Female Urethral Reconstructive Surgery

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Introduction

Female urethral reconstruction is an uncommon surgery for urethral strictures, urethral diverticula, or urethral tissue loss (e.g., fistulas). Consequently, there are significantly less data regarding outcomes and prevention of complications compared to male urethral reconstruction. However, from available sources and anecdotal experience conclusions can be drawn. Complications can be minimized with careful preoperative assessment and focus on principles of surgical technique and approach. Intraoperative complications include hemorrhage and bladder or ureteral injury. Early postoperative complications include infection, flap or graft necrosis, and late complications include stricture or fistula recurrence, sphincteric incontinence, urethral obstruction, and overactive bladder. In addition, complications of ancillary procedures such as a Martius flap or buccal graft may occur.

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Preoperative Assessment

Many complications related to urethral reconstructive surgery are preventable because the elective nature of most of these surgeries permits careful preoperative surgical planning. Minimizing the risk of complications begins with a focused, but detailed history, physical examination of the urethral defect and vagina, assessment of urethral sphincter and detrusor function, exclusion of concomitant urethral obstruction, vesicovaginal or ureterovaginal fistula, and ureteral obstruction. Almost all patients who require urethral reconstruction have had prior surgery, so it is important to either obtain the operative reports or discuss the surgery with the previous surgeon. It is particularly important to determine if a foreign body such as mesh is in or near the wound. One of our patients failed a urethral reconstruction because of retained mesh at the site of an urethrovaginal fistula. Neither the patient nor the surgeon even knew that a mesh sling had been done previously. This unfortunate case emphasizes the need for obtaining an accurate surgical history.

Preoperative physical examination should be performed with a comfortably full bladder. Particular attention should be paid to the health of the vaginal tissue. In patients with vaginal atrophy and postradiation changes, preoperative estrogen cream may improve the quality of vaginal tissue. A careful speculum examination of the

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entire vaginal wall should assess the presence of sling erosion. Granulation tissue, drainage from a sinus tract and fistula are tell-tale signs of erosion.

In cases of urethral damage from previous vaginal or urethral surgery, the vaginal tissue is often scarred, fibrotic, and ischemic. The extent of urethral tissue loss, the integrity of the vaginal tissue, adequacy of the vasculature, and the need for advancement, lateral or pedicle skin flaps, should be assessed preoperatively (Figs. 19.1 and 19.2). Bimanual pelvic exam should focus on the presence of urethral masses or pelvic organ prolapse. When incontinence is observed from the urethral meatus, and a fistula suspected, the examination should be repeated with a finger occluding the meatus to observe leakage from the fistula itself.

Videourodynamics may show urethral obstruction, sphincteric incontinence, low bladder compliance, impaired detrusor contractility, or detrusor overactivity secondary to urethral damage. The voiding cystourethrogram (VCUG) is a critical component in preoperative evaluation of the diseased urethra. In patients with urethral obstruction, the VCUG demonstrates the site, and for those with strictures, its length and location in relation to the bladder neck. If the urethral stricture is located in the distal third of the urethra or at the meatus, imaging typically reveals ballooning of the bladder neck on voiding (Fig. 19.3). In addition, residual diverticular contrast after void-

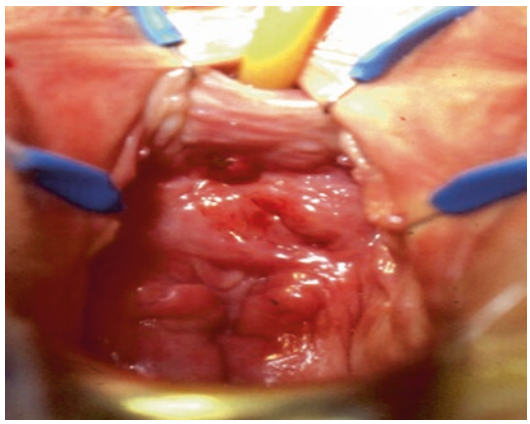

Fig. 19.1 Inspection of the anterior vaginal wall in a woman with a seemingly straightforward urethrovaginal fistula. She underwent a simple repair with vaginal wall flaps and a Martius flap, but the fistula recurred within 3 weeks. At secondary repair, a mesh sling was encountered and excised. Neither the patient nor the surgeon knew that mesh had been used in a prior anti-incontinence operation (Figure Copyrighted © J.G. Blaivas, M.D.)

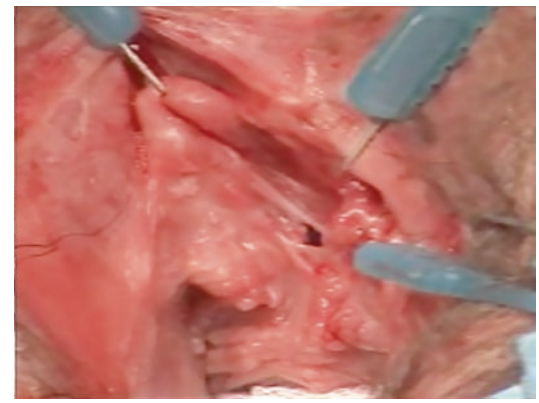

Fig. 19.2 Inspection of the anterior vaginal wall in a woman who had previously undergone an extensive urethral reconstruction after excision of a sterile periurethral abscess that formed after injection of calcium hydroxylapatite (Coaptite) for sphincteric incontinence refractory to two mesh slings. Despite the obvious stricture, she had severe sphincteric incontinence as well. At the time of surgery, after incising the stricture, the proximal urethra was only about 2 cm in length, just barely large enough to accept an autologous fascial sling (Figure Copyrighted © J.G. Blaivas, M.D.)

