Historical and Current Practices in the Management of Fossa Navicularis Strictures

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Abstract

Purpose of Review Fossa navicularis strictures represent a surgically challenging disease process that requires detailed preoperative planning and an understanding of each patient's goals in order to achieve a satisfactory long-term outcome. This review summarizes the various approaches used in the management of fossa navicularis strictures over the past several decades.
Recent Findings In addition to existing evidence to support open flap- and graft-based reconstruction, recent studies suggest a potential role for limited open repair via a transurethral approach.
Summary Open repair of fossa navicularis strictures has become the standard of care with high success rates using local skin flaps or tissue grafts. There remains a very limited role for minimally invasive techniques in definitive management of this disease.

Keywords Female urology · Fossa navicularis strictures · Minimally invasive

Introduction

Urethral stricture disease represents a pathologic process with a significant negative impact upon patients' quality of life. The incidence of stricture disease has been increasing in recent years, a phenomenon that has been attributed to a rising number of transurethral procedures with an associated increase in the number of iatrogenic strictures. While management of urethral stricture disease in the bulbar and pendulous urethra has been discussed at length in the literature, there exists a paucity of recommendations for the management of fossa navicularis strictures. It has been reported that 18% of men with urethral stricture disease have disease that involves the fossa navicularis [1]. Despite the relatively common nature of these strictures, they remain difficult to manage, as surgical management requires a functional and durable result without compromising the esthetics of the distal penis and glans. With open repair often proving complex, minimally invasive approaches such as urethral dilation or direct visual internal urethrotomy (DVIU) remain the most common interventions.

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Despite the frequency of endoscopic interventions, there has been a recent trend toward utilizing urethroplasty as a primary intervention [2, 3].

Etiologies

The causes of strictures arising from the fossa navicularis tend to differ from those in the bulbar or pendulous urethra, which is an important factor in the approach to management. Historically, the most common causes of distal anterior urethral strictures were infections such as gonococcal urethritis [4]. More recent series have demonstrated a shift toward iatrogenesis and lichen sclerosus atrophicus (LSA) being the most common etiologies today [4]. Iatrogenic strictures are thought to occur as a result of urethral compression and ischemia in the setting of large caliber cystoscopes or catheters [5, 6]. Additionally, endoscopic manipulation and LSA can result in meatal stenosis, which leads to high-pressure voiding and inflammation proximal to the site of stenosis. This can in turn lead to extension of scarring and pathologic narrowing into the fossa navicularis or further proximal into the pendulous urethra [7, 8]. Traumatic injuries also play an important role in the formation of penile and bulbar urethral strictures, while being less frequent causes of disease in the fossa navicularis.

Patients who previously underwent hypospadias repairs can also develop distal penile strictures lateral in life. The reported incidence of such strictures ranges from 2 to 9.7% [4]. Due to the underdevelopment of the ventral penis characteristic of hypospadias, the fossa navicularis is either hypoplastic or absent. These strictures are thus not classically disease of the fossa navicularis, and management of this challenging disease process is beyond the scope of this review.

The potential etiology of a stricture can have profound implications for management options and the expected success rate of a repair. For this reason, a thorough preoperative evaluation including identification of likely causes should occur prior to offering a definitive intervention.

Evaluation

The evaluation of a patient with a suspected fossa navicularis stricture includes a detailed history and physical exam. The phallus should be evaluated for meatal position and patency, the extent of any palpable periurethral fibrosis, the presence of lichen sclerosus changes to the skin, and the availability of healthy-appearing penile skin (including preputial skin if the patient is uncircumcised). Distal strictures have a propensity for proximal extension, especially in the presence of LSA, and radiographic and/or cystoscopic evaluation must be performed in order to characterize the location and full length of the stricture [9].

Disease involving the fossa and meatus is often particularly difficult to assess due to the inability to accommodate a cystoscope or catheter for visual or radiographic evaluation. Small-caliber pediatric cystoscopes or ureteroscopes can be helpful for better visual evaluation of the tissue. Additionally, a small-caliber–inserted device such as a modified angiocatheter may be required to perform an adequate retrograde urethrogram (RUG). With limited or no normal tissue distal to the diseased segment, even a RUG can yield an incomplete evaluation [10]. A voiding cystourethrogram combined with examination findings can be a more effective method to evaluate stricture length in the distal anterior urethra. This still requires retrograde filling via the urethra or placement of a suprapubic catheter to instill contrast agent into the bladder [10]. In some cases, bladder filling can be achieved using a small-caliber ureteral catheter via the urethra or with a suprapubic needle puncture. It is imperative to adequately evaluate stricture length; thus, it may be necessary to establish a suprapubic tract in order to perform an adequate antegrade urethrogram. This tract would also allow for antegrade cystoscopy to be performed, further assisting in preoperative and intraoperative evaluation [11].

