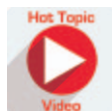


An Update on Genital Reconstruction Options for the Female-to-Male Transgender Patient: A Review of the Literature

Jordan D. Frey, M.D.
Grace Poudrier, B.A.
Michael V. Chiodo, M.D.
Alexes Hazen, M.D.

New York, N.Y.



Summary: Although many transgender individuals are able to realize their gender identity without surgical intervention, a significant and increasing portion of the trans population is seeking gender-confirming surgery (alternatively, gender reassignment surgery, sexual reassignment surgery, or gender-affirming surgery). This review presents a robust overview of genital reconstruction in the female-to-male transgender patient—an operation that, historically, was seldom performed and has remained less surgically feasible than its counterpart (male-to-female genital reconstruction). However, as the visibility and public awareness of the trans community continues to increase, the demand for plastic surgeons equipped to perform these reconstructions is rising. The “ideal” neophallus is aesthetic, maintains tactile and erogenous sensibility, permits sexual function and standing urination, and possesses minimal donor-site and operative morbidity. This article reviews current techniques for surgical construction, including metoidioplasty and phalloplasty, with both pedicled and free flaps. Emphasis is placed on the variety of techniques available for constructing a functional neophallus and neourethra. Preparative procedures (such as vaginectomy, hysterectomy, and oophorectomy) and adjunctive reconstructive procedures (including scrotoplasty and genital prosthesis insertion) are also discussed. (*Plast. Reconstr. Surg.* 139: 728, 2017.)

Gender dysphoria is characterized by a marked discrepancy between one’s natal sex and one’s gender identity, and is associated with immense bodily and emotional distress.^{1–4} Although many transgender individuals are able to realize their gender identity without surgical intervention, a significant and increasing portion of the gender-dysphoric population is seeking gender-confirming surgery.^{5,6} In such cases, the desired operations are regarded as standard-of-care interventions.⁵

Surgical procedures for the natal female subject being affirmed as a male subject (hereto referred to as female-to-male transgender surgery) can include genital reconstruction (“bottom surgery”), often paired with a combination of other hormonal and surgical interventions (e.g., facial reconstruction, urethroplasty, hysterectomy, oophorectomy).^{7,8} Male chest contouring (“top surgery”) and facial feminization are not discussed in this review.

Prevalence of the Transgender Population

The majority of research on the prevalence of gender dysphoria originated outside the United States (Tables 1 through 3).^{6,8–12} In their 2011 review, Conway and Winter estimate that the worldwide population of transgender individuals exceeds 15 million.^{6,13} Irrespective of geography, male-to-female (natal male patients being affirmed as female patients) transgender patients are approximately three to four times more prevalent than their female-to-male counterparts, with the latter population far less studied.^{14–16}

It follows that the majority of transgender patients who present for gender-confirming surgery are natal

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From the Hansjörg Wyss Department of Plastic Surgery, New York University Langone Medical Center.

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Table 1. Summary of Outcomes in Included Primary Studies Examining Metoidioplasty Reported in Terms of Characteristics of the Ideal Neophallus*

Study	Country of Primary Author	Age (yr)	Follow-Up (yr)	Hormone Therapy?	Single-Stage Procedure (%)	Aesthetic Neophallus (%)	Erogenous Sensation (%)	Tactile Sensation (%)	Standing Micriturion (%)	Neourethra			Notes
										Fistulae/Strictures per Patient	Sexual Function (%)	Donor-Site Morbidity (%)	
Perovic et al., 2003	Serbia	22	26.2	3.9	Y	77.3	NR	NR	NR	0.23	NR	0	0.23
Hage, 1996	The Netherlands	32	34	NR	Y	NR	NR	NR	31.3	0.34	NR	6.2	0.44
Djordjevic et al., 2013	Serbia	207	32	2.67	Y	100	100	NR	100	0.11	NR	0	0.39
Hage et al., 2006	The Netherlands	70	30	8	Y	NR	NR	NR	NR	0.73	NR	17.1	1.37
Vukadinovic et al., 2014	Serbia	97	29	2.5	Y	81.6	100	NR	100	0.08	79.4	0	0.26

NR, not reported; Y, yes; N, no.

*From Hage JJ, De Graaf FH. Addressing the ideal requirements by free flap phalloplasty: Some reflections on refinements of technique. *Microsurgery* 1993;14:592-598.

males, and that genital reconstruction surgery—both historically and presently—is more frequently sought and performed in the male-to-female transgender patient population.¹⁷ Largely because of this disparity, medical researchers have directed the overwhelming majority of their attention to the health disparities and needs of the male-to-female transgender population, leaving the female-to-male transgender population comparatively underrepresented in the academic literature.^{18,19}

The World Professional Association for Transgender Health recommends that female-to-male transgender genital reconstruction proceed in accordance with the following criteria: “[if] persistent gender dysphoria is documented, [if] the patient has capacity to make informed consent [and] has reached legal age (if younger follow the standard of care for children and adolescents), [if] significant medical or mental health concerns are present they must be well controlled, [if] the patient has undergone 12 continuous months of hormone therapy (unless there is a medical contraindication or the patient is unwilling), and [if] the patient has lived continuously for at least 12 months in the gender role that is congruent with their gender identity.”¹⁵

HORMONAL THERAPY IN FEMALE-TO-MALE TRANSGENDER PATIENTS

Masculinizing hormone therapy is initiated to induce virilization. The effects of ongoing testosterone therapy are multiple and, most relevant to genital reconstruction, include clitoral hypertrophy (Table 4).²⁰ The primary hormonal treatment is a testosterone preparation.²¹ The risks of masculinizing hormone therapy are important to note, and have been discussed extensively elsewhere.^{12,21}

SURGICAL TECHNIQUES FOR CREATION OF A NEOPHALLUS

According to Hage and De Graaf, the “ideal” neophallus is crafted reproducibly in a single-stage procedure, is aesthetically pleasing to the patient, has tactile and erogenous sensation, has a functional neourethra that permits standing urination, and confers minimal complications and donor-site morbidity.^{22,23} Although no singular procedure is yet capable of meeting all of these goals, a variety of operative techniques are available to construct an aesthetic and functional neophallus.

