REVIEW

Management of bulbar urethral strictures: review of current practice

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Male urethral stricture disease is one of the common conditions encountered in the day-to-day urological practice. It can present at any age and has a wide range of etiological factors including infection, trauma and instrumentation. It usually manifests itself as lower urinary tract symptoms or urinary tract infections with significant impairment in the quality of life. There are several treatment options for this condition and these mainly depend on the site, length, the underlying cause and previous treatment. The management of bulbar urethral strictures has greatly evolved over the last few decades with more patients being offered reconstructive surgical operations as a primary treatment option. This article provides an overview on the management of bulbar urethral strictures and the wide range of surgical procedures offered to the patients.

Key Words: bulbar urethra, strictures, urethrotomy, anastomosis, urethroplasty

Introduction

Urethral stricture disease has long been mentioned in the history textbooks especially with the spread of venereal diseases. Jacques-Gillis Maisonouve first described the use of bougies or dilators in the treatment of urethral stricture in 1855. Subsequently Fessenden N. Otis from the United States described his Otis dilator in 1876. The first use of direct vision urethrotomy was described in 1865 when Antonin Jean Desormeaux from France used a cold thin knife to cut urethral strictures through an endoscopic sheath. However the gold standard direct vision internal urethrotomy was developed in 1971 by Hans Sachse from Germany who used the cold light illumination to guide his internal urethrotomy.[1]

Surgery has later emerged to be a vital tool in the management of urethral strictures. In 1962 J. M. Pierce described the total abdominal pubectomy for exposure of the urethra. This was abandoned and replaced in 1968 by direct transpubic excision of the stricture with end-to-end anastomosis of the urethral ends through a transabdominal approach. Perineal approach for mobilization of the urethra combined with an abdominal incision for transpubic anastomosis between the bulbar urethra and the prostatic apex was later described in 1973 by Waterhouse. In 1986 Webster and Goldwasser described posterior urethroplasty with transperieal wedge excision of the pubic bone.[2]

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Surgical anatomy

The male urethra is 20 cm in length and it is contained within the corpus spongiosum. It is anatomically divided into two main parts:

1. The anterior urethra: which is the longest part (15 cm) and it is subdivided into three parts from proximal to distal
   a) The bulbar urethra: starts at the root of the penis and ends at the urogenital diaphragm. It is situated dorsally in relation to the corpus spongiosum.
   b) The penile (or pendulous) urethra: it comprises the mobile part of the urethra and it has a more central position within the corpus spongiosum.
   c) The fossa navicularis: it is the most distal part of the urethra and it is situated within the glans.
2. The posterior urethra: this in turn is divided into two parts:
   a) The membranous urethra: is 1.5 cm in length and it pierces the urogenital diaphragm. It is surrounded by the external urethral sphincter.
   b) The prostatic urethra: it is approximately 3.5 cm in length and traverses the prostate. The prostatic glands open on either side of the urethral crest which widens distally to form the vermentanum with the two ejaculatory ducts open on either side.

The lining of the male urethra is transitional epithelium as it leaves the bladder through the prostatic urethra. This changes into stratified or pseudostatified columnar epithelium in the membranous, bulbar and penile urethra. Towards the fossa navicularis the lining changes into squamous epithelium.

The blood supply of the urethra is from the common penile artery, which is a branch of the internal pudendal artery. The common penile artery gives off several branches, including the bulbourethral, cavernosal, and deep dorsal penile arteries. The corpus spongiosum receives a dual blood supply via anastomoses between dorsal and urethral artery branches in the glans.

Pathophysiology of urethral strictures

The pathological events that lead to the development of strictures are the same regardless to the underlying cause in the majority of cases. It usually starts with a minor insult to the urethral epithelium or corpus spongiosum. This triggers the release of inflammatory mediators and inflammatory cell infiltrate in the subepithelial tissues. Subsequently there will be fibroblast infiltrate with the release of collagen resulting in scar formation and fibrotic narrowing of the urethra. The length and the extent of the stricture depend on the nature and the extent of the initial insult. Spongiofibrosis results when the fibrosis extends into the underlying corpus spongiosum.

Urethral strictures in males can present with voiding type lower urinary tract symptoms such as poor flow or spraying urinary stream. With advanced disease, patients may present with bladder trabeculation and diverticulation, bladder stones and eventual renal impairment as a result of back pressure on the bladder and the upper urinary tracts. This will predispose to recurrent urinary tract infections and renal impairment.

