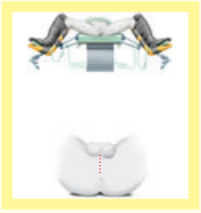
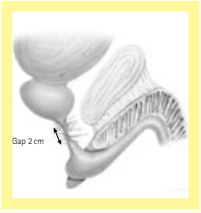
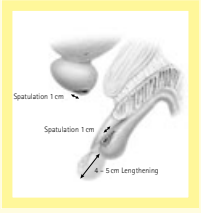
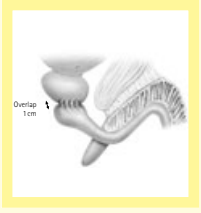
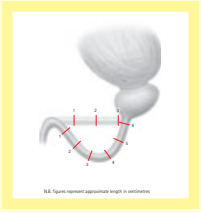
Surgery Illustrated

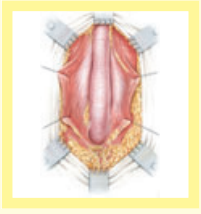












Surgical Atlas

Anastomotic urethroplasty

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ILLUSTRATIONS by STEPHAN SPITZER, www.spitzer-illustration.com

INTRODUCTION

Anastomotic urethroplasty (AU) is appropriate for traumatic or otherwise for short strictures of the bulbar or membranous urethra.

TRAUMATIC

Although the commonest forms of injury are instrumental or other iatrogenic injuries, most of which are internal, these usually cause long strictures of ≥2 cm, for which AU is not usually appropriate. The typical injury of the bulbar urethra causing a stricture for which AU is appropriate is a fall-astride injury which crushes the bulbar urethra against the underside of the pubic symphysis. In most instances, this causes fibrotic obliteration of a short segment of the bulbar urethra, but can sometimes cause complete loss of continuity and significant loss of length of the bulbar urethra.

More proximally, the bulbomembranous junction or membranous urethra may be partly or completely disrupted as a consequence of a pelvic fracture. The exact nature of this is unclear but current thinking is that this is either a partial or complete avulsion of the membranous urethra from the bulbar urethra at the level of the perineal membrane, or a 'scissors' effect of a bone fragment cutting across the urethra at this point. Typically, there is no loss of urethral length but a fibrotic block between the ends, with a variable degree of distraction or distortion.

Otherwise short strictures appropriate for an AU are the idiopathic strictures found in the bulbar urethra in adolescents and young adults, which are possibly of congenital origin. Unlike other acquired strictures, the urethra on either side of an idiopathic/congenital stricture is normal, as with traumatic strictures. AU is rarely applicable to the penile (or pendulous) urethra, as shortening of the urethra in this segment as a result of surgery will lead to serious degrees of chordee.

SELECTION

Many patients have few symptoms beyond a slow flow and a feeling of incomplete emptying. As most patients suitable for AU have had an injury at some stage, this is an obvious factor in the history. Many with traumatic strictures will have an indwelling suprapubic catheter. If the patient is still able to void, the flow rate should be measured to assess the peak flow rate and the flow pattern. Ultrasonography of the bladder will show the bladder wall thickness and any residual urine. Definitive diagnosis is with an ascending urethrogram (or retrograde urethrogram) together with a micturating cystogram to show both ends of the stricture clearly and any association complications such as fistulae or false passages. Endoscopy usually provides no additional information in straightforward cases but in more severe cases rigid endoscopy of the distal urethra and flexible endoscopy of the proximal urethra through a suprapubic catheter tract

may be helpful, particularly in pelvic fracture urethral injuries when the bladder, bladder neck or prostatic urethra look radiologically abnormal.

Ideally, the patient will have had no previous surgery or instrumentation. Such surgery or instrumentation often makes any stricture worse and in doing so may extend the damage along the length of the urethra and make the patient unsuitable for an anastomotic repair.

PREPARATION

It is sensible to know the patient's blood group, although blood transfusion is rarely necessary. It is also sensible to have an up-to-date urine culture to be sure that the routine prophylactic antibiotics administered are appropriate for any bacterial growth. The patient is admitted on the day of surgery.

During consent, the patient should be warned that there is an ≈5% risk of a recurrent stricture, a 5% risk of erectile dysfunction, which usually resolves within a year or is otherwise treatable, and occasional instances of incontinence if the bladder is abnormal or if there has been damage to the bladder neck from previous surgery or the cause of injury.

EQUIPMENT

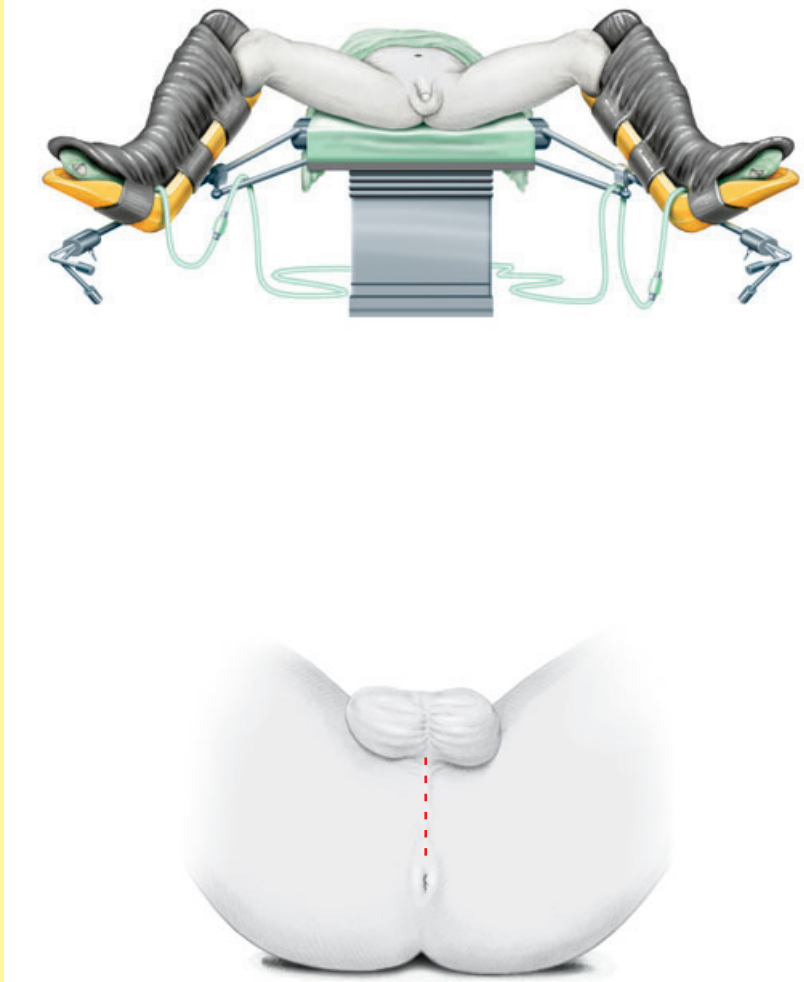
Most of the dissection is with a pair of DeBakey forceps, McIndoe scissors and hand-held diathermy. The anastomosis is with 5/0 polyglactin or other absorbable sutures; 3/0 polyglactin is used for most other purposes. At the end of the operation, I leave in a 16 F silicone Foley urethral catheter and, if there is potential space left behind at the end of the procedure, a small drain for the first 24 h after surgery.

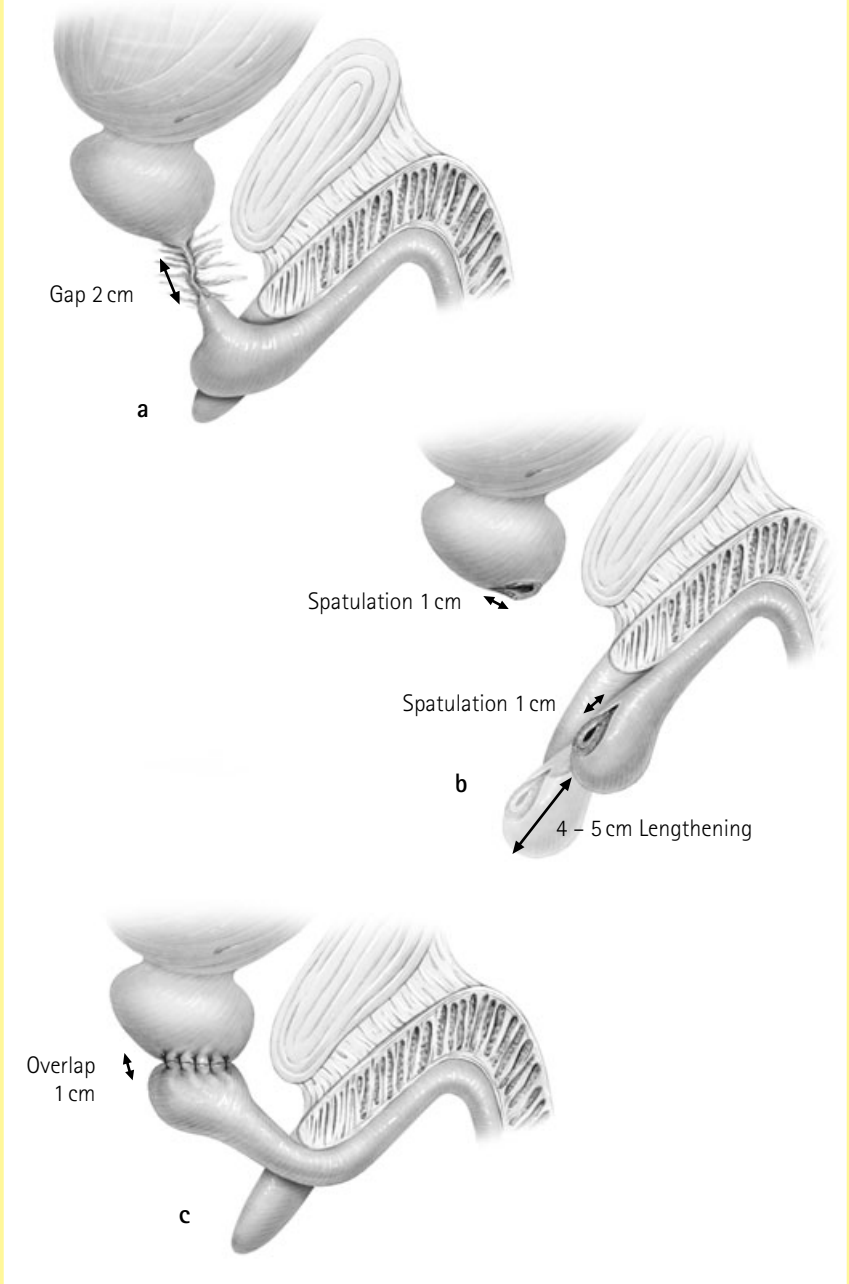
Specific equipment to facilitate the procedure includes a ring retractor (I use the Turner-Warwick ring retractor) a Travers self-retaining retractor and a gorget, all as a matter of routine. If any bone resection is necessary then I use a Capener's gouge (11 mm) with a hammer and a pair of double-action bone nibblers.

