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

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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.)

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

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males, and that genital reconstruction surgery—both historically and presently—is more frequently sought and performed in the male-to-female transgender patient population. 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.

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.”

**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). The primary hormonal treatment is a testosterone preparation. The risks of masculinizing hormone therapy are important to note, and have been discussed extensively elsewhere.

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

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

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.

| Study | Country of Primary Author | No. | Age (yr) | Follow-Up (yr) | Hormone Therapy? | Single-Stage Procedure (%) | Aesthetic Neophallus(226x235x229x241)(%)
</td> | Erogenous Sensation (%) | Tactile Sensation (%) | Standing Micrurten Sexual Function (%) | Donor-Site Morbidity (%) | Complications per Patient | Notes |
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<tr>
<td>Van Caenegem et al., 2013</td>
<td>Belgium</td>
<td>44</td>
<td>28</td>
<td>7</td>
<td>100</td>
<td>NR</td>
<td>NR</td>
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<tr>
<td>Monstrey et al., 2009</td>
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<td>287</td>
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<td>0.75</td>
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<td>United States</td>
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<td>NR</td>
<td>NR</td>
<td>100</td>
<td>NR</td>
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<td>100</td>
<td>1.0</td>
<td>NR</td>
<td>0</td>
<td>1.0</td>
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<tr>
<td>Schaff et al., 2009</td>
<td>Germany</td>
<td>15</td>
<td>36.6</td>
<td>4.52</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>86.7</td>
<td>NR</td>
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<td>Fibula flap</td>
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<tr>
<td>Hage et al., 1996</td>
<td>The Netherlands</td>
<td>1</td>
<td>21</td>
<td>1.00</td>
<td>NR</td>
<td>0</td>
<td>100</td>
<td>100</td>
<td>2.0</td>
<td>†</td>
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<td>Prelaminated flaps</td>
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<tr>
<td>Papadopulos et al., 2008</td>
<td>Germany</td>
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<td>34.1</td>
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<td>100</td>
<td>100</td>
<td>0.53</td>
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<td>NR</td>
<td>1.03</td>
<td>Majority of outcomes not stratified by radial vs. fibula flap construction</td>
</tr>
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<td>Schaff et al., 2009</td>
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<td>31</td>
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<td>Lateral arm flap</td>
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<tr>
<td>Hage et al., 1993</td>
<td>The Netherlands</td>
<td>1</td>
<td>38</td>
<td>1.17</td>
<td>Y</td>
<td>0</td>
<td>100</td>
<td>100</td>
<td>0</td>
<td>2.0</td>
<td>NR</td>
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<td>2.0</td>
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<tr>
<td>TDA-based flaps</td>
<td></td>
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<tr>
<td>Lin et al., 2009</td>
<td>Taiwan</td>
<td>1</td>
<td>24</td>
<td>1.5</td>
<td>NR</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>100</td>
<td>100</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>Vesely et al., 2007</td>
<td>Czech Republic</td>
<td>22</td>
<td>28.6</td>
<td>23.9</td>
<td>NR</td>
<td>0</td>
<td>83</td>
<td>NR</td>
<td>NR</td>
<td>N/A</td>
<td>42</td>
<td>17</td>
<td>0.55</td>
</tr>
</tbody>
</table>

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

†Patient had not attempted sexual intercourse; prefabricated flap.
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.\(^31\)

### Pedicled 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.\(^7\)\(^,\)\(^25\) 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

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

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

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. 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.

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

Free Flap Phalloplasty

The radial free forearm flap is regarded as the workhorse flap in female-to-male phalloplasty. The flap design in total phalloplasty is significantly larger than that for other common indications, and can be modified in several ways. 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. 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. 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. The radial artery is dissected to its takeoff from the brachial artery, along with the cephalic vein. The antebrachial cutaneous nerves are included in the flap to enable innervation for neophallus tactile and erogenous sensation. After harvest, the flap is tubed over the reconstructed neourethra. Arterial recipient vessels options include the inferior epigastric and femoral vessels with or without vein grafting. The greater saphenous vein is preferable for venous anastomosis. An arteriovenous loop can also be fashioned. Neurorrhaphy is performed to the dorsal clitoral and/or ilioinguinal nerves. Although radial forearm flap phalloplasty may be staged, without prelamination it can be performed in one stage. 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. The most common complications are urologic, with total complications nearing 40 percent. Rates of stricture and fistula formation are reported at 7 to 20 percent and 18 percent, respectively; rates of flap loss are low.