Etiology

Idiopathic

These account for the majority of cases. Recently there has been some evidence that they are caused by unrecognized perineal trauma during childhood.[3]

Congenital

These are usually uncommon and are found in infants and young boys. They are frequently found in the fossa navicularis but can also be seen in the membranous urethra. These can be severe and may lead to renal failure.[4] Nocturnal and diurnal enuresis could be the first manifestation of congenital urethral strictures and it should alert the family doctor to this condition.[5]

Repair of congenital anomalies such as hypospadias repair may result in meatal stenosis. This is most commonly caused by technical issues at the time of repair, such as fashioning of the urethral meatus with too narrow a lumen or performance of glanuloplasty too tightly. Urethral meatal dilation or meatotomy may be sufficient for the mildest forms of meatal stenosis. However, a more complex distal urethral stricture also involving the meatus may require a more extensive flap procedure.[6]

Acquired

This can in turn be classified into the following causes:

Trauma: this is the common cause of urethral strictures in men. It can be caused by direct blunt trauma to the perineal region such as saddle injury or penetrating injuries such as gun or bullet injuries. Recent military actions have shown, however, that high-speed projectiles can pass through superficial structures with relatively little cavitation effect and hence less propagation of energy to the adjacent tissues.[7]

The damage caused by genital burns depends on how well the normal structures have been maintained after the acute injury. The unique vascular qualities of the penis allow careful repeated debridement as opposed to aggressive debridement.[8]

Radiation trauma to the penis could lead to urethral strictures in two potential subsets: patients in whom radiation has been used therapeutically for the penile lesions and those in whom radiation to the pelvis has caused chronic lymphedema.[9]

Iatrogenic strictures following urethral instrumentation such as catheterization or transurethral resection could be found in 6.3% of patients. This is of utmost importance when counseling patients for transurethral prostatectomy. Anastamotic or other urethral strictures should be managed initially with dilation, but internal incision and endoscopic injection of glucocorticoids may often be required. For a long or persistent anastomotic stricture, a transurethral resection of the scar tissue cephalad to the external sphincter may be necessary. After the resection, an interval of catheter self-dilation of the anastomosis is usually necessary. Continued self-dilation or intermittent dilation by the urologist is required in difficult, persistent cases. Urethroplasty is rarely required.[9,10]

Infection: sexually transmitted disease such as *N. Gonorrhea* was the commonest cause of urethral strictures in the past. They tend to be extensive and difficult to treat. Most of those patients will end up with infertility.[11] However better sexual education and the prompt use of antibiotic therapy has helped to eliminated gonorrhea as an important cause of urethral strictures. The role of chlamydia infection as a cause of urethral stricture is yet to be determined.[12-14]

Balanitis xerotica obliterans (BXO) or lichen sclerosus et atrophicus is an inflammatory skin lesion that typically affects the prepuce or the glans although the anterior urethra may also be involved. The etiology is not very clear but autoimmune mechanisms have been implicated. It clinically presents as a whitish sclerotic ring at the tip of the prepuce. With disease progression, the sclerotic lesion leads to contraction of the genital mucosa with subsequent phimosis. Urethral involvement starts at the meatus, with tendency to form superficial adhesions between the meatal lips in milder cases. In extensive BXO entire urethra maybe involved; buccal mucosal free grafts is used for repair of such cases, to improve on an alarming 50% complication rate with the use of skin grafts for urethroplasty.[15-17]

Acquired curvatures of the penis: these usually follow trauma to the penis and can be a manifestation of Peyronie's disease. Occasional patients who had vigorous internal urethrotomy with the cold knife incision extending outside the urethra and corpus spongiosum and involving the tunica of the corporal bodies, causing scarring is significant enough to be associated with curvature.[18]

Diagnostic work up

Patients who have urethral strictures most often present with voiding lower urinary symptoms or urinary tract infections including prostatitis and epididymoorchitis. However, on close inquiry, most of these patients are found to have tolerated notable voiding symptoms for a long time before progressing to complete obstruction hence a careful history is essential. Examination of the abdomen may reveal a palpable bladder due to chronic urinary retention and that of the external genitalia that might show features of BXO or induration of the urethra as a result of fibrosis. It is essential to examine the prostate to have an initial estimate of the prostate size and to exclude the presence of prostatitis (a complication of the urethral stricture) or prostate cancer.

