IJUH
The International Journal of Urologic History
www.ijuh.org

The Historical Origins and Contemporary Role of the Endoscopic Treatment for Urethral Stricture Disease

Kunal Jain[1]*,†, Thomas M Southall[1]*, Suvig Dua[1], David Chung[1], Umesh Jain[2]

From the [1]Department of Surgery, Section of Urology, University of Manitoba, Winnipeg, MB; [2]Department of Urology, St. Joseph's Health Centre, University of Toronto, Toronto, ON
** Joint first authors*

†*Correspondence: Kunal Jain, MD, 472 Centennial St., Winnipeg, MB, R3N 1P7, Canada; (e-mail: jaink2@myumanitoba.ca)*

Introduction: Stricture of the urethra has plagued humans likely longer than the historical record. Modern approaches to urethral stricture disease (USD) include excision and primary anastomosis, buccal mucosal onlay repair, and the emerging potential of tissue regeneration. Those who managed patients with USD benefits form a compelling narrative shaped by centuries of medical advancements, societal attitudes, and evolving treatment techniques. Urethral dilation and urethrotomy remain important tools in general urology, especially for those with short, benign appearing strictures. We explore the historical origins and developments of dilation and urethrotomy for the treatment of urethral stricture disease (USD).

Sources and Methods: Primary and secondary sources related to USD were reviewed and put into perspective within current practices.

Results: The earliest known treatment for USD is from the Ayurveda, in which its author(s) used urethral dilators lubricated with *ghee*. Erasistratus of Greece was said to have developed S-shaped metal catheters around 200 BCE, adapted and modernized by the Romans who used lead and bronze dilators. A renewed focus on USD arose in the 16th century during the first recorded gonorrhea epidemic and a primitive form of internal urethrotomy was developed. The introduction of the lanceolate-shaped catheter in 1795 allowed for successful internal urethrotomy. In the 1990s, Freid and Smith described a Seldinger technique for dilation over a wire and Steenkamp et al. demonstrated equivalent outcomes between filiform dilation and direct visual internal urethrotomy. In 2007, Herschorn of Canada introduced S-shaped coaxial urethral dilators. In 2011, Gelman et al. described direct vision balloon dilation. Recently, drug-coated balloon dilation is being investigated.

Conclusions: The origins of the endoscopic treatment of USD can be traced back to over 26 centuries ago and are dependent on corresponding advances in microchip development, fiber optics, and tissue regeneration.

Keywords: Urethral Stricture Disease, Dilation, Urethrotomy

Urethral stricture disease (USD) is a common urological condition defined by narrowing of the urethral lumen secondary to fibrosis of the urothelium and associated corpus spongiosum. The etiology of USD may be idiopathic, or due to trauma, infection, or instrumentation. Symptoms of bladder outlet obstruction are often associated with USD. Further complications such as urinary tract infections, ejaculatory dysfunction, and renal failure may occur in cases of unrecognized and unrelieved obstruction.

USD was identified early in the history of medicine and our current treatments share similarities with many of surgery's predecessors. Most modern initial approaches to USD are endoscopic, and often repeatedly so due to patient preference, ease of access, less perceived invasiveness, and the training required for formal urethroplasty.(1)

This study aims to summarize the historical roots, evolution, and contemporary role of the endoscopic treatment in USD. We hope to demonstrate how previous developments have impacted our current treatment options.

SOURCES AND METHODS

We identified secondary source materials on the history of urethral strictural disease and urethrotomy by consultating online resources through PubMed and the National Library of Medicine (www.nlm.gov); the National Library of France (gallica.bnf.fr);

https://doi.org/10.53101/IJUH.3.1.092415
Vol. IV (i), pp 35-43, Fall 2024
Electronically distributed

and artefacts and archives at specified museums and reources including the WIlliam P. Didusch museum of the American Urological Association (AUA), Linthicum, Maryland (http://urologichistory.museum).

