

# 30 Years of Experience in Musculocutaneous Latissimus Dorsi Flap Phalloplasty with Reinnervation: Optimal Principles

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**Background:** The technique of urogenital plastic surgery continues to pose difficulties for surgeons due to physical features of the anatomical region, which complicates the correction of various severe male urogenital pathologies. The goal of the surgeon is to create a neophallus that allows for urination and intercourse with minimal damage to the donor site. This special topic provides a historical overview and principles for optimal phalloplasty. To improve results in latissimus dorsi free-flap phalloplasty, we share our approach, its benefits, and the lessons we have learned.

**Methods:** We performed a retrospective review of patients who underwent shaft-only, two-stage or one-stage latissimus dorsi flap phalloplasty with or without reinnervation at a single institution from 1991 through 2020. Patients with a minimum of 1 year of follow-up were included. Data on the patient's demographics, the procedure, and the results of the operation were maintained.

**Results:** In total, 592 latissimus dorsi flap phalloplasties were performed during the entire study period. Of the phalloplasties, 494 (83.5%) were performed for gender-affirming surgery, of which 470 were performed for transgender patients and 24 for intersex patients. Twenty-five patients (4.2%) had congenital malformations, 17 (2.9%) had oncologic resections, and 56 had posttraumatic loss (9.5%).

**Conclusion:** Latissimus dorsi flap total phalloplasty with reinnervation is currently one of the few methods that can solve not only an aesthetic problem, but also a functional one without the use of an endoprosthesis if the level of reinnervation and muscle contraction is sufficient. (*Plast Reconstr Surg Glob Open* 2023; 11:e4963; doi: 10.1097/GOX.0000000000004963; Published online 26 April 2023.)

## INTRODUCTION

Penile reconstruction for penile malformations or traumatic loss can be divided into three stages. The first stage covers the period of using methods based on the Filatov stem, a phalloplasty method introduced by N.A. Bogoraz in 1936.<sup>1</sup>

We referred to various methods of phalloplasty based on the use of rotated pedicled flaps with axial blood supply (groin flap, gracilis flap, anterolateral thigh flap, and

flaps based on tender thigh muscles and rectus abdominis muscles) in the second stage.<sup>2-7</sup>

The third stage unambiguously includes phalloplasty methods based on the use of microsurgical flaps and microsurgical techniques. The gold standard for this stage is phalloplasty using the Chang method.<sup>8</sup> This method has aesthetic and functional possibilities compared with the previously presented phalloplasty methods. However, this technique requires harvesting a large flap from an anatomically important area of the forearm. Consequently, healing of the donor area and adequate rehabilitation of the hand are additional challenges.<sup>9</sup> Moreover, the use of synthetic phalloprosthetics is a negative aspect of this method. Nevertheless, this disadvantage affects almost all the mentioned methods, except for those that have a rigid automaterial in the form of cartilage, such as the Bogoraz

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method using rib cartilage or the Sadove method using a fibula.<sup>10,11</sup>

Recently, the phalloplasty method using the latissimus dorsi flap (LDF) has attracted interest as evidenced by frequent publications and presentations by colleagues from various countries.<sup>12,13</sup> However, the radial forearm free flap and anterolateral thigh flap methods were dominant. The authorship of this method of phalloplasty using an LDF in these publications is not definitely cited and is mainly attributed to Perovic.<sup>14</sup> Only one of the publications we encountered noted our authorship priority for this methodology.<sup>15</sup>

This study aimed not only to publish our experience in penile reconstruction, but also to substantiate our claim to the authorship of the LDF phalloplasty method and demonstrate the reliability and advantages of this method. In this context, we present a local historical overview of the reasons and aspects that have enabled us to propose and develop this phalloplasty method.

