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CARE FOR THE TRANSGENDER PATIENTS (C FERRANDO, SECTION EDITOR)

Gender Affirmation Surgery for the Transmasculine Patient

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Abstract

Purpose of Review The aim of this review is to introduce and describe many of the surgical procedures, physical elements, and associated complications that can be performed and encountered for transmasculine patients pursuing gender affirmation.
Recent Findings Increased exposure and understanding of the variations, elements, differences, and complications that exist within gender affirmation surgery (GAS) can lead to improved care for transmasculine patients.
Summary Gender affirmation care represents a burgeoning field within healthcare across the globe. As increasing numbers of patients demonstrate interest and pursuit in surgical transition, more providers will find themselves tasked with providing postoperative and general health care to this growing population. Gender affirmation surgery for transmasculine patients encompasses a tremendous breadth of procedures as well as outcomes in the pursuit to resolve gender dysphoria. While each procedure can be intricate in its details, a strong foundation in the overarching surgical offerings, elements, outcomes, and associated complications can lead to improved patient outcomes.

Keywords Transmasculine · Transgender · Gender affirmation surgery · Gender dysphoria

Abbreviations

US	United States
GAS	Gender affirmation surgery
WPATH	World Professional Association for Transgender Health
HRT	Hormone replacement therapy
TWT	Tube within a tube
ALT	Anterolateral thigh flap
MLD	Musculocutaneous latissimus dorsi flap
RFFF	Radial forearm free flap

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Introduction

Transgender individuals are estimated to account for less than 1% (0.6%; 1.4 million) of the population within the United States (US), a number suspected to underestimate the true prevalence [1]. Transmasculine patients represent a subset of individuals categorized under the term transgender and can more specifically be described as individuals assigned female at birth yet identify as male. This discordance between gender assignment and expression leading to significant personal distress is widely known as gender dysphoria and leads to significant social, financial, and personal costs reducing these patients' overall quality of life [2, 3].

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The need for increasingly comprehensive and quality care for transgender patients can be demonstrated through the growing proportion of patients pursuing physical, surgical, transformation to be congruent with their gender identity. By 2015, nearly one quarter of all transgender individuals surveyed via the US Transgender Survey stated they had undergone at least one transgender procedure, with transgender men reportedly twice as likely to have undergone some sort of procedure over transgender women (48% to 28%) [4].

While gender transition requires a multidisciplinary approach with medical, hormonal, and psychiatric intervention, our aim is to focus on the surgical aspects of transmasculine surgery within this review. Surgical transition encompasses a multitude of procedures, divided simply as top (mastectomy) and bottom (metoidioplasty/phalloplasty/hysterectomy) surgery. Existing literature illustrates a lag between the proportion of transmasculine patients who desire gender affirmation procedures (61% top surgery; 57% hysterectomy; 25% metoidioplasty; 19% phalloplasty) and those that have completed a surgical procedure (36%; 14%; 2% and 3%, respectively), with top surgery being the most prevalent procedure performed [5, 6]. While a smaller proportion of transmasculine patients have undergone bottom surgery, literature suggests that this is likely an underestimate due to inadequate access and resources to undergo bottom surgery [7].

With increasing recognition of transmasculine patient needs, these patterns are beginning to change. Gender affirming bottom surgery is becoming increasingly available and as a result, it is essential for providers to recognize and become familiar with the growing realm of surgical transgender care.

Surgical Techniques and Offerings

Many options exist for transmasculine patients pursuing gender affirming bottom surgery. Procedures include utilizing native tissue and organs or transfer and incorporation of tissue flaps. The decision to pursue one over the other is often personal and can be established through discussion preoperatively. While phalloplasty requires staged procedures and tissue transfer techniques, patients can experience similar success and satisfaction with the relatively less complex metoidioplasty. Decision to pursue metoidioplasty does not preclude patients from eventually pursuing a phalloplasty further down the road.