Metoidioplasty

Metoidioplasty is the creation of a neophallus from the hypertrophied clitoris.^{23,24} The procedure

Table 2. Summary of Outcomes in Included Primary Studies Examining Pedicled Flap Phalloplasty Reported in Terms of Characteristics of the Ideal Neophallus*

Study	Country of Primary Author	No.	Age (yr)	Follow-Up (yr)	Hormone Therapy?	Single-Stage Procedure (%)	Aesthetic Neophallus (%)	Erogenous Sensation (%)	Tactile Sensation (%)	Standing Micturition (%)	Neourethra/Fistulae/Strictures per Patient	Sexual Function (%)	Donor-Site Morbidity (%)	Complications per Patient	Notes
Pedicled ALT flap Lee et al., 2009	United States	2	43	0.83	N/A	100	NR	100	100	NR	1.0	50	0	1.0	Performed for acquire penile absence; tube-within-a-tube design
Rubino et al., 2009	Italy	1	31	0.5	Y	100	100	100	100	N/A	N/A	100	100	0.0	Innervated flaps, neourethra construction deferred by patient
Morrison et al., 2014	United States	1	60	2	N/A	100	100	NR	NR	100	4.0	100	0	6.0	Tube-in-tube flap, mushroom shape for coronal reconstruction, patient with acquired penile absence
Holzbach et al., 2011	Germany	1	36	0.5	NR	100	100	NR	100	NR	NR	NR	NR	0.0	
Sinove et al., 2013	Belgium	13	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	0	NR	Evaluated CT planning in pedicled ALT phalloplasty to reduce donor-site complications
Inferiorly-based abdominal flaps Schmidt et al., 2015	Austria	1	26	0.25	NR	100	100	NR	NR	100	0.0	NR	0	0.0	Performed for failed metoidioplasty
Bajpai et al., 2013	India	4	14.3	0.58	NR	0	NR	NR	NR	NR	N/A	NR	0	0.0	Bird's-wing modification, cases include patients with penile deficiency
Bettocchi et al., 2005	United Kingdom	85	34.4	NR	Y	40	68	100	100	47	1.12	18.8	0	1.51	
Zhang et al., 2010	People's Republic of China	1	NR	0.5	NR	0	NR	100	100	100	0.0	100	0	0.0	Prefabricated flap
Garcia et al., 2014	United Kingdom	10	35.1	2.23	NR	NR	NR	NR	NR	NR	NR	100	NR	NR	
Groin flaps Aköz et al., 2002	Turkey	1	21	3	Y	0	NR	NR	NR	100	1.0	100	0	1.0	Composite osteocutaneous flap based on DCIA and SCIA

NR, not reported; N/A, not applicable; Y, yes; N, no; ALT, anterolateral thigh; DCIA, deep circumflex iliac artery; SCIA, superficial circumflex iliac artery; CT, computed tomography.

*From Hage JJ, De Graaf FH. Addressing the ideal requirements by free flap phalloplasty: Some reflections on refinements of technique. *Microsurgery* 1993;14:592-598.

Table 3. Summary of Outcomes in Included Primary Studies Examining Free Flap Phalloplasty Reported in Terms of Characteristics of the Ideal Neophallus*

Study	Primary Author	No.	Age (yr)	Follow-Up (yr)	Hormone Therapy?	Single-Stage Procedure (%)	Aesthetic Neophallus (%)	Erogenous Sensation (%)	Tactile Sensation (%)	Standing Micturition (%)	Neourethra Fistulae/Strictures per Patient	Sexual Function (%)	Donor-Site Morbidity (%)	Complications per Patient	Notes
Radial forearm flap															
Van Caenegem et al., 2013	Belgium	44	28	7	100	NR	NR	NR	NR	NR	NR	NR	0	NR	
Monstrey et al., 2009	Belgium	287	NR	NR	NR	100	NR	NR	NR	NR	0.41	NR	1.4	0.75	280/287 in transgender genital construction
Gottlieb et al., 1993	United States	4	NR	NR	NR	100	NR	NR	100	NR	1.0	NR	0	1.0	Central tube-within-a-tube flap design
Matti et al., 1988	United Kingdom	5	NR	NR	NR	NR	NR	NR	NR	40	0.4	0	0	1.0	
Kim et al., 2009	Republic of Korea	40	34	6	NR	100	97.5	100	100	90	0.2	NR	5	0.4	Osteocutaneous tube-within-a-tube flaps
Garcia et al., 2014	United Kingdom	15	36.6	4.52	NR	NR	NR	NR	NR	NR	NR	NR	86.7	NR	
Schaff et al., 2009	Germany	6	NR	1.08	NR	0	NR	NR	NR	NR	NR	NR	83.3	NR	Majority of outcomes not stratified by radial vs. fibula flap construction
Fibula flap															
Hage et al., 1996	The Netherlands	1	21	1.00	NR	0	100	100	100	NR	2.0	†	0	2.0	
Papadopoulos et al., 2008	Germany	32	34.1	NR	NR	0	100	100	100	NR	0.53	100	NR	1.03	Prelaminated flaps
Schaff et al., 2009	Germany	31	NR	1.08	NR	0	NR	NR	NR	NR	NR	100	NR	NR	Majority of outcomes not stratified by radial vs. fibula flap construction
Lateral arm flap															
Hage et al., 1993	The Netherlands	1	38	1.17	Y	0	100	100	100	0	2.0	NR	0	2.0	Bladder mucosa graft used for neourethra construction
TDA-based flaps															
Lin et al., 2009	Taiwan	1	24	1.5	NR	0	100	0	100	100	0.0	100	0	0.0	TDA perforator flap
Vesely et al., 2007	Czech Republic	22	28.6	23.9	NR	0	83	NR	NR	NR	N/A	42	17	0.55	Innervated latissimus dorsi myocutaneous flaps

