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Phalloplasty in Transgender Men with and without Urethral Lengthening

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Abstract

Our goal in trans man phalloplasty is to decrease the patient's level of gender incongruence, obviate the use of an external prosthesis, be able to orgasm, and give the patient the ability to urinate standing (if desired), while also attempting to decrease urinary complications. The decision to undergo urethral lengthening is considered early in this surgical process. However, urethral complications are among the most common problems we see in phalloplasty, and surgical techniques have evolved to decrease these complications. We have developed an advanced two-stage mucosa-only prelaminate neourethra phalloplasty technique to address these issues. Our surgical technique is detailed in addition to providing patient demographics, co-morbidities, flap complications, and urinary sequelae. We also discuss the perineal urethroplasty in patients opting for no urethral lengthening in phalloplasty. All options should be given and risks considered in trans men undergoing soft tissue phalloplasty, and these will be discussed in detail.

Keywords: phalloplasty, sex reassignment surgery, transition, transgender, urethroplasty

1. Introduction

The radial forearm flap is the most commonly used technique for phalloplasty. The goals of penile construction in a transgender man are to decrease the patient's gender incongruence, obviate the use of an external prosthesis, give the patient the ability to orgasm, and to urinate through the constructed phallus if desired. Urethral strictures and fistulas are common complications following a phalloplasty with urethral lengthening that may be mitigated with a two-stage technique that utilizes a mucosa-only prelaminate neourethra. Sources of the mucosa may include vaginal and oral mucosa and less commonly, uterine, bladder, and colonic mucosa.

Transition of the trans man genitalia is commonly performed in multiple stages including a hysterectomy and oophorectomy primarily and if desired, followed by a vaginectomy with urethral diversion to the perineum or lengthening with a phalloplasty, scrotoplasty, and glansplasty. The ovaries may be preserved at the time of hysterectomy

for possible egg preservation. If the decision is made to preserve the ovaries, it is crucial for the patient to be monitored for abnormalities through yearly routine surveillance.

First stage surgery may consist of a hysterectomy and oophorectomy (if not done prior) along with a vaginectomy with urethra lengthening using an anteriorly based vaginal flap with labia minora tissues along with prelamination of the nondominant radial forearm flap using vaginal mucosa, buccal mucosa, and less common skin grafts.

Second stage surgery, which commonly occurs 2–3 months following the first stage, consists of tubularization of the radial forearm tissue with free flap transfer, microvascular anastomosis, neurotization, urethroplasty, scrotoplasty, and glansplasty.

2. Justification for the radial forearm free flap

Given the large cutaneous surface of a native male phallus, autologous construction of a neophallus commonly will necessitate a large cutaneous donor site. Flaps, such as the tube-in-tube radial forearm flap, latissimus dorsi flap, scapular flap, deltoid flap, abdominal pedicled flap, and anterolateral thigh (ALT) flaps have all been used for phalloplasty [1]. Though many techniques have been described, the radial forearm free flap (RFFF) remains the most common for phalloplasty due to its long, reliable vascular pedicle, multiple nerve innervations for anastomosis to the recipient site, and pliability of the tissue facilitating eventual implant placement [2]. In addition, the radial forearm flap has a lower urethral and flap loss complication rate compared to the anterolateral thigh flap [3]. Harvest allows for simultaneous operative sites at the pelvis, upper extremity, and oral region if buccal mucosa is needed. This ability allows for decreased operative time, which can last from 5–12 hours. The RFFF technique makes it possible for patients to fulfill their desires of standing micturition, aesthetic acceptability, and erogenous and tactile sensation.

