Management of the stricture of fossa navicularis and pendulous urethral strictures

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ABSTRACT

Objective: Management of distal anterior urethral stricture is a common problem faced by practicing urologists. Literature on urethral stricture mainly pertains to bulbar urethral stricture and pelvic fracture urethral distraction defect. The present article aims to review the management of the strictures of fossa navicularis and pendulous urethra.

Materials and Methods: The literature in English language was searched from the National Library of Medicine database, using the appropriate key words for the period 1985-2010. Out of 475 articles, 115 were selected for the review based on their relevance to the topic.

Results: Etiology of stricture is shifting from infective to inflammatory and iatrogenic causes. Stricture of fossa navicularis is most often caused by lichen sclerosus et atrophicus and instrumentation. Direct visual internal urethrotomy is limited to selected cases in the management of pendulous urethral stricture. With experience and identification of various prognostic factors, conservative management by dilatation and internal urethrotomy is being replaced by various reconstructive procedures, using skin flaps and grafts with high success rates. Single-stage urethroplasty is preferred over the 2-stage procedure as the latter disfigures the penis and poses sexual problems temporarily.

Conclusions: Flaps or grafts are useful for single-stage reconstruction of fossa navicularis and pendulous urethral strictures. The buccal and lingual mucosa serves as a preferred resource material for providing the inner lining of the urethra. Off-the-shelf materials, such as acellular collagen matrix, are promising.

Key words: Balanitis xerotica obliterans, fossa navicularis, lichen sclerosus, local flap, oral mucosa, pendulous urethral stricture

INTRODUCTION

Fossa navicularis and pendulous urethral strictures differ from bulbar stricture with respect to their etiology and nature. Pendulous urethral strictures are usually longer than bulbar strictures and most often have a nontraumatic etiology.[1] Anatomy of bulbar urethral segment is also different from distal anterior urethra. The former is surrounded by rich vascular spongiosal tissue and can be mobilized to gain length for end-to-end anastomosis, but the same is not true about pendulous urethra, which is straight and fixed to the corpora cavernosa and hence difficult to mobilize and gain much length.

Treatment of a stricture of fossa navicularis is challenging as it entails not only providing the functional urethra but also cosmetically appealing glans.[2] Traditionally, distal anterior urethral strictures have been treated with dilatation and internal urethrotomy, respecting the so-called reconstructive ladder. Open surgery has usually been chosen as a last option. However, it has now been realized that these minimally invasive options do not have a durable effect and may further compromise the quality of the local tissue for future reconstruction.[3-5] Although urethral dilatation and direct visual internal urethrotomy remains the most commonly performed procedure by practicing urologists,[6] primary urethroplasty is now emerging as a preferred approach in these cases. Previously, various kinds of penile skin flaps were used in distal anterior urethral reconstruction; however, now buccal mucosal graft has emerged as a preferred option, especially in cases of lichen sclerosus et atrophicus (LSA). LSA has now been recognized as a distinct entity because of the location and length of
urethral involvement, intrinsic nature of the disease process, and its tendency for recurrence if genital skin is used for reconstruction.[7,8]

MATERIALS AND METHODS

The literature in English language was reviewed from the National Library of Medicine database using the key words “pendulous urethral stricture,” “stricture fossa navicularis,” “anterior urethral stricture,” “distal anterior urethral stricture,” “penile urethral stricture,” “lichen sclerosus et atrophicus,” and “balanitis xerotica obliterans” for the period 1985-2010. The available literatures were analyzed with regard to various etiologic factors responsible for the causation of the anterior urethral stricture and the various management options.