### OUR FIRST EXPERIENCE

In 1991, our first patients visited our clinic as part of a gender-affirming program. We used a two-stage technique that combined a sartorial muscle flap and an inguinal flap. First, we wrapped a right inguinal flap around the vascular pedicle of the right sartorius muscle (motor innervation of the sartorius muscle was preserved). This formed a combined “suitcase handle” flap with fixation to the periosteum of the pubic bone (Fig. 1). After 2 months, before admitting this patient to the second stage of the operation for cutting off the feeding part of the “stem,”

**Takeaways**

**Question:** Are there optimal principles for latissimus dorsi phalloplasty?

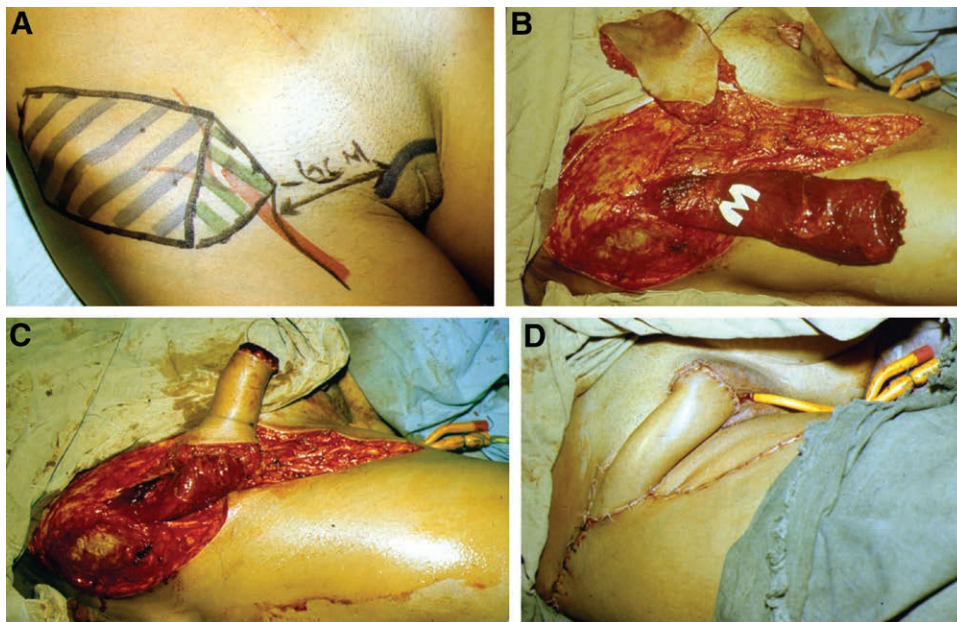
**Findings:** We analyzed 30 years of experience in latissimus dorsi phalloplasty with reinnervation in different clinical situations.

**Meaning:** The basis for successful phalloplasty depends on the anthropometric data of the patient, mandatory primary imitation of the external urethra and coronary sulcus, preference for using the deep epigastric vascular bundle for microsurgical revascularization, primary motor reinnervation of the muscular base of the neophallus by the obturator nerve, and the sequence of surgical steps.

the patient was able to spontaneously tense the neophallus with quite pronounced turgor. However, intraoperative crossing of the temporarily feeding “stem” resulted in complete decompensation of blood flow in the flap, thus requiring an immediate, intraoperative solution to this surgical disaster.

We performed phalloplasty from a microsurgical LDF (our department had vast experience with the LDF in various clinical situations). The latissimus dorsi muscle was also reinnervated based on the previous observation of the tension function of the sartorius muscle.

The deep epigastric vessels were the source of flap revascularization. We selected the motor branch of the obturator nerve as the source of motor reinnervation (extensive previous experience in using the femoral tendon as a microsurgical muscle flap allows the use of this nerve). The long-term



**Fig. 1.** Formation of the flap using the inguinal flap and the sartorius muscle for phalloplasty in 1991. A, Marking the design in the right inguinal flap area in our first patient. B, The sartorius muscle and the inguinal flap. C, Modeling of the flap. D, General view of the flap with fixation of the free end to the pubic bone.