Erectile rigidity is another commonly reported goal of phalloplasty. To achieve an erection, radial bone can be utilized as an osteocutaneous flap at the time of neophallus creation, or a patient can opt to undergo insertion of a semirigid or hydraulic prosthesis at least 1 year after phalloplasty. It should be noted, however, that our practice prefers to no longer perform the osteocutaneous RFFF due to dyspareunia experienced by the patient post-surgery. This is due to the anchoring of the radius bone at the pubic symphysis. Additionally, most centers report a 30%+ extrusion rate necessitating implant removal at 2–3 years, and reoperation rates reach 100% at 5 years (**Figure 1**) [4]. There is a significant risk of complications following placement of penile prosthesis including mechanical failure, infection, and mal-positioning. It is critical to have a plastic surgeon trained in microvascular surgery present during the placement of the penile implant as the vascular pedicle may be readily injured during the dissection and subsequent dilation process required for placement of the cylinders. It is critical to avoid multiple passing of the dilators so that devascularization of the phallus does not ensue.

Adding to the complexity of phalloplasty is the creation of a functional penile urethra. The urethra after neophallus construction can be divided into distinct segments, from proximal to distal: native (female) urethra, fixed or lengthened urethra, the anastomotic urethra, penile shaft urethra, and external meatus. The fixed urethra is the portion of the urethra formed after lengthening the native urethra via local vaginal or labial flaps, extragenital flaps, and grafts of skin or mucosa (**Figure 2**). The phallic urethra can be constructed by prelamination, tube-in-tube techniques, or pedicle flaps [2].

Figure 1.
Radius bone exposure following radial forearm osteocutaneous flap phalloplasty.

Figure 2.
Patient 3 months following urethral lengthening using labia minora and anterior vaginal wall flaps.

2.1 Inflow for phalloplasty: preoperative assessment

The preoperative assessment begins with a physical examination. The patient is assessed for adequate perfusion to the lower extremities. Ideally, the patient should have a palpable pedal pulse bilaterally. If perfusion is in question especially when dealing with patients with peripheral arterial disease, one can obtain noninvasive studies such as arterial duplex or plethysmography to determine which side to use. Preoperative vein mapping can be performed to assess for deep venous thrombosis as well as the caliber and quality of the great saphenous vein. Ideally, the great saphenous vein should be 2.5–3 mm and free of sclerosis.

2.2 Branch of profunda femoris artery

A branch of the profunda femoris artery is an option for inflow. The perfusion to the thigh is robust thus a branch of the profunda femoris artery can typically be sacrificed without significantly affecting thigh perfusion. To expose the profunda femoris artery, a longitudinal skin incision is made in the thigh overlying the femoral arteries. The femoral bifurcation is identified and the superficial femoral artery is preserved. The main trunk of the profunda femoris artery is identified and preserved. There are tributary branches of the profunda femoris vein that are ligated to facilitate exposure and hemostasis. The branches of the profunda femoris artery are identified and circumferentially dissected. Typically, the ascending branch is of adequate caliber and length to be used for the inflow. If this branch is not long enough or the caliber is too small, the remaining branches of the profunda can be explored.

2.3 Great saphenous vein to femoral artery transposition in a loop configuration (loop graft)

An alternative source of inflow can be the superficial femoral artery or the common femoral artery. The great saphenous vein can be used as a conduit. An oblique incision is made in the medial groin overlying the femoral artery bifurcation as well as the saphenofemoral junction. The saphenous vein is identified first and preserved. The superficial femoral artery is then exposed that lies medial to the femoral vein. The artery is sequentially dissected and controlled, and the skin incision is extended distally along the course of the saphenous vein. The length of the vein needed to perform the loop transposition varies by patient. The length required can be estimated with a free tie. Ideally, the loop graft needs to be able to reach the pubis when is oriented medially. Once the saphenous vein is exposed, it is circumferentially dissected and its tributary branches are ligated and divided. Careful attention needs to be made when ligating the branches too close to the vein as it may cause stenosis. The saphenous vein is then transected distally, and the distal end is ligated. The vein is then cannulated and distended with heparinized saline solution. Any defects are identified and repaired. When the vein is distended, it is marked for orientation. To perform the loop configuration, the distal end of the vein is swung in a counterclockwise fashion toward the femoral artery. The patient is systemically heparinized. The femoral artery was clamped proximally and distally and an arteriotomy is made using 11 blades and then lengthened with Potts scissors. Alternatively, an aortic punch device can be used to enlarge the arteriotomy to the desired size. The anastomosis should be approximately 4 mm. An end-to-side anastomosis was performed between the femoral artery and the saphenous vein paying careful attention to maintaining