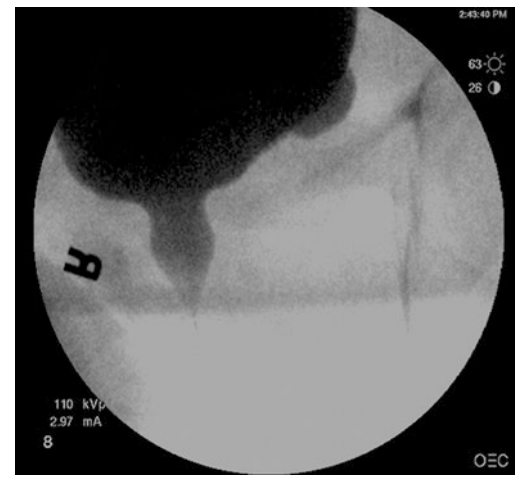

Fig. 19.3 Voiding cystourethrogram in this patient confirms a distal urethral stricture. There is almost no possibility of sphincteric injury during reconstructive surgery that is limited to the distal urethra, so either a ventral or dorsal approach may be considered (Figure Copyrighted © J.G. Blaivas, M.D.)

ing may help provide details about the anatomy of the diverticula to aid in surgical planning.

Other imaging techniques like MRI and delayed CT with contrast may be useful to distinguish abscess, cyst, tumor, and urethral diverticulum in patients with periurethral masses, to assess foreign bodies, and to rule out additional injury to the urinary tract following pelvic trauma.

Cystourethroscopy will confirm a urethral stricture, the presence of a foreign body, including suture or sling material, and evaluate the extent of the fistula. It can also evaluate the remainder of the urethra, particularly the length, viability of the proximal urethra.

Principles of the Surgical Technique

The choice of surgical technique is dictated by a number of factors including (1) the experience and expertise of the surgeon, (2) the desires of the patient, (3) the patient's age and comorbidities, (4) lower urinary tract and renal function, (5) the presence of concomitant conditions such as pelvic organ prolapse or abdominal or pelvic disease requiring surgical correction, (6) prior abdominal and pelvic surgical procedures, and (7) sexual function:

1. *The surgeon*: Urethral reconstruction ranges from simple ventral incision and meatotomy for distal urethral strictures to full-length dorsal buccal grafts for longer strictures to neourethral reconstruction with local vaginal wall flaps reinforced with Martius flaps and occasionally, gracilis, thigh, or rectus flaps. Few of these procedures are learned in residency or fellowship; most of the expertise is garnered over decades of experience in tertiary referral centers. In our judgment, the most demanding part of the expertise is decision making both before and during the surgery. With the exception of proximal dorsal buccal mucosal grafts for strictures, ventral bladder neck reconstruction and complex urethral diverticula, the technical aspects of the surgery are usually straightforward. With these caveats in mind, it is up to the individual surgeon to decide whether he or she possesses the requisite surgical expertise for each individual patient. In some instances, referral to a reconstructive expert is prudent.
2. *The patient*: For practical purposes, the damaged urethra presents one or more of three potential problems—incontinence, urethral obstruction, and pelvic pain. Surgical treatment of incontinence and pain is entirely elective; whereas, untreated urethral obstruction may portend urinary retention or upper tract damage and even renal failure. Further, the success rate for treating urethral obstruction and sphincteric incontinence is very high—over 90 %, while the success rate for pelvic pain and overactive bladder is far less. Keeping these facts in mind, it is important that the patient be apprised of the pros and cons of surgical intervention and that the decision about how to proceed is based on realistic expectations for success, failure, and complications.
3. *Patient age and comorbidities*: Age and comorbidities are factors insofar as the patient's life expectancy and ability to withstand the morbidity of surgery that could last as long as 4–6 h should be taken into account, although excessive blood loss during surgery is rare. The decision to undergo elective surgery is based on a complex calculus involving factors such as the bother to the patient, risk of complications if no surgery is pursued versus the likelihood of success and duration of recovery based on the patient's preoperative age and comorbidities. For example, in an elderly patient with minimal bother from a urethrovaginal fistula and difficulty with ambulation, the improvement in quality of life may not be worth the risks of surgery and morbidity of recovery to the patient.
4. *Urinary tract function*: It is axiomatic that lower urinary tract function is an essential component of decision making in planning surgery. As a general rule, we believe it is most prudent to treat sphincteric incontinence as part of the reconstructive procedure, although some surgeons prefer a staged operation. Low bladder compliance and detrusor overactivity often improve after successful

surgery, so they are not addressed at the same time except in rare circumstances when due to multiple surgeries or radiation. In these instances, urinary diversion rather than urethral reconstruction might be considered (Fig. 19.4).

5. *Concomitant conditions*: When concomitant conditions such as vesicovaginal fistula, urethral diverticulum and localized urethral cancer are present, the decision about how to proceed should be made on a case by case basis taking particular care to assess the potential impact on flap or graft survival if more than one procedure is done at a time. *Prior surgery*: It is important to know what prior pelvic surgeries the patient has undergone, particularly if mesh has been used for prior repairs. As a general rule, as much mesh as can be safely removed should be taken; when that is not feasible, it is important that all mesh be at least removed from the urethra and bladder when there has been erosion. In patients complaining of pain, it is best to remove all mesh from the affected side whenever possible, but this can be extremely challenging in patients who have undergone TOT repairs.
6. *Sexual function*: It is essential that the patient's desires about postoperative sexuality be discussed and incorporated into surgical planning and informed consent. The literature about sexual complications of urethral reconstructions is rudimentary at best, but dyspareunia can occur after any of these operations. When maintaining sexual function is a factor, special attention must be paid to insuring adequate vaginal size of at least two loose finger breaths to a depth of at least 8 cm.

Surgical Techniques

Before proceeding with the vaginal incision, it is critical to choose the site and shape of the initial incision for the urethral reconstruction. We have previously described several methods of urethral reconstruction for stricture, and in the majority of the cases, the repair can be accomplished with a single transvaginal operation [1].

All surgical approaches follow the same rules: fine sharp dissection is preferable and homeostasis is maintained. Sharp dissection permits the development of correct planes and excision of the dense fibrotic tissue and may prevent inadvertent injury to the bladder or sphincter. The urethra should be opened proximal enough to clearly see the extent of the urethral stricture when present. If the edges of the stricture are uncertain, we place progressively larger bougie-a-boule sounds into the urethra past the area of suspected stricture. As the sound is pulled back it will catch on the stricture. The urethrotomy is extended until the bougies can be withdrawn without resistance. In addition to aiding visualization, attention to homeostasis may prevent hematoma and breakdown of the sutures lines. When excessive bleeding is encountered, pressure should be applied until the bleeding stops or bleeding vessels individually clamped and sutured or coagulated. Frantic efforts to control hemorrhage without clearly identifying the bleeding vessels may lead to unnecessary injury to adjacent organs.

