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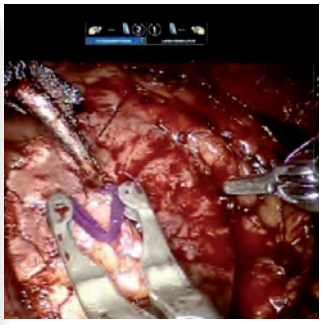

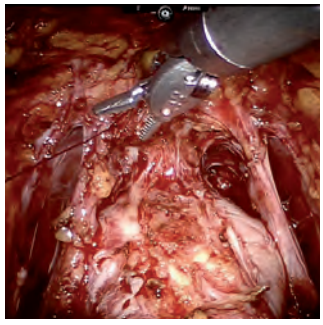

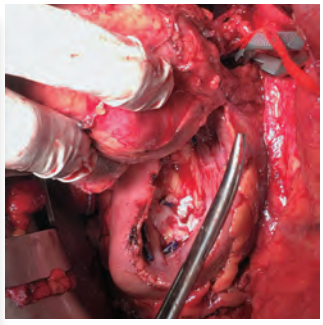

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REVIEW

What urologists need to know about female-to-male genital confirmation surgery (phalloplasty and metoidioplasty): techniques, complications, and how to deal with them

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ABSTRACT

Transmasculine gender-affirming surgery (GAS) is technically challenging, and in the past associated with a high but improving complication rate. Few surgical centers are performing this surgery, which can include metoidioplasty and phalloplasty, and patients often travel great distances for their surgery. While many will continue care with their original surgeons, others cannot due to social/geographic factors, or because emergencies arise. Thus, patients may seek care with their local urologist for relief of delayed complications, the most common of which include urethral stricture, penile prosthesis issues and urethrocutaneous fistula. This review will discuss the surgical elements behind metoidioplasty and phalloplasty, and the diagnosis and treatment for the most common postoperative issues.

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KEY WORDS: Transgender persons; Gender dysphoria; Sex reassignment surgery; Fistula; Urethral stricture.

The treatment of gender dysphoria is multifaceted. Genital gender-affirming surgery (GAS) often the last step in a patient's long journey to achieve mind-to-body congruity. These surgeries can be vital to the well-being of patients: the attempted suicide rate in unoperated transgender people is a shocking 32%, and GAS has been shown to greatly ease the psychopathology of gender dysphoria and subsequently decrease the risk of death by suicide.[1, 2] GAS should be thought of as necessary surgery rather than an elective one, due to the risk of bodily harm in the absence of treatment.

Genital GAS has been on the rise in the United States, more than doubling between the years 2000-2005 and 2006-2011. Furthermore, Medicare coverage for these procedures has increased from 25% in 2012-2013 to 70% in 2014.[3] GAS is a complex multidisciplinary surgical endeavor that few centers perform, and historically, metoidioplasty and phalloplasty have been associated with high complication rates. As such, patients often travel great distances to centers of excellence for treatment, but may need to rely upon the locally-available urologist for treatment of complications. These can commonly

include urethral stricture, penile prosthesis issues, wound dehiscence/infection and urethrocutaneous fistula. This review will focus on the urologic aspects of female-to-male GAS and the relevant anatomy required to enable the urologist to approach these issues knowledgeably.

Metoidioplasty

The term metoidioplasty is derived from the Greek "meta" meaning toward, "oidion" meaning male genitalia, and "plasty" meaning surgical modeling.[4] Some reasons a transman might choose metoidioplasty is that it is less morbid with fewer complications compared to phalloplasty. It allows for standing micturition in most cases, and simultaneously achieves some desired surgical outcomes such as vaginectomy and scrotoplasty. Metoidioplasty is a 3- to 4-hour operation that can be reliably completed by a single surgeon in a single stage. Furthermore, there is no donor site morbidity as with phalloplasty, where a large 22X16 cm flap must be harvested. Erogenous sensation and corporal tumescence are preserved. The shortcoming with the procedure is that the phallus created is small, and it may not achieve the patient's goals in terms of penetrative intercourse. The average length of the metoidioplasty phallus in three studies ranged from 5.7 to 8.7 cm.[5-7] Greater lengths have been reported using an "extensive metoidioplasty" in which the crura were nearly completely detached from the pubic arch bilaterally and approximated to each other. This achieved a 70% reported intromission rate in small single-center series. It also requires a regimen of specialized penile traction devices in the postoperative period.[7] While promising, this technique is not widely studied or adopted.