Presurgical evaluation consists of a thorough history, physical, hematologic, and metabolic evaluation. The physical examination is essential in planning for transmasculine surgery. Evaluating the native genitalia and surrounding tissues in addition to any potential donor sites should be performed when considering either procedure. For example, with regard to metoidioplasty, the volume, location, and quality of structures such as the labia minora, labia majora, and clitoris are important and serve as a guide for transmasculine reconstruction. With regard to phalloplasty, noting potential donor site skin laxity, ensuring intact palmar arch blood supply with Allen's test, presence or absence of hair, and sufficient collateral blood supply are all essential toward procuring and grafting a viable and successful neophallus [8].

A simple, yet essential examination ahead of potential phalloplasty is the Allen's Test. This is a simple maneuver to evaluate the integrity of the palmar arch and ensure perfusion of the radial digits through the radial artery occluded so that the harvest of a radial artery-based flap would not cause ischemia of the hand [9, 10•, 11, 12]. In case of an equivocal Allen's test, forearm Doppler or angiography can be considered. Alternatively, on table occlusion of the radial artery may be performed and flow in the thumb and thenar eminence assessed. If there is continued Doppler signal in the princeps pollicis artery with intraoperative occlusion of the radial artery, radial flap harvest may safely commence, if not, an abdominal phalloplasty or anterior lateral thigh phalloplasty is considered–depending on donor site habitus and vasculature.

Metoidioplasty

Metoidioplasty, derived from loosely translated Greek meaning "*towards male genitalia*," is the most prevalent form of surgical transition performed [12]. Metoidioplasty is regarded as a more safe and effective surgical option for transmasculine patients and is an ideal option for those preferring an aesthetically identifiable neophallus, persistent erogenous sensation and stimulation as well as the ability to void standing. In addition, this procedure features limited morbidity and costs as it is often a single surgical event with an abbreviated hospital and recovery course [13•, 14]. In our clinical experience, these patients are often dissatisfied with their ability to achieve penetration and with their ability to void while standing. Furthermore, almost all patients who undergo metoidioplasty require an interval second stage 'touch up' procedure involving monsplasty and reduction of upper labio-scrotal folds to improve cosmesis and voiding.

Simple Metoidioplasty

The simple metoidioplasty starts with degloving the hormonally enlarged clitoris (Fig. 1A) and separating it from the pubic suspensory and fundiform ligaments; adding length to the clitoris by eliminating any chordee present with clitoral enlargement [13•]. Next, the urethral plate is divided

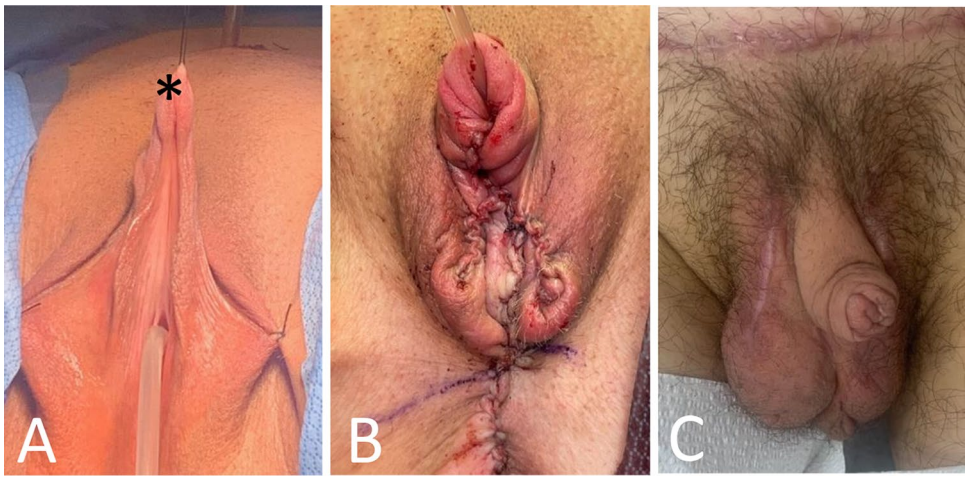

Fig. 1 Surgical progression through Metoidioplasty. **A** Initial surgical appearance following hormonal therapy with enlarged clitoris (*). **B** Reconstructed clitoral body resembling a phallus with urethra. Labial and clitoral skin are incorporated for bulk and girth. **C** 3-month post-operative metoidioplasty following monsplasty, upper scrotal reduction, and testicular prosthesis