In preparing for vaginal surgery, the patient is placed in a dorsal lithotomy position with the least degree of Trendelenburg that is necessary for adequate exposure. Draping should permit access to the vagina as well as abdominal area (when concomitant surgery is planned). At the onset of surgery, the bladder is drained via a transurethral catheter and palpation of the balloon allows identification of the bladder neck. If suprapubic cystotomy, pubovaginal sling, or rectus muscle graft is planned, these should be done prior to the vaginal reconstructive surgery to avoid subsequent damage to the reconstruction during dissection for these procedures. For pubovaginal slings, though, the sutures should not be tied until the reconstruction has been completed so that tension can be judged.

In cases of minimal urethral disruption, such as small urethrovaginal fistula or diverticulum, the defect can be circumscribed and closed over a catheter with tension-free, interrupted sutures of 3–4:O chromic catgut. An inverted U anterior vaginal wall flap is usually adequate for closure, but sometimes a lateral vaginal flap may be more appropriate.

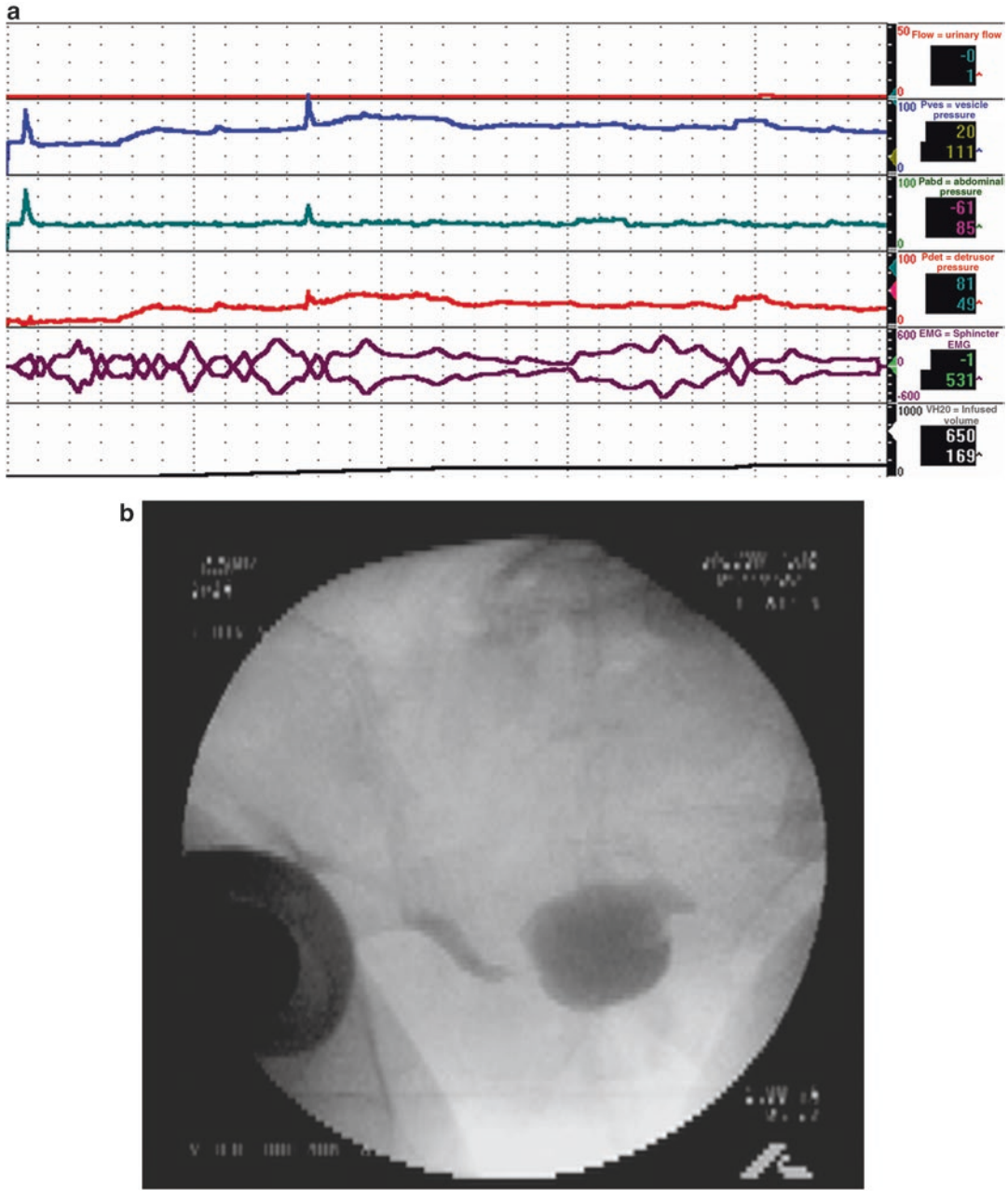

Fig. 19.4 Videourodynamic study in a 72-year-old woman who underwent anterior prolapse repair and TVT sling complicated by colovesical and urethrovaginal fistula. She subsequently underwent unsuccessful attempts at surgical repair of these defects and presented with refractory urge incontinence as well as sphincteric incontinence and colovesical fistula. She had arthritis that precluded self-catheterization through the urethra. Because of the findings described below, she underwent continent urinary diversion instead of another attempt at lower urinary tract reconstruction. (**a**) Urodynamic tracing demonstrates severe low bladder compliance (2 mL/cm H_2O) at a bladder volume of only 50 mL. Note that each time infusion is stopped, detrusor pressure falls. (**b**) Cystogram reveals a tiny bladder with right vesicoureteral reflux. The colovesical fistula and sphincteric incontinence was not visualized (**a**, **b**: Copyrighted © J.G. Blaivas, M.D.)