The first step towards metoidioplasty begins with exogenous testosterone to hormonally enlarge the clitoris. This is almost always already being given to the patient as part of his gender transition. While topical dihydrotestosterone has additionally been used in preadolescent natal males to lengthen the phallus before planned hypospadias surgery,[8] it appears ineffective in lengthening the phallus further in adult transmen who are already taking generally high doses of parenteral testosterone. Understanding the steps of the surgery is based on thorough understanding of natal female genital anatomy. The clitoral glans is attached to two corporal bodies that are adherent to the pubic rami. As in male genitalia, the clitoris is supported by suspensory and fundiform ligaments. Some steps of surgery are analogous to hypospadias surgery, where chordee repair is paramount: release of the "physiologic" chordee of the clitoris is also most important in metoidioplasty. A suprapubic tube is placed. First, vaginectomy is performed if desired, and the former vaginal cavity mostly closed. Second, ventral paravaginal tissue flaps are raised to later form the neourethra. The future urethral flap is designed to include the paravaginal tissue down to the inferior vaginal introitus, as the newly lengthened phallus will require several centimeters of extra urethral length. Third, as the urethral flap dissection continues distally, the clitoris is partially degloved and its ventral and lateral attachments are completely severed to gain length and upward mobility. Fourth, the ventral urethral plate is deeply incised transversely to further free up and treat the physiologic chordee of the future phallus. This incision is made at the level of, and brought down to, the pubic bone, as this is both an effective and safe plane of dissection. This transverse incision is then closed longitudinally, greatly releasing the ventral chordee. Fifth, the suspensory ligaments may be dissected free from the corporal bodies to potentially further lengthen the phallus, using a second incision above the phallus. This incision is deepened to the level of the pubis in a manner that the nerves/artery/vein of the phallus is not transected. Nowadays, most high volume centers only perform this if there is a clear dorsal tethering of the dorsal phallus by the suspensory ligament. We most commonly do not perform this step. Sixth, the well-vascularized and maximally thick paravaginal flap is tubularized to create the urethra and is also connected in continuity with the native urethra. Some centers may place a buccal graft dorsally in the urethral plate as part of the urethroplasty, but we neither routinely use nor need additional buccal augmentation of the urethra.

Seventh, well vascularized flaps based on the superior labial artery are made from the labia majora and lifted cephalad to make a scro-

