no decrease in fertility was seen with titres below this (Table 32.5). Similar numbers of pregnancies were produced by patients with or without seminal plasma antibodies, in titres of up to 16. This is different from the conclusions of Linnet et al. (1981), and from spontaneously infertile males. Further studies have shown that this distinction may be due to the antibodies being of a different class. Most of the antibody produced after vasectomy is IgG, and some may transude from serum into the seminal plasma, whereas in spontaneously infertile males much of the seminal plasma antibody is IgA, probably produced locally in the genital tract. It appears that the locally produced IgA exerts a more powerful adverse effect on fertility (Parslow et al. 1985).

The spontaneously infertile male with azoospermia differs from the vasectomised male in a number of respects. If the block is congenital, many years will have elapsed since the antigenic stimulus first appeared, and since the induction of the immune response was gradual, a degree of tolerance may have occurred. With acquired, post-infective blocks, on the other hand, the obstruction followed an acute inflammatory disease of the genital system that may well have stimulated considerably more local antibody formation than the comparatively clean surgical procedure of vasectomy. In analysing the findings in 168 azoospermic males (Hendry et al. 1983), it was interesting to observe that serum antisperm antibodies occurred approximately twice as often in the acquired group than in the congenital group. Statistical analysis showed that these antibodies occurred significantly more often with blocks at the cauda epididymis (53%) than with those at the caput epididymis (29%), and also significantly more often than in men with congenital bilateral absent vasa (21%). Taking all 27 of the patients with spermatozoa in the ejaculate after surgical correction of caudal epididymal or vasal blocks, or with unilateral absence of the vas, and comparing those who produced pregnancies with those who did not, relative to the presence or absence of serum antisperm antibodies (Table 32.6), it may be seen that production of pregnancy was significantly more likely in those patients who did not have such antibodies (by Fisher's exact test, $P<0.05$).

**Table 32.6.** Serum antisperm antibody titres of patients with spermatozoa in the ejaculate following surgical correction of obstructive azoospermia[a]

| Serum GAT or TAT titre | Female partner | |
|---|---|---|
| | Not pregnant | Pregnant |
| 0 | 5 | 8 |
| 4 | 1 | |
| 8 | | |
| 16 | 2 | |
| 32 | 2 | 2 |
| 64 | 1 | |
| 128 | 1 | |
| 256 | 2 | 1 |
| 512 | 1 | |
| ≥1024 | | |
| Total | 16 | 11 |

GAT, gelatin agglutination test.
[a]Reproduced from Hendry et al. (1983) by kind permission of the Editor of *British Journal of Urology*.

The significant association between production of pregnancy in the spouse and absence of antisperm antibodies is of great interest, and suggests that a number of failures of surgical correction of obstructive azoospermia may have an immunological basis. It is possible that antisperm antibodies may have different and more potent effects in those patients with acquired post-inflammatory blocks than in men undergoing vasectomy reversal, and there may be an indication for a trial of steroid therapy in selected cases.

## References

Alexander NJ, Fulgham DL, Toyooka DL, Uno H, Wicklund R (1979) Innervation of the rabbit ductus deferens after vasectomy and vasovasostomy. Biol Reprod 21: 161–171

Bagshaw HA, Masters JRW, Pryor JP (1980) Factors influencing the outcome of vasectomy reversal. Br J Urol 52: 57–60

Ball RY, Setchell BP (1983) The passage of spermatozoa to regional lymph nodes in testicular lymph following vasectomy in rams and boars. J Reprod Fertil 68: 145–153
Ball RY, Naylor CPE, Mitchinson MJ (1982) Spermatozoa in an abdominal lymph node after vasectomy. J Reprod Fertil 66: 715–716
Brindley GS, Scott GI, Hendry WF (1987) Vas cannulation with implanted sperm-reservoirs for obstructive azoospermia or ejaculatory failure. Br J Urol 58: 721–723
Cos LR, Valvo JR, Davis RS, Cockett AJK (1983) Vasovasostomy: current state of the art. Urology 22: 567–575
Dubin L, Amelar RD (1982) Epididymovasostomy. In: Garcia CR, Mastroianni L, Amelar RD, Dubin L (eds) Current therapy of infertility. BC Decker, Trenton, pp 77–79
Hagan KF, Coffey DS (1977) The adverse effects of sperm during vasovasostomy. J Urol 118 (2): 269–273
Handelsman DJ, Conway AJ, Boylan LM, Turtle JR (1984) Young's syndrome: obstructive azoospermia and chronic sinopulmonary infections. N Engl J Med 310: 3–9
Hanley HG (1955) The surgery of male subfertility. Ann R Coll Surg Engl 17: 159–183
Hellema HWJ, Rumke P (1978) Sperm autoantibodies as a consequence of vasectomy. I. Within 1 year post-operation. Clin Exp Immunol 31: 18–29
Hendry WF (1981) The long term results of surgery for obstructive azoospermia. Br J Urol 53:664–668
Hendry WF (1987) The clinical significance of unilateral testicular obstruction in subfertile males. Br J Urol 58: 709–714
Hendry WF, Polani PE, Pugh RCB, Sommerville IF, Wallace DM (1975) 200 Infertile males: correlation of chromosome, histological, endocrine and clinical studies. Br J Urol 47: 899–908
Hendry WF, Knight RK, Whitfield HN et al. (1978) Obstructive azoospermia: respiratory function tests, electron microscopy and the results of surgery. Br J Urol 50: 598–604
Hendry WF, Parslow JM, Stedronska J, Wallace DMA (1982) The diagnosis of unilateral testicular obstruction in subfertile males. Br J Urol 54: 774–779
Hendry WF, Parslow JM, Stedronska J (1983) Exploratory scrototomy in 168 azoospermic males. Br J Urol 55: 785–791
Hendry WF, Treehuba K, Hughes L et al. (1986) Cyclic prednisolone therapy for male infertility associated with antibodies to spermatozoa. Fertil Steril 45: 249–254
Howard G (1982) Who asks for vasectomy reversal and why? Br Med J 285: 490–492
Hulka JF, Davis JE (1972) Vasectomy and reversible vasocclusion. Fertil Steril 23: 683–696
Jameson RM (1985) Infective causes of male infertility. In: Whitfield HN, Hendry WF (eds) Textbook of genitourinary surgery. Churchill Livingstone, Edinburgh
Kessler DL, Smith WD, Hamilton MS, Berger RE (1985) Infertility in mice after unilateral vasectomy. Fertil Steril 43: 308–312
Linnet L, Hjort T, Fogh-Andersen P (1981) Association between failure to impregnate after vasovasostomy and sperm agglutinins in semen. Lancet I: 117–119
Neville E, Brewis R, Yeates WK, Burridge A (1983) Respiratory tract disease and obstructive azoospermia. Thorax 38: 929–933
Pabst R, Martin O, Lippert H (1979) Is the low fertility rate after vasovasostomy caused by nerve resection during vasectomy? Fertil Steril 31: 316–320
Parslow JM, Royle MG, Kingscott MMB, Wallace DMA, Hendry WF (1983) The effects of sperm antibodies on fertility after vasectomy reversal. Am J Reprod Immunol 3: 28–31
Parslow JM, Poulton TA, Besser GM, Hendry WF (1985) The clinical relevance of classes of immunoglobulins on spermatozoa from infertile and vasovasostomised males. Fertil Steril 43: 621–627
Pavia D, Agnew JE, Bateman JRM et al. (1981) Lung mucociliary clearance in patients with Young's syndrome. Chest 80 [Suppl]: 892–895
Rose NR, Lucas PL (1979) Immunological consequences of vasectomy. II. Two-year summary of prospective study. In: Lepow IH, Crozier R (eds) Vasectomy: immunologic and pathophysiologic effects in animals and man. Academic Press, New York, pp 533–560
Royle MG, Hendry WF (1985) Why does vasectomy reversal fail? Br J Urol 57: 780–783
Rumke PH, Titus M (1970) Spermagglutinin formation in male rats by subcutaneous injected syngeneic epididymal spermatozoa and by vasoligation or vasectomy. J Reprod Fertil 21: 69–79
Rutland J, Cole PJ (1980) Non-invasive sampling of nasal cilia for measurement of beat frequency and study of ultrastructure. Lancet II: 564–565
Schoysman R (1982) Epididymal causes of male infertility: pathogenesis and management. In: White R de V (ed) Aspects of male infertility. Williams and Wilkins, Baltimore, pp 233–249
Silber SJ (1977) Microscopic vasectomy reversal. Fertil Steril 28: 1191–1202
Silber SJ (1978) Vasectomy and vasectomy reversal. Fertil Steril 29: 125–140
Silber SJ (1984) Microsurgical vasoepididymostomy. In: Silber SJ (ed) Reproductive infertility microsurgery in the male and female. Williams and Wilkins, Baltimore, pp 132–146
Wicklund R, Alexander NJ (1979) Vasovasostomy: evaluation of success. Urology 13: 532–534
Young D (1970) Surgical treatment of male infertility. J Reprod Fertil 23: 541–542

*Chapter 33*

# Transsexualism in the Male: Male to Female Gender Reassignment

*P. F. Philip*

## Introduction

Gender identity, the individual's sense of being male or female, appears to be a fundamental psychological phenomenon and not related in any way to chromosomes or anatomy. In transsexualism, gender identity and anatomy are incongruous.

Psychotherapy designed to reverse the gender dysphoria has failed to help these patients. In 1953 (after the publicity following the sex conversion of Christine Jorgensen), Dr Christian Hamberger urged the medical and legal professions to work together to help these patients. Harry Benjamin in the USA is undoubtedly the pioneer who has done most to advance the cause of the transsexual, and John Money has followed his lead. In the UK, the late Dr John Randell devoted much of his energy to this problem after 1953 and established the Gender Identity Clinic at Charing Cross Hospital. It was due to his stimulus and enthusiasm that I became involved in the surgical aspects of the problem in 1957.

The pattern and history given by most male transsexuals is fairly uniform: from a very early age they wanted to be with the girls, they preferred the sort of toys and games associated with little girls and felt they were themselves girls. In a percentage (perhaps 10%–12%) there is a history in childhood of being cross-dressed by parent or grandparent, of parents having wanted a daughter, or of being raised totally or to a large extent by a grandmother; thus we may suppose that an external influence was also at work.

At puberty there is attraction to males and early sexual activity as a passive homosexual, but usually in imagination playing a feminine role.

Sometimes there is a strong aversion to the male genitalia, even to the extent of self-mutilation. In this group, the male transsexual has usually had no sexual contacts, and would be upset by the thought of his male organs being seen by anyone else. Many are definitely not homosexual, and would not countenance anal intercourse.

At school they are effeminate and are often teased and bullied. They tend to go into domestic or social service, hairdressing, ships's stewarding and other similar occupations whilst seeking surgery. Marriage, embarked upon in a mistaken belief that this will solve the problem, almost always fails, even when children are born. Undoubtedly, the last 30 years have seen a much greater awareness of the transsexual's problems. Special clinics have been established to assist them and observe their progress into a female role, with perhaps about one-third of cases being referred for surgery such as breast implants, modification of thyroid cartilage and vocal cords, orchidectomy and amputation of penis and vaginaplasty.

## Assessment

Initial referral should be to a psychiatrist in a Gender Identity Clinic where there is assistance in speech therapy, mannerism and dress, and support. It may be evident at the first attendance in many cases that there are other psychiatric problems and that major surgical procedures would not be appropriate. On average, at the Charing Cross Gender Identity Clinic patients are started on stilboestrol or Premarin once the psychiatrist is convinced of their stability and intention. Hormones alone were found to be beneficial by Dr H. Benjamin. Patients must demonstrate that they can pass without much comment in the female role and must live entirely and earn their living in the role for 1 year before they can be considered suitable for referral for surgery. Whether the simpler operations such as adjustment of thyroid cartilage, nasal surgery and breast augmentation should be undertaken before gender reassignment is a moot point.

Once a decision to refer for surgery has been made it is essential for the surgeon to make clear to the patient the difficulties and dangers of surgery, to impress upon the patient what can and cannot be achieved, to make it clear that surgery can never change his sex but only produce a reasonable approximation to the female genitalia, with, it is hoped, a "vaginal" canal which will permit intercourse. I have not met any patient who has been deterred by the possible dangers.

It is not possible to be fair by choosing only those younger patients who pass very well as females; the drive for surgery is just as strong in a middle-aged transsexual. The surgeon must, however, be at liberty to turn down any patient whom he feels is unstable. Even careful preselection by the psychiatrists may overlook some problems. Gross obesity and diabetes have caused problems in my patients.

## Consent for Gender Reassignment Surgery

Castration in the male seemed, in the early days, to be a mutilation which might be difficult to defend if litigation arose. The consent form reproduced here, which is really a request for surgery, has been used throughout with all our patients, in addition to the more standard operation consent form.

> I, (patient's name) hereby request (surgeon's name) to perform a gender reassignment operation upon me; to remove my penis and testicles and to form if possible an artificial vagina. I recognise that this operation does not change my sex, but is to enable me to live in the female role in which I am better adjusted and to prevent deterioration in my mental health. I also consent to the administration of an anaesthetic for the purpose of the operation and to any or alternative procedures which might be necessary.
>
> SIGNED ....................................................................
> DATE .......................................................................

There has been some anxiety that even such consent forms might not provide a complete protection from an action for tort. In the USA, in early cases proposed for surgery the patient was interviewed by a panel including his own legal representative to try to avoid such incidents.

Problems might also arise in patients who have been married. One should not operate in the absence of absolute divorce, and we feel that operations should not be performed if the patient is under the age of 21 years.

## Preoperative Preparation

The patient is admitted 24 h preoperatively and advised to eat well up to the time of admission and to keep air circulating around the genitals so that the skin is not moist. The main aim is to avoid bowel actions for the first 5 postoperative days, during which time the vaginal pack is in position, and to give some protection from infection because during perineal dissection inevitably lymphatics from the anal canal will be breached. I use colonic lavage, a liquid diet for 24 h preoperatively, sulphamethoxazole/trimethoprim (Septrin) and metronidazole (Flagyl) by mouth. A thorough pubic and perineal shave is done.

## The Operation

The patient is placed in a modified lithotomy position with the poles angled at 45° forwards. The skin is prepared with a weak iodine solution, washed off with surgical spirit. It is important not to irritate the scrotal skin.

The incision (Fig. 33.1) is planned to produce a long scrotal flap supplied by the posterior scrotal arteries; this forms the posterior wall

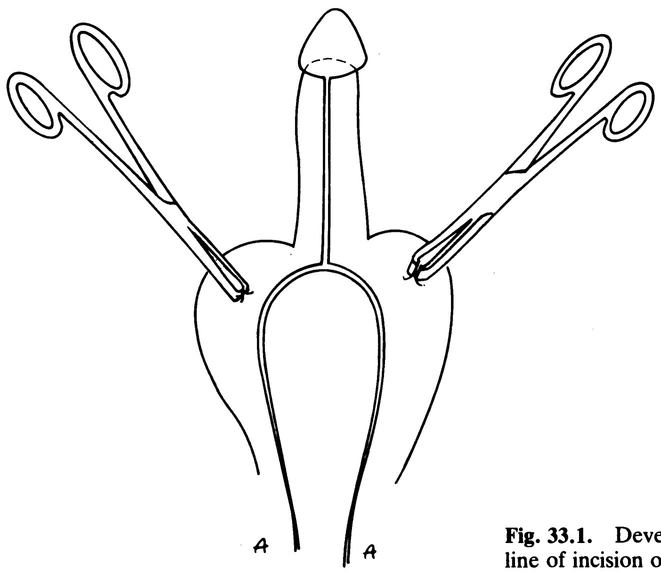


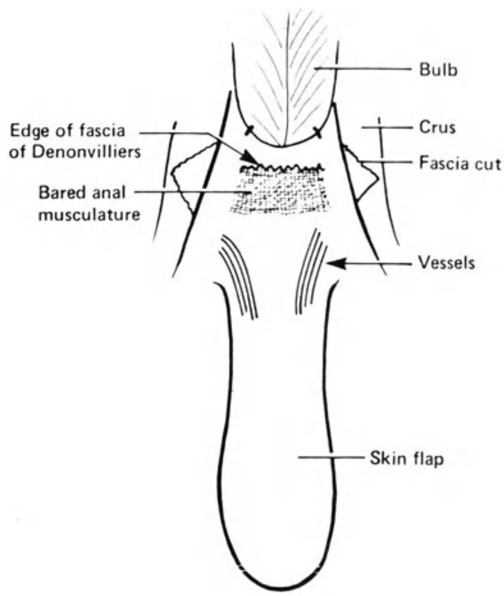

**Fig. 33.1.** Development of the posteriorly based scrotal skin flap and the line of incision of penile shaft skin.

and vault of the new vagina. The penile skin, incised in the midline ventrally, forms the anterior wall. Relative lengths of flap depend on the amount of skin available. Subcutaneous infiltration with 1/200 000 adrenalin in saline is performed prior to incision. The penile incision goes through Buck's fascia, which is kept on the flap.

Two Aliss forceps placed on the scrotum stretch it; these should be capable of reaching points A–A (Fig. 33.1) when depressed downwards. The scrotal flap is about 2 cm across at its base and 4–7 cm at the widest point.

The scrotal incision is deepened close to the edge of the flap to expose Colles' fascia, which covers the posterior scrotal arteries and veins at the anal end of the incision. The scrotal flap, fat and vessels are freed from the shaft and bulb of the penis (Fig. 33.2).

The angle between crus and bulb on each side is opened and crossing vessels are fulgurated. The sheath overlying the cavernosus muscle is cut laterally to free this angle and in the depth the artery to the bulb is fulgurated and divided on each side. Bilateral orchidectomy is performed at the external ring; the cord is transfixed and allowed to retract into the inguinal canal. The back of the bulbar muscle is exposed and the flap freed from it. A 16/20 urethral sound is passed into the bladder; angling this will push the prostate down and the apex of the gland can be palpated on the sound. A transverse cut 1 cm proximal to the apex is made and deepened until the fascia of Denonvilliers is split behind the prostate. Once this plane has been reached by dissecting the anal canal away from the prostate, upward enlargement of the space is easy. The peritoneal reflection is often seen and should be lifted forwards. The space can be deepened as far as needed, and this depends on the length of skin flap available. I use a sponge holder to open the depths, probably to 15 cm, and there place a long nylon stitch through the tissues at the




◀ **Fig. 33.2.** Reflection of the scrotal skin flap and perineal dissection between the posterior urethra and prostate anteriorly and the anal canal posteriorly to develop space for the neovagina.

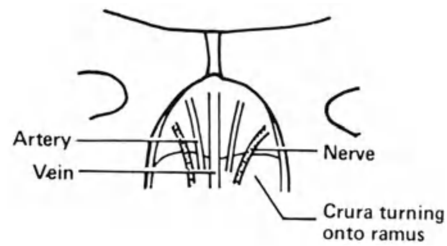


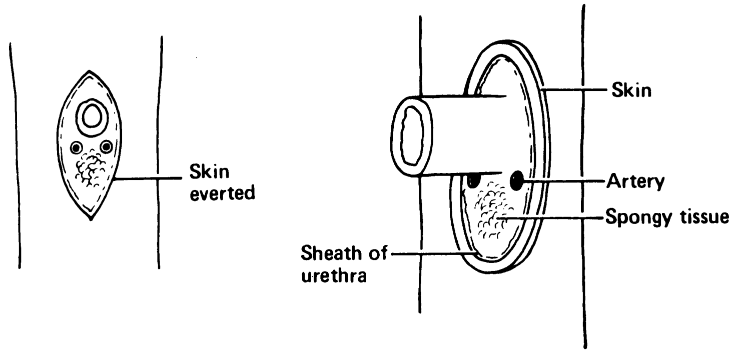

**Fig. 33.3.** Infrapubic dissection of the penis to allow posterior dislocation with subsequent division of the crura and amputation.

apex of the space. This stitch will be threaded through the vaginal pack from top to bottom and used to guide it into position.

Next, the bulbospongiosus muscle is removed except for a thin strip on either side just below the triangular membrane. The urethra is freed 7 cm or so in front of the bulb from the crura, transected and then freed back completely from the crura.

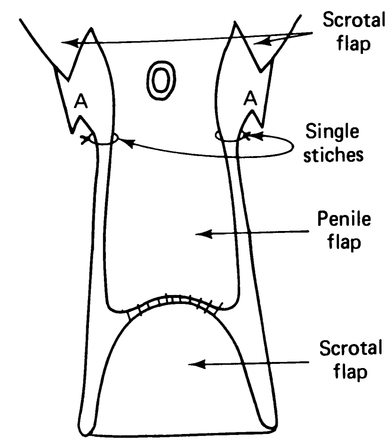
The penis is turned down and dissected off from the anterior surface of the pubes, dividing the branch of the dorsal vein running on to the pubes (Fig. 33.3). The penis will drop down off the arch, revealing the dorsal nerve on each side with arteries and dorsal vein between them. The nerves should be cut cleanly and allowed to retract. The arteries and vein are tied and divided. The crura are divided obliquely leaving only a small segment on the ramus, and the penis is removed. The edges of the crura are closed with a running catgut stitch drawing the ischiocavernosus muscle over the cut edge.

The stage is now set for the reconstruction. The fat is drawn together in front of the pubes. A slit is made in the penile skin through which the urethra can be passed (Fig. 33.4). The underside of the skin incision is anchored at four points to the sheath of the bulb and the crus is included laterally as a firm anchor. The sheath of the bulb is divided 0.5 cm distal to the skin edge; much of the spongy tissue of the bulb is excised and the bulbar arteries are secured within the bulb. The spongy tissue is dissected leaving a little on the urethra and this is divided about 2 cm distally. The urethra can be sutured and its mucosa everted with a continuous 3–0 chromic catgut stitch to the skin and sheath of the bulb. A 12 FG self-retaining balloon catheter is inserted.




◀ **Fig. 33.4.** Incision at base of the penile skin flap for construction of an external urinary meatus.

**Fig. 33.5.** Construction of the "skin tube" to form the vagina.
▼



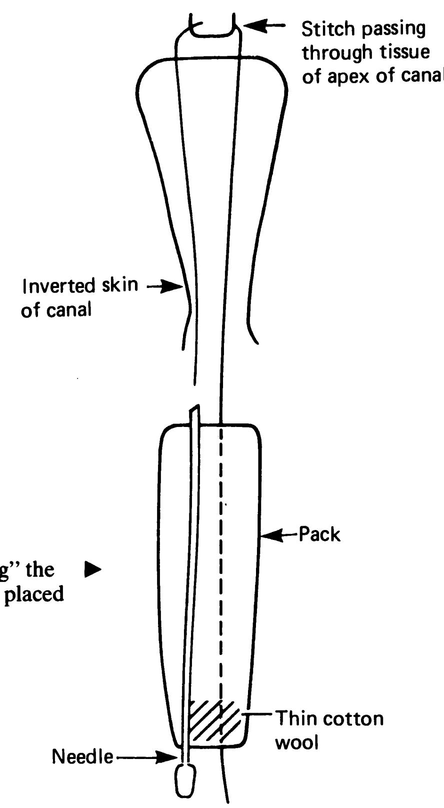




**Fig. 33.6.** Method of "railroading" the vaginal pack over the nylon suture placed in the vault. ▶

Scrotal and penile flaps are joined at their ends and then the disposition of the flaps and apex of the vagina becomes clear (Fig. 33.5). Single stitches are placed between the edge of the penile flap and the base of the scrotal flap at the level of the new introitus. The nylon stitch is brought through the end of the vagina. The edges of the vagina are closed with a continuous stitch of catgut. After the space has been dried and some sulphathiazole powder has been inserted on the raw anal canal wall the vagina is now inverted into the space using a sponge forceps. The nylon stitch is checked for free movement, and then a two-gutter corrugated latex drain is placed on either side of the vagina. It is important to make sure that the nylon stitch is not loose in the space before inserting the drains.

The base of the scrotal flap can now be narrowed, provided that only the skin is cut. The point which the Aliss forcep held should now be stitched to the lowest point (A, Fig. 33.1). The medial edge lies along the introitus and is stitched with 2–0 Mersilk to the edge of scrotal and penile flaps leaving a gap for the drain against the penile flap.

In most cases it will now be necessary to excise redundant scrotal skin laterally and also a triangle of groin skin to make the labia. This incision is closed with a continuous subcuticular 2–0 nylon stitch, after inserting catgut sutures to the underlying fat.

A pack of appropriate size is made from polyvinyl foam, covered with tulle gras and kept in shape with three Mersilk ties around it. It is wider at the vault end. A long needle is passed through the pack from base to vault end and one end of the nylon stitch is threaded through the pack; the other end is similarly treated (Fig. 33.6).

Langdon retractors open the introitus, and the pack, grasped in a sponge forcep is "railroaded" along the nylon guides. A little thin wool on the anterior side of the pack at the bottom helps to draw in the penile skin below the urethra. The nylon stitch ends are tied over the end of the pack while the sponge forcep keeps it stretched.

A small supplementary square of foam in tulle gras is placed over the end of the pack; this is useful if the bowels should act because it can be removed without disturbing the pack.

Gauze and wool pressure dressings are held in place with two T bandages, which must be tightly tied over thick wool padding to protect the skin over the iliac crests. The tails of the bandages apply pressure to the perineum and keep the pack in place.

## Postoperative Care

It is not uncommon to see some elevation of the temperature for 48 h, probably because of some blood in the space. The drains are removed after 48 h without disturbing the vaginal pack, and the skin wounds redressed as before.

Occasionally, haemorrhage from the urethra may require the insertion of an additional stitch. This can be done in the bed. I leave the catgut stitch on the urethra long; it is useful to have a guide.

Dextrose saline is given intravenously until the patient is drinking freely. Antibiotics are continued until the pack and catheter are removed on the fifth day. A full solid diet is only taken after the pack has been removed. After removal of the pack the patient passes two vaginal dilators lubricated with K–Y jelly. These are straight perspex rods with a coned apex, 20 cm long. The smaller is 2.5 cm, and the larger 3.0 cm in diameter. The first is kept in, with slight pressure on the end, for 5 minutes, the larger for 10 minutes, 3 times a day.

Occasionally, micturition may be difficult to re-establish because of oedema of the urethra, which will look bruised and swollen for 3–4 weeks. Occasionally, the catheter may have to be re-inserted. On average, patients leave hospital on the eighth postoperative day after removal of sutures. I have had to let a few patients go with an indwelling catheter for a further week, but micturition returns as oedema of the urethra subsides.

The patient is instructed that after leaving hospital he should douche the canal three times weekly and use a 1.5 mg hydrargaphen (Penotrane) pessary once a week for 10 weeks. Dilatation to stretch the tissue around the introitus and the neovaginal canal should be done for 6 months, three times a day for the first 2 months and then twice daily. Sexual relations can be started after 2 months. If hormones are to be continued, these can be restarted 2 weeks after leaving hospital.

### Complications

In general, complications are few:

1. *Meatal strictures* have occurred but are very easy to deal with as a day-case by a simple meatotomy, cutting backwards in the midline and stitching the mucosa to the skin incision.
2. *Granulating areas* along the skin incisions may need the application of a silver nitrate stick.
3. *Sloughing* of some of the penile flap has been seen occasionally. Continuing dilatation usually results in good healing.
4. *Prolapse* of the neovaginal skin, usually in obese patients, has occurred. The space must be re-dissected and scarified and the vagina replaced without stitching the edge opened to gain access to the space. Vaginal packing is required as previously for 5 days.
5. *Rectovaginal fistula* is a possible complication. In most cases this probably results from injury to the anal canal going unrecognised during dissection of the space. If a breach is seen it can be closed at the time without problems developing.

## Results

The results seem to be pleasing to the patients. In only 2 patients out of over 1000 operated upon has there been a change of mind some years later and a return to living in the male role. Orgasm from vaginal intercourse is reported by about half the patients and may take a year to achieve. In patients with unsatisfactory surgical results from previous surgery performed in other quarters of the world it has been possible to use an isolated segment of sigmoid to produce a very satisfactory vagina. Closure of rectovaginal fistulae and urethrovaginal fistulae, and removal of dermoid cyst, usually from sequestered skin, have been successfully managed at the same time without establishing a colostomy.

*Chapter 34*

# Penile Reconstruction in Exstrophy and Epispadias

*C. R. J. Woodhouse*

## Introduction

The genitourinary tract is the commonest system to suffer from congenital anomalies. In the past the severe malformations often led to early death or such severe disability that normal adult life was impossible. Urological and nephrological care has, since the Second World War, advanced to such a degree that there are a large number of adolescents who need a little help to develop into mature adults.

The treatment of exstrophy is a typical example of this trend. The condition was first described about 2000 BC and has been the subject of intense surgical interest since modern surgery began in the nineteenth century (Rogers 1973). The principles of reconstruction were described in 1906 and, although refined, have not greatly changed (Trendelenberg 1906). Unfortunately, the long-term prospects were poor and half the patients were dead before their tenth birthday (Mayo and Hendricks 1926). However, the last 30 years have seen a revolution in the results of reconstructive surgery. Not only are these children surviving, but they are growing up as mature and well-adjusted adolescents (Jeffs 1978; Lattimer et al. 1979; Woodhouse et al. 1983). As part of this process, they are naturally concerned about their sexual function. In spite of the obvious genital malformations they appear to have normal libido.

For males, the problem lies in the shortness of the penis and the almost universal dorsal chordee. The same abnormalities are also found in proximal epispadias, and the following description of reconstruction also applies to that condition.

## Penile Lengthening

The visible part of the penis is short in exstrophy because the corpora are deficient in length (Woodhouse and Kellett 1984). Extra visible length cannot be obtained either by dissecting the corpora off the inferior pubic rami (Woodhouse and Kellett 1984) or by doing a pelvic osteotomy to bring the pubic bones closer together (Johnston 1974).

A single report has suggested that the corpora can be completely detached from the pubic bones and drawn forward on a pedicle from the pudendal vessels. Additional visible length would thus be available (Kelley and Eraklis 1971). There has been no follow-up of this report and it would seem, theoretically, a rather hazardous procedure. At a practical level, it would probably involve division of the superficial neurovascular bundle which would denervate the glans (Hurwitz et al. 1986).

At present it seems that lengthening the visible part of the penis in exstrophy and epispadias is impossible. The technique described in this chapter for straightening of chordee does produce slight overall lengthening but not sufficient to be a main indication for the operation.

## Penile Straightening

Three types of erectile deformity of the penis occur in exstrophy (Woodhouse and Kellett 1984). Two of them, lateral deviation and bilateral rudimentary corporal development, are rare and will not be considered further. The commonest type is dorsal chordee, which holds the erect penis tightly against the abdominal wall (Fig. 34.1). It was found in 15 of 20 patients in the present author's series (Woodhouse 1985/1986).

**Fig. 34.1.** Artificial erection showing typical dorsal chordee in an exstrophy patient.

Dorsal chordee is found in some degree in all patients and is the main cause for failure of vaginal penetration during intercourse. Improvement of the angle that the penis subtends with the abdomen allows limited vaginal penetration, sufficient for satisfactory intercourse and impregnation.

## Selection of Patients

Patients should be considered for chordee correction when they have completed pubertal penile growth. At this stage the boy is aware of the physical requirements for intercourse and can appreciate the objectives of the operation. It is helpful if he has a sympathetic sexual partner, but surgery should not be delayed until frequent sexual failures have damaged his ego.

Dural phalloplasty has been performed on young children as part of the primary reconstructive surgery (Ransley 1985). This seems perfectly reasonable as it does not add substantially to the procedure, but it remains to be seen whether correction with non-viable tissue will survive later penile growth.