and separated ventrally leaving the native urethral orifice in its orthotopic position and available for potential lengthening. The remaining external genitalia tissue including the labia majora, minora and clitoral skin are incorporated into a reconstructed clitoral body adding bulk and girth (Fig. 1B) [13•, 14]. While aesthetically successful, one drawback of the simple metoidioplasty is that it requires patients remain seated to void. This can be addressed; however, it requires additional procedures to lengthen the urethra. In general, complications following simple metoidioplasty remain low, impacting fewer than 5% of cases. Complications are often associated with failure to adequately reapproximate tissue to complete the reconstruction [15].

Urethral lengthening is achieved by joining the native urethral plate with the labia minora. This involves the dissection of the urethral plate from the urethral orifice proximal to distal. This can compromise urethral vasculature and increase the risk of associated complications [13•]. A small series published by Perovic et al. describing metoidioplasty with urethral reconstruction illustrated a 23% complication rate, of which urethral stenosis and fistula were predominantly identified [16]. While an increased risk, urethral lengthening often leads to higher satisfaction and affords patients the ability to void while standing which is often desirable.

Ring Metoidioplasty

Similar in concept as the simple metoidioplasty, the ring metoidioplasty differs through its execution, primarily with regard to creation of urethral plate and urethral lengthening. A fasciocutaneous graft is harvested and advanced from the labia minora to serve as the new urethral plate. This is then tubularized and connected to the native urethral orifice. A Martius modified labial fat pad flap (MMLFPF) more commonly knows and as simply a Martius flap is then harvested from the contralateral labia majora to be used as and interpositional bolster layer to the neourethra to avoid fistula formation. The remaining labial and clitoral tissues can then be used to reconstruct the clitoral body and add bulk and girth to the neophallus.

Belgrade Metoidioplasty

This is a procedure with surgical principles based on hypospadias repair. Embryologically analogous, the corporal bodies in the penis are similar to those within the clitoris. Penile corporal bodies are significantly larger thus facilitating advanced urethroplasty to be performed via mucosal grafts and or genital tissue flaps [13•, 14, 17]. In the Belgrade metoidioplasty, the goal is to create a tabularized neourethra extending distally to the tip of the enlarged clitoris, similar to hypospadias reconstructions using penile corporal bodies. The ideal result effectively allows patients to void standing.

First the clitoral ligaments are transected increasing length similar to simple metoidioplasty. Neourethral reconstruction within a Belgrade metoidioplasty is divided into bulbar and neophallic components. First the proximal native urethral plate is divided while the space distally, which is to become the neophallus, is incised between the corpora cavernosa. The length of the urethral plate defect is filled with buccal mucosal graft. Ultimately the entire length of the buccal mucosal graft ventral plate is sutured together with the cutaneous labial or skin flap over a 12–14 French catheter completing the neourethroplasty [13•, 18, 19]. Literature has described an average neourethra and phallic length following metoidioplasty between 9.1–14.2 cm and 4–10 cm, respectively [14].

Surgical principles in construction of the neourethra are to maximize mobilization and minimize tension as well as to conceal suture lines and anastomosis with well-vascularized layers to reduce fistula formation.

Simultaneous to these surgical steps is the closure and elimination of the vaginal mucosa via colpocleisis. Following colpocleisis, a more masculine perineal silhouette is achieved. Penile reconstruction is often completed through local tissue rearrangement of labial and clitoral skin. Lastly, scrotoplasty is performed by fusion of bilateral labia majora often coupled with simultaneous testicular implantation [14, 19]. An important post-operative step to patients undergoing Belgrade metoidioplasty is that they should be familiar with and should be able to utilize a vacuum erection device to prevent retraction of the newly constructed external genitalia [13•, 19].