Urethral ultrasonography has been described as a feasible and effective means of evaluating stricture length in the distal anterior urethra. In one series, sonourethrography was more accurate than other techniques at predicting intraoperative recorded stricture length [12]. Conventional fluoroscopic evaluation was noted to underestimate length, although this may be less of an issue in the penile urethra than the bulbar urethra. A more recent study utilized three-dimensional reconstruction of strictures evaluated with both RUG and sonourethrogram [13]. This demonstrated that the modalities were equivalent throughout most of the bulbar and pendulous urethra, but of note only sonourethrography was able to characterize the fossa navicularis and meatus. Three-dimensional analysis provided the added benefit of characterizing the degree of fibrosis of corpus spongiosum, which provides a better understanding of the complexity of disease and more complete surgical planning.

The fossa navicularis is thought to play a role in forming a directed urinary stream as urine exits the penis. As urine passes through the fossa, it develops a spiralized pattern of flow that aids with maintaining a straight and relatively uniform stream. As such, patients with stricture disease may report bothersome splitting, splaying, or spraying of the urinary stream. Reconstruction achieves a patent urethra at the level of the fossa navicularis but does not generally reconstitute the precise native anatomy of the glanular urethra, which can contribute to spraying of the urinary stream long-term even in the setting of a successful repair. These are important functional considerations that should be kept in mind when counseling patients on expected outcomes after surgical intervention.

Management

The choice of management should incorporate patient preferences and consideration of the relative risks and benefits inherent to each option. Traditionally, the approach to management of urethral strictures has proceeded in a stepwise manner beginning with minimally invasive approaches such as dilation or DVIU. In patients who develop stricture recurrence, more invasive techniques are considered such as meatoplasty or repair with flaps or grafts [2, 10, 14]. Given the low success rate of endoscopic interventions, some surgeons may offer an open surgical repair upfront for patients healthy enough to tolerate a longer procedure.

Urethral Dilation

Dilation continues to be one of the most common approaches to treatment of urethral stricture disease [15]. Many urologists view dilation as a minimally invasive procedure with low risk [16]. The theory underlying the intervention is to incrementally stretch the scar tissue while minimizing mucosal tearing and inflammation that can lead to recurrence or progression of disease [17]. An initial dilation is often performed in the office or operating room, followed by regular self dilation with a tapered device.

In the setting of LSA, dilation may actually worsen the disease process in tissue already predisposed to inflammation. Given its low success rate in this setting, dilation is not indicated in patients with LSA [3, 7]. Long-term success rates of dilation are less than 50% when considering all urethral strictures, with many patients requiring multiple dilations, both increasing the potential morbidity and cost [16]. The success rate of dilation specifically in fossa navicularis strictures is likely significantly lower.

While there has been a trend toward primary urethroplasty, there may still be a role for dilation/self calibration as an initial modality in select patients that are either unfit for or unwilling to undergo more invasive procedures [17]. The addition of intermittent intraurethral steroid application may improve outcomes, with small series reporting success rates as high as 89% at 2-year follow-up [18].

Direct Visual Internal Urethrotomy

DVIU has been used in the same manner as urethral dilation, as it has historically been considered a low-risk intervention. The theory underlying this modality is that incision of the band of fibrotic tissue allows release of the scar and luminal expansion, followed by re-epithelialization of the incised plate rather than recurrent scar contraction [17]. The success rate in all anterior urethral strictures has paralleled that for dilation, with success again even lower when used in the fossa navicularis [2, 8, 16, 17]. This modality also has limited utility in the setting of LSA, as the underlying inflammatory process is likely to result in contracture and stricture recurrence rather than re-epithelization [7].

DVIU in the fossa navicularis can also be very technically challenging. Given the proximity of the fossa to meatus, adequate cystoscopic visualization can be difficult if not impossible. Visualization is critical to allow cold-cut knife or laser incision of the scar while avoiding injury to adjacent healthy mucosa and the underlying delicate tissue of the glans [17]. This may be best achieved using a holmium laser fiber and a pediatric cystoscope for short strictures with minimal spongiofibrosis. With significant challenges and a high recurrence rate, the role of DVIU in the management of fossa navicularis strictures is questionable.