Flow studies can demonstrate reduced maximum flow rates with the typical "plateau" pattern of the urinary flow. Postvoiding scan usually show high residual volumes due to chronic retention. Any urinary tract infection detected on urine testing should be treated with the appropriate antibiotics.

Further investigations

Imaging studies

Retrograde cystourethrogram (RCUG): this radiographic assessment provides objective evidence on the presence and extent of strictures disease which is of paramount importance in subsequent management. The procedure involves placing a small (8F-10F) Foley catheter into the fossa navicularis and inflating the balloon with 1 mL-3 mL of sterile water. Once the position is confirmed with a preliminary film, 20 mL-30 mL of iodinated contrast media is injected into the catheter under fluoroscopy, and images of the anterior urethra are taken. Slow injection is recommended to avoid sudden spasm of the external sphincter and to prevent extravasation.[19]

Antegrade voiding cystourethrography (ACUG): this is usually performed through a suprapubic catheter in those who underwent catheterization secondary to retention of urine and failure of urethral drainage of the bladder with and without urethroscopy. It involves distending the bladder with at least 250 mL of contrast solution and asking the patient to void after the suprapubic catheter is clamped. The combined retrograde and antegrade urethrograms can give the accurate estimate of the extent of the strictures (length and location and depth).

Ultrasonography (US): this can be of value in the initial assessment of patients with urethral strictures, and can be augmented with contrast studies to

determine the length of narrow calibre strictures in addition to the location; the main value of US is to gauge the length in bulbar urethra and location bearing in mind that the absolute length of spongiofibrosis may not be evident on ultrasound. The probe can either be placed intraurethrally, along the penile shaft (dorsal or ventral surface) or in the perineum. The urethra is usually instilled retrogradely with normal saline or a lubricant jelly.[20] It demonstrates thicker periurethral tissues at the level of the stricture in comparison to the normal urethra.[21] It has shown comparable results to RCUG but is less commonly used as a result of small field and being operator dependent.[22]

Magnetic resonance imaging (MRI): this is the ultimate diagnostic test for the male urethral pathologies and in case of urethral disruption with pelvic fractures. It can be of special value in complex urethral stricture as it can clearly demonstrate the anatomy in the sagittal, coronal and transaxial planes. MRI shows diffuse thickening of the urethral wall with moderate enhancement on contrast images. It is also useful to delineate the extent of spongiofibrosis.[19,23]

Cystourethroscopy

This allows for direct visualization of the stricture segment and it provides information about the length of the stricture by visualizing both ends. It is also possible to use the flexible cystoscope through a suprapubic stoma in proximal urethral strictures in addition to it's value in evaluating strictures in children bearing in mind that it is not beneficial to dilate the stricture during the initial endoscopic examination.

Surgical treatment

The choice of the operation depends on several factors: stricture site, the length, the underlying pathology and the presence or absence of previous surgery. The surgical treatment of urethral strictures has changed rapidly over the years and many patients can now be offered curative surgical operation with good success rates. It is essential to realize that there is no single universally accepted treatment of urethral stricture and different modalities are available that suit different cases and this makes the management of urethral stricture a challenging task for the urologist.[24]

Urethral dilatation

This is the oldest and simplest treatment modality for treating urethral strictures. It is performed using urethral dilators or sounds (under local or general anesthesia) as a day case procedure. The aim is to stretch the scar and it gives good results in strictures with no spongiofibrosis.

Direct vision internal urethrotomy (DVIU)

This is performed using cold knife or laser (under regional or general anesthesia) as a day case procedure. The aim is to incise the stricture ring at 12 o'clock. Postoperatively the catheter is removed within 24-48 hours based on local protocols or experience. The subsequent epithelialization of the incised constriction ring aids healing of the urethra.[25]

The practice of postoperative self-intermittent dilatation following DVIU is a much debated subject although recently it has been shown that it can significantly prolong the time to stricture recurrence.[26]

Both dilatation and optical urethrotomy are ideal for short virgin bulbar strictures.[25] Recurrence rate at 12 months was approximately 40% for strictures shorter than 2 cm and 80% for those longer than 4 cm whereas the recurrence rate for strictures 2 cm-4 cm long increased from approximately 50% at 12 months to approximately 75% at 48 months.[27] However, repeated dilatation and DVIU render subsequent reconstructive surgery more difficult.[28] In addition, surgical repair for patients with short urethral strictures is more cost-effective than repeated urethrotomy.[29]