Complications following Belgrade metoidioplasty can vary from issues managed conservatively (i.e., tissue infection, urinary tract infection, Grade 1 or 2 Clavien Dindo complications) to more substantial issues, namely urethral stenosis and or fistulation in 2–3% and 7–15%, respectively [13•, 19–21].

Phalloplasty

The paradigm of phalloplasty is to reconstruct an aesthetically appealing, anatomically functional, and sensate phallus capable of upright voiding and penetrative intercourse. This procedure constructs a neophallus, often including a neourethra, from an autologous tissue flap harvested from the patient. While the desired outcome is identical, multiple donor sites for tissue flaps exist within GAS. One example is pedicle flaps which allow for local tissue transfer preserving native vasculature and reducing complexity and necessity for microvascular anastomosis [14]. These flaps most commonly originate from the anterolateral thigh, suprapubic abdominal wall, groin, and gracilis muscle. Free flaps, in contrast, originate from an autologous donor site, most commonly the forearm (based on the radial arterial supply), latissimus dorsi or osteocutaneous fibular flaps [14].

Phalloplasty is a procedure that requires the expertise and skill set of both plastic and urologic surgeons, often requiring multiple staged portions before a complete external transformation is achieved. Donor sites including anterolateral thigh (ALT) and musculocutaneous latissimus dorsi (MLD) flaps can be covered with skin grafts at the time of harvest whereas the forearm grafting can be delayed if so desired [22]. Single-staged procedures can be performed; however, it requires simultaneous reconstructive and microvascular surgeons available.

When staged, phalloplasty often consists of between three to four separate procedures depending on institutional and surgeon experience and preference. Stage 1 often consists of harvesting a donor flap for tubularization into the neophallus and neourethra as well as neurovascular anastomosis to the orthotopic recipient site. Immediate skin grafting may be included if ALT/MLD flaps are utilized, otherwise is performed 3–5 weeks later following RFFF. Stage 2, roughly 4–6 months following stage 1, typically includes completion of vaginectomy, neourethra maturation (if voiding while standing is desired), scrotoplasty, and perineoplasty. If the patient has not previously undergone hysterectomy and bilateral salpingo-oophorectomy, this can be done in conjunction with Stage 2. Lastly, stage 3 is often performed 1 years following stage 1 or 4–6 months after Stage 2 and involves testicular and penile prosthetic implantation for aesthetic and functional rigidity should the patient desire penetrative intercourse. If the patient does not desire voluntary voiding while standing or penetrative intercourse, this stage would not be necessary. The goal outcome is to construct external genitalia that is not only aesthetically analogous to cis gender male genitalia but be in accordance with the gender affirming goals of the patient.

Phalloplasty Donor Sites

Many factors influence the use or avoidance of donor sites for flap phalloplasty. These factors are often patient specific and include their overall health, comorbidities, build, and underlying vasculature. The three most predominant flaps include the RFFF, ALT, and MLD [14].

RFFF are procured following the aforementioned Allen's test, in which adequate collateral blood supply to the forearm is confirmed allowing a flap to be created along the radial artery distribution. The non-dominant hand is often preferred. Within our practice, we aim for an average neophallus length between 14–17 cm. This requires procurement of a radial flap that is a minimum 13 cm wide proximally, 8–9 cm wide distally and roughly 15–16 cm in length. A cartoon illustration of an ideal template flap is illustrated in Fig. 2A and again intraoperatively in Fig. 2B. The skin, subcutaneous tissues, nerves, veins, and arterial supply between the wrist and proximal forearm are harvested en bloc (Fig. 2C and D) [23, 24•]. The medial and lateral antebrachial cutaneous nerves are preserved and coapted to the ilioinguinal and dorsal clitoral nerves microscopically allowing for native erogenous and tactile stimulation [13•].