RESULTS AND DISCUSSION

600 BCE – 1000 BCE: Sushruta

Prominent historical figures in medicine have tackled the treatment of USD. The earliest written documentation of USD began over 26 centuries ago in Ayurvedic medicine, indicating that USD has not only been an issue in the present day but also one that plagued our ancestors. Sushruta was said to be the founder of Ayurveda medicine. Known as the 'Father of Surgery', and of Indian Medicine, He was the first to describe a treatment of urethral strictures.(2) Sushruta is given credit as the source of the *Sushruta Samhita*, a veritable compendium of ancient Indian medical care. In the *Samhita*, he describes the use of bamboo and reed catheters lubricated with a clarified butter called *ghee*. Other cultures, including the Chinese, used bamboo catheters for strictural disease. The ancient Egyptians have long been credited with fashioning urethral dilating catheters from stiffened reeds but a reading of the Ebers Papyrus, the major surviving text from 1500 BCE of this period, mentions nothing of them and its translator, Cyril P Bryan pointed out that "it is to the credit of Egypt's surgeons that they did not practice urethral dilation in cases of stricture."(3)

460 BCE – 370 BCE: Hippocrates

Hippocrates (c. 450-c.380 BCE) spoke of urinary retention caused by urethral strictures, calculi, and abscesses but never directly referenced catheters or dilators.(4) In addition to his work on urethral pathologies, he was one of the first to reference sub-specialization in medicine in the famed Hippocratic oath that spoke of leaving lithotomy to experts in that art. During this time, lithotomy was being performed in Greek, Byzantine, and Islamic Civilizations.(5)

25 BCE – 50 CE: Cornelius Celsus

Cornelius Celsus (c. 25 BCE – c. 50 CE) authored *De Medicina*, known as one of the best sources of medical literature in the Roman Empire.(6) *De Medicina* described S-shaped catheters that are reminiscent of modern

Figure 1. (Left) Watercolour drawing of Sushruta by H. Solomon, from an Indian original. (Wellcome Collection, Public Domain) (Right) Fragment of a 12th -13th century copy of the *Susruta Samhita*, from Nepal, in Sanskrit using ink and watercolor on palm leaf. (Los Angeles County Museum of Art, Public Domain)

Figure 2. Reproduction of an S-shaped male catheter that was found buried in the Roman city of Pompeii following the eruption of Mount Vesuvius in 79 AD. (Courtesy of the Claude Moore Health Sciences Library, University of Virginia).

S-curve dilators:

> *"For this purpose bronze tubes are made, and the surgeon must have three ready for males and two ready for females, in order that they may be suitable for everybody, large and small … They ought to be a little curved, but more so for men, and they should be very smooth."*

Fitting his description, an S-shaped male catheter was found, buried in the Roman city of Pompeii following the eruption of Mount Vesuvius in 79 CE (Figure 2).(7) Additionally, Cornelius Celsus described a perineal lithotomy method that remained largely unchanged for 1400 years. Celsus was a proponent of prescribing diet as first-line treatment for bladder calculi, then perineal lithotomy if non-surgical interventions failed.(8,9)

169 CE – 216 CE: Galen

Galen (c.130 CE-c.210 CE) was a Greek surgeon and philosopher who lived in the Roman Empire.(10) He described a case in which a young boy in acute urinary retention due to urolithiasis required probing of the urolith away from the bladder neck with a catheter to allow urine flow.(8,11) Similar tactics for blood clots, as well as "some flesh growing out from an ulceration … obstructing the neck of the bladder" were also described.(8,11) Like Hippocrates, Galen was also a proponent of sub-specialization:

> "*In truth it is often necessary to deliver cures through the penis into the bladder. I need not say anything further on the catheter, except that it should only be used by those who are very familiar with the entire bladder system.*" (8,12)

Paul of Aegina (c. 625 CE- c. 690 CE) was an active surgeon in the Byzantine era whose descriptions of short- and long-term catheterization point to a recognition that urethral strictures may be a result of benign, malignant, or traumatic causes. According to Moog et al, Paul was the first to propose a metal quasi-permanent catheter. "If the whole glans be consumed," Paul was said to write, "a leaden tube is introduced into the urethra, and we direct the patients to make water through it." (8)

Middle Ages

The American surgeon John B. Deaver once wrote that "there was a time in the history of medicine when the surgeon simply furnished hands for the physician to whom any form of manual treatment was barred as beneath his dignity."(13) During the Middle Ages, urethral strictures and genitourinary problems were no longer deemed worthy of physicians. The treatment of these conditions fell to charlatans, quacks, and those following beliefs of witchcraft and religious superstition, resulting in the stagnation of urethral stricture management.(14)