the orientation of the vein to avoid twisting and kinking. Just prior to completing the last few sutures of the anastomosis, the femoral artery is forward and back-bled. The lumen of the artery and vein are flushed with heparinized saline solution to flush any thrombus. Once the anastomosis is completed, the clamps are released. The loop graft is assessed for orientation and flow. The patient's leg and foot also need to be assessed to ensure there are no changes to baseline perfusion. One can expect a weak pulse and a thrill when palpating the graft. A Doppler can also be used to assess the presence of flow. If the loop graft is kinked or twisted, it may thrombose. When the loop graft is ready to be used, it is transected in the middle; the proximal end is the arterial inflow and the distal end is the venous outflow.

2.4 Complications of urinary stricture and fistula

Complications of urinary stricture and fistula are prevalent. Variations of urethral lengthening techniques among centers have resulted from attempts to improve upon urologic complication rates, which range from 33 to 77% in large case series [5]. Urethral cutaneous fistulas following surgery may range from 22 to 75% [6]. Fistulas occur most commonly at or just proximal to the anastomosis between the phallic urethra and fixed urethra due to vascular insufficiency of the flap and decreased lumen of the phallic urethra. Rates of urethral strictures in female-to-male phalloplasty recipients range from 11 to 74% [7–9]. Since the plastic surgeon alone is not trained in the management of urethral strictures or fistulas, we believe it is essential to have a qualified reconstructive urologist involved in the management of these complications to optimize patient care.

The radial forearm flap may allow the patient to have penetrative sexual intercourse, has minimal donor site scarring, results in a cosmetically acceptable phallus, has tactile and erogenous sensitivity, and potentially creates a competent neourethra that allows for standing urination. These ideal characteristics, described by Hage et al, are mostly met by the RFFF (radial forearm free flap) [10].

Recognizing that urethral strictures and fistulas remain the most challenging complication we face, we have been able to decrease their occurrence with a staged technique. We have found that the radial forearm tube-within-a-tube technique not only requires electrolysis of the forearm to avoid hair growth within the urethra—a common cause of stricture—but also requires a larger donor site since flap skin is used to create the urethra. Minimizing the donor site and decreasing stricture rates

Figure 3.
Cystoscopy of prelaminated neourethra prior to stage 2 phalloplasty revealing mucosa which mimics that of native urethral mucosa.

have encouraged us to continue the two-stage technique with mucosal prelamination, which more closely mimics native urethra mucosa (**Figure 3**).

3. Patient evaluation

Given the potential morbidity associated with the complex phalloplasty procedure, an adequate preoperative evaluation is essential. The need for gender dysphoria evaluation and medical clearance is unique to this patient population. Gender identity disorder or gender incongruence is classified by the International Classification of Disease Manual as ICD-10-CM F64.9. The DSM-5 defines gender dysphoria as an incongruity between the patient's experienced and expressed gender and their assigned gender, which causes clinically significant distress lasting at least 6 months, however, this has often lasted nearly the individual's entire life [11]. According to the World Professional Association for Transgender Health (WPATH), a psychological evaluation and two letters recommending gender affirmation surgery from two psychiatrists or licensed mental health therapists, who independently assessed the patient, are required for the removal of reproductive organs and/or phalloplasty [12]. In addition, the patient must have taken hormone replacement therapy and lived as their true gender for at least 1 year. These prerequisites are not only required by most insurance companies for authorization of the procedure but also ensure that patients have a realistic understanding of the procedure and serve to minimize disappointment and patient regret.

