Urethral Stricture Disease

Editors:

Alex J. Vanni, MD, FACS

Authors:

Alexander T. Rozanski, MD

Last Updated:

Tuesday, February 7, 2023

This section of the Core Curriculum closely reflects the AUA Guideline on Male Urethral Stricture (2016), which is a seminal reference for this section. It is highly recommended that readers study this Guideline as well.

1. Introduction

Urethral stricture disease should be considered in the differential diagnosis of any male patient who presents with weak stream, incomplete emptying, dysuria or recurrent UTIs. Once the diagnosis is made, determining the length and location of the stricture is crucial for proper patient counseling and management decisions. A wide variety of techniques are available to appropriately treat the diverse nature and presentation of urethral stricture disease. Referral to reconstructive urologists with expertise in urethral reconstruction is strongly recommended. [1,2]

1.1 Key Words

Urethral Stricture, Urethroplasty, Reconstruction

2. Definition

Anterior urethral stricture disease occurs when normal urethral mucosa and its associated corpus spongiosum is replaced with scar tissue. This results in narrowing of the urethral lumen via scar contracture or fibrosis.[1] The anterior urethra includes the urethral meatus, fossa navicularis, penile urethra, and bulbar urethra.

As the corpus spongiosum is absent in the posterior urethra, scar formation in this region is referred to as urethral stenosis or bladder neck contracture rather than urethral stricture.[3]

3. Risk Factors and Pathophysiology

Urethral strictures occur after damage to the urothelium and/or corpus spongiosum of the anterior urethra is significant enough to result in progressive fibrosis. This can occur due to: **trauma** to the perineum or urethra such as straddle injuries, **iatrogenic causes** such as urethral catheterization, endoscopic procedures or radiation therapy, **sexually transmitted infections** causing urethritis, inflammatory conditions such as **lichen sclerosus**, or **hypospadias**-induced stricture disease.

Despite there being multiple distinct etiologies for urethral stricture development, an idiopathic presentation is common.

Urethral strictures may result in urinary obstruction with a reduction in urinary flow and incomplete emptying. Patients often present with obstructive voiding symptoms, urinary tract infections, or urinary retention. Urethral stricture formation is thought to occur due to replacement of normal tissue with hyaline scar. This has been demonstrated with histological analysis and postulated due to chronic extravasation of urine into the corpus spongiosum after the initial urothelial insult. [1,2,4,5] Lichen sclerosus urethral stricture disease shows increased inflammatory markers on histopathological evaluation and possibly a viral etiology, although the exact etiology is currently poorly understood.[6,7,8]

4. Epidemiology

The incidence of urethral stricture disease is estimated as high as 0.6% in the U.S. male population in 2000 with a peak incidence of urethral stricture at age 55 years. In the United Kingdom, peak incidence of urethral strictures was found in men 65 years and older.[9,10,11] The bulbar urethra is the most common location for stricture disease. Many of these strictures are secondary to iatrogenic causes, trauma, or inflammatory disorders, but up to half of all urethral strictures are idiopathic in nature.

5. Diagnosis

Evaluation should begin with a **history and physical examination**. Patient age and history may help distinguish between urinary obstruction due to urethral stricture versus other causes. History should include evaluation of **urinary and sexual function**. There are multiple available questionnaires or patient-reported outcome measures that can be utilized to help assess urinary and sexual function in the pre-operative and post-operative setting.[12,13] A review of prior stricture interventions in patients with pre-existing stricture disease is required for treatment planning. [1,2] Medical co-morbidities must also be taken into account when determining optimal management options. Physical examination of the **penis, scrotum, perineum, and mouth** should be performed, as non-hair bearing penile skin and oral mucosa are sometimes used for urethral reconstruction. Previous surgical scars in the genital area and overall body habitus are important to assess. Range of motion of the lower extremities should also be evaluated as many urethral surgeries require dorsal lithotomy positioning. **Urinalysis** should be performed to evaluate for infection or infectious etiologies of stricture disease.