If urethral injury is extensive and sufficient vaginal wall tissue exists, vaginal wall flaps may be considered. Flap-based urethroplasty techniques have been demonstrated to be effective and improve the outcome in the urethrovaginal fistulas and are the treatment of choice for most female urethral strictures that are distal to the sphincter mechanism [2–4]. In one such technique, the anterior vaginal wall can be mobilized and a rectangular incision around the urethral defect is made. A lateral vaginal wall flap is advanced, rolled over the catheter, and sutured to the contralateral side, without tension, to form the entire posterior urethral wall. However, if the extent of urethral injury and lack of vaginal tissue preclude simple repair, use of an advancement flap may be required. Another choice is to create a labia minora flap. An oval-shaped incision is made in an adjacent hair-free portion of the labia minora and carried through the underlying tissue and a pedicle is raised on a posterior- or anterior-based blood supply. This island flap is tunneled beneath the vaginal wall, rotated, and sutured over the catheter, so the vaginal epithelial surface creates the inner wall of the urethra. Rarely, it is not possible to close the defect in the vaginal wall primarily and in such instances, it is possible to create a labia majora flap to cover the wound. We have only needed a gracilis flap on one occasion and have never used any other major kind of flap (rectus, Singapore, etc.), but of course, those are available if needed [1].

Urethral damage associated with erosion of synthetic material poses unique considerations and the repairs can be even more challenging [5]. Most authors agree that eroded synthetic slings require complete removal of the sling from the urethra and bladder. The literature on the surgical management of erosions suggests midline anterior vaginal wall incision at the erosion site, bilateral dissection into the retropubic space, and removal of the entire synthetic sling including sutures, and when possible, bone anchors if they were used [6]. In our experience, especially with transobturator techniques, attempting to remove the entire sling leads to difficult and morbid surgery and should probably be reserved for those who failed at first attempt. Once the sling has been excised, the urethra can usually be repaired primarily. If this is not feasible, any of the techniques described above may be considered.

For patients with distal urethral strictures, ventral urethroplasty using vaginal and labial skin flaps is, in our judgment, the least morbid technique. This approach is utilized in patients with mid-to-distal urethral strictures and an intact bladder neck and urinary sphincter mechanism. However, ventral urethrotomy risks urethral sphincter damage and de novo urinary incontinence when the stricture involves the proximal urethra or when sphincteric incontinence was present preoperatively. In cases of documented preoperative sphincteric incontinence, the dorsal approach offers easier access to the bladder neck and permits an easier concomitant anti-incontinence procedure.

Unlike the dorsal approach, ventral urethroplasty may redirect the urethra and the urinary stream anteriorly or posteriorly. When the urethra is too short, a vaginally directed urinary stream that causes post-void dribbling may occur. In some patients, there has been spontaneous resolution; in others, reconstructive surgery to lengthen the urethra may be required [7]. If the urethra is too long, there may be an excessive arc to the stream and the patient may actually void over the toilet bowl. This is easily corrected with a ventral meatotomy.

Vaginal tissue from the labia minor has be reported as a free inlay graft with minimal short-term complications [8]. Several groups have proposed a dorsal onlay urethroplasty using buccal mucosa graft [9, 10], labia minora skin graft [11], or vestibular flap [12]. The dorsal technique has several advantages, but requires different surgical expertise, utilizing many of the surgical principles derived from urethral reconstruction in men. A surgical plane is developed between the urethra and overlying clitoral cavernous tissue. Care should be taken during the dissection of the dorsal urethra to avoid injury to the clitoral bulb, body or crura, and the clitoral neurovascular bundle and minimize excessive bleeding. The clitoro-urethrovaginal complex is supplied by pudendal neurovascular bundles which arise from pelvic

side walls and bifurcate into clitoral and perineal divisions. The clitoral neurovascular bundle ascends along the ischiopubic ramus and adjacent clitoral crura on both sides, runs under the surface of the symphysis pubis in the midline, and then travels along the cephaled surface of the clitoral body towards the glans (Fig. 19.5). The nerves of the clitoral neurovascular bundle are not large enough to be seen on the MRI. However, the histological dissections show that they accompany the vessels [13].

From a practical standpoint, it is fairly straightforward to avoid these structures during the dissection by confining the dissection to the dorsal urethra. We are not aware of any reports of injury to the clitoral structures, nor have there been any reports of orgasmic changes. Our experience corroborates these findings.

Not infrequently during the dissection troublesome bleeding is encountered, but we caution against blind coagulation or suture ligature. All that is usually necessary is to place a gauze pack between the dorsal urethra and pubis, extending into the retropubic space for compression. Positioning the graft on the dorsal surface preserves intact ventral midurethra and provides a better vascular bed for a graft. In our judgment, doing so minimizes the likelihood of requiring an incontinence procedure. However, unlike the ventral approach, dorsal dissection is infrequently performed in pelvic reconstructive surgery, and for most surgeons, the anatomy is not