**Fig. 2.** Our first patient with LDF phalloplasty. A, General view of the same patient who first underwent LDF phalloplasty (28 years after surgery). Scarring is visible in the right inguinal area and right thigh as a consequence of an ineffective attempted phalloplasty with sartorial muscle flap and inguinal flap. B, General view of the donor area.

results we obtained with thoracodorsal flap phalloplasty have been very promising and have become a baseline in our practice, not only in the practice of the gender-affirming program, but also in any urological loss (Fig. 2).

This phalloplasty technique is versatile and suitable for almost all clinical situations, including genital gender-affirming surgery for transgender men or intersex conditions, penile malformations, posttraumatic penile loss, and uromanual high-voltage injuries.<sup>16-21</sup>

From 1991 to 2020, our cumulative experience with LDF phalloplasty amounted to over 500 cases (an average of 15 phalloplasties yearly). For the first time, we presented observations in Berlin in 1993.<sup>16,22,23</sup>

### METHODS

We retrospectively reviewed the data of patients who underwent shaft-only, two-stage, or one-stage LDF phalloplasty with or without reinnervation at a single institution between 1991 and 2020. Patients with a minimum follow-up of 1 year were included in the study. We analyzed the flap outcomes and microsurgical techniques to define the principles of optimal LDF phalloplasty with reinnervation. All research components were approved by the I.M. Sechenov First Moscow State Medical University of the Ministry of Health of the Russian Federation. All study participants provided informed consent before receiving surgery.

### CLINICAL SITUATIONS AND SELECTION OF THE FLAPS

Phalloplasty has been performed in various clinical situations, including gender-affirming surgery for transgender men or intersex conditions, penile malformations,

posttraumatic penile loss, and high-voltage injuries. To enable urination while standing, patients were advised to either select urethral lengthening or a shaft-only design without a neourethra and with a perineal urethral aperture to reduce the possibility of urethral complications.

### APPROACHES

Primary phalloplasty was accomplished with phallo-urethroplasty, comprising the following stages: LDF shaft-only phalloplasty at the first stage, followed by radial forearm free flap urethroplasty at the second stage, with an interval of at least 4 months. Patients who refused the second stage and those who were poor radial forearm free flap candidates were offered shaft-only LDF phalloplasties. One-stage phallo-urethroplasty was performed only at the beginning of our training in this technique, and afterward, it was not recommended to patients because of the risk of complications. One-stage phallo-urethroplasty using only the resources of the thoracodorsal flap was offered if the patient was asthenic in constitution. The width of the skin part of the flap was 12–12.5 cm in patients with asthenia, 13–13.5 cm in those who were normosthenic, and 14–15 cm in those who were in hypersthenic.

### TECHNIQUE

The patient was placed in a full lateral right-side upper torso position. After a cutaneous incision was made, the myocutaneous flap, which contains the thoracodorsal artery, nerve, and veins, was meticulously dissected. A neophallus was formed by folding the flap into a tube using dermal sutures while strictly observing the longitudinal

**Table 1. Types of Reconstruction**

Variables	Categories	Abs.	%	95% CI
Reason for reconstruction	Transgender	470	79.4	75.9–82.6
	Intersex	24	4.1	2.6–6.0
	Congenital malformations	25	4.2	2.8–6.2
	Oncologic resections	17	2.9	1.7–4.6
	Posttraumatic loss	56	9.5	7.2–12.1
Type of reconstruction	Two-stage phallo-urethroplasty (LDF + RFFF)	278	47.0	42.9–51.1
	Shaft-only LDF phalloplasty	284	48.0	43.9–52.1
	One-stage phallo-urethroplasty using only the resources of the thoracodorsal flap	18	3.0	1.8–4.8
	One-stage phallo-urethroplasty	12	2.0	1.1–3.5