## Investigations

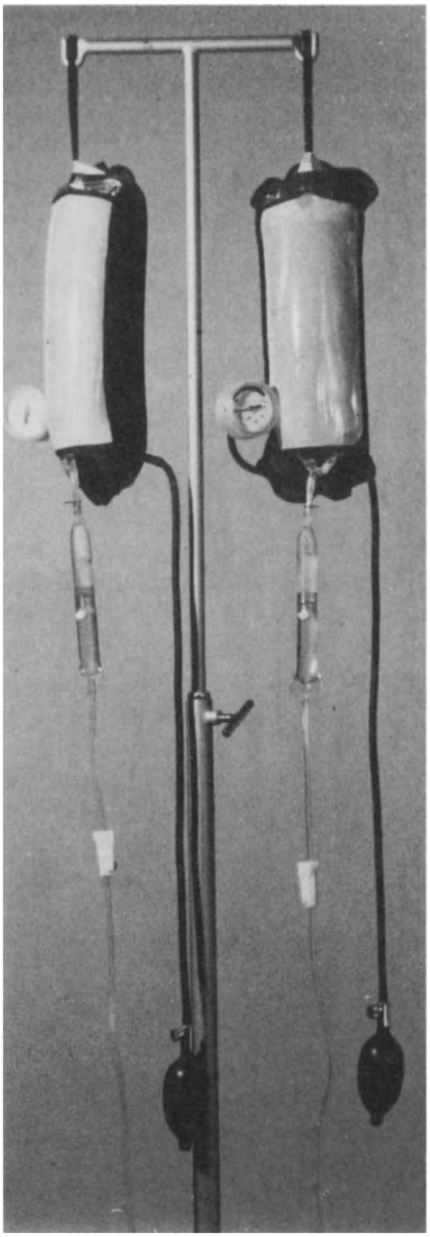
Aside from investigation of the patient's general and urological fitness, the only specific investigation is a cavernosogram. The technique has been described in detail elsewhere (Herzberg et al. 1981; Woodhouse and Kellett 1984). In brief, it is as follows:

1. The patient is sedated with 10–20 mg diazepam.
2. Two infusion packs are made up with 120 ml 65% urograffin in 250 ml physiological saline.
3. A 19 gauge butterfly needle is inserted percutaneously into each corpus (in exstrophy there is no cross circulation between the corpora).
4. The contrast is infused into the corpora at 300 mmHg generated by Fenwall infusion bags (Fig. 34.2).
5. Corporal filling is monitored on an image intensifier. Static radiographs are taken in the anteroposterior, oblique and lateral planes in full erection.

The cavernosogram should demonstrate the anatomy of the deep portions of the corpora and identify the site of curvature. The surgeon should be present at the examination to view the scale of the problem for himself.

## Surgical Options for Chordee Correction

There are two ways in which a curved penis can be straightened: by lengthening the concave side or shortening the convex side. Shortening



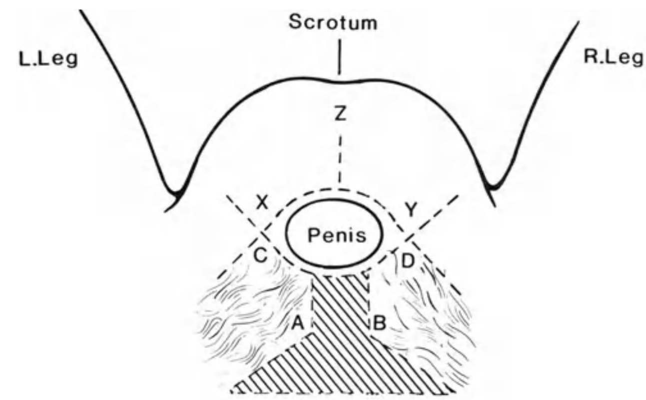



**Fig. 34.3.** Diagram of incision.

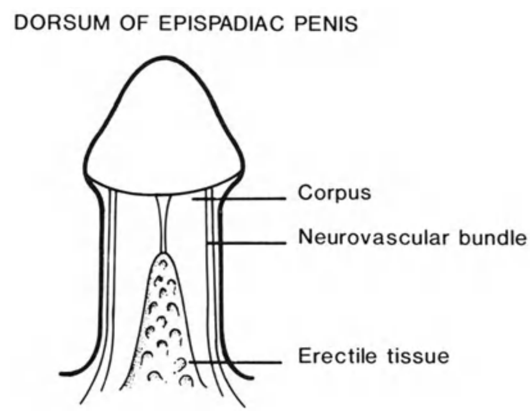



**Fig. 34.4.** Anatomy of the neurovascular bundles and extracorporeal erectile tissue.

◀ **Fig. 34.2.** Apparatus for cavernosography and artificial erections. Two infusions are needed in exstrophy and epispadias as there is no cross circulation between the corpora.

of the convex side (Nesbit's procedure) is well established for the treatment of Peyronie's disease (Frank et al. 1981). It was used once in the author's exstrophy series; however, where the penis is already too short, it seems rather unattractive. An ingenious variation which achieves the same objective has been described by Koff and Eakins (1984). The corpora were separated from each other, rotated appropriately, and sutured back together so that the curves were equal and in opposite directions; the overall effect being straightening.

Lengthening of the concave side produces slight overall lengthening and is the procedure of choice. A variety of materials have been used as patches for this purpose in Peyronie's disease, including fat (Lowsley and Boyce 1950), skin (Horton and Devine 1973), aponeuresis (Bruschini and Mitre 1979), tunica vaginalis (Das 1980), Dacron (Lowe et al. 1982) and Dexon mesh (Bazeed et al. 1983). It has also been suggested that the concave side of the exstrophy penis can be lengthened by meticulous dissection of the overlying scar tissue and release of the corpora from the pubic bones (Spehr and Melchior 1985). Clearance of scar tissue and corporal mobilisation is an essential first step for all the techniques; it has only been successful in correcting chordee in one of the present author's cases, as judged by intraoperative artificial erection.

Lengthening of the concave side by insertion of an ellipse of lyophilised dura mater is the preferred procedure. Dura was first used experimentally by Kelami and co-workers (Kelami 1971; Kelami et al. 1975) and later for Peyronie's disease (Kelami 1980). It is easy to use and freely available. Once in place, it does not shrink and is replaced by collagen and, sometimes, a few fibres of smooth muscle (J. R. A. Ramsay 1985, personal communication).

## Operative Technique

### *Preparation*

A pubic and scrotal shave is essential; however, part of the wound closure involves flap rotation to bring the pubic hair-bearing skin to a more normal position. The surgeon should, therefore, examine the patient before the shave. Pre-medication should include antibiotic cover: gentamicin, metronidazole and ampicillin are the current favourites.

### *Pre-incision*

Most patients have a urinary diversion, but those with a working bladder require a suprapubic catheter. An artificial erection is performed (as for a cavernosogram, but without the contrast medium), to confirm the site and extent of chordee.

### *Incision*

A holding stitch is put through the glans. The incision must be planned for each patient, but a rough guide is shown in Fig. 34.3. The essential elements are:

1. Excision of poor midline skin (shaded in Fig. 34.3).
2. Raising of adequate, hair-bearing flaps for midline closure (A, C and B, D in Figs. 34.3 and 34.7).

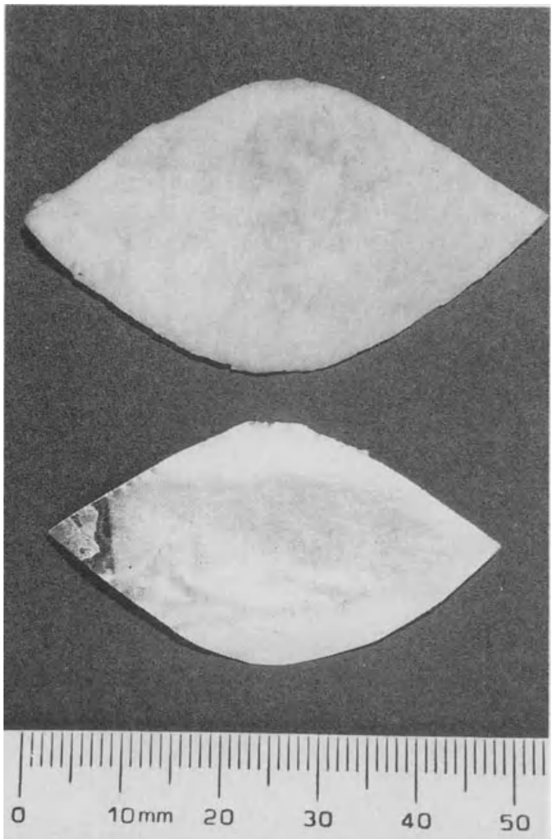



**Fig. 34.5.** Template (*bottom*) and dural ellipse (*top*).

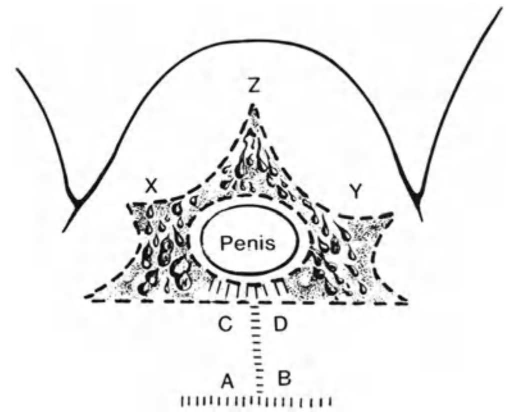



**Fig. 34.7.** First stage of closure.

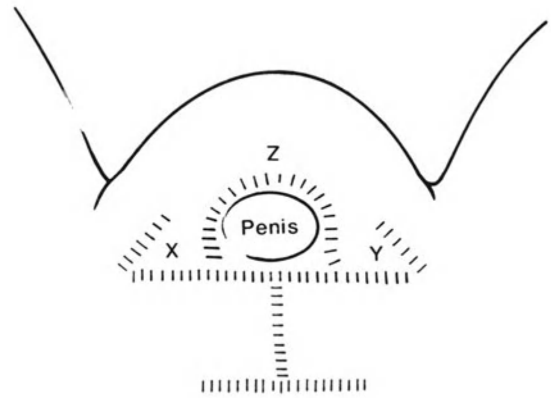
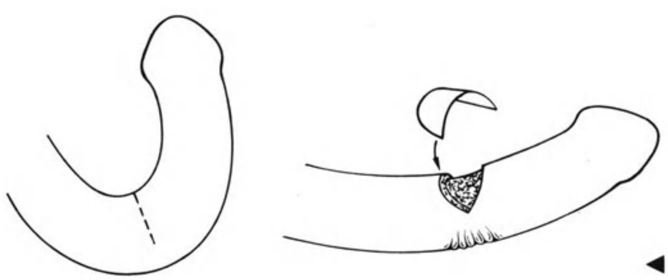



**Fig. 34.8.** Second stage of closure.



◀ **Fig. 34.6.** Procedure for dural insertion.

3. Raising of scrotal flaps to close the defects left by the rotation of the hair-bearing flaps (X, Y, Z in Figs. 34.3, 34.7 and 34.8).
4. A suitable incision on the dorsum of the penis to expose the ventral neourethra and distal corpora.

### *Dissection*

The rather fragile neourethra is mobilised, divided distally and allowed to drop back. In patients that have not had previous extensive surgery, there is a triangle of extracorporeal erectile tissue around the urethra which bleeds profusely during this dissection (Fig. 34.4). The plane between the corpora and the urethra is then developed, down to the attachment of corpora to the inferior pubic rami. The limits laterally are the 3 and 9 o'clock points on the corpora and medially the space between the corpora, which must be completely opened. The superficial neurovascular bundles are vulnerable at the lateral limits (Fig. 34.4). All of the fibrous tissue on the dorsum of the corpora must be cleaned. This dissection is tedious and bloody. When it is completed a further artificial erection is performed just in case the chordee has been corrected.

### *Insertion of Dura*

The site of maximum curvature is usually immediately distal to the pubic attachment, but the intraoperative artificial erection should confirm this point. A template of tinfoil (salvaged from a suture packet) is prepared as shown in Fig. 34.5. It is elliptical, the long axis being sufficient to cover half the circumference of the corpus and the short axis being 2.5–3 cm, depending on the correction required. If the penis has a minor degree of lateral deviation it can be straightened by a greater correction on one side. From the template an ellipse of lyophilised human dura is prepared. It must be slightly larger than the template to allow for the suture line.

A transverse incision is then made in the corpus and the dural patch sutured in place with 3–0 Dexon (Fig. 34.6). The tunica albuginea is quite thick and there are often some deep strands, all of which must be divided.

### *The Urethra*

The dorsal urethra is now too short to reach the end of the penis. Occasionally, there may be enough skin for a urethroplasty; on two occasions the present author has made a new urethra by turning down a tube of urothelium from the defunctioned bladder. Usually, however, it is necessary to suture the urethra as a cutaneous seminal fistula and perform a urethroplasty 6 months later. It seems more satisfactory to have a ventral urethra so that it is brought through between the corpora and positioned at the penoscrotal junction (point Z in Fig. 34.8).

### *Wound Closure*

The wound is closed with 4–0 or 5–0 Dexon as shown in Figs. 34.7 and 34.8. A Redivac drain is put in each side and suction is applied, even during the closure; in this way an airtight closure and minimal haematoma are ensured.

## Complications

In the present author's series no serious complications occurred. Bleeding was occasionally heavy enough to require transfusion. One patient (not given antibiotics) became infected but eventually healed with a good final result. After this, antibiotics were given to all patients: gentamicin for 48 h, metronidazole and ampicillin for a week. Two patients have been impotent postoperatively, one for a few weeks and one for 3 months. Both recovered spontaneously.

## Results

A total of 14 dural phalloplasties have been performed, of which 12 have been reassessed at least 6 months postoperatively. The longest follow-up is 3 years. Of these 12 patients, 8 have had a good result, with the penis having a suitable angle of erection for vaginal penetration (Fig. 34.9).

One case appeared to be successful but at 1 year the patient developed a further dorsal chordee, distal to the original one. Another dural phalloplasty was done and the result is good at 2 years. One patient was improved but still does not have an angle of erection suitable for intercourse. In two patients the erection was exactly the same postoperatively as before. One of these has since had another dural phalloplasty with a good result.

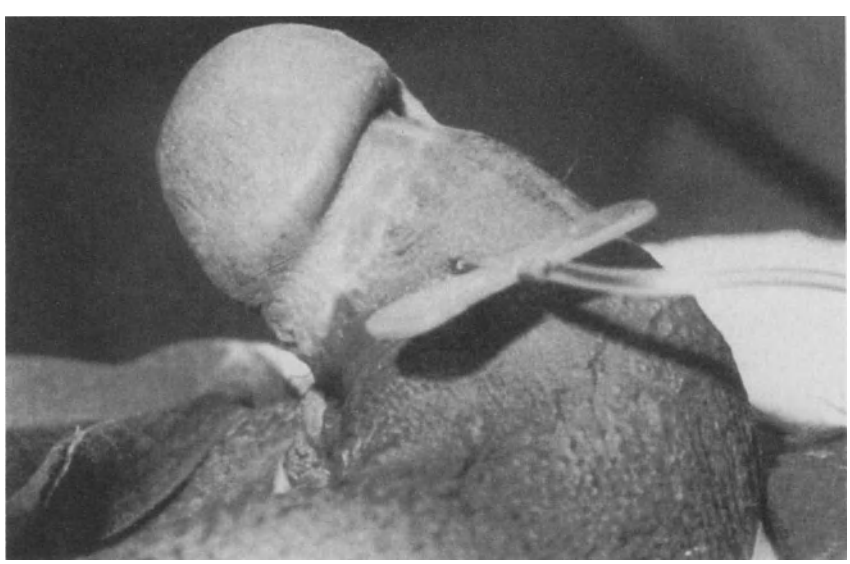


**Fig. 34.9.** Artificial erection 8 months postoperatively (same patient as in Fig. 34.1).

# Addendum

It has recently been reported that the sterilisation procedures for human dura are not adequate to inactivate the Creutzfeld–Jacob agent. A case has been reported of a 28-year-old woman who died of Creutzfeld–Jacob disease 22 months after receiving a dural graft (Editorial 1987). Although some preparations of dura are processed in different ways, the American Food and Drug Administration considers that all the preparations carry a risk of transmitting the disease. In the light of this finding, I think it would be preferable to use this technique with material from the patient, such as rectus sheath or tunica vaginalis rather than dura.

# References

Bazeed MA, Thüroff JW, Schmidt RA, Tanagho EA (1983) New surgical procedure for management of Peyronie's disease. Urology 21: 501–504

Bruschini H, Mitre AI (1979) Peyronie's disease: surgical treatment with muscular aponeurosis. Urology 13: 505–506

Das S (1980) Peyronie's disease: excision and auto-grafting with tunica vaginalis. J Urol 124: 818–819

Editorial (1987) Update: Creutzfeld–Jacob disease in a patient receiving a cadaveric dura mater graft. JAMA 258: 309–310

Frank JD, Mor SB, Pryor JP (1981) Surgical correction of erectile deformities of the penis in 100 men. Br J Urol 53: 645–647

Herzberg Z, Kellett MJ, Morgan RJ, Pryor JP (1981) Method, indications and results of corpus cavernosography. Br J Urol 53: 641–644

Horton CE, Devine CJ (1973) Peyronie's disease. Plast Reconstr Surg 52: 503–510

Hurwitz RS, Woodhouse CRJ, Ransley PG (1986) The anatomic course of the neurovascular bundles in epispadias. J Urol 136: 68–70

Jeffs RD (1978) Exstrophy and cloacal exstrophy. Urol Clin North Am 5: 127–140

Johnston JH (1974) Lengthening of the congenital or acquired short penis. Br J Urol 46: 685–687

Kelami A (1971) Lyophilised human dura as a bladder wall substitute: experimental and clinical results. J Urol 105: 518–522

Kelami A (1980) Peyronie's disease and surgical treatment; a new concept. Urology 15: 559–561

Kelami A, Gross U, Fiedler U, Richter-Reichhelm M, Tsaoussidis N (1975) Replacement of tunica albuginea of corpus cavernosum penis using human dura. Urology 6: 464–467

Kelley JH, Eraklis AJ (1971) A procedure for lengthening the phallus in boys with exstrophy of the bladder. J Pediatr Surg 6: 645–649

Koff SA, Eakins M (1984) The treatment of penile chordee using corporeal rotation. J Urol 131: 931–932

Lattimer JK, Hensle TW, Macfarlane MT, Beale L, Braun E, Eposito Y (1979) The exstrophy support team: a new concept in the care of the exstrophy patient. J Urol 121: 472–473

Lowe DH, Ho PC, Parsons CL, Schmidt JD (1982) Surgical treatment of Peyronie's disease with dacron graft. Urology 19: 609–610

Lowsley OS, Boyce WH (1950) Further experiences with an operation for the cure of Peyronie's disease. J Urol 63: 888–892

Mayo CH, Hendricks WA (1926) Exstrophy of the bladder. Surg Gynecol Obstet 43: 129–134

Ransley PG (1985) A single stage technique for epispadias repair. Presented at the 41st annual meeting of the British Association of Urological Surgeons. Eastbourne, 1985, abstracts p 120

Rogers BO (1973) History of external genital surgery. In: Horton CE (ed) Plastic and reconstructive surgery of the genital area. Little, Brown and Co, Boston, pp 3–47

Spehr CH, Melchior HJ (1985) Operative correction of the penis deformity in bladder exstrophy. Presented at the 20th congress of the International Society of Urology, Vienna, 1985, abstract 1008, p 320

Trendelenberg F (1906) The treatment of ectopia vesicae. Ann Surg 44: 281–289

Woodhouse CRJ (1985/1986) The management of erectile deformity in adults with exstrophy and epispadias. J Urol 133: 142A (abstract) and J Urol 135: 932–935

Woodhouse CRJ Kellett MJ (1984) The anatomy of the penis and its deformities in exstrophy and epispadias. J Urol 132: 1122–1124
Woodhouse CRJ, Ransley PG, Williams DI (1983) The patient with exstrophy in adult life. Br J Urol 55: 632–635

*Chapter 35*

# Treatment of Erectile Impotence by Intracavernosal Injection of Drugs that Relax Smooth Muscle

*G. S. Brindley and J. C. Gingell*

## Introduction

Smooth muscle relaxants are known to provoke erection if injected into the corpora cavernosa of most men, including most impotent men. The first to be discovered was papaverine (Virag 1982). The second, whose action when given intracavernosally was discovered after Virag's first observations on papaverine, but before their publication, was phenoxybenzamine (Brindley 1983). Both drugs are now in use for the treatment of erectile impotence and both are effective, but their safety for long-term use cannot be firmly established until many years have elapsed.

There are two ways in which such drugs might be used therapeutically. The first is to give the drug only in the clinic, and only with the aim that after a few good erections produced in this artificial way erections in other circumstances might improve, either because of the powerful psychological effect on the patient of seeing and feeling his penis fully erect, or because of hoped-for local organic changes. This was the approach of Virag (1982) and Virag et al. (1984). They reported moderately favourable results. The other, and much more successful approach (Brindley 1983, 1986; Virag 1985; Zorgniotti and Lefleur 1985) is to teach the patient to self-administer the injections at home in order to have coitus after each injection. This has been used fortnightly for periods of up to 2½ years with great success. It may be a good long-term treatment for a man over 50 years of age who is content with fortnightly coitus. For a young impotent man who wants frequent coitus, it can be used as a temporary treatment and an aid to deciding whether his needs will be well met by a penile prosthesis; but if used frequently over many years the repeated minor mechanical trauma of injecting may well cause local fibrosis, even if the drugs themselves are perfectly harmless.

## Choice of Drug

The best drug for most impotent patients is papaverine, of which even a dose of 120 mg rarely causes any detectable side effects. The dose needed to give an erection of the desired duration, i.e. at least 40 min but not more than 4 h, varies from patient to patient, between 12 mg and 80 mg.

## Selection of Patients

Cavernosal unstriated muscle relaxant injection (CUMRI) is especially appropriate in patients with spinal cord injury or disease, diabetic autonomic neuropathy, or other evident neurological cause for their impotence. In impotence attributed to peripheral vascular disease it may fail or succeed; if it succeeds it is useful. Impotence in the absence of relevant demonstrable nervous or vascular disease or injury is commonly deemed psychogenic, though often for no reason except inability to establish an organic cause. Some physicians maintain that patients of this kind should not be allowed CUMRI unless they have had a trial of psychotherapy first, on the ground that psychotherapy is entirely harmless, whereas CUMRI carries some (albeit small) risks. We do not share this view. Psychotherapy is time consuming and is less successful in erectile impotence than in other disorders of sexual function. Treatment of psychogenically impotent patients is usually only required over a short term, because, as satisfactory coitus is achieved, performance anxiety is alleviated, and intercourse is then possible without the need for self-injection.

Patients with impotence of known organic neurological cause are very suitable. The proportion of them who persist in domestic use of CUMRI is higher than in other patients, perhaps because on average they are younger. CUMRI can succeed even where the preganglionic peripheral nervous pathways of erection (both parasympathetic and sympathetic) are completely destroyed.

Nearly all able-bodied domestic users inject themselves. Disabilities that make self-injection impossible are no bar to domestic use, if the patient's wife is willing to learn to inject.

In patients with severe penile arterial insufficiency, CUMRI is likely to fail. However, the only way to be sure what CUMRI will do for a given patient is to try it. Therefore, if the objective tests for penile vascular function are not easily available, it is reasonable to omit them. If they are done, evidence of arterial insufficiency should not preclude trial of CUMRI.

## A Practical Approach to Treatment

At the first visit a full history and clinical examination is undertaken to ascertain the likely cause of the problem. An injection of papaverine is then given into the right corpus cavernosum and the penis massaged to distribute the drug. The dose of papaverine used is determined by the likely cause of the impotence. Young patients and those with neurogenic impotence readily respond to as little as 15 mg, whereas 30 mg can be safely employed in older patients; 60 mg can be usefully administered to patients considered to have a vasculogenic cause. It is important to warn the patient before injection that one is only giving a test dose to assess response rather than to produce an erection, so that if the penis does not become erect he is not disappointed. Often a full erection is not achieved, but in all patients except those with a marked vascular inflow problem encouraging tumescence is achieved. This is always enhanced by getting the patient to stand and partly occlude the venous drainage from the penis by applying the index and middle finger of the left hand to the base of the penis as an inverted V while massaging the penis with the right hand. If, as is usually the case, good tumescence is achieved it is suggested to the patient that this would, under appropriate circumstances, outside of the clinical setting, proceed to an erection. The patient is then given a self-injection protocol (Fig. 35.1) to read at home so that on his next visit he is well informed and able to be instructed and supervised in giving his own injection. If the degree of tumescence achieved by the "test dose" was only modest, or the response of short duration, then the dose administered is increased accordingly on the next visit. Failure to respond to the initial and subsequent increased dose implies a vascular aetiology which should be confirmed by detailed study so that the possibility of venous leak impotence is not overlooked. If the problem is a significantly reduced penile arterial blood flow caused by major arterial or more peripheral minor vascular disease, then appropriate surgical treatment including the insertion of penile prostheses can be undertaken.

In those patients who have responded to papaverine, on the third consultation they must both dispense the drug in the agreed dose and inject themselves. Only if this is undertaken competently can the patient be allowed a supply of ampoules, syringes and needles and skin cleanser (Sterets). Instructions are given to limit the use to once weekly and sufficient supplies given to last for between 1 month and 6 weeks. Thereafter all patients on a self-injection programme are reviewed every 3 months, when further supplies are provided. It is essential that the patient is able to contact the medical practitioner supervising the treatment if any problems arise, particularly in the event of a prolonged erection.

PROTOCOL FOR SELF-INJECTION

PLEASE FOLLOW THESE INSTRUCTIONS

1. Ensure that the room is well lit. You should perform the injection standing up.

2. Carefully snap open the ampoule containing the drug. Remove the sterile syringe from its wrapper and take the orange cap off.

3. Draw up the prescribed drug to mark ________ on the syringe.

4. Hold the penis between thumb and index finger stretched to one side. Cleanse the skin with the swab provided. Insert the needle firmly into the fleshy part of the penis making certain that you avoid any obvious veins on the surface of the penis.
   You will feel a slight resistance as the needle goes through the tough sheath surrounding the penis as illustrated. Inject the drug slowly. It should go in easily and will probably cause a tingling or burning sensation in the tip of the penis. Undue resistance to inject the drug may imply incorrect placement of the needle in which case you should either adjust the position of the needle or take it out and re-insert it.
   After completing the injection withdraw the needle and massage the penis from its root to the tip in order to spread the drug evenly.

5. Once the procedure has been completed, dispose of the syringe, needle and used glass ampoule carefully.

6. You should perform the self-injection once a week initially, and for the purpose of sexual intercourse.

7. In the unlikely event of an erection persisting for more than 6 HOURS you should at once contact ____________________________________

   ________________________________________________________

   ________________________________________________________

8. You will be asked to attend for regular review in the UROLOGY OUT-PATIENT CLINIC at            Hospital and you should do so without fail.

9. Kindly fill in the chart supplied and bring it with you to your next visit.

YOU MUST NOT EXCEED THE DOSE OF DRUG RECOMMENDED.

**Fig. 35.1.** Self-injection protocol given to patient on first clinic visit.

## CONSENT FORM

I ______________________________________________

of ______________________________________________

______________________________________________

suffer from sexual dysfunction which is preventing me from having normal sexual intercourse. I hereby elect to undertake treatment to alleviate this problem by means of self-administered injection into the penis of Papaverine either alone or in combination with Phentolamine. I agree to fully comply with the specified instructions, particularly with regard to sterile injection technique, injecting only the designated sites on the penis, and to restrict the frequency and dose of injections as ordered. I understand that there is no long term knowledge concerning this treatment or of possible side-effects resulting from either repeated injection into the penis, or the use of the aforementioned drugs. Although no serious complications have been documented to date, I accept that the risks include,

a) prolonged erections (possibly requiring medical or surgical remedy)
b) scarring or deformity of the penis,
c) eventual loss of effect,
d) bruising of the penis,
e) difficulty in ejaculating
f) infection in the penis.

I am aware of the alternative methods of treatment for my impotence which have been explained to me by ____________________

I have been instructed in the method of injection and have also had a full opportunity to clarify matters pertaining to this treatment.

I confirm that I have read this consent form prior to signing.

____________________
(PATIENT)

____________________
(WITNESS)

____________________
(DOCTOR)

**Fig. 35.2.** Consent form which must be signed by patient before embarking on self-injection treatment.

## Complications

In an atmosphere of increasing medical litigation, we consider it important that a consent form for treatment is signed by the patient before being allowed to perform self-injection treatment (Fig. 35.2). The most important side effect of CUMRI that requires urgent medical advice and treatment is a prolonged erection, which might proceed to priapism if left untreated. Every patient on treatment must be warned of this possibility and every doctor supervising such treatment (or a responsible deputy) must be readily available to deal with it. There exists a difference of opinion as to how long an erection induced by CUMRI can be safely left without active intervention. A consensus opinion, however, advises that the patient should inform the supervising medical practitioner if an erection has persisted for 6 h after induction.

### Method for Relieving a Prolonged Erection

A 19 standard wire gauge butterfly needle is inserted into one corpus cavernosum and as much dark blood as possible is withdrawn by a 60 ml syringe, while the penis is being squeezed. Next, 1 mg metaraminol (Aramine) diluted in 10 ml of saline is administered.

## Summary

Intracavernosal injection of papaverine undertaken at home by the patient or his wife weekly or less often in order to have coitus is an effective way of treating erectile impotence. In nearly 4 years of use it has caused no significant long-term harm to any patient. The only worrying short-term complication is priapism. This seems to be of a fairly benign kind, and it is easily treated with metaraminol (Brindley 1984).

## References

Brindley GS (1983) Cavernosal alpha-blockade: a new technique for investigating and treating erectile impotence. Br J Psychiatry 143: 332–337
Brindley GS (1984) New treatment for priapism. Lancet II: 220
Brindley GS (1986) Maintenance treatment of erectile impotence by cavernosal unstriated muscle relaxant injection. Br J Psychiatry 149: 210–215
Virag R (1982) Intracavernous injection of papaverine for erectile failure. Lancet II: 938
Virag R (1985) Du bon usage de la papaverine intracaverneuse et d'autres drogues vasoactives dans le traitement de l'impuissance. Gaz Med (Paris) 274: 25–98
Virag R, Frydman D, Legman M, Virag H (1984) Intracavernous injection of papaverine as a diagnostic and therapeutic method in erectile failure. Angiology 35: 79–87
Zorgniotti AW, Lefleur RS (1985) Auto-injection of the corpus cavernosum with a vasoactive drug combination for vasculogenic impotence. J Urol 133: 39–41

*Chapter 36*

# Bladder Neck Incision vs. Resection for Bladder Outflow Obstruction

*L. E. Edwards*

## Historical Review

The relief of outflow tract obstruction has been part of recorded medical history for not less than three millenia. The problem presented by retention in the female was relatively simple and could be relieved by intermittent catheterisation. The material of which the catheter was made—gold, silver, ivory or even a hollow reed—reflected the status of the patient. Relief of the condition in males, of course, presented an entirely different series of attendant hazards and the prognosis of a man faced with a catheter existence was poor.

In both men and women the stasis of retention led to sepsis, which in turn led to stone formation. Generations of itinerant lithotomists, of whom the most eminent must be Frère Jacques, brought relief to the sufferers. Samuel Pepys presents a vivid account of his experiences. It is not two centuries since the first attempt was made at open vision of the bladder neck by Blizard. The first attempt at transurethral bladder neck disruption was made by Guthrie (1836) of Westminster Hospital, and hence a direct predecessor of Terence Millin. Civiale (1841) and Mercier (1850) developed similar instruments in France, but it was left to the Italian, Botini (1887) to introduce diathermy into bladder neck incision. The procedure failed to achieve any degree of popularity, possibly because it was undertaken in blind fashion, a situation shortly rectified by the development of the optical cystoscope by Nitze in the last quarter of the nineteenth century.

At the beginning of the twentieth century incision gave way to resection, first undertaken with a cold punch (Young 1913) and later with the hot loop. The hot-loop carrier, the resectoscope, has barely changed since the 1920s, and resection has become the accepted normal treatment for benign enlargement of the prostate. The mortality has been reduced to levels usually lower than 1% following improvements in the understanding of fluid balance and replacement, reliable blood transfusion, the introduction of antibiotics and the introduction of solid-rod lens systems.

The concept of the "small fibrous prostate" is not new, but with improvements in our understanding of the physiology of micturition following the increase in expertise and equipment for urodynamic assessment an appreciation of a small "trapped" prostate was proposed by Turner-Warwick et al. (1973). If the early stage of prostatic hypertrophy is accompanied by detrusor/sphincter dyssynergia, where the small lateral lobes of the prostate are prevented from opening during micturition because of the failure of the internal sphincter to relax, then myotomy at bladder neck level should relieve the symptoms.

I learnt the technique of bladder neck myotomy in 1972 and was impressed by the clinical results. In this chapter I propose to discuss the technique, the results and complications, and the various applications of the operation.

## Introduction

Outflow tract obstruction is one of the commonest conditions the urologist is expected to treat. Most patients presenting with symptoms of outflow tract obstruction will have a clinically enlarged benign prostate, an apparently normal prostate or a prostate which feels malignant. When these patients are investigated further and outflow tract obstruction at prostatic level is demonstrated, the clinician is faced with the decision whether surgery is indicated and, if so, whether to recommend prostatic ablation or the more conservative surgical procedure of bladder neck myotomy.