1520 CE: The First Gonorrheal Epidemic

During the early 16th century, the first gonorrheal epidemic sparked a change in how urethral strictures were viewed.(14) USD began to be described as obstructing growths instead of urethral luminal constrictions. Thierry de Hery (1505 – 1599) was a French barber and surgeon who coined the term "carnosities" to describe flesh protuberances in the urethra, also

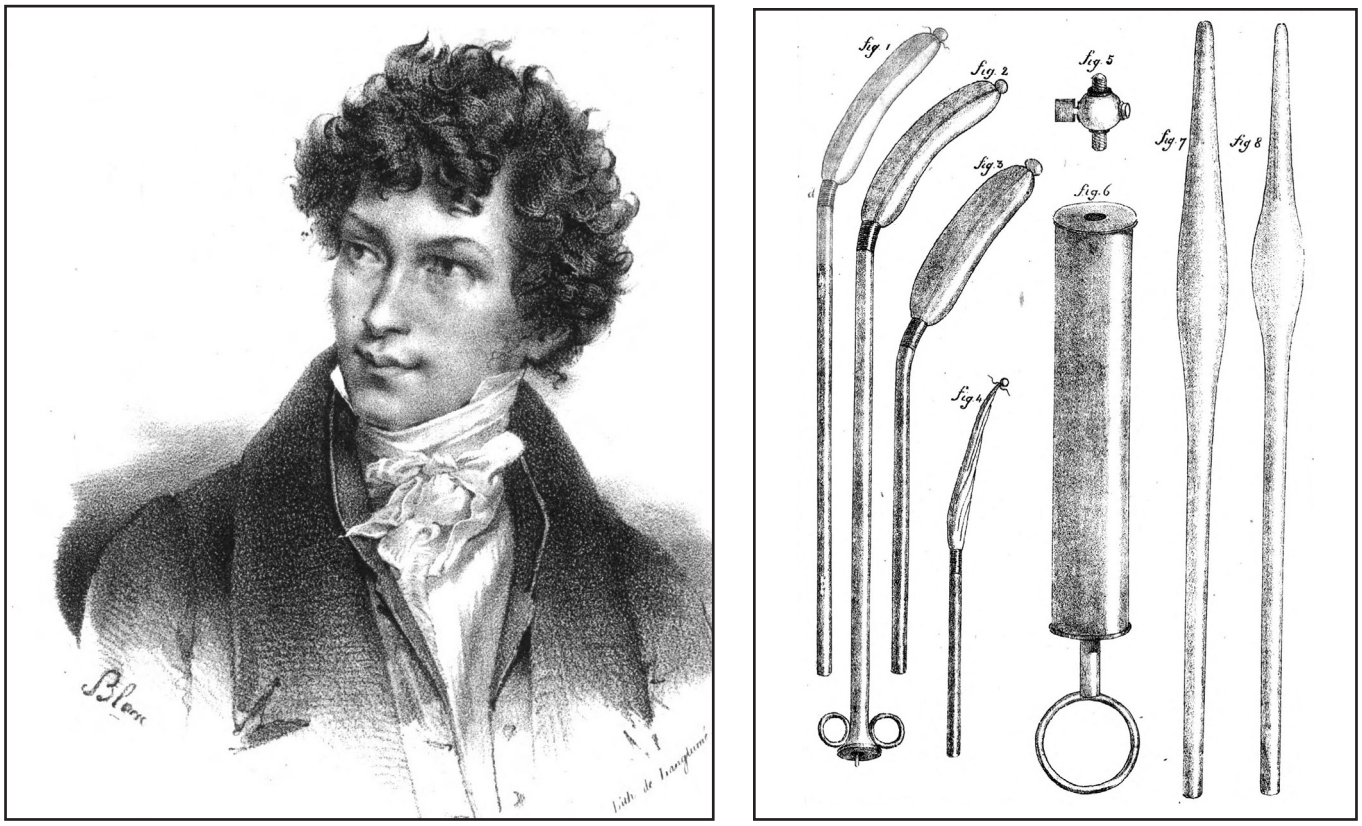

Figure 4. (Left) Theodore Ducamp (1793-1823), the brilliant author of the posthumously published text *A Treatise on Retention of Urine* (1827) in which he described wax casting to calibrate urethral stricture length and balllon dilation (right) as early as the 1820s. (Wellcome Library, Public Domian)