Neourethra within the Phalloplasty

Patients wishing to experience phallic urination can have a neourethra incorporated within a RFFF. Incorporation of a urethral plate within a flap typically requires a 2–4 cm extension on the ulnar side of the flap (Fig. 2A, B and C) [23, 24•]. These edges are then "rolled" in opposite directions of each other so that the future urethral plate (medial border) is sutured over a foley catheter, epidermal surface

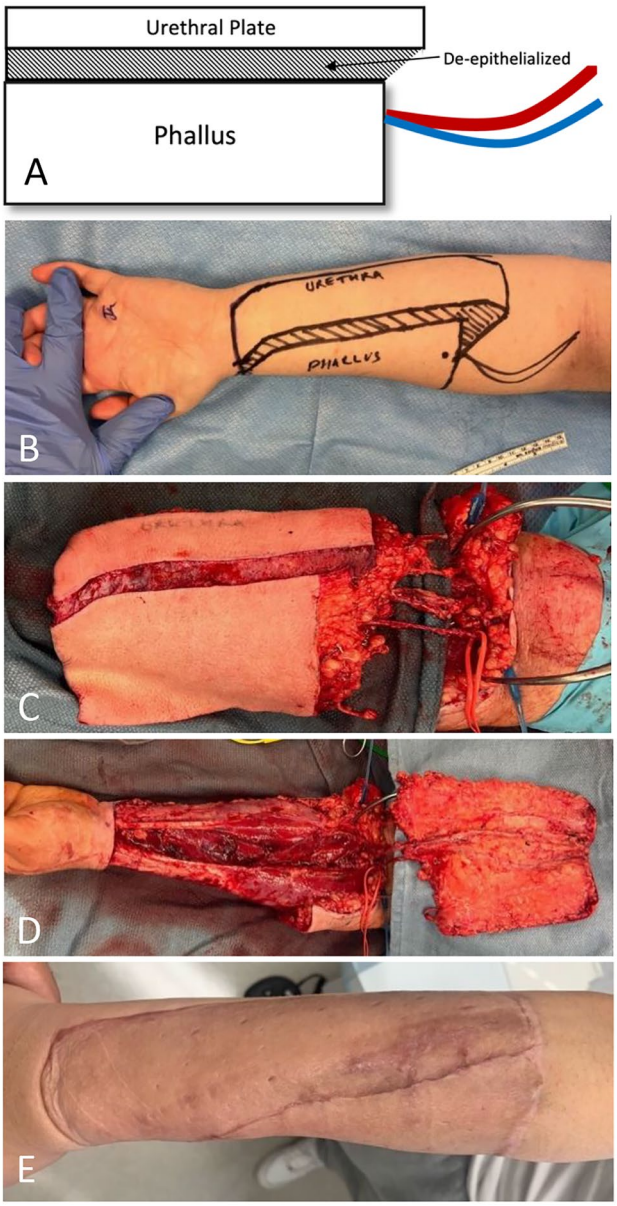

Fig. 2 Radial forearm free flap (tube-within-a-tube) template, procurement, and resultant healing/scar. **A** Illustration of flap template including vascular pedicle and inclusion of future urethral and phallic skin. **B** Template applied to left upper extremity. **C** Forearm flap illustrating procured template for both urethral and phallic "tube-within-a-tube" preparation in addition to vascular pedicles. **D** Forearm flap with vascular pedicle preserved and associated forearm defect prior to closure and grafting. **E** Forearm defect and healing following skin grafting

becoming the neourethra [13•, 24•]. Next the lateral border is rolled in the opposite direction (skin externally) to surround and cover the urethral tube forming the neophallic shaft (Fig. 3A) [23, 24•]. A strip of skin 1 cm wide is de-epithelialized between the 2 tubes to achieve closure (Fig. 2A, B and C). This is known as a tube within a tube (TWT) phalloplasty.