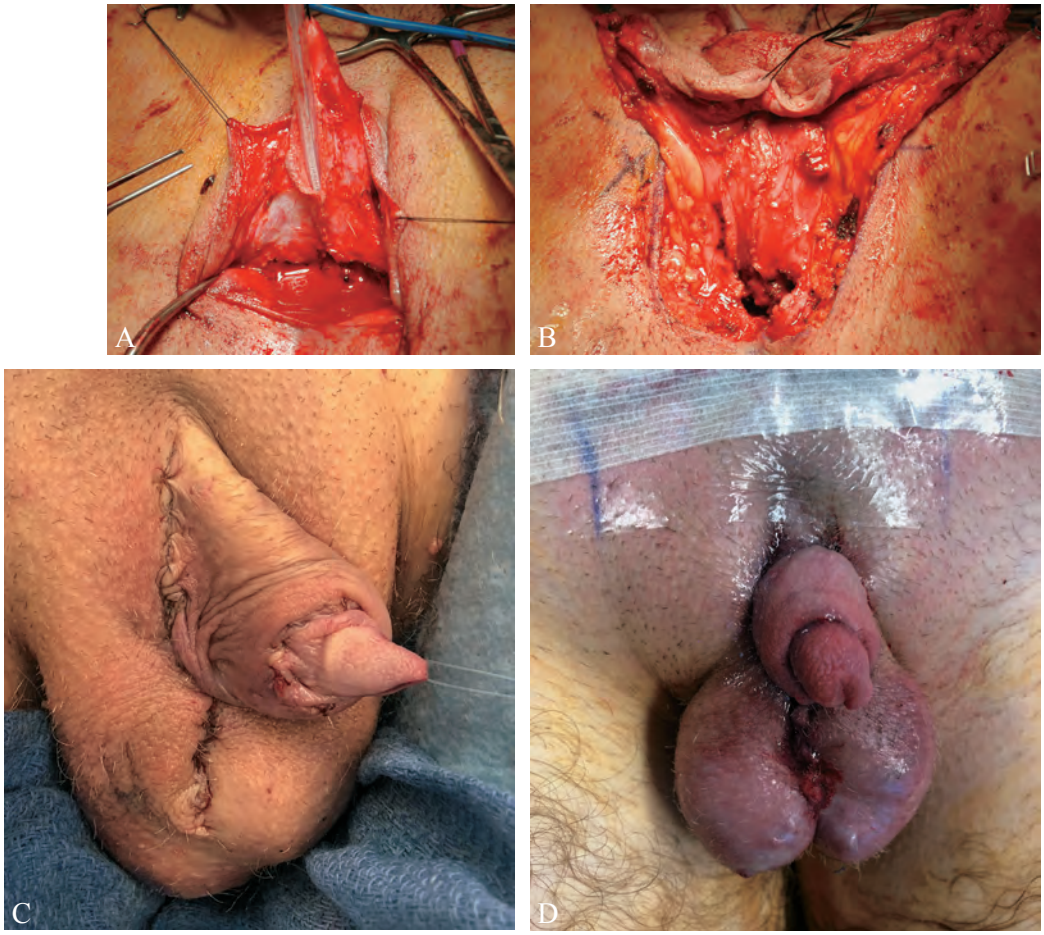

Figure 1.—A) The labia minora are incised to create a urethral plate. An anterior vaginal flap has been advanced (not shown) and the edges of the urethral plate are tubularized, creating the fixed urethra; B) vaginectomy allows for the harvest of the bulbospongiosus muscle, which is closed as a second layer to reduce the incidence of urethrocutaneous fistula; C) completed metoidioplasty; D) testicular implants are placed in the neoscrotum.

tum, which is both round and high up out of the perineum. Eighth, the bulbospongiosus muscle is lifted and closed across the urethral suture line, generally bolstering the proximal half of the urethra. The distal urethral suture line is additionally bolstered by a second layer of nearby tissue sewn across midline. Finally, the remaining vaginal cavity and skin is closed to create a flat male-type perineum. No urethral catheter or scrotal drain need be left in place. Urine is diverted for 14-21 days after surgery (Figure 1).

In a systematic review, Frey *et al.* reported an overall complication rate of 43% after metoidioplasty with a subset of 27% strictures or fistulas.[9] Eighty-eight percent of these patients underwent a single-stage metoidioplasty, with 100% maintaining erogenous sensation and 89% reporting standing micturition. In recent series of single stage metoidioplasty, Vukadinovic *et al.* report an overall complication rate of 28% in their cohort of 97 transmen; 84% were satisfied with the appearance of their genitalia while 88% were satisfied sexually; 12% went on to have phalloplasty, which highlights a key feature of metoidioplasty: if unsatisfied with metoidioplasty, phalloplasty may still be performed.

The pendulous urethra is quite short in metoidioplasty, explaining why urethral complications are (at least) twice as likely in phalloplasty as in metoidioplasty.[9]

Phalloplasty

Phalloplasty is the creation of a phallic structure that closely resembles its cis male counterpart. The ideal phalloplasty requirement was described by Gilbert *et al*.:[10]

- aesthetically pleasing;
- allows for standing micturition if desired;
- provide erogenous sensation for sexual stimulation;
- provide tactile sensation to protect the neophallus from prosthesis erosion;
- have enough bulk to eventually accommodate a penile prosthesis for penetrative intercourse;
- minimize donor site scarring and functional loss;
- standardized technique that is reproducible and teachable.

Several phalloplasty techniques have been developed, with radial forearm free flap (RFFF) emerging as a commonly performed technique. Anterolateral thigh (ALT) flap is also extensively used, as it has the benefit of being a rotation flap without the clotting/bleeding risks found after microvascular anastomosis in the RFF free flap. Alternatively, latissimus dorsi musculocutaneous free flap can also be done, particularly if the patient wishes to avoid visible arm/leg scars. We do not favor this flap as it has several negative characteristics of both the RFFF and ALT flap, and little to recommend it other than the concealability of the donor site.