Meatotomy

Meatotomies are classically performed with a ventral incision extending to a point proximal to the stricture, splaying open the meatus along this length. The edge of incised mucosa is sutured to adjacent skin to facilitate healing of the opened meatus and limit the risk of recurrence. A wedge of fibrotic tissue may also be excised ventrally at the time of the procedure. Typically, this intervention is limited to patients with meatal stenosis or relatively short, distal strictures. Meek and

colleagues described the use of urethromeatoplasty for 93 patients with short (< 2 cm) distal urethral strictures [9]. Patients were treated with the minimal incision felt necessary to treat the diseased urethral segment, and all tissue involved with LSA was resected prior to closure. With a median follow-up of 50 months, they reported an impressive 85% success rate. Given the resection of any grossly involved LSA segments, it is likely that the patients selected for this repair had minimal or no LSA as their underlying disease process. In the LSA population, the durability of this procedure may be lower, but in some patients, this technique may reestablish the low-pressure voiding critical to successful control of lichen sclerosus.

While meatotomy is relatively simple and considered less invasive than urethroplasty, patients must be willing to accept cosmetic changes including a wider, more ventrally placed meatus. Patients will often experience downward deflection of the urinary stream and may report spraying or splaying of the stream. For many patients, this tradeoff may be preferable to undergoing a larger surgery.

Urethroplasty

Open surgical repair of distal anterior urethral strictures was previously reserved for patients that had stricture recurrence after minimally invasive interventions as previously described [8]. This stepwise approach to intervention has become antiquated with improved understanding of the pathophysiology underlying the disease. With growth in surgical experience and dissemination of techniques in urethral reconstruction, open urethroplasty has clearly become the gold standard in repair [17, 19]. In general, surgeons attempt to calibrate the urethra to a 24 French or larger at the time of repair.

Penile Skin Flaps

Flap urethroplasty has been the mainstay of open repair, predating substitution grafts. The stricture is generally approached either through a ventral midline, subcoronal, or circumcising incision with exposure of the fossa navicularis aided by creation of a glans-cap or raising glans wings.

One of the most reliable forms of flap urethroplasty is the fasciocutaneous ventral transverse island skin flap, originally described by Jordan [20]. This involves isolating a ventral skin flap with blood supply maintained through a dartos pedicle flap that could be brought to the glans for urethral coverage while providing an adequate cosmetic outcome. Over time, flap approaches have proven effective and durable with success rate ranging from 83 to 100% [3, 20–22, 23••].

In cases with LSA, the durability of genital skin flap repair is significantly worse due to a high risk of lichen sclerosus recurrence on the genital skin used for repair [4, 24]. Virasoro and colleagues performed a long-term follow-up study of the Jordan method and reported a success rate of 83% (29/35) at

10.2 years. Most notably, there were 12 patients with prior diagnoses of LSA and all six of the failures were in the LSA group, resulting in a 50% recurrence rate in this subset and 100% success rate in the rest of the cohort [23••]. These findings reflect the significant risk of stricture recurrence when local tissue is utilized for repair in cases with LSA.

Babu et al. similarly evaluated the Jordan meatoplasty for repair of fossa navicularis strictures. In their series of 25 patients with a mean follow-up for 30 months, there was one recurrence [25]. Of note, patients with LSA were excluded from the study. This further reinforces that the single-stage flap urethroplasty remains a durable and effective means of repair in the setting of fossa navicularis strictures.

Patients with any degree of LSA have a contraindication to the use of penile skin as part of the urethral reconstruction, due primarily to the high risk of disease recurrence on genital skin and associated stricture recurrence.

Substitution Grafts

The first substitution graft for fossa navicularis stricture disease was described in 1986 by Devine, who actually used a graft harvested from penile skin for this repair. The initial approach was via a staged procedure, and flap reconstruction continued to be the preferred method as it could be completed as a single-stage repair [26]. In 1998, Venn and colleagues reported on a series of patients with LSA strictures for which they performed two-stage skin grafts repairs. They utilized genital skin in 12 patients and extragenital skin in another 12. Ultimately, they showed a 93% success rate in the nongenital group compared with a 0% success rate with the use of genital skin [3]. This again illustrated the important role of the underlying inflammatory process in LSA and its impact on potential tissue selection for urethral repairs.

While the work of Devine to illustrate LSA recurrence rates was striking and experience with graft urethroplasty became common with its growing use in the bulbar urethra, many urologists remained hesitant to perform grafts reconstructions in the fossa navicularis as the blood supply was felt to be limited from a deficiency in spongiosum [27]. Dubey described dorsal buccal mucosal graft (BMG) onlay in 2005 as a feasible and effective technique for panurethral stricture reconstruction including fossa navicularis strictures [28]. In their series, the procedure was typically performed in a single stage unless there was complete urethral plate obliteration in the setting of LSA, in which case a two-stage repair was performed [28–30].

