

Primary Use of the Deep Inferior Epigastric Pedicle for Free-flap Phalloplasty: Rationale, Technique, and Outcomes

Nance Yuan, MD*†

Edward C. Ray, MD, FACS*†

Shannon Smith, MD*§

Maurice M. Garcia, MD, MAS*§¶

Background: Most free-flap phalloplasty reports describe the femoral artery and great saphenous vein as recipient vessels, with the deep inferior epigastric artery and *venae comitantes* (DIEA/V) only rarely reported. We review our experience with preferentially using the DIEA/V as recipient vessels in gender-affirming free-flap phalloplasty, with DIEV as primary venous outflow.

Methods: We retrospectively reviewed consecutive patients who underwent gender-affirming free-flap phalloplasty at our single institution from June 2017 through June 2021. The DIEA/V was used as recipient vessels, with the DIEA/V pedicle externalized via a passageway made through the external inguinal ring.

Results: Thirty-eight consecutive free flaps (26 radial forearm free-flap phalloplasties, 10 anterolateral thigh phalloplasties, and two radial forearm free-flap urethroplasties) were performed. Mean age was 37.3 years; mean BMI was 25.7. Mean follow-up was 17.9 months. All flaps were anastomosed to the DIEA/V, without use of vein grafts. Most flaps (89.5%) had at least two veins anastomosed. To augment outflow, a saphenous vein branch was used in one of 38 (2.6%) cases and other superficial veins were used in two of 38 (5.3%) cases. One of 38 (2.6%) cases (early in our experience) resulted in total flap loss.

Conclusions: Advantages of the DIEA/V as free-flap phalloplasty recipient vessels include a short, direct pathway for vessels, excellent donor-recipient vessel size match that allows end-to-end anastomoses, and elimination of risks associated with arterialized interposed veins. When venous outflow appears compromised, we recommend a low threshold to use additional local or saphenous veins, though this is rarely needed given the DIEV's reliability. (*Plast Reconstr Surg Glob Open* 2022;10:e4307; doi: 10.1097/GOX.0000000000004307; Published online 10 June 2022.)

INTRODUCTION

Phalloplasty has important applications in gender-affirming genital surgery, trauma, postoncologic reconstruction, and disorders of sexual differentiation.¹ Although pedicled-flap phalloplasties are described,²⁻⁶ most phalloplasties today use free flaps,⁷⁻¹² with the radial forearm free flap (RFFF) often considered the gold-standard option.^{8,13-15} Despite high patient satisfaction rates,⁷ phalloplasty complications are common.^{6,8,15-17} Further technical advancements are needed to optimize outcomes.

Proper recipient vessel selection is crucial for all free flaps,¹⁸⁻²⁴ but literature explaining phalloplasty recipient vessel selection is extremely limited.²⁵ Most phalloplasty descriptions^{8,10,11,15,26-31} highlight the femoral artery (FA) and great saphenous vein (GSV) as recipient vessels, whereas some do not mention recipient vessel choice at all.^{1,7,32}

From the *Cedars-Sinai Transgender Surgery and Health Program, Cedars-Sinai Medical Center, Los Angeles, Calif.; †Huntington Plastic Surgery Institute, Pasadena, Calif.; ‡Division of Plastic Surgery, Cedars-Sinai Medical Center, Los Angeles, Calif.; §Division of Urology, Cedars-Sinai Medical Center, Los Angeles, Calif.; and ¶Departments of Urology and Anatomy, University of California San Francisco, San Francisco, Calif.

Received for publication November 19, 2021; accepted March 7, 2022.

Presented at the Plastic Surgery the Meeting, online, October 2020; 21st Annual Fall Scientific Meeting of the Sexual Medicine Society of North America (SMSNA), online, November 2020, World Professional Association for Transgender Health (WPATH) 26th Scientific Symposium, online, November 2020, American Urological Association (AUA), online, September 2021.

Copyright © 2022 The Authors. Published by Wolters Kluwer Health, Inc. on behalf of The American Society of Plastic Surgeons. This is an open-access article distributed under the terms of the Creative Commons Attribution-Non Commercial-No Derivatives License 4.0 (CCBY-NC-ND), where it is permissible to download and share the work provided it is properly cited. The work cannot be changed in any way or used commercially without permission from the journal.

DOI: 10.1097/GOX.0000000000004307

Disclosure: The authors have no financial interest to declare in relation to the content of this article.

Related Digital Media are available in the full-text version of the article on www.PRSGlobalOpen.com.

When alternatives to the FA, including the deep inferior epigastric artery and its venae comitantes (DIEA/V), are mentioned, only cursory attention is paid to technique and selection rationale.^{12,33,34} Danker et al²⁵ published one of the only reports discussing specific technique and outcomes using DIEA/V. Of note, although they describe the DIEA as their preferred recipient artery, they only discuss DIEV use together with the GSV. According to our review, no prior publications have examined phalloplasty outcomes using the DIEV exclusively for venous outflow.

This study reviews our experience with the DIEA/V as the preferred recipient vessels in free-flap phalloplasty, contributing to the sparse literature on this topic. We discuss our technique, its advantages, and lessons learned to optimize outcomes in free-flap phalloplasty.

METHODS

A retrospective review of consecutive transgender men who underwent gender-affirming free-flap phalloplasty (with or without urethral creation) at a single institution from June 2017 through June 2021 was performed. In all cases, the DIEA/V pedicle was used as recipient vessels. Flaps with minimum one month of follow-up were included. Patient demographics, operative details, and surgical outcomes were recorded. As this study focuses on microsurgical technique and flap outcomes, we analyzed each individual free flap separately (eg, in staged reconstructive cases where two free flaps were performed for a patient).

Flap Selection

Patients were offered either RFFF or anterolateral thigh (ALT) free flap unless contraindications were identified. Patients with excessively thick subcutaneous fat were only offered RFFF or shaft-only ALT phalloplasty to avoid unacceptably thick flaps. Benefits and risks of options were discussed, accounting for each patient's donor-site anatomy and preferences.

The ALT was selected when patients refused the RFFF donor site, and where ALT flap thickness would yield a phallus of reasonable girth. Patients were counseled about choosing either urethral lengthening within the phallus to achieve standing micturition or a shaft-only design without a neourethra and a perineal urethral opening instead, to avoid the risk of urethral complications. Examples of flap designs are shown in [Figure 1](#). Preoperatively, all patients underwent permanent hair removal from the flap donor site with electrolysis or laser hair removal.

Staged Approach

Primary phalloplasty was accomplished in two stages, as described by Garaffa et al³⁵ with free-flap elevation, tubularization, inset, microvascular anastomoses, and nerve coaptation performed in the first stage (or, when two free flaps were planned, during the first two stages).