Some patients elect to not elongate the urethra and will void out of the native urethra for life after phalloplasty. In patients choosing urethral lengthening, the neophallus urethra is generally made up of the same components: the native urethra, fixed urethra (pars fixa) made of tubularized periurethral tissue (as in the metoidioplasty urethroplasty description above), pendulous urethra (pars pendulans) generally made using a skin "tube within a tube" technique during phalloplasty creation, and the urethral meatus (Figure 2). Other methods of pendulous urethral creation are possible, including using a second tubularized groin flap made of nearby skin fed by the superficial circumflex iliac artery (SCIP).

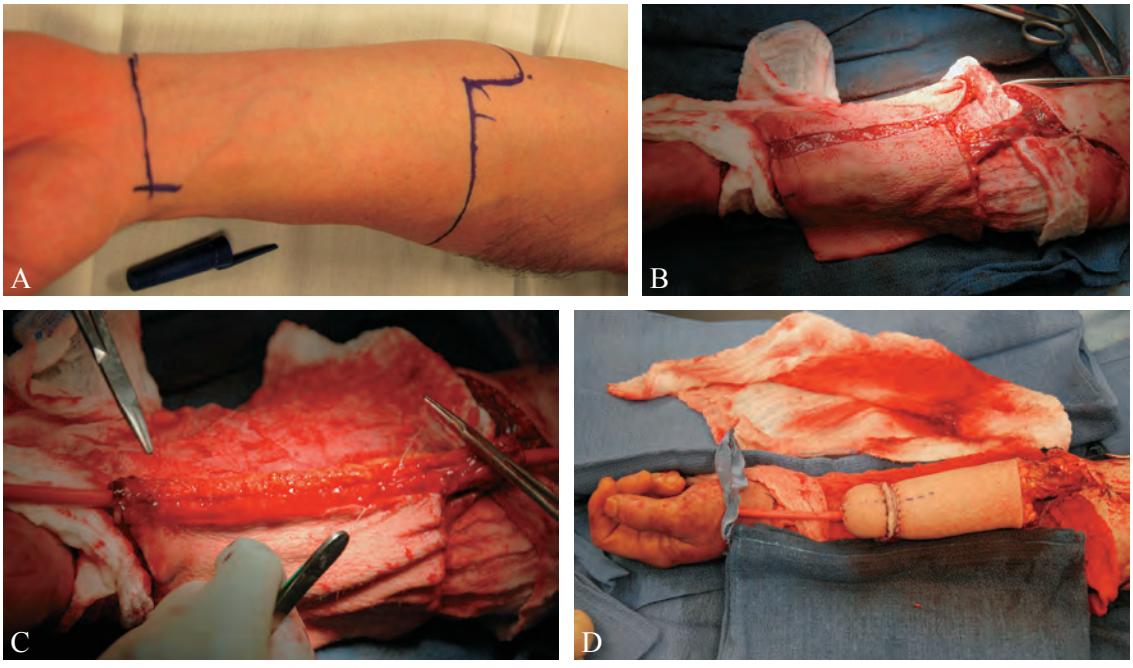

Figure 2.—A) The radial forearm free flap incision is carefully planned; B) a thin strip of skin has been removed, and the urethral tubularization has begun; note that the RFFF remains on its pedicle; C) the urethral closure is completed; D) the neophallus is now fully tubularized and glansplasty has been performed. The RFFF will remain on its pedicle until the microanastomosis site is fully prepared.

Other methods, still, might use prelaminated tissue (buccal, vaginal mucosal) placed previously in the future RFFR, tubularized labia, or staged Johanson-type urethroplasty.[11] We only rarely use other techniques than the tube within the tube urethral configuration, which is well proven and quite predictable in its performance characteristics. Surgical anatomy of the neourethra is important here as the anastomotic urethra between the fixed and pendulous urethra is the site of most neourethral complications (Figure 3). The external landmark for this is generally in the upper scrotum. The reason for the vulnerability of this anastomotic region to stricture/fistula is the fact that it is in the watershed area most at risk of ischemia. In a meta-analysis of 11 studies involving 665 RFFF patients, the long pendulous urethra of the neophallus results in strictures or fistulas an average of 51% (range 20-80%) of the time.[9] Optimized techniques have resulted in 15% rate of strictures in our recent series.[12]