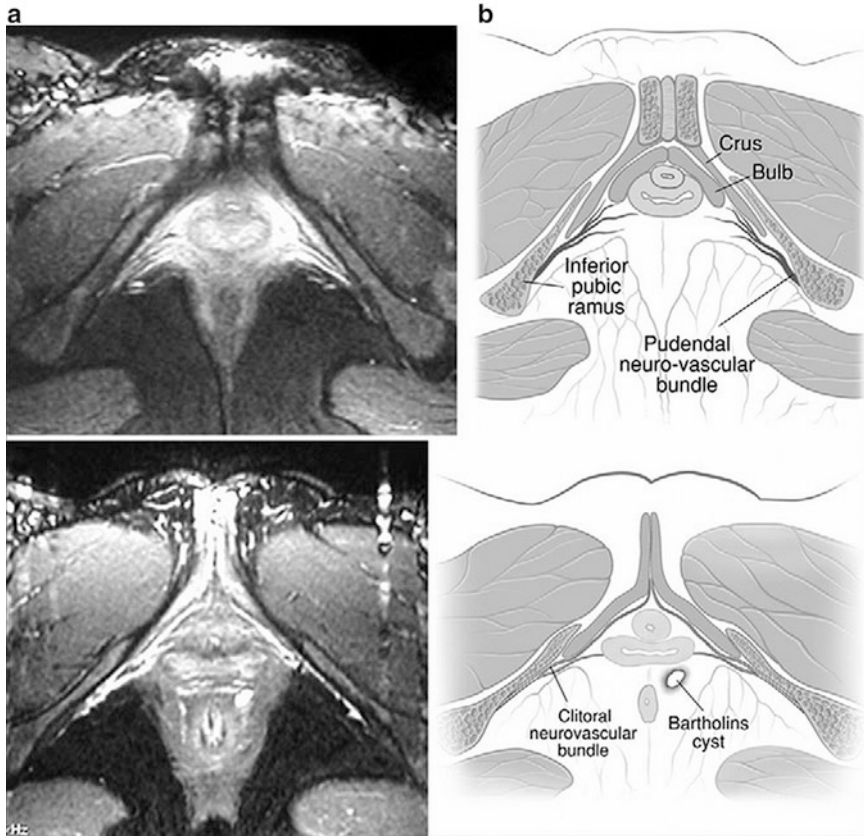

Fig. 19.5 (**a**) MRI of the clitoris in the axial section as seen on the left shows divisions of the pudendal neurovascular bundle, which arises from the pelvic side wall and bifurcates into perineal and clitoral neurovascular bundle. Vascular component of the bundle and cavernous tissue are bright white due to fat saturation technique. Muscles and bone appear as dark structures. (**b**) On the right is an artist's rendition of the images (Used with permission of John Wiley and Sons, Inc., from Rehder P, Glodny B, Pichler R, Exeli L, Kerschbaumer A, Mitterberger MJ. Dorsal urethroplasty with labia minora skin graft for female urethral strictures. BJU international. 2010;106(8):1211–4)

well known. Further, most pelvic surgeons are unfamiliar with the techniques of graft reconstruction that are done much more commonly in men.

Use of a Graft and Potential Complications

One of the challenges of urethral reconstruction is achieving a long and stricture-free lumen that allows nonobstructive voiding and maintains continence. Due to the variable etiology of the urethral pathology, local tissue may not be available for the urethral repair. In cases of extensive posttraumatic or postsurgical urethral fibrosis, congenital malformations, and recurrent urethral strictures, reconstructing the urethra with a free graft provides an alternative to a vaginal flap or bladder flap.

Various graft urethroplasty techniques have been proposed in small series. These techniques can be complicated and require knowledge and experience with processing and tissue transfer.

Buccal mucosa grafts are commonly used in male urethral reconstructive surgery and have been shown to be successful in construction of the neourethra in female pediatric patients [14]. The buccal mucosa graft has been applied to female urethral strictures using both dorsal and ventral approaches [7, 9, 10, 15].

In our experience, buccal mucosa graft is an option in patients with previously failed reconstructive surgery and urethral stricture recurrence. It is also our treatment of choice for proximal urethral strictures in women who do not have a current or past history of sphincteric incontinence because we believe that there is no need for anti-incontinence surgery when the dorsal approach is used. Buccal mucosa has several advantages, is easy to harvest, is resilient to infection, and is already accustomed to a wet environment. Properties like elasticity and thick epithelium make it easy to handle [16]. It has the ability to supplement the native urethral plate to form a conduit that closely resembles a normal functioning urethra with low risk of sacculation and diverticulum formation. In addition, buccal grafts have a panlaminar vascular plexus which eases graft take to the recipient bed. In animal studies, extensive neovascularization in the subepithelial layer was evident 3 weeks after surgery, followed by inflammation and minimal fibrosis at 6 weeks [17]. Supple urethral coaptation can be accomplished by buccal mucosa graft and may play a role in achieving continence after urethral reconstruction [14]. The graft is harvested from the buccal mucosa inferior to Stensen's duct which is identified adjacent to the second upper molar. The graft typically measures between 2 and 2.5 cm wide and 2–5 cm in length depending on the amount of tissue needed. The graft is defatted and sutured to the urethrostomy. To maximize outcomes after free grafts, ensuring adequate vascularity of the donor bed is necessary. All fibrotic tissue has to be excised and the graft must be anastomosed to the recipient bed using monofilament absorbable sutures. In order to allow possible postoperative shrinkage of graft, it should be trimmed to larger size than urethral defect or stricture.

Complications associated with harvesting buccal mucosa graft are rare and have not been reported in any female case series. In male reconstructive surgery, complications reported include donor site wound pain, swelling, damage to Stensen's duct, postoperative perioral numbness, and infection. Wound contraction can also occur which manifests as a sensation of tightness when the mouth is opened. According to data from male case series, 59 % of patients developed short-term numbness after surgery, which persisted in 16 % beyond 1 year [18]. Complications of buccal grafts are uncommon; however, the possibility of a mental nerve neuropathy is unique to buccal graft surgery [19]. Injury to Stensen's duct is extremely rare and can be avoided by marking the buccal mucosa and careful closure of the donor site. When it is difficult to perform closure, some surgeons prefer to leave the harvest site open. One randomized study found that while there were no long-term differences, primary closure of the buccal mucosal graft bed decreased postoperative pain and improved oral intake [20]. If buccal mucosa graft is used ventrally and adequate periurethral tissue does not exist for cover-

age of the graft, it may be advisable to use well-vascularized tissue flaps to provide an adequate blood supply and prevent fistula formation. However, to our knowledge tissue flaps have not been utilized in dorsal approach.

Sharma has described the use of dorsal onlay lingual graft urethroplasty in 15 women with urethral stricture [21]. Lingual mucosa, harvested from lateral and ventral surfaces of the tongue, has similar tissue characteristics as buccal mucosa thick epithelium, high content of elastic fibers, thin lamina propria, and rich vascularization [22]. There were no functional limitations or intraoral complications at 1-year follow-up. Advantages reported of harvesting lingual mucosa graft instead of buccal mucosa graft are avoidance of injury to parotid gland duct and facial nerve without risk of the mouth deviation or lip retraction [21].