## Presentation and Management

The majority of patients will complain of frequency, urgency with or without incontinence, dysuria from urinary tract infections complicating obstruction, hesitancy, post-micturition dribbling and nocturia. Other patients will present with acute retention, that painful inability to pass urine which requires urgent treatment by catheterisation. My preference for relieving such a situation is suprapubic catheterisation rather than urethral; I feel that embarking on subsequent surgical manipulations on a tract which has been traumatised and infected by urethral catheterisation is rash, despite the availability of potent broad-spectrum antibiotics and a consequent reduction in the risk of postoperative sepsis.

The small number of patients presenting with chronic retention pose a further problem in that considerable controversy exists regarding preoperative bladder decompression. Many authorities hold the view that bladder decompression is unnecessary, irrespective of elevation of the blood urea, and will embark on prostatectomy as soon as it can be arranged. I do not agree with this course of action because a prostate gland responsible for such chronic retention is probably significantly larger, from vascular congestion, than it would be otherwise. A decision to operate on such a patient without decompression could lead to performing the wrong operation:

1. Enucleating a "150 g" prostate when it really weighed 50 g, which is within resectable limits, or
2. Resecting a "75 g" prostate when its true size, say 35 g, would be eminently treatable by myotomy.

It would also be reasonable to expect a large engorged gland to bleed more peroperatively and postoperatively, suggesting that it might be wiser and safer to delay surgery until decompression has been achieved, notwithstanding the profuse natriuresis which may accompany sudden decompression of the upper tract. I am yet to be convinced of the safety of "emergency" treatment of chronic retention and have no doubt that the patient should be operated upon when conditions are optimal and stable.

Jenkins and Allen of Southampton (1978) said that bladder neck myotomy was not a procedure suitable for the management of chronic retention. My clinical experience is contrary to theirs, and I employ myotomy rather than formal transurethral resection in all cases where the obstructing prostate, on clinical examination, weighs less than 35 g. It may be argued that this criterion cannot be sufficiently accurate as a single factor for determining the nature of an operation, but I have little doubt that the experienced practitioner can assess the size of the prostate within 5 g by a careful bimanual examination under the proper conditions of anaesthesia and when the bladder is empty. Size as a single criterion can be further justified by noting that the margin of error in assessing prostatic weight is necessarily lower the smaller the prostate. Moreover, in considering bladder neck myotomy as an alternative procedure to formal resection one considers prostatic size of the order of 30–35 g. The accurate assessment of prostatic size is a necessary qualification for a practising urologist under normal circumstances; in the situation under discussion this accuracy is of paramount importance as the success or failure of myotomy will depend upon it.

In summary, I consider that the following courses of action are reasonable for the management of retentions:

1. *Acute retention*. Assessment is done in the Casualty Department, omitting rectal examination because of the false information it may provide. After the patient has been admitted to the ward, analgesia is administered; this must be intramuscular and of a dose appropriate to the

patient's size and general medical condition (e.g. cardiovascular and respiratory status). The patient next takes a warm bath.

Alleviation of retention is carried out by catheterisation suprapubically, if the above-noted conservative methods have failed. Detailed assessment includes full blood count, urine microbiology, plasma urea and creatinine, electrolyte estimations, electrocardiogram (ECG), chest X-ray and intravenous pyelogram (IVP). Ablation by resection or myotomy is performed as appropriate and when convenient.

2. *Chronic retention*—when the blood urea is less than 12 mmol/litre. The patient is admitted and kept mobile. It has been reported that recumbency in such patients may lead to progressive renal failure because of the loss of the hydrostatic pressure which normally assists renal outflow and ureteric transit to the bladder (George et al. 1984). Recumbency will prevent this relatively free drainage, especially when the bladder is distended and subject to high pressures; impairment of renal function ensues.

In these patients the IVP usually shows upper tracts which are not dilated. The patient, ambulant and with legs supported by anti-embolus stockings, is operated upon as soon as convenient, by resection or myotomy.

3. *Chronic retention*—when the blood urea exceeds 12 mmol/litre. The most important initial investigations must be the ECG, plasma potassium and creatinine, and the blood urea. The IVP demonstrates bilateral hydronephrosis and hydroureter, and a large bladder which will opacify poorly. A small suprapubic cannula is inserted to establish slow decompression. Relative immobilisation should be avoided and anti-embolus stockings worn. There seems little purpose in carrying out a rectal examination until bladder decompression has been achieved; this may take 4–6 days and will be reflected in the blood urea level. This will fall rapidly at first and then more slowly; in most cases the defined upper limit of operability, 12 mmol/litre, is reached in due time. In some patients this level will never be achieved but the blood urea will stabilise at an elevated level consistent with the degree of irreversible renal impairment which has already occurred. In such cases operation is undertaken when the blood urea level is as low as it ever will be.

## Which Procedure Should One Choose?

The three procedures employed routinely for the relief of outflow tract obstruction in the male are retropubic prostatectomy (RPP), transurethral resection of the prostate (TURP) and bladder neck incision or myotomy (BNI). The decision to use one of these rather than the other two is of fundamental importance both to the surgeon and the patient. My criteria are as follows:

1. RPP, using Millin's technique (Millin 1947) or variations thereof, when the operative assessment of prostatic size indicates that the

gland is larger than 75 g. This low limit may surprise some but is not at variance with that suggested by Whittaker et al. (1983).
2. TURP by Blandy's technique (1978) when the prostate weighs 35–75 g.
3. BNI according to the method described by ourselves (Edwards et al. 1985) if the prostate weighs less than 35 g.

None of us can be perfect in our assessment of prostatic size and there must necessarily be exceptions to these rules. The following limitations should be given consideration:

1. RPP is difficult unless the gland exceeds 50 g in size.
2. BNI is difficult and unlikely to alleviate the patient's symptoms when the gland is larger than 50 g.
3. TURP is tedious, difficult, time consuming and often haemorrhagic when the gland exceeds 120 g in weight.

Careful bimanual examination of the prostate under general anaesthesia is critical to the choice of procedure. The mortality of an open prostatectomy is significant, as is its morbidity. The morbidity relating to incontinence probably increases in inverse proportion to prostatic size; the morbidity of the resection increases directly in proportion to prostatic size, not only for the patient, but also for the operator. Cervical spondylosis is a reality for the endoscopist who continually uses a rigid instrument, whether he is a urologist or an orthopaedic surgeon.

Thus, the question remains, is there a procedure which is safer for the patient, easier for urologists to learn and teach and, ultimately, as effective as TURP or RPP in the relief of the symptoms of outflow tract obstruction? I think it likely that there is such a procedure, provided that:

1. Case selection is correct.
2. The assessed prostatic size is less than 35 g.
3. It can be shown that patients treated by myotomy do as well as those treated by enucleation or resection.

## Technique

The anaesthetic technique employed for TURP should not differ from that used for formal retropubic enucleation. The patient is paralysed and intubated and is ventilated throughout the procedure. The duration of RPP is more or less predetermined, at approximately 40 min including the preliminary cystoscopy, and the anaesthetist's work is less complex with regard to planning of ventilation/reversal. A TURP, however, takes a particularly variable time proportionate to prostatic size: 1 min for each 2 g of prostate removed provides a fair guideline. Difficulties such as haemorrhage or bladder perforation, the latter sometimes relating to inadvertent obturator nerve stimulation under anaesthesia which is less than perfect, will extend the duration of the operation considerably, and occasionally (0.61%) laparotomy is required.

Simple anaesthesia is adequate for bladder neck myotomy, and a conventional gas/oxygen/halothane-ethrane mixture without endotracheal intubation is the rule. An intravenous infusion and cardiographic monitoring are usual, as with RPP or TURP. I have noted previously that the single criterion for myotomy is prostatic size and that the final decision regarding size cannot be made until the patient is under anaesthesia. Errors of preoperative assessment do occur from time to time but my colleagues from the Department of Anaesthesia agree that it is easier to prepare a patient for resection and then face the 10 min cystoscopy/myotomy than to prepare for myotomy and then be asked to paralyse and ventilate a patient for TURP/RPP.

I use the 24 FG Storz resectoscope sheath and carry out a preliminary urethroscopy with the 30° telescope. Once within the bladder, a 70° telescope is used to exclude an intravesical lesion. The length of the prostate from bladder neck to verumontanum can be measured directly from the scale on the instrument or by experience. After reaching the decision to embark upon myotomy the appropriate electrocautery knife is attached to the working element.

The right ureteric orifice is identified, then the sulcus between the middle and right lateral lobe of the prostate, and finally the verumontanum. The line of incision is then "scored" with a series of diathermy cautery marks and the incision begun along this line at the level of the bladder neck. The incision is deepened at bladder neck level and extends proximally towards the ureteric orifice and distally towards the verumontanum. Muscles at the bladder neck are divided and "spring apart" as the incision deepens. Fat is encountered quickly in the bladder area, but muscles at the level of the bladder neck continue to "spring apart" to expose and open the prostatic ducts from which small brown calculi extrude and are irrigated into the bladder. The incision deepens still further until the seminal vesicle is entered so that a considerable volume of turbid seminiferous fluid escapes, coagulating with the heat of the electrocautery and obscuring the view for a moment. There is no difficulty in proceeding, however, if the continuous irrigation resectoscope is used, although the "bladder neck spring" may not be as evident with this modified instrument as with the standard resectoscope sheath. The incision lasts approximately 2 min, which is enough time to provide the degree of bladder distension necessary for the whole procedure to be accomplished without overdistension or the risk of extravasation of the glycine irrigant. When the incision is complete, fat is visible throughout its length. It is an extensive incision and it may be that "myotomy" is an inadequate term; the incision divides far more than muscles, not only transecting these but the whole thickness of the prostate. "Prostotomy" might be more appropriate.

At the conclusion of the procedure it is our practice to pass a 22 FG Porges Dufour irrigating catheter on a curved introducer. It is essential in introducing this catheter that the large retrovesical/sub-trigonal space created by the incision is avoided: the catheter tip must lie intravesically or gross extravasation of irrigant will occur.

The catheter remains in place for 48 h, the first 24 of these with irrigation. Following removal of the catheter, normal micturition with complete control is normally achieved within a further 24 h, after which the patient is discharged from hospital.

Frequency, urgency with some urgency incontinence and minor continuing haematuria are invariable post-myotomy effects of which the patient should be warned. They rarely last more than 10 days.

The procedure is covered with antibiotics in the following circumstances:

1. A catheter has been in place preoperatively. A single bolus of gentamicin 160 mg or piperacillin 1 g is given intravenously at the time of induction of anaesthesia.

2. A proved urinary tract infection exists at the time of operation, in which case the patient will be covered by the antibiotic appropriate to the culture result.

3. Whenever the mid-stream urine specimen result after catheter removal is positive. An appropriate antibiotic is prescribed for the patient to take home.

## Complications

There must be complications associated with myotomy, as there must be with prostatectomy in general. They may be divided into early and late complications.

### Early Complications

There has been no mortality in a personal series which extends over 12 years and includes 593 cases. During the same period of time seven patients have died following TURP out of 754 procedures (0.93%).

Other early complicating factors related to the surgical procedure itself include:

1. In-patient stay postoperatively—shorter after myotomy when compared with TURP.
2. Duration of catheter stay postoperatively—shorter following myotomy.
3. Blood transfusion—less after myotomy.
4. Postoperative incontinence at 6 weeks is lower after myotomy.

Cardiorespiratory complications have been lower after myotomy, as has the incidence of epididymo-orchitis, clinical bacteraemia and septicaemia, and clinically detectable deep vein thromboses.

## Late Complications

There are three specific complicating factors which should be discussed under this heading. The first of these is incontinence at the 1-year follow-up. The figure for myotomy is low at 0.4%, compared with 1.3% after TURP.

The second relates to the incidence of retrograde ejaculation; our figures are at gross variance from those quoted by others. This will be discussed at greater length later (see p. 423).

The third is the "re-do rate", i.e. the number of patients who required further corrective surgery for recurrent obstruction. Our figures are no worse after BNI than after TURP. It is interesting to note that of all those who required such further "adjustment" approximately half in each group required a further similar procedure and the remainder the alternative operation!

**Table 36.1.** Comparative results of BNI and TURP

| Complicating factor | BNI | TURP |
|---|---|---|
| No. of cases | 312 | 388 |
| Postoperative deaths | 0 | 3 |
| Transfusion | 1.7% | 18.7% |
| Units per patient transfused | 2.1 | 2.65 |
| Postoperative catheter stay: | | |
| Series 1 | 4.3 } 2.01 | 3.22 |
| Series 2 | 1.9 } | |
| Postoperative stay: | | |
| Series 1 | 6.1 } 5.34 | 3.23 |
| Series 2 | 5.06 } | 7.35 |
| Postoperative incontinence: | | |
| 6 weeks | 3.8% | 4.13% |
| 1 year | 0.32% | 1.5% |
| Re-do rate | 1.7% | 1.8% |

The comparative results of BNI and TURP are shown in Table 36.1. A brief explanation of "Series 1" and "Series 2" is necessary. For the first 102 cases our practice after BNI was to leave the catheters for 5 days postoperatively, on the assumption that "this was the time it took for the cavity to re-epithelialise", or "it will re-stenose if we remove the catheter sooner". We felt later that these assumptions were illogical, led to an increase in morbidity, and removed two main advantages of the procedure, namely, the shorter catheter stay and the shorter inpatient stay. From case 103 onwards we removed the catheter as soon as the effluent was clear, almost always on the second day, occasionally on the first and rarely beyond the third day. Morbidity decreased and the long-term results were unchanged.

## When Should One Perform Myotomy?

It is my opinion that one should perform myotomy as opposed to formal resection whenever the gland is clinically benign and weighs less than 35 g. Our short objective and subjective analysis (Edwards and Powell 1982) showed that myotomy was as effective as resection in relieving obstructive symptoms. Myotomy has a lower morbidity than resection and so far a nil mortality. Although our first study related to urodynamic/subjective parameters and our latest (Edwards et al. 1985) to subjective parameters only, there appears to be no reason why our conclusions should alter with time. The clinical results of our continuing study demonstrate that myotomy can be as effective and permanent as resection in the relief of obstruction when the prostate is small and benign. It seems reasonable to suggest that myotomy is preferable to resection, provided that this single and simple criterion can be fulfilled.

## When Should One Resect?

If myotomy is suitable for small and benign glands it could be suggested that prostatic resection should be undertaken only when the gland is clinically benign and exceeds 35 g in weight. If the prostate is greater than 75 g the complications of resection must include (1) increased risk of haemorrhage, (2) perforation leading to laparotomy and (3) incontinence, particularly in the hands of the inexperienced.

When the gland weighs less than 30 g the increased risks of (1) perforation and (2) external sphincter ablation will apply. It is probable that sphincter damage occurs from indiscriminate use of the coagulation diathermy rather than striated external sphincter muscle resection.

## Retrograde Ejaculation

Many figures have been quoted for the incidence of the phenomenon of retrograde ejaculation; they are summarised in Table 36.2. It is my opinion that the lower the figure quoted the less effective the procedure in the long term. Ejaculation depends on integrity of the internal and external sphincter mechanisms. Normal ejaculation is experienced by 85% of my patients treated with thymoxamine 40 mg four times a day and 75% of those treated with phenoxybenzamine 10 mg at night—both alpha-antagonists which may relieve outflow tract obstruction, whereas the same satisfaction is experienced by only 60% of those subjected to myotomy. This figure is at considerable variance with the other published data, particularly those of Andersen et al. (1980); however, I suggest that if the myotomy is to alleviate obstruction it must be long and deep and

**Table 36.2.** Reported incidence of retrograde ejaculation

| Reference | Retrograde ejaculation (%) |
|---|---|
| Keitzer et al. (1961) | "Temporary" |
| Orandi (1973) | "Temporary" |
| Turner-Warwick et al. (1979) | |
| Bilateral incision | 15 |
| Unilateral incision | 5 |
| Jonas et al. (1979) | 7 |
| Andersen et al. (1980) | 0 |
| Moisey et al. (1982) | 16 |
| Edwards and Powell (1982) | 18 |
| Delaere et al. (1983) | 37 |
| Hedlund and Ek (1985) | 22 |
| Edwards et al. (1985) | 35 |
| Orandi (1985) | 6 |
| Christensen et al. (1985) | 22 |

must therefore provide ejaculatory reflux into the vesicles (Fig. 36.1). In our hands, therefore, the incidence of retrograde ejaculation must be of the order of 40%, and, as the tendency is towards an increase in the rate of medicolegal litigation, this is the incidence which we describe to our patients.

**Fig. 36.1.** Micturating cystogram taken just before catheter removal 48 h after BNI. Reflux into the right seminal vesicle is clearly shown together with some extravasation into the paraprostatic plane.

*Why Not Myotomy?*

Having defined a specific criterion of size, the next consideration must be that of clinical malignancy. Our colleagues in the USA have been quick in their riposte to our suggestion that myotomy is appropriate in small glands: they are concerned with the possibility of clinically undetectable malignant changes occurring within the prostate. Some will argue that clinically malignant prostates are best left untreated unless symptoms of obstruction or of metastatic deposits develop. The opinion which I share with my colleagues in the Department of Radiotherapy at Westminster Hospital is that primary prostatic carcinoma should be treated by radiotherapy, provided that it can be demonstrated that the disease is confined to the bony pelvis. We reserve surgical manipulation of a malignant gland for those patients whose malignant obstruction is resistant to radical radiotherapy, unless, of course, the disease is widespread, in which case we place reliance on hormonal manipulation by orchidectomy, the administration of luteinising hormone releasing hormone (LHRH) agonists, cyproterone acetate or simultaneous infusion of fosfestrol tetrasodium and 5-fluorouracil. Myotomy has no place in the management of malignant prostatic disease as the prostate is rigid and the segments cannot "spring apart", however deep the cut extends.

## Is Myotomy Prophylactic?

There are many apparent advantages to myotomy when one considers the treatment of benign outflow tract obstruction. The morbidity is lower than that of formal resection, and not one patient has yet died. Orandi (1985) has suggested that the bladder neck incision he describes can prevent further hypertrophy by devascularisation of the middle and lateral lobes of the prostate. He has gone so far as to suggest that atrophy of the two lobes on either side of his ipsilateral myotomy ensues following this vascular deprivation. He reports a minimal incidence of retrograde ejaculation.

I have stated that the operation as I have described it above carries little risk of haemorrhage, and we have no record of transfusing a patient undergoing a myotomy during the last 2 years. If one were to propose that vascular obliteration or division was important with regard to subsequent prostatic adenomatous regression it should follow that the arterial division necessary for this to occur would result in haemorrhage sufficient to require significant transfusion. Furthermore, in dividing the prostatic vessels on one side, would not the middle receive a cross-over blood supply and therefore not atrophy?

My hypothesis is that the prostate grows because its fibromuscular tissues must hypertrophy in order to expel, through the prostatic ducts, the inspissated secretions and calculi which accumulate with advancing age. The prostatic ducts cannot accommodate these inspissatons and will dilate as I have observed and described. When these dilated ducts are incised and opened, thick brown "toothpaste" is extruded in large quantity. The muscular hypertrophy has occurred in an attempt to extrude this semi-solid material. When the ducts are transected by myotomy free drainage is provided and the secretions escape in unhindered fashion so that the fibromuscular hypertrophy is no longer necessary and naturally regresses.

I think it unlikely that Orandi's procedure could devascularise two lobes of the prostate. The procedure which I advocate could, but in my opinion probably does not, otherwise the haemorrhagic complications would be considerably higher than he and I have experienced. It seems likely that his incision is relatively superficial in its nature, and this is probably reflected in his low incidence of postoperative retrograde ejaculation. During the procedure that I describe semen frequently floods out of the right vesicle because my incision is long and deep.

## Does Myotomy Work for Other Conditions?

In considering the patient with outflow tract obstruction in the presence of a small benign prostate, the current evidence suggests that myotomy is as effective as resection in alleviating the symptoms, not only in the short term but also in the long term. However, the role of myotomy, as part of the standard operative armamentarium of the urologist, cannot be so minor as to be restricted solely to the relief of obstruction under the circumstances described. There are several other conditions in which I consider that it has a significant part to play.

### Seminal Vesiculitis

Seminal vesiculitis is an uncommon acute condition characterised by severe perineal discomfort, malaise, pyrexia and dysuria. It is often difficult to diagnose clinically, but the affected organ will be acutely tender and may be demonstrable on pelvic ultrasound or computed tomography (CT) scanning of the pelvis. Its aetiology often relates to acute obstruction of the ejaculatory ducts and can be relieved by incising the bladder neck on the affected side, extending the cut into the vesicular ducts. Achievement of the desired depth will be manifest by the sudden efflux of purulent fluid and disappearance of the mass which can be felt on rectal examination. Chronic inflammatory conditions of the seminal vesicle may be even more difficult to diagnose but can be relieved in similar fashion.

### Chronic Prostatitis

The symptoms of chronic prostatitis are often so intractable that a surgical remedy is sought. Prostatic resection may appear radical when one considers that the patients are relatively young, whereas myotomy would be an effective alternative, subject to the limitations imposed by the described risk of retrograde ejaculation. Unilateral incision is usually sufficient to achieve the necessary effect. Inspissated secretions are always seen escaping under pressure as the ducts are transected.

I have no experience of the procedure in acute prostatitis.

### Calculous Prostatitis

Most patients with prostatic calculi are symptom free, at least with regard to their stones, although there may be superimposed symptoms of obstruction. Some patients, however, are troubled by pain and discomfort relating to the collection of small abscesses, usually chronic, which may develop around each stone nidus. Incision of the dilated ducts and release of the stones are readily accomplished, with symptomatic improvement. As the stones are released they are irrigated into the bladder, from which they may be retrieved by evacuation or, more usually, allowed to pass spontaneously when the catheter is removed postoperatively.

## Will Myotomy Work if the Gland is Big?

If incision results in devascularisation of the prostate and consequent atrophy, it could be suggested that the upper limit of 35 g which I have imposed is too low. What happens if the gland is larger than the defined limit? In the first place it is much more difficult to undertake a myotomy as the lobar "spring" is less apparent and one cuts deeper and deeper into semi-rigid fluffy prostatic tissue. Eventually, however, the extravesical/extraprostatic fat planes are reached and an enormous funnel of a bladder outlet develops.

Over the last 15 months I have intentionally attempted "myotomy" (now properly named "prostotomy") in eight glands in excess of 35 g, but none of these has been greater than 50 g. Seven of these patients reported a subjective improvement in their symptoms and are still well, but the period of follow-up must be far too short. I have not yet detected any difference in the clinical size of these seven glands. The other patient, however, failed to pass urine at all after surgery and required a formal resection for what can only be described as iatrogenic retention: 47 g were resected at operation.

It would seem that little is to be gained by pursuing this aspect of treatment as a routine alternative to formal resection of larger glands, but it should certainly be borne in mind that myotomy must have a place in those patients with large glands in whom the least possible surgical trauma is likely to be the most beneficial.

# References

Andersen JT, Nordling J, Meyhoff HH, Jacobsen O, Hald T (1980) Functional bladder neck obstruction. Scand J Urol Nephrol 14: 17–22

Blandy JP (1978) Transurethral resection, 2nd edn. Pitman Medical, London

Bottini F (1887) Permanent Ischaemie wegen Prostatahypertrophie: thermogalvanische Operation. Cent Chir 28: 157

Christensen MG, Nordling J, Andersen JT, Hald T (1985) Functional bladder neck obstruction. Results of endoscopic bladder neck incision in 131 consecutive patients. Br J Urol 57: 60–62

Civiale J (1841) Traite pratique des maladies des organes genito-urinaire. Paris

Delaere KPJ, Debruyne FMJ, Moonen WA (1983) Extended bladder neck incision from outflow obstruction in male patients. Br J Urol 55: 225–228

Edwards L, Powell C (1982) An objective comparison of transurethral resection and bladder neck incision in the treatment of prostatic hypertrophy. J Urol 128: 325–327

Edwards LE, Bucknall TE, Pittam MR, Richardson DR, Stanek J (1985) Transurethral resection of the prostate and bladder neck incision: a review of 700 cases. Br J Urol 57: 168–171

George NJR, O'Reilly PH, Barnard RJ, Blacklock NJ (1984) Practical management of patients with dilated upper tracts and chronic retention of urine. Br J Urol 56: 9–12

Guthrie GJ (1836) On the anatomy and diseases of the urinary and sexual organs. J and A Churchill, London

Hedlund H, Ek A (1985) Ejaculation and sexual function after endoscopic bladder neck incision. Br J Urol 57: 164–167

Jenkins JD, Allen NH (1978) Bladder neck incision—a treatment for retention with overflow in the absence of adenoma. Br J Urol 50: 395–397

Jonas U, Petre E, Hohenfellner R (1979) Indication and value of bladder neck incision. Urol Int 34: 260–265

Keitzer W, Cervantes L, Demaculangan A, Cruz B (1961) Transurethral incision of bladder neck for contraction. J Urol 86: 242–246

Mercier F (1850) Recherches sur les valvules du col de la vessie. Paris

Millin T (1947) Retropubic urinary surgery. Livingstone, Edinburgh

Moisey CU, Stephenson TP, Evans C (1982) A subjective and urodynamic assessment of unilateral bladder neck incision for bladder neck obstruction. Br J Urol 54: 114–117

Orandi A (1973) Transurethral incision of the prostate. J Urol 110: 229–231

Orandi A (1985) Communication to the annual meeting of the British Association of Urological Surgeons, Eastbourne, July 1985

Turner-Warwick RT (1979) A urodynamic review of bladder outlet obstruction in the male and its clinical implications. Urol Clin North Am 6: 171–192

Turner-Warwick R, Whiteside CG, Worth PHL, Milroy EJG, Bates CP (1973) A urodynamic view of the clinical problems associated with bladder dysfunction and its treatment by endoscopic incision and transtrigonal posterior prostatectomy. Br J Urol 45: 44–59

Whitaker RH (1983) Communication to the annual meeting of the British Association of Urological Surgeons, Harrogate, June 1983

Young HH (1913) A new procedure (punch operation) for small prostatic bars and contracture of the prostatic orifice. JAMA 60: 253–257

*Chapter 37*

# New or Improved Treatments for Failure of Ejaculation

*G. S. Brindley*

## Introduction

A man may lack both ejaculation and orgasm. This state is called anorgasmia; it may be primary, i.e. present since puberty, or secondary, i.e. coming on after a period during which orgasms occurred.

Primary anorgasmia of men (Brindley and Gillan 1982; Brindley 1984a) is uncommon, and only about 50 cases have been reported in the world literature. The condition is often supposed to be psychogenic, but the grounds for supposing this are weak. In a few cases relevant psychological abnormalities exist and appear to be causal, but in the majority there is no good evidence for a psychological cause. The condition has many similarities to primary anorgasmia of women, which is much commoner. Secondary anorgasmia of men is most often due to spinal injury, but many diseases affecting the central nervous system (CNS) can cause it.

A quite different disorder is loss of external ejaculation, with orgasms still occurring. Such orgasms can non-committally be called "dry orgasms" until post-orgasmic urine has been examined. If post-orgasmic urine contains numerous spermatozoa, the orgasm was dry because of retrograde ejaculation; if it does not, ejaculation has failed ("non-ejaculation with preserved orgasm"). Retrograde ejaculation can be caused by surgical interference with the bladder neck, and either condition can be caused by lesions of the pelvic sympathetic pathways, for example in diabetic autonomic neuropathy or after surgical removal of para-aortic lymph nodes. Complete lesions cause non-ejaculation, usually with preserved orgasm. Incomplete lesions may do the same, but more often cause retrograde ejaculation.

In all these conditions, the usual chief reason for seeking treatment is the wish to have children. In anorgasmia the desire to experience the sensual pleasure of orgasm is a common secondary reason and sometimes the principal reason. There has recently been much progress in enabling patients with primary anorgasmia to have orgasms.

## Treatment

### Spinal Injuries

A recent paper (Brindley 1984b) has reviewed the means of achieving fertility in men with spinal injuries fully enough to make detailed description here unnecessary. There are two established techniques, electroejaculation (Francois et al. 1978; Brindley 1981a) and the application of a powerful vibrator to the penis (Francois et al. 1980; Brindley 1981b). Choice of which technique should be tried first depends on the time since injury, the level of the lesion, the presence or absence of multisegmental lumbosacral reflexes, and the presence or absence of autonomic dysreflexia. Both techniques require equipment which at present costs several hundreds of pounds. Commercial massage vibrators, and vibrators sold in sex shops, are cheap, but are insufficiently powerful to cause ejaculation in the majority of patients with spinal injuries. If a powerful vibrator fails, electroejaculation remains worth trying. If electroejaculation fails, vibrators will also fail.

### Primary Anorgasmia

Of 29 cases of complete primary anorgasmia reported by Brindley (1984a), 22 could be caused to ejaculate by powerful vibrator. Five of these then progressed to ejaculation on masturbation. Four of them made the further progress to ejaculation during coitus. Whether the patient can make such progress or not, repeatable success with the powerful vibrator can suffice for fertility, and 7 of the 22 patients for whom the powerful vibrator succeeded are now fathers.

If the powerful vibrator fails, electroejaculation under general anaesthesia is needed to obtain semen. It has been successful in all the 19 patients with primary anorgasmia in whom I have tried it.

### Secondary Anorgasmia Other than that Resulting from Spinal Injury

The same two techniques are worth trying. For electroejaculation, a general anaesthetic will be required unless the patient has no pain sensitivity below about L–1.

## Centrally Acting Drugs that may Reinforce Reflex Ejaculation

Neostigmine (Prostigmin) given intrathecally causes multiple emissions of semen in men with spinal injuries (Guttmann 1949; Guttman and Walsh 1971; Chapelle et al. 1976). It has done the same in a normal volunteer (Brindley and Rushton, unpublished observations), and in him the multiple emissions were true ejaculations, with orgasms. Chapelle (1984) has reported that physostigmine (used instead of neostigmine because it crosses the blood–CNS barrier), given subcutaneously in dosage 2 mg together with butyl hyoscine to prevent peripheral cholinergic effects and metoclopramide to prevent vomiting, enables paraplegic men to obtain semen by masturbation. I have not seen published independent confirmation, and my own attempts at confirmation have not yet succeeded. However, the claim is probably valid and, if valid, certainly very useful.

In three men with complete primary anorgasmia who did not have hyperprolactinaemia or Parkinsonism, I have failed more than once to trigger ejaculation by vibrator in the absence of any drug, and then succeeded on the first trial after giving bromocriptine 2.5 mg or 3.75 mg by mouth 2 h before (Brindley 1984a). The theoretical ground for trying bromocriptine was weak, and the successes could perhaps have been due to suggestion, so the finding needs confirmation, preferably in a double-blind controlled trial.

## Retrograde Ejaculation and Non-ejaculation with Preserved Orgasm

The surgical treatment of retrograde ejaculation is considered in the following chapter. For both conditions, if there is reason to suspect an *incomplete* lesion of the pelvic sympathetic pathway, medical treatment with noradrenaline re-uptake blocker is well worth trying. What is needed is not a long-term increase in the tone of sympathetically innervated smooth muscle. Thus alpha-adrenoceptor stimulating drugs such as phenylpropanolamine hydrochloride and midodrine are irrational. Successes have been reported with both these drugs (Stewart and Bergant 1974; Schwale et al. 1980), but only in dosage which raises the blood pressure substantially. One should aim rather to maintain a relatively low resting activity of the smooth muscle of the bladder neck and genital tract so as to avoid fatigue, but try to achieve a large increase in this activity at the moment of ejaculation. Noradrenaline re-uptake blockers should theoretically do this in patients with incomplete pelvic sympathetic lesions, by increasing the survival time of the burst of noradrenaline output from those sympathetic fibres that are still functioning. Empirically, they increase the volume of semen ejaculated by normal volunteers (Brindley, unpublished observations). In two diabetic patients who ejaculated retrogradely, Brooks et al. (1980) found that imipramine 25 mg given three times daily caused them to ejaculate externally within a week. Desipramine, a more specific blocker of noradrenaline re-uptake, given 3–4 h before masturbation in dosage of 75 or 100 mg, has converted retrograde ejaculation or non-ejaculation to external ejaculation in seven of my patients (unpublished observations).