NR, not reported; N/A, not applicable; Y, yes; N, no; TDA, thoracodorsal artery.

*From Hage JJ, De Graaf FH. Addressing the ideal requirements by free flap phalloplasty: Some reflections on refinements of technique. *Microsurgery* 1993;14:592–598.

†Patient had not attempted sexual intercourse; prefabricated flap.

Table 4. Effect and Time Course of Masculinizing Hormonal Therapy*

Effect	Time Course
Skin changes: oil, acne	1–2 yr
Body hair distribution	3–5 yr
Male pattern hair loss	Variable
Male pattern muscle mass distribution	2–5 yr
Cessation of menses	6 mo
Clitoral enlargement	1–2 yr
Vaginal mucosa atrophy	1–2 yr
Voice deepening	1–2 yr

*Adapted from Coleman E, Bocking W, Botzer M, et al. Standards of care for the health of transsexual, transgender, and gender-nonconforming people, version 7. *Int J Transgen*. 2011;13:165–162.

begins with an incision superiorly around the clitoris between the inner and outer clitoral prepuce.^{24,25} Next, depending on the urethroplasty procedure planned, a connecting incision is made under the urethra, or a W-shaped incision anterior to the urethra.^{24–26} Clitoral degloving proceeds, followed by detachment of the clitoral ligaments to lengthen the neophallus.^{24,26}

The urethral plate can be left intact or divided and lengthened with local flaps or grafts during urethroplasty.^{24,27} If a urethral lengthening procedure is not performed, the resulting neophallus is shorter and ventrally curved.²⁴ The native urethral plate may be divided to elongate the neophallus; however, this division necessitates additional urethroplasty to recreate a functional neourethra.^{24,27} Alternatively, the urethral plate may be left intact by using a W incision anterior to and above the urethra.²⁶ Local flaps for urethral reconstruction include dorsal clitoral flaps, which incorporate a superior buttonhole to allow passage of the flap over the neophallus, and inferior labia minora flaps.^{24,26} Reconstruction of the bulbar urethra can be bolstered or extended by an anterior vaginal wall flap.^{24,27} On completion of the urethroplasty, the clitoral bulbs around the neourethra are closed.²⁴

The advantages of metoidioplasty include like-with-like glans reconstruction with tactile and erogenous sensate clitoral tissue, sustained erectile rigidity without prostheses, and minor donor-site scarring. Metoidioplasty has been associated with shorter hospitalization and operative times, and is less expensive than other techniques.^{12,24,25,28,29}

Compared to other techniques, the metoidioplasty-constructed penis is considerably shorter, ranging from approximately 5 to 7 cm.^{25,30} This may result in impeded sexual function, difficulty with penetration, and an impaired ability for standing urination.^{5,24} Overall complications range from 14 to 37 percent; these are generally

minor and related to urethroplasty, such as dribbling with urination, but can also include urethral strictures and fistulae.^{24,25,30,31} Although metoidioplasty is often considered a one-stage procedure, Hage and van Turnhout reported that an average of 2.6 procedures were required for complete reconstruction.³¹

Reports of sexual function and standing urination following metoidioplasty vary widely. Vukadinovic et al. reported standing urination and satisfactory sexual function with orgasm in 74 consecutive cases.³⁰ Patient-reported satisfaction with sexual function exceeded 80 percent; patient satisfaction with aesthetic outcome has been described as greater than 77 percent.^{25,30} However, in 70 patients, Hage and van Turnhout found that small penis size precluded penetrative sexual intercourse for most of the study population, and 50 percent of patients could not void standing up.³¹

Pedicated Locoregional Flap Phalloplasty

The anterolateral thigh flap has been touted as the pedicled flap of choice for neophallus creation.³² In this procedure, the flap is tubularized and passed under an inguinal tunnel to craft the neophallus.^{16,32–35} Urethroplasty can be accomplished by incorporating a “tube-within-a-tube” design using prelamination with skin or mucosal grafts, or by using other flaps, such as the pedicled groin flap or free radial forearm flap.^{16,23,36} Advantages of the pedicled anterolateral thigh flap include reliable vascular supply, reduced risk of total flap failure, a discrete donor site, and the capacity for reinnervation by means of the femoral cutaneous nerves.^{7,15,31,32} One drawback to use of the anterolateral thigh flap is the presence of a thick subcutaneous fat layer, which can limit the ability to create a tube-within-a-tube neourethra.^{7,23} Adequate tactile and erogenous sensation has been reported in one case of phalloplasty with an innervated anterolateral thigh flap.³³ Although the aesthetic results appear promising, research on technique-specific long-term outcomes is scarce.^{16,32,34}