known as strictures.(15) De Hery recommended the use of lead sounds to perform "progressive dilation" of these strictures and viewed the resultant hemorrhage as therapeutic.(15,16) A classmate of de Hery from the Surgical School of Saint Louis, in Paris, was the famed surgeon Ambroise Paré (1510-1590). Paré aimed to improve de Hery's methods using a safer alternative in which wax candles and lead sounds were also lubricated with ointments or caustics before the procedure was performed.(16)

Modern Period

The Modern Period can be further divided into both Early and Late periods, with present-day included in the latter. Collectively, these were times of gradual improvement in both technology and procedural techniques used in urological procedures, some of which remain in practice today. Given the vast differences in technology accessible between time periods, the authors would like to note historic documentation is almost certainly limited in diagnostic accuracy and reporting. With the advent and improvement of modern-day cystoscopes, diagnosis of urethral stricture disease may be quite accurate, but we must recognize limitations of tools available during each time period.

Early Modern Period

Progress in the early modern period began, like many things, with the Scottish surgeon John Hunter (1728 – 1793). With Hunter's extensive work on USD and urolithic stone disease, he was able to classify urethral strictures to be either permanent, spasmodic (due to pathologic contraction of muscles around the urethra), or mixed. (3,14) In his practice, much like Paré, Hunter used dilators with caustics, such as silver nitrate or soda but in addition, used wax dilators he referred to as "bougies." The term bougie comes from Bujiyah, the name of an Algerian town where the best wax for French candles was said to originate.(14,17,18) Hunter advocated for the use of such bougies due to their ability to become malleable when heated. That property allowed him to model the stricture with the bougie and measure the distance to the stricture from the opening of the urethra.(17,18) Hunter was also able to treat bladder stones using bougies and used them for identification of the stones through a sounding technique. His advancements in medicine led

to The Hunterian Society of London, which was named in his honor.

Following in John Hunter's footsteps, several advancements in urologic surgery arrived in succession. In 1795, silver lanceolate-shaped catheters were invented for internal urethrotomy and quickly gained popularity due to their superior ability in cutting through strictures.(3,14) Later, in 1822, Theodore Ducamp (1793-1823) began using the first balloon dilation tool to treat strictures (Figure 4).(14,19) Thomas Jefferson (1743-1826) wrote to his personal physician, Robert Dunglison, in May 1825 that "a chronical complaint which has been troublesome for some time has within a few days become too much so to be longer unattended to. I must ask your advice in it (and) as soon as you can come with convenience. It disables me from going out either on horseback or in a carriage."(20) The "chronical complaint" was urinary retention and Dunglison arrived in Monticello to catheterize the former President several times well into 1826. In 1836, Leroy d'Etiolles (1798-1860) introduced the use of filiform guides and catheters to increase the success of the dilation of strictures, termed "bougie a boule," which allowed for easier passage through the urethra.(13,21)

Late Modern Period (Including Present Day)

To begin the Late Modern Period, in 1848, Jules Francois Maisonneuve (1809-1897) began to use the urethrotome, an instrument able to cut through strictures in the urethra. (14) He built on d'Etiolles use of filiform guides by using them to guide his urethrotome, allowing for directed internal urethromies. Soon after, in the 1870s, Fessenden Nott Otis (1825-1900), began to use his invention which he called the "urethra-meter," more commonly known as a urethrometer, to measure the appropriate caliber of the sounding tool required for urethral dilation (Figure 5).(14,21) Otis also created different mechanical dilators as well as a two-bladed dilating urethrotome which remains in use today.(14,22)

Leading up to the present day, the endoscopic dilator has progressed through many iterations. Notably, in 1979 the addition of a 30-degree angled lens was introduced.(23) Then, in 1984, a balloon was joined to the apparatus to aid in the dilation of targeted strictures.(24) In 1996, Russel Freid and Arthur Smith replaced filiform guides with "glide wires" that would extend fully into the bladder and allow for the improved direction of the catheter.(25) The glide wires would cannulate the urethra allowing for dilation to be subsequently performed using a Seldinger technique.(25)