Patients who present with acute urinary retention can be managed with endoscopic treatments or immediate suprapubic tube (SPT) placement. These patients should be followed for stricture recurrence after catheter removal. A SPT can also be placed prior to urethral reconstruction in patients who require self-dilation or chronic catheterization to maintain urethral patency. A period of urethral rest, typically 1-3 months, allows the stricture to mature prior to surgical intervention.[2]

6. Investigations

Uroflowmetry in males with significant urethral stricture disease may demonstrate diminished flow

and elevated post void residuals. **Retrograde urethrography (RUG) and voiding cystourethrography (VCUG)** are the primary radiographic methods for evaluation of urethral stricture disease with ultrasound as an optional adjunctive test (**Figures 1 - 4**). A RUG is a very effective imaging tool for the anterior urethra; however, if the stricture extends past the level of the bulbomembranous junction, RUG and VCUG at the same setting may be necessary to effectively characterize the stricture disease as the RUG alone poorly evaluates the posterior urethra. **Cystoscopy** may also be used to evaluate urethral strictures, especially in the setting of inconclusive fluoroscopic tests. In patients with an indwelling SPT, concurrent RUG and antegrade cystoscopy can also be performed to clarify stricture details. This can be particularly helpful in the setting of an obliterative stricture when a VCUG, via retrograde bladder filling, is not possible. The length, location and caliber of a urethral stricture should be evaluated for proper operative planning. **Ultrasound** can be performed to evaluate and confirm the length of a stricture and any associated spongiofibrosis. Ultrasound measurements are taken while a 60 mL catheter tipped syringe with sterile saline is used to gently distend the urethra in a retrograde fashion while a crede maneuver is performed to distend the urethra in an antegrade fashion. Ultrasound provides an accurate measurement of stricture length.[1,2,10,14]

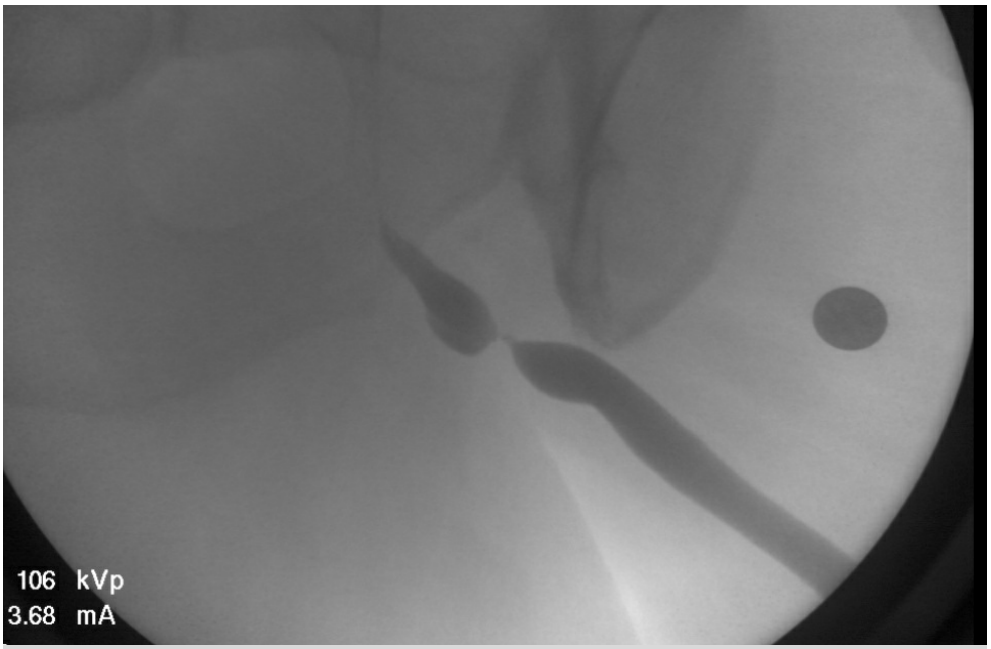

Figure 1: RUG after straddle injury showing short, high-grade traumatic bulbar stricture.