Inferiorly based pedicled abdominal flaps based on the inferior epigastric and circumflex iliac arterial systems have been described for phalloplasty.^{7,36–40} These flaps are tubed to create a neophallus with a clitoris retained at its base.^{37–39} A “bird-wing” modification of the abdominal flap, based on the superficial inferior epigastric and circumflex iliac arteries, has been described for increased tissue recruitment.³⁸ Advantages to this approach include less conspicuous donor-site scarring.^{7,37,38} Conversely, reports of a less

aesthetic neophallus, high complication rates, a paucity of named donor nerves for neophallus innervation, and minimal data on long-term outcomes are notable issues for this technique.^{7,37,38} In the one series of 85 patients, total complications from one- or two-stage urethroplasty with abdominal flap reconstruction exceeded 90 percent. Standing urination was reportedly satisfactory for 28 percent of patients; only 20 percent of the study population could engage in penetrative intercourse.³⁹

Pedicled groin flaps have also been used in female-to-male phalloplasty.^{23,41} There has been one report of a unilateral tubed groin flap based on the superficial and deep circumflex iliac arteries, including bone prelamination with a skin graft for urethroplasty.⁴¹ The patient achieved satisfactory sexual function and standing urination.⁴¹ The advantages and disadvantages of using groin flaps resemble those of abdominally based flaps.⁴¹

Free Flap Phalloplasty

The radial free forearm flap is regarded as the workhorse flap in female-to-male phalloplasty.^{21,22,41–43} The flap design in total phalloplasty is significantly larger than that for other common indications, and can be modified in several ways.^{43,47–49} Designs incorporating an ulnarly based or anterior “cricket bat” skin flap for tube-within-a-tube neourethra construction have been advocated by Hage and several others.^{21,44,45} With these design modifications, a separate, smaller portion of the forearm flap is tubed to create the neourethra over which a larger portion of the flap is tubed to form the bulk of the neophallus.^{21,44,45} In this way, the neourethra is constructed out of healthy vascular tissue that, compared to grafts, is less prone to stricture.

Although suprafascial dissection with flap harvest is preferable, reports note no difference in donor-site morbidity compared with subfascial dissection.^{42,47} The radial artery is dissected to its takeoff from the brachial artery, along with the cephalic vein.⁴³ The antebrachial cutaneous nerves are included in the flap to enable innervation for neophallus tactile and erogenous sensation.⁴⁸ After harvest, the flap is tubed over the reconstructed neourethra. Arterial recipient vessel options include the inferior epigastric and femoral vessels with or without vein grafting.^{42,43} The greater saphenous vein is preferable for venous anastomosis.⁴⁹ An arteriovenous loop can also be fashioned.⁴³ Neuroorrhaphy is performed to the dorsal clitoral and/or ilioinguinal nerves.⁴⁹

Although radial forearm flap phalloplasty may be staged, without prelamination it can be performed in one stage.^{7,23,45} Primary outcome measures for phalloplasty using the radial forearm flap—including aesthetic satisfaction, ability to achieve standing urination, and tactile and erogenous sensation—are all excellent.^{23,48–50} The most common complications are urologic, with total complications nearing 40 percent.^{48,49} Rates of stricture and fistula formation are reported at 7 to 20 percent and 18 percent, respectively; rates of flap loss are low.^{48,49}

Donor-site morbidity is the principal disadvantage of the radial forearm flap technique.^{5,49} Typically reconstructed with skin grafts, resultant scarring has been described as the unaesthetic and stigmatizing “signature” of this phalloplasty procedure.^{23,42} Despite this, Van Caenegem et al. reported that long-term patient satisfaction with aesthetic outcome exceeded 75 percent, and described the scar as generally functional and pain-free.⁴² Meanwhile, Selvaggi et al. also report an acceptable, functional, and pain-free donor site with this technique.⁴⁷

Consideration has been given to use of osteocutaneous flaps in phalloplasty.⁵¹ Incorporating an osseous component in the radial forearm flap can afford adequate rigidity for sexual penetration without prosthesis, with no significant donor-site morbidity.^{42,48} This bone component can soften over time.^{48,52} The fibula flap confers a more robust osseous segment.^{43,51,53} It can be prelaminated for staged neourethra reconstruction and made sensate using the sural or cutaneous nerves.⁵¹ The bone segment is fixed to the pubic symphysis using permanent sutures.⁵¹ In a series of 32 patients, aesthetic results were uniform and adequate tactile and erogenous sensation was reported in all cases.⁵¹ Rates of neourethra stenosis and fistula formation range from 31 to 32 percent and 16 to 22 percent, respectively; flap failure occurred in approximately 0 to 12.5 percent of cases.^{51,53} Perforation of the bone through the flap does not appear to be an issue.⁵¹

Alternative soft-tissue flaps include the free anterolateral thigh, lateral arm, and thoracodorsal artery-based flaps.²² The free anterolateral thigh flap can be designed into a neophallus in a manner similar to that described for pedicled anterolateral thigh flap phalloplasty. Hage et al. described tubing an innervated lateral arm flap over a bladder mucosal graft, reporting an aesthetic, sensate neophallus that permitted standing urination.⁵⁴ However, recurrent meatal stenosis was an issue.⁵⁴ A purported advantage of the lateral arm flap is a

less conspicuous donor site.^{22,54} Good tactile and erogenous sensation has been described in the lateral arm flap.⁵⁰ The latissimus myocutaneous and thoracodorsal artery perforator flaps have also been used in female-to-male phalloplasty.^{55,56} In one series of innervated latissimus flap phalloplasty, 42 percent of patients achieved sexual intercourse directly through erection achieved by contraction of the latissimus flap.⁵⁶ Lin and Chen described phalloplasty with a staged prelaminated thoracodorsal artery perforator flap.⁵⁵ Aesthetics were satisfactory to the patient, who reported standing urination, a hidden donor site, and no complications.⁵⁵ Sexual function was not ideal.⁵⁵

Penile Prostheses/Epitheses

The idea of a penile epithesis was first introduced by Selvaggi et al. In this two-stage procedure, osteointegrated titanium implants are placed into the pubic bones, followed by placement of the epithesis in a second procedure.^{57,58} Compared with silicone prostheses, possible advantages include the potential for sexual penetration, micturition, transmission of vibratory stimulation, and aesthetic appearance.^{57,58} However, data on short- and long-term outcomes and patient satisfaction with this procedure have yet to be described.