In 2007, S-curved dilators were introduced by Herschorn of Canada who demonstrated their superiority over rigid, straight dilators, some 1500 years after the Roman design. The S-curve copied the curve of a normal male urethra, allowing for an easier passage over the guide wire.(26) These dilators are also covered with a hydrophilic coating, allowing for smoother entry through the urethra. Prototypes ranging in size from 8Fr to 20Fr were used to perform the procedure in thirty patients. After each procedure, a physician would complete an evaluation form with a rating scale between one and four, to describe excellent to unsatisfactory, for the design, hydrophilic coating, and ease of passage. It was concluded that S-shaped dilators were safe, effective, and retained specific advantages over rigid dilators, such as the ability to drain the bladder for patient comfort. (26)

Four years after the introduction of S-shaped dilators, direct vision balloon dilation was introduced. The addition of a camera into the urethra allowed for direct visualization

Figure 5. "Urethra-meter," more commonly known as a urethrometer, developed by Fessenden Nott Otis (1825-1900),to measure the appropriate caliber of the sounding tool required for urethral dilation. (Courtesy, WP Ddidusch Museum, Linthicum, Maryland)

of the stricture before dilation was performed.(27) Once the stricture was located, a balloon would be inflated with sterile water for five to ten minutes in duration, causing a constant radial force on the stricture. Further studies demonstrated that balloon dilatation under direct visualization lead to significant improvements in IPSS as well as uroflowmetric parameters.(28) In 2020, balloon dilation was improved further by the addition of paclitaxel, an antiproliferative chemotherapeutic that stops cell proliferation in an effort to decrease fibrotic scarring and therefore prevent stricture formation. Its addition to the surface of the balloon promoted better long-term outcomes after the initial dilation.(29) Drug-coated balloons may be associated with multiple benefits over local injection of the medication such as easy absorption due to hydrophobic properties, a prolonged half-life in the tissue with decreased risk of overdosing due to low serum concentrations when compared to injection into the same space, and circumferential delivery over the entire stricture while avoiding the spread of medication to unintended periurethral tissue.(30,31) The ROBUST I trial on this method showed good safety and excellent success, with no significant treatment-related severe adverse events such as urethral rupture and urethral fistula formation at 24 months post-procedure.(31) The ROBUST III trial, a randomized single-blind trial of drug-coated balloon dilation in comparison to either classic dilation or urethrotomy, showed a higher stricture-free rate at six months (76% vs 27%), less need for repeat intervention, and greater durability of symptom improvement in the drug-coated balloon dilation group.(32) The drug-coated group retained a side-effect profile in keeping with the classic dilation group.

Dilation or Direct Visual Internal Urethrotomy

Direct visual internal urethrotomy (DVIU) is usually done in the operating room and uses either a Sachse urethrotome (i.e.'cold knife'), developed in 1974 by Hans Sachse (1926-2018), or laser to incise through the scar formed by the stricture. Both DVIU and balloon dilation are currently used as first-line procedures to manage urethral strictures. However, there is no evidence that DVIU is superior to balloon dilation, or that any specific technique within DVIU - for example, laser in comparison to cold knife - is superior.(33) There may be weak support for using DVIU over dilation in the bulbar urethra, as visually-controlled dilation might reduce complications secondary to false passage of the endoscopic apparatus, such as spongiosum tissue perforation and urethral bleeding.(33) Another important consideration is the potential increased risk of erectile dysfunction when DVIU is performed for penile urethral strictures.(33)

The main study that compared balloon dilation with DVIU was done by Steenkamp et al. who randomized 210 patients with seemingly comparable non-obliterative strictures at all locations of the urethra to receive either filiform dilation or DVIU. The study showed that DVIU and balloon dilation are equally effective, both with a recurrence rate of approximately 40% at 12 months for strictures less than two centimeters and 80% for strictures longer than four centimeters.(33) As such, the indications for DVIU and dilation at the anterior urethra are the same, with the most suitable indication being previously untreated patients with a single, short (one centimeter or less) bulbar urethral stricture. For this selection of patients, a 5-year patency rate of 77% has been reported.(34)