Urethral alignment, Glansplasty, and Scrotoplasty

Following successful stage 1 (Fig. 3B), neophallic reconstruction continues with construction of a pars fixa (if phallic voiding is desired) as well as further external genitalia reconstruction including glans, scrotal, and perineoplasty. The pars fixa is the portion of the urethra that connects the native urethra and base of the neophallic, or "pars pendulans" urethra. With regards to phallic cosmesis, the most common technique for an aesthetic and defined coronal sulcus and glans is the Norfolk procedure. This creates a coronal ridge through the inversion of a circumferential skin flap with interrupted monofilament sutures in the location of the distal neophallus (Fig. 3D and E) [25].

Construction of a scrotum most commonly involves creating an inverted V incision to both labia majora forming anteriorly based paired flaps [26]. These are then rotated anteriorly either 90 degrees (London style scrotoplasty) or 180 degrees (Ghent style scrotoplasty) and approximated together. Vaginectomy is generally performed but can be omitted based on the patient's wishes. It is important to counsel patients that vagina sparing phalloplasty is associated with higher rates of urethral complications [26, 27]. Literature suggests that complete robotic vaginectomy with gracilis interposition may yield a lower rate of urethral complication with an additional source of vascular bed for subsequent urethroplasty and graft utilization if needed [28]. Testicular implants may be placed as soon as stage 2; however, is often delayed so that adequate healing and neural sensation can be restored which ultimately aid in prosthetic longevity [8].

Rigidity within a Neophallus

Rigidity can be incorporated into the neophallus in the third staged portion of phalloplasty 8–12 months following stage 1. Most commonly, this is achieved through insertion of a prosthetic implant (inflatable or malleable) but can also be accomplished through incorporation of autologous bone, most commonly a portion of the radial or fibular bone as part of an osteocutaneous free flap [29, 30, 31].

Complications rates such as infection, migration, and mechanical failure are unfortunately higher than those among the cis-male population and subsequently lead to a higher proportion of revision surgery as well. Reported infection, mispositioned, and migration rates range between 8.5–17.8%, 4.4–19.4%, and 5–22%, respectively [32]. While this can be multifactorial, the most likely culprit centers on the fact that neither inflatable or malleable implants are initially designed for or durable within flap phalloplasty [11, 14, 25]. This is due to an absence of corporal bodies and