Figure 1

Many surgeons use the so-called 'exaggerated lithotomy' position but the risks of neurovascular complications with this are a concern. I prefer what I term 'social lithotomy' which I think is self-explanatory. The patient should have thromboembolic deterrent stockings and inflatable leggings to provide intermittent compression of the legs, which should be supported in special stirrups. These items minimize the risks of deep vein thrombosis, compartment syndromes and neurological problems.

The skin is prepared from the umbilicus down to the mid thigh and the patient draped to expose the perineum and the suprapubic area around any suprapubic catheter site or in case access to the suprapubic area is required for more complicated patients. Prophylactic antibiotics are given intravenously with anaesthesia.

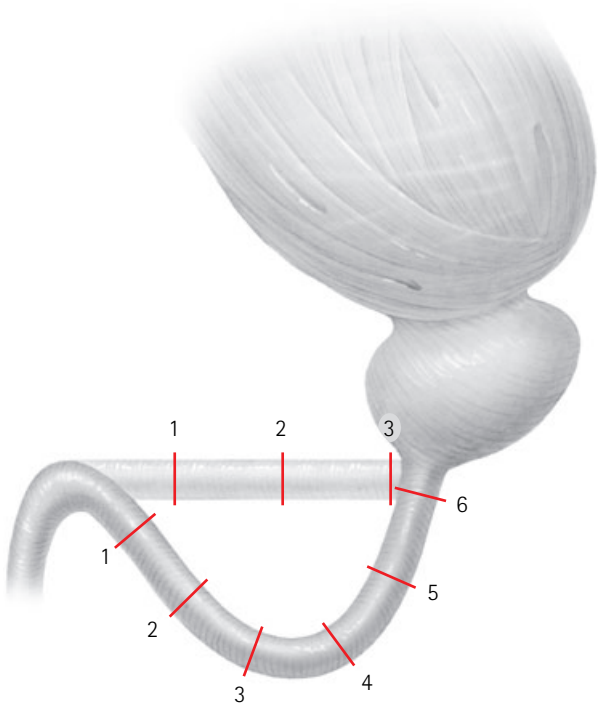




Figures 2 and 3

There are two main principles; first, the bulbar urethra is elastic and can therefore stretch to allow bridging of any defect in length and the centimetre or so required for a spatulated anastomosis (Fig. 2). Second, the natural course of the bulbar urethra is a half to five-eighths of a circle (Fig. 3). Although this is not a true geometric curve, nonetheless the geometric relationship that the circumference of a circle is $\pi \times$ diameter means that the diameter of the half to five-eighths of a circle from the peno-bulbar junction to the apex of the prostate is 30–40% shorter than the natural course of the bulbar urethra. Thus straightening the natural curve of the bulbar urethra will also help to bridge any defect in length and allow a tension-free anastomosis. The curve of the bulbar urethra is produced by the base of the penis at the point when the two crura come together to form the shaft of the penis, and the underlying pubic symphysis. Separating the crura, coupled with a wedge resection of the inferior aspect of the pubis, will allow this curve to be straightened.

As a general rule, the natural elasticity of the bulbar urethra will allow resection of 1–2 cm of the bulbar urethra or bridging of a defect of that length and a spatulated anastomosis; and the straightening of the natural curve of the bulbar urethra will gain an additional ≥2–4 cm according to circumstances.



N.B. figures represent approximate length in centimetres

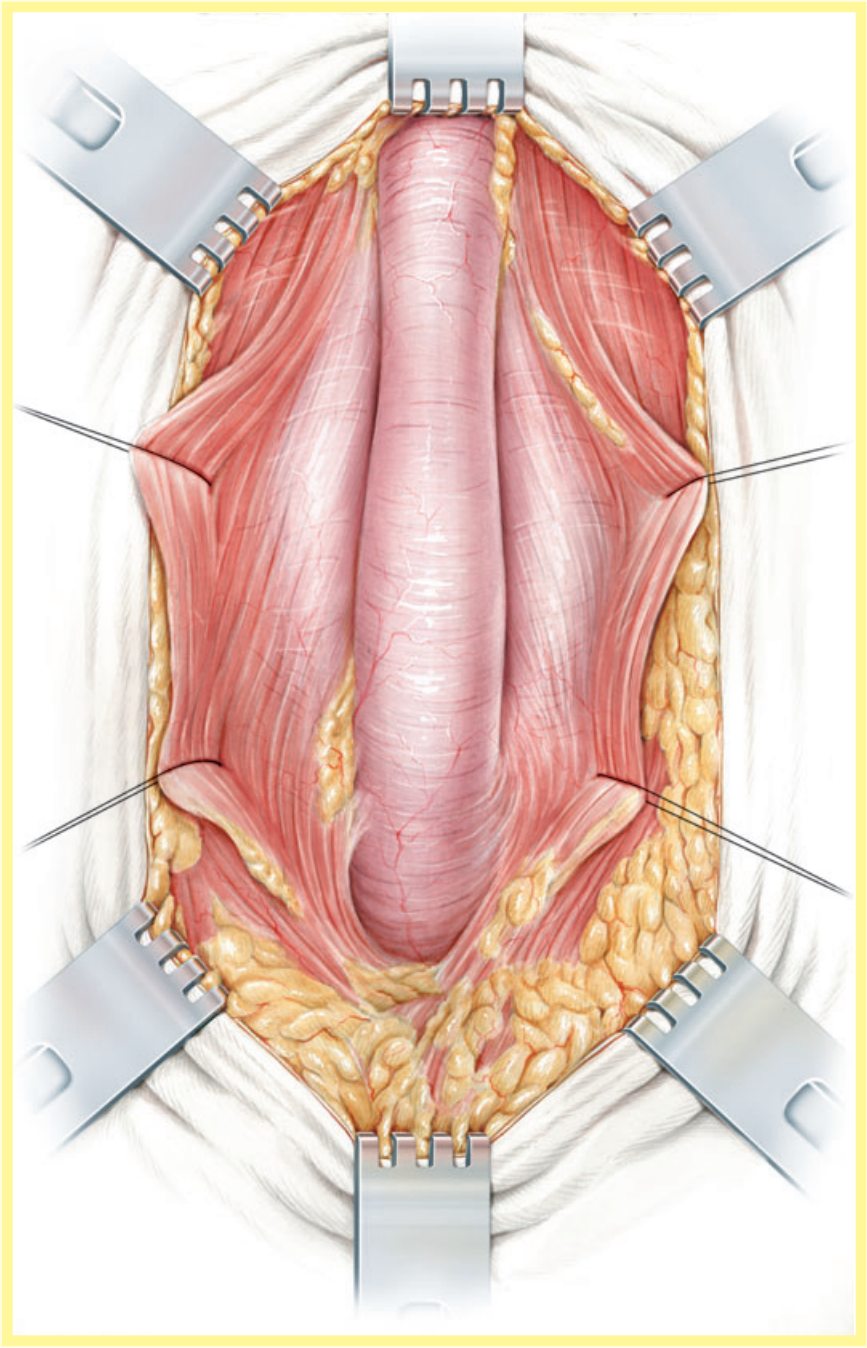


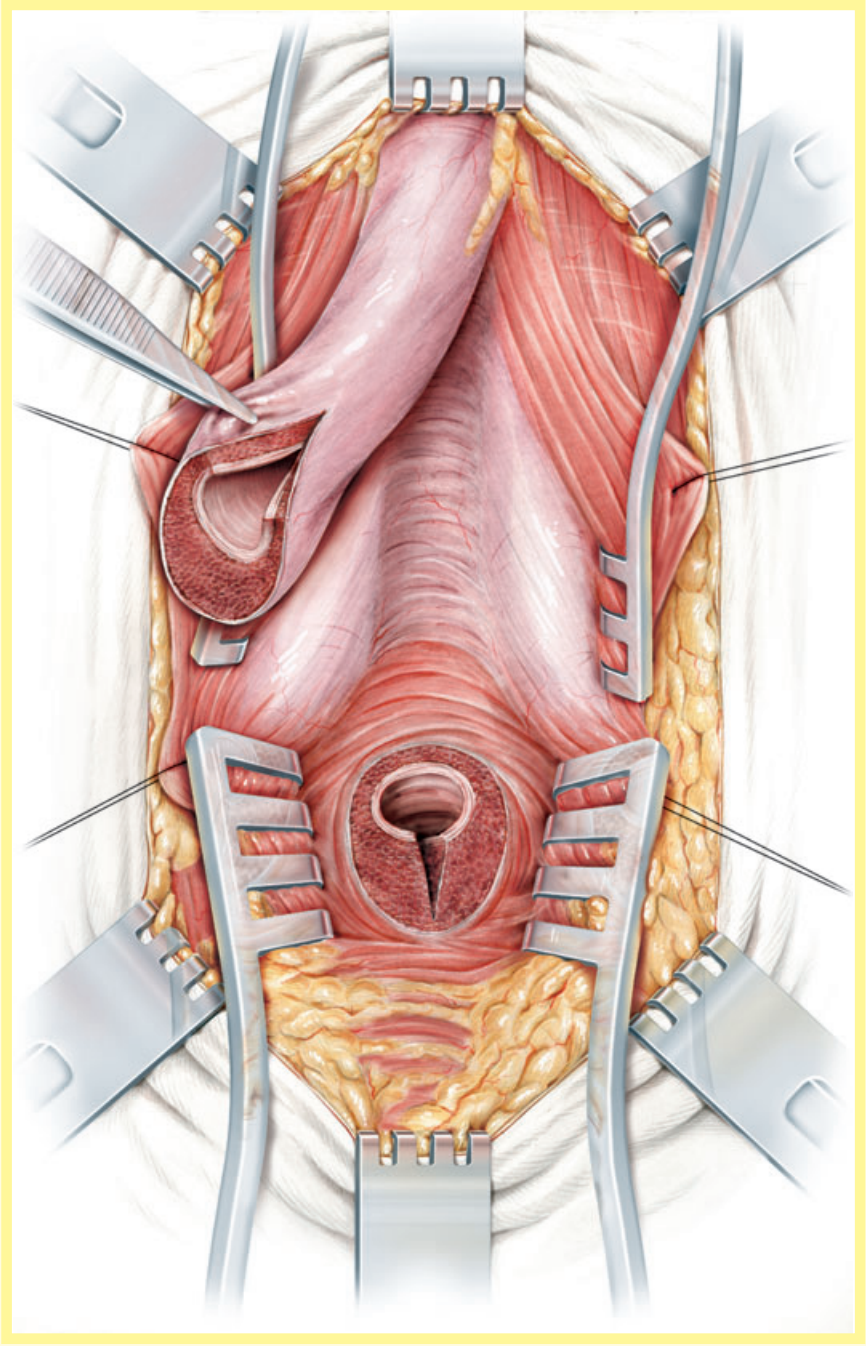
Figure 4

A midline perineal incision, ≈10 cm long (Fig. 1), is made along the line of the raphe, almost to the anal margin. The incision is deepened through the subcutaneous tissue, Colles' fascia and onto the bulbospongiosus muscle in the centre of the wound, exposing the urethra itself, distal to bulbospongiosus, in the upper part of the wound and the subcutaneous part of the external anal sphincter in the lower part of the wound. The bulbospongiosus muscle is then carefully reflected off the bulbar urethra and retracted out of the way. This frees the ventral aspect of the urethra back to the perineal body. The proximal bulbar urethra is then separated posteriorly from the perineal body by sharp dissection, all the way up to the membranous urethra. It is then separated dorsally from the tunica albuginea of the penis by dividing Bucks' fascia on either side of the urethra, which is what tethers it in place. The bulbar urethra should now be completely free from the peno-bulbar junction, all the way up the membranous urethra. The remaining postero-lateral attachments are the points where the bulbar arteries run into the corpus spongiosum on either side. For AU of the bulbar urethra, these can be left alone in most instances. For pelvic fracture urethral injuries they will need to be ligated and divided if they are still intact following the injury.