The importance of a thorough preoperative psychosocial evaluation cannot be overstated. Adequate social support is encouraged to facilitate a successful recovery. The patient should be informed to expect frequent postoperative visits 1–2 months following surgery and should understand that the operation will impact their ability to work for 4–6 weeks. The surgeon should remain involved in all stages of the preoperative evaluation by corresponding with the patient's mental health provider and urogynecologist.

A clear and candid discussion regarding the patient's desired goals from surgery, including the length and circumference of the neophallus, allows the surgeon to determine whether expectations are realistic given the patient's anatomy. The limitations, functional outcomes, recovery, risk of complications, timing of procedures, and cost of each surgery should be honestly discussed with the patient.

It is critical to accurately document current medications, including antiplatelet agents and hormones, in addition to the patient's smoking history. Androgens such as testosterone must be discontinued 2 weeks prior to surgery to reduce the risk of thrombosis, and smoking cessation is required 4 weeks prior to surgery and up to 4 weeks after to ensure proper healing. Specific information regarding prior infections helps in selecting postoperative antibiotics, as postsurgical infection will delay healing and increase morbidity.

The microsurgical component of RFFF phalloplasty requires additional preoperative evaluation. Adequate recipient vessels will be needed for the microsurgical construction. If arterial inflow from the thigh will be used then pedal vessels should be assessed for adequate inflow. The abdominal wall should be examined for prior incisions particularly if the inferior epigastric vessels will be used as recipient's vessels. We have used the inferior epigastric artery, descending branch of the lateral femoral circumflex or on occasion arterio-venous loops for recipient arteries and the inferior epigastric vein or saphenous veins for recipient venous outflow.

Allen's test of the patient's nondominant hand confirms that harvest of the RFFF flap will not compromise the blood supply to the hand. If the results of Allen's test are poor, that is, the hand remains cool and pale after the release of ulnar artery occlusion, using another donor site should be considered or the dominant forearm. In addition, sensitive tattoos of the proposed forearm should be evaluated. Patients who live in cold climates may need reconstitution of their arterial anatomy with vein grafts after flap harvest.

Figure 4.
Clitoral nerves are exposed as recipient's nerves at stage 2 RFFF phalloplasty.

Prior to surgery, it is also vital to assess patient sensation to determine if orgasm can be achieved through clitoral stimulation. The dorsal clitoral nerve (**Figure 4**), ilioinguinal nerve, and genitofemoral nerve co-apted to the medial and lateral antebrachial cutaneous nerves will provide both erogenous and protective sensation to the neophallus. If a patient has difficulty achieving orgasm prior to surgery, it is unlikely that the patient will be able to after surgery.

It should also be noted that part of the patient population has forearm tattoos that will affect the cosmesis of the neophallus. Patient preference will dictate whether the presence of forearm tattoos on the neophallus is acceptable. Clear expectations should be set with the patient regarding the forearm donor site scar, which may be perceived as a stigma, however, we argue the scar is more acceptable than the anterolateral thigh flap scar (**Figure 5**).

3.1 Preoperative preparation

In our practice, we construct the penile urethra by forearm prelamination with mucosa, which obviates the need for forearm depilation (as would be the case in a tube-within-a-tube technique). The native urethra is a fibromuscular tube lined by urothelium, columnar epithelium, and nonkeratinizing squamous epithelium. Mucosal grafts have greater homology to the native urethra as they are also composed of nonkeratinized epithelium, which has led to less scar contracture and subsequent urethral strictures and fistulas following neourethral construction [1].

Figure 5.
Patient with urethral and flap-related complications following ALT phalloplasty from an outlying institution.

Prior to phalloplasty, a patient should have had a hysterectomy and oophorectomy. If he has not yet had these procedures, it is possible to have them performed during the first stage of our approach to staged phalloplasty. We have found that uterine mucosa is readily available if the patient is undergoing hysterectomy in the same operative setting as phalloplasty, and can be used to construct a patent, functional penile urethra [1]. If a patient is interested in egg harvesting prior to oophorectomy, this is performed before definitive and irreversible hysterectomy and oophorectomy.