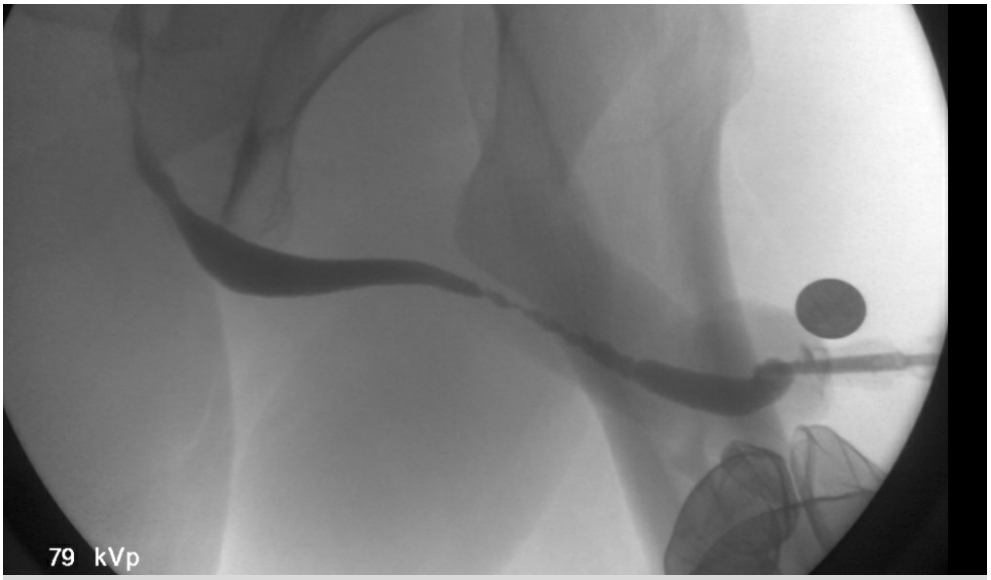

Figure 2: RUG showing long segment penile stricture disease after TURP procedure.

Figure 3: Concurrent RUG and antegrade cystoscopy via suprapubic tract to optimally characterize an obliterative stricture.

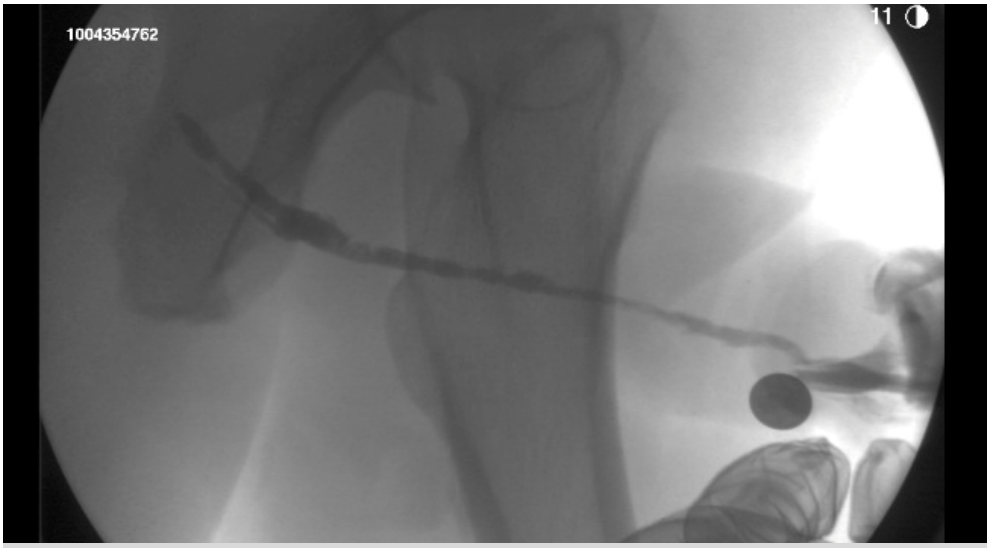

Figure 4: RUG showing panurethral stricture disease secondary to Lichen Sclerosus.

7. Treatment

7.1 Urethral Dilation or Direct Vision Internal Urethrotomy

7.1.1 Indication

Endoscopic management consists of urethral dilation or direct visual internal urethrotomy (DVIU). Endoscopic management is an option for **initial bulbar urethral strictures less than 2 cm in length.** Meatal or fossa navicularis strictures can also initially be treated with endoscopic approaches. For penile strictures, endoscopic management should be avoided, even in the initial setting, due to the expected high recurrence rates.

For any stricture location, patients should be counseled that they are likely to need additional treatment for their stricture disease after endoscopic management, as this is commonly utilized as a temporizing measure rather than a definitive therapy. Repeat dilation or DVIU should be avoided due to poor long-term success rates, and these patients should be offered urethral reconstruction.

Repetitive endoscopic approaches can be offered as a palliative measure combined with self-dilation if the patient is a poor surgical candidate or unwilling to undergo urethral reconstruction.[2]

7.1.2 Operative Considerations

A **urine culture** is recommended prior to surgery as urinary retention or stasis is often associated with urethral stricture disease. If the pre-operative urine culture demonstrates infection, this should be treated prior to proceeding. When no infection is present, a single dose of pre-operative antibiotics is recommended per **AUA antibiotic prophylaxis guidelines** best practice statement.