Figure 5

A 20 F catheter is then passed down the urethra to the site of the obstruction, if this is not obvious. The urethra is then transected through the site of obliteration, trimmed back to healthy tissue on either side and spatulated, dorsally on one side and ventrally on the other. Healthy tissue is judged by a healthy looking epithelium and a granular appearance of the spongiosum with no plaques of scar tissue on either.

After a severe crush injury with loss of urethral continuity and apparent separation of the two ends of the urethra, this dissection may be difficult because of the associated scarring. Nonetheless, the principle is the same; the two ends are freed up proximally and distally and then trimmed and spatulated.



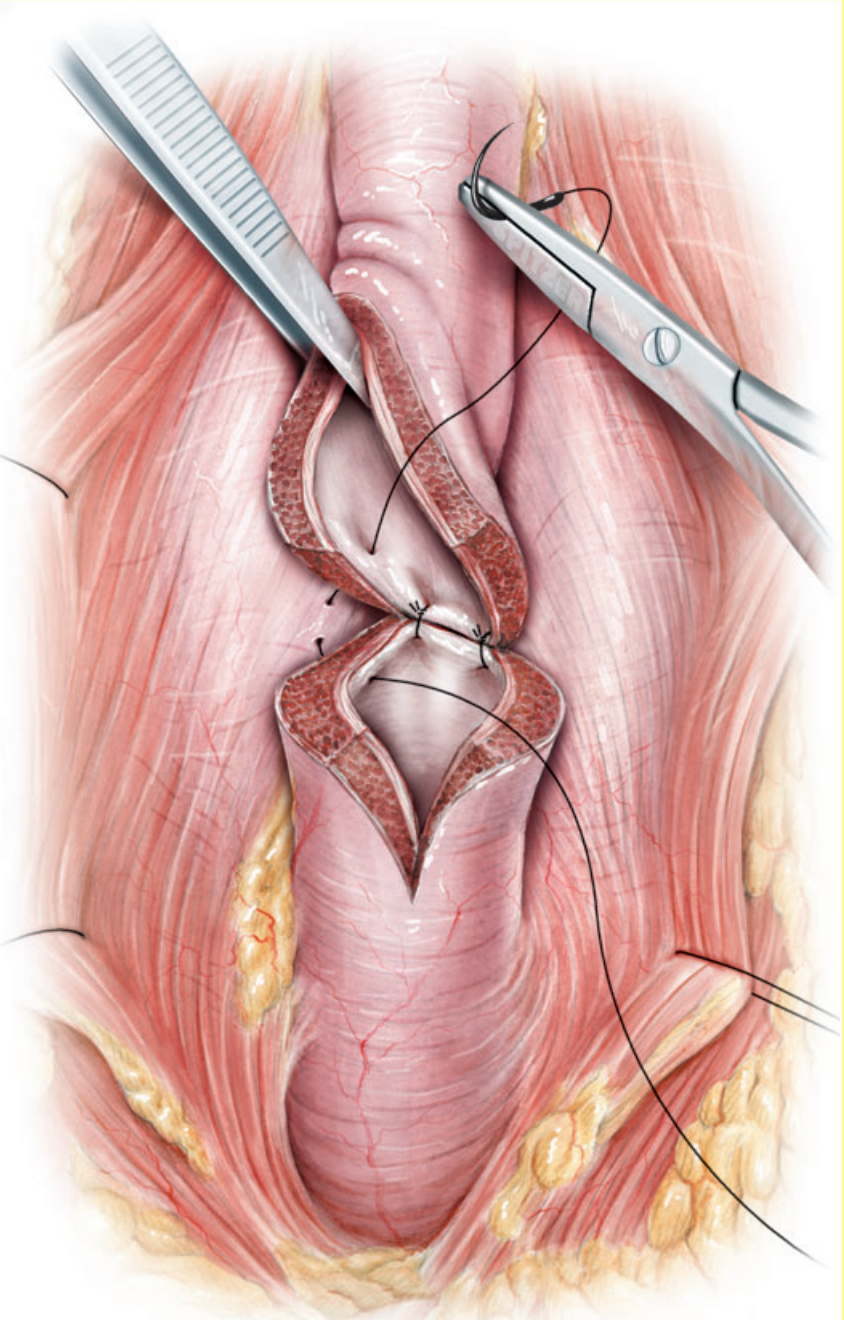
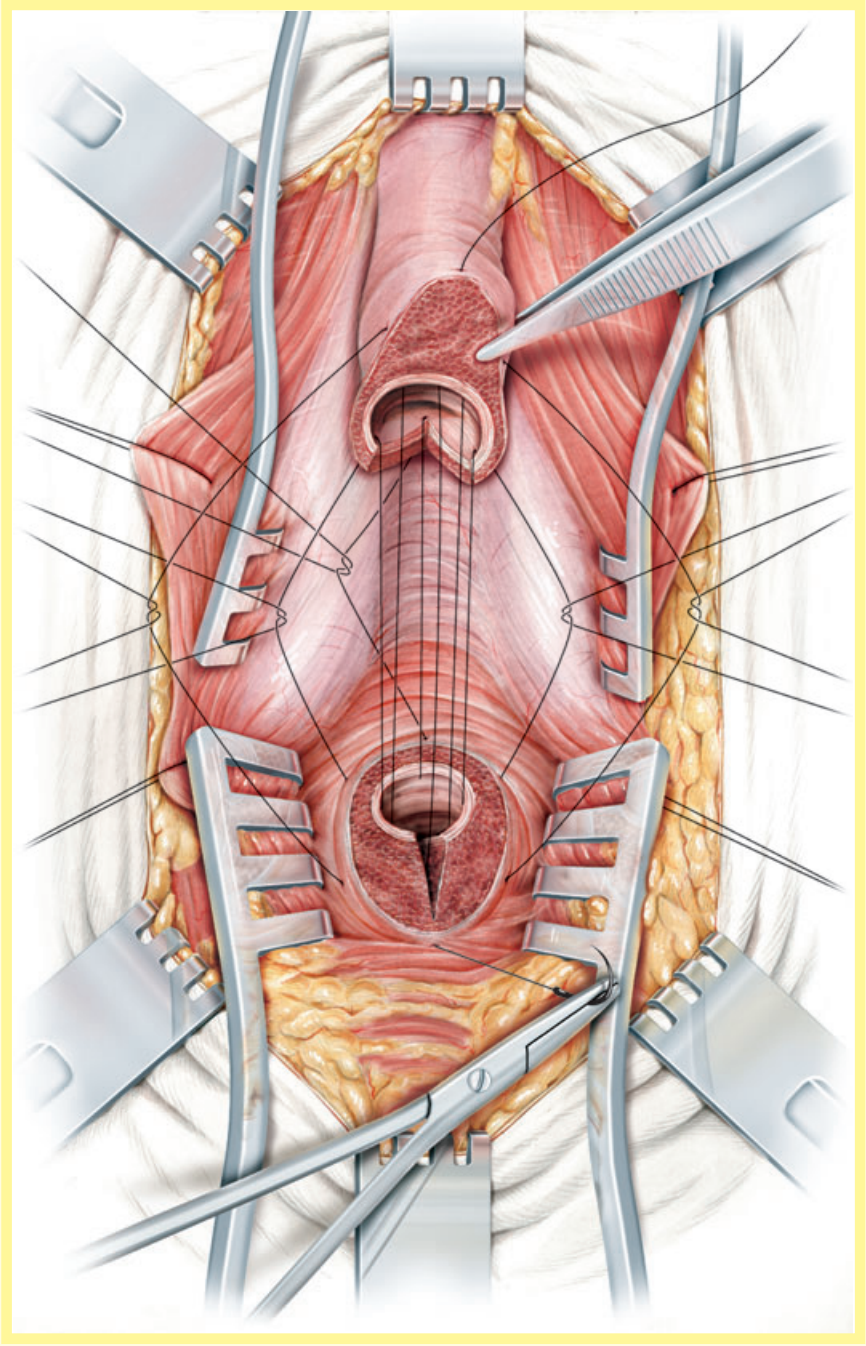


Figure 6

In an uncomplicated situation, where it is clearly possible to bring the two ends of the bulbar urethra together with no tension, nothing need be done other than to make a spatulated anastomosis. Six to eight 5/0 polyglactin or other absorbable sutures are placed around the circumference of the repair. Each suture collects the full thickness of the dorsal aspect of the distal urethra, then a 'bite' of the tunica albuginea at the site where the anastomosis is to lie, and then the full thickness of the distal aspect of the proximal urethra, so that the knots will be tied on the inside of the urethra. The first suture is placed in the dorsal midline and then two on either side at ≈0.5 cm intervals. Picking up the tunica albuginea and the spacing of these first five sutures stabilizes the anastomosis and holds it spatulated open as the two ends of the urethra are brought together. The ventral hemi-circumference of the urethra is then closed by three full-thickness sutures, tying the knots on the outside. For distal bulbar anastomotic repairs, the sutures can be placed and tied one at a time.

Figure 7

For more proximal bulbar anastomosis it may be easier to place all eight sutures, clipping the two ends one by one, and retracting them out of the way, 'parachute style', and then tying them all, one after the other, at the end.