arrangement of the muscle fibers along the longitudinal axis of the neophallus. The external orifice of the urethra and coronary sulcus was imitated for each type of phalloplasty during LDF modeling. With the patient in supine position, a recipient bed was formed for the base of the neophallus by making an arcuate incision above the pubic joint. In patients with traumatic loss, the stump of the corpora cavernosa and urethra was isolated and mobilized by cutting the suspensory ligaments. Consequently, the cavernous bodies and urethra were separated. Hence, we managed to lengthen the penile stump by 3–4 cm. Urethral lengthening using labia minora and anterior vaginal wall flaps were performed in transgender individuals. The formed neophallus was fixed with the muscular part to the periosteum of the pubic bone using three PDS 0-0 sutures. In patients who underwent traumatic amputation, a stump of the cavernous bodies was inserted into the base of the flap, and the stump of the urethra was exposed by a fistula to the lower surface of the phallus for subsequent urethroplasty. Revascularization and reinnervation were performed with the inferior epigastric vessels (arteries and veins) and anterior branch of the obturator nerve.

Postoperatively, the patients underwent visual assessment of the flap and Doppler ultrasonographic vascular examination. Twelve months after the LDF stage of surgery, neophallus muscle activity was monitored. Subsequently, the patients reported their condition annually. If the required level of muscle activity was lacking, the patients were offered phalloprosthetics.

## RESULTS

### Demographics and Operative Details

In total, 592 LDF phalloplasties were performed during the entire study period. Of the phalloplasties, 494 (83.5%) were performed for gender-affirming surgery, of which 470 were performed for transgender patients and 24 for intersex patients. Twenty-five patients (4.2%) had congenital malformations, 17 (2.9%) had oncologic resections, and 56 had posttraumatic loss (9.5%). A two-stage phallo-urethroplasty was performed in 278 patients, Shaft-only LDF phalloplasty was performed in 284 cases, one-stage phallo-urethroplasty using only the resources of the thoracodorsal flap was performed only in 18 cases, and one-stage phallo-urethroplasty was performed in 12 cases (Table 1).

A simple survey of patients revealed that 80% of the patients were satisfied with erectile function if the flap was reinnervated. Reinnervation occurred in 91% of the cases, on average within 6–9 months postoperatively. The mean age of the patients was 27 years (range, 18–66 years). The mean follow-up period was 15 years, with a minimum of 1 year. (See table, Supplemental Digital Content 1, which demonstrates patient demographics. <http://links.lww.com/PRSGO/C529>.)

### Clinical Outcomes

In total, 197 complications were observed. Eight total and 29 partial flap losses were recorded. In the case of total loss, we performed repeated phalloplasty with an LDF from the opposite side in six cases. Autodermoplasty (36, including primary and secondary) is required in patients with partial flap loss (29). Debridement was performed in 37 cases, eight cases required complete necrectomy, and 29 cases required partial necrectomy. Owing to scar deformities of the neophallus (26), local tissue grafting was performed in 22 cases. A groin flap was created in 17 patients with deep necrosis. Microvascular anastomosis was revised in 14 patients with acute flap ischemia. The complications and treatment are summarized in Table 2 and Supplemental Digital Content 2. (See table, Supplemental Digital Content 2, which demonstrates the treatment of complications. <http://links.lww.com/PRSGO/C530>.)

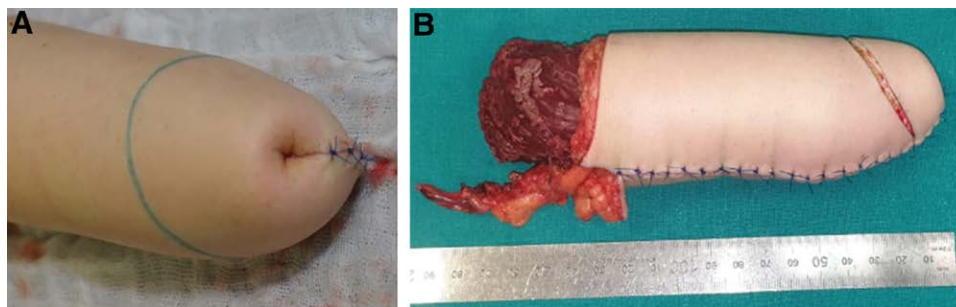
## DISCUSSION

### Optimal Principles for LDF Phalloplasty

Based on our experience, we developed the following optimal principles for LDF phalloplasty.