Patients that refused RFFF and that were poor ALT candidates were offered staged reconstruction with two free flaps: ALT shaft-only phalloplasty at the first stage, followed by RFFF urethroplasty at the second stage. RFFF

Takeaways

Question: What are optimal recipient vessels for gender-affirming free-flap phalloplasty?

Findings: Using the deep inferior epigastric vessels (DIEA/V) as free-flap phalloplasty recipient vessels is safe and effective.

Meaning: DIEA/V should be considered for primary use as recipient vessels in free-flap phalloplasty.

urethroplasty was also performed as salvage surgery for patients lacking a urethra (eg, after groin-flap phalloplasty). In such cases, the neourethra free flap was inset into the existing phallus ([Fig. 2](#)).

Radial Forearm Flap Harvest

The fasciocutaneous RFFF was harvested as previously described^{36,37} to include the radial artery with its associated *venae comitantes* (VC), the cephalic vein, and both the medial and lateral antebrachial cutaneous nerves. In most cases, we grafted the forearm donor site with full-thickness skin grafts from the infragluteal crease bilaterally.

Anterolateral Thigh Flap Harvest

The ALT fasciocutaneous flap was harvested as previously described.^{12,38} Flap perforators were visualized and marked using duplex-ultrasound before flap elevation. The flap was based on the descending branch of the lateral circumflex FA with its VC and elevated with the lateral femoral cutaneous nerve. It was conservatively thinned by removing sub-Scarpa fat during the first stage, with further thinning performed at subsequent stages when needed.

We performed all ALT flaps as free flaps. Although pedicled ALT phalloplasties have been commonly described,^{3,4,11,14} based on our experience, we have moved to preferentially performing ALT phalloplasties as free flaps. Pedicled ALT flaps are associated with unique challenges, including need for significant flap manipulation during tunneling, risks of pedicle compression and tethering, and need for a larger counterincision to facilitate tunneling. We have found that ALT free flaps are highly reliable in an experienced microsurgical center, with improved ease of inset.

Recipient Vessel Preparation and Microsurgical Anastomoses

All cases used the DIEA/V as recipient vessels. To facilitate a two-team approach, the DIEA/V pedicle was dissected contralateral to the flap donor site, except in cases of free-flap urethroplasty or secondary phalloplasty, when the DIEA/V were harvested contralateral to the prior flap pedicle.

The neo-phallus recipient site was marked at the patient's midline as a 13-cm circle, with the base positioned 1–2 cm cephalad to the anterior clitoral fold ([Fig. 3](#); [Video 1](#)). ([See Video 1 \[online\]](#), which displays an intraoperative review of surgical anatomic landmarks and surgical approach.)

The skin incision was a 6-cm oblique extension from this marking, approximately 2 cm cephalad and parallel to

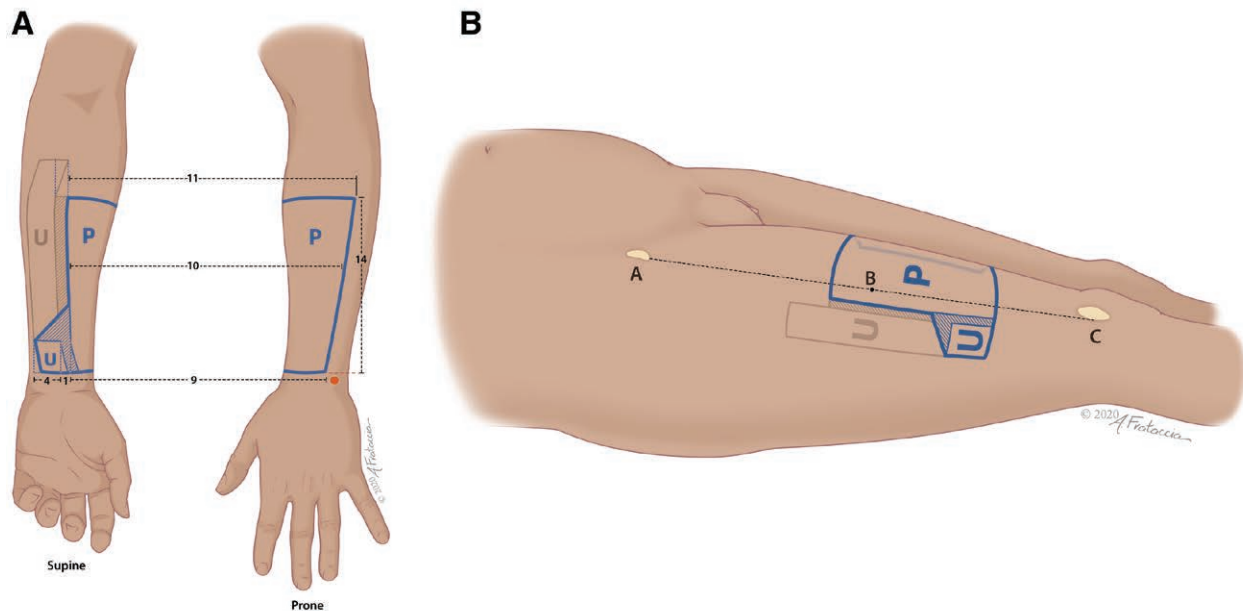


Fig. 1. Phallourethroplasty donor-site templates. A, RFFF. The urethra segment (U) is tubularized with the skin facing the lumen. The phallus segment (P) is wrapped (skin facing outside) around the tubularized urethra. The distal end of the flap is marked just proximal to the ulnar styloid process (orange dot). A 1-cm-wide strip of skin between U and P (blue hatch-lines) is de-epithelialized, to allow the urethra segment to be centered within the phallus. If additional bulk is needed in the proximal shaft to augment girth, skin along the lateral edges of the P segment can be de-epithelialized and involuted beneath the epithelium of the P segment. B, ALT flap. This template for an ALT flap is similar to the template for the RFFF. Landmarks: the flap is centered over a line that connects the anterior superior iliac spine (ASIS, A), and the lateral edge of the patella (C). Vascular supply is from perforator vessels from the descending branch of the Lateral femoral circumflex artery. The urethra segment (U) can be located lateral or medial to the P segment, to minimize flap thickness and optimize vascular supply.

the inguinal ligament. The fascia was incised parallel and slightly cephalad to the skin incision (Fig. 4). The DIEA/V pedicle was dissected as far cephalad as possible. Before division, microvascular clamps were placed near their vascular origin.

With a finger placed behind the external inguinal ring (EIR) from within the pelvis for protection, a Kelly-clamp tip was used to bluntly dissect an opening through the medial aspect of the conjoint tendon and transversalis fascia comprising the EIR's posterior wall (Figs. 4A and 5; Video 2), to create a 1-cm tunnel for the DIEA/V pedicle. (See Video 2 [online], which contains an intraoperative review of the anatomy of the DIEV/A passageway and a step-by-step surgical approach for externalizing the DIEV/A pedicle.)