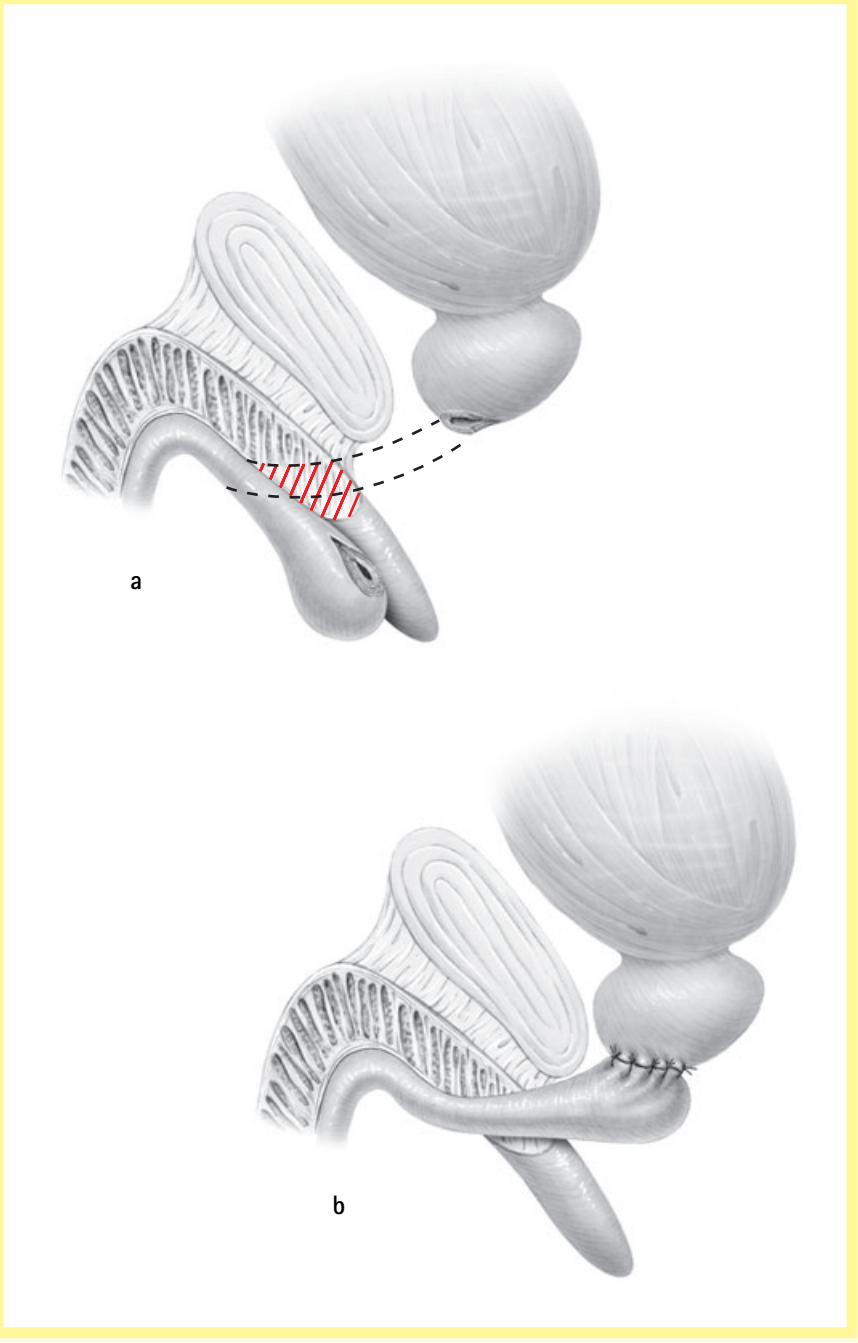
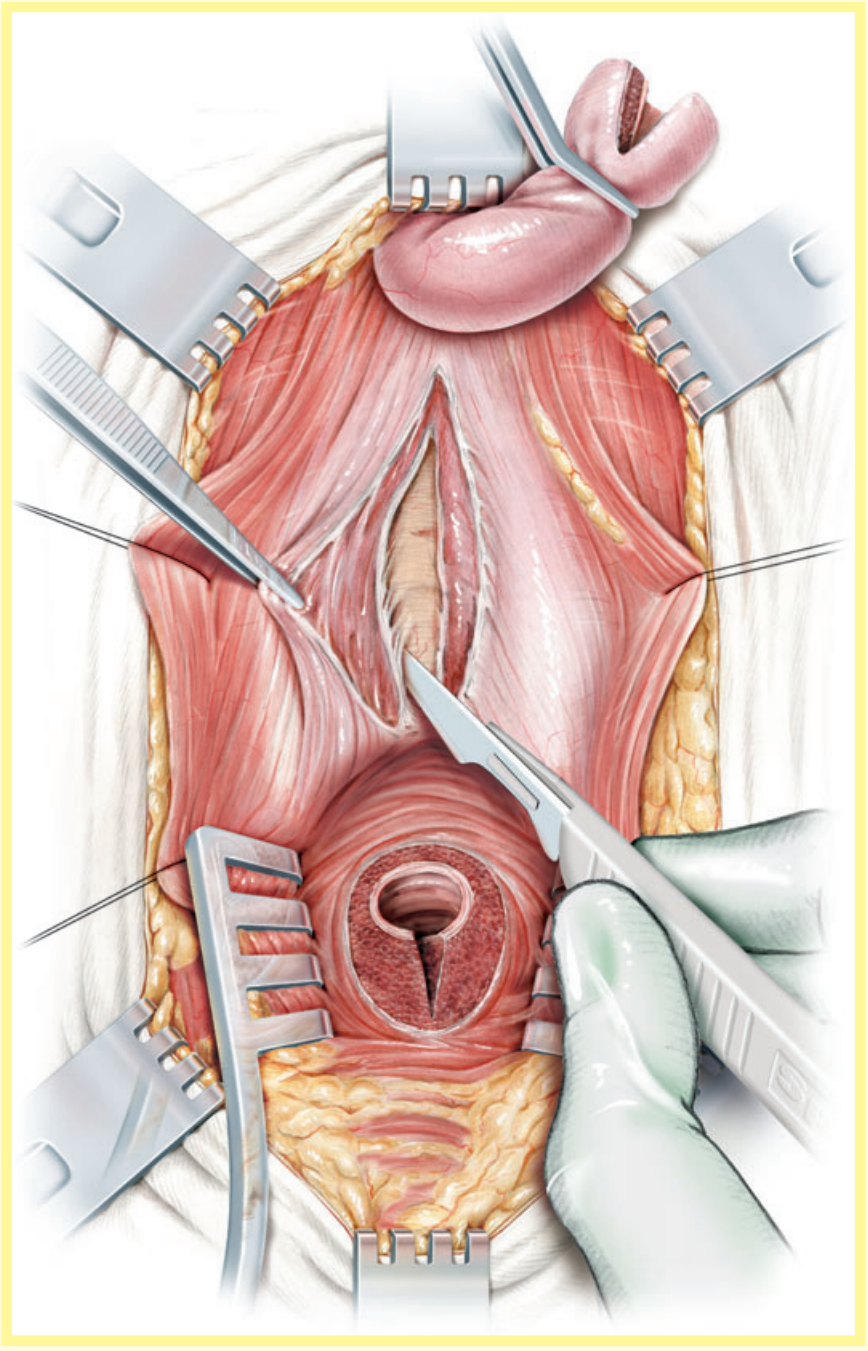


Figure 8

In more complicated cases where there has been a more significant loss of length, there may be tension at the attempted anastomosis if only the urethra has been mobilized to allow it to stretch. There are two ways of resolving this. The first is to reduce some of the curvature of the bulbar urethra and thereby reduce the tension on the anastomosis. This can be achieved by separating the two crura at the base of the penis where they first come together and then run together for 5–7 cm distally as two separate structures bound together by their fascial coverings. There is a potential space between them here that can be opened until, more distally, they fuse together to form a single functional unit.

Figures 9 and 10

If the ventral midline between the corpora is carefully incised to open the plane between them then the reconstructed urethra can lie within the inter-crural plane and tension on the anastomosis is relieved.



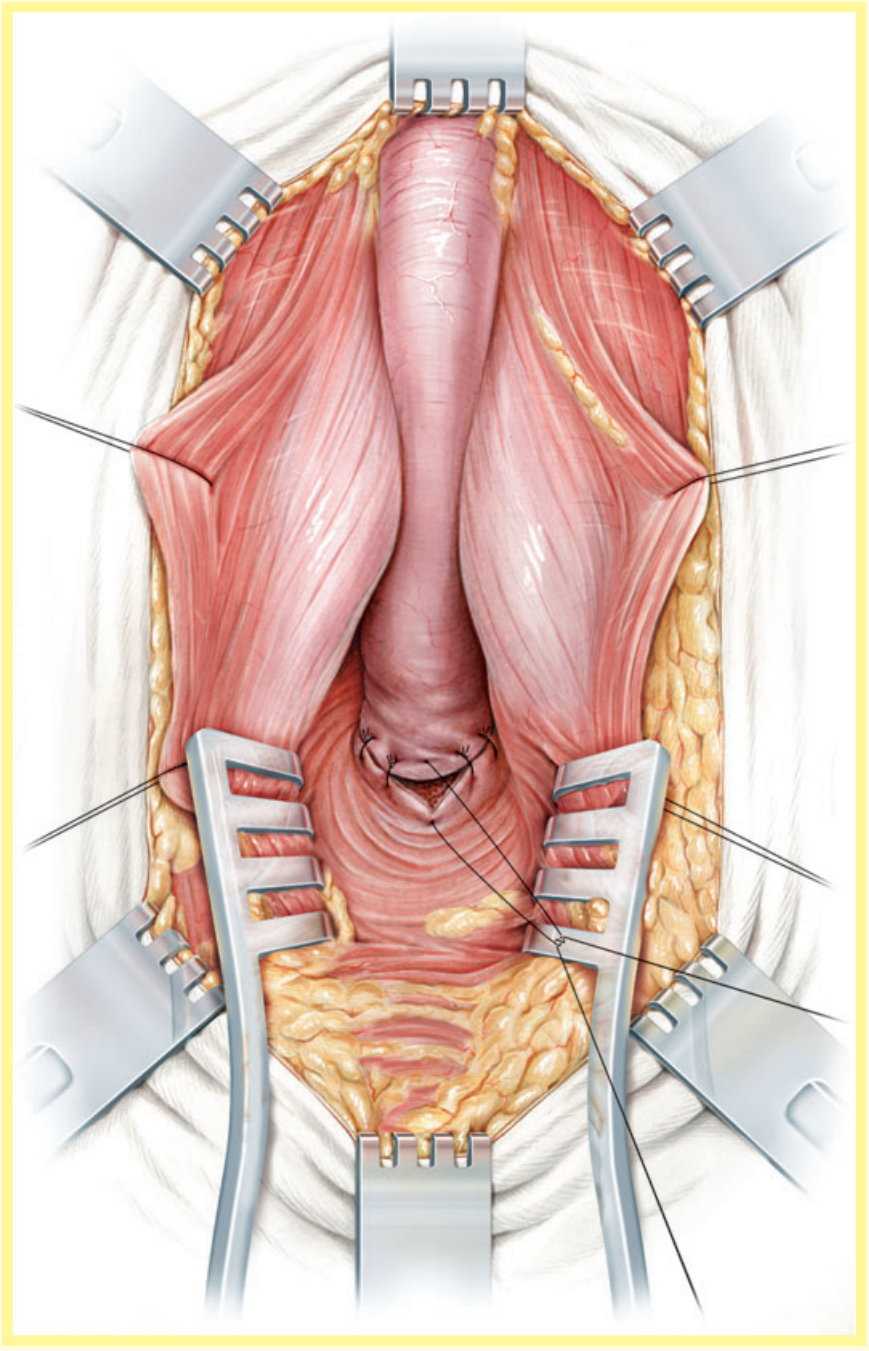
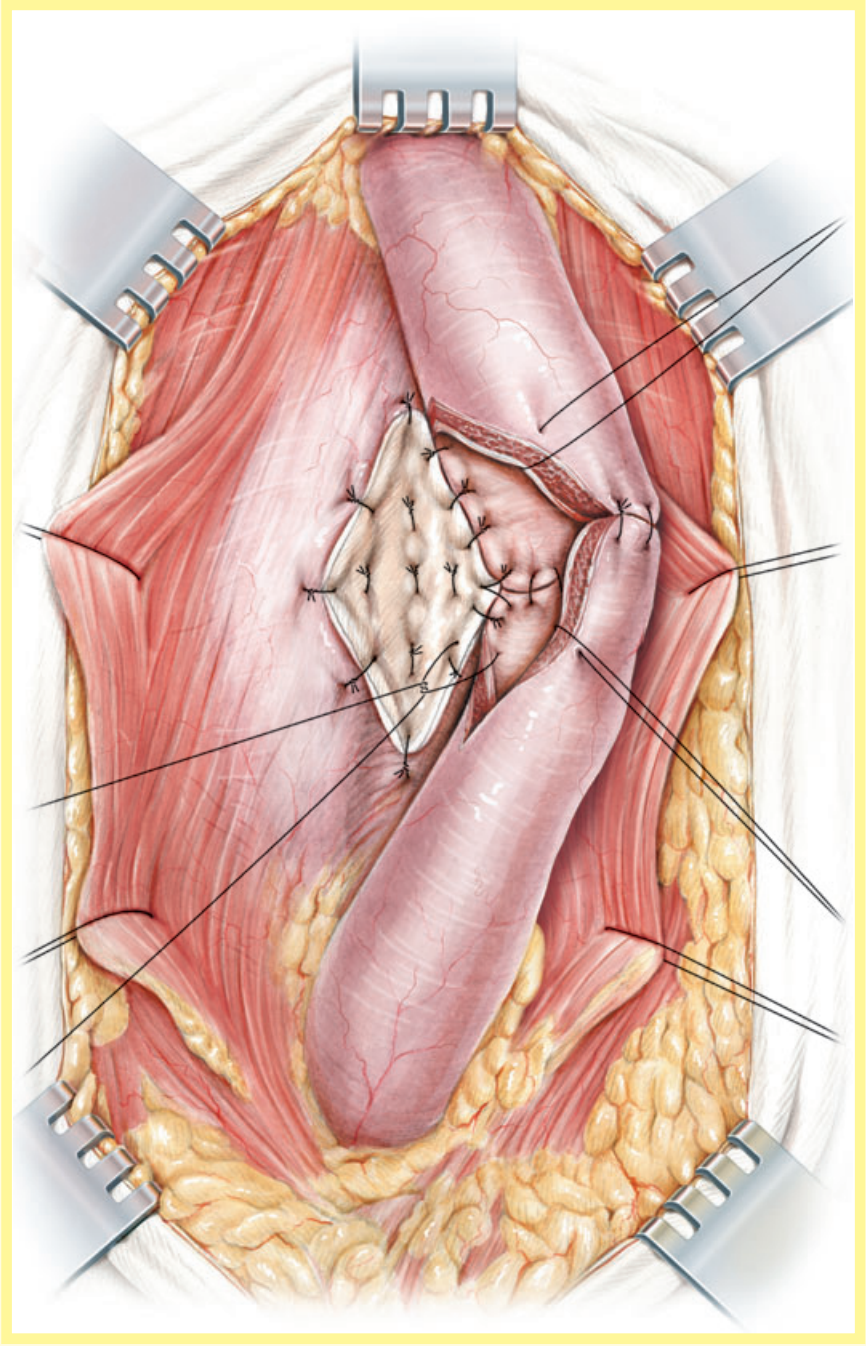