Urethral dilation may be performed with sounds, serial dilators, or filiforms and followers. Co-axial balloon dilation may also be performed with cystoscopic and/or fluoroscopic guidance to aid in

localization of the stricture. The specific technique chosen depends on surgeon preference, location of the stricture, and patient anatomy. Male sounds and serial dilators require experience to atraumatically guide into the bladder. Filiforms and followers provide confirmation that the follower has correctly entered the bladder with return of urine through the hollow follower. Balloon dilation requires availability of a disposable co-axial balloon dilator and pump. The cystoscopic and/or fluoroscopic guidance available with balloon dilation can help to directly target the location of the stricture and monitor success of dilation.

Internal urethrotomy is intended to incise the scar tissue radially and adequately open the lumen of the urethra. Typically, a cold knife is used with direct endoscopic visualization to incise through the scar tissue and open the urethral lumen. The cold knife can be used to incise the stricture in quadrants (12-, 3-, 6-, and 9-o'clock), a chevron pattern (12-, 4-, and 8-o'clock), or horizontally (3- and 9-o'clock). A laser may also be used to incise strictured tissue; studies have failed to show a difference in outcomes or complication rates between urethrotomy utilizing cold knife versus laser, though cold knife urethrotomy is less expensive. [15]

After formal dilation or DVIU in patients who are poor operative candidates, regular self-catheterization can be used to maintain patency of the urethral lumen. Long-term usage of self-obturation for urethral stricture management has been associated with reduced quality-of-life.[16]

More recently, a novel endoscopic management technique has become available for patients with recurrent strictures <3 cm in length – **the Optilume® drug coated balloon**. The stricture is dilated to provide symptomatic relief, as with a standard balloon dilation procedure. However, in addition, there is circumferential and local application of paclitaxel, an antimitotic agent, which inhibits cell proliferation and migration.[17]

7.1.3 Outcomes

Urethral dilation and DVIU report similar success rates.[2] The median time to urethral stricture recurrence after endoscopic management is approximately 6-12 months. Success rates worsen with longer follow up and repeated endoscopic procedures. **Short bulbar strictures have a roughly 50% success rate for first time DVIU**.[2] However, in a series of over 100 patients who underwent 3 endoscopic procedures, all patients suffered recurrence at 24 months. [18]

Similar results have been observed in more recent studies evaluating the utility of repetitive attempts at DVIU, with diminishing stricture-free rates with increasing number of procedures.[19,20] Additionally, previous studies have demonstrated that multiple transurethral treatments for stricture disease are associated with increased stricture complexity as well as a delay to definitive urethroplasty.[21,22]

With regard to the Optilume® drug coated balloon, three-year results are now available from the ROBUST I Study.[17] This study included adult men with recurrent bulbar urethral strictures <2 cm in length and a history of 1-4 prior endoscopic interventions. **Functional success, defined as >50% reduction in International Prostate Symptom Score (IPSS) without need for retreatment, was achieved in 67%. Overall freedom was retreatment was seen in 77%.**

7.1.4 Complications

Risks of dilation, especially when performed blindly without confirmation of access to the bladder, include urethral injury and injury to surrounding structures including the rectum. Either dilation or DVIU can cause complications in 11-14% of cases including bleeding and infection with high rates of recurrence.[23] The Optilume® drug coated balloon has not had any paclitaxel-specific serious adverse effects to date.[17]

7.2 Urethroplasty

f,

7.2.1 Indication

Urethroplasty is the gold standard treatment of urethral stricture disease and can be offered as initial therapy for all strictures. Surgeons who do not routinely perform urethroplasties should refer to appropriate high-volume centers.[5] Urethroplasty consists of urethral reconstruction with either excision of scar and anastomosis of healthy urethral segments or incision of scar and substitution with a flap or graft. **Oral mucosa and preputial skin** are recommended over hair-bearing graft/flaps such as scrotal or abdominal skin. Common sites of oral mucosa harvest include buccal, labial, and lingual mucosa, all with similar success rates; in fact, a systematic review from Italy demonstrated no significant difference between buccal graft vs. lingual graft in terms of functional outcomes.24.[24]

7.2.2 Operative Considerations

Urethroplasties may be performed as **one or two-stage operations** depending on length of stricture, complexity of repair, and quality of remaining urethral tissue. **Anastomotic urethroplasties, transecting or non-transecting, are typically performed for short bulbar strictures <2 cm in length. Longer bulbar strictures or any penile strictures typically require a graft or flap procedure** .[1]

Buccal mucosa grafts are the most common grafts used, typically as either a dorsal or ventral onlay technique. A systematic review of graft urethroplasties showed no difference in outcomes between the two approaches.[25] Grafts should not be tubularized due to poor long-term success rates.[5] When harvesting buccal grafts, Stensen's duct should be identified and avoided. Closure of the donor site is optional. Excess tissue is removed after harvest, to maximize the chances of graft neovascularization and survival. The first 48 hours of graft take is defined by a process of imbibition during which the graft receives nutrients via diffusion. This is followed by inosculation over the next 48 hours, which is characterized by graft vessels connecting with recipient bed vessels. A neovascularization process then follows to allow for a healthy, well vascularized graft.