The tunnel floor (pubic bone) was cleared of residual EIR fascia choking the pedicle. When needed, we shortened the pedicle's trajectory to the recipient site by incising the lateral edge of the rectus abdominis muscle's pubic insertion (red hatch line, Figs. 4B and 5C). The dissected passageway was retracted upward using umbilical tape to facilitate pedicle passage (Fig. 6).

Flap Harvest, Inset, and Anastomosis

Flaps were tubularized in situ at the donor-site preharvest and then partially inset at the recipient site to allow microvascular anastomoses and nerve coaptation.

The recipient pedicle end was delivered through the EIR to the recipient site using a one-fourth inch Penrose

drain as a conduit (Fig. 7). Under microscope magnification, the flap's sensory nerves (Medial/Lateral antebrachial cutaneous) were coapted to the ipsilateral clitoral nerve using interrupted epineural 9-0 nylon sutures. Veins were anastomosed with couplers (Synovis MCA, Birmingham, Al.). Arterial anastomoses were hand sewn using interrupted 9-0 nylon sutures.

Postoperative Care

Patients were inpatient for 5 days and underwent scheduled flap checks by visual inspection (flap color/turgor/capillary refill) and handheld Doppler vascular checks. Donor-site skin grafts were bolstered with a wound vac until postoperative day (POD) 5, with local wound care thereafter. For RFFF, a removable volar forearm splint was used continuously until discharge and thereafter only nightly to encourage wrist range of motion. Patients were on bed rest until POD 3 and transitioned to ambulation by POD 4, with discharge on day 5 if meeting all discharge criteria. Patients were instructed to elevate the phallus using gauze and to avoid heavy lifting or direct pressure for 8 weeks.

RESULTS

Demographics and Operative Details

Thirty-eight free flaps (36 unique patients) were performed for gender-affirming phalloplasty (36/38) or urethroplasty (2/38) (Table 1). Of 36 phalloplasties,

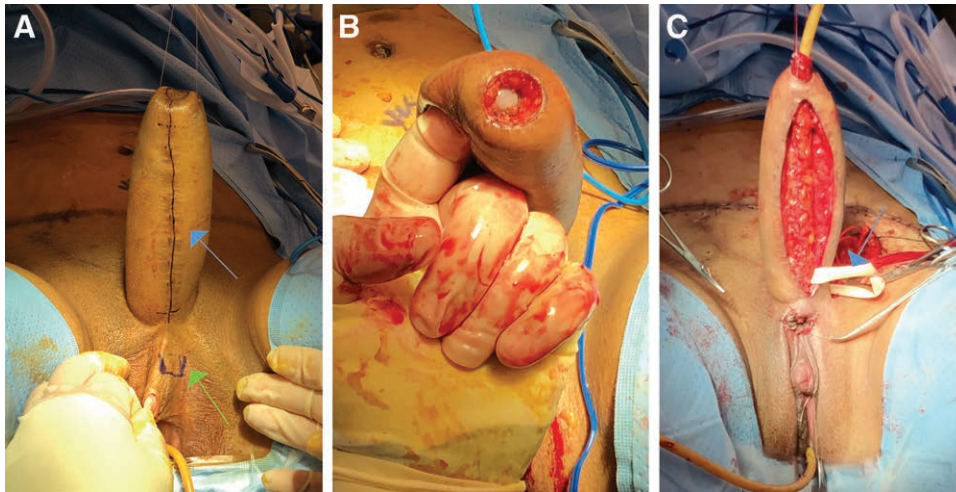


Fig. 2. RFFF urethroplasty. A, The ventral midline scar of the prior phalloplasty (blue arrow) is incised. A “U-shaped” marking 3 cm posterior to the phallus base is made for inset of the proximal neourethra (green arrow). B, The phallus is thinned by carefully excising adipose tissue along its length, avoiding injury to the phallus’ vascular pedicle. Skin at the phallus tip is excised to make a circular inset site for the new urethra. C, The neourethra flap is harvested, tubularized, and inset. The DIEA/V pedicle is exteriorized from the pelvis via a passage-opening made in the posterior wall of the external inguinal ring (EIR); it is anastomosed to the neourethra pedicle through a skin incision made directly over the EIR.

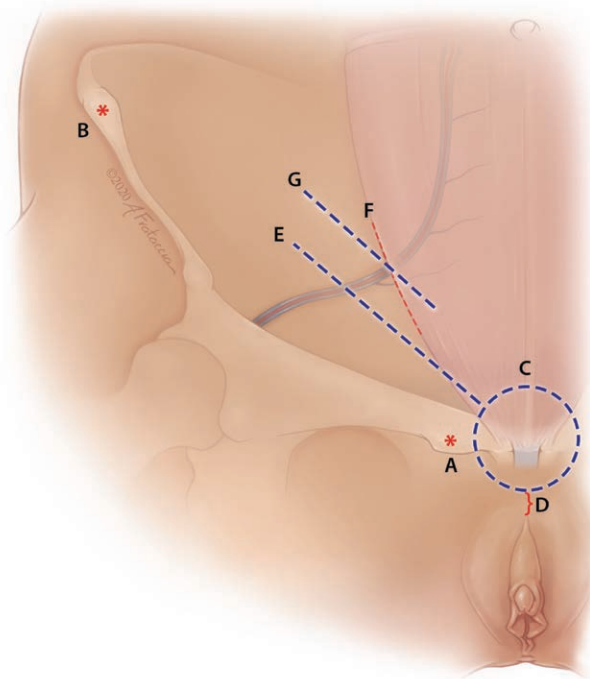


Fig. 3. Phalloplasty recipient site anatomic landmarks and incision markings. A = pubic tubercle (location marked by orange asterisk). B = anterior superior iliac spine. The phallus recipient site (hatched line, C) is marked as a circle 12–13 cm in circumference, at the patient’s mid-line. Its lower edge is 1–1.5 cm anterior to the anterior clitoral base (D). The ipsilateral DIEA/V pedicle is harvested through a 6- to 7-cm-long skin incision (hatched line, E) located 2–3 cm anterior and parallel to the inguinal ligament (defined from A to B). Abdominal-wall fascia deep to E is cleared of adipose tissue and the lateral edge of the rectus abdominis muscle (red hatched line, F) is identified. A 5- to 6-cm linear incision is made through the abdominal-wall fascia (G) parallel to and 2 cm anterior to the skin incision E. This fascial incision lies over the DIEA/V pedicle, where it emerges from beneath the inguinal ligament at a point typically half-way between A and B.

26 were RFFF and 10 were ALT free flaps; 27 of 36 included a neourethra. There were two cases of RFFF urethroplasty.