Over 475 articles were identified, out of which 115 were selected for the review based on their relevance to the current topic. Articles pertaining to the bulb urethral and posthypospadias strictures were excluded. Management considerations in posthypospadias repair stricture essentially remain the same as for any anterior urethral stricture but is influenced by prior multiple surgeries, scarring, lack of spongiosal tissue-associated chordee, and fistulae. Most of the studies on anterior urethral stricture are retrospective in nature, involve small number of patients, and consist of strictures of diverse etiology and combination of different types of procedures. Furthermore, the majority of the series are from a few select centers and as suggested by leaders or a few reconstructive surgeons. We found a frustrating lack of high or medium level of evidence pertaining to the success such as dilatation, internal urethrotomy, meatotomy, and reconstructive techniques. The selection of the proper procedure is important in achieving a successful outcome. Factors affecting the choice of management include the length and location of the stricture, associated spongiosfibrosis, quality of preputial and distal penile skin, and the presence or absence of LSA changes. Location and length of stricture is assessed by retrograde urethrogram. Micturating cystourethrogram (MCU) is helpful in the evaluation of fossa navicularis and for delineation of urethra proximal to impassable stricture. When the bladder neck does not open during MCU, antegrade urethrogram with ureteric catheter passed through suprapubic tract can delineate the urethra.[18] Sonourethrography has been claimed to have advantage over conventional urethrography.[19] Spongiosfibrosis is clinically felt as induration and can be objectively assessed by contrast spongigraphy[20] or ultrasonography. Patients with severe spongiosal fibrosis are better served by urethroplasty. Other considerations which are important are age, overall condition of the patient, and prior treatment. In patients with multiple comorbidities, dilatation and internal urethrotomy can be used as a palliative procedure or simple laying open of the distal urethra could be an alternative. More than cosmesis, providing the durable functional urethra remains the main goal.

Iatrogenic strictures are typically caused by instrumentation and prolonged catheterization due to compression and ischemia at places where the urethra is narrow and fixed. In our experience, instrumentation is the most common cause for meatal and fossa navicularis strictures. Posthypospadias repair urethral stricture accounts for 2.9.7% of anterior urethral strictures.[1,13] A stricture after hypospadias surgery is reported to occur in about 6.5% of the patients. [15] Hypospadias repair may fail many years after achieving successful functional and cosmetic results by primary repair, and urethral stricture may develop decades after initial hypospadias surgery.[3] Posthypospadias repair strictures differ from other anterior urethral strictures[16] because of the presence of more densely scarred, immobile, hypovascular tissue, lack of spongiosis, shortened penis, and chordee. The presence of fistulae and hair-bearing area may further add to the problems of management. External trauma leading to navicular fossa and pendulous urethral strictures is very uncommon and includes direct blunt or penetrating trauma and fracture penis. Idiopathic strictures are more common in younger patients and in bulbar urethra.[13] It may be the delayed manifestation of unrecognized (childhood) trauma or may be congenital in origin.[17]
**Management of fossa navicularis stricture**

*Urethral dilatation*

Select strictures of the fossa navicularis and meatus may respond to dilatation; however, long-term success is questionable. Simple stricture without much spongiosfibrosis is treated by dilatation. The patient can use the nozzle of lidocaine jelly tube for self-dilatation. Use of stainless steel chopstick has also been advised for self-dilatation in Chinese male to prevent stricture recurrence.[21] In cases of LSA-related stricture, urethral dilatation can potentially exacerbate the inflammatory process.[14]

*Direct visual internal urethrotomy*

Direct visual internal urethrotomy (DVIU) is technically difficult in fossa navicularis and distal pendulous strictures due to poor fulcrum and lack of leverage needed to incise the scar. This makes any cutting motion awkward, and inadvertent incision into the glans penis or corpora cavernosa can cause significant hemorrhage and possibly erectile dysfunction.[2]

*Dorsal or ventral meatotomy*

A dorsal or ventral meatotomy can be performed for select meatal and fossa navicularis strictures. The urethra is incised and whenever possible, the mucosal edges are sutured. The ventral approach will produce a small degree of hypospadia that is preferable to a dorsal incision, which can result in significant bleeding by cutting into the vascular glans penis. However, ventral meatotomy causes slaying of urinary stream for which patients need to be counseled before the procedure.[22] In patients with meatal stenosis due to LSA, a wide meatotomy followed by long-term application of high potency steroid (clobetasole or mometasone) or tacrolimus ointment may be tried. Use of topical tacrolimus has been proposed in an effort to avoid late atrophy and further potency steroid (clobetasole or mometasone) or tacrolimus wide meatotomy followed by long-term application of high potency steroid to “re-pave” the fossa navicularis. The rich glanular blood supply provides an ideal host for successful graft take. More recent studies incorporate extragenital tissue, such as postauricular skin graft[26] and buccal mucosal grafts.[27,28] Extragenital tissue is preferred in patients with LSA, because urethral substitution with genital skin leads to recurrence of stricture.[7,8] Although buccal mucosal grafts have solidified their place in our armamentarium for reconstruction of bulbar urethral strictures, there is limited experience with its use in the reconstruction of fossa navicularis and meatus. Most of the reported series using buccal mucosal grafts in glanular urethral reconstruction are for hypospadia repairs.[29,30] Although, the etiology and tissue characteristics of posthypospadias repair stricture are distinct from those of urethral stricture disease, buccal mucosal graft has been utilized with success for strictures involving pendulous urethra and fossa navicularis.[27,28]