Figure 11

The alternative, for greater degrees of tension when the two mobilized ends of the urethra only just meet each other, is to create an augmented AU. Instead of spatulating the two ends of the urethra on opposite sides of their circumference, as would be done for an overlapping spatulated anastomosis, both ends are spatulated dorsally. The dorsal spatulations are then sutured round a full-thickness graft of skin or buccal mucosa quilted onto the tunica albuginea. The anastomosis is then completed by closing the ventral hemi-circumference with four or five full-thickness interrupted sutures, bringing the two ends of the urethra together.



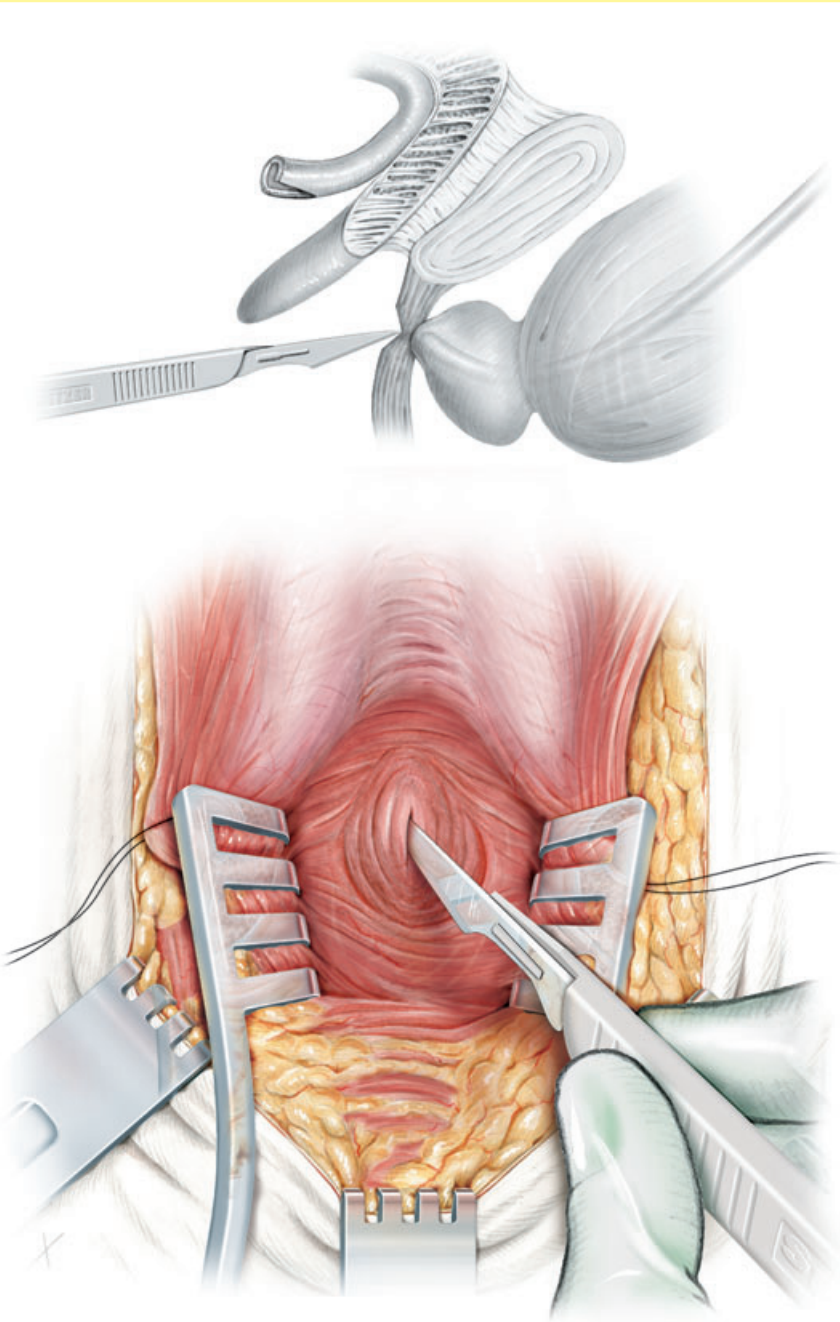


Figure 12

PELVIC FRACTURE URETHRAL INJURIES (BULBOPROSTATIC ANASTOMOSIS)

Mobilization of the bulbar urethra is as described earlier for a bulbo-bulbar anastomosis but extends more proximally to the site of obliteration, where there may or may not be a distraction of the upper end of the bulbar urethra from the more proximal urethra. The bulbar arteries on either side must be divided and sutured if they are still patent. The urethra is then transected through the site of obliteration to free it. It is then trimmed back to healthy tissue and spatulated on its dorsal aspect, and then lightly clamped with an atraumatic vascular clamp and retracted out of the way.

Most patients will have a suprapubic catheter and through the suprapubic catheter tract a metal sound or bougie can be passed down into the bladder, and then into the prostatic urethra so that the tip of the metal sound can be felt through the fibrosis. It is then possible to cut down onto the tip of the sound. The margins of the proximal urethra are then exposed by trimming as much fibrotic tissue as necessary from around them, without risking damage to the penile neurovascular structures by excessive dissection. As well as trimming fibrosis around the dorsal and lateral margins, a definitive spatulating incision is made dorsally up to the verumontanum. As well as spatulating the proximal end this ensures that all scar tissue has been incised, if not completely excised.

Figure 13

Six 5/0 polyglactin sutures can then be placed through the full thickness of the proximal urethra at 2, 4, 6, 8, 10 and 12 o'clock positions as a preliminary move to the anastomosis, and to spatulate open the posterior urethra to make sure that it is clearly visible and healthy.

Occasionally it is possible to make an end-to-end anastomosis with no further preparation. The 5/0 polyglactin sutures previously placed through the proximal urethra are then passed at appropriate points through the distal urethra and the sutures are then tied. Usually, it is necessary to do one or more of the manoeuvres designed to straighten the natural curve of the bulbar urethra and thereby shorten the length of the defect, and in turn relieve any tension at the anastomosis. The first of these is to open the intercrural plane (dotted line) as described above and illustrated in Figs 8–10. In about half of patients this is all that is necessary.