Complications of metoidioplasty and phalloplasty

Urethrocutaneous fistula

In a recent multi-institutional study, Dy *et al.* reported the presenting complications of 55 patients after metoidioplasty or phalloplasty to a reconstructive urologist. Median time to presentation was 4 months, and most importantly, 100% involved some form of urethral complication.[13] Urethrocutaneous fistula (UCF) is the most common complication of phalloplasty and metoidioplasty. The reported incidence is as high as 64% of patients,[14] although more modern series has seen this figure decrease significantly with Doornaert *et al.* reporting a fistula rate of 17% in their series.[15] Use of sound reconstructive techniques, such as the use of multiple-layer closures can account for these improvements. UCF can be found anywhere along the urethra with a suture line. UCF is an early complication that often spontaneously resolves, and treatment plans should suppose that most fistulas will heal in time. Ascha *et al.* noted that when UCF did heal spontaneously, most did so within 3 months.[12] Doornaert *et al.* has reported that in the largest cohort to date, when UCF was the only complication, spontaneous closure occurred in 66% of cases.[15] Consistent with our experience and the fact of the poorly vascularized "watershed" of the distal urethral anastomosis, Fang *et al.* noted that all UCF occurred at the junction between the neophallus and neoscrotum, which corresponds to the location of the anastomotic urethra[14] (Figure 4).

There is meaningful data showing that the use of the bulbospongiosus muscle as a well-vascularized second urethral coverage layer is important in the prevention of UCF. Al-Tamini *et al.* demonstrated that the UCF rate after phalloplasty decreased from 59% without colpectomy (when this muscle flap is not available) compared to 24% with colpectomy, when the flap is available for use. There was a more marked decrease with metoidioplasty, with UCF decreasing from 42% to 8% when colpectomy is done and the bulbos-

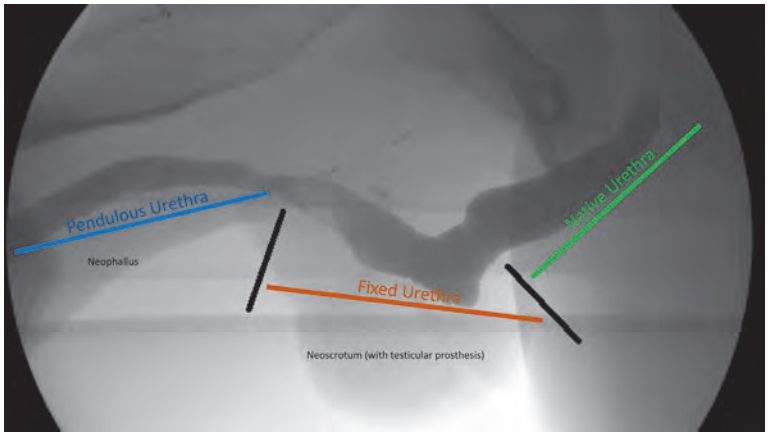

Figure 3.—A retrograde urethrogram highlights the anatomy of a healthy urethra after phalloplasty, showing the pendulous urethra in blue, the fixed urethra in orange, and the native urethra in green in the on-line version. The shadow of the neophallus and neoscrotum with testicular prosthesis can be seen.

Figure 4.—A) Urethral fistula at the penoscrotal junction; an inverted "T" incision is made centered over the fistula; B) the fistula is closed primarily followed by an additional layer composed of local random flaps; C) the skin is closed in a manner to avoid over-lapping suture lines.

pongiosus muscle is available as a reliable second urethral coverage layer.[16] Massie *et al.* showed that UCF after phalloplasty decreased from 56% to 14% when vaginectomy is performed, and the bulbospongiosus muscle becomes available as a second urethral layer.[17] Other muscle flaps have also shown promise. Salgado *et al.* used a gracilis flap for urethral coverage in patients undergoing RFFF. No patients in this small demonstration study of four patients developed a UCF.[18] Currently, it is not clear to us that the benefit of decreasing the rate of often-self-limited urethral fistulae are worth the increased surgical time and morbidity of harvesting a gracilis flap and transferring it as a coverage layer over the urethra.

UCF typically present with a chief complaint of urinary leakage from an ectopic site during voiding. Additional symptoms may include decreased force of steam, incomplete emptying, dysuria and post void dribbling, especially when associated with a distal urethral stricture. An obvious fistulous tract is usually seen on physical exam, with or without attendant induration, erythema, and tenderness.