Intraoperative Complications

Intraoperative complications during urethral reconstructive surgery are rare based on our review of the literature. One case of intraoperative hemorrhage has been reported in early series by Elkins on 20 women who underwent repair of a vesicovaginal fistula involving the urethra with the anterior bladder flap technique and Martius flap. During total urethral reconstruction, a patient developed hemorrhage in the space of Retzius and required postoperative blood transfusion [23]. However, there is no surgery that spares the patient from potential risk of other anesthetic complications or injury to adjacent organs such as bladder, ureter, or rectum. For bleeding that occurs during the dissection for creating vaginal flaps, we believe it is best to simply apply pressure with a pack unless there is an obvious bleeding vessel that can be coagulated or ligated. Bleeding that occurs from the retropubic space after entry from the vagina is best handled with the same approach. If bleeding seems excessive, we advise against trying to explore from the vaginal wound; rather, one or two 4 × 4 sponges or a lap pad should be inserted into the retropubic space through the vagina to tamponade the bleeding while other parts of the operation are continued. In thousands of reconstructive surgeries, we have never found it necessary to explore the retropubic space from above to control bleeding. Another potential source of excessive bleeding is during the dissection for the Martius flap that is discussed in "Complications of Ancillary Procedures" section. It is possible to injure the distal ureter during a dissection for urethral reconstruction, but we have never seen this nor has it been reported. On two occasions, though, the ureter has been transected or avulsed in the course of removing mesh to which the ureter was adherent. One should be alert to the possibility of this complication whenever the dissection extends to the vicinity of the ureter or when traction is exerted on retropubic mesh. For that reason, it is always prudent to administer intravenous dye and check for ureteral patency by observing efflux of blue urine from each ureteral orifice through a cystoscope. If there is preoperative suspicion of ureteral involvement with mesh, ureteral stent placement prior to commencing surgery is helpful. If intraoperative concern exists about ureteral injury, retrograde pyelography should be done and a ureteral stent left in place if there appears to be an injury. In cases of avulsion or transaction of the ureter, immediate ureteroneocystotomy should be done.

Early Complications

All types of urethral reconstructive surgery share common complications like infection, flap necrosis, urinary retention, and postoperative bleeding, yet the overall incidence of major complications such as bleeding is very low. Complications related to the ancillary procedures like graft, flap, or sling placement are discussed below.

One of the earliest, but rare, complications of urethral reconstruction is wound infection and flap necrosis. Unrecognized infection may lead to the disruption of the suture lines, flap necrosis, and fistula formation; however, we could find no reports on this and none has ever occurred in our series.

Sharma and colleagues in a case series of 15 patients, who underwent dorsal onlay lingual mucosal graft urethroplasty for urethral stricture, reported one case of wound infection requiring antibiotics. The patient subsequently developed submeatal stenosis treated with monthly dilation [21].

Another potential complication is inadvertent traction on the urethral catheter that occurred in one elderly patient in our series completely disrupting the repair. To prevent that, we routinely suture the Foley catheter to the anterior abdominal wall with a gentle loop in order to minimize tension on the urethra. Failure to maintain a correct position of the catheter may result in necrosis of the urethra. The urethral wound and the catheter should be checked frequently during postoperative care to ensure that there is no pressure on the suture line. Additionally, adequate bladder drainage should be maintained until the patient voids at 3 weeks postoperatively and VCUG does not show extravasation.

Another complication that may be encountered in the early postoperative period is urinary retention, but there are no reports of this in the literature that we reviewed and none has occurred in our series. If urinary retention were to occur, first check for meatal stenosis, and if present, a gentle attempt at urethral dilation should be done. If there is no obvious meatal stenosis, we recommend a gentle attempt at placement of a small Foley catheter followed by trial of voiding after about 2 weeks. If placement of the catheter is unsuccessful, a suprapubic catheter should be placed. If the patient fails the second voiding trial, we recommend cystoscopy, and if there is no obvious cause of obstruction, videourodynamics should be done. If urethral stricture is diagnosed, it should be dilated. Recurrent strictures may require repeat reconstruction.

Late Complications

Because of the relatively small number of case series reported in the literature, available data cannot provide a consensus for management of various complications of urethral reconstructive surgery. In general, when urethral reconstruction is properly performed, it is associated with high long-term anatomic success rate and low complication rates. However, functional complications including overactive bladder and stress incontinence have been reported.

Postoperative Sphincteric Incontinence

Postoperative stress urinary incontinence is a result of unrecognized sphincteric incontinence before the procedure or a consequence of injury to the sphincter during dissection. In proximal urethral injuries, postoperative incontinence rates may range between 44 and 80 % unless a concomitant anti-incontinence surgery is performed [24]. In the majority of studies, the criteria for incontinence following the reconstructive surgery are not specified leading to a likely underestimation of incidence.

In our previously published series of 74 patients who underwent vaginal flap urethroplasty, 62 women with preoperative incontinence underwent concomitant fascial pubovaginal sling placement. Successful anatomical repair was achieved in 93 % patients and 87 % considered themselves cured or improved with respect to incontinence. All patients with persistent postoperative stress incontinence were successfully treated by secondary procedures [1].

In our most recent case series of nine women who underwent urethral stricture repair, five concomitant fascial slings were performed synchronously due to sphincteric incontinence. Postoperatively no urinary incontinence was reported. Success or failure of anatomical repair and incontinence was assessed subjectively and objectively by validated questionnaires, physical examination, voiding diaries, and 24 h pad tests. There was no recurrence at 1 year but two women had stricture recurrence at 5.5 and 6 years, respectively [25].

In patients undergoing urethral reconstruction following mesh sling surgery, some authors suggest that extensive scarring may preclude the successful repair and recommend a staged proce-

dure to correct the incontinence [6]. Amundsen and colleagues reported persistent stress incontinence in two of three cases following synthetic sling removal, repair of the urethra, and Martius flap placement. All were treated with a second stage pubovaginal sling placement and injection of transurethral collagen. Interestingly, none of the patients after excision of the non-synthetic sling required further anti-incontinence procedures. Clemens and colleagues reported five cases of recurrent postoperative stress incontinence in six patients who underwent removal of an eroded sling from the urethra or vaginal mucosa [26]. In our view, documented preoperative sphincteric incontinence and compromised integrity of the sphincter during reconstruction are sufficient reasons to perform concomitant pubovaginal sling at the time of urethral reconstruction. First, harvesting of the fascial graft and placement of the sling around the urethra should be done, then the urethral reconstruction should be completed and, when necessary, a Martius flap is interposed between the reconstructed urethra followed by tensioning and tying the sling in place [27] (Fig. 19.6a–c).