Mean age was 37.3 (range 18–74) years. There were no active smokers. Mean BMI was 25.7 kg/m². One patient (2.6%) was diabetic. The mean follow-up was 17.9 months (minimum 1.3 months). Demographics are summarized in Table 2.

No cases used the FA or interposition vein grafts. Arterial and venous anastomoses were performed end-to-end. All veins were coupled. Median coupler size was 2.0 mm (range 1.5–3.0). Two veins were anastomosed in 33 of 38 (86.8%) cases; one of 38 (2.6%) had three venous anastomoses, and four of 38 (10.8%) had one venous anastomosis. The GSV was used for supplemental venous outflow in one (2.6%) case. Other superficial veins (superficial inferior epigastric vein and ilioinguinal vein) local to the recipient site were used in two (5.3%) cases, in conjunction with the DIEV.

Clinical Outcomes

Complications are summarized in Table 3. Of 38 free flaps, there was one (2.6%) take back (Table 4) for venous congestion early in our experience; this was also the only case of total flap loss (2.6%). Four (10.5%) patients experienced hematoma (two on a forearm donor site and the other two at the recipient site): two occurred in the acute postoperative period and two presented beyond 1 week postoperative. Two (5.3%) flaps had dehiscence requiring surgical intervention; the rest were managed conservatively without further sequelae. No vascular complications occurred in the four patients with only one venous anastomosis. There were no cases of postoperative inguinal hernia.

Two of 38 (5.3%) cases had aberrant patient anatomy requiring modifications to the described recipient vessel preparation technique. In one case, this contributed

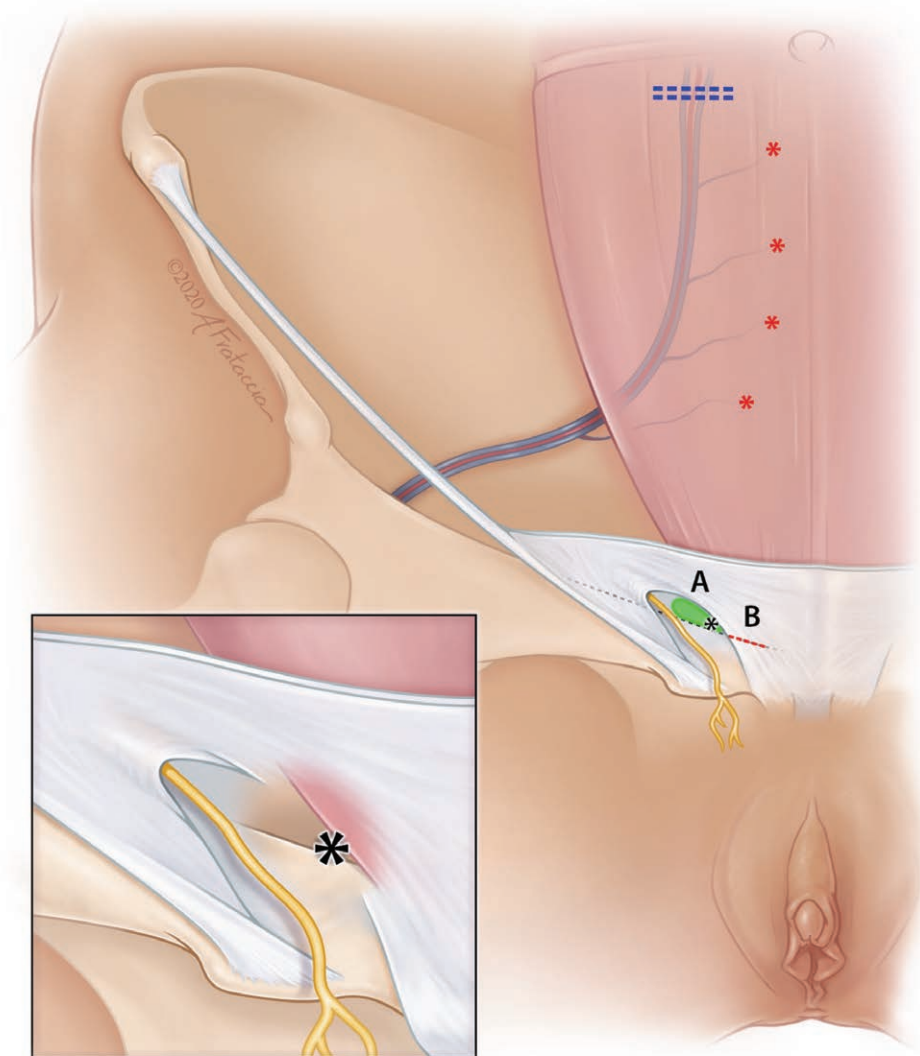


Fig. 4. Dissection of DIEA/V pedicle. The DIEA/V pedicle is dissected as far cephalad as possible, to where it passes into the belly of the rectus abdominis muscle (blue hatched double lines). The DIEA/V medially oriented small-vessel branches (red asterisks) are clipped and cut. The DIEA/V will later be clamped and ligated, and then exteriorized to the phallus recipient site via an opening made by blunt dissection through the posterior wall of the medial-most aspect of the EIR (A, green), at the latter's medial-most aspect (black asterisk). The floor of the passage is pubic bone, which is cleared of any decussating external ring fascia which could potentially choke the vascular pedicle. The ilioinguinal nerve (yellow) is prospectively identified at the lateral edge of the EIR. If the DIEA/V pedicle is too short, or if the EIR opening is located too laterally, the lateral edge of the RA tendon's insertion into the pubic bone can be incised (B, red hatched line), to create a more direct passage for the DIEA/V pedicle to the phallus recipient site. *Marks the location of the passageway through the back wall of the external inguinal ring that is created for passage of the DIEA/V pedicle from inside the pelvis, to the externally located recipient site.

to total flap loss. The EIR was unusually lateral creating an unfavorable trajectory for the DIEA/V pedicle. Therefore, the DIEA/V was externalized through an abdominal-wall fascial opening instead of using the usual tunnel. Though the flap initially appeared healthy, venous congestion occurred on POD 3. Operative exploration revealed venous thrombosis within veins kinked outside the fascial opening. Despite thrombectomy and anastomotic revision, the patient suffered unsalvageable venous congestion on POD 6, and the phallus was

resected. Subsequent repeat phalloplasty using the contralateral RFFF and DIEA/V pedicle was successful.

In another case of aberrant anatomy, a patient with incidental femoral hernia required repair with an overlay acellular dermal matrix (ADM). A keyhole incision was made through the ADM, near the EIR, to externalize the DIEA/V.