A symptom check for obstructive symptoms (poor force of stream, frequency, urgency, nocturia, prolonged voiding time, not feeling empty after voiding) and bladder scan should be performed to clinically rule out urinary retention. Exam under anesthesia is a helpful adjunct, along with flexible cystoscopy to determine the precise anatomy. Usually we suspect fistula by history, and can often confirm it on physical examination. If not, intraoperative flexible cystoscopy generally can delineate the pathology well, at the time of planned open repair. Retrograde urethrogram may also be used to delineate anatomy, but we have seldom found this to be necessary.

As UCF is usually an early complication after transmasculine GAS, suprapubic drainage is often still in place (we remove suprapubic drainage one month after phalloplasty and three weeks after metoidioplasty irrespective of the presence of UCF). As previously stated, most UCF will close within 3 months. We refrain from extended urinary diversion as we feel that it does not alter the likelihood of UCF closure while increasing the risk of urinary tract infection; however, data regarding the optimal length of urinary diversion is currently lacking. A tenet of reconstructive surgery that should not be compromised is refraining from reoperation until the tissue has had enough time to completely heal. We wait 6 months for repair, and longer if possible.

Patients are usually placed in dorsal lithotomy for surgical repair. Exam under anesthesia is performed, followed by flexible cystoscopy. Techniques of fistula repair are the same as for cis-male urethral fistulae. The urethra is opened at the fistula and closure is performed in multiple layers with local advancement flaps and non-overlapping suture lines if possible. Recalcitrant UCF may require local fasciocutaneous flaps for adequate coverage. If this option is pursued, the flap should be harvested from the side contralateral to the neophallus blood supply.[19] When UCF occurs together with urethral stricture in close proximity, simultaneous repair can often be performed with excision of both UCF and stricture, followed by an anastomotic urethroplasty.

Urethral stricture

All techniques of urethral lengthening for metoidioplasty and phalloplasty require long suture lines that may be prone to stricture. Edges furthest from the blood supply are watershed points where most urethral strictures will form. In phalloplasty patients, this is usually at the distal anastomosis between the pars fixa and pendulous "skin" urethra, or at the meatus. Phalloplasty urethral strictures can be found at the urethral meatus in 15%, pendulous urethra in 24%, anastomotic urethra in 41%, fixed urethra in 13% and multifocal in 8%.[20] Patients will often present with classic obstructive lower urinary tract symptoms, including decreased force of stream, dribbling, incomplete emptying, frequency, and urgency. A specific complaint in men after phalloplasty can also be "ballooning" of the urethra just proximal to the stricture, or prolonged post void dribbling as the entrapped urine leaks slowly past the stricture after each void. Confirmation can be made with flexible cystoscopy, or more simply by attempting to place a urinary catheter into the urethra. A typical stricture will prevent passage past the penoscrotal region where the anastomotic urethra is located. While a RUG can be helpful in determining stricture length, we have found that the consistent nature of the phalloplasty urethral stricture makes RUG less critical in contrast to natal male urethral strictures.

Metoidioplasty urethral stricture

Urethral stricture after metoidioplasty fall into two broad categories: meatal stenosis versus all other strictures. Diagnosis, assisted by the simple placement of a catheter in the urethra, is made with physical exam and augmented by cystoscopy if necessary. RUG is seldom needed except to determine the length of the urethral stricture to help counsel the patient on the possible need for buccal mucosa repair. All urethroplasty approaches involve a ventral midline urethrotomy and will be extended proximally until normal caliber urethra is encountered. If the meatal stenosis is very short, it can be treated with simple meatoplasty. If the stenosis is longer and meatoplasty may risk the creation of a hypospadiac urethral meatus, then we will opt for dorsal urethral augmentation with buccal mucosa. We prefer to perform a dorsal inlay Asopa style single-stage urethroplasty for short strictures. Staged Johanson urethroplasty with buccal mucosa is reserved for the rare long stricture.

Figure 5.—The edges of the phallus mark the greatest distance from the vascular supply and are at most risk for necrosis. This figure shows necrosis of the edge of the urethral tube which can scar down, resulting in meatal stenosis.

Phalloplasty urethral stricture

The meatus is at risk for stenosis as it is far from its flap blood supply and partial flap necrosis can follow surgery, leading to loss of urethral domain or obliterative scarring (Figure 5). Treatment is with a simple meatoplasty. One must ensure that there is no stricture further upstream at the time of surgery with flexible cystoscopy or RUG. If the meatal stenosis extends further and is actually a distal pendulous urethral stricture whose treatment would leave the patient with a hypospadiac meatus, then we prefer a staged Johanson urethroplasty with placement of full thickness skin grafts which are then thinned to split thickness skin grafts before placement. We specifically avoid buccal mucosa within the neophallus as we have noticed that it does not take well and greatly contracts when fully healed. Furthermore, the urethra is already composed entirely of skin and there is a virtually unlimited supply of donor skin in contrast to the limited amount of buccal mucosa.