In cases of recurrent strictures, repeat DVIU or dilation are acceptable in certain conditions, according to the Canadian Urological Association (CUA), Société Internationale d'Urologie (SIU), and the American Urological Association (AUA).(35–39) Scenarios in which a solitary stricture or bulbar urethral stricture, with a length less than two centimeters, has recurred more than three to six months after the previous treatment are suitable for a repeat procedure. Strictures that have recurred at three months or less after the initial DVIU or dilation procedure have a poor success rate with a repeat procedure and are found to have no value after 48 months. In contrast to this, strictures that recur more than six months after the initial procedure have a 40% stricture-free rate at the 48-month mark after a repeat procedure. The CUA and SIU, however, do not recommend a third DVIU or dilation procedure after further recurrence unless in special situations involving patient comorbidities or resource availability, and in these cases a more invasive urethroplasty is indicated.(35–37)

The American Urological Association's (AUA) guideline originally did not fall in line with the CUA and SIU recommendations for recurrent strictures, stating that a second DVIU or dilation should not be performed as it is cost-ineffective and rather suggest a urethroplasty to manage the obstruction.(37) The AUA's reasoning for this recommendation was that repeated endoscopic procedures are unlikely to be successful

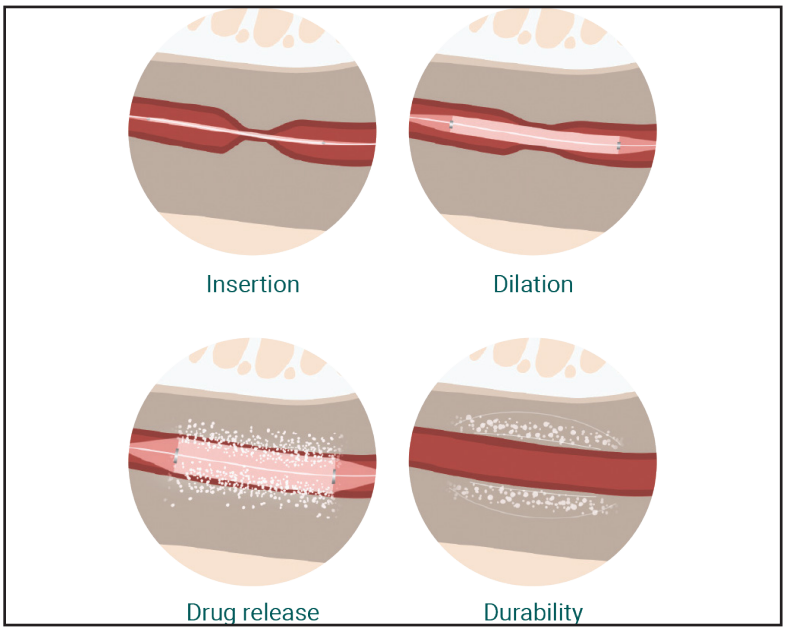

Figure 5. Mechnanism of Optilume®, the intraurethral balloon designed to be inserted and dilated within a urethral stricture, allowing for drug release of paclitaxel. (Courtesy, Laborie Medical Technologies, Portsmouth)

and carry the risk of exacerbating spongiofibrosis, complicating definitive reconstruction. The AUA based these guidelines on the premise that prior endoscopic treatment for urethral stricture is an independent risk factor for stricture recurrence after urethroplasty.(33,37) In a 2023 addendum, the AUA changed their stance stating surgeons may perform urethral dilation or DVIU for recurrent urethral strictures if they are < 3 cm. Changes were made in light of new evidence as well as consideration for patient preferences. Updated AUA guidelines suggest endoluminal treatment for recurrent strictures < 3 cm may be considered as a palliative option for patients not interested in, or unable to undergo urethroplasty.(36) Furthermore, the ROBUST III RCT showed that 83.2% of patients treated endoscopically combined with paclitaxel-coated urethral balloon for recurrent anterior urethral strictures < 3 cm in length were intervention free at 1 year. ROBUST III participants also showed promising results with 67% of patients showing functional success at 3 years with use of the drug-coated balloon.(40)

