Anterior Urethral Strictures: Causes and Current Management Strategies

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Abstract: Urethral strictures often cause significant symptoms in children. No single approach is appropriate for all urethral strictures. For surgical repairs, proper procedure selection and surgical expertise are of paramount importance. An understanding the urethral anatomy is important for the diagnosis and treatment of urethral stricture disease. In this review we have tried to assess the common causes of anterior urethral strictures and their possible management strategies.

Keywords: Anterior urethral stricture, Buccal mucosal graft, Urethral dilatation, Urethroplasty, Urethrotomy

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Introduction

Urethral strictures often cause significant symptoms in children. No single approach is appropriate for all urethral strictures. For surgical repairs, proper procedure selection and surgical expertise are of paramount importance. An understanding the urethral anatomy is important for the diagnosis and treatment of urethral stricture disease. An extensive PubMed and Google scholar search was done to see the available literature and current practice.

Male urethra is divided into an anterior and posterior division. The anterior division consists of the fossa navicularis, penile and bulbar urethra. The posterior division consists of the membranous and prostatic urethra. The membranous urethra marks the dividing line between the anterior and posterior urethra. The normal male urethra is surrounded by the corpus spongiosum. The corpus spongiosum has a dual blood supply from both distal branches of the deep internal pudendal artery. The deep internal pudendal artery then continues as the common penile artery. The distribution of urethral stricture is as shown in table -1.

<table>
<thead>
<tr>
<th>Serial No.</th>
<th>Location of stricture</th>
<th>Subdivision</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Posterior Urethra</td>
<td>Posterior Urethra</td>
<td>7.8%</td>
</tr>
<tr>
<td>2.</td>
<td>Anterior Urethra</td>
<td>Penile</td>
<td>30.5%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bulbar</td>
<td>46.9%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Penile plus</td>
<td>9.9%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bulbar</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Panurethral</td>
<td>4.9%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td>100%</td>
</tr>
</tbody>
</table>

Table 1. Distribution of Urethral Stricture

Etiology

The data on causes of urethral strictures in children is scarce. The major causes of anterior urethral strictures in children are trauma, hypospadias surgery, traumatic catheterization, iatrogenic, unknown and congenital. In children hypospadias repair, cystoscopy for various indications and catheterization constitute the major iatrogenic causes. Strictures are classified as one resulting from catheterization when urethral catheter insertion is the only urethral manipulation done. Other minor causes of strictures include congenital and infection. In the 0-10 year age group, the strictures are mainly localized in the penile urethra, and in the >10 year group, in the bulbar urethra. The main cause of stricture is iatrogenic (particularly HR) in the 0-20 year group.

Clinical Features

Weak stream, incomplete emptying and frequency were noted to be the most prevalent symptoms for patients undergoing operations.
urethroplasty for anterior urethral strictures.\(^{[1]}\) Symptoms other than LUTS or urinary retention account for 22.3% of the presenting complaints. These include urinary tract infection (6.1%), difficult catheterization (4.8%), gross hematuria (3.1%), pain (2.9%), and urethral abscess (2.3%). 1.3% had renal failure as the initial presenting symptom of urethral stricture.\(^{[2]}\)

**Clinical Evaluation**

Initial evaluation for urethral stricture begins with a thorough history and physical examination. Any history of previous urethral instrumentation or a history of hypospadias surgery, genital injury, urethral discharge, hematuria, and dysuria should be elicited. Lower urinary tract symptoms should be assessed with an AUA system.\(^{[4]}\) Physical examination should include palpation of the penile shaft for thick urethral scarring and examination of the glans penis, meatus and perineum.

**Investigation**

Any investigation for urethral stricture should confirm the length, location, depth and density. The diagnosis of a urethral stricture is evaluated using direct visualization, sonography and contrast imaging. To identify a stricture direct visualization with a cystoscope is most commonly undertaken. Cystoscopy can help gauge the caliber of the stricture and its location along the course of the urethra. Limitation of cystoscopy is its inability to determine the length and depth of the stricture. To determine stricture length, radiographic techniques such as a dynamic retrograde urethrogram and voiding cystourethrogram are required. Retrograde urethrogram has been the gold standard for urethral stricture diagnosis and has a specificity and sensitivity of 90%.\(^{[5]}\)

Urethral sonography provides an adjunct to the retrograde urethrogram in defining the degree of stricture spongiosis and for surgical planning. Sonography can more accurately describe and detect anterior urethral strictures. Sonography is able to visualize spongiosis which appears as an anechoic irregular density next to and/or invading the urethral lumen.\(^{[8]}\) Ultrasound can further help delineate periurethral pathology that includes calculi, abscesses, fistula or diverticula.