**Table 2. All Complications**

Categories	Abs.	%	95% CI
Total flap loss	8	4.1	1.8–7.8
Partial flap loss	29	14.7	10.1–20.5
Hematoma	14	7.1	3.9–11.6
Infection	26	13.2	8.8–18.7
Donor-site complication	43	21.8	16.3–28.3
Urethrocutaneous fistula	47	23.9	18.1–30.4
Urethral stenosis	4	2.0	0.6–5.1
Scar deformity with curvature of the neophallus	26	13.2	8.8–18.7



**Fig. 3.** Formation of the coronal sulcus and external urethral orifice. A, Stage of shaping an external urethral orifice. B, Shaping the coronal sulcus of the neophallus.

**Principle 1:**

The basis for successful phalloplasty depends on the anthropometric data of the patient.<sup>24,25</sup> We currently adhere to the following parameters for marking a thoracodorsal flap: flap length median value (neophallus), 16 cm; width, 15 cm. The width of the muscle base of the flap was at least 8–10 cm. In patients with hypersthenia, reducing the thickness of the neophallus by marginal resection of the subcutaneous fat and the latissimus dorsi muscle up to 4 cm was acceptable.<sup>26</sup> This approach can eliminate possible complications associated with the self-compression of the tubularized flap.

**Principle 2:**

In the mandatory primary imitation of the external urethra and the coronary sulcus,<sup>27</sup> the simple steps do not lengthen the operative time (performed in parallel with the closure of the donor back defect) and provide the neophallus a natural shape and appearance, which is extremely beneficial for the patient’s psychological well-being (especially important for transgender patients) and directly affects the quality of their social rehabilitation.<sup>28</sup> Our experience has demonstrated that an aesthetic and authentic appearance of the neophallic external urethra imitation in 20% of cases may lead to abandonment of the second urethroplasty step. Such patients adapt more quickly to perineal urinary options and are more likely to refuse complex and often unnecessarily risky surgical procedures. Of all the different ways we have tried and tested to simulate the external urethral orifice, we mainly use a simple but aesthetically effective method. The method

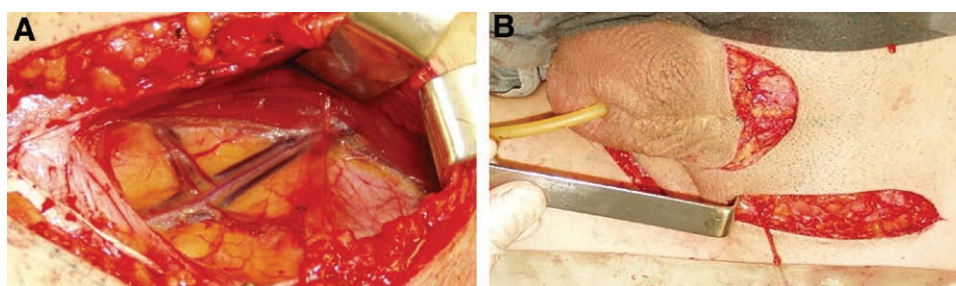


**Fig. 4.** Intraoperative marking.

involves suturing the central triangular part of the distal edge of the flap “skin in.” For the formation of the coronal sulcus, we prefer the “scarring” method, which involves cutting the skin along the anterior margin of the head of the neophallus to achieve a 3–4 mm free divergent skin edge effect (Fig. 3). These simple methods are quick to perform and provide a natural look in the long term.