The current sequence of surgery in our practice is first a subcutaneous mastectomy, followed by a hysterectomy and oophorectomy combined with a vaginectomy, scrotoplasty, and reconstruction of the horizontal part of the urethra, and later the actual phalloplasty.

3.2 Surgical technique

We have found our two-stage technique allows for a urethral conduit which mimics that of a native urethra with no hair growth while minimizing the donor site on the forearm. Our decreased stricture rate has encouraged us to continue the use of this technique in patients pursuing phalloplasty with urethral lengthening.

3.3 Stage 1: prelamination technique

The main procedures are as follows:

1. Vaginectomy with the harvest of vaginal mucosa tissue (combined with hysterectomy and oophorectomy if not already performed)—Procedure performed concurrently by urogynecologist or gynecologic oncologist
2. Urethral lengthening utilizing labia minora flaps and anteriorly based vaginal mucosa flap harvested at the time of vaginectomy
3. Occasional harvest of buccal mucosa if required for neo-urethra
4. Radial forearm flap elevation ulnarly for flap urethra prelamination

IV antibiotics against gram-positive, gram-negative organisms and anaerobes are administered to the patient 1 hour prior to incision.

The first stage entails flap prelamination during which the radial forearm flap is designed and the neourethra is formed using autologous tissue; mucosa is preferentially used in our practice. The markings for the planned flap are determined preoperatively following a normal Allen's test on the patient's nondominant upper extremity, ensuring that the patient's hand can be perfused with the ulnar artery alone. The flap is elevated from the ulnar to radial direction in the supra-fascial plane to allow placement of the neourethra.

Prelamination of the patient's eventual penile urethra is performed by grafting vaginal, and/or buccal mucosa in a suprafascial plane of the donor volar and ulnar forearm. The vaginal mucosa is harvested during the vaginectomy for the creation of the neourethra. We lengthen the native female urethra using labia minora tissues and an anterior pedicled vaginal flap. If a hysterectomy has not already been performed, it can be performed during this stage to provide additional mucosal tissue for the neourethra. The buccal mucosa is also harvested at this time if necessary (**Figures 6 and 7**). To allow

Figure 6.
Markings of buccal mucosal graft. Avoid injury to Stenson's duct.

for irrigation of the entire prelaminated neourethra, holes are cut into a 24-French Foley. After mucosal harvest, the mucosal grafts are cleansed with a betadine and normal saline solution and then sewed around the holed catheter construct, exteriorizing the sub-mucosal surface using a running, locking suture. Placing this construct lengthwise in the subcutaneous forearm (suprafascial plane) allows for the creation of a tubular graft, which will become the penile neourethra of the eventual phalloplasty. The patient is then immobilized in a splint for several days. Irrigation of the prelaminated flap is then performed twice daily beginning 1 week after surgery, a practice continued until flap transfer to prevent infection.

Creating the urethra with mucosal tissue and not using forearm tissue decreases the width of the flap skin paddle compared to the traditional tube-within-a-tube urethra and yields a more aesthetically acceptable donor site scar. With this method, the patient can place his upper extremity across his chest with the flexor aspect against the chest and the scar will not be visible (**Figure 8**). Furthermore, with this technique, the patient does not need to undergo costly depilation treatments as there will be no hair growth within the urethra. Prelamination can also be completed with a skin graft from the thigh or abdomen when mucosal tissue is inadequate in patients who have undergone metoidioplasty with vaginectomy, however, this may lead to increased stricture rates.

3.4 Stage 2: radial forearm free flap transfer

Approximately 8–12 weeks after the first stage flap prelamination, creation of the neophallus can be performed. Although allowing more time between stages may be

Figure 7.
Vaginal and buccal mucosa with mucosal surface toward the foley catheter in preparation for tubularization around the catheter.

favorable, we have found that 8 weeks is long enough to achieve successful wound healing and favorable results and is a time frame that is tolerable for our patients [1].