## References


Brindley GS (1981a) Electroejaculation: its technique, neurological implications and uses. J Neurol Neurosurg Psychiatry 44: 9–18

Brindley GS (1981b) Reflex ejaculation under vibratory stimulation in paraplegic men. Paraplegia 19: 299–302

Brindley GS (1984a) Le syndrome de "primary anorgasmia" chez l'homme. In: Buvat J, Jouannet P (eds) L'ejaculation et ses perturbations. Simep, Lyon, pp 79–83

Brindley GS (1984b) The fertility of men with spinal injuries. Paraplegia 22: 337–348

Brindley GS, Gillan PW (1982) Men and women who do not have orgasms. Br J Psychiatry 140: 351–356

Brooks ME, Berezin M, Braf Z (1980) Treatment of retrograde ejaculation with imipramine. Urology 15: 353–355

Chapelle PA (1984) Traitement de l'anejaculation du paraplegique complet par association metoclopramide-eserine. In: Buvat J, Jouannet P (eds) L'ejaculation et ses perturbations. Simep, Lyon, pp 54–55

Chapelle PA, Jondet M, Durand J, Grossiord A (1976) Pregnancy of the wife of a complete paraplegic by homologous insemination after an intrathecal injection of neostigmine. Paraplegia 14: 173–177

Francois N, Maury M, Jouannet D, David G, Vacant J (1978) Electroejaculation of a complete paraplegic followed by pregnancy. Paraplegia 16: 248–251

Francois N, Lichtenberger JM, Jouannet P, Desert JF, Maury M (1980) L'ejaculation par le vibromassage chez le paraplegique à-propos de 50 cas avec 7 grossesses. Ann Med Phys 23: 24–36

Guttmann L (1949) The effect of prostigmine on the reproductive functions in the spinal man. In: Proceedings of the 4th International neurological congress. Masson, Paris. p 69

Guttmann L, Walsh JJ (1971) Prostigmin assessment test of fertility in spinal man. Paraplegia 9: 39–50

Schwale M, Frosch P, Tölle E, Niermann H (1980) Behandlung retrograder Ejakulation und Anorgasmie mit einem Alpha-Sympathomimetikum (Midodrin). Z Hautkr 55: 756–759

Stewart BH, Bergant JA (1974) Correction of retrograde ejaculation by sympathomimetic medication: preliminary report. Fertil Steril 25: 1073–1074

*Chapter 38*

# Reconstruction of Bladder Neck for Retrograde Ejaculation

*J. P. Pryor*

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Retrograde ejaculation is only of importance when a man wishes to father children as it is otherwise associated with normal sexual function. It is usually possible to retrieve spermatozoa from the urine and perform artificial insemination of the partner and thereby avoid the need for surgery. There are many techniques for this (Hargreave et al. 1983), and sometimes sympathomimetic drugs may be a valuable adjunct; desipramine 50 mg on alternate days may be useful in this respect.

Bladder neck reconstruction may be performed to correct retrograde ejaculation for the purposes of improving fertility in those men where other means of treatment are not available or have failed. An alternative approach is to implant a vasal sperm reservoir from which sperms may be aspirated. On occasion, the reconstruction is performed on "elderly" patients who have undergone bladder neck surgery without having been adequately warned of the risks of retrograde ejaculation. The technique of bladder neck reconstruction is similar to that described by Dees (1949) and is a modification of the operation that I learnt from Mr Harland Rees, who performed it on young adults with nocturnal enuresis.

## Technique

The patient is prepared as for any retropubic operation under general anaesthesia. The operation is performed with the patient supine and the head lowered in order to allow the abdominal contents to fall away from the bladder. The bladder and prostate are exposed through a transverse lower abdominal incision and the anterior wall of the bladder incised

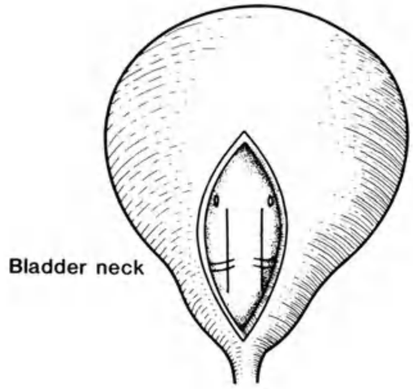



**Fig. 38.1.** Vertical cystotomy incision and mucosa incisions outlining neourethra; bladder neck and ureteric orifices indicated.

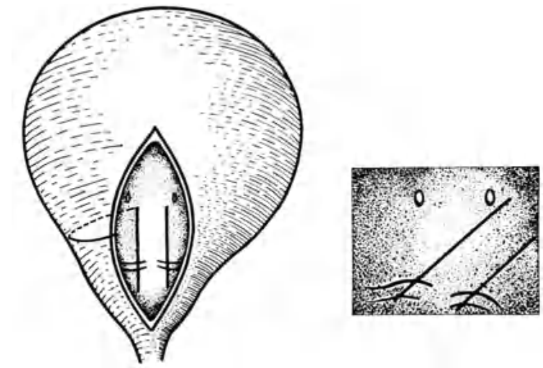


**Fig. 38.2.** Position of right lateral flap outlined. *Inset*, Oblique incision to obtain extra length of urethra.

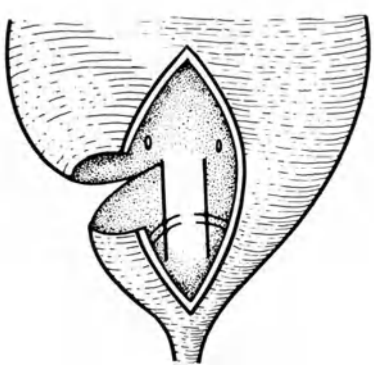


**Fig. 38.3.** Bladder incised to produce right lateral flap.

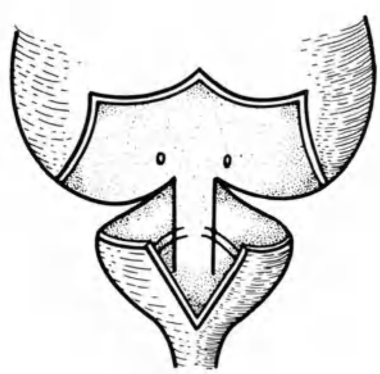


**Fig. 38.4.** Both lateral flaps fashioned.

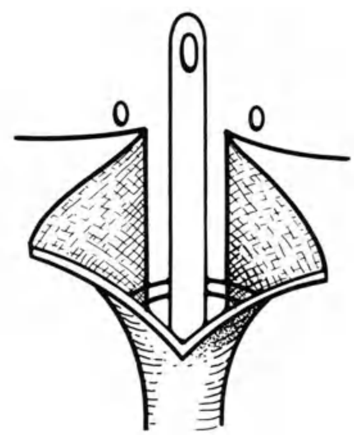


**Fig. 38.5.** Mucosa stripped from lateral flaps and raised on edge of neourethra.

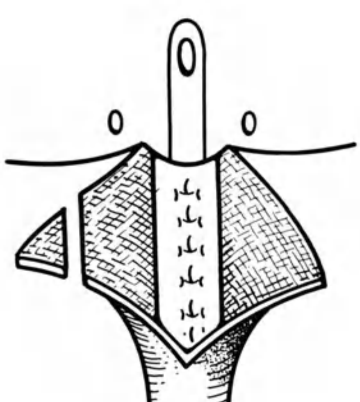


**Fig. 38.6.** Urethra tube and apex of right lateral flap excised.

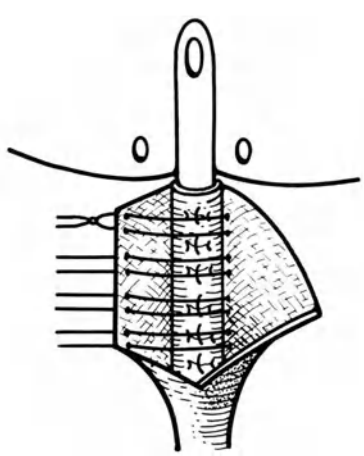


**Fig. 38.7.** Interrupted mattress sutures placed to roll right-hand flap over the neourethra.

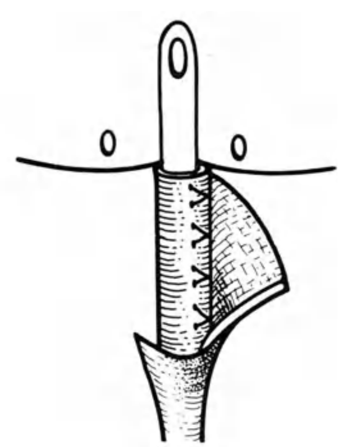


**Fig. 38.8.** Right-hand flap sutured to base of left-hand flap.

vertically with suitable stay sutures. The incision is extended as far distally into the prostatic urethra as is practicable. The ureteric orifices and bladder neck are identified and a strip of mucosa 4–5 cm long and 2 cm wide is marked out on the posterior wall of the bladder and posterior urethra with a diathermy needle (Fig. 38.1). Should the ureteric orifices be too close to the bladder neck to allow this, or because the access to the prostatic urethra is difficult, the mucosal strip may deviate laterally in order to obtain sufficient length (Fig. 38.2).

Lateral incisions are then made in the bladder wall from the original vertical incision around to the proximal corners of the neourethral mucosal strip. The incision is carried out through the full thickness of the bladder wall, and it is useful to place additional stay sutures in order to facilitate subsequent dissection and reconstruction. Care is taken to avoid damaging the ureteric orifices, and sufficient mucosa should remain beneath them in order to close the bladder without fear of obstructing the ureters (Figs. 38.2–38.4).

The mucosa is then stripped from the two distal flaps of bladder/prostate that are lateral to the central mucosal strip (Fig. 38.5). The stay sutures provide convenient holds but it may also be necessary to use a Babcock forceps to hold the muscle. Sometimes the mucosa is stripped off easily but on other occasions it has to be picked off piecemeal.

A 14 FG silicone urethral catheter is passed into the bladder and the edges of the mucosal strip are elevated for 3 mm on each side. The mucosal strip is tubed around the catheter using a continuous 4-0 synthetic absorbable suture (Fig. 38.6). A suprapubic catheter is placed in the bladder, which may be closed with two layers of synthetic absorbable sutures at this stage. The distal muscle flaps require trimming and are then wrapped around the neourethra. The right-hand flap is cut back until it is about 4 cm wide and a series of interrupted 00 absorbable mattress sutures are placed through the edge of this flap and the base of the left-hand flap. These are then tied (Figs. 38.7, 38.8).

The left-hand flap is then folded over the front of the urethral tube and its first muscle layer, trimmed to a convenient size and sutured to both the lateral aspect of the right-hand flap and to the base of the bladder (Fig. 38.9), so that the bladder closure is completed (Fig. 38.10). The wound is closed with a retropubic drainage tube, and both urethral and suprapubic catheters are left on continuous drainage.

## Postoperative Care

Simple prophylactic antibiotics are given to the patient in view of a period of catheterisation of more than 4 days. The retropubic drain is removed as soon as drainage ceases (usually 48 h), the urethral catheter is removed after 10 days and a voiding cystourethrogram is performed on the 14th day to check that there is no extravasation. Should there be any extravasation, the suprapubic catheter is left in situ until the bladder is soundly healed. Once the radiological study (Fig. 38.11) shows that there

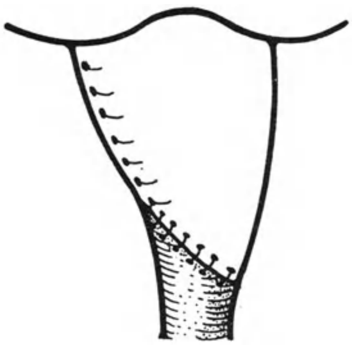


**Fig. 38.9.** Left-hand flap wrapped over the right-hand flap and sutured to it.

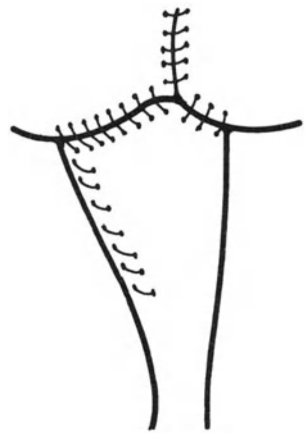


**Fig. 38.10.** Flap sutured to base of bladder and bladder closure completed.

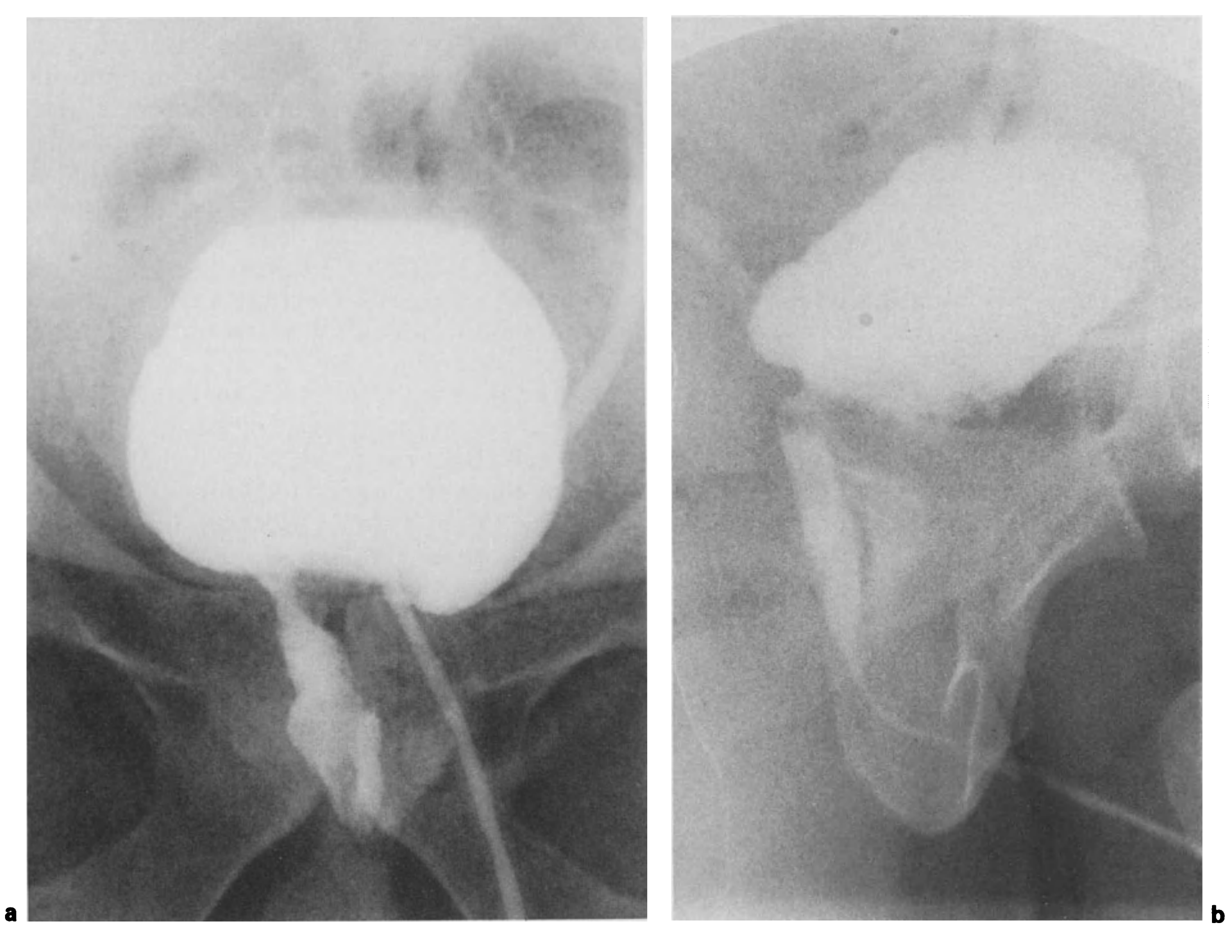


**Fig. 38.11a,b.** Postoperative cystogram following bladder neck reconstruction for retrograde ejaculation. **a** Anterior and **b** anterolateral views of bladder neck. The length of the urethra between the bladder neck and internal sphincter is doubled.

is no leakage from the suture line, the suprapubic catheter is clamped and removed when the patient is voiding satisfactorily. The patient is advised to abstain from intercourse for at least 4 weeks after the operation or until he is pain free.

## Discussion

I have performed the operation on six occasions (five times for infertility and once following a transurethral prostatectomy). The results have been satisfactory in that antegrade ejaculation was restored in all patients, although not necessarily on every occasion—particularly if coitus occurs more than once daily. The use of the posterior bladder and urethral mucosa to form a new bladder neck has also been used by Ramadan et al. (1985), who have found a similar technique more satisfactory than the technique of Abrahams et al. (1975), who tightened the bladder neck region through a transvesical approach. It is probable that the success of the operation is due to the creation of a long and narrow tube between the bladder and the ejaculatory ducts and that the resistance of this allows antegrade ejaculation. This is similar to the use of an anterior bladder tube to correct post-prostatectomy urinary incontinence, as has been described by Tanagho (1981) and also used by Boccon-Gibod et al. (1985).

## References

Abrahams JI, Solish GI, Boorjian P, Waterhouse RK (1975) The surgical correction of retrograde ejaculation. J Urol 114: 888–890

Boccon-Gibod L, Beniot G, Steg A (1985) Bladder neck reconstruction using an anterior bladder flap in post-prostatectomy incontinence. Eur Urol 11: 150–151

Dees JE (1949) Congenital epispadia with incontinence. J Urol 62: 513–522

Hargreave TB, Pryor JP, Jequier AM, Crich JP (1983) Erectile and ejaculatory problems in infertility. In: Hargreave TB (ed) Male infertility. Springer, Berlin Heidelberg New York, pp 246–260

Ramadan AES, el Demiry MIM, Ramadan AED (1985) Surgical correction of post-operative retrograde ejaculation. Br J Urol 57: 458–461

Tanagho EA (1981) Bladder neck reconstruction for total urinary incontinence: 10 years of experience. J Urol 125: 321–326

Section IX

# Paediatrics

# Introduction

*R. H. Whitaker*

It is strange how often new diseases which appear to have been discovered have clearly existed for many years but have gone unrecognised. A good example of this is the posterior urethral valve that is seen in young boys. It was not recognised as a clinical entity until Young's description in 1919 (Young et al. 1919). It remained a serious cause of death in male infants in the 1950s and 1960s, but, subsequently, with surgical understanding and nephrological expertise, it has been possible to keep most of these boys alive. Whilst this may be an excellent objective, many of these boys, particularly those with the severest forms of intrauterine urinary obstruction and renal impairment, are eventually doomed to irreversible renal failure at puberty despite treatment. The appearance of proteinuria in these boys, early or late, is a grave prognostic sign (J. D. Frank and P. G. Ransley 1986, personal communication). Some of these children will be taken on to dialysis and transplantation programmes, but late problems may be encountered from poor bladder function.

In a proportion of boys who have had a posterior urethral valve destroyed, the bladder remains hyperactive—the so-called valve bladder (Whitaker 1973). Although imipramine is useful to treat this, there are those who believe that the harmful effects within the urinary system can be avoided by early vesicostomy (Krueger et al. 1980). Debate continues as to how valuable it is to diagnose such obstructive conditions as urethral valves, megaureters and hydronephrosis at an early stage of intrauterine development. Intrauterine intervention is now possible but there is little, if any, evidence that it tips the balance in the child's favour. The risks to life and lung function may outweigh any chance of improving renal function. Early delivery is tempting but, in the presence of a normal amount of amniotic fluid, there is probably no long-term benefit.

Although experience so far has fostered a somewhat conservative approach, antenatal diagnosis has undoubtedly allowed us to act swiftly and effectively as soon as the child is born. Isotope and ultrasound scans can now rapidly provide early and accurate assessment of function and anatomy so that relief of the obstruction by urethral catheter or percutaneous drainage is simple. Some caution, however, is needed as some dilated systems do revert to normal after birth: there is, as yet, no adequate explanation for this phenomenon.

A reappraisal of the short-term management of hypospadias has resulted in the use of more one-stage procedures that are effective and reliable. Construction of skin tubes on vascularised pedicles or as free grafts has found favour, and "buried strip" methods are generally regarded as unacceptable. An exciting new technique, still being researched, is the growth of skin tubes in vitro from small pieces of skin taken from the same patient some weeks earlier. However, there have been disappointingly few papers describing how the various hypospadias repairs look and function in teenage life and beyond: we may be storing up for ourselves a harvest of strictures and secondary chordee for later attention.

Whether to reimplant refluxing ureters still remains a vexed question 20 years on. No longer do we live in fear, as we did in the 1960s, of children with normal kidneys suddenly developing scars. The "big-bang" theory, with the shape of the papillae playing a major role, has helped us to plan a more logical approach (Ransley and Risdon 1978). New or increasing scarring does, of course, occur, but an extensive search for examples in the UK revealed only 74 children with such scarring out of a potential population of many thousands (Smellie et al. 1985). The decision as to whether to reimplant ureters for reflux has been made more difficult by the results of trials in young children with severe reflux treated either surgically or medically, showing that there is little or no difference in the clinical outcome (Birmingham Reflux Study Group 1983).

There are good anatomical reasons for reimplanting a refluxing ureter associated with certain duplications or paraureteral saccules, but often the final decision is a social one. Parents and urologists accept that there is only a 70% chance of spontaneous cessation of reflux but a 95% chance of surgical cure. The number of X-ray examinations, clinic attendances and antibiotics are lessened and the prima facie case for reimplanting is convincing.

Diagnostic techniques to confirm or refute the presence of obstruction in the dilated but non-refluxing upper tract have become more sophisticated. There has been debate in the last few years as to whether the less invasive isotope studies can be relied upon to give the correct answer. Although undoubtedly a great help, they can be misleading in approximately 20% of cases, mostly those with poor kidneys or excessively dilated systems (Whitaker and Buxton-Thomas 1984; Gonzalez and Chiou 1985).

Antegrade pressure/flow tests are invasive and less amenable to serial studies but, if performed correctly, rarely fail to give a definitive measure of the degree of mechanical resistance. Whether or not action needs to be taken on the result of these isotope or urodynamic studies remains debatable, and factors hitherto not considered must be taken into account: the compliance of the system, the function of the kidney, the age of the patient and the condition of the opposite kidney. Debate will continue but we can take some satisfaction in the knowledge that attitudes have changed and the view, voiced only 20 years ago, that all abnormally dilated systems must be obstructed is no longer tenable.

## References


Birmingham Reflux Study Group (1983) Prospective trial of operative versus non-operative treatment of severe vesico ureteric reflux: two years observation in 96 children. Br Med J 287: 171–174

Gonzalez R, Chiou R-K (1985) The diagnosis of upper urinary tract obstruction in children: comparison of diuresis renography and pressure flow studies. J Urol 133: 646–649

Krueger RP, Hardy BE, Churchill BM (1980) Growth in boys with posterior urethral valves. Urol Clin North Am 7: 265–272

Ransley PG, Risdon RA (1978) Reflux and renal scarring. Br J Radiol [Suppl] 14

Smellie JM, Ransley PG, Normand ICS, Prescod N, Edwards D (1985) Development of new renal scars: a collaborative study. Br Med J 290: 1957–1960

Whitaker RH (1973) The ureter in posterior urethral valves. Br J Urol 45: 395–403

Whitaker RH, Buxton-Thomas M (1984) A comparison of pressure flow studies and renography in equivocal upper urinary tract obstruction. J Urol 131: 446–449

Young HH, Frontz WA, Baldwin JC (1919) Congenital obstruction of the posterior urethra. J Urol 3: 289–365

*Chapter 39*

# Antenatal Diagnosis of Urological Abnormalities

*J. D. Frank*

## Introduction

The use of ultrasound to scan women during the second trimester of pregnancy to determine gestational age of the fetus and during the third trimester to assess fetal growth and placental site has become routine in many centres. Not infrequently these scans lead to the detection of fetal abnormalities affecting the heart, central nervous system, abdominal wall, chest or urogenital tract. There is no doubt that the early diagnosis of severe congenital anomalies such as anencephaly offers an obvious advantage: pregnancy can be terminated at an early stage. In many other instances, however, the abnormality detected may be compatible with normal life with or without surgery, and it may even transpire that the baby is normal and the scan misleading. In these circumstances the mother goes through pregnancy with the knowledge that the fetus is abnormal and suffers all the associated anxieties instead of the normal joys of pregnancy (Griffiths and Gough 1985). This chapter will confine itself to the antenatal diagnosis and management of urological abnormalities, but it is in this group of patients that major controversy concerning management exists. The antenatal diagnosis of a urological abnormality leads to certain possible courses of action, which are described below.

## Termination of Pregnancy

An early scan at less than 20 weeks of gestation may reveal an abnormality that is incompatible with life. Urologically this implies that

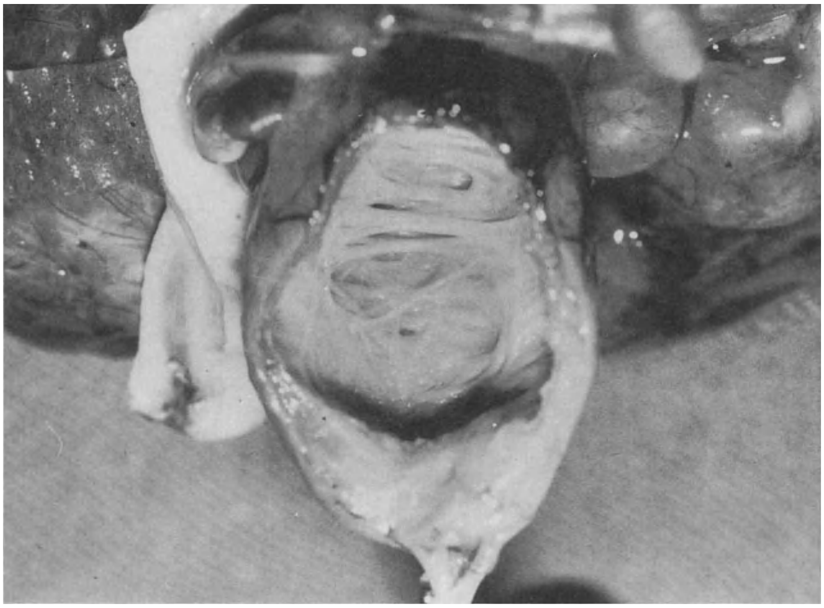


**Fig. 39.1.** The trabeculated bladder at post-mortem of a 17-week fetus. Termination of pregnancy was performed because of severe oligohydramnios and bilateral hydronephrosis.

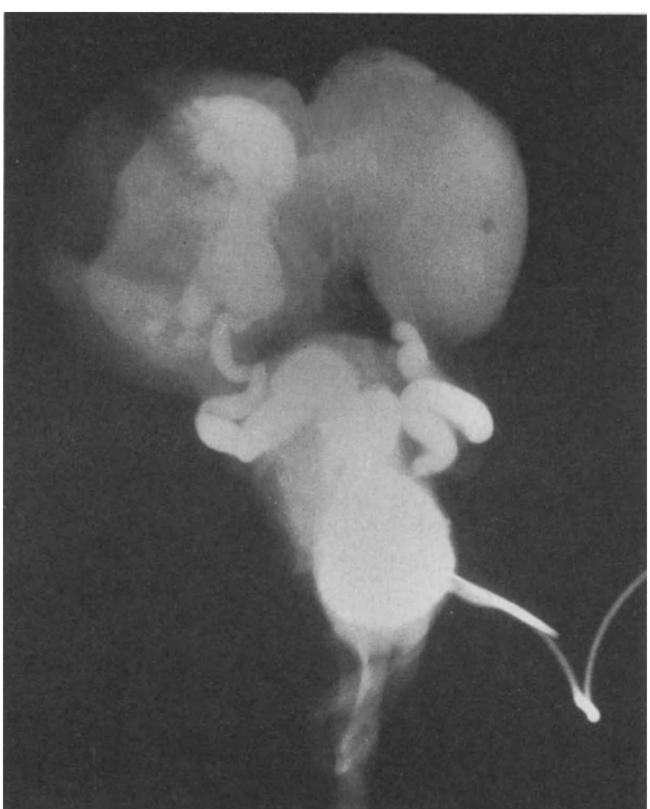


**Fig. 39.2.** Post-mortem cystogram of fetus with severe urethral obstruction showing bilateral reflux and left ureteric atresia.

there is insufficient functioning renal tissue to produce adequate volumes of urine. Urine is produced by the inner cortical nephrons during the tenth week of gestation, and early obstruction to the flow of urine has been shown to lead to renal dysplasia in the experimental animal (Tanagho 1972). Later obstruction leads to hydronephrosis without dysplasia. If severe oligohydramnios occurs before 20 weeks the fetus, if born, will die of severe pulmonary hypoplasia and renal insufficiency.

Harrison and Lorimer (1982), who were aggressive intrauterine interventionists early in their experience, now state that they are pessimistic about the future for fetuses who develop severe oligohydramnios before 20 weeks' gestation. In a recent review of our experiences, Pocock et al. (1985) reported that 7 of 28 pregnancies with an antenatal diagnosis of a major urological abnormality were terminated (Figs. 39.1, 39.2). The indications were severe oligohydramnios before 20 weeks' gestation in six fetuses and hydrocephalus associated with bilateral hydronephrosis in the seventh. Pathological examination of the fetuses confirmed severe renal dysplasia incompatible with life. Thus early termination of pregnancy must be the correct management of these cases. We have certainly never had cause to regret this decision, although it is important that sequential scans are performed to confirm the diagnosis before a decision to terminate is taken. It is also important that parents are given adequate emotional and psychological support both before and after this decision has been taken.

## In Utero Surgery

In the past few years fetal surgery has developed from a theoretical to a practical possibility; this is due in no small measure to the work of Harrison et al. in the Fetal Treatment Programme at the University of California (Harrison and Lorimer 1982; Harrison et al. 1982a, b). Fetal surgery was initially greeted with great enthusiasm. However, it has become apparent that there are major problems in deciding which fetuses will benefit from surgery. Patients with unilateral hydronephrosis have an excellent prognosis and should be left alone antenatally. Patients with severe early oligohydramnios have already been discussed; pregnancy should be terminated in such cases. Between these two extremes are those patients with a bilateral obstructive uropathy. Many of these patients will have urethral valves. If one looks at the postnatal outcome of this condition it is apparent that there are enormous variations in the severity of the obstruction and thus the outcome. How does one decide which fetus will benefit from in utero surgery? The mere presence of dilated upper tracts or even the severity of the dilatation is of no help. Patients with the prune belly syndrome have grossly dilated upper tracts but may have normal renal function because there is no associated obstruction. Intervention in these cases would be meddlesome.

At present, fetal surgery should be restricted to those patients with outflow obstruction, bilateral hydronephrosis and progressive oligohydramnios. The insertion of a vesicoamniotic shunt passed either percutaneously using ultrasound or via a fetoscope will allow the bladder to decompress into the amniotic cavity. This procedure, however, is not without its own problems of haemorrhage, infection and abortion. Severe oligohydramnios before 18–20 weeks' gestation is an indication for termination rather than intrauterine surgery. Between the extremes of renal damage there will be a group of patients in whom a vesicoamniotic shunt will prevent progression of renal damage. Some method, however, must be found to define this group. Attempts have been made to determine the degree of obstruction more accurately. Aspiration and biochemical analysis of fetal urine has not helped. Assessment of fetal urine production after an injection of frusemide to the mother has helped to define those patients who have no renal tissue and are anuric but has not helped to elucidate the problems of partial obstruction (Harrison and Lorimer 1982). Until a method is found to determine fetal renal function accurately, successful antenatal surgery will happen more by accident than design. It is necessary to demonstrate that not only is there progressive deterioration of fetal renal function prior to surgery, but also that the deterioration is halted or function improved following drainage, before we can say that surgery has been successful. At present this is sadly beyond our capabilities.

## Early Induction of Labour

If the obstruction to the urinary tract is mild or only occurs late in pregnancy, renal dysplasia will be minimal. Renal damage may progress, however, as pregnancy continues. The early scan at 18–20 weeks may be normal and the abnormality may only be detected in a scan after 30 weeks' gestation. In the series of 28 cases with a significant antenatal abnormality reported by Pocock et al. (1985), 15 women had both an early and a late scan and their infants had normal renal function after birth. The early scan was normal in 14 of these cases. This suggests that in the vast majority of fetuses without oligohydramnios and with only a moderate uropathy the obstruction occurs late in pregnancy. It has been suggested that these fetuses should be delivered early so as to prevent progression of the renal damage. However, all the infants in this series have done well, even those with bilateral obstructive lesions, suggesting that intervention by early induction of labour is not indicated. Premature induction is not without its own problems of fetal respiratory distress and a higher than normal Caesarean section rate.

## Postnatal Management

The antenatal diagnosis of a urological abnormality poses certain problems over the indications for fetal surgery and the best time to operate postnatally. The obvious advantage of antenatal diagnosis, however, is that the urinary tract can be investigated postnatally before the appearance of a urinary infection, and thus the baby will be clinically well. After birth the urinary tract should be re-examined by ultrasound and investigations tailored to the presumptive diagnosis. Early investigations of the urinary tract with an intravenous urogram or a renal isotope scan during the period of the transitional phase of neonatal renal function leads to poor upper tract definition. Imaging of the kidneys should therefore be delayed until after the first 2–3 weeks of life whenever possible. Patients should be placed on antibiotic prophylaxis whilst awaiting a definitive diagnosis. Further investigations will depend on the provisional ultrasound diagnosis.