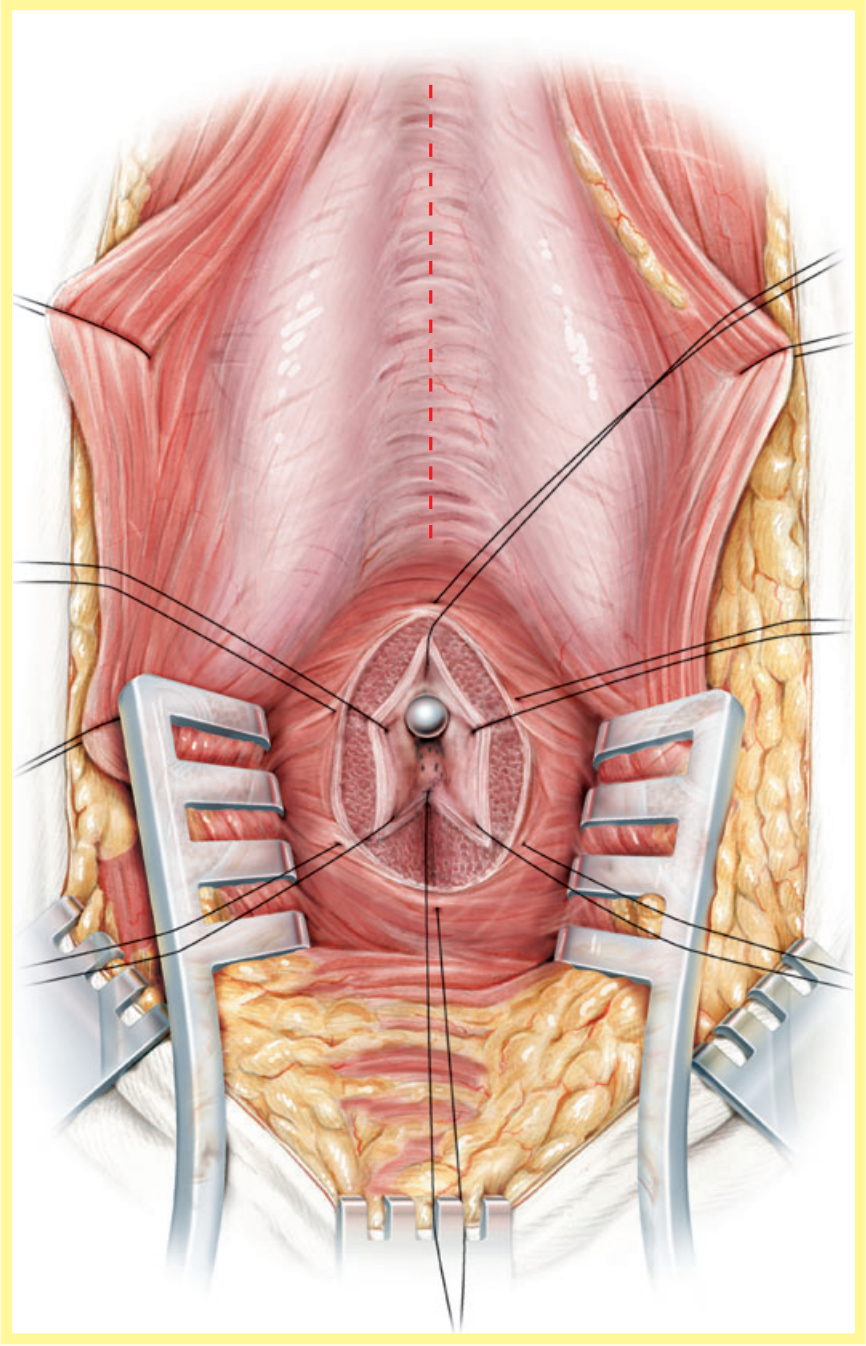
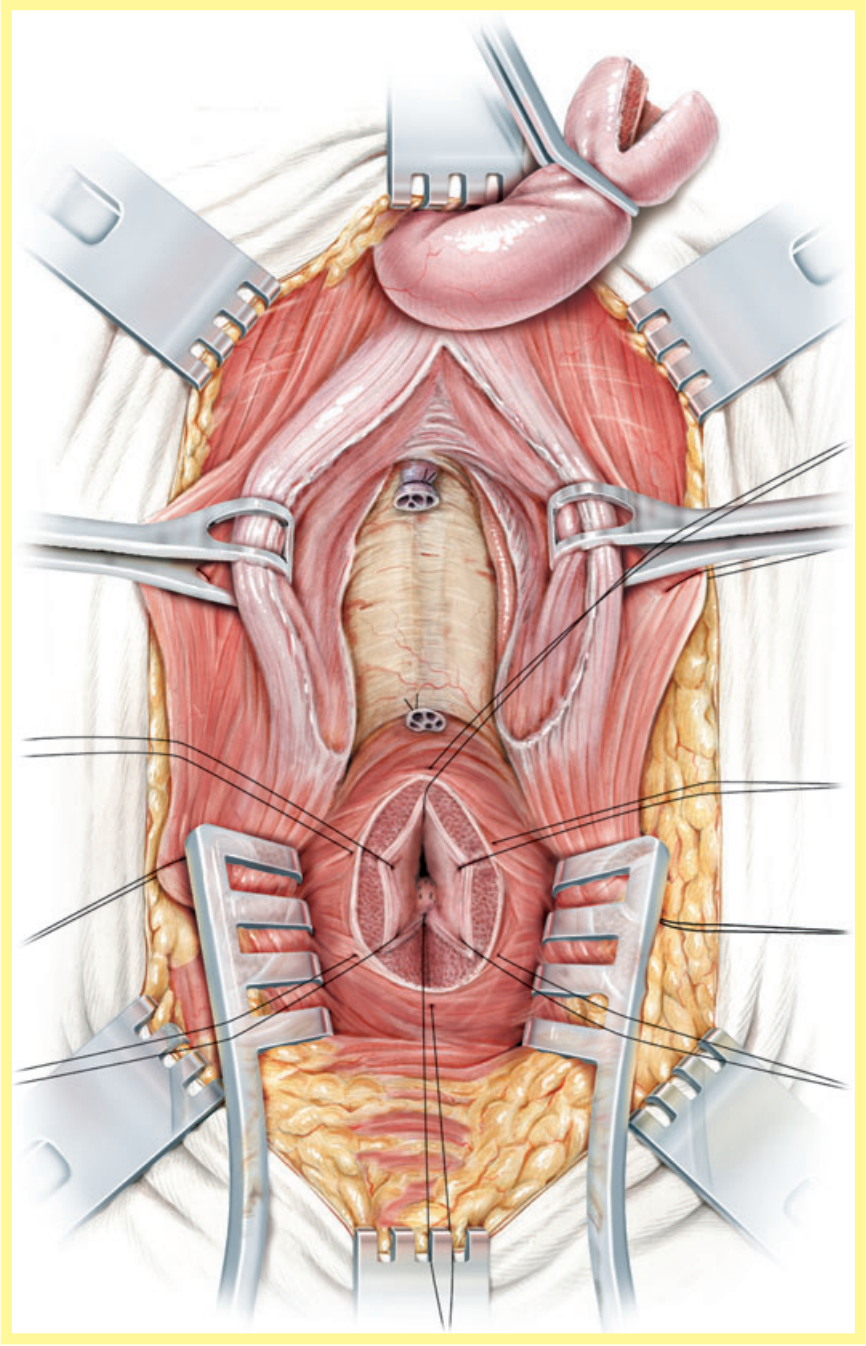


Figure 14

In some cases there will still be tension of the anastomosis and an obvious 'step' produced by the pubic symphysis along the path between the peno-bulbar junction and the apex of the prostate. This 'step' is therefore removed by an inferior wedge pubectomy.

Figure 15

Having opened the intercrural plane as far distally as possible, the two crura then need to be retracted laterally off the pubic symphysis ligating and dividing the deep dorsal vein of the penis. In achieving this mobilization of the crura from the pubic symphysis, the dorsal artery and sometimes the nerve will be exposed on each side of the anterior aspect of the respective crus. This allows the arteries and nerves to be identified, retracted and therefore preserved.



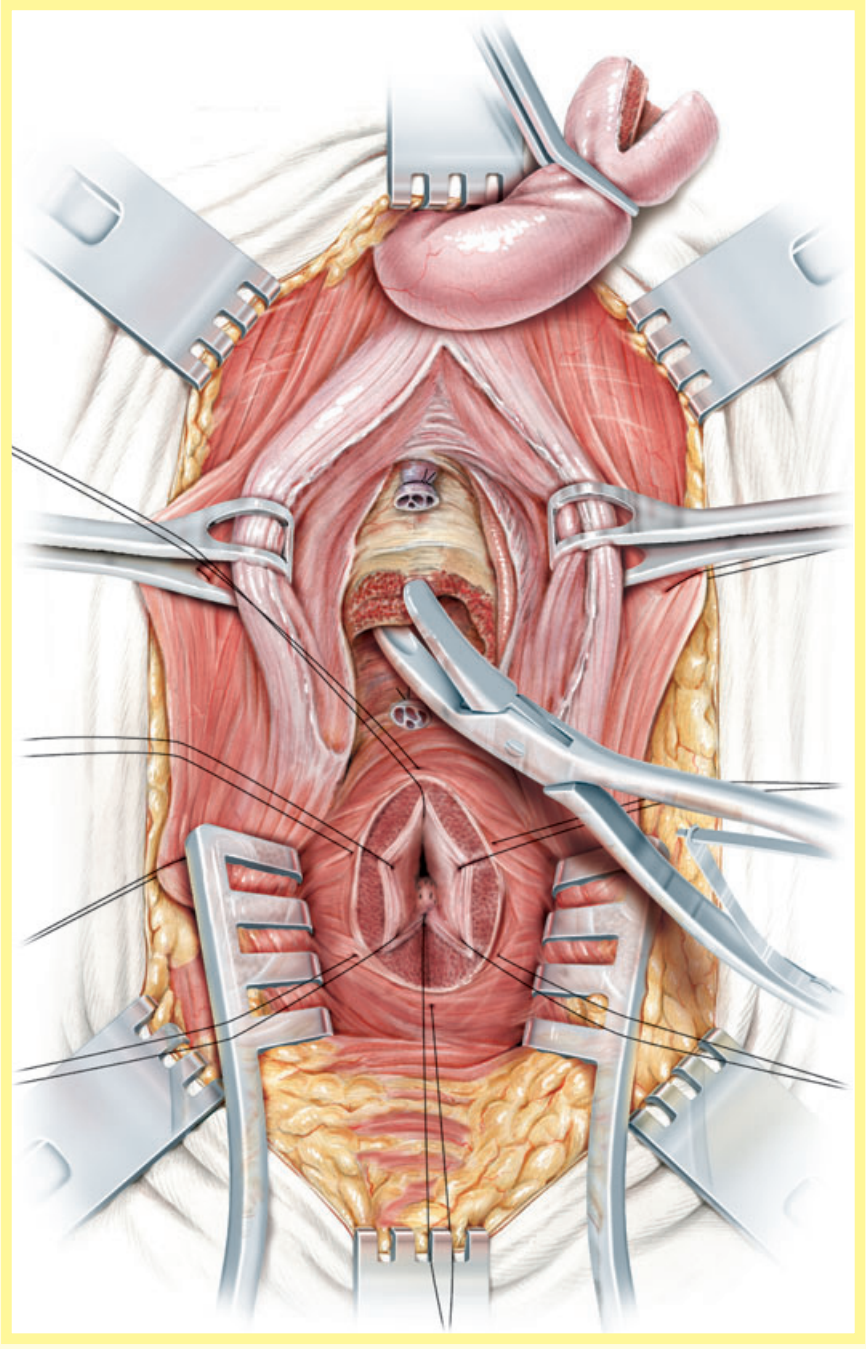
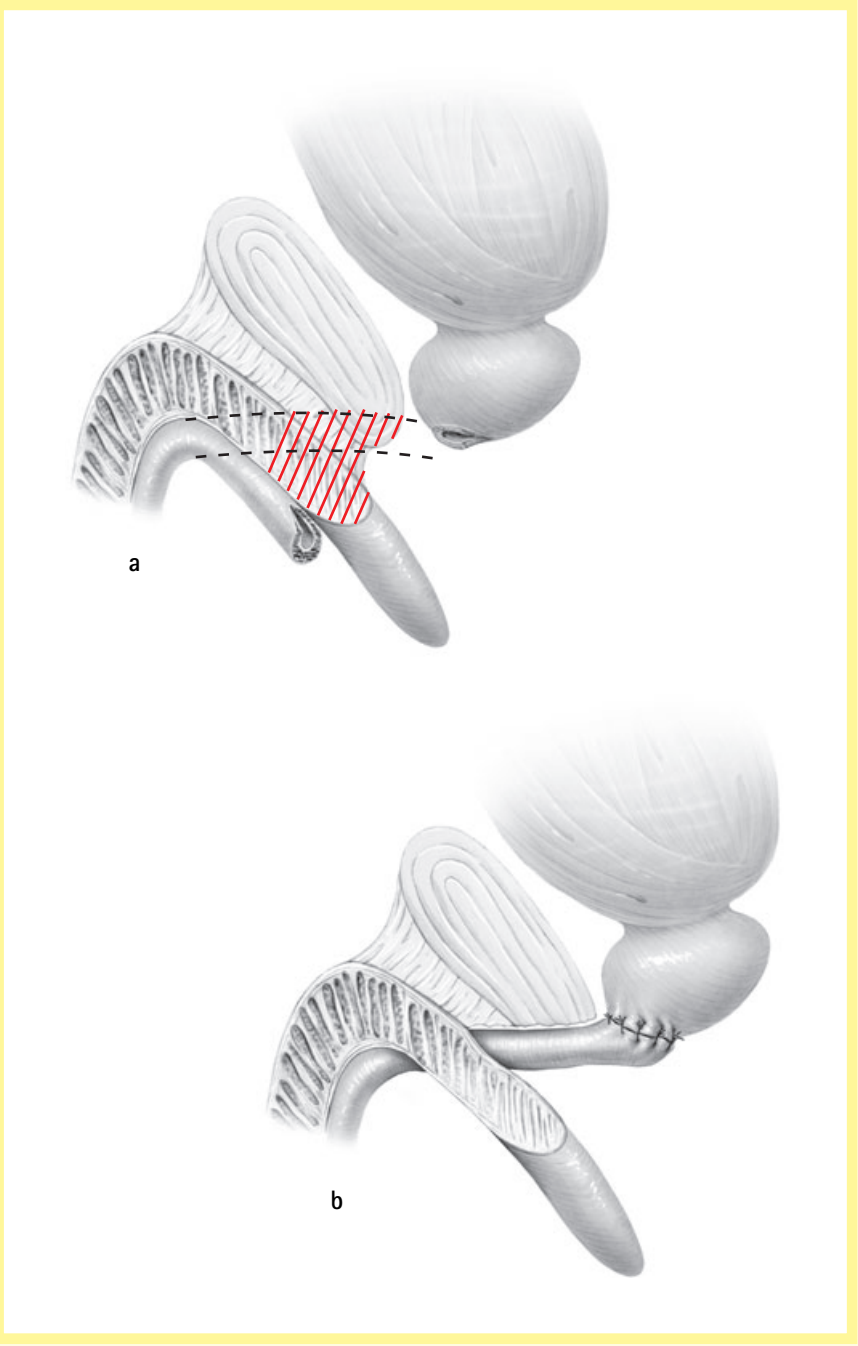