One hour before incision is made, antibiotics against gram-positive, gram-negative, and anaerobic organisms should be intravenously administered to the patient. A tourniquet is used for flap harvest, in addition to a hand table. Separate surgical set-ups are used for the pelvic area and upper extremity to avoid cross-contamination. Two surgical teams can work simultaneously—one team performs the RFFF harvest and the second team performs the dissection of the recipient's vessels (inferior epigastric artery and vein and/or descending branch of the lateral circumflex artery and saphenous vein), recipient nerves, preparation of the urethra for anastomosis and scrotoplasty.

The design of the radial forearm flap was defined in the first stage. A marking pen is used to delineate the dimensions of the flap, which will commonly measure 5.5–7.5 inches in length and 5.5–6.5 inches in width. Whereas the flap was elevated in the suprafascial plane for prelamination at Stage I, the flap is now elevated in the subfascial plane to avoid injury to the neourethra. The dissection begins on the ulnar side of

Figure 8.
Patient following staged radial forearm flap harvest revealing limited donor site secondary due to prelamination of the urethra.

the forearm and proceeds to the flexor carpi radialis and brachioradialis tendons for the RFFF harvest. The medial and lateral antebrachial cutaneous nerves are preserved during dissection of the radial forearm flap for coaptation to one dorsal nerve of the clitoris end-to-side for erogenous sensation and the ilioinguinal or genitofemoral nerve for tactile sensation. The radial artery and venae comitantes are ligated distally and proximally dissected for vascular anastomosis. Prior to distal ligation, the artery may be temporarily clamped to ensure blood flow to the hand. The basilic and/or cephalic veins are preserved and dissected with the flap. While the RFFF remains connected to its inherent blood supply, the flap is tubed into a phallus and sutured so that the neourethra is buried within the tubed phallus (**Figure 9**).

Using a modification of Monstrey's scrotoplasty technique, the clitoris is dissected free from the lengthened urethra and denuded of skin [13]. The clitoral hood skin is removed and used for the coronaplasty using a technique described by Gottlieb [14] (**Figure 10**). The recipient arteries harvested for the vascular anastomoses are either the inferior epigastric artery or the descending branch of the lateral femoral circumflex

Figure 9.
Tubed radial forearm flap at the donor site with the prelaminated urethra.

Figure 10.
Trans male patient during the harvest of clitoral (or T-dick) hood skin for coronaplasty using Gottlieb technique.

Figure 11.
Descending branch of the lateral femoral circumflex artery as recipient artery and saphenous vein as recipient artery in preparation for free flap phalloplasty.

artery. Of note, once we switched to using the descending branch of the lateral femoral circumflex artery as our recipient artery, we no longer had re-open procedures due to vascular compromise [2]. The thigh incision made for the lateral femoral circumflex is also used for the harvest of the great saphenous vein (**Figure 11**). Since we use the greater saphenous veins as recipient veins for the radial forearm flap, the proximal incision made to harvest the greater saphenous vein is also used for the gracilis muscle harvest. The distal free end of the muscle, harvested via a separate distal incision, is delivered through the proximal incision. Undermining of the soft tissues is performed from the proximal thigh incision to the level of the midline groin defect where the urethral anastomosis is to be performed.

After vessel preparation with a microscope and confirming adequate outflow from the descending branch of the lateral femoral circumflex artery and inflow from the great saphenous vein, the RFFF is transferred to the pubic area. The forearm donor site can be covered with either an autologous split-thickness skin graft or the surgeon can apply a dermal substitute that can be grafted later. The first maneuver is to place the foley catheter, which is located in the neourethra, directly into the patient's bladder. Absorbable sutures are used for the urethral anastomosis in two layers, which is the first anastomosis performed (**Figure 12**).