## Normal Postnatal Ultrasound

Occasional patients have mild upper tract dilatation or an enlarged bladder on a number of prenatal examinations but are found to have a normal ultrasound postnatally (Hellstrom et al. 1984). No further investigations will be required, but these patients should be followed up and a repeat ultrasound examination performed at approximately 6 months and 1 year of age. Ransley and Manzoni (1985) have reported an individual case of a female infant who had upper tract dilatation in utero but a normal postnatal ultrasound. She re-presented at the age of 6 months with a urinary infection and a classic pelviureteric junction (PUJ) obstruction.

## Unilateral and Bilateral PUJ Obstruction and Multicystic Kidney

The antenatal differentiation between these two conditions is not always easy. A postnatal ultrasound will usually be diagnostic. In neither condition is there any rush to make a firm diagnosis since the majority of these infants, even those with bilateral PUJ obstruction, will have normal renal function (Fig. 39.3). A multicystic kidney, providing it is not large, can reasonably be left without surgical intervention (Fig. 39.4). Imaging of the contralateral kidney with an intravenous urogram (IVU) or diethylene triamine pentacetic acid (DTPA) renal scan is important to exclude an associated contralateral PUJ obstruction. If the mass is large it is probably better removed to avoid the risk of subsequent trauma.

The decision as to whether hydronephrosis caused by a PUJ obstruction requires surgery and as to when is the optimum time for intervention is more controversial. Ransley and Manzoni (1985) have discussed the management of infants with this condition. They divided them into three groups. Group I had a normal uptake curve by DPTA scan, and the affected kidney had greater than 40% overall renal function; group II had delayed uptake curves and 10%–40% overall renal function; and group III had flat uptake curves and less than 10% overall renal function. The authors suggested that these groups reflected the

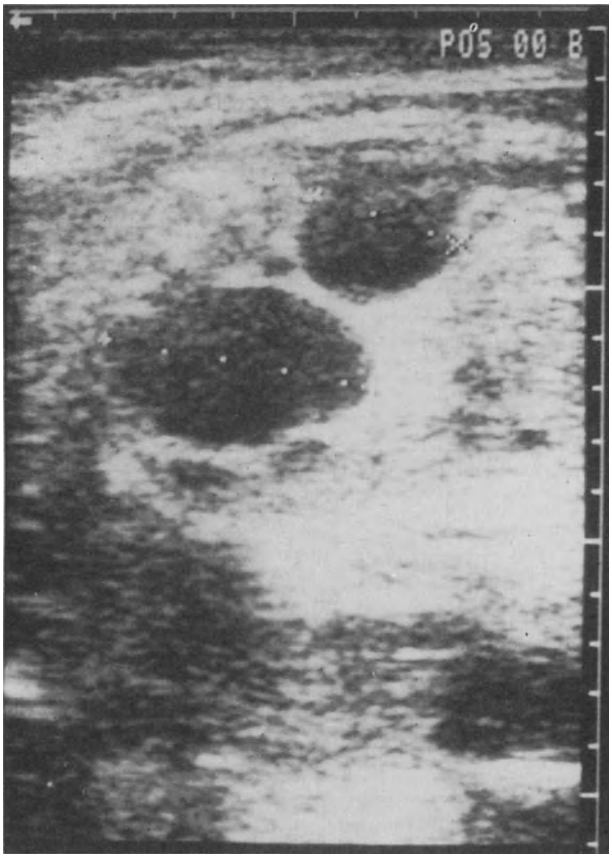


**Fig. 39.3.** Prenatal ultrasound showing bilateral hydronephrosis caused by PUJ obstruction.

**Fig. 39.4.** Prenatal ultrasound of a multicystic kidney.

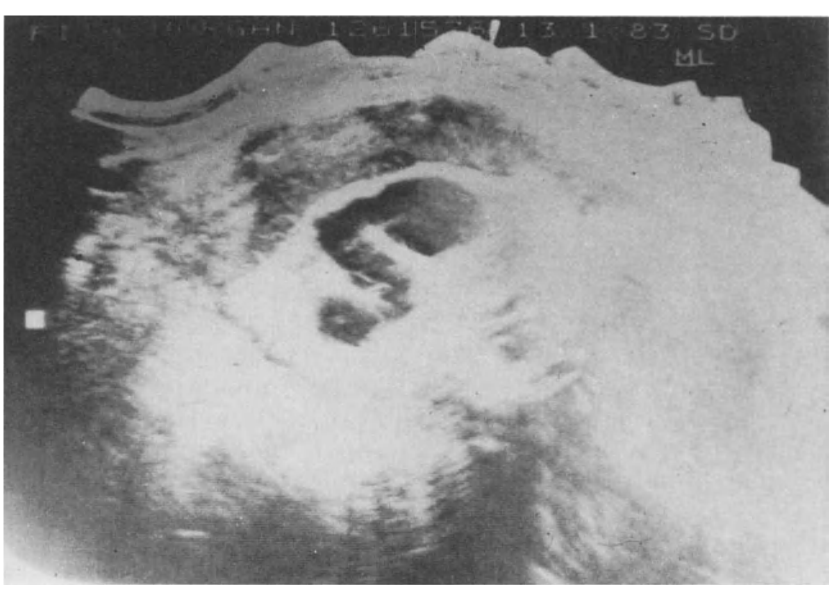


**Fig. 39.5.** Prenatal ultrasound showing a hydronephrotic kidney and hydroureter.

degree of prenatal obstruction. Thus group I had kidneys that were still functioning well at birth, suggesting that the obstruction was fairly mild. Twelve kidneys in this group have been followed for up to 2 years conservatively and only one patient has required a pyeloplasty for infection. Renal function has remained stable and the children remain asymptomatic. All nine kidneys in group II were subject to a pyeloplasty; of these, five have subsequently showed improved function. Of the four kidneys in group III, two have showed sufficient improvement after pigtail nephrostomy drainage to justify a pyeloplasty. Thus it would seem that there are gradations in the severity of PUJ obstruction. Some infants will require early surgery whilst others can be treated conservatively. Certainly there is no desperate rush to operate. Whatever its severity the obstruction has been present for many weeks prior to birth. Time should be allowed for the infant to thrive and for maternal/infant bonding to occur, preferably at home, prior to surgery.

## Bilateral Hydronephrosis and Hydroureter

There are many causes of bilateral hydronephrosis detected by an antenatal ultrasound. In the male it is of paramount importance to exclude urethral valves soon after birth. Thus a micturating cystourethrogram in the male is an urgent investigation. The further management of neonatal urethral valves is beyond the scope of this chapter, but early decompression of the bladder is mandatory. The diagnosis of bilateral vesicoureteric reflux as the cause of upper tract dilatation with a normal bladder leads to the interesting possibility that for the first time we will be able to follow the natural history of sterile reflux without infection complicating the picture. This group of patients, therefore, should be closely followed and may help in deciding the relative merits of operative versus conservative management of sterile reflux.

Other causes of hydronephrosis, such as obstructive megaureters, the neuropathic bladder and an obstructing ureterocele, need to be treated on their merits (Fig. 39.5). The principles of management of the obstructive megaureter may be similar to that of the PUJ obstruction. The problems of persuading parents to submit their child, who is apparently normal, to surgery for an asymptomatic condition is often difficult. Recently the parents of one of our patients with an ectopic ureterocele causing outflow obstruction refused surgery. The child was re-admitted at the age of 3 months, by which time she was extremely ill with hyponatraemia secondary to a urinary infection and vomiting. At least the initial antenatal diagnosis allowed us to undertake the initial investigations when the child was well and we were able to treat her without the necessity for further investigations. This problem of parental consent will always be difficult.

## Summary

The antenatal diagnosis of urological abnormalities has produced both advantages and disadvantages to the patient and the medical profession. A careful appraisal of our management decisions and results is necessary to try to define those patients in whom intrauterine surgery is beneficial and those patients who require postnatal surgery on the urinary tract.


## References


Griffiths DM, Gough MH (1985) Dilemmas after ultrasonic diagnosis of fetal abnormality. Lancet I: 623–624

Harrison MR, Lorimer AA (1982) Fetal intervention for obstructive uropathy. Dialog Paediatr Urol 5: 3–4

Harrison MR, Anderson J, Rosen MA et al. (1982) Fetal surgery in the primate. I. Anaesthetic, surgical and tocolytic management to maximize fetal-neonatal survival. J Paediatr Surg 17: 115–122

Harrison MR, Gulbus MS, Filly RA, Nakayama DK, Callen PW (1982b) Management of the fetus with congenital hydronephrosis. J Paediatr Surg 17: 728–742

Hellstrom WJG, Kogan BA, Jeffrey RB, McAninch JW (1984) The natural history of prenatal hydronephrosis with normal amount of amniotic fluid. J Urol 132: 947–950

Pocock RD, Witcombe JB, Andrews SA, Berry PJ, Frank JD (1985) The outcome of antenatally diagnosed urological abnormalities. Br J Urol 57: 788–792

Ransley PG, Manzoni GA (1985) Extended role of DTPA scan in assessing function and UPJ obstruction in neonate. Dialog Paediatr Urol 8: 6–8

Tanagho EA (1972) Surgically induced partial urinary obstruction in the fetal lamb. Invest Urol 10: 25–43

*Chapter 40*

# Hypospadias: the MAGPI Operation and Fistula Repair

*R. H. Whitaker*

## MAGPI Hypospadias Repair

### Introduction

There must be as many operations devised for the repair of hypospadias as there are variations in the anatomy of hypospadias itself. This suggests that none is perfect. The search continues for a single-stage operation that results in a straight, neat penis with a meatus on the glans that points forwards. The two operations popularised by Duckett (Duckett 1981a,b), namely the *MAGPI* and the *transverse preputial island flap* repair have gone a long way towards providing operations to cover most situations, unless previous operations have exhausted the supply of skin. The MAGPI (Meatal Advancement and Glanuloplasty) operation is extraordinarily simple and safe, and yet it achieves as much in terms of an effective reconstruction as almost any other operation for distal hypospadias.

### Selection of Patients

The MAGPI operation is designed primarily for boys with minor to moderate degrees of coronal or subcoronal hypospadias who have had no previous operations. Minimal chordee can be corrected effectively as part of the procedure, and boys with a short ventral penis are also suitable as dorsal skin can be transposed. The meatus can be several millimetres below the corona and still be advanced into the glans. A small meatus is no bar to the operation, as a dorsal meatotomy is part of the technique.

# Technique

## Principles and Timing

The operation aims to straighten the penis, advance the meatus into the glans, so that it points forwards, and to remove or use the foreskin so that the final appearance is tidy. It can be done at almost any age. Although some recommend that it is done between 12 and 18 months, we usually wait until the child is out of nappies at night (2–3 years), but this is not essential.

## Operation

The patient is anaesthetised and the genital area is thoroughly cleaned with a water-soluble skin preparation. At the same time the adhesions between the glans and foreskin are broken down. An injection of 5 ml of long-acting local anaesthetic (0.25% bupivacaine; Marcain) is given as a suprapubic nerve block. The area is then formally cleaned and draped.

A 3-0 black silk holding suture is placed in the dorsal aspect of the tip of the glans. A tourniquet is applied around the base of the penis and the corpora cavernosa are inflated with normal saline via a small butterfly needle (Fig. 40.1). Any chordee is easily detected by this method and the operation can be planned accordingly. It is surprising how often chordee is shown to be absent when it was suspected beforehand.

The tourniquet is then removed and firm pressure is applied to the site of puncture for 1 min to avoid a haematoma. A tourniquet for the actual operation is optional; it certainly helps to keep the area of dissection blood free but it is by no means essential. I do not use infiltration with adrenaline but this has been recommended (Duckett 1981b).

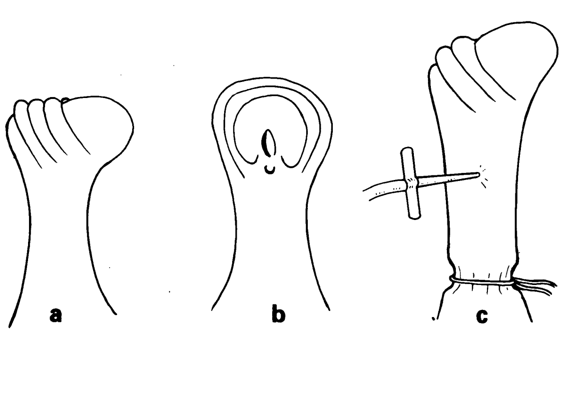



**Fig. 40.1a–c.** Detection or exclusion of chordee by injecting normal saline into the corpora cavernosa.

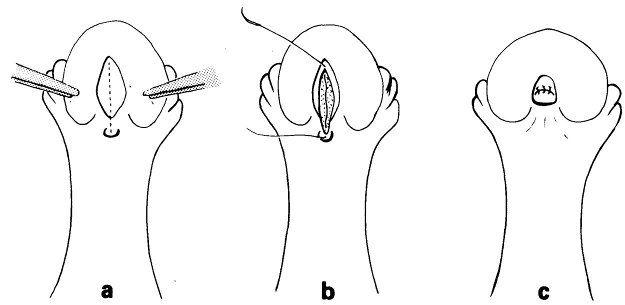



**Fig. 40.2.** Incision and repair of glans to advance the meatus.

The operation begins with the meatoplasty. With the help of an assistant and Adson's forceps, the glans is held apart and an incision is made between the dorsal edge of the meatus and its future site in the glans with sharp pointed scissors (Fig. 40.2). This needs to be a sufficiently deep incision so that the meatus advances freely; it is a common mistake to incise insufficiently deeply when first attempting this procedure. The dorsal edge of the meatus is then sutured to the distal edge of the incision in the glans with three 6-0 chromic catgut sutures. If the original meatus is narrow the incision in it is simply made deeper so that a wide edge of mucosa is advanced.

An incision is then made with a knife across the ventral side of the penile skin just below the meatus (Fig. 40.3a). Although this was originally described as a straight, transverse incision (Duckett 1981b), I find that an arrow-shaped incision allows better approximation in the next step (Fig. 40.3b). This incision must be made with extreme care as the floor of the urethra at this point may be exceedingly thin. On either side the incision is deepened and the skin is teased off the urethra in the midline. The skin over the proximal shaft of the penis is freed to allow easier approximation later. At this stage minimal chordee can be excised. The forward edges of the skin below the meatus are now sutured together with 6-0 chromic catgut, again being careful to avoid injury to the urethra (Fig. 40.3b). As these sutures are tied the glans rotates on a sagittal axis so that the meatus now points even further forwards (Fig. 40.3c,d). It also tends to bury itself into the glanular tissue, but this is not a problem.

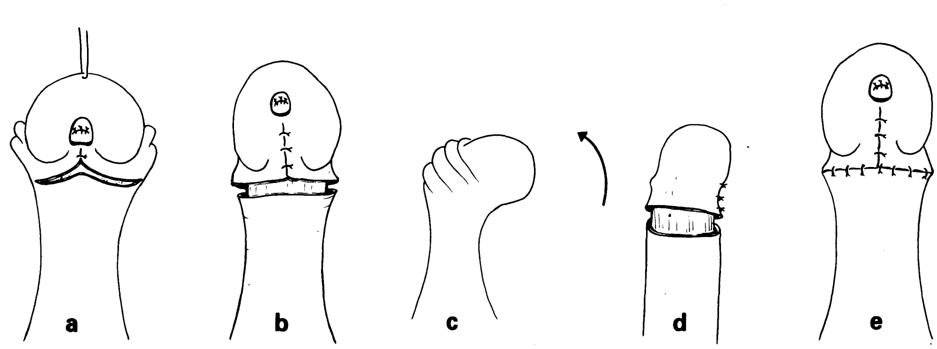



**Fig. 40.3.** **a** Arrow-shaped incision below meatus. **b** Approximation of skin edges below meatus. **c,d** Before (**c**) and after (**d**) the approximation of the skin edges, showing how the glans rotates sagittally to allow the meatus to point forwards. **e** Simple closure if there is enough skin.

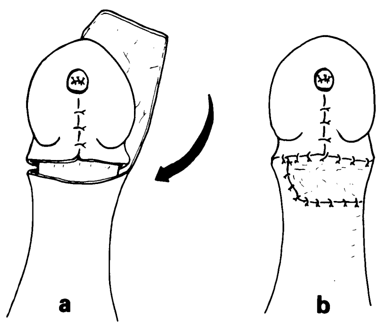



**Fig. 40.4a,b.** Half the dorsal hood providing extra skin on the ventral aspect.

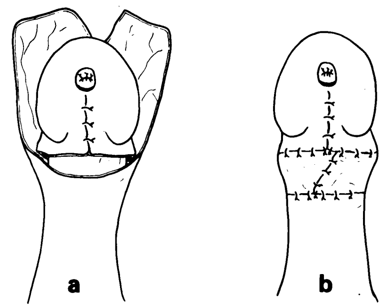



**Fig. 40.5a,b.** Split dorsal hood giving extra coverage on the ventral aspect.

It is possible to extend this suture line too far resulting in distortion of the tissues. Usually two to three sutures are all that are required.

At this stage it must be decided whether there is enough ventral skin to meet the newly constructed ventral aspect of the glans. If there is enough then the dorsal hood is excised and the closure is simple (Fig. 40.3e). If it is not a comfortable fit some skin must be transposed around from the dorsal side. Coverage can be achieved with a single flap from one side (Fig. 40.4) or smaller flaps from both sides (Fig. 40.5). There are advantages and disadvantages of each method, and the surgeon will usually develop a personal preference after trying each. My personal preference is for a single flap as it extends across the midline ventrally and avoids a midline suture line (Fig. 40.4).

The initial incision in any event is around the corona, leaving a 5 mm margin of mucosa which always retracts to less after the incision. The hood is opened up as a flat flap of skin and then either removed or incised as necessary. There is a tendency to leave too much dorsal skin, and to avoid this the correct level should be determined in relation to the proximal level of the glans before incision. The remainder of the skin edges are approximated with 6-0 chromic catgut.

If a tourniquet has been used it should have been removed after completion of the meatoplasty. Haemostasis is achieved throughout with pinpoint diathermy on a low coagulation level and with careful avoidance of penile stretching. If this has been accurate then there should be virtually no swelling at the end of the procedure and no dressing is required. A firm squeeze for 2–3 min whilst the child awakes is most helpful in avoiding swelling later. If the dissection has been extensive and there is appreciable swelling, a Silastic foam dressing (De Sy and Oosterlinck 1982) is best applied for 2–3 days (Fig. 40.6).

A catheter is probably not essential, and in many centres the operation is performed as a day-case (Duckett 1981b). However, we find that it is both convenient and expedient to pass a 6 FG infant feeding tube, using the glans stay suture to secure it, and leave it overnight. The tube comes out the next morning and the child goes home. This avoids the worry of whether he will void satisfactorily in the first 12 h. A Foley catheter should never be used as it is too large and potentially irritant.

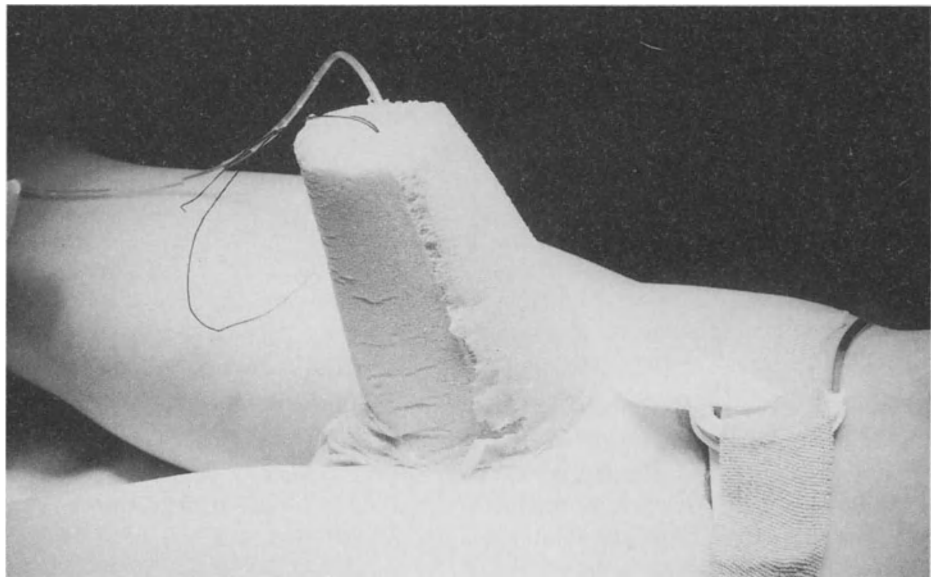


**Fig. 40.6.** Silastic foam dressing.

## Complications

Some swelling is inevitable but it is usually minimal. If a dressing is applied it needs to be soaked off in the bath after 48 h and its removal may be associated with some bleeding from the suture line—a good reason for avoiding a dressing if possible. If a dressing is necessary then a Silastic foam one is much the best (De Sy and Oosterlinck 1982). Infection is most unusual, but increasing redness or pus would indicate the need for antibiotics; they are not otherwise necessary as a routine. We have not encountered any boy who has experienced difficulty in voiding after removal of the catheter. Some spraying of the stream is common in the early postoperative stages but most unusual in the long term. Fistulae should not occur.

## Follow-up

We see the patients at 6 weeks, and if everything is satisfactory no further appointment is made unless the parents or general practitioner request it. If there is too much skin we are prepared to remove it at a later date, but this is unusual once one has gained the confidence to remove the correct amount on the first occasion.

## Results

The procedure gives a remarkably good-looking penis which is functionally normal. Follow-up so far has covered only a few years, but there is no reason to suspect problems at puberty or beyond.

## Conclusion

This is a splendid operation for the minor to moderate degrees of hypospadias in boys who have had no previous operations and can also be useful in some situations after previous surgery. It is simple and effective and requires a minimal hospital stay. The suprapubic nerve block with long-acting local anaesthetic allows at least 6 h of freedom from pain afterwards.

# Fistula Repair

## Introduction

There are few more depressing problems than a fistula after a careful hypospadias repair. Despite good technique by avoiding overlying suture lines and tension, and by respecting the blood supply with careful handling of the tissues and with the use of antibiotics, the rate of fistula formation for the complicated hypospadias repairs (excluding the MAGPI) is still in excess of 15% in most surgeons' hands, whilst less experienced surgeons may have a fistula rate far in excess of this. Depressing though they are, most fistulae can be closed; however, more than one operation may be needed in a few unfortunate boys. Causes of fistula other than hypospadias include trauma, urethral incision for stone or foreign body, urethrostomy drainage and stricture.

Fistulae come in all shapes and sizes. In the absence of distal obstruction, small ones can occasionally seal off spontaneously even months after the original urethral insult. Once the epithelial lining is established, however, the fistula usually stays open, and nearly always so in the presence of urethral obstruction distal to the hole. The amount of urine that appears from the fistula and terminal urethra during voiding is variable and depends on the size of the fistula and the adequacy of the urethra beyond. Some boys can cope temporarily by putting a finger over the hole during voiding, and this can be a useful trick.

Occasionally, the fistula is so large that only a small amount of new urethra is still present, perhaps as a narrow bridge. If this is the case it may be more expedient to remove this poor bit of urethra and start again.

## Principle and Timing

In order to keep the fistula closed the urethral mucosa must be approximated over the hole without tension and the urethra beyond must be of adequate calibre to allow free flow at a normal pressure. In addition, it is necessary to cover the area of urethral closure with healthy skin and its underlying tissues under no tension and without overlying suture lines.

Provided that adequate skin is still present from previous operations, these objectives are usually easy to achieve. If skin is not adequate then other more complex procedures are called for, such as temporarily burying the penis in the scrotum, swinging flaps of skin from the groin on vascular pedicles or performing a dorsal releasing incision which is left open to heal or be grafted. Such operations will not be discussed here. For success the skin around the fistula must be supple and well vascularised. This usually means leaving an interval of at least 6 months from the time of the original operation or the last attempt to close the defect. Social pressures for earlier closure should be firmly resisted.

## Technique

With the patient under a general anaesthetic the skin should be assiduously prepared as for a hypospadias operation. If necessary, chordee can be looked for by inflating the corpora, but it is unlikely that anything can be done about it at the same time. The urethra distal to the fistula or fistulae is assessed with probes or small sounds. If it is not adequate there is no point in going ahead with closure of the fistula, but instead an alternative technique is necessary such as dorsal internal urethrotomy. The management of a narrowed urethra distal to a hypospadias is outside the scope of this discussion.

The operation is then planned and, if necessary, the skin flap incisions can be marked with dye or ink. The site and extent of the skin flap to be lifted is determined by its looseness, vascularity and lack of scars. The flap is dissected with as much underlying subcutaneous tissue as possible and its base is kept as wide as is compatible with the need for mobility to cover the area in question (Fig. 40.7). The incision is extended around the fistula and the skin on the opposite side to the flap is mobilised widely. This allows plenty of room for the fistula closure and ensures that the flap is advanced well across the area of closure afterwards. With a size 6 or 8 FG infant feeding tube in the urethra the excess skin and epithelial lining of the fistula are removed but with as little underlying tissue as possible. After this there should be no epithelial tissue visible and it is then an easy matter to close the residual hole using 5-0 or 6-0 Vicryl or chromic catgut and with no epithelium in the stitch line. The closure can be continuous or interrupted but must not be under tension. With a distal fistula it is unusual to be able to place a second layer of sutures.

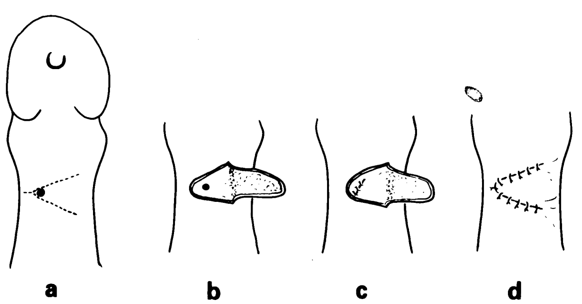



**Fig. 40.7a–d.** Y–V advancement of triangular skin flap over the closed fistula.

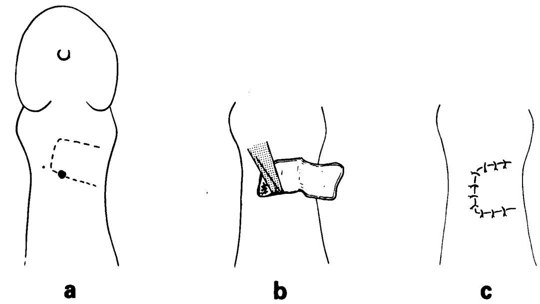



**Fig. 40.8a–c.** Alternative closure using a square skin flap.

The flap of skin is then laid over the defect so that the underlying suture line lies well under the flap. The skin is closed with 5-0 or 6-0 chromic catgut sutures. The same procedure is applied to other fistulae if there are more than one, but if they are near to each other a single flap may suffice. Alternatively, a flap may be rotated across the site of the fistula closure instead of the Y–V plasty described above (Fig. 40.8). A dressing is usually unnecessary, but if there is a worry that the child may pick at the wound or if the dissection has been extensive then a Silastic foam dressing can be applied for 4–6 days.

It is controversial as to whether a catheter is necessary. I usually avoid one if at all possible and certainly do not use one in a simple closure of a small fistula where I am certain that the distal urethra is wide. Irritation and the risk of pressure necrosis is thus avoided. If a foam dressing is applied or the dissection of flaps has been extensive then an infant feeding tube should be left in for a few days and the need for a suprapubic catheter considered. I only use a suprapubic catheter (Cystofix-Braun Melsungen) if previous attempts at closure have failed and I would then leave it in for 2 weeks.

As the skin is closed with chromic catgut there are no sutures to be removed. Patients can usually go home the following day even if they have foam dressings or suprapubic catheters, provided that the parents are shown how to look after them. Foam dressings should probably not be left on for more than 6 days because of the risk of infection going undetected. If a suprapubic catheter was deemed necessary then it is worth leaving it in for 2 weeks to allow firm healing. Antibiotics are not used routinely.

## Follow-up

Patients are reviewed at 6 weeks and again at 6 months to make sure that the stream is adequate. If there has been a break down of the repair with fistula formation an interval of at least 6 months should elapse before a further attempt is made.

## References

De Sy WA, Oosterlinck W (1982) Silicone foam elastomer: a significant improvement in postoperative penile dressing. J Urol 128: 39–40

Duckett JW (1981a) The island flap technique for hypospadias repair. Urol Clin North Am 8: 503–511

Duckett JW (1981b) MAGPI (Meatoplasty and Glanuloplasty). A procedure for subcoronal hypospadias. Urol Clin North Am 8: 513–519

*Chapter 41*

# Reimplantation—Which Child?

*J. J. Corkery*

## Reflux Nephropathy

The clinical and pathological significance of vesicoureteric reflux (VUR) lies mainly in its association with reflux nephropathy (RN). RN develops as a result of infection ascending from the urethra via the bladder and an incompetent ureterovesical valve to the renal pelvis; access to the renal parenchyma is via the collecting tubules. In the presence of intrarenal reflux (IRR) this access is greatly facilitated. There is both experimental (Ransley and Risdon 1978) and clinical (Rolleston et al. 1974) evidence to support the view that IRR is important in the pathogenesis of RN. It is particularly noteworthy that the scars of RN occur predominantly in those parts of the kidney where compound refluxing papillae are usually found. Furthermore, it is common clinical experience that new scars are rarely seen to develop in children over the age of 5 years, the age beyond which IRR is not seen (Rolleston et al. 1974). This would seem to imply that once the "at risk" refluxing papillae have been damaged by the initial infection the remainder of that kidney is at very low risk of being scarred by further infection, even in the presence of persistent VUR.

There is a notable lack of evidence to support the view that sterile VUR can damage the kidney. Certainly in the experimental model renal scarring can be produced by sterile reflux, but only at very high pressure (Ransley et al. 1984). Such sustained pressures do not occur in these children clinically. In the refluxing child with a stable bladder the kidneys are exposed to abnormally high pressure only during micturition. It is difficult to imagine how such brief intermittent high-pressure episodes could result in significant renal damage in the short term. On the other hand, occurring as they do several times a day for 5, 10 or 15 years, it is not beyond the realms of possibility that they might eventually produce some damage.

A few children with VUR suffer from flank and loin pain comparable in severity with ureteric colic. A greater number suffer from longstanding loin discomfort, especially at micturition. Such symptoms are abolished by successful reimplant. Pain and discomfort are nature's way of alerting us to damage in the body. It would be imprudent to disregard such symptoms as of no significance, just because their significance is not at present understood.

The extent to which total renal function is affected in RN is closely related to the extent of renal scarring and the presence or absence of compensatory hypertrophy in the remaining unscarred areas of kidney. The extent of damage is infinitely variable, depending on whether one or both kidneys are affected and whether the process is focal and isolated, or generalised.

Long-term follow-up (mean 13 years; Wallace et al. 1978) has shown that in cases with unilateral RN 11.3% will develop significant hypertension. If the disease is bilateral the incidence rises to 18.5%.

Although the majority of children with VUR and RN who are treated thrive and grow into adulthood, and although 80% of them will experience spontaneous cure of their VUR by that time (if not already abolished by operation), "reflux nephropathy is not a benign disorder in adults" (Kincaid-Smith et al. 1984). Kincaid-Smith reports (Kincaid-Smith et al. 1984) that in a 10-year period, of 145 patients aged 14–65 years who presented with RN, 7 deteriorated to end-stage renal failure (ESRF). The most useful predictive sign of impending renal failure was the development of proteinuria. Once this appears, ESRF will supervene within 5–10 years.

The development of proteinuria indicates the emergence of a glomerular lesion. That this glomerulopathy may develop in the contralateral non-refluxing normal kidney in a case of unilateral VUR is particularly worrying (Bailey et al. 1984). There is more to VUR than meets the eye!

Women with impaired renal function caused by RN run a real risk in becoming pregnant. The onset of ESRF may be greatly accelerated, occurring either during pregnancy or shortly thereafter (Kincaid-Smith et al. 1984).

## Vesicoureteric Reflux

There are varying degrees and many descriptive classifications of VUR. In the Birmingham Children's Hospital the following system is used –

| | |
|---|---|
| VUR grade I | Into the lower ureter |
| VUR grade II | Filling but not distending the pelvicalyceal system |
| VUR grade III | Filling and distending the pelvicalyceal system |

Primary VUR is due to a congenital deformity of the vesicoureteric junction. Most commonly this defect consists of an abnormally short tunnel where the ureter traverses the detrusor muscle. With general growth of the child there is also growth of the intramural ureter so that what initially was an incompetent valve may well become an effective antireflux mechanism with the passage of time. Indeed, 80% of primary refluxing ureters in children become non-refluxing by the time they reach adulthood (Smellie et al. 1975). This spontaneous cure rate is not affected by the frequency or otherwise of recurrent urinary infections (Mulcahy and Kelalis 1978).