Dubey et al.[27] reported successful use of buccal mucosa dorsal onlay for single-stage reconstruction of LSA-related strictures involving the meatus and glans. Their technique involved, mobilizing the penile urethra and extending on by Blandy are based on V-Y principle and have been criticized due to their suboptimal cosmetic results.[2] Further modifications suggested by Brannen and subsequently by De Sy also did not add much to the functional and cosmetic outcome.[2]

Jordan[2] revolutionized the treatment by using a more versatile flap (distal penile transverse ventral fasciocutaneous island flap) based on robust and broad darts pedicle. The flap is sutured to the urethra as ventral onlay after splitting the glans. Glans wing is created and closed over the flap. Virasoro et al.[24] studied 35 patients treated using this technique. With a mean follow-up of 10 years, a recurrence rate of 50% was seen in patients with strictures associated with LSA, whereas all patients with strictures of other etiologies had excellent results. Armenakas et al.[25] further improvised the technique by using a similar flap but preserving the glans (glans cap glanuloplasty). Glans was elevated off the glanular urethra and onlay flap was tunneled under the glans, bringing it out through the meatus and avoiding the direct incision over the glans. Excellent results were reported in 16 men with short strictures (average length 2.6 cm) with this glans cap procedure. The procedure has the esthetic advantage of preserving the integrity of the entire glans, limiting unnecessary scarring to this most prominent terminal penile segment. With a severely diseased or flattened glans, creating glans wings is preferable because this allows the excision of all fibrotic tissue with anatomic resculpturing of the glans.

**Reconstruction with grafts**

One of the earliest reconstructive procedures for fossa navicularis strictures is the patch-graft urethroplasty, described by Devine.[2] It incorporates a full-thickness distal penile skin graft to “re-pave” the fossa navicularis. The rich glanular blood supply provides an ideal host for successful graft take. More recent studies incorporate extragenital tissue, such as postauricular skin graft[26] and buccal mucosal grafts.[27,28] Extragenital tissue is preferred in patients with LSA, because urethral substitution with genital skin leads to recurrence of stricture.[7,8] Although buccal mucosal grafts have solidified their place in our armamentarium for reconstruction of bulbar urethral strictures, there is limited experience with its use in the reconstruction of fossa navicularis and meatus. Most of the reported series using buccal mucosal grafts in glanular urethral reconstruction are for hypospadia repairs.[29,30] Although, the etiology and tissue characteristics of posthypospadias repair stricture are distinct from those of urethral stricture disease, buccal mucosal graft has been utilized with success for strictures involving pendulous urethra and fossa navicularis.[27,28]
the dorsal urethrotomy into the glans. Buccal mucosa was put as dorsal onlay and brought in continuity through the glans dorsally to the meatus, thus reconstructing the meatus also. Using a similar technique with lingual mucosa, Das et al.\cite{31} also reported good results in such cases. They reported 83\% success rate in 30 patients with a mean follow-up of 9 months. We have observed excellent graft uptake on vascularized glanular bed. Hematoma does not form underneath the graft due to compression provided by indwelling catheter. Staged procedure is a viable option in cases with unsalvageable urethral bed with extensive fibrosis.\cite{8} Diseased urethra is completely excised and graft is applied to the vascular bed, which can be tubularized later on.

**Management of pendulous urethral stricture**

Management options include dilatation, internal urethrotomy, excision, and end-to-end anastomosis, penile fasciocutaneous onlay flaps, onlay graft, or 2-stage repair. The stricture of pendulous urethra is usually longer than the stricture of bulbar urethra. Anastomotic urethroplasty in pendulous urethra is possible only when the stricture segment is very short (<1 cm) and both the ends can be brought together without causing tension and chordee.

**Direct visual internal urethrotomy**

This procedure is successful in highly selected patients with short strictures and minimal spongiosfibrosis.\cite{32} Repeated attempts at urethrotomy may not increase success rates, rather create increased procedural difficulty and may decrease the success of urethroplasty. Pansadoro\cite{32} reported a recurrence rate of around 84\% for penile and 89\% for penobulbar stricture after DVIU. Greenwell et al.\cite{33} refuted the claim that repeat endoscopic management is safer and more cost-effective than open repair.