When sphincteric incontinence develops after urethral reconstruction, treatment should be tailored to the patient. Of course any treatment at all is elective and some patients are not bothered enough to want to consider further treatment. In our judgment, the patient should be evaluated just as would be done if she had not had prior urethral reconstruction and, for us, that means a bladder questionnaire, diary, exam, uroflow, assessment of post-void residual urine, videourodynamics, and cystoscopy. As a general rule, though, we defer this evaluation until about 3 months from the reconstructive surgery. If recurrent sphincteric incontinence is documented, we recommend a biologic sling, and prefer autologous fascia. Ideally, the sling should be placed at a virgin site at the bladder neck, or the mid or proximal urethra,

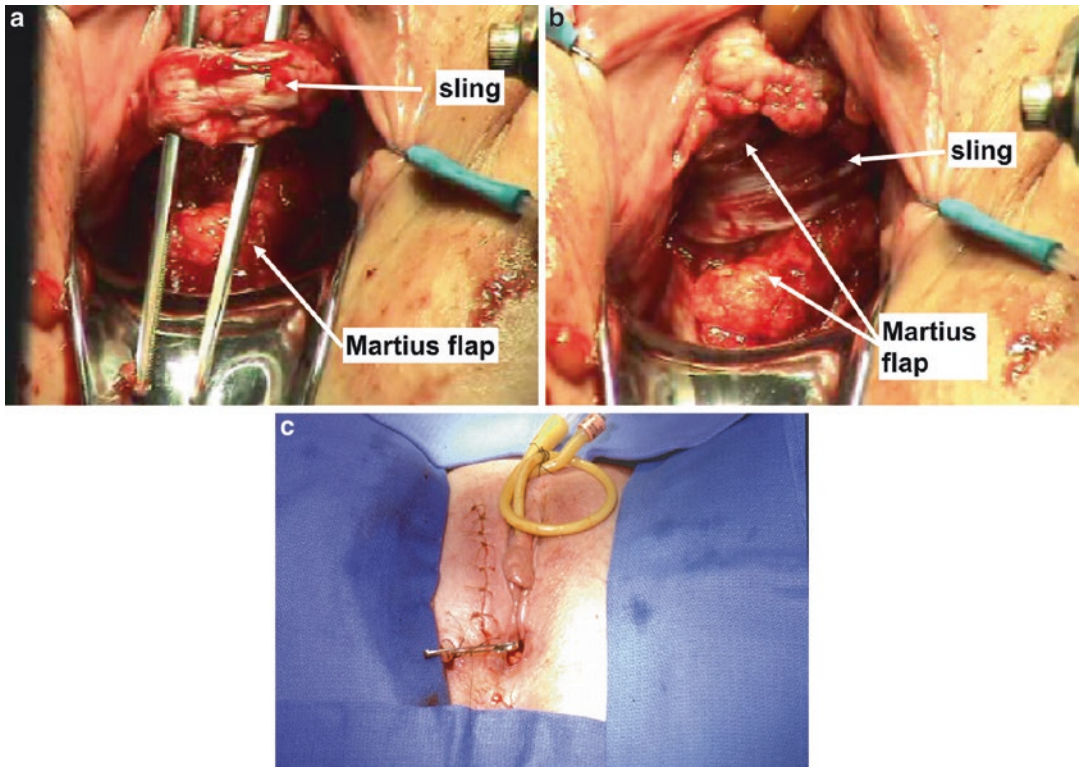

Fig. 19.6 (**a**, **b**) After mobilization of the Martius flap, it is placed between the reconstructed urethra and the autologous fascial sling. (**c**) The completed repair with the Foley catheter sutured in place to prevent downward traction that could disrupt the wound (**c**: Copyrighted © J.G. Blaivas, M.D.)

proximal to the site of the reconstruction. If the entire mid and proximal urethra has been reconstructed, it is possible to place the sling at the reconstructed urethra, but special care should be taken to not injure the urethra during the surgery. To this end, we recommend that the plane of dissection around the urethra be accomplished sharply under direct vision with a scissor staying in a very superficial plane just beneath the vaginal epithelium. If there is any difficulty extending the dissection into the retropubic space, it should be opened from abdominal side and completed under direct vision. Depending on the nature of the prior reconstruction and the characteristics of the urethra, a Martius flap may be considered as well, placing it between the sling and reconstructed urethra. We believe a synthetic sling is contraindicated in these circumstances.

Overactive Bladder

Persistent or de novo overactive bladder symptoms can be problematic postoperatively. In our series of 74 women after urethral reconstruction, 16 % of patients had severe urinary urgency or urge incontinence postoperatively, including those who underwent concomitant autologous pubovaginal sling placement [1]. The series by Onol and colleagues reports 2 cases of persistent urge incontinence in 17 women who underwent urethral stricture repair [7]. Similarly, Gormley counted 2 cases of persistent urge incontinence and 1 de novo urge incontinence among 12 women who had repair for urethral stricture [3].