Figure 16

It is then safe to incise with diathermy through the pubic periosteum, in the window of the pubic symphysis exposed down on to the bone, and then to excise a wedge of bone with a Capener's gouge and hammer, or with the double-action bone nibblers, to create a trough and thereby a straight channel from the bulbo-penile junction to the spatulated proximal urethra.

Figure 17

Sometimes even this is not enough to achieve a tension-free anastomosis. Unfortunately, having opened the intercrural plane as far distally as possible it is not possible to split the penis further without direct damage to the penis, thereby risking erectile dysfunction as a result. Therefore, rather than going between the crura up as far as the peno-bulbar junction, the surgeon must re-route the urethra around the crus at the peno-bulbar junction to straighten the natural curve of the bulbar urethra completely.



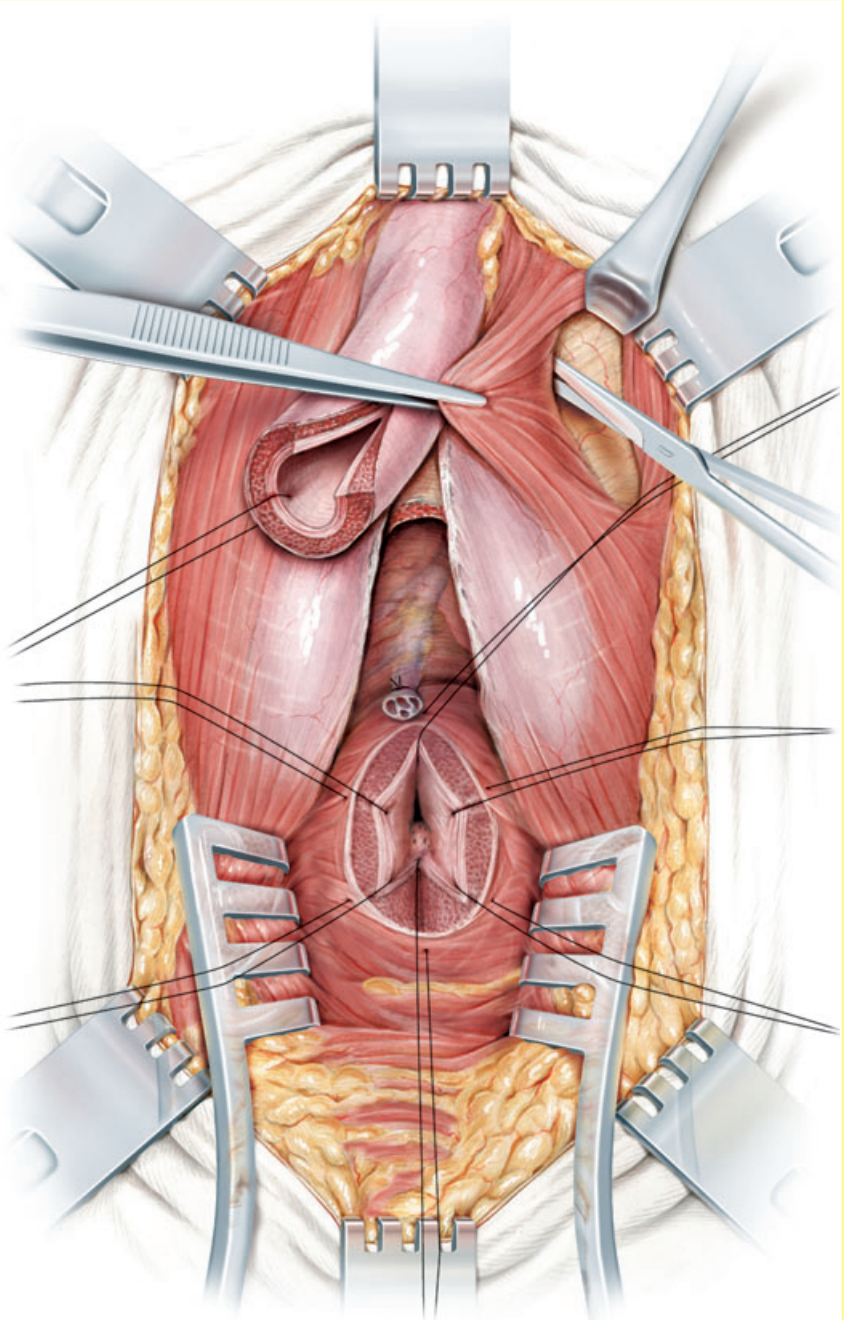
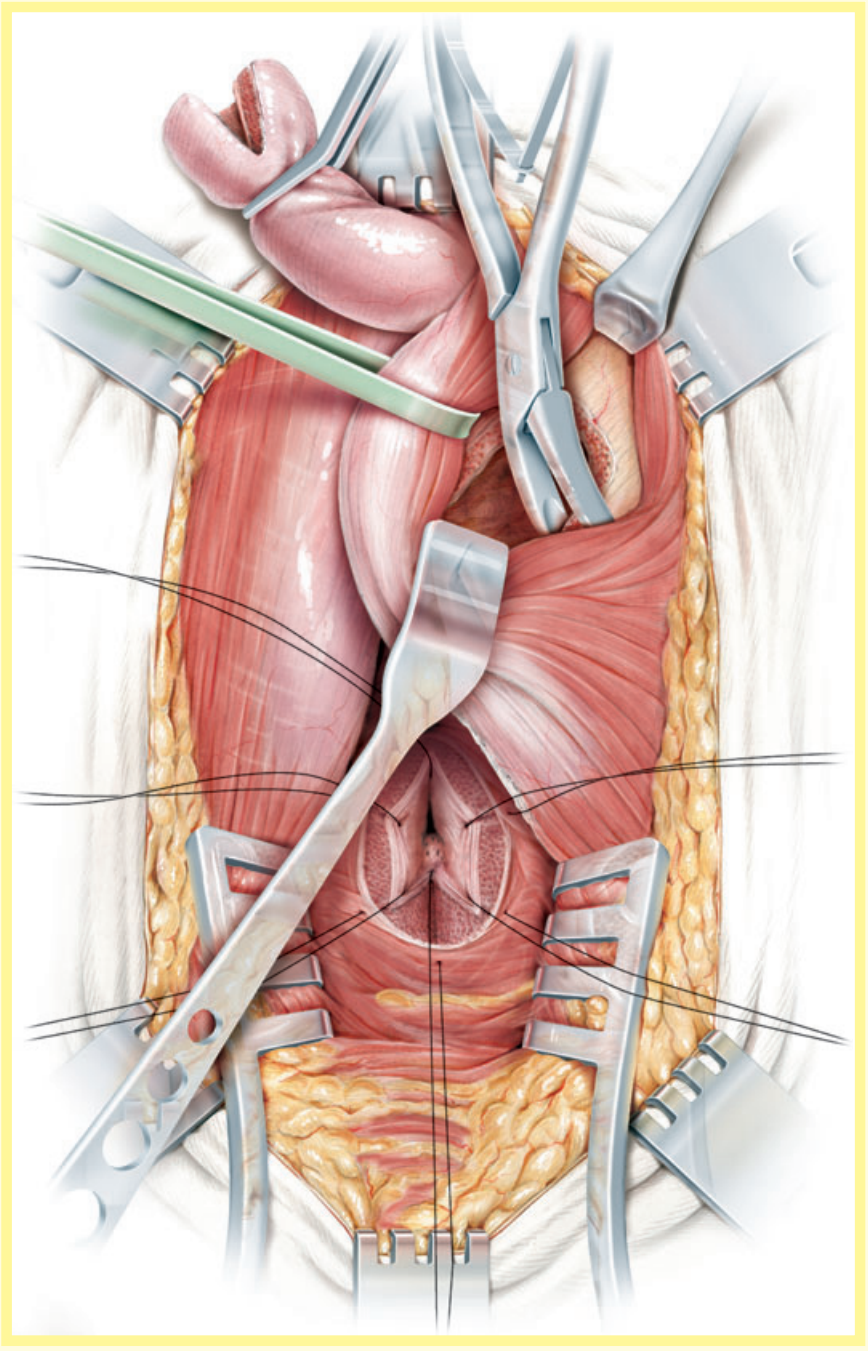