Another substitution technique, **fasciocutaneous flaps**, may be used for penile or bulbar urethral strictures. Keeping a healthy pedicle for blood supply is technically demanding, but crucial for flap success. Fasciocutaneous flaps are used less often than buccal grafting as they can be more technically challenging and have higher complication rates.[1]

7.2.3 Outcomes

In a systematic review of urethroplasty outcomes, **anastomotic repairs had success rates of 92%.**[26] **Buccal grafts or flap urethroplasty have differing success rates depending on the study with either equivalent outcomes or slightly improved for buccal mucosa with success rates of 84-87%**.[27] Given this high success rate compared with dilation and internal urethrotomy, it is argued that urethroplasty procedures are more cost effective than repeated endoscopic treatments.[28]

When bulbar urethral strictures do recur after urethroplasty, initial management consists of observation (if asymptomatic) or endoscopic treatment. While DVIU and dilation have been shown to have approximately equal outcomes when used as primary management of urethral stricture, a multi-institutional study of 53 patients revealed that when used in the management of post-urethroplasty stricture recurrence, DVIU was more successful than dilation at 5 month follow up. [29] Both methods are better suited for short recurrences versus longer recurrences which are less amenable to endoscopic management.[30]

7.2.4 Complications

Potential complications and sequelae after urethroplasty include **recurrence of urethral stricture disease (8-15%), erectile dysfunction (approximately 1% one year postoperatively), urethral diverticulum, post void dribbling, and fistula formation**.[26,27] For buccal or lingual mucosal graft urethroplasty in particular, the incidence of oral complications are uncommon, but have been described, including **oral pain and impaired speech** in the short-term postoperative period and **impaired or altered sensation, dysgeusia, or mouth "tightness" or scarring** at long-term follow up.[31,32]

7.3 Perineal Urethrostomy

7.3.1 Indication

Panurethral strictures, typically from lichen sclerosus or multiple previous hypospadias repair failures can be very challenging to manage. A perineal urethrostomy is a reasonable option, particularly in elderly patients or patients with severe stricture disease.[2,33]

7.3.2 Operative Consideration

A number of urethrostomy approaches have been described including transecting and non-transecting techniques.[33] Multiple skin flaps have also been described.[34] All options include mobilizing a healthy skin flap and typically anastomosing to the bulbar urethra distal to membranous urethra to preserve continence.

7.3.3 Outcomes

Men will have to sit to void, but in the properly selected patient a lack of obstructive symptoms and freedom from catheterizations leads to high satisfaction. An Italian series with 173 patients showed success rate of 70% with 97% satisfaction rates. [34]

A study from the TURNS group evaluated urinary and sexual satisfactions rates in 131 patients undergoing anterior urethroplasty vs. perineal urethrostomy for strictures longer than 6 cm. Validated questionnaires were administered before and after intervention. At median 390 days of follow up, patients in both groups reported improvement in urinary and sexual function; there was no significant difference in 2-year failure rates or patient reported outcomes between the two groups.[35]

7.3.4 Complications

A diseased proximal bulbar urethral segment may lead to recurrent stricture of the perineal urethrostomy requiring repeat procedures. Wound complications including infection, hematoma and skin dehiscence can also lead to failures.

8. Post-Operative Pathways

After endoscopic management of a urethral stricture, a catheter may be left for 1-3 days. Prolonged catheterization has shown no benefit.[2] Most urethroplasties can be discharged home the same day with a catheter in place. After urethroplasty, typically catheters are left in for 1-4 weeks. Non-narcotic post-operative pain management is feasible and preferred by the authors.