Urethroplasty

This is considered as the ideal treatment for anterior urethral strictures.3 This can be offered to males at all age groups and can even be performed as a day procedure with costs comparable and even less that DVIU.[28,29]

The operations described under the term urethroplasty include:

End-to-end anastomosis: this involves excision of the stricture segment and anastomosis of the two ends and it is recommended for short bulbar strictures (1 cm-2 cm). This procedure is performed though a perineal incision with the patient in the extended lithotomy position. The corpus spongiosum is dissected off the corporal bodies and the stricture segment is identified and excised and the two healthy ends are spatulated and closed with 4-0 PDS sutures. The anastomotic site is stented with a size 18F Foley catheter and further drainage of the bladder is performed using a suprapubic catheter. End-to-end anastomosis can provide success rates of up to 95%.[30-31] Barbagli and coworkers published their series of 153 cases of patients with urethral stricture treated with end-to-end anastomosis between 1988 and 2006. The mean time for follow up was 68 months. Their definition of recurrence was the need of any postoperative instrumentation. They reported 9.2% recurrence rates which was more frequent in patients whom had a traumatic cause of their recurrence. The majority of recurrences were treated with DVIU. Furthermore 50%

of recurrences occurred in the first year of operation with the rates gradually reduced after that.[32] Eltahawy and coworkers published their series of 260 patients who underwent end-to-end anastomosis over 10 years with a mean follow up of 50.2. With a mean stricture length of 1.9 cm the authors described a success rate of 98.8%. Stricture recurred in three patients (1.2%). The time of recurrence of the stricture was early in the first year in two patients, and after 4 years in the third patient. The former patients elected an intermittent dilation protocol while the later responded to a single DVIU. One of the patients who elected dilation has subsequently elected urethral reconstruction which has been done successfully.[33] On the other hand, Gupta and coworkers published the results of 114 patients who underwent end-to-end anastomosis in their center with a mean follow up of 26.7 months and average stricture length of 2.2 cm. The success rate of the procedure was 82.6%, there was no re- stonosis in their cohort of patients.[34] Jenkins and coworkers described 20% failure rate associated with end-to-end anastomosis with a mean follow up of up to 8 years; significant postoperative infection occurred in 11 (15%) and restenosis in 15 (20%), of whom 7 required a revision urethroplasty.[35] Finally Al-Quddah and Santicci compared end-to-end anastomosis to buccal mucosal onlay urethroplasty for short urethral strictures and concluded that the latter procedure is associated with higher success rates and lower incidence of complications.[36]

Augmented roof-strip anastomosis: this technique is used when there is a degree of tension between the two mobilized ends of the urethra whereby the two ends of the urethra are spatulated dorsally and then sutured round a graft that is quilted onto the tunica albuginea.[37] The anastomosis is then completed by closing the ventral hemi-circumference to bring the two ends of the urethra together. This repair can also be performed with the graft on the ventral surface with comparable results.[38]

Substitution urethroplasty: this is the most commonly practiced type of urethroplasty and it is the area of much progress in reconstructive urology. It entails replacing the strictured part of the urethra partly or wholly with another tissue. The desirable characteristics of the replacement tissue include thick epithelial layer and thin lamina propria, easy harvesting, abundance, minimal donor site complications and minimal shrinkage.[39] Bladder mucosa was initially used as a substitute but it was associated with 12% failure rates and harvesting a bladder meant exposing the patient to an even bigger operation with its associated morbidities.[40] Penile and scrotal skin were also used in the beginning but were associated with high failure rates of up to 20%-30%. In addition the presence of hair in the genital skin makes it a less favorable choice for grafting.[41] The buccal mucosa subsequently became the most popular tissue for substitution urethroplasty. It has several characteristics such as availability, ease of harvesting with minimal oral morbidity and concealed scarring. It also has a highly vascular lamina propria that facilitates tissue take.[42]

The site of application of the graft remains to be a source of controversy

Dorsal inlay graft

This technique was first described by Barbagli and coworkers in 1996. It has the advantages using the corporal bodies to provide a secure well-vascularized graft bed to prevent the protrusion of the graft with pseudodiverticulum formation. In addition, the spread fixation preserves graft width and hence urethral caliber.[43]

Surgical technique: the corpus spongiosum is completely mobilized off the underlying corporal bodies and then rotated 180°. A dorsal urethrotomy incision is performed and continued for 1 cm both proximally and distally. Later the graft is spread and fixed on the corporal bodies with the epithelial surface facing the lumen. The graft is sutured to the corporal bodies and subsequently to the cut-edges of the urethra. The area of the graft onlay is supported with a size 18F Foley catheter.

