Review Article

Urethroplasty for Stricture Disease: Contemporary Techniques and Outcomes

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Urethral reconstruction is now considered optimal therapy for most men presenting with symptomatic urethral strictures. The rapid development of innovative tissue transfer techniques over the past decade provides today's reconstructive urologist with a high probability of achieving excellent long-term outcomes after urethroplasty, even in the reoperative setting. Fundamental principles such as accurate initial stricture staging by urethrography, along with critical assessment of both stricture severity and tissue quality during urethroplasty are critical for success. This review illustrates the way in which stricture length, location, severity, and etiology influences the application of reconstructive techniques during contemporary urethroplasty. UROLOGY 89: 12–18, 2016. © 2016 Published by Elsevier Inc.

Urethral strictures have been recognized since antiquity. The oldest known documentation of treatment for urethral stricture comes from India in the 6th century BCE,[1] where it was palliated with dilation. Various forms of internal urethrotomy and attempts at urethrostomy were subsequently developed over the past few centuries. Staged urethroplasty and excision with direct anastomotic urethroplasty only came into prominence in the second half of the 20th century, offering the possibility of a cure for what had always previously been considered to be an incurable, chronic disease.[1]

This is an exciting time for urethral stricture treatment, perhaps even a "golden age" of urethroplasty. It is now widely recognized that internal urethrotomy is a poor treatment option with 5-year success rates of less than 10%.[2] Rather than a salvage procedure when all else has failed, urethroplasty has become the first-line treatment of stricture disease due to its reliable long-term results and low morbidity. Creative surgeons from multiple high-volume centers of excellence continue to refine and popularize advanced reconstructive techniques. This article reviews current urethroplasty techniques and outcomes, organized by anatomic area of the urethra (penile, bulbar, and posterior), with the proviso that stricture disease may affect more than one segment.

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ANATOMICAL CONSIDERATIONS

The extensive vascular supply to the bulbar urethra affords a variety of definitive treatment options based on stricture length and etiology. The bulbar arteries directly supply the proximal corpus spongiosum, while retrograde flow is also contributed from the dorsal penile arteries via the glans to the spongiosum. Additionally, there are circumflex branches of the dorsal arteries that run from dorsal to ventral within Buck's fascia,[3] and perforating vessels traversing the corpora cavernosa.

The anatomy of the penile urethra makes treatment of stricture disease much more challenging than in the bulbar urethra. Unlike the bulbar urethra, where excision with primary anastomosis urethroplasty (EPA) is highly successful, EPA is rarely an option in the penile urethra because shortening the urethra here is likely to cause penile curvature. Thus, substitution urethroplasty (bringing in new tissue from outside the urethra) is the general rule. Unlike in the bulbar urethra, the spongiosum surrounding the penile urethral lumen is less hearty, and thus less optimal for support of grafts. To increase stability, grafts in the penile urethra are often placed directly against the surface of the corporal bodies. A pedicled penile skin flap brings with it its own blood supply and may alternatively be placed on the ventral surface of the urethra.

Prior to a discussion of techniques, it should be noted that retrograde (and if possible, voiding) urethrography should be considered mandatory to provide a "roadmap" prior to urethral reconstruction. The finding of a tight stricture endoscopically rarely provides enough information to guide effective therapy. Urethrography, although imperfect, remains the most effective diagnostic technique in planning treatment for stricture disease.

The concept of urethral rest is important to accurately diagnose stricture severity. If a man has had recent urethral catheterization or instrumentation, urethrography may

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not manifest the full extent of the stenosis for several weeks afterward. A 4-8 weeks period of tissue recovery after catheter removal (with concomitant placement of a suprapubic catheter if warranted) will facilitate stricture remodeling, thus facilitating the performance of a successful urethroplasty.[4]

PENILE URETHRAL STRICTURES

Stricture etiology is particularly important in the penile urethra, where strictures tend to be diffuse in nature—especially those associated with lichen sclerosus (LS), alternatively known as balanitis xerotica obliterans. LS is thought to be an autoimmune disease associated with extensive scarring and functional loss of the penile skin, urethral meatus, and/or anterior urethra. Urethroplasty techniques using penile skin as grafts and/or flaps have up to 100% stricture recurrence rate and should not be used when a patient is suspected of having LS.[5] Men with a history of prior hypospadias repair represent another group where penile skin flaps are discouraged because the vascular pedicle (tunica dartos) that supports the skin island has been disrupted by prior surgery.