Post-operative evaluation for stricture recurrence starts with a history as patients will often report obstructive symptoms. Patients are typically followed with **routine uroflowmetry, post-void residual volume, cystoscopy, and/or retrograde urethrography though details vary depending on the surgeon's preference**.[36]

9. Costs

The estimated **annual healthcare cost** of urethral stricture disease was almost **$200 million** in the United States in 2000. In cost analysis, urethroplasty has been argued to be the most cost-effective method of treating urethral stricture disease. However, for short segment bulbar strictures, an argument has been made that a single internal urethrotomy prior to urethroplasty is also cost effective.[9,11,28] Patient comorbidities, post-operative complications, and graft urethroplasty have been the factors that have increased cost of reconstruction most substantially.[37] Surveillance for stricture recurrence after urethroplasty should be driven by development of symptoms in order to minimize costs.[38]

10. Clinical Care Pathway

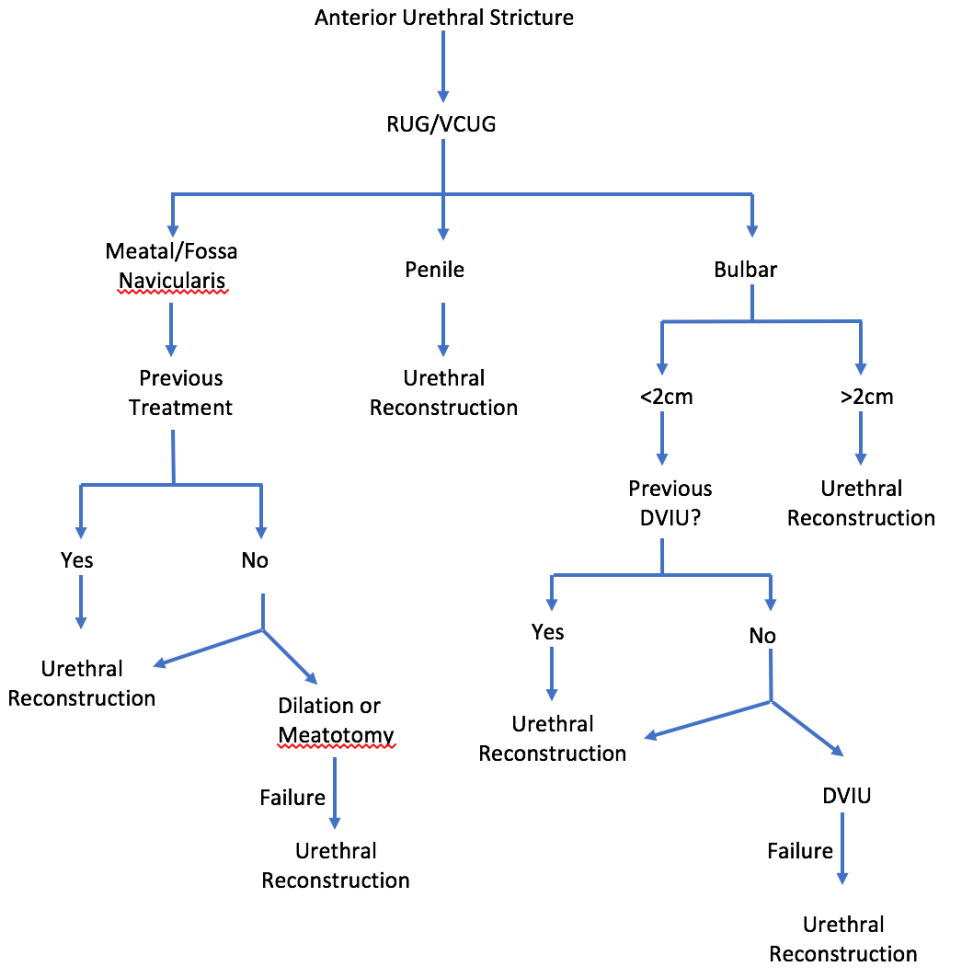

Figure 5: Operative Algorithm For Anterior Urethral Stricture Disease (From AUA Update Series Lesson 20, Vol 29)

Patients with urethral stricture disease should be evaluated with history and physical examination and uroflowmetry/post void residual volume. The location and length of the urethral stricture must be assessed to determine appropriate intervention. This is typically accomplished with retrograde urethrography and voiding cystourethrography although cystoscopy/urethroscopy and urethral ultrasound can provide additional information. For short, bulbar strictures, endoscopic treatments may be performed as an initial step. Urethroplasty is the gold standard treatment for urethral stricture disease and should be performed in strictures longer than 2 cm, in the penile urethra or in patients who have failed dilation or DVIU. Meatal stenosis or fossa navicularis strictures can be treated with dilation or meatotomy initially, but recurrences should be managed with urethroplasty. (**Figure 5**).[2,39]

11. Take Home Message

Urethral stricture disease is caused by fibrosis or scarring of the urethra mucosa and associated spongiosum resulting in narrowing and lower urinary tract voiding symptoms. Intervention includes endoscopic management with lower success rates and urethroplasty with improved outcomes. Referral to a urologist with reconstructive expertise should be strongly considered when a stricture is diagnosed.