Penile Transplantation

Although penile transplantation has been reported only in the context of trauma and oncologic resection, it could theoretically be extended to female-to-male transgender patients.⁵⁹ The first successful penile transplant was performed in South Africa in 2015 for a traumatic amputation, with good results; the first transplant performed in the United States was reported in 2016 after oncologic resection. Advantages include a like-with-like tissue reconstruction without donor-site morbidity. However, lifelong immunosuppression therapy is a major drawback, and ethical concerns with composite tissue allotransplantation persist.⁶⁰

Adjunctive Procedures in Female-to-Male Transgender Genital Reconstruction

Total Hysterectomy, Salpingo-oophorectomy, and Vaginectomy

Typically performed before neophallus creation, total hysterectomy and salpingo-oophorectomy obviate the need for long-term cancer surveillance.^{61–63} Although vaginectomy is often performed at the same time as neophallus creation, it can also be carried out at the time of chest wall reconstruction or during the first stage of a

staged phalloplasty. In phalloplasty and metoidioplasty procedures that do not incorporate an anterior vaginal wall flap, an incision is made surrounding the vaginal introitus. The vagina is circumferentially dissected and excised.²³ If an anterior vaginal wall flap is used to reconstruct the bulbar urethra, all vaginal mucosa is excised and the anterior wall flap is transposed out of the vagina.^{24,64} The vaginal introitus is then closed.

Urethroplasty

The ability to void standing up is an important goal for the majority of patients.^{22,23,33,38} Close cooperation with urologists in a multidisciplinary team is imperative for successful urethroplasty.^{49,65} Techniques for urethroplasty in metoidioplasty are delineated earlier under Metoidioplasty.^{22,24,27} With regard to urethroplasty in pedicled and free flap phalloplasty, general principles apply. The native female urethra is advanced anteriorly using techniques similar to those used in metoidioplasty. Next, the bulbar urethra can be reinforced with local vestibular or labial skin flaps. The anterior vaginal skin flap can also be used.^{22,39} In the longer phallus produced with these flaps, a greater length is required for the pendulous urethra. Depending on the flap used, the neourethra can be constructed using either prelamination with skin or mucosal grafts, a tube-within-a-tube flap design, or by including a second flap for urethroplasty.^{7,22,23,36,44} Any phalloplasty procedure may be staged to allow for stable urethroplasty by means of prelamination or another technique before the completion of phalloplasty.

The majority of complications in female-to-male phalloplasty concern the neourethra. According to Selvaggi et al., the majority of patients who undergo phalloplasty will experience some form of incontinence and urinary dribbling.⁶⁶ Regarding major complications, strictures and fistulas occur most frequently and can be addressed using open or endoscopic techniques.^{49,67} Open techniques include meatotomy, excision and primary anastomosis, free graft or pedicle flap urethroplasty, perineostomy, and endoscopic incision.^{36,67,68} Rates of recurrence are high.⁶⁷

Scrotoplasty and Insertion of Genital Prostheses

Scrotoplasty can be performed concurrently with a primary metoidioplasty or phalloplasty procedure. A neoscrotum is typically constructed using the labia majora.^{23,25,69} Testicular prostheses can be inserted directly into the labia majora, with or without tissue expansion.^{24,25,69} The labia majora can also be closed in the midline to create

the neoscrotum.²³ Although simple, these techniques are generally unaesthetic and leave the neoscrotum in a posterior position.⁷⁰

A number of flaps have been described for scrotoplasty.⁷⁰ Local skin flap options include V-Y and M flaps, usually based on the labia majora or perineum. A technique described by Selvaggi et al. involves bilateral superiorly based labia majora V-Y flaps, wherein both flaps are rotated medially and “bent on themselves.”⁷⁰ In this technique, dorsal clitoral skin is transposed to recreate the anterior scrotum, which may help preserve erogenous sensation in addition to further transposing the neoscrotum anteriorly. Complications were minor and satisfaction with surgical outcome across the study population was 100 percent.⁷⁰

Although testicular implants may be advantageous for erectile function and cosmesis, a number of problems have been described, including implant expulsion, mechanical failure, and dislocation.^{62,71,72} In a study of 70 patients who underwent simultaneous metoidioplasty and scrotoplasty, loss and dislocation of testicular prosthesis were reported in 30 percent and 49 percent of cases, respectively.