If the stricture is very short (1 cm) and the urethra is supple, then we will generally perform a Heineke-Mikulicz non-transecting urethroplasty

in which a longitudinal urethrotomy is made and closed transversely with absorbable suture. Success rate has been reported at 57%.[20] In distinction to the natal male variant, this procedure is performed on the ventral aspect of the urethra. Alternatively, we prefer EPA in cases where there is dense scarring, the stricture is slightly longer (1.5 cm to 2 cm), or if the stricture is very high-grade. Success rate is similar at 58%.[20] Mobilization must be done carefully to avoid devascularization of the remaining urethra. To minimize blood supply disruption, we mobilize the urethral stump proximally more than distally. We also perform more mobilization ventrally since the blood supply to the pars fixa originates from the dorsal aspect and we attempt to preserve this area maximally. The urethral ends will be spatulated and closed with absorbable suture. If anastomotic urethroplasty is unsuccessful, we will then perform a staged Johanson urethroplasty with skin graft. It is important to mention that one must wait at least 6 months after previous surgery in that area, to allow for complete healing as any inflammation or induration will only make a hard surgery even more difficult. If the stricture develops before 6 months out from the index surgery, then temporizing measures must be taken to delay definitive repair until the 6-month milestone has been reached. This can be achieved with suprapubic cystotomy, dilation, or internal urethrotomy (DVIU). In our opinion, dilation/DVIU's only role in the care of the transmasculine patient is temporary management, as its lasting success rate is low.[21]

Staged Johanson urethroplasty with skin graft to widen the urethral caliber is our preferred management for strictures that are longer than 2 cm. This is an increasingly rare entity in the era of microsurgery. A ventral urethrotomy is performed until normal caliber urethra is encountered. Skin graft is then laid down alongside the strictured urethra. The second stage is performed 6 months later. Staged urethroplasty often has highest success rates, at 70%.[20] In difficult cases refractory to standard techniques, some have resorted to fasciocutaneous flaps from the scrotum, medial thigh, gracilis musculocuteaneous flaps,[22] or urethral substitution with a separate vascularized groin skin pedicle usually based on the SCIP. One must be mindful of the blood supply of the neophallus flap and generally harvest these flaps from the contralateral side.

In these difficult recalcitrant urethral strictures, patients should be counselled on the option of a first stage Johanson without a second stage, essentially creating a hypospadias urethral meatus for which they may need to sit to void forever. A perineal urethrostomy is also an option in this case where a 5-cm ventral urethrotomy is made at the pars fixa and the edges are fixed to the skin with absorbable suture. A long urethrotomy must be made to account for the contraction that inevitably occurs during healing.

Persistent vaginal remnant

The concept of complications from a "persistent vaginal remnant" is in flux. This was more common in the past, with Dy *et al.* report that amongst those patients returning with complications after masculinizing GAS, 47% included a persistent vaginal remnant.[13] However, with improved techniques this is now a rare finding. Further, some cases of proximal urethral anastomotic disruption will leak urine into the former vaginal space, and can create urinomas that are sometimes very large. Sometimes these are misnamed "persistent vaginal remnants" despite the fact that they are not.

Our vaginectomy technique involves completely removing about 4/5 of the vaginal mucosa, then using electrocautery to thoroughly ablate the mucosa of the remaining vaginal cap. This results in thorough elimination of the vaginal mucosa. Some have advocated for complete sharp surgical excision in an open or laparoscopic manner to ensure complete removal of the vaginal mucosa,[16]although this creates a risk of immediate small bowel herniation through the vaginectomy site and can be difficult or dangerous to fix. This approach also comes at a cost of a 10% reported risk of major complication involving bowel, bladder, or ureter - further reason for avoiding it.[16]

A true persistent vaginal cavity may present with post-void leakage due to urinary retention in the cavity, infection, and palpable mass or abscess. Cystoscopy is especially useful to rule out the urethral discontinuity with urine leakage

that might wrongly be labeled "persistent vaginal remnant." We have also found MRI and voiding cystourethrogram to be most useful in the diagnosis of a persistent cavity and its mimics.