Nine patients (23.7%) required additional revision before their planned second-stage surgery (Table 5). These included washout of a delayed hematoma, urethroplasty for urethral stricture, repair of flap dehiscence,

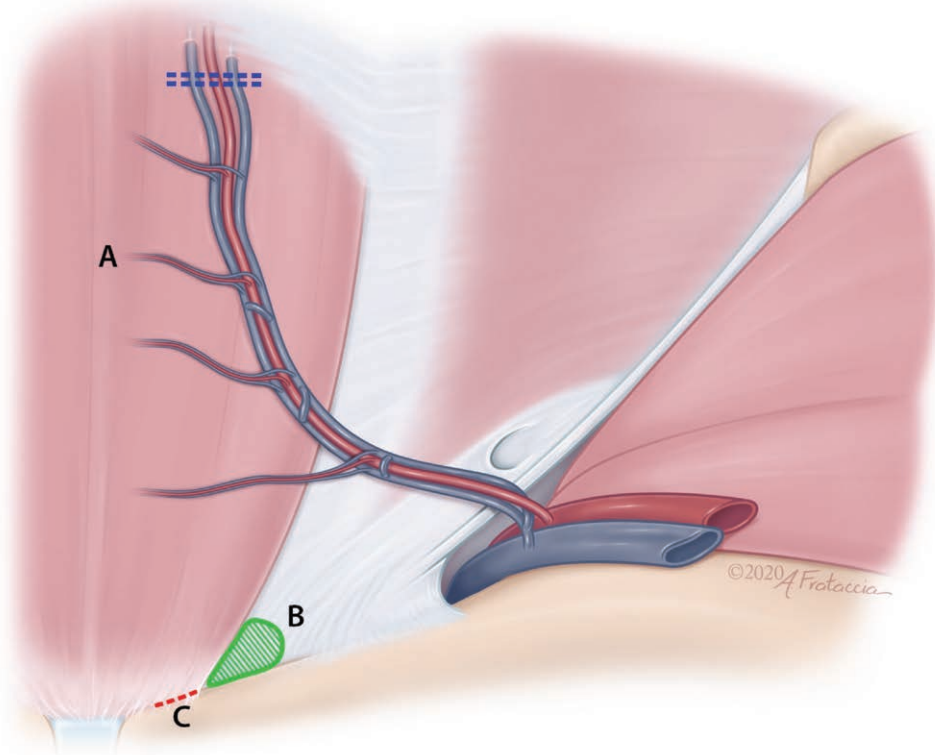


Fig. 5. DIEV/A pedicle: view from within the pelvis. The DIEV/A pedicle is dissected through the fascia incision shown in Fig. 1. Medially directed pubic branches of the deep pedicle of inferior epigastric vessels (A) are clipped and cut to completely mobilize the pedicle cephalad to the point where the pedicle inserts into the posterior aspect of the rectus abdominis muscle (RA; blue hatched lines). The pedicle will ultimately be exteriorized to the phallus recipient site (shown in Fig. 4) through an opening created by the surgeon through the medial-most of the external inguinal ring (B; green area). If the pedicle's length is limited, making a more direct trajectory for the pedicle through this opening to the recipient site desirable, the RA's lateral insertion/attachments to the pubic symphysis can be incised (C; red hatched line). This incision should be made directly on the bone, to create a smooth floor for the pedicle to pass through and in this way eliminate any tissues or fascia that could impinge on the pedicle.

neurolysis for radial-forearm sensory nerve pain, ligation of a bleeding radial artery pseudoaneurysm, and regrafting of a thigh flap donor site.

DISCUSSION

This work is the first to report outcomes of using the DIEV exclusively for venous outflow in free-flap phalloplasty. Complication rates for total and partial flap loss were 2.7% and 5.3%, comparable to rates in other series.⁷ We describe a surgical technique for externalizing the DIEA/V pedicle via a technically simple and reliable approach that avoids risks associated with using the FA or GSV, such as vessel size mismatch, inadequate recipient pedicle length, and anastomotic pseudoaneurysm.

Though optimal recipient vessel selection is crucial for any free-flap reconstruction,¹⁸⁻²⁴ this topic has been neglected in most phalloplasty reports,²⁵ which only describe the FA and GSV as recipient vessels.^{8,10,11,15,26-31} In one of the only available studies discussing alternative recipient vessel choices,^{25,39} Danker et al²⁵ discuss the DIEV's reliability as an adjunct to the GSV for venous

outflow, with improvement of outcomes after adding the DIEV. From our literature search, no reports have described phalloplasty outcomes using the DIEV as the primary source of venous drainage.

We achieved excellent clinical outcomes with primary use of the DIEA/V as recipient vessels. While many surgeons are comfortable using the FA and GSV, use of the DIEA/V has important advantages. Compared to the FA and GSV, the DIEA/V takes a shorter, more direct course to the recipient site. Favorable donor-recipient vessel size match allows for end-to-end anastomosis, providing less turbulent arterial blood flow that may decrease thrombosis risk relative to end-to-side anastomosis,⁴⁰ which is required when using the FA. To reach the FA, vein grafts are sometimes needed; these are prone to neointimal hyperplasia as well as eventual thrombosis.⁴³ High central arterial pressure from the FA can also increase the risk of vascular complications such as blowout and pseudoaneurysm. Avoiding the FA may hypothetically mitigate these risks, though long-term studies are lacking.

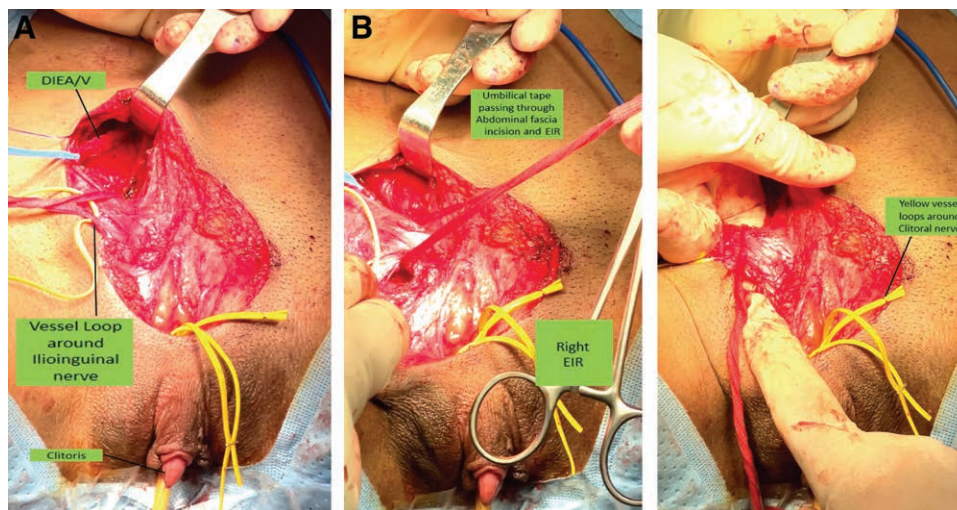


Fig. 6. Dissected tunnel for passage of DIEA/V pedicle. A, The DIEA/V pedicle is visible through the abdominal fascia incision. The ilioinguinal nerve and clitoris are shown. B, Dissection is performed through the medial aspect of the EIR, through the posterior wall of the EIR (comprised of conjoint tendon and Transversalis fascia). An umbilical tape is used to retract upwards on the tunnel to facilitate passage of the pedicle. C, After dissecting the passageway shown in (B), a gloved finger inside the pelvis is visible through the EIR.