The assessment of OAB symptoms should commence within days to weeks after their occurrence to look for remediable causes such as urinary tract infection, urethral obstruction, and incomplete bladder emptying:

Urinary tract infection should be treated with culture-specific antibiotics and urethral obstruction and incomplete emptying ruled out by uroflow and measurement of post-void residual urine. Women who preoperatively have a long standing history of obstruction and high detrusor voiding pressure will often maintain a "normal" maximum flow rate but can still be significantly obstructed. One clue for recurrence of obstruction to consider in the uroflow is a flattening of the flow curve, even if maximum flow is normal. If obstructive symptoms persist after these conditions have been treated or excluded, empiric treatment can be tried, but if they prove unsuccessful after a month or so, we recommend cystoscopy and urodynamics to look for obstruction, foreign body, and stones. Patients with refractory OAB after 3 months or so, who underwent sling surgery as part of the reconstruction, are candidates for empiric sling incision or urethrolysis even if they appear unobstructed, but in our series this has not been necessary

Urethral Stricture

Strictures have occurred after dorsal labia minora skin graft urethroplasty [11], dorsal lingual mucosa graft urethroplasty [21], ventral buccal mucosa graft urethroplasty [15], and all were distal to the initial reconstruction. In the first case, the patient reported recurrent urinary tract infections and lower urinary tract symptoms at 9 months after surgery. Meatal stenosis was diagnosed and treated with meatotomy, and she was asymptomatic thereafter [11]. In another series, two patients presented with obstructive voiding symptoms at 3 months and lower urinary tract symptoms at 5 months follow-up [15, 21]. Both were found to have submeatal stenosis requiring urethral dilations that resulted in complete resolution of symptoms at 12 months follow-up.

In our experience, late stricture recurrence of 5 years or more after surgery is possible. In two women from our recent case series who underwent vaginal flap urethroplasty, urethral stricture recurrence was noted at 5 and 6 years. Subsequently, both patients underwent successful urethral repair using dorsal buccal mucosa graft and were stricture free at 12 and 15 months follow-up [25]. Both of these patients developed the recurrent stricture at the time of menopause, so it is possible that hormonal influences played a role in their genesis. To prevent recurrent strictures, we recommend that peri-menopausal and menopausal women be treated with topical estrogens. In a report by Gormley who described follow-up on 12 patients after vaginal flap urethroplasty for

female stricture disease, one patient underwent repeat dilation 3 weeks after procedure due to narrowing of the bladder neck and another required cystoscopy with catheter insertion in the OR 58 months postoperatively [3].

Although most studies report good short-term success, long-term follow-up of every patient is recommended to avoid complications of unrecognized urethral stricture recurrence.

Unfortunately, current data are too sparse to determine what factors predispose a patient to stricture recurrence. We hypothesize that failure to expose and incise the proximal extent of the stricture during surgery, ischemic changes, and wound contracture might possibly lead to stricture recurrence.

Sexual Dysfunction

One of the possible adverse effects of urethral reconstruction is sexual dysfunction. From a theoretical standpoint, this is of particular concern after the dorsal dissection between the clitoris and urethra that is done for dorsal buccal mucosal graft urethroplasty which could damage the corporal bodies or nerves. To date, though, we are unaware of any reports of this complication after reconstructive surgery and in many other cases using the same incision for take-down of Marshall–Marchietti–Krantz or Burch procedures for urethral obstruction. We have not published these data, but have specifically queried all of our patients who underwent this surgery about changes in sexual function, including orgasm and pain and none have suffered any negative sequelae.

Complications of Ancillary Procedures

As discussed, after reconstruction of the severely damaged urethra, it is sometimes advisable to perform a concomitant pubovaginal sling and interpose a vascularized pedicle flap over the repair site. When an anti-incontinence procedure is deemed necessary, in the vast majority of cases, a Martius flap incorporating a labia majora fat pad can be successfully used. Other flaps include rectus abdominus muscle and gracilis myocutaneous flaps have never been necessary in our experience. Flaps improve vascularity of periurethral tissue bed, enhance granulation, separate the suture lines, and promote graft survival.

For construction of a Martius flaps, a vertical incision is made over the labia majora and is carried down through Scarpa's fascia. The fat pad is mobilized with attention to preserve the ventral blood supply from the external pudendal artery or dorsal from internal pudendal artery. We almost always base the flap on the internal pudendal artery. To minimize blood loss, it is important to incise Scarpa's fascia and dissect between it and the fat pad to create a flap. The fat pad is tunneled underneath the vaginal epithelium and sewn in place over the suture lines of the reconstructed urethra. To the inexperienced surgeon, the plane between Scarpa's fascia and the skin looks like a better plane. However, there are multiple, broad, flat veins from which bleeding is difficult to control, so that plane should be avoided.

If a Martius flap is used, a Penrose drain is traditionally left in for 24–48 h. The overall incidence of the complications attributable to Martius flap is low. In data by Elkins and coworkers on 35 women who underwent vesicovaginal and rectovaginal fistula repair with a Martius graft, two had blood loss of more than 350 mL from the harvest site, three experienced cellulitis, and two dyspareunia due to narrowing of the vagina. However, in two circumstances of cellulitis and vaginal narrowing, closure of the vaginal mucosa over the flap was not possible and it was left to heal by secondary intention [2].

In our cumulative experience with urethral reconstructive surgery between 1983 and 2011, 1 of 70 women who underwent vaginal flap repair with concomitant Martius graft required incision and drainage of a labial hematoma.

Serious hemorrhage can be prevented by careful dissection of the plane of fibroadipose tissue with avoidance of deep muscle tissue and attainment of meticulous hemostasis. Other complications of the labial flap may include an undesirable cosmetic effect, asymmetry, and impaired sensation at the harvest site [28].

Urinary retention, obstruction, urgency, and urge incontinence are well-known complications after pubovaginal sling. The most recent AUA panel data report 8 % urinary retention rate after pubovaginal fascial sling placement without concurrent repair of prolapse. The rates of de novo urge incontinence and postoperative urge incontinence in patients with preexisting incontinence were 9 % and 33 %, respectively [29]. In our retrospective review of more than 500 women who underwent pubovaginal fascial sling procedure for stress incontinence, de novo urge incontinence occurred in 3 % patients. Other complications such as wound infections, incisional hernia, or long-term urethral obstruction requiring surgery or intermittent catheterization each occurred in 1 % of patients [30].

Conclusions

Urethral reconstruction in women is an uncommon surgery and as such complications are not well described in the literature. Complications can be minimized by a thorough preoperative work-up and preoperative planning of the surgical approach. Intraoperative complications include hemorrhage and ureteral injury, though both are rare. Perioperative and postoperative complications include complications specific to graft or flap site, recurrence, incontinence, urethral obstruction, or detrusor overactivity. In our experience, these complications are unusual and can be treated successfully. Because of the possibility of late recurrence of stricture, long-term follow-up is mandatory.

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