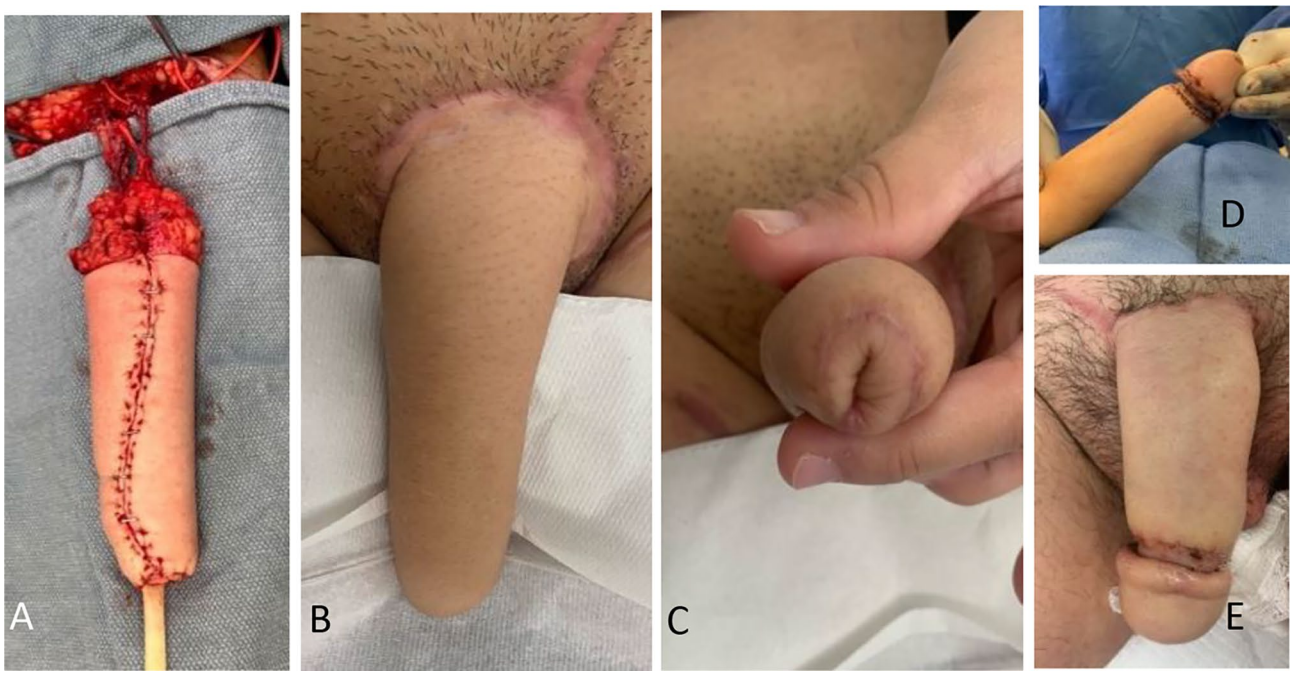

Fig. 3 Intraoperative and postoperative appearance of the tubularized radial forearm free flap with subsequent glansplasty. **A** Intraoperative appearance of the "tube-within-a-tube" forearm free creating the urethra and neophallus. **B** One-month postoperative appearance. **C** Postoperative appearance of the glans, meatus and distal urethra. **D** Intraoperative and **E** postoperative appearance of the Norfolk glansplasty procedure

tunica tissue within a flap phalloplasty that in cis male's would aids in anchoring. The result is an increased risk for implant migration, erosion, contamination, infection, and ultimate failure [11, 14, 25].

It is recommended that a single cylinder be placed as this allows for sufficient penetrative intercourse with minimal risk to prosthetic migration and erosion. Two cylinders can be placed increasing neophallic girth; however, it does increase the risk of erosion and migration. Placement should proceed once all previous perineal surgical sites have healed and neuroerogenous sensation has been restored; roughly one year from stage 1. In our practice, we routinely perform a cystoscopy to rule out any urethral pathology prior to placement of prosthetics. Implants are placed within a space created through dilatation using Hagar dilators with careful attention to not cause phallic or urethral perforation. The implant should be fixed to either the pubic rami or symphysis. Rigidity through osteocutaneous flaps, most commonly a radial osteocutaneous flap, has been published with success as a single stage alternative to RFFF with prosthetic implantation [33, 34, 35]. Published outcomes have reported excellent erogenous sensation, acceptable aesthetic appearance, girth, and length with similar morbidity to the associated donor site.

Anterolateral Thigh Flap (ALT)

ALT flaps are the second most performed and consist of a pedicled, or free, flap of skin, subcutaneous tissue, nerves, arteries, and veins from the anterolateral thigh [36]. Pedicled transposition is often preferred to minimize flap morbidity. This flap is ideal for patients wishing to prefer concealment of donor sites from the upper extremity. Once a desirable flap is isolated (approximately 13×13 cm square), dissection of the flap including the lateral cutaneous femoral nerve is performed. The resulting flap is preferably tunneled beneath the rectus and adductor musculature to its desired location in the groin [36, 37]. Advantages from ALT flap phalloplasty include the preservation of vasculature thus decreasing flap failure. Additionally, the proximity of the ALT flap to the recipient site leaves a concealed scar as well as tissue which more closely resembles the pigmentation to native perineal tissue; ultimately a more satisfactory appearance can be achieved [38].

Ultimately, not all patients are candidates for ALT flap transposition. Either through patient preference or physical features, BMI, ALT flaps have been noted to harbor higher instances of urethrocutaneous fistula formation.

Complications

Many additional complications can present however to shed light on the most prevailing for this review we have decided to focus on urethrocutaneous fistula and stenosis.