Successful use of vein couplers and end-to-end arterial anastomoses in our series was possible because our technique relies on joining comparable-diameter vessels. In most cases, the VC of the flap pedicle (namely, the radial artery or descending branch of the lateral circumflex FA) provided flap drainage. Occasionally, superficial flap veins, such as the cephalic, augmented outflow as the second venous anastomosis. The decision to use these veins was based on the absence of a second deep epigastric (or flap pedicle) VC rather than difficulty with matching vessel caliber.

Danker et al noted a relatively high rate of take backs for venous congestion when relying on cephalic-GSV anastomoses alone for venous outflow early in their series.²⁵ They hypothesized that the GSV's larger diameter slows outflow velocity, increasing venous thrombosis risk. They noted improved outcomes when later utilizing the DIEV as an auxiliary venous anastomosis in combination with the GSV, pointing out that the DIEV is the only locoregional vein not crossing the groin crease, thereby decreasing the risk of venous compression.

Here, we have further shown the DIEV's reliability by routinely using it as the primary source of venous outflow. In most cases, we performed two venous anastomoses using the paired DIEV, except in four cases where there was only one usable DIEV that maintained robust flap drainage. In one case, a GSV was successfully used to supercharge the flap for additional venous outflow; in two cases, an additional locoregional vein (ie, ilioinguinal vein and superficial inferior epigastric vein) were used. To summarize our approach to venous outflow, in most cases, a single VC was likely sufficient but when a second one was present, it was used. Following the only flap loss (due to venous congestion and unusual inguinal anatomy), our approach to venous supercharging became

more aggressive. In cases where a second VC was absent and outflow appeared compromised (judging by flap appearance, capillary refill, and engorgement of clipped flap veins), a second superficial vein was included for flap supercharging.

Our rates of re-exploration and venous thrombosis were low, lower than previously reported for DIEV use²⁵ and comparable to other free-flap phalloplasty studies.^{41–43} This is possibly due to our more direct, orthotopic technique for externalizing the DIEA/V pedicle. In this study, venous thrombosis occurred only once and prompted us to maintain a very low threshold to use additional local veins or the GSV whenever adequate venous drainage is threatened by an absent or diminutive second VC.

Our method of externalizing the DIEA/V differs from that of Danker et al,²⁵ who externalize the DIEA/V through an abdominal-wall myofasciotomy, citing theoretical concerns of inguinal hernia through the EIR. In our experience, we have not seen any iatrogenic inguinal hernias. Many urologists routinely use the EIR for passage of penile prostheses and prosthetic urethral sphincter reservoirs into the retropubic space.^{44,45} Risk of hernia through the EIR is reported to be low.^{44,45} Furthermore, use of ad hoc keyhole incisions through the abdominal-wall fascia poses risk. In our early experience, we externalized a DIEA/V pedicle through an abdominal-wall fascial opening due to an anatomically aberrant EIR. This patient subsequently developed venous congestion resulting in total flap loss, suggesting that creating an arbitrary opening in the multilayered abdominal wall may contribute to compression and obstruct venous outflow. Depending on where the keyhole incision is, fascial keyhole incisions may be more prone to kinking/choking because the pedicle

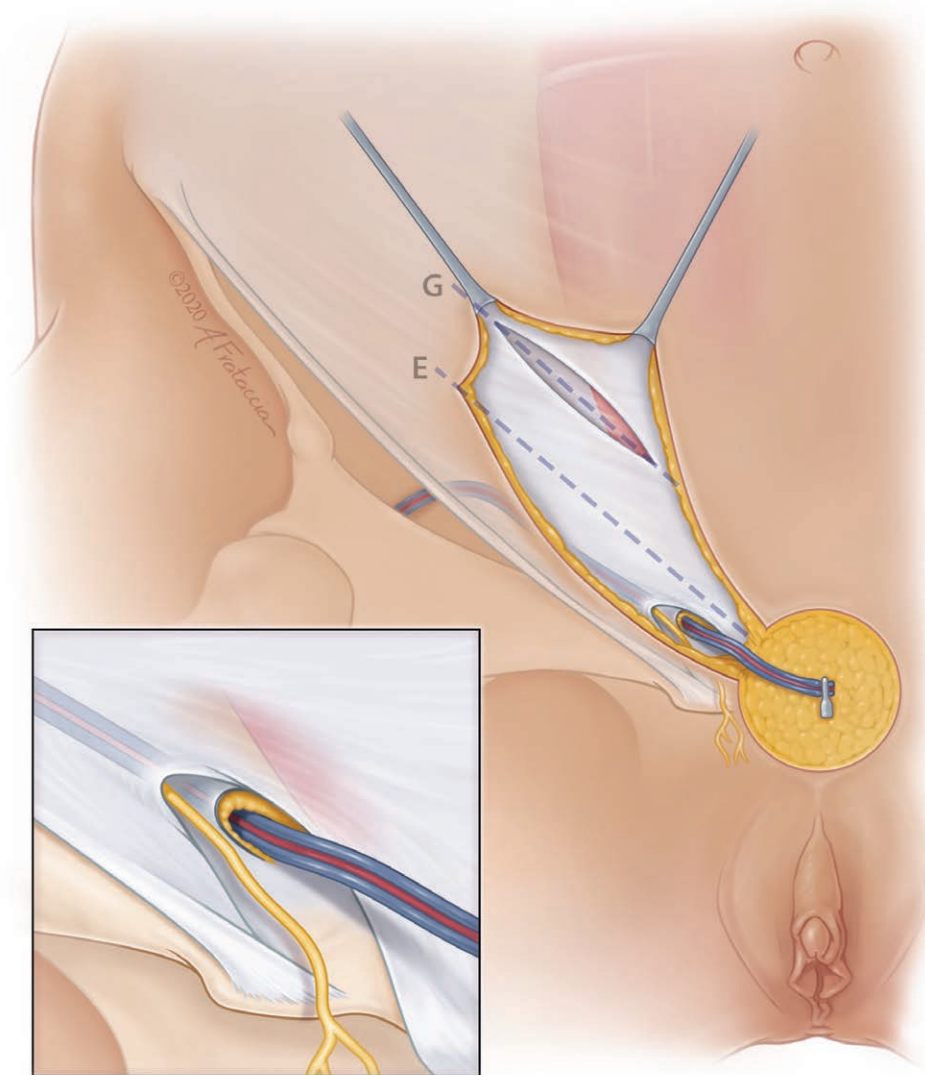


Fig. 7. DIEV/A pedicle exteriorized through the medial-most aspect EIR. Incisions through the skin (Fig. 1E) and abdominal fascia (Fig. 1G) have been made. The latter yielded access to the DIEV/A pedicle, which has been dissected and mobilized as far cephalad as possible. Following application of vascular clips and transection of the cephalad end of the pedicle, the pedicle is passed through and exteriorized via the incision opening made directly through the most medial and posterior aspect of the EIR. The clipped end of the DIEV/A pedicle reaches easily to the recipient site.