Many strategies have been implemented to combat the high recurrence rates of strictures after DVIU and dilation procedures. Intralesional injection with steroids or mitomycin C (MMC), a chemotherapeutic agent, have been shown to have decreased stricture recurrence rates and remain a possible option.(41) While intralesional MMC injection paired with urethrotomy has shown a decrease in stricture recurrence rates when compared to urethrotomy alone in a randomized clinical trial by Mazdak et al., its use in the urethra remains off-label.(39) Intermittent self-dilations, with or without the adjunctive use of intraurethral corticosteroids, have evidence to support their benefits in stabilizing the stricture and prolonging the time to recurrence, rather than reducing the recurrence rate.(42) Temporary urethral stents have also shown benefits but must be used with caution because a history of failed stenting is a predictor of increased stricture complexity and the need for more complex urethroplasty.(43)

In settings of acute urinary retention, in which more definitive reconstructive repair will be required, DVIU, balloon dilation, or suprapubic cystotomy can be used as temporizing interventions before a definitive procedure. These methods, paired with clean intermittent catheterization, can also be used when a patient is unfit for major urethral reconstruction, such as in the palliative setting.(39)

CONCLUSION

The origins of endoscopic treatment of USD can be traced back to over twenty-six centuries ago in ancient Ayurvedic medicine.(3) Though significant advances have been made, there remains a lack of research and consensus in deciding the appropriate first-line procedure for USD in addition to the treatment of recurrent urethral strictures.(35) With some of the most prominent urological associations in North America

having differing recommendations for recurring strictures, room for future studies to dictate changes in guidelines for the treatment USD is abundant.(35–37) Drug-coated balloon dilation has shown promising preliminary results to be the gold standard for endoscopic treatment of USD, but further investigation and long-term follow-up are required to conclude its efficacy and safety.(30–32)

REFERENCES

1. Anger JT, Buckley JC, Santucci RA, et al. Trends in stricture management among male Medicare beneficiaries: underuse of urethroplasty? *Urology* 2011;77:481–85.
2. Gahdvi NP. Sushruta's lateral perineal approach for primary repair of the ruptured posterior urethra. *Br J Urology.* 1988; 61: 333-335.
3. Bryan CP. *The Papyrus Ebers*, Geoffrey Bless, London, 1930, p79.
4. Lozano Ortega JL. [Methods of endoluminal treatment of urethral stenosis up to the end of the 19th Century]. *Actas Urol Esp.* 1998;22:5-10.
5. Patel SR, Caldamone AA. The history of urethral catheterization. *R I Med J.* 2004;87:240.
6. Celsus A. *De Medicina* (transl. Spencer WG).(1935) Loeb Class. Lib. Book VII, p. 435. Harvard University.
7. Feneley RCL, Hopley IB, Wells PNT. Urinary catheters: history, current status, adverse events and research agenda. *J Med Eng Technol.* 2015; 39: 459–470. doi: 10.3109/03091902.2015.1085600
8. Moog FP, Karenberg A, Moll F. The catheter and its use from Hippocrates to Galen. *J Urol*. 2005;174:1196–98.
9. Celsus A. *De Medicina* (transl. Spencer WG).(1935) Loeb Class. Lib. Book V, p. 49. Harvard University.
10. Herr H. From Galen's Urine to Harvey's Blood. *Urology*. 2017; 106:6-8. doi: 10.1016/j.urology.2017.03.039.
11. Siegel RE.(1976) *Galen on the affected parts: translation from the Greek text with explanatory notes*. S Karger.
12. Galen, Kuhn KG (Ed.)(1964) *Claudii Galeni Opera Omnia*. Hildesheims: G Olms.
13. Deaver JB. Why and by whom should surgery be advised. *Med Soc New Jersey*. 7: 63, 1910.
14. Desai D, Martins FE. (2020) History of urethral stricture and its treatment. In: Martins FE, Kulkarni SB, Kohler TS (Eds.) *Textbook of Male Genitourethral Reconstruction*. Springer. pp 3–15.
15. Bowen DK, Wan J, Engel R, et al. Sounds and Charrière: the rest of the story. *J Pediatr Urol*. 2014;10:1106–10.
16. Murphy LJ.(1972) L'histoire de l'urologie by Ernest Desnos In: *The History of Urology*. CC Thomas.
17. Cooper A, Green JH. (1832) Castle T, Ed. *A Manual of Surgery* (3rd ed., pp 252-255). New York: Monroe & Francis.
18. Blandy JP. Urethral stricture. *Postgrad Med J*. 1980;56:383–418.
19. Ducamp TJ. (1827) *A Treatise on Retention of Urine Caused by Strictures in the Urethra*, translated by William M Herbert. Samuel Wood and Sons.
20. Schneeberg NG, The medical history of Thomas Jefferson, *J Med Biography.* 2008; 16:118-25.
21. Hill B. Clinical lectures on stricture of the urethra. *British Med Jour.* 1879;2:763.
22. Kirkup J. (2006) *The evolution of surgical instruments: an illustrated history from ancient times to the twentieth century*. Norman Publishing.
23. Bapat SS. A new endoscopic urethral dilator. *J Urol.* 1979;122:30–33.
24. Glesy JD, Finn JC, Hermann GD, et al. Coaxial balloon dilation and calibration of urethral strictures. *Am J Surg.* 1984;147:611–14.
25. Freid RM, Smith AD. The Glidewire technique for overcoming urethral obstruction. *J Urol*. 1996;156:164–65.
26. Herschorn S, Carrington E. S-shaped coaxial dilators for male urethral strictures. *Urology* 2007;69:1199–1201.
27. Gelman J, Liss MA, Cinman NM. Direct vision balloon dilation for the management of urethral strictures. *J Endourol.* 2011;25:1249–51.
28. Vyas JB, Ganpule AP, Muthu V, et al. Balloon dilatation for male urethral strictures "revisited". *Urol Ann.* 2013;5:245–48.
29. Virasoro R, DeLong JM, Mann RA, et al. A drug-coated balloon treatment for urethral stricture disease: Interim results from the ROBUST I study. *Can Urol Assoc J.* 2020;14:187.
30. Elterman DS, Coutinho K, Hagedorn JC. How I Do It: The Optilume drug-coated balloon for urethral strictures. *Can J Urol.* 2020;27:10322–28.
31. Mann RA, Virasoro R, DeLong JM, et al. A drug-coated balloon treatment for urethral stricture disease: two-year results from the ROBUST I study. *Can J Urol.* 2021;15:20.
32. Elliott S, DeLong J, Coutinho K, et al. Interim results for the ROBUST III trial evaluating the optilume drug coated balloon for anterior urethral strictures. *J Urol.* 2021;206:e971–e971.
33. Steenkamp J, Heyns C, De Kock M. Internal