**Principle 3:**

Using the deep epigastric vascular bundle for microsurgical revascularization,<sup>29</sup> we isolated the vessels from a relatively small incision in the contralateral pararectal side of the abdomen, approximately 10 to 12 cm long. The vascular bundle was prominent from the iliac vessels to the point where it entered the rectus abdominis muscle (Fig. 4). The isolated epigastric vascular bundle



**Fig. 5.** Access to the recipient nerve. A, Intraoperative view of the motor branch of the obturator nerve. B, Intraoperative view of the motor branch in the muscular-fascial tunnel and its exit into the pararectal incision.

was severed from the muscle, rotated, and led through the aperture in the aponeurosis of the external abdominal muscle to the base of the neophallus in the area of subsequent anastomosis with the thoracodorsal vessels of the neophallus. Accurately determining the rotation point of the epigastric vessels by correctly sizing and positioning the aperture in the aponeurosis is important to avoid kinking and compression.<sup>30</sup>

**Principle 4:**

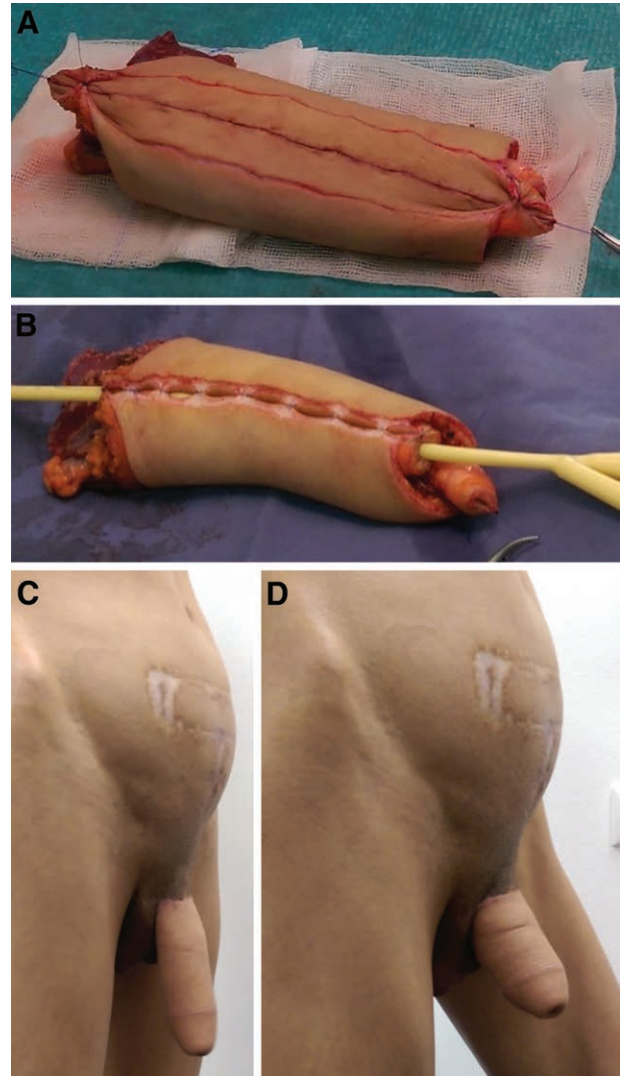
In the primary motor reinnervation of the muscular base of the neophallus,<sup>31</sup> the motor branch of the obturator nerve was isolated from the incision on the inner surface of the upper thigh. The nerve was excised along its length, cut as distally as possible, and led through the subfascial tunnel into the pararectal wound (meeting point of the donor and recipient vessels and nerves for micro-anastomosis) (Fig. 5). Our experience reveals that straining of the neophallus muscle functionally mimics its erection. (See figure, Supplemental Digital Content 3, which demonstrates the aesthetic appearance and function of the LDF neophallus without erection. <http://links.lww.com/PRSGO/C531>.) In most cases, this allows patients to engage in sexual activity without penile endo- or exoprosthesis. (See figure, Supplemental Digital Content 4, which demonstrates the aesthetic appearance and function of the LDF neophallus with erection. <http://links.lww.com/PRSGO/C532>.) Furthermore, erection is undoubtedly an important psycho-emotional factor in the social and sexual adjustment of patients.<sup>20,23,24</sup>

**Principle 5:**

The sequence of the surgical steps is as follows: flap harvesting, donor site suturing, and flap preparation and modeling.