passes through independently contracting muscle-aponeurotic layers, whereas the EIR passageway has a static, smooth floor comprised of pubic bone (Video 2) and is naturally located between the DIEV/A pedicle and the phallus-site. Based on our experience, we feel that the passageway created through the posterior wall of the EIR is a safer, more reliable method of externalizing the DIEA/V. We have not observed any hernias with an average follow-up of nearly 1.5 years. Further follow-up will confirm longer-term outcomes.

Another important advantage of using the DIEA instead of the FA as the recipient artery is the DIEA pedicle's reliably adequate length, resulting in rare need for interposed vein grafts, which are often needed to bridge distance between the flap's pedicle and the FA.³⁰ Such

grafts can contribute to complications such as neointimal hyperplasia, and anastomotic pseudoaneurysm or blow-out from high-pressure flow. Although such issues are not commonly reported, our group has cared for a patient referred for postphalloplasty symptomatic femoral pseudoaneurysm and high-pressure flow through an arterialized vein, which presented as symptomatic groin pain and visible pulsations over the pseudoaneurysm. Diagnosis was confirmed with CT angiogram. Vascular repair, removal of the flap, and secondary free-flap phalloplasty were successfully performed. This diagnosis requires high clinical suspicion and is therefore likely missed and under-reported. The reliable length and reach of the DIEA/V pedicle obviate the need for interposed vein grafts and thus eliminate these risks.

Table 1. Types of Free Flap

n = 38	Total Number	RFFF	ALT Free Flap
Phalloplasty	36	26	10
With neourethra	27	23	3
Without neourethra	9	3	7
RFFF urethroplasty	2	2	-

Table 2. Patient Demographics and Operative Details

n = 36	
Mean age	37.3 (SD 13.5) y
BMI	25.7 (SD 5.9)
Current smoker	0
Diabetic	1/36 (2.78%)
Mean follow-up	17.9 (SD 11.3) mo

Table 3. All Complications

N = 38	
Total flap loss	1 (2.6%)
Partial flap loss	2 (5.3%)
Hematoma (including acute and delayed)	4 (10.5%)
Infection (minor, treated with antibiotics alone)	5 (13.2%)
Infection requiring washout	0
Wound dehiscence	6 (15.8%)
Donor-site complication	3 (7.9%)
Skin necrosis (nonflap)	1 (2.6%)
Urethrocutaneous fistula	6 (15.8%)
Urethral stenosis	4 (10.5%)
Any complication (including minor)	19 (50.0%)
Complication requiring surgical intervention	15 (39.5%)
Complication requiring acute takeback (within 1 wk postoperative)	2 (5.3%)
Complication requiring additional revision surgery before planned second-stage surgery	9 (23.7%)

Table 4. Operative Takebacks within 1 Week Postoperative

n = 38	
All takebacks within 1 wk of first-stage operation	2/38 (5.3%)
For flap perfusion-related concern (venous congestion)	1/38 (2.6%)
For hematoma	1/38 (2.6%)

Table 5. Additional Revisions before Planned Second-stage Surgery

n = 38	
Need for revision surgery before planned second-stage	9/38 (23.7%)
Washout of delayed hematoma	3/38 (7.9%)
Debridement of necrotic skin (nonflap)	1/38 (2.6%)
Repair of wound dehiscence	2/38 (5.3%)
Neurolysis of entrapped radial sensory nerve	1/38 (2.6%)
Repair of brachial artery injury w/delayed presentation and hematoma	1/38 (2.6%)
1 skin grafting of thigh donor site	1/38 (2.6%)

Any vascular transposition technique has the potential to cause pedicle compression. As we learned from the single total flap loss, clinical judgment to ensure that the microvascular anastomoses are tension-free, with no kinking or torsion of the pedicle, is crucial. In our series, an additional superficial vein was anastomosed to supercharge

outflow in only three cases. As with any free tissue transfer, limitation to venous outflow is often the most pernicious factor, and so we recommend using two DIEV or, when not possible, maintaining a low threshold to use a second superficial vein, such as the GSV, to augment flap drainage.

CONCLUSION

At our institution, preferential use of the DIEA/V as recipient vessels in free-flap phalloplasty has resulted in excellent outcomes, with low rates of flap loss and vascular complications. Advantages of the DIEA/V include a shorter, more direct course to the recipient site and more favorable vessel size match, allowing for end-to-end arterial anastomosis. This technically simple technique eliminates the need for interposed vein grafts and their associated risks such as anastomotic pseudoaneurysm, neointimal hyperplasia, and vessel blowout. The DIEA/V are easily dissected through a cosmetically acceptable scar. The DIEA/V is the preferred recipient pedicle for free-flap phalloplasty at our institution.

Maurice M. Garcia, MD, MAS
 4635 Third St., Suite 1070 W
 Los Angeles, CA 90048
 Email: maurice.garcia@cshs.org

REFERENCES

- Sarkaya S, Ralph DJ. Mystery and realities of phalloplasty: a systematic review. *Turk J Urol.* 2017;43:229–236.
- 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.
- 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.
- Lumen N, Monstrey S, Ceulemans P, et al. Reconstructive surgery for severe penile inadequacy: phalloplasty with a free radial forearm flap or a pedicled anterolateral thigh flap. *Adv Urol.* 2008;2008:704343.
- Terrier JE, Courtois F, Ruffion A, et al. Surgical outcomes and patients' satisfaction with suprapubic phalloplasty. *J Sex Med.* 2014;11:288–98.
- Hage JJ, Bouman FG, de Graaf FH, et al. Construction of the neophallus in female-to-male transsexuals: the Amsterdam experience. *J Urol.* 1993;149:1463–1468.
- Morrison SD, Shakir A, Vyas KS, et al. Phalloplasty: a review of techniques and outcomes. *Plast Reconstr Surg.* 2016;138:594–615.
- Chen ML, Safa B. Single-stage phalloplasty. *Urol Clin North Am.* 2019;46:567–580.
- Heston AL, Esmonde NO, Dugi DD III, et al. Phalloplasty: techniques and outcomes. *Transl Androl Urol.* 2019;8:254–265.
- Jun MS, Pušica S, Kojovic V, et al. Total phalloplasty with latissimus dorsi musculocutaneous flap in female-to-male transgender surgery. *Urology.* 2018;120:269–270.
- van der Sluis WB, Smit JM, Pigot GLS, et al. Double flap phalloplasty in transgender men: surgical technique and outcome of pedicled anterolateral thigh flap phalloplasty combined with radial forearm free flap urethral reconstruction. *Microsurgery.* 2017;37:917–923.
- Felici N, Felici A. A new phalloplasty technique: the free anterolateral thigh flap phalloplasty. *J Plast Reconstr Aesthet Surg.* 2006;59:153–157.
- Schechter LS, Safa B. Introduction to phalloplasty. *Clin Plast Surg.* 2018;45:387–389.