We have categorized vaginectomy-site-specific complications into three categories: superficial persistent wounds, deep persistent wounds, and complex deep persistent wounds. Urinary drainage via urethral catheter or suprapubic catheter may be needed in cases involving urethral leakage. Superficial persistent wounds are managed with local wound care. If refractory after six months, then we will excise the affected area and close primarily. Deep persistent wounds are also initially approached with local wound care, moving on to operative management after 6 months of failed therapy. Any persistent mucosa, if present, will be excised, and the area closed. Additional maneuvers, such as Y-V plasty may be required in order to close the defect. Complex deep persistent wounds can often present with urethrovaginal fistula, urethral stricture, or a chronic urinoma with chronic infection and inflammation. Treatment may additionally involve fistulectomy or urethroplasty as required. Alternatively, robotically-assisted laparoscopic remnant colpectomy has been shown to be a feasible alternative to the open approach, in cases where actual vaginal tissue has been left.[23]

Figure 6.—Appearance of phallus after implantation of a single Coloplast Titan™ inflatable penile prosthesis cylinder.

Penile prosthesis complications

Penile prosthesis can be placed after phalloplasty to allow for penetrative intercourse after a delay of at least 9 months from the index surgery (Figure 6). Adequate time must be given for any urethral complication to develop and be addressed, as dealing with a urethral complication with a penile prosthesis *in situ* makes the urethroplasty much more difficult, or impossible without compromising the implant. If phallus liposuction is required, as in most ALT phalloplasties, we prefer to wait until all swelling post liposuction has subsided. Additionally, the patient must be sure they will not require a second liposuction before proceeding with prosthesis placement.

A penile prosthesis in a neophallus is inherently riskier than in a natal male, with higher rates of infection, mechanical failure, malposition and need for revision surgery.[24-27] In a cis-male, the corpora cavernosa are attached to the pubic bone and pubic rami, and one need simply place a prosthesis into this structure. No such structure exists in the neophallus, and a variety of techniques have been developed to overcome this. We fix the proximal end of the prosthesis with nearly unbreakable titanium suture (Fiberwire™, Arthrex) to the periosteum of the pubic bone, with excellent results. Others have advocated for a corticotomy into the pubic bone that would allow the rear tips to be inset into the bone for proximal fixation,[25, 28] although we have never found this necessary. Others have wrapped the proximal prosthesis with a Dacron sheath to simulate the tunica albuginea and facilitate fixation to the pubic bone, again a technique that we have not needed since the adoption of Fiberwire suture periosteal fixation. Additionally, one must be cautious with Dacron prosthesis sheaths as it appears that the prosthesis is more prone to mechanical failure, and the Dacron itself can be difficult to remove in cases of infection.[24, 26] We generally place a single cylinder and this is nearly always stiffens the phallus sufficiently for intercourse. It has been noted that dual cylinder implantation can lead to poor aesthetics and asymmetry, a finding with which we agree.[25]

In a recent systematic review of 1056 patients undergoing phalloplasty, 75% had a penile pros-

thesis placed, 84% of which were inflatable; 61% were single cylinder. With a mean follow-up of 3 years, the total complication rate was 36% with 12% reporting mechanical dysfunction and 9% with infection.[29] Currently, there is no purpose-built transmasculine penile prosthesis — all current penile prosthesis used in phalloplasty are originally designed as cis-male devices. However, the Coloplast Titan™ device seems well-suited for this indication, despite not being specifically designed for it. There is hope that the ZSI 475FtM penile prosthesis (Zephyr surgical instruments, Geneva, Switzerland), the first purpose-built device that offers a single cylinder with a glans shaped distal end and a more testicle-like pump, might usher in a new era of transmasculine inflatable penile prosthetics.[30] Studies seeking its approval are ongoing, and evidence that it truly is a better surgical option is at this time completely absent.

Conclusions

Techniques of metoidioplasty, phalloplasty, and the surgical repair of their complications are improving at a rapid rate. Still, complications abound, and few patients are lucky enough to live near where their index surgeries are performed, meaning that they seek follow-up care with local reconstructive urologist. These safety-net urologists must be prepared with the knowledge of diagnosis and treatment of GAS complications as they will be called upon to help this population in need.

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