Overall, satisfaction following surgical transition within the transmasculine patient remains high. Creation of external genitalia with organic form, function and appearance has its challenges yet continues to evolve despite the inherent complexity. Overall satisfaction following metoidioplasty has been reported near 93% with successful sensation, ability to void standing and have erections reported near 100%, 94.1%, and 100%, respectively [21, 37, 39, 40]. Satisfaction is significant and has been described in respectable results in terms of sensitivity (98.4% RFFF and 97.5% ALT) as well as ability to void (75% RFFF and 66.7 ALT) while standing [20, 41, 42, 43]. Overall satisfaction following RFFF, and ALT remains high nearing 78.1% and 57.1%, respectively, despite the higher complications associated with phalloplasty.

The most encountered phallic complications include urethrocutaneous fistula (~27%), urethral stenosis (~20%), flap necrosis (~5.4%), donor site defect (~1.4%), or issues with wound healing (~7.4%) [33]. Despite this, within our practice, complication rates appear equivocal further into follow-up regardless of flap type (RFFF vs ALT) at ~30% [44].

Donor site morbidity is often one of the primary complaints following phalloplasty. Poor donor site healing due to patient comorbidity or iatrogenic healing issues can lead to unaesthetically pleasing outcomes requiring additional procedures or grafting [33]. Reported issues with grafted tissue involve atrophy of the transplanted tissue after revascularization in addition to altered coloration of transferred tissue to native perineal tissue.

The most devastating of complications involves the failure of a tissue flap to coapt and be viable following anastomosis or translocation. Pedicle flaps are less likely to fail as their vasculature is not compromised; however, all flaps with concern for failure present an urgent surgical emergency [6].

Not all complications require surgical intervention, and many minor complications can be managed conservatively. The most likely complications that may require intervention include neourethral fistula and or urethral stenosis.

When urethral stenosis is suspected, it is most likely to present as a patient reported reduction in urine flow, force, urinary retention, urgency, or frequency. Strictures most often occur near the anastomosis of the pars fixa and pars pendulans (41%) followed by within the phallic urethra (24%), and meatus (15%) [45]. Stenosis is likely due to vascular compromise near the anastomosis prior to revascularization and vitalization of the tubularized flap [46]. Early diagnosis via endoscopic (cystoscopy) or radiographic (RUG) evaluation is imperative for expedited repair [47]. Urethral stricture repair is technically challenging within a neophallus due to anatomic and surgical limitations of the flap versus a native penile structure. Many patients require interventions; however, these can have negative outcomes on aesthetic and overall satisfaction if unsuccessful. Understanding the complications associated with urethral formation within a neophallus can help aid in setting the appropriate expectations during preoperative counseling [48].

The next most often encountered complication involves urethrocutaneous fistula. This most often occurs between the urethra and the perineum, near the site of native and neophallic urethral anastomosis. Patients often present several weeks to months postoperatively with complaints of urine leakage, irritative symptoms, and even obstructive voiding symptoms. Like urethral stenosis, expeditious identification of a fistula can lead to simpler, non-operative repairs. Small fistula can sometimes resolve spontaneously whereas larger fistula may require staging and surgical intervention for resolution [47].

Standard surgical principles regarding fistula repair are utilized in these cases and consist of minimizing tension on the anastomotic repair as well as layering the closure with well vascularized tissue.

Conclusion

Gender affirmation surgery for transmasculine patients is complex yet rewarding intervention. With the increasing acceptance and pursuit of GAS to resolve gender dysphoria, encounters with and familiarity with the surgical transition are increasingly likely and necessary to care for these patients. While unable to be comprehensive within the realm of transmasculine GAS, our hope is that this review brings to light the opportunities and available potential to both patients and providers. Much more procedural techniques, complications and opportunities exist both in practice and in the literature. We ultimately hope to provide a foundation of understanding and familiarity so that timely and appropriate care for transmasculine patients can be achieved.

Declarations

Conflict of Interest The authors have no relevant financial or non-financial interests to disclose. The authors have no competing interests to declare that are relevant to the content of this article. All authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript. The authors have no financial or proprietary interests in any material discussed in this article.

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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