The arterial, venous, and neural anastomoses are performed next in that order and are all hand-sewn using 9-0 nylon suture with the aid of an operative microscope. The radial artery is connected end-to-end to the descending branch of the lateral circumflex artery. The venous anastomosis is performed between the cephalic or basilic vein and the greater saphenous vein. A second venous anastomosis can be performed between a radial venous comitante vein with the contralateral greater saphenous vein. Two to three nerve anastomoses may also be performed. The medial and lateral antebrachial cutaneous nerves are anastomosed end-to-end to the ilioinguinal nerves

Figure 12.
First of two-layered urethral anastomosis in staged radial forearm flap phalloplasty.

and to one of the dorsal clitoral nerves end-to-side. The ilioinguinal nerve is commonly found exiting the external inguinal ring. A cadaver nerve graft may be used as an interposition nerve graft when needed.

The gracilis muscle may be harvested in a minimally invasive fashion and wrapped around the urethral anastomosis, avoiding compression of the vascular pedicle, to provide vascularity to a minimally vascular urethral anastomosis (**Figure 13**). This maneuver also provides bulk to the neo-scrotum often obviating the need for scrotal implants. At our institution, we have been able to minimize urethral fistula rates using a gracilis muscle flap to augment the urethral anastomosis [15].

A suprapubic tube is placed and used for urinary diversion if needed during urinary training of the neo-phallus.

Upon closure of all incisions, a Norfolk coronoplasty is performed with either a skin graft or labial graft obtained from the clitoral hood region by denuding the clitoris before transposition (**Figure 10**) [16].

Following surgery, patients are transferred to the intensive care unit for flap monitoring and will remain on strict bed rest for a minimum of 3 days. An implantable Doppler device has been very helpful in flap monitoring. Prophylaxis for microvascular thrombosis is typically subcutaneous heparin and aspirin. Strict monitoring of the free tissue transfer is performed by the intensive care unit and resident staff [17]. Patients whose forearm donor site was first covered with a dermal substitute are taken back to the operating room for definitive coverage with a skin graft after 2 weeks. Several days later the patient may be discharged home with both a penile catheter and suprapubic catheter (**Figure 14**). A pericatheter retrograde cystourethrogram can be planned 12 weeks post-surgery. If there is no extravasation of dye, indicating that there is no urinary fistula, the foley catheter can be removed and the suprapubic catheter can be clamped (**Figure 15**). Patients are encouraged to urinate through their neophallus with the suprapubic catheter clamped. We then check for residual urine in the bladder using a bladder scan if necessary. If the patient is successfully able to urinate from the phallus and adequately empty the bladder for several days the suprapubic tube can be discontinued.

If the patient desires, he can tattoo the glans and shaft of the neophallus for aesthetic enhancement, which is ideally performed before full tactile sensation has been achieved

Figure 13.
Gracilis muscle harvest via minimally invasive approach prior to alpha wrap around the urethral anastomosis.

Figure 14.
Trans man following Stage II phalloplasty revealing suprapubic tube and penile foley catheter.

Figure 15.
Pericatheter retrograde cystourethrogram 8 weeks following second stage phalloplasty operation in trans man. The study reveals no contrast extravasation indicating no fistula and no stricture noted.

(typically 1-year postop). Similarly, the donor site can be tattooed to avoid the stigmata of a skin graft (**Figure 16**).

Since the RFFF phalloplasty lacks bone, it may be too soft to allow for penetrative intercourse. Implantation of an erectile prosthesis is a definitive procedure, that may be performed after 8–12 months when tactile sensation is achieved at least $\frac{3}{4}$ distally of the penile shaft. A simple Tinel sign is often used to assess postoperative tactile sensation in the neo-phallus postoperatively. Both malleable dual or single cylinder

Figure 16.
RFFF donor site with tattoo concealment.

penile prostheses or inflatable prostheses may be used for the erectile device commonly anchored to the ischial tuberosities. We strongly recommend plastic surgery involvement in placement of the prosthesis since knowledge of the location and preservation of the neo-phallus vascular supply is critical to successful placement. More technical details of the neo-phallus implant placement will be discussed in a separate chapter. Prior to implant placement, as the patient is awaiting neural sensation, patients may have successful penetrative intercourse by using an elastic 3M Coban wrap and a condom.