12. Abbreviations

SPT = Suprapubic tube
RUG = Retrograde Urethrogram
VCUG = Voiding Cystourethrogram
DVIU = Direct Visual Internal Urethrotomy

Videos

Bulbar Urethroplasty With Excision And Primary Anastomosis

Dorsal Onlay Urethroplasty With Buccal Mucosa Graft

Presentations

Urethral Stricture Disease and Reconstruction Presentation 1

References

1 † Virasoro R, Jordan GH, McCammon KA. Surgery for Benign Disorders of the Penis and Urethra. Campbell-Walsh-Wein Urology: 12th Edition; 82: 1804-1842.e4.

Thorough and detailed information on this core curriculum topic.

2 ☆ Wessells H, Angermeier KW, Elliott S et al: Male urethral stricture: American Urological Association guideline. J Urol 2017;?197:?182.

3 Gallegos MA, Santucci RA. Advances in urethral stricture management. F1000Res. 2016;5:2913.

4 ☆ Akopriaye LE, Jordan GH and Devine CJ (1997): Balanitis Xerotica Obliterans (BXO) AUA Update SeriesVolume: XVI Lesson: 21 Page: 166-167

5 ☆ Pugliese JM, Morey AF, Peterson AC (2007): Lichen sclerosus: review of the literature and current recommendations for management. J Urol Volume: 178 Page: 2268-2276

6 ☆ Levy A, Browne B, Fredrick A, Stensland K, Bennett J, Sullivan T, Rieger-Christ KM, Vanni AJ. Insights into the Pathophysiology of Urethral Stricture Disease due to Lichen Sclerosus: Comparison of Pathological Markers in Lichen Sclerosus Induced Strictures vs Nonlichen Sclerosus Induced Strictures. J Urol. 2019 Jun;201(6):1158-1163.

7 ☆ Grimes MD, Tesdahl BA, Schubbe M, Dahmoush L, Pearlman AM, Kreder KJ, Erickson BA. Histopathology of Anterior Urethral Strictures: Toward a Better Understanding of Stricture Pathophysiology. J Urol. 2019 Oct;202(4):748-756.

8 ☆ Rozanski AT and Vanni AJ. Male Genital Lichen Sclerosus and Urethral Stricture Disease. AUA Update Series: Vol. 39, Lesson 14, 2020.

9 Litwin MS, Saigal CS. Urologic Diseases in America 2012. RAND Health. 2012.

Mundy, A.R., Andrich, D.E. (2010): Urethral Strictures. British Journal of Urology Volume: 107 Page: 6-26 Excellent review article.

10 Excellent review article. Concise overview of the entire topic with illustrations and photographs.

11 ☆ Santucci RA, Joyce GF, Wise M. Male urethral stricture disease. J Urol Volume: 177 Page 1667-1674.

12 Baradaran N, Hampson LA, Edwards TC et al. Patient-Reported Outcome Measures in Urethral Reconstruction. Curr Urol Rep. 2019 May; 19(7): 48.

13 ☆ Breyer, BN., Edwards, Todd C, Patrick DL., Voelzke BB. Comprehensive Qualitative Assessment of Urethral Stricture Disease: Toward the Development of a Patient Centered Outcome Measure. J Urol, 2017. 198(5): p. 1113-1118.

14 ☆ McCallum RW (1991): Method of Dynamic Retrograde and Voiding Cystourethrography in Urethral Stricture. AUA Update Series Volume: 10 Lesson: 12 Page:

15 Jhanwar A, Kumar M, Sankhwar SN, Prakash G. Holmium laser vs. conventional (cold knife) direct visual internal urethrotomy for short-segment bulbar urethral stricture: Outcome analysis. Can Urol Assoc J. 2016;10(5-6):E161-E164.

16 ☆ Lubahn JD, Zhao LC, Scott JF, Hudak SJ, Chee J, Terlecki R, Breyer B, Morey AF. Poor quality of life in patients with urethral stricture treated with intermittent self-dilation. J Urol. 2014 Jan;191(1):143-7.

17 Virasoro R, DeLong JM, Estrella RE et al. A Drug-Coated Balloon Treatment for Urethral Stricture Disease: Three-Year Results from the ROBUST I Study. Res Rep Urology. 2022 May 6; 14:177-183.