**Management**

The treatment for urethral strictures was first described by Susruta in India. He described using an iron, wood or shellac rod lubricated with butter and introduced into the urethra every 3 days with rods of increasing size. The principles of management have changed little since the beginning of urethral dilation; however, newer imaging and operative techniques have improved to provide patients with better curative outcomes. It has been a common practice to treat urethral strictures according to the "reconstructive ladder"; use simple methods first before progressing to more complex treatment options. This practice has been challenged by several authors. Improved imaging and surgical interventions have led some urologist to treat initially with urethroplasty if the urethral strictures and patient characteristic allows. Literature has shown that repeated futile attempts at less invasive procedures can make future surgical repair more difficult. The level of evidence upon which to base therapy of strictures in children is low and consists mostly of case series from single institutions. Hence most of the information is extrapolated from the adult literature.

The current options for urethral stricture management and cure include urethral dilation, direct visual internal urethrotomy (DVIU), and urethroplasty.

**Urethral Dilation**

Urethral dilation has been extensively used as primary means of managing urethral strictures. It is believed that dilation creates small tears within the scar that heal by epithelialization with healthy mucosa. However the tear can also heal by further scar formation thereby contracting the stricture more and worsening symptoms and creating a more difficult future surgical repair. Repeated dilation does not treat the underlying spongiosis in patients with more complex strictures. Spongiosis found on ultrasound should direct intervention to include DVIU or urethroplasty.

**Direct Visual Internal Urethrotomy (DVIU)**

Direct Visual Internal Urethrotomy (DVIU) treats the stricture directly by incision. Patients who have superficial spongiosis may benefit from DVIU when the incision is carried out through all depths of the scar. Predictors of success include stricture length and degree of spongiosis.\(^{[7]}\) DVIU is best utilized for short strictures less than 1.5 cm that involve the bulbar or penile urethra. DVIU has a long term success rate of 74% if the above criteria are met. DVIU success can be improved if urethral dilation is performed greater than 1 year (80%). Literature comparison of DVIU vs. repeated urethral dilation revealed no significant difference in stricture recurrence or reduction in urethral caliber up to 4 years post procedure.\(^{[9]}\)

Data suggest that a second endoscopic treatment after initial DVIU of post-hypospadias stricture should not be undertaken given the low success rate when compared to urethroplasty (17% vs 67%). If the stricture is distal, endoscopic therapy has an even lower success rate when compared to urethroplasty (11% vs 52% at first treatment and 0% vs 71% at second treatment). If DVIU is to be implemented for the treatment of a stricture after hypospadias repair, it may be most suitable for the initial treatment of short, proximal strictures.
Mitomycin C submucosal injection at incision sites has shown to reduce scar formation. Mitomycin C has both antifibroblast and anticollagen properties. 10% risk of retraction with Mitomycin C vs. 50% for DVIU alone during a 6 month follow up has been noted.[9]

DVIU with the holmium: YAG laser reduced operative time and higher recurrence free rate of stricture recurrence at 6, 9, and 12 months compared to DVIU using cold knife.[10]

Urethrotomy combined with other techniques like hydraulic self-dilatation, endoscopic resection of callus, intraurethral mitomycin C,[11] intraurethral captopril gel,[12] intraurethral hyaluronic acid,[13] and urethrotomy combined with postoperative intermittent dilatation by clean intermittent self-catheterization[14] have shown to be of benefit in various small studies.

**Urethroplasty**

Urethroplasty provides the optimal surgical repair of strictures that consist of excision with primary anastomosis. It may also be done in two stages where the first stage involves creation of perineal urethrostomy with excision of scar tissue and after adequate healing has taken place, urethroplasty can be performed. In some instances, stricture excision produces a gap that is too long for an end-end anastomosis. In such cases placement of a buccal mucosal graft or penile shaft flap to bridge the gap is used. There are many different types of urethroplasty, each appropriate for a particular patient. The type of stricture, length and nature of underlying problem and history of previous surgery dictates urethroplasty technique.[14]

a). **Choice of Tissue: Penile Skin vs. Buccal Mucosa**

Buccal mucosa has become the most popular substitute material in the treatment of urethral strictures, as it is readily available and easily harvested from the cheek or lip, allowing for a concealed donor site scar and low oral morbidity.[15]

Prior to the use of buccal mucosa, penile skin was the preferred tissue for urethroplasty. The overall success rate of penile skin urethroplasty was 84% (mean follow-up 201 months), while the success rate of buccal urethroplasty was 87% (mean follow-up 48 months) and no statistically significant difference was found between the two groups.[16]