4. Postoperative sequelae/complications

It is important that the patient is aware of the potential complications that may occur following surgery, included in the informed consent. Some complications may include partial or total flap loss, hematoma at the donor or recipient site, an insensate flap, anorgasmia, skin graft loss, chronic pain, numbness, urinary complications, hypertrophic scarring, infection, cold intolerance, vascular compromise, abdominal wall weakness or hernia, implant infection or malfunction, dyspareunia, tendon exposure, limited hand function, and persistent gender dysphoria.

Urethral fistulas and strictures are common untoward events following phalloplasty in the transgender male and may prevent the patient from voiding while standing. A meta-analysis of 665 patients drawn from 11 studies found that an average of 0.51 strictures and/or fistulas can be expected per free forearm flap phalloplasty [17]. The published rate of urologic complications following penile reconstruction ranges from 23 to 75% [18, 19]. The subsequent management of urethral fistulas and strictures can be challenging. Initially, conservative measures such as periodic urethral dilatation or internal urethrotomy can be employed as temporizing measures prior to definitive surgical management.

Most urethral fistulas occur at the anastomosis between the fixed urethra and phallic urethra, and often can occur proximal to a concomitant stricture. The techniques for fistula repair described are the simple fistula repair, the use of local tissue transfer, two-stage procedures with use of mesh graft, bladder, or buccal mucosa [20]. When the fistula is small with substantial overlying tissue, spontaneous resolution is likely. However, when a urethrocutaneous fistula is large and superficial, the above-mentioned surgical repair is necessary.

Urethral strictures also primarily occur at the anastomotic urethra. The keystone surgical procedures for urethral stricture include urethroplasty (excision and primary anastomosis) and staged Johanson-type urethroplasty with additional skin grafts, preferentially buccal mucosa [21]. Surgical approaches are customized to the length of the stricture. A patient who has both a urethral fistula and stricture should have both problems addressed at the same time.

There are many variations of urethroplasty available owing to the considerable heterogeneity of phallic and neourethral construction techniques. Well-vascularized local flaps are utilized when available, as well as buccal mucosal grafts. A patient who has undergone several urethral fistula and/or stricture repair attempts will have progressively fewer options for reconstruction. At our institution, we have significantly decreased our fistula rates in transgender male phalloplasty by augmenting the paucity of vascularized tissue at this anastomosis using a pedicled gracilis flap at the time of flap transfer [15]. Prelamination with mucosal grafts may also decrease urethral stenosis and fistula formation [2].

5. Conclusion

The goals of phalloplasty include a sensate, cosmetically acceptable phallus with an incorporated neourethra, and the ability to place an implantable penile prosthesis to allow rigidity for penetrative intercourse. In the majority of cases, phalloplasty is the final stage of treatment for gender dysphoria.

While other donor sites may be used, the radial forearm free flap is a favorable technique due to its high vascularity, adequate sensation, sufficient tissue pliability,

and good cosmetic outcome. We have found that our two-stage technique allows for a neourethra, which mimics a native urethra with no hair growth, while minimizing the donor site on the forearm compared to the previously used skin for a tube-within-a-tube radial forearm flap technique. Using a pre-laminated urethra our patients do not need to undergo electrolysis since the urethra is not created from forearm tissue, so we do not have the risk of hair growth in the urethra and its associated complications. Our decreased stricture rate has encouraged us to continue the use of this technique in patients pursuing phalloplasty with urethral lengthening. Although there have not been any blinded, randomized controlled trials comparing single-stage to two-stage phalloplasty, we believe that prelamination using mucosa for the construction of the trans male phallus urethra is a worthwhile technique that has demonstrated a reduction in the prevalence of complications with this already very challenging procedure.

Conflict of interest

The authors declare no conflict of interest.

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