18 ☆ Heyns CF, Steenkamp JW, De Kock ML, Whitaker P. (1998): Treatment of male urethral strictures: is repeated dilation or internal urethrotomy useful? J Urol Volume: 160 Page: 356-358

19 ☆ Santucci, R., and Eisenberg, L. (2010): Urethrotomy has a Much Lower Success Rate than Previously Reported. Journal of Urology Volume: 183 Page: 1859-1862

20 Pal DK, Kumar S, Ghosh B. Direct visual internal urethrotomy: Is it a durable treatment option?. Urol Ann. 2017;9(1):18-22.

21 ☆ Hudak SJ, Atkinson TH, Morey AF. Repeat transurethral manipulation of bulbar urethral strictures is associated with increased stricture complexity and prolonged disease duration. J Urol. 2012;187(5):1691-5.

22 ☆ Horiguchi A, Shinchi M, Masunaga A, Ito K, Asano T, Azuma R. Do Transurethral Treatments Increase the Complexity of Urethral Strictures?. J Urol. 2018;199(2):508-514.

23 Heyns C (2014). Urethrotomy and Other Minimally Invasive Interventions for Urethral Stricture. Advanced Male Urethral and Genital Reconstructive Surgery. Ch. 9 Excellent Textbook for Advanced Reconstructive Surgery

24 Abrate A, Gregori A, Simonato A. Lingual mucosal graft urethroplasty 12 years later: Systematic review and meta-analysis. Asian J Urol. 2019;6(3):230-241.

25 Mangera A, Patterson JM, Chapple CR. A systematic review of graft augmentation urethroplasty techniques for the treatment of anterior urethral strictures. Eur Urol. 2011;59(5):797-814.

26 Gomez R. (2014) Stricture Excision and Primary Anastomosis for Anterior Urethral Strictures. Advanced Male Urethral and Genital Reconstructive Surgery. Ch. 12

27 Barbagli G. Sansalome S. (2014) Oral Mucosal Graft Urethroplasty. Advanced Male Urethral and Genital Reconstructive Surgery Ch. 13.

28 ☆ Wessells H (2009): Cost-Effective Approach to Short Bulbar Urethral Strictures Supports Single Internal Urethrotomy Before Urethroplasty. Journal of Urology Volume 181 Page 954-955

29 ☆ Sukumar S, Elliott SP, Myers JB, et al. Multi-institutional Outcomes of Endoscopic Management of Stricture Recurrence after Bulbar Urethroplasty. J Urol. 2018;

30 ☆ Kahokehr AA, Granieri MA, Webster GD, Peterson AC. A Critical Analysis of Bulbar Urethroplasty Stricture Recurrence: Characteristics and Management. J Urol. 2018;

31 Dublin N, Stewart LH. Oral complications after buccal mucosal graft harvest for urethroplasty. BJU Int. 2004;94(6):867-9.

32 ☆ Lumen N, Vierstraete-verlinde S, Oosterlinck W, et al. Buccal Versus Lingual Mucosa Graft in Anterior Urethroplasty: A Prospective Comparison of Surgical Outcome and Donor Site Morbidity. J Urol. 2016;195(1):112-7.

33 Myers JB, McAninch JW. Perineal urethrostomy. BJU Int. 2011 Mar;107(5):856-65

34 ☆ Barbagli G, De Angelis M, Romano G, Lazzeri M. Clinical outcome and quality of life assessment in patients treated with perineal urethrostomy for anterior urethral stricture disease. J Urol. 2009 Aug;182(2):548-57

35 ☆ Murphy GP, Fergus KB, Gaither TW, et al. Urinary and Sexual Function after Perineal Urethrostomy for Urethral Stricture Disease: An Analysis from the TURNS. J Urol. 2019;201(5):956-961.

36 Zaid UB, Hawkins M, Wilson L, Ting J, Harris C, Alwaal A, Zhao LC, Morey AF, Breyer BN The cost of surveillance after urethroplasty. Urology. 2015 May;85(5):1195-9.

37 Harris CR, Osterberg EC, Sanford T, Alwaal A, Gaither TW, McAninch JW, McCulloch CE, Breyer BN. National Variation in Urethroplasty Cost and Predictors of Extreme Cost: A Cost Analysis With Policy Implications. Urology. 2016 Aug;94:246-54

38 Osterberg EC, Murphy G, Harris CR, Breyer BN. Cost-effective Strategies for the Management and Treatment of Urethral Stricture Disease. Urol Clin North Am. 2017;44(1):11-17.

39 ☆ Voelzke B., and Wessels, H. (2010): Role of Direct Vision Internal Urethrotomy in the Management of Urethral Stricture. AUA Update Series Volume: 29 Lesson: 20 Page