urethrotomy versus dilation as treatment for male urethral strictures: a prospective, randomized comparison. *J Urol.* 1997;157:98–101.
34. Pansadoro V, Emiliozzi P. Internal urethrotomy in the management of anterior urethral strictures: long-term followup. *J Urol* 1996;156:73–75.
35. Bayne DB, Gaither TW, Awad MA, et al. Guidelines of guidelines: a review of urethral stricture evaluation, management, and follow-up. *Transl Androl Urol.* 2017;6:288.
36. Rourke KF, Welk B, Kodama R, et al. Canadian Urological Association guideline on male urethral stricture. *Can Urol Assoc J.* 2020;14:305.
37. Proceedings of International Consultation on Urologic Diseases: Urethral Strictures, International Consultation on Urethral Strictures, in conjunction with the Société Internationale d'Urologie (SIU) World Meeting, 13–16 October 2010, Marrakech, Morocco. *Urology.* 2014;83:S1-73.
38. Wessells H, Morey A, Souter L, et al. Urethral stricture disease guideline amendment (2023). *J Urol.* 2023;210:64–71.
39. Wessells H, Angermeier KW, Elliott S, et al. Male urethral stricture: American urological association guideline. *J Urol.* 2017;197:182–90.
40. 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. *Research and Reports in Urology.* 2022;177–83.
41. Mazdak H, Meshki I, Ghassami F. Effect of mitomycin C on anterior urethral stricture recurrence after internal urethrotomy. *Eur Urol.* 2007;51:1089–92.
42. Zhang K, Qi E, Zhang Y, et al. Efficacy and safety of local steroids for urethra strictures: a systematic review and meta-analysis. *J Endourol.* 2014;28:962–68.
43. Temeltas G, Ucer O, Yuksel MB, et al. The long-term results of temporary urethral stent placement for the treatment of recurrent bulbar urethral stricture disease. *Int Braz J Urol.* 2016;42:351–55.