**Step 1:** The operation was started by harvesting the flap. We prefer harvesting the flap from the right side, requiring the use of left epigastric vessels for revascularization. The right iliac region of the abdomen is preserved for future surgery, thus eliminating the risk of vascular damage due to a possible appendectomy later in life.

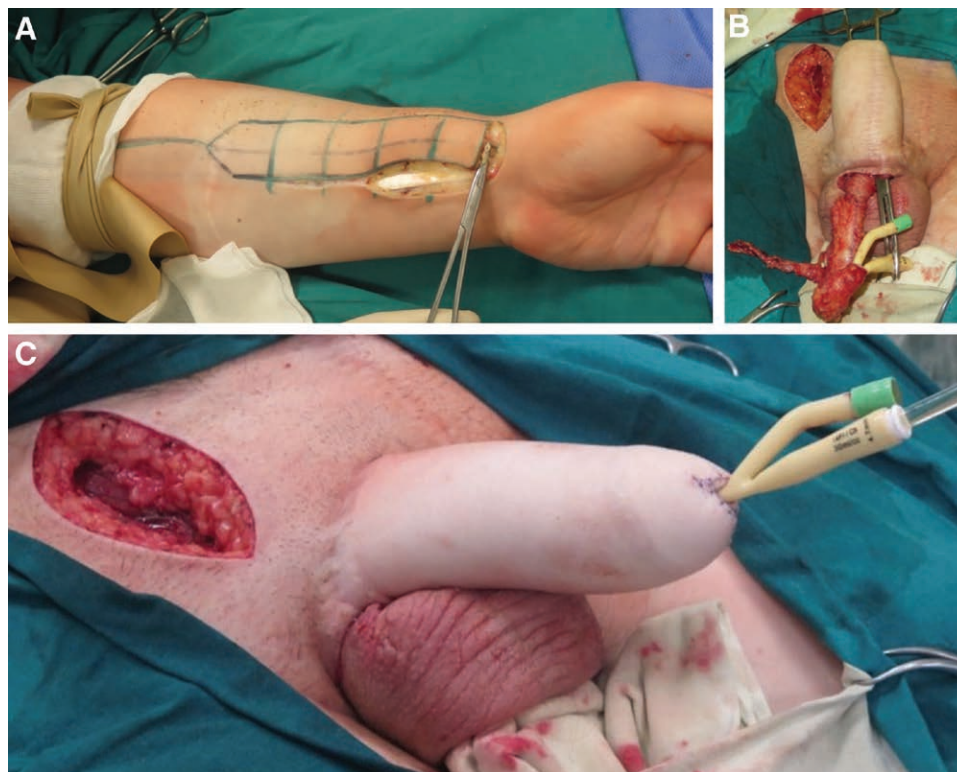
Alternative sources of flap revascularization (femoral artery branches and great saphenous vein) were also investigated as extra insurance in cases of force majeure. Our experience demonstrates a low probability of such an event. In only three cases, revascularization was performed using alternative vessels because of occlusion or insufficient line flow in the epigastrum due to mechanical damage from previous trauma or surgery. The use of alternative vascular sources remains relevant for possible revision due to complications such as thrombosis. Approximately 90% of all complications during LDF phalloplasty were observed at the beginning of mastering the technique. The high reliability of the method was confirmed by the fact that a large series of phalloplasty procedures (150 cases) were performed, and these patients were followed up for a long period of time (>15 years).



**Fig. 6.** One-stage phalloplasty and urethroplasty using only the LDF resources. A, Intraoperative modeling of the complex LDF neophallus in the asthenic patient with penile loss due to gunshot injury. B, Intraoperative modeling of the complex LDF neophallus: step of the urethroplasty. C, Aesthetic appearance and function outcome of the complex LDF neophallus without erection. D, LDF neophallus with erection.