The dorsal onlay technique of Barbagli and the dorsal inlay technique of Asopabuccal mucosal graft urethroplasty provided similar success rates. The Asopa technique is easy to carry out, provides shorter operative time and less blood loss, and is associated with fewer complications for anterior urethral stricture repair.[17]

b.) **Penile Urethral Reconstruction**

The use of flaps or grafts, in single or multi-stage repair, should not compromise penile length or cause chordee, and should provide good cosmetic appearance

(i) **Flap vs Graft:** It is not clear whether a pedicled flap will fare better than a free graft, as the thin penile corpus spongiosum and the dartos fascia do not ensure sufficient graft support in all patients.[18–19]

(ii) **Single stage vs multiple stage:** Penile urethroplasty should be performed in a single-stage whenever possible to avoid patient discomfort and disability that can be caused by the use of multi-stage procedures. In patients with urethral strictures caused by trauma, infection, instrumentation or catheter, the penis is generally normal and the penile skin, urethral plate, corpus spongiosum and dartos fascia are suitable for urethral reconstruction. In such cases, one-stage urethroplasty is the surgery of choice. Instead, in patients who have experienced failed hypospadias repair or in whom the penile skin, urethral plate and dartos fascia are not suitable for urethral reconstruction, two-staged urethroplasty has been recommended.[20]

c.) **Bulbar Urethral Reconstruction**

The surgical technique used in the repair of the bulbar urethral stricture is dictated by the stricture length. Strictures ranging from 1 to 2 cm are treated by using end to end anastomosis; strictures ranging from 2 to 3 cm are managed using augmented roof-strip anastomosis; strictures longer than 3 cm are treated using substitution.

(i) **End-to-End Anastomosis:** Short strictures in the bulbar urethra are generally amenable to complete excision with primary anastomosis via a perineal incision, affording a high success rate of 95%, as reported by Santucci et al.[21] Excision of a longer urethral segment risks penile shortening or chordee, even if lengthening maneuvers are applied, Al-Qudah & Santucci suggested that the use of end-to-end anastomosis is also controversial in the treatment of short and medium length urethral strictures (range 0.5 to 3.0 cm). The recurrence rate was 7% in those patients who underwent end-to-end anastomosis and 0% in patients who underwent buccal mucosal graft urethroplasty. In conclusion, buccal mucosal onlay graft urethroplasty is suggested as the operation of choice even for short urethral strictures.[22]

(ii) **Augmented Roof Strip Anastomosis:** In this technique the worst section of the stricture is removed and the urethra is re-anastomosed and dorsally augmented with a free graft.[23] Delvecchio et al. suggested that the use of augmented roof-strip anastomotic urethroplasty incorporating the graft onlay into the receiving urethral plate is less successful, either because of the inherent deterioration of transferred tissues exposed to urine or...
to the fact that the onlay is performed in an area of dense spongiofibrosis, generally at a site where the stricture disease originated, which is unsuitable for simple onlay grafting.

(iii) **Substitution Urethroplasty Using Buccal Mucosal Graft:** Buccal mucosa graft is the most widespread method for the repair of strictures in the bulbar urethra. Location of the graft on the urethral surface is debatable. Success with bulbar buccal mucosal grafts has been high with dorsal or ventral graft location and the different graft positions have shown no difference in success rate.

Urethrectomy with salvage reconstruction using buccal mucosal grafts in a staged fashion is the optimal method for managing complex anterior urethral stricture. Surgical revision of the first or second stage may be required in up to 25% of cases. Despite the high complexity and severity of the urethral stricture burden, a 90% success rate was achieved by this technique.

(iv) **Use of Fibrin Glue in Urethral Reconstruction:** Fibrin glue contains fibrinogen, Factor XII, plasmafibronectin and plasminogen dissolved in an aprotin solution (bovine) with an activate thrombin component (human) mixed with a calcium chloride solution. When combined, a dense gelatinous clot is quickly formed at the point of application. Because this fibrin sealant is non-synthetic and, therefore biocompatible with the natural fibrinolytic mechanism, healing is promoted without inflammation and fibrosis formation. However, further comparative studies are necessary to confirm that the use of fibrin glue is really beneficial and to evaluate whether its use reduces restenosis rate following substitution urethroplasty.

(v) **Tissue Engineering Urethroplasty:** Ribero-Filho et al. recently presented a new urethroplasty technique that uses human cadaveric urethral acellular matrix. After harvesting from a cadaveric donor the urethral mucosa and spongiosum tissue were enzymatically converted into a urethral acellular matrix graft. The graft was then applied onto the urethra as a ventral onlay patch.

References


22 Al-Qudah HS, Santucci RA. Buccal mucosal onlay urethroplasty versus anastomotic urethroplasty (AU) for short urethral strictures: which is better? J Urol. 2006;175:103