**Substitution urethroplasty**

Long stricture requires tissue transfer in the form of graft or flap for substitution urethroplasty. Stricture etiology and length of stricture are the important considerations, while choosing the appropriate graft or flap for substitution. Again due to the same reason as for fossa navicularis stricture, penile skin flaps are avoided in LSA-related strictures. Some authors initially reported good result using the penile skin flap in cases of LSA, which were not sustained on follow-up and have changed their practice.\cite{24} Graft or flap, whenever feasible should be used as onlay rather than tube to avoid high rate of stricture recurrence.\cite{33}

**Flap urethroplasty**

Preputial and various penile skin flaps, such as longitudinal flap, the hockey stick flap, and the circular penile fasciocutaneous flap based on darts have been used for penile urethral reconstruction. After Orandi\cite{34} first described a longitudinal penile skin flap for 1-stage urethroplasty in 1968, the technique has been the most popular method of repair of urethral stricture. Quartey\cite{34} used the same principle and described a ventral flap with a dorsal or circumferential “hockey stick” extension, which could provide a length of up to 15 cm to repair panurethral stricture. Distal circumferential/circumpenile flap, devised by McAnnich\cite{33} in 1993 is one of the most versatile flaps, which provides a full circular hairless skin flap up to 12-15 cm in adults. For synchronous urethral strictures, the flap may be divided into 2 pieces and/or passed under a scrotal tunnel to reach up to the proximal urethra. The Q-flap is a modification of the circumferential flap extended ventrally in order to gain additional length for use in panurethral strictures.\cite{35}

With better understanding of vascularity of penile flaps, broad and robust darts-based flap, such as distal circum penile flap, is increasingly being used now. It has high success rate both in short and long term. Whitson et al.\cite{36} reported success rates of 95\%, 89\%, 84\%, and 79\% at 1, 3, 5, and 10 years, respectively, in 124 men with non-BXO stricture of 8.2 cm. Earlier, with the use of preputial, penile, or scrotal skin flap, Andrich et al.\cite{37} observed an increased stricture rate with passage of time and attributed it to the natural attrition. Penile skin flap harvesting is technically more demanding and requires longer operating time. It is associated with more complications, such as penile skin loss, disturbed penile sensation, and less patient satisfaction.\cite{9}

**Graft urethroplasty**

Penile/postauricular skin\cite{26} and various other tissues, such as bladder mucosa,\cite{38} intestinal mucosa,\cite{39,40} and mucosa from lip, cheek, and tongue,\cite{41} have been utilized for urethral reconstruction. Buccal mucosa is versatile, can be easily harvested and has been reported to have an excellent outcome even in long term due to its inherent character, such as panlaminar vascular plexus.\cite{42} El–Kasaby et al.\cite{42} for the first time in 1993 reported the use of a buccal mucosal graft from lower lip for the treatment of penile and bulbar urethral strictures. Barbagli et al.\cite{43} first reported the use of dorsal free graft (penile skin) in pendular urethra in 1996. Since then, many have used penile/preputial skin graft\cite{44} and buccal mucosal graft in dorsal onlay fashion. In the last few years, buccal mucosa has become an increasingly popular graft tissue for pendulous urethral reconstruction performed in 1 or 2 stages. The graft can be applied ventrally\cite{45} or dorsally\cite{45} or dorsolaterally\cite{46} with comparable success rates. For dorsal and dorsolateral onlay tunica albugenia of corpora provide the firm vascular bed where the graft can be spread fixed. As in the bulbar urethra, spongiosplasty maneuver is not possible in pendulous urethra and darts fascia forms the bed for ventral onlay. Dorsolateral onlay requires unilateral mobilization of urethra; and therefore avoids the devascularization of the urethra due to circumferential mobilization.\cite{46} Single-stage buccal mucosa onlay graft urethroplasty is advised when urethral lumen is more than 6-Fr and urethra appears to...
be salvageable. For panurethral stricture, whole of the urethra can be accessed by inversion of penis through the perineal approach.

Controversy remains regarding the best means for reconstruction of penile urethra. The assumption that flap would fare well due to intact vascularity has not been a consistent observation. In a prospective randomized study, penile skin flap and buccal mucosal graft have similar success in intermediate term. Wessells et al. also found comparable outcomes of flap urethroplasty and graft urethroplasty. On the contrary, Barbagli et al. have shown that skin or oral mucosal graft urethroplasty has higher success rates as compared with flap urethroplasty. In a recent meta-analysis of 1263 patients, the success rate of buccal mucosal graft was more than skin graft for bulbar as well as pendulous urethral stricture. The success rate of buccal mucosa was similar in dorsal and ventral onlay, while skin graft was more successful when used dorsally. Graft urethroplasty had a better success rate in bulbar urethra than in pendulous urethra.