14. Ascha M, Massie JP, Morrison SD, et al. Outcomes of single stage phalloplasty by pedicled anterolateral thigh flap versus radial forearm free flap in gender confirming surgery. *J Urol*. 2018;199:206–214.
15. Monstrey SJ, Ceulemans P, Hoebeke P. Sex reassignment surgery in the female-to-male transsexual. *Semin Plast Surg*. 2011;25:229–244.
16. Esmonde N, Bluebond-Langner R, Berli JU. Phalloplasty flap-related complication. *Clin Plast Surg*. 2018;45:415–424.
17. Schardein JN, Zhao LC, Nikolavsky D. Management of vaginoplasty and phalloplasty complications. *Urol Clin North Am*. 2019;46:605–618.
18. Hiller A, Davis J, Schulz S, et al. Recipient vessel selection in head and neck reconstruction. *Eplasty*. 2017;17:e42.
19. Lee YJ, Baek SE, Lee J, et al. Perforating vessel as an alternative option of a recipient selection for posterior trunk-free flap reconstruction. *Microsurgery*. 2018;38:763–771.
20. Fujiki M, Ozaki M, Iwashina Y, et al. Clinical outcomes and recipient vessel selection for free flap transfer following arteriovenous malformation resection. *J Plast Surg Hand Surg*. 2019;53:56–59.
21. Yazar S, Lin CH. Selection of recipient vessel in traumatic lower extremity. *J Reconstr Microsurg*. 2012;28:199–204.
22. Park S, Han SH, Lee TJ. Algorithm for recipient vessel selection in free tissue transfer to the lower extremity. *Plast Reconstr Surg*. 1999;103:1937–1948.
23. Yang SJ, Eom JS, Lee TJ, et al. Recipient vessel selection in immediate breast reconstruction with free abdominal tissue transfer after nipple-sparing mastectomy. *Arch Plast Surg*. 2012;39:216–221.
24. Henry FP, Leckenby JL, Butler DP, et al. An algorithm to guide recipient vessel selection in cases of free functional muscle transfer for facial reanimation. *Arch Plast Surg*. 2014;41:716–721.
25. Danker S, Annen AW, Cylinder I, et al. Technical description and microsurgical outcomes in phalloplasty using the deep inferior epigastric artery and locoregional veins. *Plast Reconstr Surg*. 2020;146:196e–204e.
26. Perovic SV, Djinovic R, Bumbasirevic M, et al. Total phalloplasty using a musculocutaneous latissimus dorsi flap. *BJU Int*. 2007;100:899–905; discussion 905.
27. Djordjevic ML, Bumbasirevic MZ, Vukovic PM, et al. Musculocutaneous latissimus dorsi free transfer flap for total phalloplasty in children. *J Pediatr Urol*. 2006;2:333–339.
28. Jun MS, Pušica S, Kojovic V, et al. Total phalloplasty with latissimus dorsi musculocutaneous flap in female-to-male transgender surgery. *Urology*. 2018;120:269–270.
29. Zaheer U, Granger A, Ortiz A, et al. The anatomy of free fibula osteoseptocutaneous flap in neophalloplasty in transgender surgery. *Clin Anat*. 2018;31:169–174.
30. Kim S, Dennis M, Holland J, et al. The anatomy of forearm free flap phalloplasty for transgender surgery. *Clin Anat*. 2018;31:145–151.
31. Rashid M, Tamimy MS. Phalloplasty: the dream and the reality. *Indian J Plast Surg*. 2013;46:283–293.
32. Aggarwal A, Singh H, Mahendru S, et al. Minimising the donor area morbidity of radial forearm phalloplasty using prefabricated thigh flap: a new technique. *Indian J Plast Surg*. 2017;50:91–95.
33. Namba Y, Watanabe T, Kimata Y. Flap combination phalloplasty in female-to-male transsexuals. *J Sex Med*. 2019;16:934–941.
34. Dennis M, Granger A, Ortiz A, et al. The anatomy of the musculocutaneous latissimus dorsi flap for neophalloplasty. *Clin Anat*. 2018;31:152–159.
35. Garaffa G, Spilotros M, Christopher NA, et al. Total phallic reconstruction using radial artery based forearm free flap phalloplasty in patients with epispadias-exstrophy complex. *J Urol*. 2014;192:814–820.
36. Chang TS, Hwang WY. Forearm flap in one-stage reconstruction of the penis. *Plast Reconstr Surg*. 1984;74:251–258.
37. Wong CH, Wei FC. Anterolateral thigh flap. *Head Neck*. 2010;32:529–540.
38. Ali RS, Bluebond-Langner R, Rodriguez ED, et al. The versatility of the anterolateral thigh flap. *Plast Reconstr Surg*. 2009;124(6 Suppl):e395–e407.
39. Gilbert DA, Horton CE, Terzis JK, et al. New concepts in phallic reconstruction. *Ann Plast Surg*. 1987;18:128–136.
40. Ueda K, Harii K, Nakatsuka T, et al. Comparison of end-to-end and end-to-side venous anastomosis in free-tissue transfer following resection of head and neck tumors. *Microsurgery*. 1996;17:146–149.
41. Cylinder I, Heston A, Carboy J, et al. Partial flap loss in gender affirming phalloplasty. *J Reconstr Microsurg*. 2021 Jul 20 [Online ahead of print].
42. Matti BA, Matthews RN, Davies DM. Phalloplasty using the free radial forearm flap. *Br J Plast Surg*. 1988;41:160–164.
43. D'Arpa S, Claes K, Lumen N, et al. Urethral reconstruction in anterolateral thigh flap phalloplasty: a 93-case experience. *Plast Reconstr Surg*. 2019;143:382e–392e.
44. Park SH, Wen L, Mulcahy J, et al. Nuances of subcoronal inflatable penile prosthesis for physicians accustomed to penoscrotal approach. *Int J Impot Res*. 2020.
45. Garber BB, Gross MS, Stember D. Sub-external oblique placement of inflatable penile prosthesis reservoirs-initial experience. *Int J Impot Res*. 2019;31:400–403.