Nearly all techniques for female-to-male phalloplasty require the insertion of a penile prosthesis to enable penetration during intercourse.²³ Although multiple devices are available, inflatable devices are preferable to rigid and semirigid prostheses, which risk perforation.²³ Device insertion is achieved with a lateral incision on the neoscrotum and blunt dissection of a penile pocket followed by device placement.⁷³ Complication rates are high, with Hoebeke et al. reporting a 41 percent device revision or removal rate.⁷¹

ASSESSING OUTCOMES

The vast majority of existing information on outcomes in female-to-male genital reconstruction is considered low-quality evidence.⁶² Existing studies on patient satisfaction are limited by a general lack of validated, standardized methods, a paucity of controlled studies, little prospective data collection, and poor response rates in long-term follow-up studies.^{32,62,74} In addition, there is enormous variation in follow-up periods.⁷⁴ Emphasis is placed on the need to develop “standardized methods to assess the outcomes of surgery” in terms of quality of life before and after surgery, and long-term data collection on preoperative versus postoperative sexual function/satisfaction.^{62,75}

Perhaps most notably, the authors found no reports of direct comparisons or analyses

investigating how outcomes differ by surgical technique.^{62,72,75} Similarly, the factors influencing patients’ decisions to pursue (or forgo) female-to-male transgender procedures have scarcely been considered.^{29,72} There exists no evidence or proposed algorithm to offer surgeons and female-to-male transgender patients guidance in determining the most appropriate technique.⁵

The impetus to both improve existing techniques and develop new ones is a laudable goal for patient care and future research on female-to-male bottom surgery. All centers performing these reconstructions should strive to collect high-quality validated data on outcome measures for individual techniques and patient-reported outcomes. Collecting this information will help elucidate where improvements in existing surgical techniques are still needed, and by extension, further advance best practices in this very important area of transgender care.^{72,74–77}

Alexes Hazen, M.D.

Hansjörg Wyss Department of Plastic Surgery
New York University Langone Medical Center
550 1st Avenue
New York, N.Y. 10016
alexes.hazen@nyumc.org

REFERENCES

1. Snaith P. Gender dysphoria. *Adv Psychiatr Treat.* 1998;4:356–359.
2. Gooren LJ. Clinical practice: Care of transsexual persons. *N Engl J Med.* 2011;364:1251–1257.
3. American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders.* 5th ed. Washington, DC: American Psychiatric Association; 2013.
4. American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders.* 4th ed. Washington, DC: American Psychiatric Association; 2000.
5. Selvaggi G, Dhejne C, Landen M, Elander A. The 2011 WPATH standards of care and penile reconstruction in female-to-male transsexual individuals. *Adv Urol.* 2012;2012:581712.
6. Meier SC, Labuski CM. Demographics of the transgender population. In: *International Handbook on the Demography of Sexuality.* Dordrecht, The Netherlands: Springer; 2013:289–327.
7. Monstrey SJ, Ceulemans P, Hoebeke P. Sex reassignment surgery in the female-to-male transsexual. *Semin Plast Surg.* 2011;25:229–244.
8. Selvaggi G, Bellringer J. Gender reassignment surgery: An overview. *Nat Rev Urol.* 2011;8:274–282.
9. Decuypere G, Vanhemelryck M, Michel A, et al. Prevalence and demography of transsexualism in Belgium. *Eur Psychiatry.* 2007;22:137–141.
10. Reed B, Rhodes S, Schofield P, Wylie K. Gender variance in the UK: Prevalence, incidence, growth and geographic distribution. June 2009. Supported by the Gender Identity Research and Education Society. Available at: <https://www.gires.org.uk/assets/medpro-assets/gendervarianceUK-report.pdf>. Accessed June 27, 2016..