Lingual mucosa is a viable option when buccal mucosa is not healthy, especially in tobacco and betel nut chewer or if it has been used earlier. Singh et al. retrospectively compared their results of lingual mucosa graft dorsal onlay urethroplasty for distal anterior urethral stricture using Asopa’s sagittal ventral urethrotomy approach or Barbagli’s dorsal approach. Overall success rate was better in Asopa’s approach at 6 and 12 months. However, the 2 groups do not appear to be comparable for the caliber of stricture as the group with high success rate had high flow rate preoperatively. Moreover, ventral sagittal urethrotomy approach for dorsal inlay requires wider caliber of stricture.

Traditionally, LSA-related pendulous strictures have been treated with 2-stage urethroplasty, wherein whole of the diseased urethral plate is excised and replaced with buccal mucosal graft and later on tubularized in 4-6 months. Recently, some investigators have suggested single-stage oral mucosa dorsal onlay urethroplasty in LSA-related stricture and have shown good results in short and intermediate term. Long-term result for this is yet to be seen. Complex urethral stricture should favorably be considered for the 2-stage procedure rather than making frustrating attempt for single-stage repair. Two-stage procedures are not without complications and sometimes it may become a 3-stage or multistage procedure. Although 2-stage procedure has a significantly lower resection rate than 1-stage urethroplasty for complex strictures in the penile urethra, it does so at the expense of a significantly higher revision rate. Some patients may get satisfied with 1st stage of the 2-stage procedure and may elect to remain so or some may choose perineal urethrostomy as first and final option.

An alternative 1-stage method of reconstructing the obliterated/unsalvageable urethra is to use dorsal onlay buccal mucosal graft combined with a ventral onlay skin flap. The combination of graft and dorsal flap providing a urethral tube has more durable success than a tubularized flap. Penile skin flap and graft are complimentary and can be used for graft urethroplasty for one segment and flap urethroplasty in other segments of the stricture.

Colonic mucosa has also been shown to have a high success rate in intermediate term; however, morbidity of harvesting the graft is hindrance to such undertaking. Other than autograft, some off-the-shelf materials have also been tried in anterior urethral reconstruction, but only collagen-based acellular matrix used in onlay fashion has shown promise. Atala et al. first reported the use of human bladder acellular collagen matrices for reconstruction of urethra and reported patent urethra with good lumen at 1 year. El-Kassaby et al. have also shown success with use of collagen-based inert matrix. With the passage of time, acellular collagen matrix gets covered with typical urethral stratified epithelium. However, tubularized acellular collagen matrix is fraught with failure. Synthetic grafts of silicone rubber, siliconized Dacron, and polytetrafluoroethylene have shown poor results for urethral reconstruction in animal studies.

**Erectile function following reconstruction of pendulous urethra**

Reconstruction of pendulous urethra can have psychologic impact on patients. Altered penile sensation due to damage of the nerves during a flap urethroplasty can adversely affect the sexual function. In a substantial number of patients, altered penile length, angulations, and erectile dysfunction (ED) have been reported after a flap urethroplasty. Longer the stricture, higher the chances of transient sexual problems. ED has also been reported following graft urethroplasty; however, the incidence was similar to that of circumcision. The significance of this is not clear and appears to be psychogenic rather than organic. Fortunately, altered penile appearance and ED in these patients is short lived. Erectile function after a 2-stage urethroplasty has rarely been studied, giving the functional urethra being the primary aim in difficult cases. It is therefore imperative to counsel the patients of pendulous urethral stricture regarding the sensory, ejaculatory, and erectile disturbances beforehand.

**CONCLUSIONS**

The last 25 years have seen the emergence of several techniques and options for the repair of anterior urethral strictures. There seems to be a better understanding of the etiology of these strictures and the etiology has shifted from infective to inflammatory and iatrogenic causes. The management has shifted from a 2-stage procedure to a single-stage urethroplasty wherever feasible. Although buccal
mucosa onlay has fixed its place in bulbar urethroplasty, its use in pendulous urethra has shown encouraging results. Off-the-shelf material, such as acellular collagen matrix, holds promise for the future.

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