On the other hand, the incidence of persistent VUR in the non-operated group in the Birmingham series 5 years after diagnosis is 50%. Only 20% of ureters in children over the age of 6 years, and with bilateral grade III VUR at diagnosis, have stopped refluxing after 5 years' observation (Birmingham Reflux Study Group 1987).

It seems reasonable to suppose that the appearance of the ureteric orifice at cystoscopy would be helpful in assessing the likelihood of resolution of VUR. If the orifice is grossly abnormal, gaping and without a tunnel, one can confidently predict that resolution will not occur within 5 years. However, in the commoner, less abnormal-looking orifices cystoscopy is of less value. Even in experienced hands there is a poor correlation between the prediction of cessation of VUR and orifice assessment (Bellinger and Duckett 1984).

### Bladder in VUR

Bladder instability is a common finding in association with VUR. A history of urgency of micturition and, especially, urge incontinence in a child with VUR is almost pathognomonic of detrusor instability. Taylor et al. (1982) were able to demonstrate a lack of any significant correlation between bladder instability and RN in VUR. Furthermore, it was not possible to demonstrate, over a 2-year period, that untreated instability adversely affected the spontaneous cure rate of VUR as compared with stable controls. However, Koff and Murtagh (1984), in a more prolonged study (1.5–7 years with a mean of 3.9 years in those with persistent VUR), demonstrated a significant improvement in the resolution rate of VUR when the unstable bladders were treated diligently with bladder drill and anticholinergics.

There is a poorly documented impression among surgeons that a successful ureteric reimplant for VUR occasionally relieves the symptoms of instability. Why this should be the case is not clear and it needs to be studied more closely. By the same token it is a very foolish surgeon indeed who promises his patient that her symptoms of instability will be cured by a reimplant! In most cases there will be no change.

## Need for Treatment

In a study of RN in children in South Brazil Goldraich et al. (1984) have demonstrated that, untreated, the disease is progressive. In their patients the diagnosis was invariably late, with the result that the majority had suffered recurrent symptomatic infections by the time of diagnosis. Analysis showed that whereas in patients under 2 years old at diagnosis the incidence of renal scarring was 28.3%, in those aged 6 years it was 53.7%. Once treatment with continuous low-dosage prophylactic chemotherapy was instituted this progressive trend was halted.

However, another study (Verrier Jones et al. 1984) concludes that "prolonged urinary tract infection (UTI) was not associated with a reduction of glomerular filtration rate in girls after age 4 years and no benefit from intermittent antibiotic treatment was shown". This was a study of covert, asymptomatic infection diagnosed by bacterial colony counts without any importance being attached to the presence or absence of pus cells in the urine. And herein lies part of the problem.

Unfortunately, it has become fashionable, especially in paediatric nephrology circles, almost completely to disregard symptoms and pus cells in the urine in studies of RN. The clinical diagnosis of acute pyelonephritis is still a valid one. The signs and symptoms are very familiar to general practitioners, casualty officers, general paediatricians and surgeons—the doctors who usually see most of these children in their presenting acute illness. The diagnosis is confirmed by finding organisms and pus cells aplenty in the urine. To label such an illness "UTI" and equate it in any way, but in particular in terms of its pathological significance to the kidney, with a so-called UTI diagnosed on the basis of totally asymptomatic bacteriuria is surely mistaken.

Recurrent attacks of acute pyelonephritis also occur. Each attack produces a febrile illness which is acutely debilitating and produces real morbidity in terms of loss of feeling of wellbeing, quite apart from any damage it might be doing to the kidneys. Symptoms are important!

It stands to reason, and there is experimental evidence (Ransley and Risdon 1981) to support the view, that if the appropriate antibiotic is given in the very early stages of acute parenchymal infection of the kidney permanent tissue damage can be completely aborted. This has important implications for the urgency with which it is necessary to treat every case of childhood acute pyelonephritis, but especially the first presenting attack. Over the years it has become overwhelmingly clear that the first kidney infection is the one that results in the most damage. No sensible doctor would delay instituting effective antibiotic treatment for meningitis or osteomyelitis. Acute pyelonephritis must be thought of in the same league.

## Treatment

Essentially, there are two modes of treatment of VUR, namely operative and non-operative. It is misleading to refer to these as "operative" and "conservative". There is nothing conservative about a mode of treatment which involves a 2-year old girl in taking antibiotics daily and attending the doctor regularly for maybe 3 years or more.

Non-operative treatment consists of low-dose continuous prophylactic chemotherapy. Equally important it includes continual medical supervision by someone who is willing and able to induce compliance with such a regime. Additionally, bladder drill and anticholinergics are useful adjuncts in patients with detrusor instability.

The treatment is continued throughout the period of risk with regular monitoring of the urine and renal function. Once the reflux can be seen to have resolved, the antibiotics can be stopped. At this stage those children without evidence of RN can be discharged from medical supervision. Those with RN will need continued medical supervision, albeit perhaps at infrequent intervals depending on the severity of the kidney involvement. Some will need such supervision because of impaired renal function; all will need it for annual blood pressure monitoring. Furthermore, since it has now become clear that a proportion of such patients will at some stage, even in the apparently normal kidney, develop a glomerulopathy which heralds ESRF within 5–10 years, all will need regular monitoring for the development of proteinuria.

For those in whom the reflux persists, is there a point at which the risk of development of RN abates? The general consensus appears to be that after the age of 5 years the risk of new scarring developing as the result of VUR is absolutely minimal. The relationship between persistent reflux and the subsequent development of glomerulopathy is a completely unknown quantity at the moment.

Operative treatment consists of an antireflux procedure, the details of which are the subject of the next chapter. In practised hands the technical results of the open operation are uniformly good, and even in dilated ureters the success rate in abolishing the reflux without producing ureteric obstruction exceeds 95%. The less invasive sub-ureteric Teflon injection technique of O'Donnell and Puri (1984) is attended by slightly less success but shows great promise. As in the other groups, once the reflux has been abolished, and if there is no evidence of established RN, the child can be discharged from medical care. However, if there is RN, subsequent follow-up must be as in the non-operated group.

## Which Treatment for Which Child?

Since July 1975 the Birmingham Reflux Study Group has been conducting a prospective randomised trial of operative versus non-operative treatment of severe VUR. When 96 children had completed 2 years' observation following entry to the trial the first formal assessment of the results was made and reported (Birmingham Reflux Study Group 1983). Using the following parameters there was no significant difference in the results of the two groups:

1. Height
2. Weight

3. Blood pressure
4. Incidence of breakthrough UTI
5. New scar formation
6. Progression of existing scars
7. Renal growth
8. Total renal excretory function

Already 104 children (145 ureters) have reached the 5-year assessment point and no clear difference has yet emerged between the two groups (Birmingham Reflux Study Group 1987). In the non-operative group, of those ureters with grade III VUR at entry, 49% were unchanged at 5 years, while a further 20% had only improved to grade II, still a significant degree of reflux (Table 41.1).

**Table 41.1.** Changes in VUR grade after 5 years' non-operative treatment

| VUR grade | | Ureters |
|---|---|---|
| Grade III at allocation | | 75 |
| Outcome grade: | III | 37 (49%) |
| | II | 15 (20%) |
| | I | 11 (15%) |
| | 0 | 12 (16%) |

How is one to choose the appropriate treatment for a particular child? Children with grade I VUR require no active treatment. Spontaneous cure with growth can be confidently awaited.

Most cases of grade II VUR have no reflux nephropathy and go on to spontaneous cure. While awaiting that happy outcome chemoprophylaxis is essential until the child is 5 years old. Operation is rarely indicated but it may be the prudent choice in the child under 5 years of age if the parents do not comply with prescribed medical treatment. In the older child, if recurrent symptomatic acute pyelonephritis becomes a problem, there is little to choose between the two forms of treatment.

In those with grade III VUR treatment by operation has the great advantage that 6 months after the procedure, when a check cystogram has demonstrated that the reflux has been cured in over 95% of ureters, antibiotic prophylaxis can be discontinued. The nagging worry that persistent marked reflux over the course of years may cause some further renal damage, as yet undefined, is also alleviated. The risk of subsequent symptomatic ascending acute pyelonephritis is virtually abolished. And all this can be achieved during an inpatient stay of 8–14 days (depending upon the extent of any ureter tapering involved), during which there is only significant physical discomfort to the child for 3 or 4 days in the great majority of cases.

Some parents react with horror to the thought of an operation on their child. The facts need to be put to them in as balanced a fashion as possible. In particular they need to be reassured that non-operative treatment is almost as good as operative. Its only disadvantages are the need for prolonged antibiotic intake and the fact that 50% at least of the ureters will still retain their gross reflux even after 5 years' treatment, the pathological significance of which remains entirely speculative.

There is a tiny but important minority of patients with severe reflux who experience severe loin or iliac fossa pain. Others experience significant discomfort short of pain, especially at micturition. Operation is the treatment of choice in such patients.

The evidence of others (Weston et al. 1982) in adult patients confirms my own experience in children that the surgical correction of VUR in patients with chronic renal failure caused by RN does nothing to delay the emergence of ESRF.

## Conclusion

Vesicoureteric reflux is common in childhood. It is mainly of significance insofar as it is frequently associated with kidney damage. It has been estimated that the chance of any one patient with RN progressing to ESRF is 1 in 1000 (Kincaid-Smith 1984).

The recent definition of a glomerulopathy developing late in apparently stable patients with RN has helped to highlight once again the fact that we continue to walk on shifting sands. Much is known but there is more to learn. Close collaboration between urologists and nephrologists remains the key to progress, and each child with significant VUR should have the benefit of an opinion from both specialists before being committed to any particular treatment regime.

*Acknowledgements*. Although the views expressed in this chapter are my own, in formulating them over the years I have drawn heavily on the experience of the other members of the Birmingham Reflux Study Group: R. H. R. White, M. H. Winterborn, C. M. Taylor, R. C. Clark, R. Astley, K. J. Shah and P. Gornall. I also record my particular gratitude to Miss Karen Day for her expert typing assistance.

## References

Bailey RR, Swainson CP, Lynn KL, Burry AF (1984) Glomerular lesions in the "normal" kidney in patients with unilateral reflux nephropathy. Contrib Nephrol 39: 126–131

Bellinger MF, Duckett JW (1984) Vesicoureteral reflux: a comparison of non-surgical and surgical management. Contrib Nephrol 39: 81–93

Birmingham Reflux Study Group (1983) Prospective trial of operative versus non-operative treatment of severe vesicoureteric reflux: two years' observation in 96 children. Br Med J 287: 171–174

Birmingham Reflux Study Group (1987) Prospective trial of operative versus non-operative treatment of severe vesicoureteric reflux in children: five years' observation. Br Med J 295: 237–241

Goldraich NP, Goldraich IH, Anselmi OE, Ramos OL (1984) Reflux nephropathy: the clinical picture in South Brazilian children. Contrib Nephrol 39: 52–67

Kincaid-Smith P (1984) Closing Remarks. Contrib Nephrol 39: 376–377

Kincaid-Smith PS, Bastos MG, Becker GJ (1984) Reflux nephropathy in the adult. Contrib Nephrol 39: 94–101

Koff SA, Murtagh D (1984) The uninhibited bladder in children: effect of treatment on vesicoureteral reflux resolution. Contrib Nephrol 39: 211–220

Mulcahy JJ, Kelalis PP (1978) Non-operative treatment of vesicoureteric reflux. J Urol 120: 336

O'Donnell B, Puri P (1986) Endoscopic correction of primary vesico-ureteric reflux: results in 94 ureters. Br Med J 293: 1404–1406

Ransley PG, Risdon RA (1978) Reflux and renal scarring. Br J Radiol 51 [Suppl 14]: 1–35

Ransley PG, Risdon RA (1981) Reflux nephropathy: effects of antimicrobial therapy on the evolution of the early pyelonephritis scar. Kidney Int 20: 733–742

Ransley PG, Risdon RA, Godley ML (1984) High pressure sterile vesicoureteral reflux and renal scarring: an experimental study in the pig and minipig. Contrib Nephrol 39: 320–343

Rolleston GL, Maling TMJ, Hodson CJ (1974) Intra renal reflux and the scarred kidney. Arch Dis Child 49: 531–539

Smellie J, Edwards D, Hunter N, Normad ICS, Prescod N (1975) Vesicoureteric reflux and renal scarring. Kidney Int. 8[Suppl 4]: S65–S72

Taylor CM, Corkery JJ, White RHR (1982) Micturition symptoms and unstable bladder activity in girls with primary vesicoureteric reflux. Br J Urol 54: 494–498

Verrier Jones K, Asscher W, Verrier Jones R et al. (1984) Renal functional changes in schoolgirls with covert asymptomatic bacteriuria. Contrib Nephrol 39: 152–163

Wallace DMA, Rothwell DL, Williams DI (1978) The Long term follow up of surgically treated vesicoureteric reflux. Br J Urol 50: 479–484

Weston PMT, Stone AR, Bary PR, Leopold D, Stephenson TP (1982) The results of reflux prevention in adults with reflux nephropathy. Br J Urol 54: 677–681

*Chapter 42*

# Reimplantation—Which Operation?

*R. H. Whitaker*

## Introduction

No two surgeons who deal with paediatric urology would agree on the exact indications for operating on a refluxing ureter, and some of the arguments for and against are discussed in the preceding chapter, "Reimplantation—Which Child?" The fact that carefully controlled trials have shown no significant difference between a successful operation and a non-operative approach to reflux emphasises the narrow margins between the two approaches (Birmingham Reflux Study Group 1983). If an operation has so little, if anything, to offer when compared with a non-operative approach it is clear that there is no place at all for an unreliable operation. Thus, unless the surgeon can guarantee a 95%–98% success rate for simple reflux, he or she should not be performing such operations. Reimplanting ureters in children should be restricted to those who perform it regularly and well, and throughout the discussion that follows a high degree of surgical competence is assumed. The reimplanting of obstructed ureters is outside the scope of this discussion.

## Indications

Since it remains debatable whether the natural history of reflux is influenced to any extent by reimplanting the ureter, the decision to reimplant is inevitably a question of personal preference. I use the following criteria:

*Absolute*

1. Failed medical treatment resulting from non-compliance, break-through infections or inability to tolerate antibiotics.

2. The presence of intrarenal reflux where early operation has at least some prospect of preventing scarring.
3. The unlikelihood of spontaneous cessation as in certain duplications, paraureteric diverticula, ectopic ureteroceles, previous failed reimplants or from cystoscopic evidence of a short submucosal tunnel.
4. Excessive ballooning of the renal pelvis suggestive of secondary pelviureteric obstruction.

*Relative*

5. Gross reflux in early childhood.
6. Reflux continuing at puberty.
7. The desire by surgeon or parents to sort out the problem at an early stage, to avoid repeated consultations and uncomfortable investigations.

## Preoperative Assessment

Reimplantation of a refluxing ureter is not an operation which needs to be carried out with any degree of urgency so there is time to make sure that the child is as fit as possible. In particular, infection in the urine and other intercurrent infections should be treated vigorously. The urine should ideally be kept sterile for at least a month preoperatively. If reflux has not been documented radiologically in recent months, a repeat cystogram should be performed, whilst renal scarring is best shown on a dimercaptosuccinic acid (DMSA) renal scan.

## Choice of Operation

The exact procedure to be undertaken depends on a number of factors, which include the size of the ureter, its intrinsic motility, the thickness of the bladder wall, the bladder capacity, the presence of diverticula, duplications or ureteroceles and the occurrence of previous lower ureteric surgery. In most centres throughout the western world the previously popular Politano–Leadbetter technique (Politano and Leadbetter 1958) has largely been superseded by the Cohen operation (Cohen 1977), which provides a solution for all but a few situations. The principles of a good reimplant may be summarised as follows:

1. An adequate length of submucosal tunnel within the bladder (a ratio of ureteric diameter to length of tunnel of at least 1:4).
2. Adequate stabilisation of the ureterovesical junction and the ureter immediately above it by choosing to reimplant in the relatively

immobile part of the bladder or deliberately immobilising the relevant part of the bladder with a procedure such as the psoas hitch.
3. Avoidance of kinks, bends or tightness at the point of entry of the ureter into the bladder.
4. Preservation of the blood supply to the lower ureter.

The Cohen operation fulfils these criteria in the vast majority of refluxing ureters and has been shown to be reliable and applicable to most situations. It obviates the need to dissect the ureter outside the bladder and is free of the complications of the Politano–Leadbetter operation which include the risk of kinking the ureter and damaging the peritoneum or its contents. Because the operation can be performed entirely intravesically, there is less postoperative ileus, less perivesical drainage and more rapid recovery.

## Cohen Reimplant

As with all delicate procedures attention to detail is of utmost importance. The bladder is exposed via a Pfannenstiel incision and opened between stay sutures. A Denis Browne ring retractor is used with the claws positioned in the bladder. The length of the submucosal tunnel to the refluxing ureter is assessed with a probe and a size 4 or 6 FG infant feeding tube is inserted up the ureter to the kidney; in an infant the orifice may only take a small epidural catheter. A 3-0 catgut stay suture is then placed deeply under the orifice; if it is inserted too superficially it will easily cut out. It is unnecessary to use this suture to anchor the feeding tube in place.

An assistant holds the stay suture whilst an incision is made in the mucosa around the orifice with fine-pointed, curved scissors (Fig. 42.1). The radius of this mucosal flange should be at least 5 mm as it tends to shrink. The trigonal muscle is then cut a little at a time until the clear bloodless plane between the ureter and the bladder muscle is encountered. This plane is developed all around the ureter and the bladder muscle cut to release the ureter completely. There may be a few remaining strands of muscle and fibrous connections which need division to allow the ureter to be pulled easily in and out through the muscle hiatus (Fig. 42.2).

In wider ureters there may be ureteric blood vessels that form a "mesentry" and seem to be keeping the ureter from moving freely through the bladder wall. These vessels should be preserved. If, because of these vessels, there is insufficient length of ureter to obtain a satisfactory submucosal tunnel, it will be necessary to free the ureter outside the bladder.

After the ureteric dissection there may be a wide hiatus in the muscle. It is only rarely necessary to repair this, and great care must be taken to avoid narrowing it excessively; the ureter should be a loose fit at its entry site into the bladder wall.

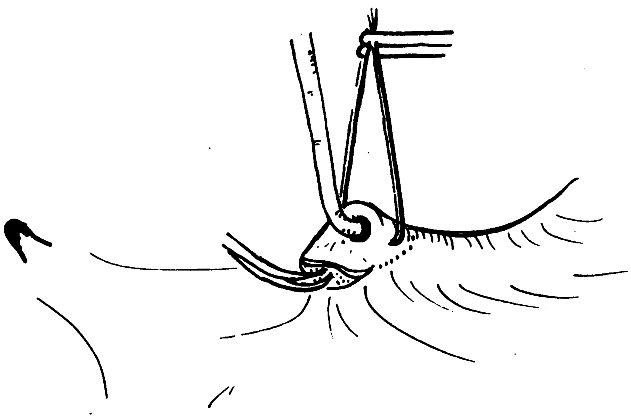


**Fig. 42.1.** An incision is made below the ureter and extended around.

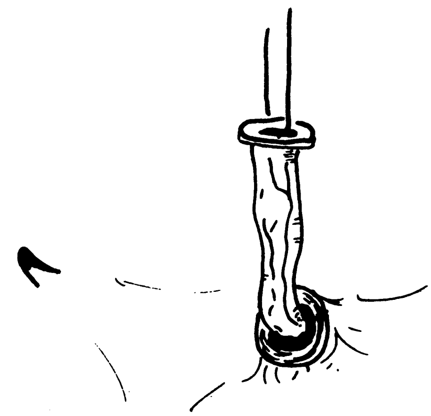


**Fig. 42.2.** The ureter is freed from the edges of the hiatus.

The submucosal tunnel is then dissected with Potts' scissors as long as necessary to give the required ratio of length to ureteric diameter (Fig. 42.3). If the reimplant is bilateral the narrower ureter should be put into the dissected hiatus of the opposite ureter and the wider one into a new position above and lateral to the previous site of the contralateral orifice. Great care is needed to avoid tearing the mucosa as the tunnel is dissected, but the tunnel must be wide enough to allow the ureter to be pulled through easily by traction on the stay suture (Fig. 42.4).

The orientation of the ureter within the tunnel is checked to avoid twisting and the mucosal flange is anchored by deep sutures to the mucosa and muscle of the new hiatus (Fig. 42.5). By leaving such a flange of mucosa it is possible to avoid sutures being placed too near the ureteric orifice. Chromic catgut (4-0) is ideal for this anastomosis and also for the repair of the mucosa at the original orifice, where the sutures are placed to give the longest effective tunnel. The distal end of the ureter only needs to be excised if it is abnormally narrow or has been shown to be obstructed.

If the lower ureter is too wide for a mucosal tunnel it can be narrowed by a simple "keeling" technique, as described by Starr (1979). I have

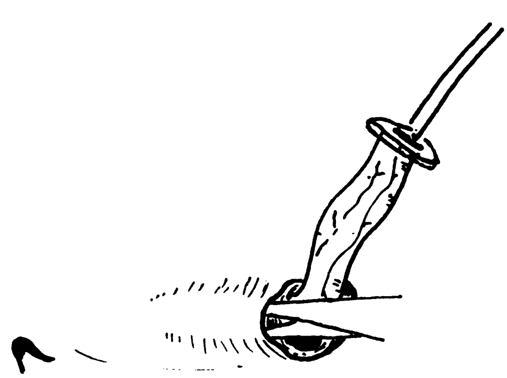


**Fig. 42.3.** A submucosal tunnel is developed.

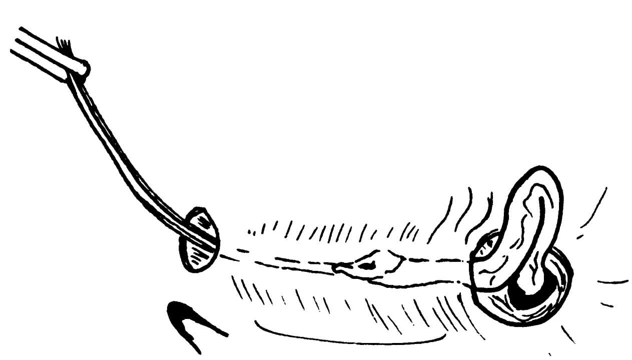


**Fig. 42.4.** The ureter is pulled through the submucosal tunnel.

**Fig. 42.5.** The position of the ureteric orifices after a bilateral Cohen reimplantation.

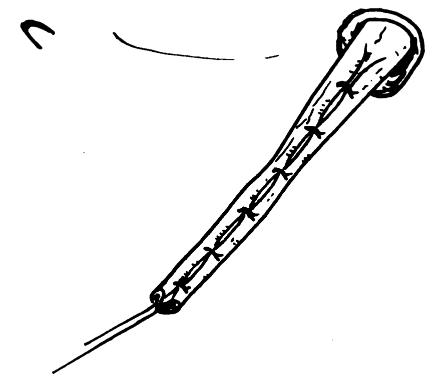


**Fig. 42.6.** The Starr method of ureteric "keeling".

found this method of tapering to be simpler than other techniques and less likely to damage the ureteric blood supply (Fig. 42.6). For ureters that are not being narrowed or tapered by any means, there is no need to leave a splint in the ureter. Indeed, it should be avoided if at all possible as it is just one more factor to complicate the operation if the tube blocks.

The bladder is closed in two layers with 2-0 chromic catgut, taking small bites of the mucosa and larger bites of the muscle in the first layer and using the second layer simply as a reinforcement. The rectus muscle is approximated with chromic catgut and the sheath with catgut or polydioxanone (PDS). A fat suture may be necessary and the skin can be closed with subcuticular polyglycolic acid (Dexon).

Although some surgeons now omit a bladder drainage tube of any type, I believe that the patient is more comfortable with drainage for 3–4 days. In boys a suprapubic Malecot catheter is perfectly satisfactory, whilst in girls a urethral catheter is well tolerated.

## Other Reimplants

Occasionally, it may be appropriate to consider an alternative form of reimplant. For instance, after the dissection of a large ureterocele from the base of the bladder there may be insufficient room for a Cohen procedure. After a previous failed reimplant there may not be enough length of lower ureter for this type of advancement procedure. In either situation, the ureter can be dissected outside the bladder as extensively as necessary and a Politano–Leadbetter type of reimplant performed with or without fixation of the bladder to stabilise the length of the submucosal tunnel.

If such a procedure is bilateral and fixation of the bladder is necessary, then it is a good plan to dissect the peritoneum from the dome of the bladder and bring one ureter over to join its fellow to run down parallel to each other on the side of the bladder fixation. An alternative is a transuretero-ureterostomy with reimplantation of the single ureter. As well as the problems mentioned earlier, the Politano–Leadbetter reimplant, if incorrectly performed, can cause the ureter to kink when the bladder is full. Ways of avoiding such kinks are discussed by Turner-Warwick (see p. 487).

## Postoperative Management

The retropubic drain is removed as soon as it ceases draining, usually after 2–3 days. The catheter may be removed when the urine is clear of blood, which is usually on the third or fourth day. As the wound is sutured with subcuticular Dexon there are no sutures to be removed. Bladder spasms can be controlled by oxybutynin chloride 3 mg, three times per day.

The parents and the patients should be warned that frequency and urgency of voiding usually occur for 2–3 weeks after the operation. We give an antibiotic, such as trimethoprim, in a small dose, routinely for a month and thereafter check the urine for infection regularly or as dictated by symptoms.

## Follow-up

Ultrasound examination of the kidneys at 1 month is wise to check for untoward dilatation. A micturating cystogram is necessary at 6 months to assess the success of the operation, and at that stage some appraisal of renal integrity is needed such as an intravenous urogram or diethylene triamine pentacetic acid (DTPA) scan. If all is well at this stage there is probably little need for further X-ray studies. If there is any renal scarring, the patient's blood pressure should be measured at least once a year and kept under observation for an indefinite period.

## Summary

A successful reimplantation of the ureter cures the underlying problem of reflux or obstruction. In the child with reflux, it allows antibiotics to be stopped and the child to have fewer X-ray studies and outpatient appointments. In the child with intrarenal reflux whose kidneys have not yet scarred it is possible that the reimplant may actually prevent the onset of scarring and thus change the natural history of the disease. Finally, there is often an indefinable improvement in the general wellbeing of children who are seen a few months after a successful reimplant. They have gained weight, improved their appetite and seem generally fitter.

## References

Birmingham Reflux Study Group (1983) Prospective trial of operative versus non-operative treatment of severe vesicoureteric reflux: two years' observation in 96 children. Br Med J 287: 171–174

Cohen SJ (1977) The Cohen reimplantation technique. Birth Defects 13: 391–395

Politano VA, Leadbetter WF (1958) An operative technique for the correction of vesicoureteral reflux. J Urol 79: 932–941

Starr A (1979) Ureteral plication. A new concept in ureteral tailoring for megaureter. Invest Urol 17: 153–158

*Chapter 43*

# Surgery for Virilising Congenital Adrenal Hyperplasia

*R. H. Whitaker*

## Introduction

Female pseudohermaphrodites with virilising congenital adrenal hyperplasia (CAH) have a normal female 46XX karyotype with normal development of ovaries, uterus and upper vagina. However, the degree of virilisation of the external genitalia in utero is extremely variable, ranging from an almost normal cryptorchid male appearance to a slightly enlarged clitoris and fused labia. The most common biochemical anomaly is 21-hydroxylase deficiency, which is inherited as a recessive disorder and associated with salt loss in approximately half the patients.

Virilisation is caused by excessive prenatal production of adrenal androgens. This occurs because the block in cortisol biosynthesis activates the feedback pathway with excessive secretion of adrenocorticotropic hormone (ACTH). The diagnosis is confirmed by demonstrating a normal female karyotype and the characteristic plasma steroid pattern with gross elevation of 17-alpha-hydroxyprogesterone. Treatment is commenced with cortisol and, if there is salt loss, also with mineralocorticoids and salt.

## Anatomy

The two extremes of anatomical variation are shown in Fig. 43.1. In the least virilised type there is a small urogenital sinus with the urethra opening either in a normal or slightly hypospadiac position; the vagina

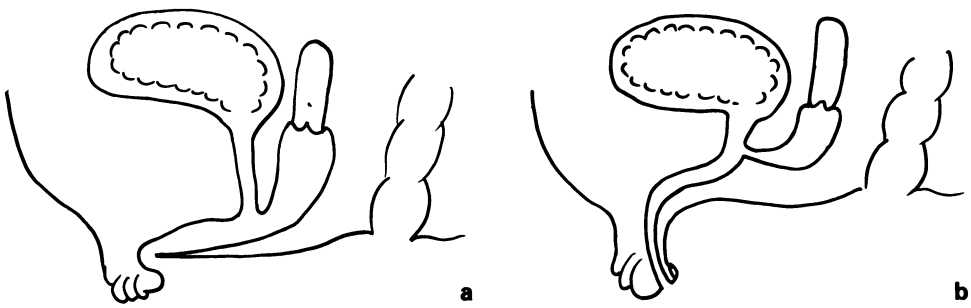



**Fig. 43.1.** **a** Less virilised form of anomaly. **b** More severe form of anomaly with vagina entering the posterior urethra.

extends down to the urogenital sinus and is easily accessible surgically. The most virilised children have a small upper vagina only, either opening through into the posterior urethra via a slit-like orifice, or occasionally fully separate from it. The vagina is then difficult to locate surgically and even more difficult to reconstruct. The anatomy in most children is transitional between these two extremes.

## Preoperative Investigations

X-ray films taken after injection of contrast medium into the sinus, or common opening, can be most helpful; in most cases they give a clear indication of the anatomy but in children with severe virilisation they may fail to show a connection with the vagina. Fortunately, this opening can usually be found by a careful cystoscopy, which in any case is a useful investigation before commencing surgical correction. An ultrasound scan of the pelvis with the bladder full can confirm the presence of ovaries and uterus. Laparotomy should not be needed if all the biochemical investigations indicate CAH.

## Surgical Management

### Timing and Preoperative Management

There is no ideal age for this operation. There are obvious psychological and social advantages in correcting the appearances early, for instance before the age of 1 year, but undoubtedly the operation is technically easier in the older child. We have tended to operate between 18 months and 2 years and have found this satisfactory. The child should be in biochemical equilibrium before surgery. Extra parenteral hydrocortisone is essential to cover the operation and early postoperative period. Careful monitoring is needed, particularly for salt loss and hypotension.

## Reconstruction

The aims of surgery are to reduce the phallus to a more reasonably sized clitoris, to expose the urethra and to open the vagina directly to the perineum. The operation is performed with the child in the lithotomy position. The simplest form (Fig 43.1a) with the least virilisation requires little more than a cut back to separate the labia and expose the urethra and lower vagina. The phallus is then reduced as described below. In the severer forms (Fig. 43.1b) the most satisfactory approach is via a posteriorly based flap (Fig. 43.2a). The sinus is opened backwards until the urethra is seen in a near normal or hypospadiac position (Fig. 43.2b,c). The incision is then extended backwards into the lower vagina until its widest part is reached. The posterior skin flap is then sutured into the posterior and lateral aspects of the lower vagina with 4-0 Dexon (Fig. 43.2d).