Donor-site morbidity is the principal disadvantage of the radial forearm flap technique. Typically reconstructed with skin grafts, resultant scarring has been described as the unaesthetic and stigmatizing “signature” of this phalloplasty procedure. 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. Meanwhile, Selvaggi et al. also report an acceptable, functional, and pain-free donor site with this technique.

Consideration has been given to use of osteocutaneous flaps in phalloplasty. Incorporating an osseous component in the radial forearm flap can afford adequate rigidity for sexual penetration without prosthesis, with no significant donor-site morbidity. This bone component can soften over time. The fibula flap confers a more robust osseous segment. It can be pre-laminated for staged neourethra reconstruction and made sensate using the sural or cutaneous nerves. The bone segment is fixed to the pubic symphysis using permanent sutures. In a series of 32 patients, aesthetic results were uniform and adequate tactile and erogenous sensation was reported in all cases. 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. Perforation of the bone through the flap does not appear to be an issue.

Alternative soft-tissue flaps include the free anterolateral thigh, lateral arm, and thoracodorsal artery-based flaps. 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. However, recurrent meatal stenosis was an issue. A purported advantage of the lateral arm flap is a
less conspicuous donor site.\textsuperscript{22,54} Good tactile and erogenous sensation has been described in the lateral arm flap.\textsuperscript{50} The latissimus myocutaneous and thoracodorsal artery perforator flaps have also been used in female-to-male phalloplasty.\textsuperscript{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.\textsuperscript{56} Lin and Chen described phalloplasty with a staged prelaminated thoracodorsal artery perforator flap.\textsuperscript{55} Aesthetics were satisfactory to the patient, who reported standing urination, a hidden donor site, and no complications.\textsuperscript{55} Sexual function was not ideal.\textsuperscript{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.\textsuperscript{57,58} Compared with silicone prostheses, possible advantages include the potential for sexual penetration, micturition, transmission of vibratory stimulation, and aesthetic appearance.\textsuperscript{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.\textsuperscript{59} The first successful penile transplant was performed in South Africa in 2015 for a traumatic amputation.\textsuperscript{42} 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.\textsuperscript{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.\textsuperscript{51-53} 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.\textsuperscript{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.\textsuperscript{24,64} The vaginal introitus is then closed.

**Urethroplasty**

The ability to void standing up is an important goal for the majority of patients.\textsuperscript{22,25,35,38} Close cooperation with urologists in a multidisciplinary team is imperative for successful urethroplasty.\textsuperscript{49,65} Techniques for urethroplasty in metoidioplasty are delineated earlier under Metoidioplasty.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{66} Regarding major complications, strictures and fistulas occur most frequently and can be addressed using open or endoscopic techniques.\textsuperscript{49,67} Open techniques include meatotomy, excision and primary anastomosis, free graft or pedicle flap urethroplasty, perineostomy, and endoscopic incision.\textsuperscript{36,67,68} Rates of recurrence are high.\textsuperscript{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.\textsuperscript{23,25,69} Testicular prostheses can be inserted directly into the labia majora, with or without tissue expansion.\textsuperscript{24,25,69} The labia majora can also be closed in the midline to create
the neoscrotum. Although simple, these techniques are generally unaesthetic and leave the neoscrotum in a posterior position.

A number of flaps have been described for scrotoplasty. 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.” 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.

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. 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. Although multiple devices are available, inflatable devices are preferable to rigid and semirigid prostheses, which risk perforation. Device insertion is achieved with a lateral incision on the neoscrotum and blunt dissection of a penile pocket followed by device placement. Complication rates are high, with Hoebeke et al. reporting a 41 percent device revision or removal rate.

**ASSESSING OUTCOMES**

The vast majority of existing information on outcomes in female-to-male genital reconstruction is considered low-quality evidence. 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. In addition, there is enormous variation in follow-up periods. 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.

Perhaps most notably, the authors found no reports of direct comparisons or analyses investigating how outcomes differ by surgical technique. Similarly, the factors influencing patients’ decisions to pursue (or forgo) female-to-male transgender procedures have scarcely been considered. There exists no evidence or proposed algorithm to offer surgeons and female-to-male transgender patients guidance in determining the most appropriate technique.

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.

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**REFERENCES**