Barbagli and coworkers described in 2006 their first series of dorsal onlay urethroplasty using fibrin glue to support the buccal graft on the corporal bodies. They followed six patients for 12 months with promising results.[44] In addition the same author described a novel technique of substitution urethroplasty with preservation of the bulbospongiosus muscle and the perineal body. Their technique was associated with less ejaculatory and post voiding complications although their results were not validated.[45]

Ventral onlay urethroplasty

This has the advantages of ease of exposure and good vascular supply (by avoiding circumferential rotation of the urethra). Ventral urethrotomy allows the lumen to be clearly delineated and thus allowing the surgeon to identify mucosal edges, measure the size of the plate, carry out a watertight anastomosis and, if necessary, excise portion of the stricture and perform dorsal re-anastomosis.[46]

Surgical technique: once the corpus spongiosum is exposed, a ventral urethrotomy is performed in the manner described above. The graft is then sutured to

the open ends of the urethral mucosa in a watertight fashion using 5-0 PDS sutures. Subsequently the corpus spongiosum is closed over the graft and the area of the graft onlay is supported with a size 18F Foley catheter.

It is important to realize that both techniques provide similar high success rates and the final choice is that of the surgeon.[47,48]

Other graft materials used in urethroplasty:

Tunica vaginalis: Fionquinos and coworkers were the first to describe this novel method of substitution urethroplasty in their series of 11 patients. They used tunica vaginalis graft to reconstruct bulbar urethral strictures. The patients were followed up for 5 months with good success rates. However longer follow ups are required to assess this new graft as a suitable substitute for buccal graft and the need for comparative studies with existing grafts.[49]

Postauricular skin graft (PASG): this involves using skin harvested from the postauricular area to reconstruct the urethra. First described by Mundy in 1999, it shows comparable results to buccal mucosal graft owing to the presence of a dense subdermal plexus.[50] More recently Manoj and coworkers described their experience with the use of PASG in patients with diseased genital skin or oral mucosa unsuitable for harvesting. They had a success rate of 89% with improved International Prostate Symptom Score IPSS and flow rates postoperatively.[51] However the follow up period in that study was not clearly defined and that might influence their results.

Lingual mucosal graft (LMG): this has recently emerged as a potential substitute for buccal mucosa. The site of the graft harvest is the lateral mucosal lining of the tongue starting from a posterior landmark and continued across the tip of the tongue to the other side if longer graft is required. The graft harvesting site is simultaneously closed with continuous running suture using 4-0 polyglactin suture for adequate homeostasis. Few studies exist in the literature to describe this procedure and the majority lack long term follow up. Das and coworkers described improvement in the flow rate in 83.3% of patients at 9 months.[52] Recently Song and coworkers published their review on studies published on the use of LMG for urethroplasty and concluded that it could be a suitable replacement for buccal mucosa as a result of easy harvesting and low morbidity.[53]

Small intestinal submucosa (SIS): with the advancement of the tissue engineering technology, scientists were able to regenerate urethral tissues using biodegradable organic matrices. Palmenteri and coworkers described their initial experience of the use of collagen tissue manufactured from porcine SIS for urethral reconstruction. They studied 20 patients who had urethroplasty using SIS as a graft with a mean follow up of 21 months. They describe 85% success rates in patients with bulbar urethral sictures.[54]

Conclusion

Controlled clinical trials are not very common in surgery (generally) and urology (specifically), and almost non-existent as far as the management of urethral stricture is concerned. Management of bulbar urethral stricture is a complex task and a large number of procedures available. Optical (endoscopic) urethroplasty can be attempted once especially for short strictures less than 2 cm, however it should be noted that recurrence will warrant a referral for open urethroplasty. The role of laser in endoscopic urethrotomy is not yet high yielding and more studies are indicated. Open urethroplasty remain the gold standard. In the absence of randomized studies to compare between different procedures the choice of the operation depends largely on the expertise of the surgeon and the materials available. □

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