In the most severely virilised types it is worth identifying the small vagina endoscopically and feeding a small balloon catheter, such as a

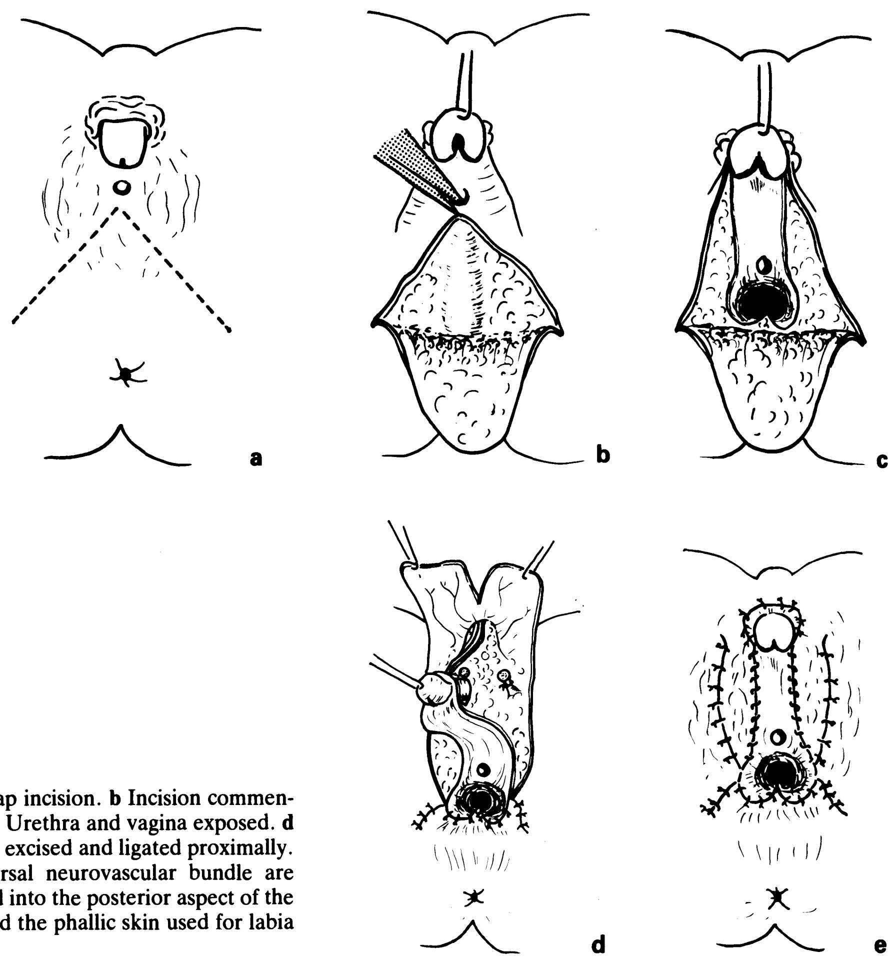
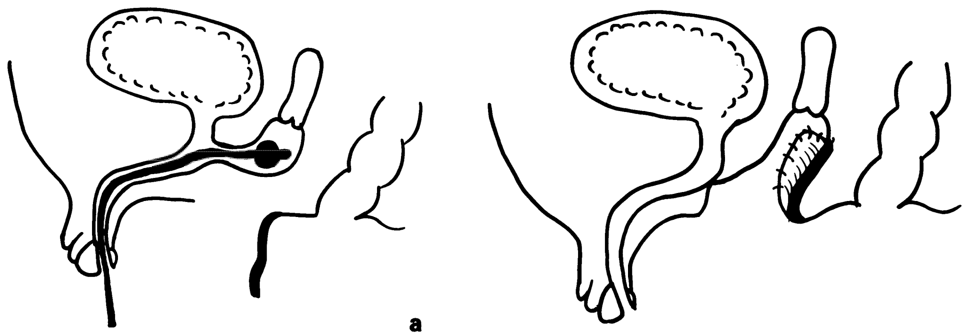



**Fig. 43.2.** **a** Posteriorly based flap incision. **b** Incision commencing at the opening of the sinus. **c** Urethra and vagina exposed. **d** The corpora cavernosa have been excised and ligated proximally. The corpus spongiosum and dorsal neurovascular bundle are preserved. The skin flap is sutured into the posterior aspect of the vagina. **e** The glans is recessed and the phallic skin used for labia minora.



a b

**Fig. 43.3.** **a** Fogarty catheter with balloon inflated in the high vagina. Skin flap reflected. **b** Skin flap inserted into posterior aspect of vagina.

Fogarty, into it (Fig. 43.3a). The sinus is incised as before but only as far as the urethral opening should be. The sinus above this then becomes the lower urethra.

All further dissection is then performed behind this new urethra and gentle traction on the balloon guides the dissection in the correct direction between the rectum and the urethra. Once the vagina is identified and opened the flap of skin is inserted and sewn to its posterior and lateral aspects (Fig. 43.3b). The anterior vaginal wall is bereft of epithelial lining, but its lower part, at least, can be partially covered by the back ends of the phallic skin that form the labia minora. A certain amount of vaginal narrowing can be allowed anteriorly as there is so much bulky and elastic skin laterally and posteriorly. Hendren (Hendren and Crawford 1969) believes that a vaginal pull-through operation is the correct procedure for these high anomalies but admits that it is a difficult operation (Hendren 1985).

Attention is then turned to the reduction of the phallus. The glans, the opened strip of corpus spongiosum beyond the urethral opening and the dorsal neurovascular bundle are all preserved. The corpora cavernosa are exposed by a circumferential incision around the glans, leaving a generous width of mucosa, and the dorsal bundle is isolated together with a strip of tunica from the corpora if necessary (see Fig. 43.2d). The ventral mucosal strip is then dissected off the corpora. An incision divides the corpora 5–8 mm below the glans, carefully avoiding the distal branches of the dorsal nerve that spread out around the distal corpora at that level. The proximal ends of the corpora are then traced backwards towards their origins from the bone and are transfixed and ligated as far back as possible (see Fig. 43.2d).

The glans is recessed forwards and upwards and sutured to the undersurface of the pubic arch, so that the ventral mucosa lies easily and the dorsal bundle tucks in anteriorly. The dorsal preputial hood and the phallic skin are then divided in the midline and brought backwards to form the labia minora (see Fig. 43.2e). The rugose tissue that was present initially becomes the labia majora. A running catgut suture is essential for the junction of the medial edge of the labia minora and the mucosal strip as the edge of the latter is extremely vascular and can give annoying haemorrhage. The skin is adjusted to fit as best as it can and closed with 4-0 Dexon or chromic catgut.

A small drain can be placed in each side of the wound for 24 h. A urethral catheter should be left in for 3 days and the vagina packed with Vaseline gauze. This pack should be removed after 48 h and vaginal dilatation begun twice daily with a plastic dilator that is approximately 1 cm in diameter. This dilatation should be continued at home for at least a month, or until all healing has occurred.

## Follow-up

Once the wound is well healed the dilatation can be stopped and no further surgical follow-up is needed until puberty. At that time an examination under anaesthetic is needed to check the adequacy of the vagina and the size of the clitoris. The shape and size of the vagina can be adjusted by swinging in flaps of nearby skin. The clitoris may have seemed a little large at a younger age but at puberty its appearance may be more compatible with the size of the girl. If it is deemed too large its lateral edges can be excised and oversewn.

## References

Hendren WH (1985) Clitoroplasty. Dialog Pediatr Urol 8: 4–6

Hendren WH, Crawford JD (1969) Adrenogenital syndrome: the anatomy of the anomaly and its repair. Some new concepts. J Pediatr Surg 4: 49–59

*Chapter 44*

# The Reflux-preventing Reimplantation of Large Ureters Without "Reduction Tailoring"

*Richard Turner-Warwick*

## Introduction

The surgical prevention of vesico-ureteric reflux (VUR) after the reimplantation of normal-calibre ureters into the bladder is generally dependent upon the creation of an intravesical-pressure-operated mechanical valve. This may take the form of either:

1. A submucosal tunnel of appropriate length, in which case the valvular occlusion created by a rise in intravesical pressure is achieved by its compression against the underlying support of the bladder wall, or
2. A cuffed nipple of appropriate length to ensure valvular occlusion on its lumen by a circumferential intravesical pressure rise (Turner-Warwick and Ashken 1967).

The "Paquin" procedure of a combination of a short tunnel and a short cuff nipple generally proved less satisfactory.

The surgical problems involved in achieving a reflux-preventing reimplantation of a ureter into the bladder are naturally increased when the calibre of its lumen is greatly enlarged; however, the basic principles involved are the same as those of normal-calibre ureteric reimplantations.

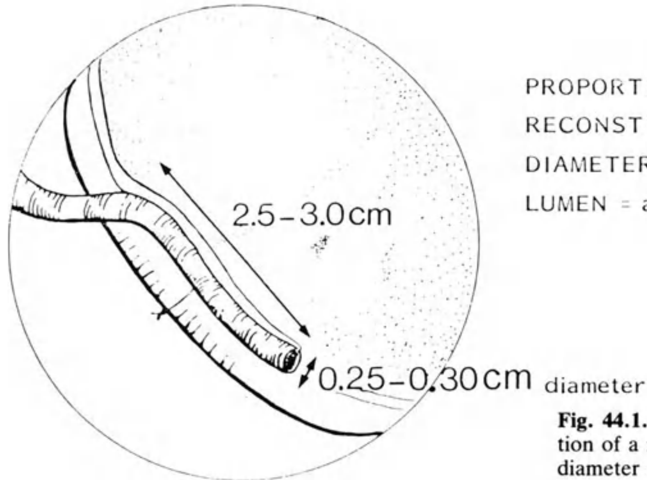



**Fig. 44.1.** The tunnel length for the reflux-preventing reimplantation of a normal ureter is usually about 3.0 cm, achieving a length/diameter ratio of about 10:1.

## Basic Principles for a Reflux-preventing Submucosal Tunnel Ureteric Reimplantation

The consensus of surgical experience with many different types of submucosal tunnel reimplantations indicates that a *healed* tunnel length of 2 cm is generally sufficient to prevent VUR if the calibre of the reimplanted ureter is normal.

Because the lumenal diameter of a normal ureter is about 3 mm, a 20 mm submucosal tunnel provides a lumen/length ratio of at least 1:7 (Fig. 44.1). However, there are of course many other factors relating to tissue resilience and pressure transmission involved in the functional efficiency

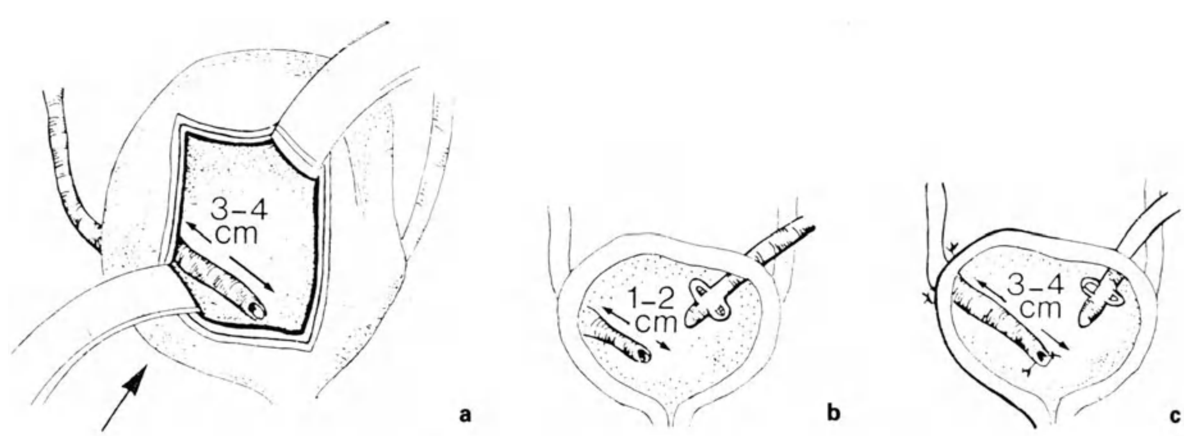



**Fig. 44.2a–c.** If the ureter is not firmly anchored to the bladder wall at both ends of the reimplantation tunnel (**c**) its preoperative length (**a**) will greatly diminish (**b**) when the bladder contracts to zero capacity on catheter drainage during the early healing period.

of a reflux-preventing procedure so that the lumen/length ratio of a submucosal tunnel is only useful as an approximate guide.

### Differential Mobility of the Trigone and the Supratrigonal Bladder Wall

The significance of the differential mobility of the trigone and the bladder wall has tended to be an under-emphasised factor in many ureteric reimplantation procedures. The dimensions of the trigone do not vary greatly; the ureteric orifices do not approximate significantly when the bladder is completely empty and they are only slightly spread apart when the bladder is fully distended. In contradistinction, any two different points on the supratrigonal bladder wall become closely approximated as the bladder contracts to zero capacity and becomes progressively separated as the bladder distends.

Thus, if a dismembered ureter is reimplanted through the expansile supratrigonal bladder wall, it is important to anchor the ureteric entry site of the bladder wall to the pelvic wall to prevent its ascent as the bladder distends with a consequent risk of obstructive ureteric kinking.

### Surgical Tunnel Length and Healing

Most surgeons reimplanting a normal-calibre ureter endeavour to achieve a submucosal tunnel length that measures about 3 cm at the time of operation. When this tunnel length relates to the relatively immobile trigonal area of the bladder, as it does in the various ureteric advancement reflux-preventing procedures, the relatively fixed position of the normal ureteric entry point tends to maintain the operative tunnel length.

However, the peroperatively measured 3 cm sub-urothelial tunnel length of a dismembered extravesical ureteric reimplantation into the mobile area of the supratrigonal bladder wall becomes grossly foreshortened postoperatively because a catheter-drained bladder contracts to zero capacity—and with it the tunnel length. In order to prevent this shortening the tunnel length should be maintained by meticulous anchorage of the uterer to the bladder wall at its new entry point (and to the lateral pelvic wall) as well as terminally at the site of its neo-orifice (Fig. 44.2).

## Reimplantation of Large-calibre Ureters

Without tailoring, a bladder base reimplantation of a large-calibre ureter results in a disproportionately short tunnel. Thus, even if a 4 cm tunnel is used for a ureter with an internal diameter of 1.5 mm the length/diameter ratio of the ureteric tunnel is only in the region of 3:1 and reflux is

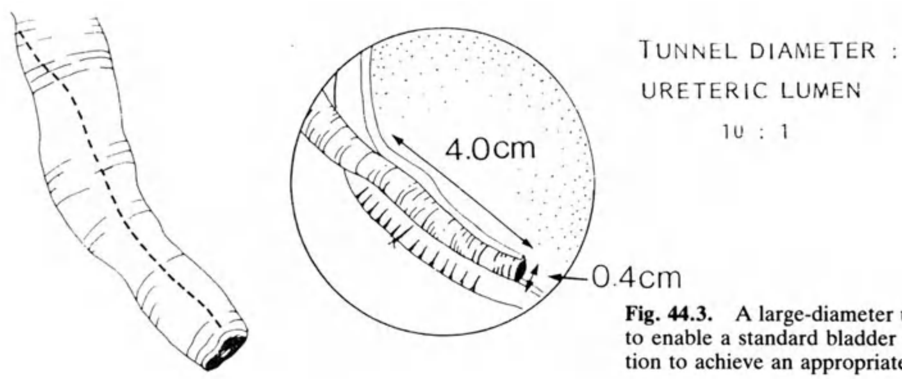



**Fig. 44.3.** A large-diameter ureter is commonly "tailored" to enable a standard bladder base short-tunnel reimplantation to achieve an appropriate length/diameter ratio.

common (unless the ureteric diameter reduces, as it often does, if the dilatation was the result of distal obstruction of a previously normal ureter).

## Reduction Tailoring Reimplantation of Large-calibre Ureters

The most commonly used method of reimplanting a large-diameter ureter is "reduction tailoring" (Fig. 44.3). The concept of this is to reduce the size of the ureter to enable a standard bladder base submucosal tunnel length reimplantation to be used; however, there is an inherent incidence of complications resulting from tailoring, the com-

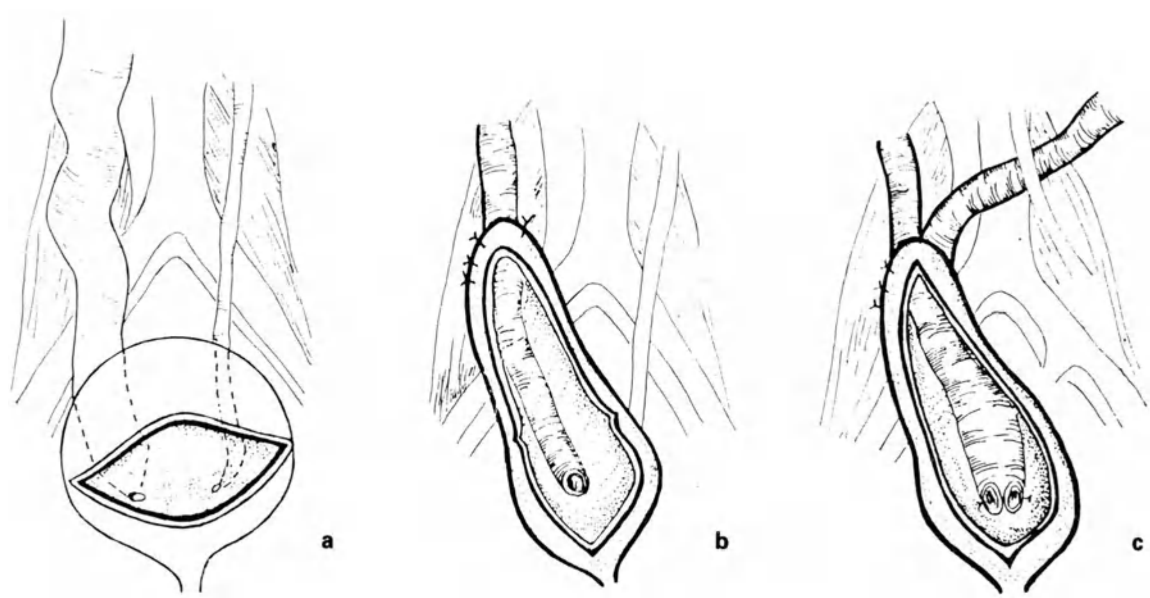



**Fig. 44.4a–c.** After a Turner-Warwick bladder-elongation psoas-hitch procedure (**a**) a tunnel length of 10–14 cm can be achieved, enabling a large-diameter ureter (**b**) (or both; **c**) to be reimplanted without "tailoring" and without significantly compromising the length/diameter ratio.

monest of which is stenosis of the submucosal ureteric segment. It seems probable that this is usually the result of impaired vascularisation of the tailored segment of the ureter, and, in spite of meticulous care and endeavours to preserve its blood supply, there is an inevitable incidence of ischaemia, which sometimes results in complete necrosis of the tailored segment. Tailored reimplantations were abandoned in the Urological Department at Middlesex Hospital more than 20 years ago.

## Reflux-preventing Reimplantation of Large-diameter Ureters without Tailoring

Large-diameter ureters can be reimplanted into the bladder without tailoring if an appropriate length/diameter ratio is maintained by creating a proportionally longer submucosal tunnel; this can be achieved by the Turner-Warwick psoas-hitch procedure (Turner-Warwick and Worth 1969). Using this procedure the tunnel length extends from the psoas muscle anchorage-point of the mobilised bladder located above the iliac vessels down to the trigone—a distance of 12–15 cm in the adult, providing a length/diameter ratio adequate to prevent reflux into ureters up to about 2.5 cm in diameter (Fig. 44.4). In children whose ureters are too large to achieve an appropriate length/diameter ratio with the available psoas-hitch tunnel length, we routinely reduce the ureteric calibre by simple longitudinal invagination/plication without tailoring resection.

A psoas-hitched tunnel remains constant in length whether the bladder is full or empty (Fig. 44.5), and, when a detrusor is capable of a sustained

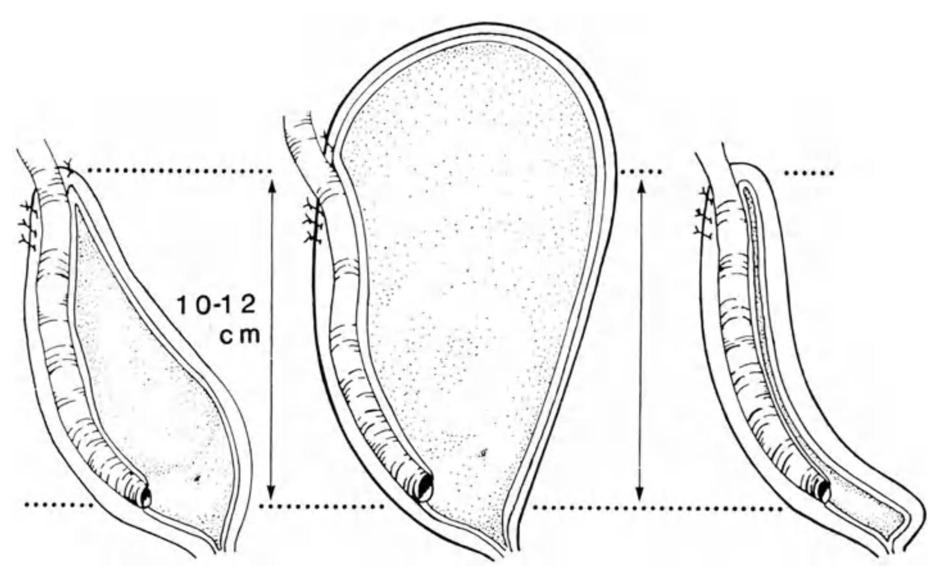



**Fig. 44.5.** The length of a psoas-hitch-to-trigone tunnel remains constant during bladder filling and emptying.

contraction to zero capacity, this is not impaired by its psoas-hitched position (Turner-Warwick and Worth 1969). To ensure that a maximum length of ureter is exposed to the valvular effect of the intravesical pressure, the urothelium is definitively hitched-up by including it in one of the extravesical ureteric anchorage polyglycolic acid (PGA) sutures.

When the ureteric dilatation is bilateral and both ureters require reimplantation, both are included in the one psoas-hitched submucosal tunnel after appropriate mobilisation and rerouting of the contralateral ureter across the midline below the root of the inferior mesenteric vessels.

## Results

In our experience, the untailored reimplantation of large-calibre ureters into a long psoas-hitched submucosal tunnel has proved very reliable and uncomplicated. If an upper urinary tract remains somewhat dilated after

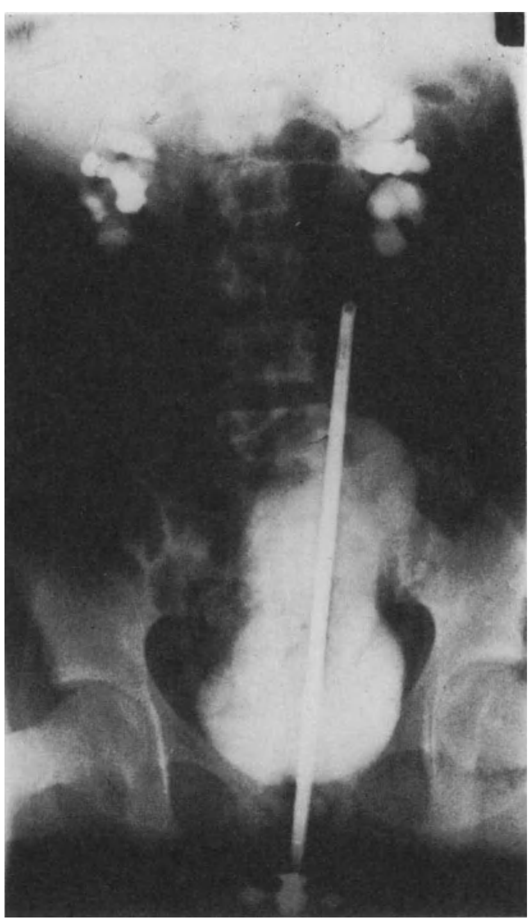


**Fig. 44.6.** Stenosis of a long-tunnel reimplantation of a large-calibre ureter is readily excluded by the passage of a standard cystourethroscope through it.

reimplantation, mechanical obstruction can be simply excluded by the passage of a full-size urethroscope through the urethra directly upwards through the intramural tunnel into the upper ureter (Fig. 44.6).

However, the functional efficiency of an unobstructed reflux-preventing operation depends upon the ability of the ureter to evacuate itself and fill the bladder at "resting" detrusor pressures. Even in the overtly proven absence of mechanical obstruction of the ureteric reimplantation, some adynamic myopathic ureters are incapable of this; for these cases Politano's mucosal stripped small bowel sleeve-wrap procedure may have a special place.

## Cuff Nipple Reimplantation of Large-calibre Ureters into Grossly Trabeculated Bladders

When the bladder is thick walled and grossly trabeculated it is technically difficult and sometimes impossible both to elevate it into a psoas-hitched position and/or to create an adequate submucosal tunnel. In such cases the cuff nipple reimplantation (Turner-Warwick and Ashken 1967; Turner-Warwick 1982) is sometimes an appropriate procedure; however, success is dependent upon a number of principles:

1. To prevent reflux the intravesical length of a nipple must be at least twice the *external* diameter of the nipple to maintain an appropriate length/diameter ratio of its lumen.
2. The surface of the intravesical projection of the nipple must be urothelialised by a cuff reflection. When the ureteric lumen is grossly dilated this is readily achieved by simple invagination, otherwise the ureter must be spatulated to provide a split cuff to avoid compression/strangulation of the reflected nipple.
3. The reimplantation of a large-diameter ureter or a bowel substitution ureteroplasty by this method creates a relatively large nipple, so it is important to prevent the descent of this during a voiding detrusor contraction from causing a "ball-valve" obstruction of the internal urethral meatus; thus the ureteric entry site should always be anchored either to the psoas, or, if it will not reach as high as this, to the lateral pelvic wall to prevent this, and also to prevent kinking obstruction of the ureteric drainage during bladder distension.
4. When the bladder is thick walled, it is important to prevent intramural obstruction of the ureteric entry immediately proximal to the cuff nipple by the creation of a generously wide opening in relation to the bladder-anchoring sutures. Furthermore, to prevent secondary fibrosis in this area, which can also cause obstruction, we endeavour to preserve its mobility by a small circumferential omental pedicle graft wrap.
5. Although some thick-walled and trabeculated bladders may prove relatively acontractile, the majority create high-pressure detrusor contractions and sometimes these are unstable, i.e. occur involuntarily during bladder filling: in general the reimplantation of dilated low-pressure ureters into such bladders is inappropriate. Detailed functional

urodynamic evaluation of thick-walled bladders associated with dilated ureters is therefore essential to determine whether a simple reflux-preventing reimplantation or a bowel substitution ureterocystoplasty is the appropriate refunctioning reconstructive procedure.

## References

Turner-Warwick R (1982) The reflex-preventing reimplantation of large calibre ureters without tailoring. Proceedings of the 19th international congress, Société Internationale de Urologie, San Francisco. Abstract 711, p 202

Turner-Warwick R, Ashken MH (1967) The functional results of partial, subtotal and total cystoplasty. Br J Urol 39: 3–12

Turner-Warwick R, Worth PHL (1969) The psoas bladder hitch procedure for the replacement of the lower third of the ureter. Br J Urol 41: 701–709

*Chapter 45*

# Functional Reconstruction of the Exstrophied Bladder

*A. M. K. Rickwood*

## Introduction

Exstrophy of the bladder is arguably the most major congenital anomaly that urologists have occasion to treat and, with an incidence of around 1 in 30 000 live births, certainly one of the rarest. For much of this century its management has been subject to wholly divergent views, with the argument centring around the means of obtaining urinary continence. While the desirability of continence *per via naturalis* is evident enough, the effort and methods necessary to achieve this, the extent to which these are truly successful and, indeed, whether the whole exercise is worthwhile at all, have been sharply divisive issues. Management of these patients has largely depended on where they were treated: if at a centre handling sizeable numbers, then probably by attempted functional reconstruction; if at one of the more numerous units dealing with only a handful of cases, more likely by primary permanent urinary diversion. Until recently the issue between these opposing policies was finely balanced; however, certain advances, notably augmentation cystoplasty, prosthetic sphincters and intermittent self-catheterisation (ISC), now point towards a general policy of functional reconstruction. This implies increasing use of major and complex surgery (perhaps best concentrated in just a few highly specialised units) and leaves certain important questions to be addressed:

—Which cases (if any) are unsuitable for functional reconstruction?
—Should reconstruction be undertaken as a single procedure or in stages?
—At what age should such procedures be performed?
—What factors influence successful primary closure of the bladder?
—Should detrusor function influence the nature of secondary continence procedures?

—Which secondary procedures may be required for continence?
—What measures are required to protect the upper renal tracts?
—What results can be achieved by functional reconstruction?
—When reconstruction is impracticable, or has failed, which form of permanent urinary diversion is advisable?

## Which Cases Are Unsuitable for Functional Reconstruction?

Most patients with exstrophy are otherwise perfectly healthy, and it is seldom that other associated congenital anomalies need influence urological management. In the occasional case with associated myelomeningocele or sacral agenesis, the consequent "neuropathic exstrophy" is no bar to successful functional reconstruction.

At birth the bladder is usually of adequate size, pliant and invertable. Occasionally, the walls becomes oedematous shortly after birth and inversion is no longer possible. Finally, there are a few cases where the bladder is inherently small and its detrusor largely fibrotic. Bladders which cannot be inverted—and these amount to less than 20% of the total—are certainly unsuitable for conventional primary closure. Hitherto it has been accepted that urinary diversion is inevitable in such cases: now there is the possibility of substitution cystoplasty (Arap et al. 1980, Grunberger et al. 1986), so that, in principle, functional reconstruction is feasible in almost any case.

## Should Reconstruction Be Staged?

Successful single-stage reconstruction, with simultaneous bladder closure and bladder neck repair, was first described by Young (1942). Since then a few similar examples have been recorded, but, as a rule, single-stage procedures are not only unsuccessful in producing a continent bladder but also put the upper renal tracts at some risk. Present consensus is for staged reconstruction, the initial operation aiming solely at bladder closure without attempt to fashion a competent bladder neck. Procedures required for continence are deferred until bladder capacity has (hopefully) improved and the child is capable of any necessary cooperation.

## When Should Bladder Closure Be Performed?

While successful bladder closure is possible even in adults, as a matter of policy it is universally agreed that closure should be performed early in childhood. Williams and Keeton (1973) routinely undertook closure around 3 years of age, while Chisholm (1979) operated at 9 months of age on the grounds that by then mineralisation of bone made for more secure approximation of the pelvic ring see p. 497). The general trend, however, has been towards bladder closure in the neonatal period, ideally around 1–2 weeks of age. At this time the procedure is technically straightforward and, with modern paediatric anaesthesia, quite safe. Removal of the unsightly defect does much for parents' morale and makes later handling of the baby easier. Early closure also avoids secondary changes in the bladder itself. Polypoid and squamous metaplasia occurring in the mucosa always reverses following closure, but fibrotic infiltration of the detrusor might be expected to be permanent (although there is no convincing evidence that delayed closure adversely affects the functional result).

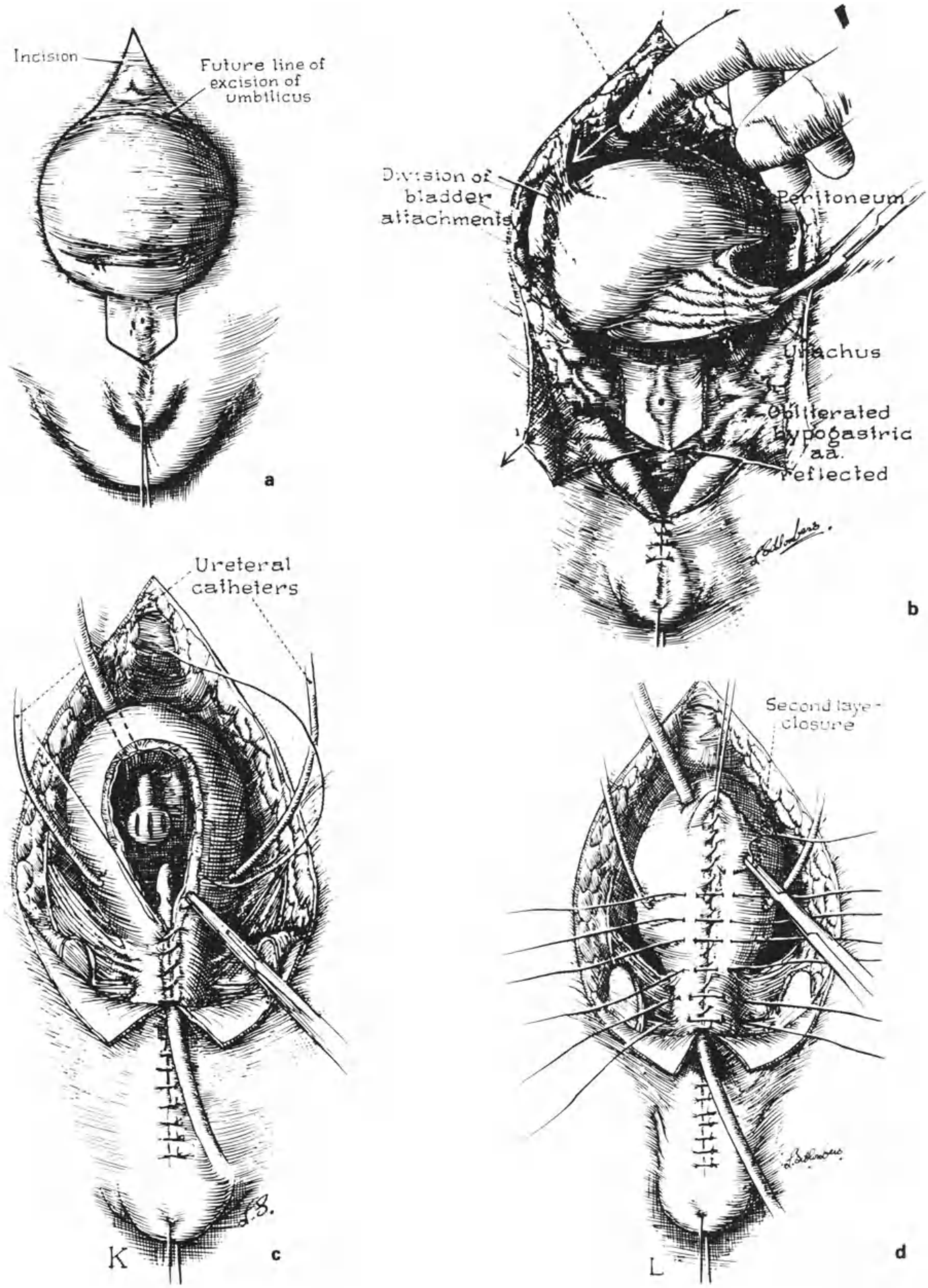
Indications for delayed closure are:

1. Where some other condition exists (e.g. congenital heart disease) requiring more urgent attention.
2. Where secondary oedema of the bladder prevents inversion; this may reverse in time, allowing delayed primary closure.
3. Where the bladder is clearly too small for primary closure; if subsequent reconstruction by way of augmentation or substitution cystoplasty is intended, this is best delayed until at least 2 years of age.