**Step 2:** We do not recommend leaving the flap on the vascular pedicle or maintaining perfusion while the donor back wound is being sutured. The flap interferes only with the process of closing the donor defect and delays the overall operative time. Our experience reveals that it takes 35–40 min to close a donor defect using local tissue. This is exactly the same as that needed to model the harvested flap as a neophallus. Thus, these steps should be performed simultaneously.

**Step 3:** Sequential preparation of recipient site and flap performance. Surgical preparation was performed in the following sequence: formation of the neophallus bed, isolation of the vessels (deep epigastric bundle) and motor nerve, fixation of the flap to the periosteum of the



**Fig. 7.** The second stage of the two-stage phallo-urethroplasty (LDF + RFFF). A, Harvesting the free radial forearm flap for neourethra. B, Intraoperative view of the urethroplasty from a tubulated radial flap. C, Appearance of the neophallus with the neourethra.

pubic bone, and isolation and rotation of recipient vessels and nerves for anastomoses to the area of the pararectal incision (made to access the “epigastric”).

**Principle 6:**

We recommend performing urethroplasty as a second separate step in all cases, except when it can be performed using only the LDF. An excellent example of such a single-stage phallo-urethroplasty is the Chang method using a radial flap, and its advantages and disadvantages have been outlined. One-stage phalloplasty and urethroplasty using only the LDF resources is possible if the patient is asthenic (Fig. 6). However, urethroplasty is commonly performed using a free radial flap in a separate step with an interval of at least 3–4 months (Fig. 7). Performing radial flap urethroplasty ensures that the flap has no hair growth. In our experience, performing separate step urethroplasty minimizes urethroplasty-specific complications such as a urethral fistula.<sup>32,33</sup> The risk of flap self-compression was also significantly increased by combining these steps. The latter conclusion was based on the experience of 14 patients with such complications.

The aesthetic appearance of the neophallus is also an important psychological factor in the success of phalloplasty. Recent advances in ectoprosthetics have led to their widespread use. To achieve maximum aesthetic resemblance to the natural environment, we used individually ordered, reusable silicone ectoprostheses. (See

figure, Supplemental Digital Content 5, which demonstrates the view of the patient without a customized ectoprostheses. <http://links.lww.com/PRSGO/C533>.) These onlays are popular even in patients with good aesthetic results from phalloplasty. (See figure, Supplemental Digital Content 6, which demonstrates the view of the patient with a customized ectoprostheses. <http://links.lww.com/PRSGO/C534>.) Motor reinnervation of the flap muscle occurred between 3 and 8 months. In our department, endoprostheses is indicated in cases where reinnervation of the flap muscle does not occur or when sufficient contractile function for penetration is not achieved.

**Limitations of the Technique**

Sensory neurotization was not observed in any of the cases. However, the nerve that branches out to the tender thigh muscle contains a sensory portion, and the thoracodorsal nerve contains fibers responsible for proprioceptive sensitivity. Hence, the growth of sensitive fasciocytes along the motor fibers or growth of motor fasciocytes along the fibers responsible for proprioceptive sensitivity may be possible. A mismatch in skin tone between the back skin and the genital region also has aesthetic downsides. The skin of most patients with LDF is excessively thick to allow for immediate urethroplasty. However, this fact allows some patients to decide and stay at the shaft-only phalloplasty stage, which reduces the number of operations and

prevents trauma to the recipient area for urethroplasty. Moreover, intraoperative positional changes are also more challenging.

## CONCLUSIONS

One significant patient requirement is the possibility of introjection and sexual intercourse after penile reconstruction. LDF total phalloplasty with reinnervation is currently one of the few methods that can solve not only an aesthetic problem, but also a functional one without the use of an endoprosthesis, if the level of reinnervation and muscle contraction is sufficient. Based on our experience, we have listed what we believe to be the optimal principles of LDF phalloplasty.

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## DISCLOSURE

*The authors have no financial interests to declare in relation to the content of this article.*

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