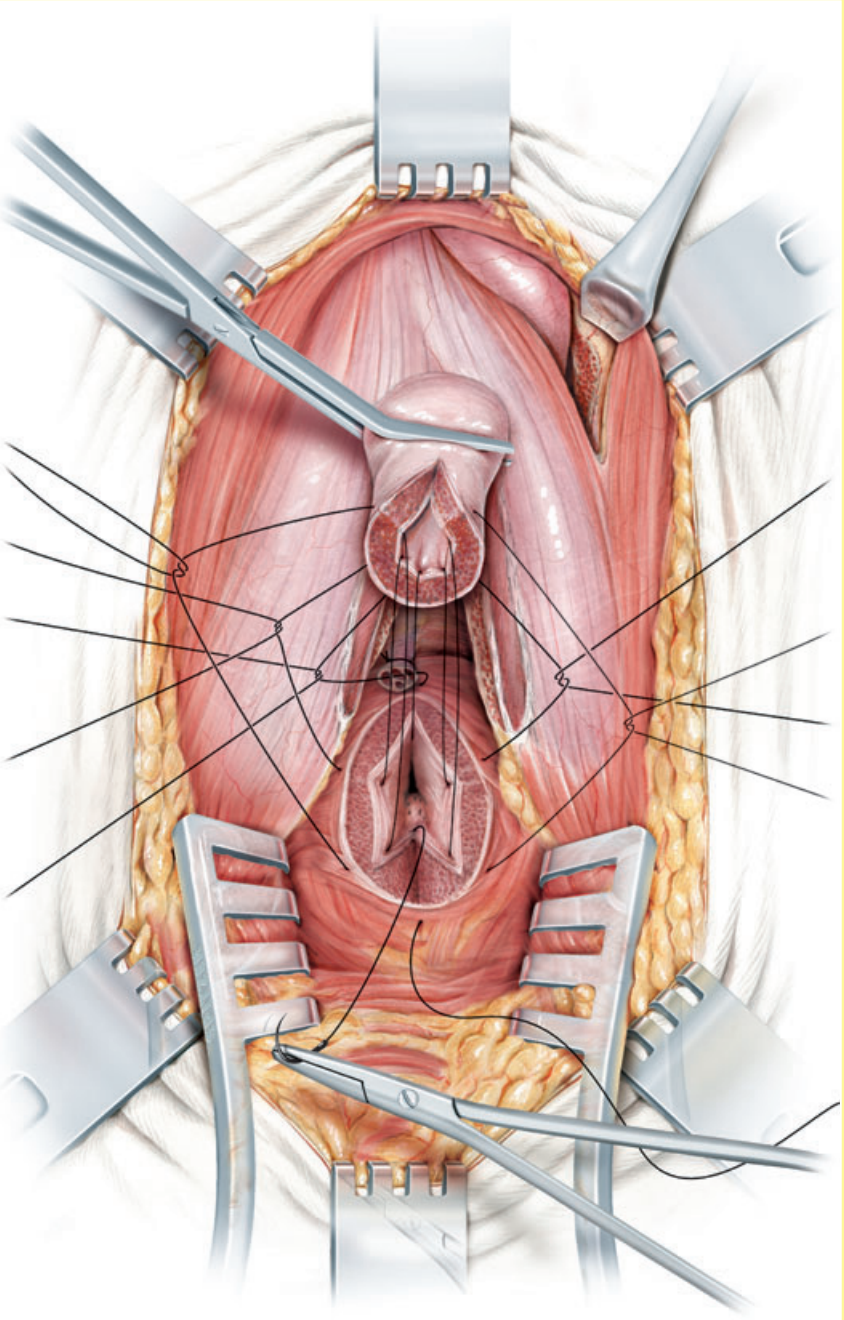
Figure 18

Having mobilized the bulbar urethra as far forward as necessary, the anterior aspect of the pubis is exposed just to one side of the pubic symphysis (the left side for a right-handed surgeon) by retracing the penis to the other side. The crus of the penis can then be detached from the pubic periosteum for 3–4 cm in the depths of the wound by carefully dividing its fascial attachment. The crus and its neurovascular structures can then be retracted medially, out of the way, to expose the inferior pubic ramus.

Figure 19

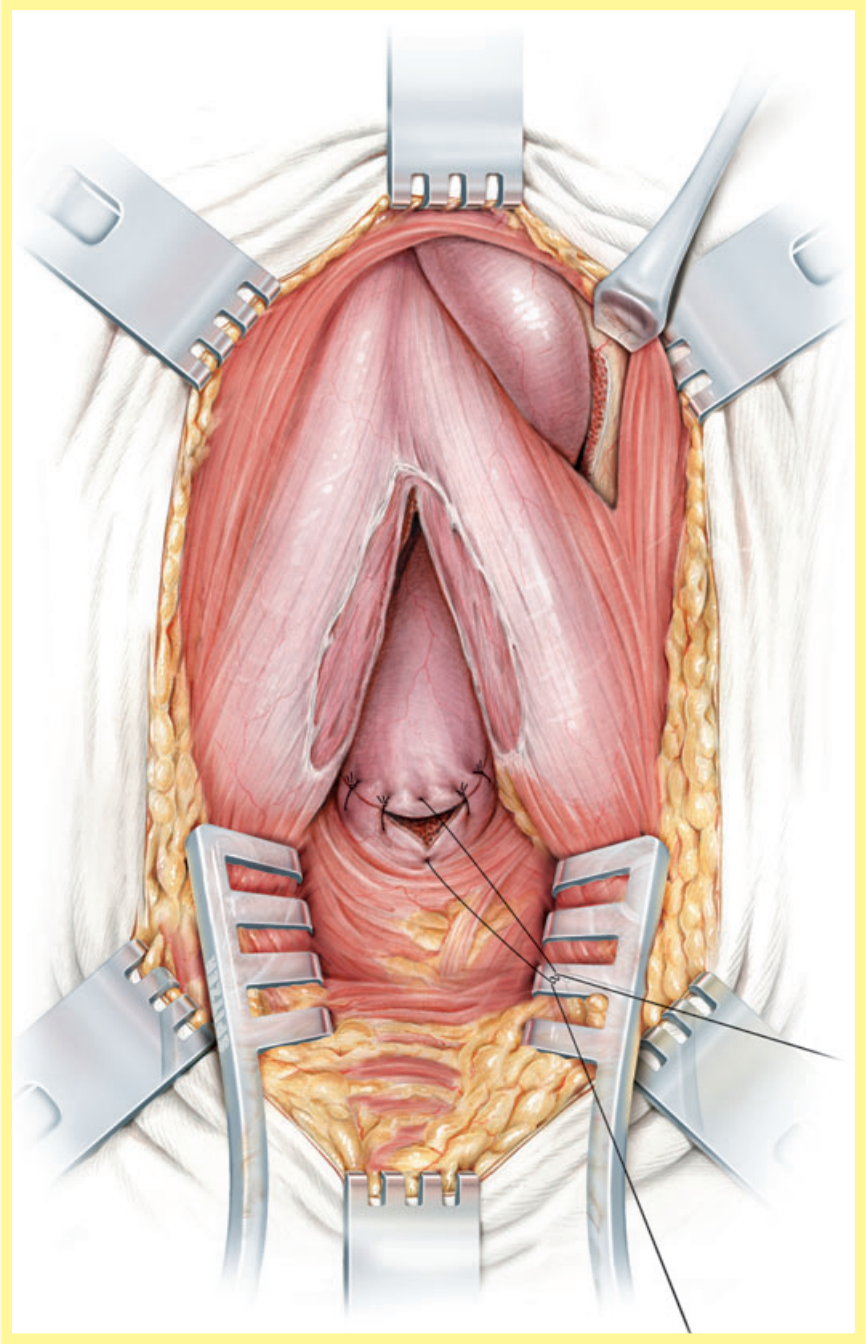
It is then possible to incise with diathermy through the pubic periosteum down to bone and then gouge out some more bone from above to connect with the inferior pubectomy already created from below. There is now a clear channel around the left crus of the penis through the inferior pubectomy to allow a tension-free anastomosis to the proximal urethra.





Figures 20 and 21

The urethra can now be passed through the bony channel for an anastomosis made with six 5/0 polyglactin sutures placed and tied in the usual 'parachute' style. At the end of the procedure, a 16 F silicone Foley urethral catheter is placed and if a wedge pubectomy has been used, with or without re-routing of the urethra, a small drain is left in the cavity thereby created for the first day or two after surgery. A 16 F catheter is chosen as this will allow good urinary drainage down the inside and is small enough to allow drainage of blood and other secretions down the urethra around the outside of the catheter.



POSTOPERATIVE CARE

The patient is usually able to eat and drink when they are awake. They can be mobilized the next day; 12–24 h of bed-rest immediately after surgery reduces the amount of scrotal swelling and therefore discomfort they might otherwise have. In most instances, there is little pain and recovery is generally uneventful.

A peri-catheter urethrogram is taken after 3 weeks to ensure that there is healing of the anastomosis, and the catheter is then removed. It is very unusual for there to be any leakage at 3 weeks so it is reasonable to take the peri-catheter urethrogram in 2 weeks (or even earlier), accepting that incomplete healing is more likely at this stage.

Failure of the operation is almost always a result of ischaemia, either because of a poor blood supply or because of tension at the anastomosis. Because these phenomena act immediately, a patient who is going to have problems usually has them within a few weeks or even within a few hours of removing the catheter. If the patient is asymptomatic with a normal urethrogram (or endoscopic appearance), a normal flow rate and no residual urine at 3 months after surgery they will almost certainly be satisfactory thereafter.

THE DIFFICULT CASE

The most unpredictable part of the operation is the ease with which the proximal end of the urethra can be identified and spatulated, having transected and reflected the bulbar urethra distally. A normal healthy posterior urethra is often much further into the pelvis than it feels it is going to be when palpating the tip of the bougie/sound in the posterior urethra through the plaque of fibrosis. As the fibrosis is trimmed away so the posterior urethra seems to vanish inwards and subsequent manoeuvres become progressively more difficult. Dealing with the bleeding from the edges of the dissection can sometimes be difficult also, but this is usually less of a problem than poor access. Dealing with these points is generally a matter of experience.

Truly difficult cases are truly difficult for other reasons. As noted, the commonest cause of failure is ischaemia; thus although the operation itself might be straightforward, results are less satisfactory in elderly patients and in smokers or diabetics, as they are more likely to have peripheral vascular disease. Those patients who have obviously had severe damage to their pelvic and perineal blood supply because they have had more severe injuries are more likely to be difficult anyway, but those who have not just erectile dysfunction but also a cold and numb penis usually have severe ischaemia, and their penile and perineal vasculature should be assessed carefully before proceeding to reconstruction.

More major or unusual injuries may cause a urethral injury different from the usual obliteration at the bulbo-membranous junction. In particular, damage to the bladder neck and the prostatic urethra may be technically difficult to repair, will require an abdomino-perineal approach, and are commonly complicated by a variable degree of incontinence because there has been damage to both the bladder neck and the urethral sphincter mechanism. Severe orthopaedic deformity may also make an abdomino-perineal approach necessary, whether or not there is bladder neck incompetence or a longer than usual defect, if adequate access to the apex of the prostate is impossible from the perineum. Fistulae or false passages affecting the bladder or bladder neck region are another reason for an abdomino-perineal approach. Previous rectal injury associated with a pelvic fracture makes dissection around the posterior urethra more hazardous because of scarring and adhesions to the anterior rectal wall. Likewise, an established recto-urethral fistula makes for a more difficult procedure, but one that can nevertheless usually be completed perineally.

Pre-pubescent children are usually more difficult because they have an underdeveloped corpus spongiosum which is less elastic than in an adult. This makes it more difficult to achieve a tension-free anastomosis in the usual way.

Finally, if the patient has a coexisting anterior urethral abnormality such as a stricture or hypospadias, then the urethral blood supply may be impaired and the safety of bulbar urethral mobilization may therefore be compromised. The urethra is thus more likely to be made ischaemic by mobilization and therefore recurrent stricture more common. Such situations may require a more imaginative approach.

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