11. Kuyper L, Wijzen C. Gender identities and gender dysphoria in the Netherlands. *Arch Sex Behav*. 2014;43:377–385.
12. Gates GJ. *How Many People Are Lesbian, Gay, Bisexual, and Transgender?* The Williams Institute, April 2011. Available at: <http://williamsinstitute.law.ucla.edu/wp-content/uploads/Gates-How-Many-People-LGBT-Apr-2011.pdf>. Accessed June 27, 2016.
13. Conway L, Winter S. How many trans* people are there? A 2011 update incorporating new data. Available at: <http://www.transgenderasia.org/paper-how-many-trans-people-are-there.htm>. Accessed June 27, 2016.
14. Conway L. How frequently does transsexualism occur? *LynnConway.com*. January 30, 2001. Available at: <http://ai.eecs.umich.edu/people/conway/TS/TSprevalence.html>. Accessed June 27, 2016.
15. van Kesteren PJ, Gooren LJ, Megens JA. An epidemiological and demographic study of transsexuals in The Netherlands. *Arch Sex Behav*. 1996;25:589–600.
16. Morrison SD, Son J, Song J, et al. Modification of the tube-in-tube pedicled anterolateral thigh flap for total phalloplasty: The mushroom flap. *Ann Plast Surg*. 2014;72(Suppl 1):22–26.
17. Garber M. Spare parts: The surgical construction of gender. In: Abelow H, Barale MA, Halperin DM, eds. *The Lesbian and Gay Studies Reader*. New York: Routledge; 1993.
18. Colton SL, Ma M, Ma KMF, Pardo ST, Babcock J. The effects of hormonal gender affirmation treatment on mental health in female-to-male transsexuals. *J Gay Lesbian Mental Health*. 2011;15:37–41.
19. Forshee AS. *Transgender Men: A Demographic Snapshot*. Abingdon, United Kingdom: Taylor & Francis; 2016.
20. Coleman E, Bockting W, Botzer M, et al. *Standards of Care for the Health of Transsexual, Transgender, and Gender-Nonconforming People*. Minneapolis: World Professional Association for Transgender Health; 2012.
21. Gooren LJ. Management of female-to-male transgender persons: Medical and surgical management, life expectancy. *Curr Opin Endocrinol Diabetes Obes*. 2014;21:233–238.
22. Hage JJ, De Graaf FH. Addressing the ideal requirements by free flap phalloplasty: Some reflections on refinements of technique. *Microsurgery* 1993;14:592–598.
23. Neligan P, Warren RJ, Van Beek A, eds. *Plastic Surgery*. London: Elsevier Saunders; 2013.
24. Stojanovic B, Djordjevic ML. Anatomy of the clitoris and its impact on neophalloplasty (metoidioplasty) in female transsexuals. *Clin Anat*. 2015;28:368–375.
25. Perovic SV, Djordjevic ML. Metoidioplasty: A variant of phalloplasty in female transsexuals. *BJU Int*. 2003;92:981–985.
26. Hage JJ. Metaidoioplasty: An alternative phalloplasty technique in transsexuals. *Plast Reconstr Surg*. 1996;97:161–167.
27. Djordjevic ML, Bizic MR. Comparison of two different methods for urethral lengthening in female to male (metoidioplasty) surgery. *J Sex Med*. 2013;10:1431–1438.
28. Morrison SD, Perez MG, Nedelman M, Crane CN. Current state of female-to-male gender confirming surgery. *Curr Sex Health Rep*. 2015;7:38–48.
29. Rachlin K. Factors which influence individual's decisions when considering female-to-male genital reconstructive surgery. Available at: http://www.academia.edu/238605/Factors_Which_Influence_Individual_s_Decisions_When_Considering_Female-To-Male_Genital_Reconstructive_Surgery. Accessed June 27, 2016.
30. Vukadinovic V, Stojanovic B, Majstorovic M, Milosevic A. The role of clitoral anatomy in female to male sex reassignment surgery. *ScientificWorldJournal*. 2014;2014:437378.
31. Hage JJ, van Turnhout AA. Long-term outcome of metoidioplasty in 70 female-to-male transsexuals. *Ann Plast Surg*. 2006;57:312–316.
32. Lee GK, Lim AF, Bird ET. A novel single-flap technique for total penile reconstruction: The pedicled anterolateral thigh flap. *Plast Reconstr Surg*. 2009;124:163–166.
33. Rubino C, Figus A, Dessy LA, et al. Innervated island pedicled anterolateral thigh flap for neo-phallic reconstruction in female-to-male transsexuals. *J Plast Reconstr Aesthet Surg*. 2009;62:e45–e49.
34. Holzbach T, Giunta RE, Machens HG, Müller D. Phalloplasty with pedicled anterolateral thigh flap (“ALT-flap”) (in German). *Handchir Mikrochir Plast Chir*. 2011;43:227–231.
35. Sinove Y, Kyriopoulos E, Ceulemans P, Houtmeyers P, Hoebeke P, Monstrey S. Preoperative planning of a pedicled anterolateral thigh (ALT) flap for penile reconstruction with the multidetector CT scan. *Handchir Mikrochir Plast Chir*. 2013;45:217–222.
36. Garaffa G, Ralph DJ, Christopher N. Total urethral construction with the radial artery-based forearm free flap in the transsexual. *BJU Int*. 2010;106:1206–1210.
37. Schmidt M, Grohmann M, Huemer GM. Pedicled superficial inferior epigastric artery perforator flap for salvage of failed metoidioplasty in female-to-male transsexuals. *Microsurgery* 2015;35:403–406.
38. Bajpai M. “Bird-Wing” abdominal phalloplasty: A novel surgical technique for penile reconstruction. *J Indian Assoc Pediatr Surg*. 2013;18:49–52.
39. Bettocchi C, Ralph DJ, Pryor JP. Pedicled pubic phalloplasty in females with gender dysphoria. *BJU Int*. 2005;95:120–124.
40. Zhang Y, Lu L, Zhang W, Jiang H, Zhu X. A simple and effective method for phalloplasty in female-to-male transsexuals. *Plast Reconstr Surg*. 2010;126:264e–265e.
41. Aköz T, Kargi E. Phalloplasty in a female-to-male transsexual using a double-pedicle composite groin flap. *Ann Plast Surg*. 2002;48:423–427; discussion 427.
42. Van Caenegem E, Verhaeghe E, Taes Y, et al. Long-term evaluation of donor-site morbidity after radial forearm flap phalloplasty for transsexual men. *J Sex Med*. 2013;10:1644–1651.
43. Hage JJ, Winters HA, Van Lieshout J. Fibula free flap phalloplasty: Modifications and recommendations. *Microsurgery* 1996;17:358–365.
44. Gottlieb LJ, Levine LA. A new design for the radial forearm free-flap phallic construction. *Plast Reconstr Surg*. 1993;92:276–283; discussion 284.
45. Gilbert DA, Jordan GH, Devine CJ Jr, Winslow BH. Microsurgical forearm “cricket bat-transformer” phalloplasty. *Plast Reconstr Surg*. 1992;90:711–716.
46. Matthews RN, Davies DM. Phalloplasty using the free radial forearm flap. *Br J Plast Surg*. 1985;38:160–164.
47. Selvaggi G, Monstrey S, Hoebeke P, et al. Donor-site morbidity of the radial forearm free flap after 125 phalloplasties in gender identity disorder. *Plast Reconstr Surg*. 2006;118:1171–1177.
48. Kim SK, Lee KC, Kwon YS, Cha BH. Phalloplasty using radial forearm osteocutaneous free flaps in female-to-male transsexuals. *J Plast Reconstr Aesthet Surg*. 2009;62:309–317.
49. Monstrey S, Hoebeke P, Selvaggi G, et al. Penile reconstruction: Is the radial forearm flap really the standard technique? *Plast Reconstr Surg*. 2009;124:510–518.
50. Selvaggi G, Monstrey S, Ceulemans P, T'Sjoen G, De Cuypere G, Hoebeke P. Genital sensitivity after sex reassignment surgery in transsexual patients. *Ann Plast Surg*. 2007;58:427–433.
51. Papadopoulos NA, Schaff J, Biemer E. The use of free pre-laminated and sensate osteofasciocutaneous fibular flap in phalloplasty. *Injury* 2008;39(Suppl 3):S62–S67.