## What Factors Influence Successful Primary Closure of the Bladder?

The basic technique of bladder closure is standardised (Fig. 45.1; Johnston 1982; Jeffs and Lepor 1986). The edges of the isolated bladder should be cleanly incised to remove any adherent skin or fibrous tissue, and the bladder and urethral strip mobilised sufficiently on either side to enable their edges to be brought together anteriorly without tension. In females the entire urethra is repaired, in males only down to the verumontanum. No attempt is made to fashion a competent bladder neck and the urethral repair should lie loosely around a 10 FG catheter. Although it is customary to bolster the region of the bladder neck by suturing around it the fibrous bands running laterally to the pubic bones on each side, there is no evidence that this little ritual contributes to the security of the repair. The bladder is drained with a 10–12 FG suprapubic Malecot catheter for 3–4 weeks postoperatively: urethral catheter drainage is avoided. It is customary to employ ureteric stents for some 7 days postoperatively, but this is not strictly necessary in straightforward cases.

There is still some controversy as to whether posterior iliac osteotomy with anterior closure of the pelvic ring (Fig. 45.2) contributes to the final



Incision
Future line of excision of umbilicus
a
Division of bladder attachments
Peritoneum
Urachus
Obliterated hypogastric aa. reflected
b
Ureteral catheters
K
c
Second laye closure
L
d

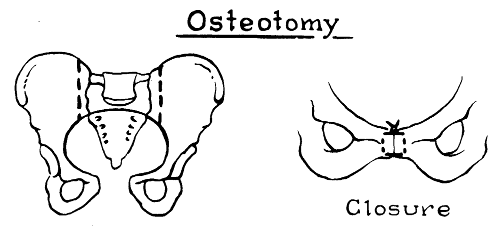



**Fig. 45.2.** Posterior iliac osteotomy and anterior closure of pelvic ring. (Reproduced from Jeffs and Lepor 1986 by kind permission of the publishers, W. B. Saunders Co., Philadelphia)

outcome. In the occasional case with very wide separation of the pubic bones, pelvic osteotomy is essential for repair, but otherwise anterior cover over the repaired bladder and urethra is obtainable by flaps taken from the anterior rectus sheath and by transposition flaps of skin. Proponents of routine pelvic osteotomy claim that:

1. Approximation of the recti provides sounder muscular cover, and vertical suture of the skin of the lower abdominal wall provides a more cosmetically acceptable appearance.
2. Approximation of the muscles of the pelvic floor improves the prospect of urinary continence and reduces the incidence of rectal prolapse and, later, genital prolapse in females.
3. Posterior placement of the repaired bladder neck and urethra within the pelvic ring straightens the vesicourethral angle, again improving continence, and making it possible to combine bladder neck repair with urethrovesical suspension (see p. 500).
4. Approximation of the corpora enhances penile length and facilitates reconstruction of the anterior urethra.

The cosmetic claim is undoubtedly valid; the others remain largely speculative. Although it seems likely that closure of the pelvic ring reduces the risk of partial or complete breakdown of the primary repair, this is unproven. However the bones are fixed anteriorly, they drift apart in time, and it is improbable that the procedure contributes permanently to the length of the penis. The most compelling argument in favour of pelvic closure is that all series reporting good functional results routinely incorporate the procedure.

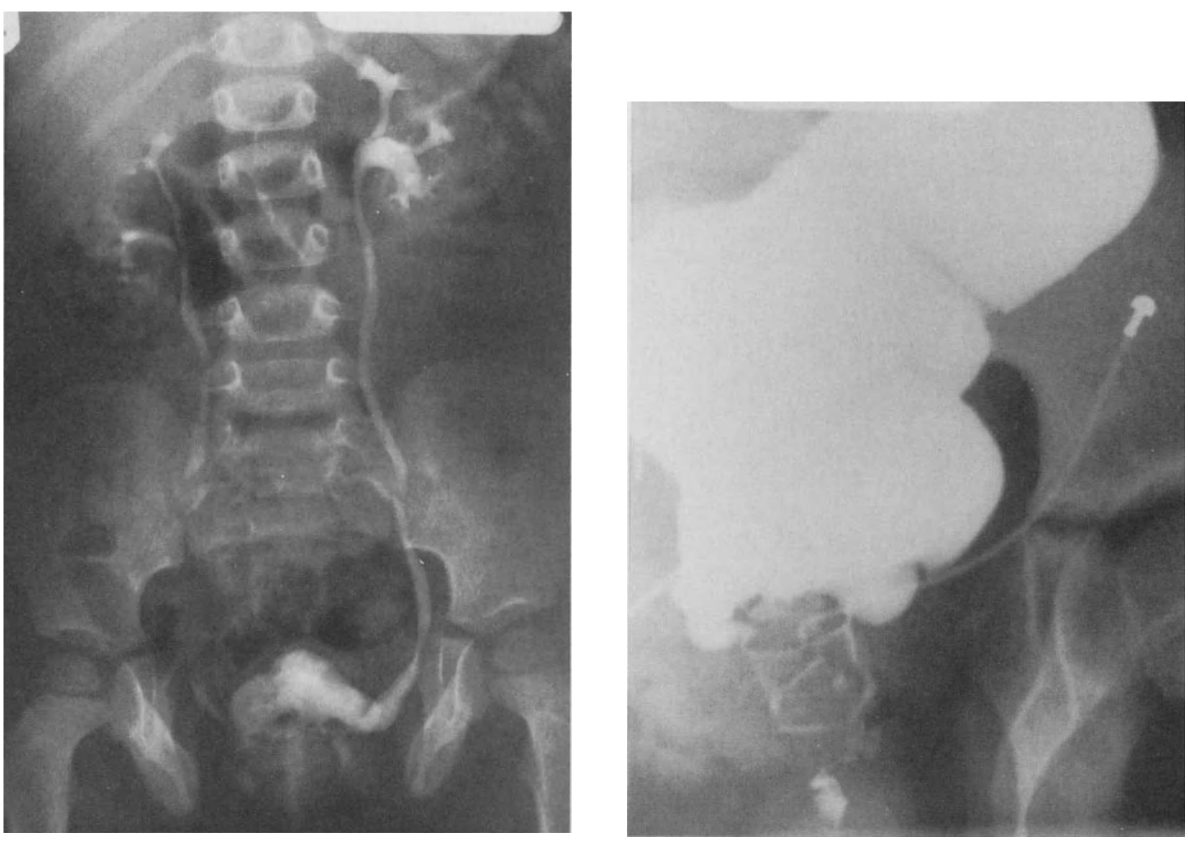
Osteotomy can be performed up to 1 week prior to bladder closure, although it is usual to combine the two procedures. Approximation of the two halves of the pelvis is more taxing than descriptions suggest. The legs should be prepared in the operative field so that the hips can be flexed, adducted and internally rotated to facilitate closure. A stout (No. 1 or 0)

◄

**Fig. 45.1a–d.** Primary closure of the bladder. **a** Incision around mucocutaneous junction and proximal urethral strip. **b** Extraperitoneal mobilisation of the bladder. **c** All-layer closure of the bladder wall and urethra. Note placement of suprapubic Malecot catheter. **d** Placement of reinforcing sutures in muscularis of bladder and urethra. (Reproduced from Jeffs and Lepor 1986 by kind permission of the publishers, W. B. Saunders Co., Philadelphia) monofilament nylon mattress suture passed through the bony portion of the pubes completes closure of the pelvic ring (Fig. 45.2). Jeffs (Jeffs and Lepor 1986) maintains the position for some 4–6 weeks postoperatively by modified Bryant's traction: with neonates it is sufficient—and simpler—to apply one crepe bandage firmly around the pelvis and another holding the legs together (Johnston 1982).

## Should Detrusor Function Influence the Nature of Secondary Continence Procedures?

Detrusor function in exstrophy patients has received surprisingly little attention. Shapiro et al. (1985) found a normal density of muscarinic cholinergic receptors in the detrusor of exstrophy cases. Toguri et al.



a b

**Fig. 45.3.** **a** IVU in an exstrophy patient following primary bladder closure. The upper tracts are normal but the bladder was small and non-compliant. End filling pressure at 100 ml was 75 $cmH_2O$. Continued sphincter weakness despite bladder neck repair. **b** Cystogram following bladder augmentation, with ileum, and placement of AMS sphincter cuff. Bladder capacity 400 ml with end filling pressure of 15 $cmH_2O$. Patient was continent following placement and activation of remainder of sphincter device.

(1978), in a study of patients with *successful* functional reconstruction, showed that two-thirds voided by detrusor contractions and the remainder, who had no detrusor contractility, by abdominal straining. In most cases pelvic floor muscles relaxed appropriately during voiding. A study of *unsuccessfully* reconstructed cases might show a different picture. Detrusor instability has not been described in relation to exstrophy, but then it has scarcely been sought for.

Detrusor compliance is an important consideration: filling cystometrograms after primary bladder closure generally show small functional capacity resulting from grossly impaired detrusor compliance (Fig. 45.3). Is this phenomenon primary? Or is it secondary because the bladder remains permanently almost empty? If it is primary—and irreversible—the expected consequences would be that:

1. Bladder neck repair fails, being, in effect, "blown apart" by the rise in intravesical pressure; even the artificial sphincter will not be proof against grossly reduced detrusor compliance.
2. If a competent sphincter mechanism is established, the consequent elevation of intravesical pressure will lead to secondary obstruction of the upper renal tracts.

If low-compliance is secondary, and improves after bladder neck repair, the process seems likely to take some while, possibly months, during which time both the repair and the upper tracts remain at risk.

Clinical evidence suggests that the phenomenon may be primary or secondary. That successful functional reconstruction is possible without detriment to the upper renal tracts implies that it is sometimes secondary. In other cases reconstruction of the bladder neck is followed by persistent dilatation of the upper tracts, in which event primary detrusor low-compliance would seem likely. In any individual case the issue could be determined before bladder neck repair by prolonged recycling of the bladder (Gearhart et al. 1986), but, for practical reasons, this is rarely undertaken.

Detrusor function clearly has a major bearing on the procedures necessary to produce a continent bladder and it should not be assumed that a poor functional result is always due to inexpert repair of the bladder neck. Possibilities which must be considered are:

1. Primary failure of the bladder neck reconstruction.
2. Secondary failure of the bladder neck reconstruction caused by detrusor low-compliance.
3. Adequate or excessive repair of the bladder neck leading to relative or genuine outlet obstruction; if detrusor compliance is good, the upper tracts remain normal and functional capacity is adequate, but effective capacity is small since lack of expulsive force (e.g. acontractile detrusor), outlet obstruction or both leads to large residual urine.
4. As previously, but in the presence of impaired detrusor compliance; dilatation of the upper tracts occurs and functional capacity is usually less good.

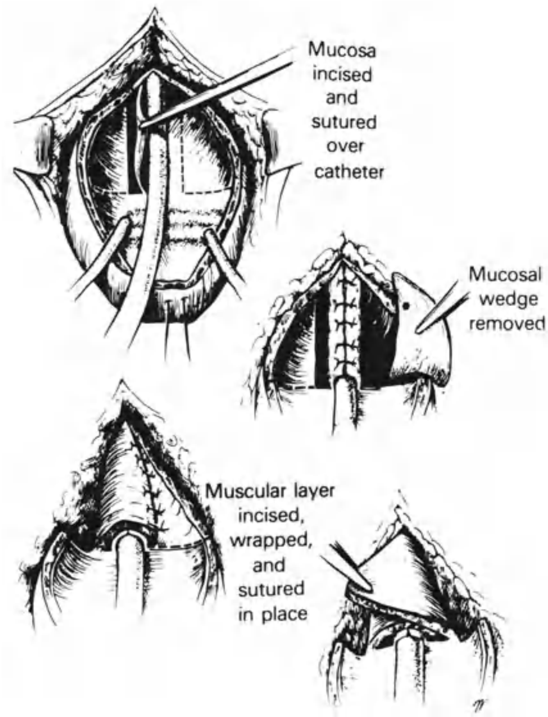



**Fig. 45.4.** Young–Dees–Leadbetter bladder neck repair. The ureters are usually reimplanted higher in the bladder as part of this procedure. (Reproduced from Diamond and Ransley 1986 by kind permission of the Editor of *Journal of Urology* and the publishers, Williams & Wilkins, Baltimore)

It is evident that successful functional reconstruction requires:

1. Adequate repair (or prosthetic replacement) of the bladder neck.
2. A low-pressure, high-capacity bladder (for which augmentation cystoplasty may be required).
3. Satisfactory emptying of the bladder (using ISC if necessary).

## Which Secondary Procedures may be Required for Continence?

### Bladder Neck Repair

Leadbetter's (1964) modification of the Young–Dees repair (Fig. 45.4) (or Mollard's (1980) adaptation of this procedure; Fig. 45.5) are employed. The neourethral strip should be some 3 cm long and 1.7–2 cm wide. Excision of mucosa from the triangular muscle flaps is less easy than might appear and is aided by submucosal injection of 1 in 100 000 adrenaline solution. Jeffs (Jeffs and Lepor 1986) employs peroperative urethral profilometry, aiming for a urethral closure pressure of 60–90 $cmH_2O$ and a continence length of some 3 cm. He also recommends vesicourethral suspension as a routine (Fig. 45.6).

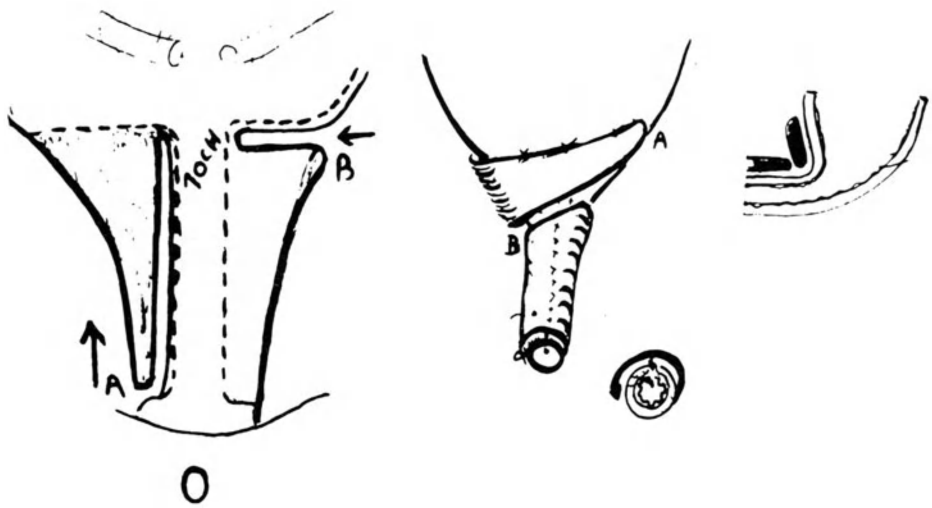



**Fig. 45.5.** Mollard's modification of the Young–Dees–Leadbetter bladder neck repair. (Reproduced from Mollard 1980 by kind permission of the Editor of *Journal of Urology* and the publishers, Williams & Wilkins, Baltimore)

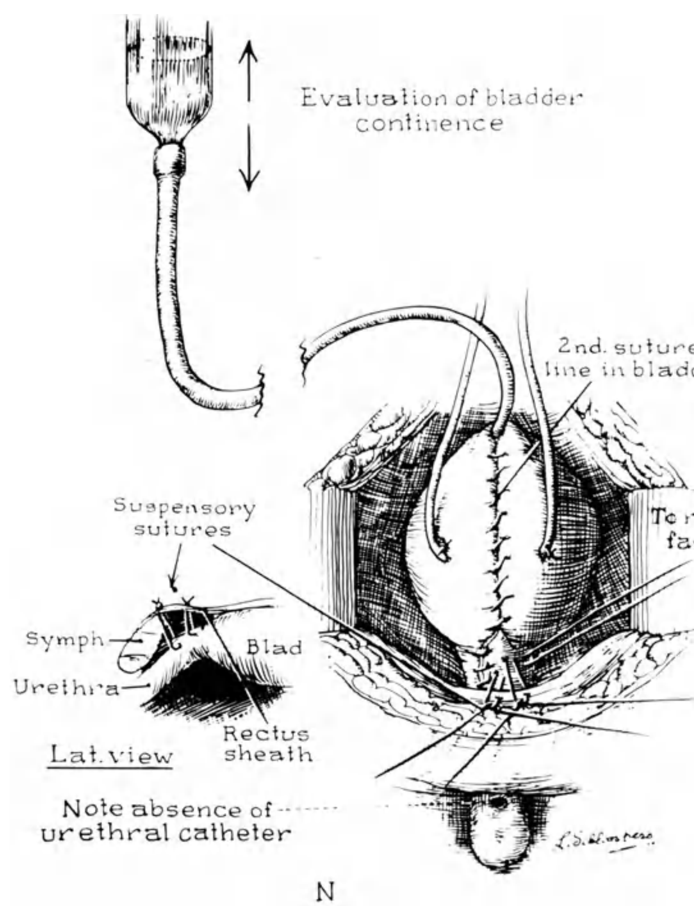



**Fig. 45.6.** Vesicourethral suspension with bladder neck repair. (Reproduced from Jeffs and Lepor 1986 by kind permission of the publishers, W. B. Saunders Co., Philadelphia)

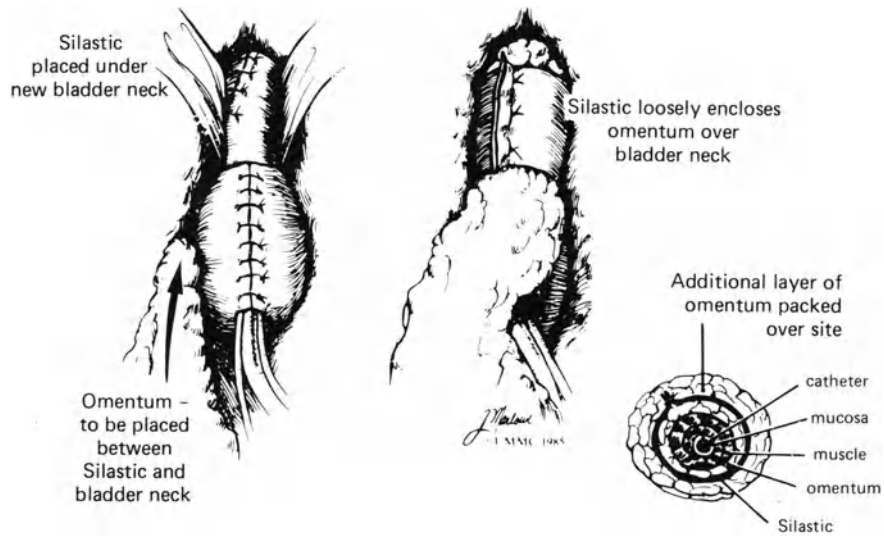



**Fig. 45.7.** Bladder neck wrap with omentum, silicone sheet and omentum sandwich. The silicone sheet used is 2.5 cm wide and 0.0127 cm thick. (Reproduced from Diamond and Ransley 1986 by kind permission of the Editor of *Journal of Urology* and the publishers, Williams & Wilkins, Baltimore)

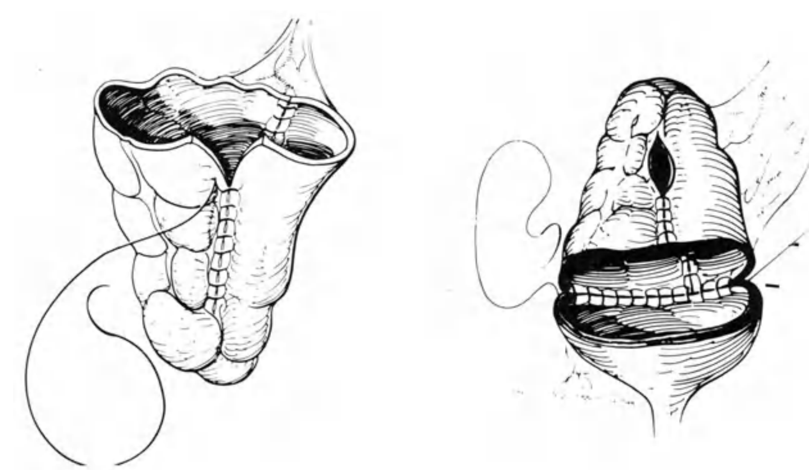


**Fig. 45.8.** Use of an ileocaecal segment as a "pouched" augmentation cystoplasty. (Reproduced from Light and Engelmann 1986 by kind permission of the Editor of *Journal of Urology* and the publishers, Williams & Wilkins, Baltimore)

## Artificial Urinary Sphincter

The implantation of an artificial urinary sphincter has been used as a primary procedure or following failed bladder neck repair (Light and Scott 1983). In the latter event, if there is much fibrosis, the bladder can be further tubularised more proximately in order to provide a supple region for the cuff to act upon. It may also be advantageous to use a pedicled omental graft (Turner-Warwick 1976) as a double wrap, the inner layer between urethra and cuff and the outer surrounding the cuff (A. R. Mundy 1987, personal communication). As a rule only the cuff is inserted at the initial procedure and the remainder of the device some months later when it is certain that there is neither infection nor erosion of the urethra. A low-pressure (51–60 $cmH_2O$) balloon minimises future risk of erosion.

Diamond and Ransley (1986) describe an approach midway between bladder neck repair and sphincter implantation (Fig. 45.7). If the combined bladder neck repair and silicone sheet/omental wrap proves insufficient, a sphincter cuff is relatively easy to insert.

## Augmentation Cystoplasty

Augmentation cystoplasty was introduced to exstrophy surgery by Arap et al. (1980). Experience of augmentation in other situations indicates that the problem of persistent bowel contractions is minimised if the intestinal segment is opened along its antimesenteric border and anastomosed to the bladder as a pouch (Fig. 45.8) or flat patch (Bramble 1982). Ileal, ileocaecal and sigmoid segments have been employed, none enjoying any especial superiority. The present author's preference is for the sigmoid, since mucous production is less than with ileum and this portion of the large bowel is more easily manipulated in the pelvis than the ileocaecal region. If necessary, augmentation can be combined with simultaneous bladder neck reconstruction or placement of a sphincter cuff.

As yet, it is impossible to be certain when augmentation will be required. In the present author's practice it is performed when a filling cystometrogram under general anaesthetic shows a capacity less than one-third that expected for age, using the formula:

$$\text{Capacity (ml)} = \text{age (years)} \times 30 + 50.$$

In cases where the bladder is too small for primary closure, bowel segments have been employed for substitution cystoplasty (Arap et al. 1980). As a novel extension of this concept, Grunberger et al. (1986) excised a small bladder along with the proximal urethra, replacing the bladder with an ileocaecal segment and the proximal urethra by the appendix. Because the caeco-appendicular junction was competent, the patient was able to stay dry by ISC.

### *Intermittent Self-Catheterisation*

Patients undergoing combined bladder neck repair and augmentation cystoplasty will probably need to practise self-catheterisation, and so also will a few who have bladder neck reconstruction only. This is not usually difficult for females (although the external urinary meatus may need to be revised to make it practicable). Males, however, require much motivation, patience and encouragement, partly because of sensation and partly because the reconstructed urethra is often irregular or kinked.

### *Medication*

In exstrophy patients, medication is usually quite useless in treating detrusor compliance or incompetence of the bladder neck, but anticholinergic agents may be required after augmentation cystoplasty to inhibit volume-related contractions of the bowel segment.

### Timing of Secondary Procedures

Simple reconstruction of the bladder neck is undertaken at 2–4 years of age. Procedures which will require a degree of cooperation from the child, (ISC, sphincter manipulation) are best deferred until 7 years of age or more.

## What Measures are Required to Protect the Upper Renal Tracts?

Damage to the upper renal tracts may occur by reason of:

1. *Vesicoureteric reflux*. This is universally present and may be supposed inconsequential if the bladder is open or, if repaired, remains empty. Clinical evidence, however, suggests that even at this stage renal scarring may occur as a result of ascending infection, and it is the present author's practice to administer low-dose antibiotic prophylaxis until reflux has been corrected.
2. *Incomplete emptying of the bladder combined with detrusor low-compliance*. This was formerly treated by vigorous urethral dilatation or by endoscopic incision of the bladder neck repair; unfortunately, this leaves the bladder without functional capacity. Alternatively, it may be treated by augmentation cystoplasty (plus ureteric reimplantation if there is reflux) combined with ISC.
3. *Ureterovesical obstruction following ureteric reimplantation*. If present bilaterally, a Whitaker test (Whitaker 1979) may be required to distinguish this from the previous problem.

## What Results can be Achieved by Functional Reconstruction?

Prior to the 1970s, reported results of functional reconstruction were poor (Marshall and Muecke 1970), and it may be supposed that unreported results were worse still. Since then the policy of staged early primary closure and later reconstruction of the bladder neck has yielded dividends (Table 45.1), with the recent results from Johns Hopkins (Lepor and Jeffs 1983) outstanding. It may be observed, however, that:

1. Other units, including those treating quite large numbers and by the same policy, have been far less successful.

2. In all but the recent series from Johns Hopkins there is still appreciable room for improvement.
3. Continence in "successful" cases is not always wholly normal and in some instances is quite precarious. Most patients need to void at regular, and some at frequent, intervals, while others are dry only by day (e.g. Mollard 1980).

**Table 45.1.** Recent results of functional reconstruction

| Reference | No. of patients | No. continent | Percentage continent |
|---|---|---|---|
| Chisholm (1979) | 95 | 43 | 45 |
| Mollard (1980) | 16 | 11 | 69 |
| Ansell (1983) | 23 | 10 | 43 |
| Lepor and Jeffs (1983) | 22 | 19 | 86 |

The impact of recent advances is too early to assess. In a small series, Light and Scott (1983) achieved impressive day and night continence using the AMS 792 artificial sphincter. Since all but one of their patients had "normal" bladder capacity preoperatively, it must be allowed that they treated an unusually favourable group of patients.

Early reports of augmentation and substitution cystoplasty are similarly encouraging (Arap et al. 1986; Diamond and Ransley 1986; Gearhart et al. 1986; Grunberger et al. 1986). There is good reason to suppose that the net effect of these various advances will be to improve the results of functional reconstruction, although inevitably at the expense of major surgery and the complications attendant on this.

The greater range of therapeutic options also makes for more complex management. Several questions remain to be answered:

—Can the indications for augmentation cystoplasty be more precisely defined?
—Should bladder neck repair or prosthetic replacement be combined with simultaneous augmentation cystoplasty or should the procedures be staged; if so, which takes precedence?
—Should the prosthetic sphincter be the primary treatment for bladder outlet incompetence (Light and Scott 1983) or should it be reserved for when bladder neck repair has failed?
—What is the role for substitution cystoplasty; is use of appendix as a urethral substitute (Grunberger et al. 1986) widely applicable?

## Which Form of Permanent Urinary Diversion is Advisable?

In the past the majority of patients with exstrophy have come to permanent urinary diversion, and undoubtedly some will continue to do so. Enthusiasm for diversion might be greater were the results better. The ileal conduit has been the most popular procedure, but the long-term results of this procedure in children are poor (e.g. Middleton and

Hendren 1976). If anal control is good (as with most patients with exstrophy), ureterosigmoidostomy would seem the ideal choice, especially since previous problems with ascending infection and metabolic alkalosis are now largely solved. Unfortunately, it is becoming clear that there is an alarming long-term incidence of juxta-anastomotic colonic carcinoma and this procedure can no longer be recommended to young patients with good life expectancy.

The final possibility is the non-refluxing colonic conduit. This gives reasonable, if not ideal, results (e.g. Altwein et al. 1977) and is probably the best of three generally unsatisfactory options.

## References


Altwein JE, Jonas U, Hohenfellner R (1977) Long-term follow-up of children with colon conduit urinary diversion and ureterosigmoidostomy. J Urol 118: 832–836

Ansell JE (1983) Exstrophy and epispadias. In: Glenn JF (ed) Urologic surgery. Lippincott, Philadelphia, pp 647–663

Arap S, Giron AM, de Goes GM (1980) Initial results of the complete reconstruction of bladder exstrophy. Urol Clin North Am 7: 477–491

Bramble FJ (1982) The treatment of adult enuresis and urge incontinence by enterocystoplasty. Br J Urol 54: 693–696

Chisholm TC (1979) Exstrophy of the urinary bladder. In: Kiesewetter WB (ed) Long-term follow-up in congenital anomalies. Pittsburgh Childrens Hospital, pp 31–36 (Pediatric surgical symposia vol 6)

Diamond DA, Ransley PG (1986) Bladder neck reconstruction with omentum, silicone and augmentation cystoplasty – a preliminary report. J Urol 136: 252–255

Gearhart JP, Albertsen PC, Marshall FF, Jeffs RD (1986) Pediatric applications of augmentation cystoplasty: the Johns Hopkins experience. J Urol 136: 430–432

Grunberger I, Catanese A, Hanna MK (1986) Total replacement of bladder and urethra by cecum and appendix in bladder exstrophy. Urology 28: 497–500

Jeffs RD, Lepor H (1986) Management of the epispadias–exstrophy complex. In: Walsh PC, Gittes RF, Perlmutter AD, Stamey TD (eds) Campbell's urology, vol 2, 5th edn. Saunders, Philadelphia, pp 1882–1921

Johnston JH (1982) The exstrophy anomalies. In: Williams DI, Johnston JH (eds) Paediatric urology, 2nd edn. Butterworth, London, pp 299–316

Leadbetter GW (1964) Surgical correction of total urinary incontinence. J Urol 91: 261–266

Lepor H, Jeffs RD (1983) Primary bladder closure and bladder neck reconstruction in classical bladder exstrophy. J Urol 130: 1142–1145

Light JK, Engelmann UH (1986) Le bag: total replacement of the bladder using an ileocolonic pouch. J Urol 136: 27–31

Light JK, Scott FB (1983) Treatment of the epispadias–exstrophy complex with AMS 792 artificial urinary sphincter. J Urol 129: 738–740

Marshall VF, Muecke EC (1970) Functional closure of typical exstrophy of the bladder. J Urol 104: 205–212

Middleton AW, Hendren WH (1976) Ileal conduits at the Massachusetts General Hospital from 1955–1970. J Urol 115: 591–595

Mollard P (1980) Bladder reconstruction in exstrophy. J Urol 124: 525–529

Shapiro E, Jeffs RD, Gearhart JP, Lepor H (1985) Muscarinic cholinergic receptors in bladder exstrophy: insights into management. J Urol 134: 308–310

Toguri AG, Churchill BM, Schillinger JF, Jeffs RD (1978) Gas cystometry in cases of continent bladder exstrophy. J Urol 119: 536–537

Turner-Warwick RT (1976) The use of the omental pedicle graft in urinary tract reconstruction. J Urol 116: 341–347

Whitaker RH (1979) The Whitaker test. Urol Clin North Am 6: 529–539

Williams DI, Keeton JE (1973) Further progress with reconstruction of the exstrophied bladder. Br J Surg 60: 203–207

Young HH (1942) Exstrophy of the bladder: the first case in which a normal bladder and urinary control have been obtained by plastic operation. Surg Gynecol Obstet 74: 729–737

# Subject Index