Isolated strictures of the meatus or fossa navicularis may be treated through simple or complex techniques. Perhaps the simplest form of urethroplasty is an extended meatotomy, cutting through the stenotic distal urethra ventrally, with excision of periurethral fibrosis and suturing the edge of urethral mucosa to the edge of penile skin until a wide, healthy urethral lumen is found. When this continues onto the penile shaft, this is often referred to as a first-stage Johanson urethroplasty, as it was described as the first stage in a two-stage procedure. If the patient is accepting of a ventral urethral opening and the associated urinary spraying, a surgeon may perform this simple maneuver as a definitive procedure with success rates exceeding 90%.[6] As in all men who are offered treatment for stricture disease, urethrography and intraoperative calibration are critical to confirm that the intended technique is appropriate. If a man has panurethral stricture disease, meatotomy alone may not be an effective treatment; on the other hand, many diffuse penile strictures have a "decrescendo" pattern, normalizing soon after distal stricturotomy to an acceptable luminal diameter.

Tissue Transfer (Substitution) Urethroplasty

An alternative to deliberately creating a hypospadiac meatus is use of a ventral penile fasciocutaneous skin flap to augment the fossa navicularis, either with division and closure of the glans[7] or via flap tunneling under the glans.[8] Published success rates are in excess of 80%, although the authors no longer advocate this method in patients with LS.[7,9]

For nonobliterative strictures of the penile urethra, grafts or flaps may be used to augment the size of the existing lumen. A minimum lumen size of 5Fr or a urethral plate of 5 mm or greater is recommended for straightforward onlay procedures.[10] Pedicled penile skin flaps consist of a skin island mobilized on its tunica dartos pedicle. Ventral flap onlay is generally preferred due to its simplicity, as dorsal tissue transfer requires mobilization of the densely adherent penile urethra from the corporal bodies. The ventral longitudinally oriented flap popularized by Orandi[11] requires relatively little dissection but has limited mobility and may involve hair-bearing skin on the proximal shaft. The circular fasciocutaneous flap according to Buckley and McAninch[12] is more versatile but requires extensive dissection of the penile skin, with reported 10-year stricture-free success of 79%.[9] Penile skin flaps require extensive penile skin dissection that may lead to tethering, torsion, or ischemic complications of the remaining foreskin, which is especially bothersome to sexually active men. Penile skin flaps are discouraged proximal to the penoscrotal junction, where they tend to be under excessive tension during erections.

Tissue transfer by grafting into the urethra has been well accepted since the 1960s, beginning with penile skin grafts.[13] Over the past 20 years, oral mucosal grafts have demonstrated better handling characteristics and long-term stricture-free outcomes, and have thus replaced both penile skin grafts and flaps.[14] Barbagli et al described dorsal placement of grafts in the penile as well as bulbar urethra.[15] Kulkarni et al popularized treatment of panurethral stricture disease with a dorsally placed oral mucosal graft with one-sided urethral dissection via penile invagination through a perineal incision.[16]

Obliterative penile urethral strictures cannot be treated by simple stricture incision and tissue augmentation alone (Fig. 1). Obliterative strictures require full or segmental urethral replacement, and the urologist must consider whether urethroplasty can be effectively performed in one operation or in a staged fashion. Complete urethral substitution

Figure 1. Retrograde urethrogram demonstrating stricture of the penile and distal bulbar urethra after neodymium: yttrium-aluminum-garnet/potassium titanyl phosphate laser prostatectomy.