In 2009, Goel described the double BMG technique for the repair of fossa navicularis and meatal strictures. This approach involved placing a dorsal graft, then glans wings were brought ventrally to cover a second ventral graft and provide additional blood supply to the graft. In their series of 10 patients, 7 had LSA and they did not identify any graft failures, though follow-up was shorter at 13.5 months [31]. A similar technique to manage longer segment, obliterative distal strictures involving the fossa navicularis and meatus was also described by Gelman in 2012. They utilized a dorsally placed buccal mucosal graft combined with a ventrally placed penile skin flap in lieu of tubularized repairs or double grafting. In 12 patients without LSA, all were reported to be free of recurrent stricture at a median follow-up time of 39 months. Two developed urethrocutaneous fistulas, with one of these patients developing a mild narrowing at the fossa repair site.

Chowdhury first described ventral onlay BMG urethroplasty for fossa navicularis strictures in 2014. In their technique, glans wings were created and anastomosed ventrally to ensure adequate blood supply to the graft. The series included 6 patients (3 with LSA) and reported an 83% success rate at median follow-up of 37 months. There was one failure, where a patient with LSA demonstrated stricture recurrence. The remaining 5 patients reported positive satisfaction scores with the cosmetic outcome of their surgery, and Chowdhury's group concluded that ventral onlay BMG is an effective, feasible, and cosmetically adequate approach to fossa navicularis strictures [32].

In patients with significant narrowing with near obliterative disease and/or conditions that would significantly compromise local blood supply (inflammatory processes such as LSA, prior surgical repairs), a staged approach may also be considered. The urethral plate may need to be resected completely and replaced with substitution material (usually BMG) with graft tubularization performed later (usually 6–12 months or longer) to form a neourethra after the tissue has been able to mature an adequate blood supply. Alternatively, proximal urethral diversion with a perineal urethrostomy can be considered in severe cases, repeated recurrences, or patients who may not be able to tolerate a long operation.

While buccal mucosa is the most common extragenital graft source, tissue can be harvested from other sites such as lingual mucosa, post-auricular skin, and rectal mucosa [33, 34]. To date, no studies exist specifically utilizing these alternative graft sources in fossa navicularis reconstruction. However, these tissues have proven acceptable options in bulbar urethroplasties, and they may be options for fossa navicularis strictures in cases where buccal tissue is not available.

Transurethral BMG

Transurethral approaches to BMG for distal strictures have been described as a means to avoid incisions in glans and distal penis that may compromise local blood supply. In 2012, Onol first described a single-stage technique with circular buccal mucosa grafts in a group of 19 patients with strictures < 2 cm in length, 16 of which had LSA. The technique involved a circum-meatal incision and dissection until healthy urethral tissue was noted. In 9 patients, a transverse subcoronal counterincision was required to aid in visualization of the proximal healthy urethra. The reported success rate

was 84.2%, with 1 patient experiencing early graft loss and 2 developing strictures at the proximal anastomosis [35].

Nikolavsky similarly described a transurethral approach with BMG using an approach that did not require a ventral incision site. A transurethral wedge of tissue including the fibrotic band was excised and replaced with a ventrally placed, tear-shaped buccal graft. This graft was fixed into place using a stay suture passed through the apex of the graft, then through the healthy proximal urethra before being externalized through the skin. The series included 3 patients, 2 of which had LSA, and all of which had at least 2 failed prior procedures. There were no reported fistulae or recurrences in the group at a mean follow-up of 18 months [36•].

Conclusions

Strictures of the fossa navicularis present complex and technically challenging obstacles for urologists. Effective management of this disease must achieve reasonable functional outcomes and cosmesis with durable results. The approach to management should be based on the underlying etiology of disease and patient-specific factors including their goals and comorbid conditions. Minimally invasive techniques should be reserved for short-segment disease in patients without LSA or that are surgically unfit for an open procedure. Open urethroplasty with flaps or grafts offers the most durable outcomes, and grafting specifically with extragenital skin should be the standard of care in patients with LSA. Transurethral BMG approaches show promise as a less extensive open technique, but data on these techniques is currently limited. Further study of transurethral approaches with longer follow-up is required to validate this potential option.

Compliance with Ethical Standards

Conflict of Interest   Brian J. Friel, Alexander J. Skokan, and Robert Caleb Kovell each declare no potential conflicts of interest.

Human and Animal Rights and Informed Consent   This article does not contain any studies with human or animal subjects performed by any of the authors.

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