52. Kim SK, Kim TH, Yang JI, Kim MH, Kim MS, Lee KC. The etiology and treatment of the softened phallus after the radial forearm osteocutaneous free flap phalloplasty. *Arch Plast Surg*. 2012;39:390–396.
53. Schaff J, Papadopoulos NA. A new protocol for complete phalloplasty with free sensate and prelaminated osteofasciocutaneous flaps: Experience in 37 patients. *Microsurgery*. 2009;29:413–419.
54. Hage JJ, de Graaf FH, van den Hoek J, Bloem JJ. Phallic construction in female-to-male transsexuals using a lateral upper arm sensate free flap and a bladder mucosa graft. *Ann Plast Surg*. 1993;31:275–280.
55. Lin CT, Chen LW. Using a free thoracodorsal artery perforator flap for phallic reconstruction: A report of surgical technique. *J Plast Reconstr Aesthet Surg*. 2009;62:402–408.
56. Vesely J, Hyza P, Ranno R, et al. New technique of total phalloplasty with reinnervated latissimus dorsi myocutaneous free flap in female-to-male transsexuals. *Ann Plast Surg*. 2007;58:544–550.
57. Selvaggi G, Branemark R, Elander A, Liden M, Stalfors J. Titanium-bone-anchored penile epithesis: Preoperative planning and immediate postoperative results. *J Plast Surg Hand Surg*. 2015;49:40–44.
58. Selvaggi G, Elander A, Branemark R. Penile epithesis: Preliminary study. *Plast Reconstr Surg*. 2010;126:265e–266e.
59. Bateman C. World's first successful penis transplant at Tygerberg Hospital. *S Afr Med J*. 2015;105:251–252.
60. Coffman KL, Siemionow MZ. Ethics of facial transplantation revisited. *Curr Opin Organ Transplant*. 2014;19:181–187.
61. Hage JJ, Dekker JJ, Karim RB, Verheijen RH, Bloemena E. Ovarian cancer in female-to-male transsexuals: Report of two cases. *Gynecol Oncol*. 2000;76:413–415.
62. Sutcliffe PA, Dixon S, Akehurst RL, et al. Evaluation of surgical procedures for sex reassignment: A systematic review. *J Plast Reconstr Aesthet Surg*. 2009;62:294–306; discussion 306.
63. Ergeneli MH, Duran EH, Ozcan G, Erdogan M. Vaginectomy and laparoscopically assisted vaginal hysterectomy as adjunctive surgery for female-to-male transsexual reassignment: Preliminary report. *Eur J Obstet Gynecol Reprod Biol*. 1999;87:35–37.
64. Rohrmann D, Jakse G. Urethroplasty in female-to-male transsexuals. *Eur Urol*. 2003;44:611–614.
65. Garcia MM. Men's health and transgender surgery: A urologist's perspective. *Transl Androl Urol*. 2016;5:225–227.
66. Hoebeke P, Selvaggi G, Ceulemans P, et al. Impact of sex reassignment surgery on lower urinary tract function. *Eur Urol*. 2005;47:398–402.
67. Lumen N, Monstrey S, Goessaert AS, Oosterlinck W, Hoebeke P. Urethroplasty for strictures after phallic reconstruction: A single-institution experience. *Eur Urol*. 2011;60:150–158.
68. Lumen N, Oosterlinck W, Decaestecker K, Monstrey S, Hoebeke P. Endoscopic incision of short (<3 cm) urethral strictures after phallic reconstruction. *J Endourol*. 2009;23:1329–1332.
69. Sengezer M, Sadove RC. Scrotal construction by expansion of labia majora in biological female transsexuals. *Ann Plast Surg*. 1993;31:372–376.
70. Selvaggi G, Hoebeke P, Ceulemans P, et al. Scrotal reconstruction in female-to-male transsexuals: A novel scrotoplasty. *Plast Reconstr Surg*. 2009;123:1710–1718.
71. Hoebeke PB, Decaestecker K, Beysens M, Opdenakker Y, Lumen N, Monstrey SM. Erectile implants in female-to-male transsexuals: Our experience in 129 patients. *Eur Urol*. 2010;57:334–340.
72. Garcia MM, Christopher NA, De Luca F, Spilotros M, Ralph DJ. Overall satisfaction, sexual function, and the durability of neophallus dimensions following staged female to male genital gender confirming surgery: The Institute of Urology, London U.K. experience. *Transl Androl Urol*. 2014;3:156–162.
73. Hoebeke P, de Cuypere G, Ceulemans P, Monstrey S. Obtaining rigidity in total phalloplasty: Experience with 35 patients. *J Urol*. 2003;169:221–223.
74. Klein C, Gorzalka BB. Sexual functioning in transsexuals following hormone therapy and genital surgery: A review. *J Sex Med*. 2009;6:2922–2939.
75. Wierckx K, Van Caenegem E, Elaut E, et al. Quality of life and sexual health after sex reassignment surgery in transsexual men. *J Sex Med*. 2011;8:3379–3388.
76. Hage JJ, Bout CA, Bloem JJ, Megens JA. Phalloplasty in female-to-male transsexuals: What do our patients ask for? *Ann Plast Surg*. 1993;30:323–326.
77. Terrier JE, Courtois F, Ruffion A, Morel J, Jourdain N. Surgical outcomes and patients' satisfaction with suprapubic phalloplasty. *J Sex Med*. 2014;11:288–298.