

Technical Note

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# Microvascular autologous breast reconstruction with the lateral thigh perforator flap

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## Abstract

The lateral thigh perforator flap is an excellent alternative to the deep inferior epigastric artery perforator (DIEP) flap for patients with absolute or relative contraindications for a DIEP flap and adequate volume at the lateral thigh. Preoperative physical examination, preoperative markings, and radiological perforator mapping are essential for adequate surgical preparation. The flap is based on septocutaneous perforators of the lateral circumflex femoral artery, located in the posterior septum between the tensor fascia latae and the gluteus medius muscle. Being relatively stiff, septocutaneous perforators are sensitive to kinking and compression, which is important to keep in mind during flap inset. A donor nerve can be taken and coapted with the flap for sensate autologous breast reconstruction. For larger breast volumes, bipediced, conjoined, or stacked flaps are viable options. Quilting sutures during donor site closure is crucial in risk reduction of seroma formation and wound dehiscence. Complication risks seem comparable to other free flap breast reconstructions, such as the DIEP flap, especially when applying the quilting sutures at the donor site. During postoperative control visits at the outpatient clinic, additional procedures will be discussed, which often consist of lipofilling in the pectoralis major muscle for increasing upper pole volume, liposuction of the non-operated lateral thigh for symmetry in unilateral cases, or dog-ear corrections at the donor site.

**Keywords:** Breast reconstruction, autologous breast reconstruction, lateral thigh perforator flap, microsurgery, free flap



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## INTRODUCTION

The deep inferior epigastric artery perforator (DIEP) flap is considered the first choice in microvascular autologous breast reconstruction worldwide<sup>[1]</sup>. There is an increasing number of women choosing a breast reconstruction after their mastectomy and accordingly, the number of challenges in autologous breast reconstruction rises<sup>[2]</sup>. One of these challenges is the DIEP flap being regularly deemed suboptimal or unsuitable in women with a history of abdominoplasty, abdominal scars, or a lack of sufficient abdominal tissue for the desired breast volume<sup>[3]</sup>. In such cases, flaps from alternative donor sites are considered viable options.

Among others, examples of these alternative flaps are the profunda artery perforator (PAP) flap, the diagonal upper gracilis (DUG) flap, and the lateral thigh perforator (LTP) flap<sup>[3]</sup>. The LTP flap is harvested, as the name says, from the lateral thigh. Initially, the LTP flap was described as a myocutaneous flap and used for reconstruction of defects in the lower body<sup>[4,5]</sup>. In 1990, Elliot *et al.* first described the use of the lateral thigh as a donor site for free flap breast reconstruction with a tensor fascia latae myocutaneous free flap, which was later refined to a perforator flap by Kind and Foster<sup>[6,7]</sup>.

The investigation and identification of septocutaneous perforators have led to the introduction of the septocutaneous TFL flap for breast reconstruction by Tuinder *et al.* in 2014<sup>[8]</sup>. The septocutaneous TFL flap was later renamed the LTP flap, based on an idea of Linda Truluck Perry, to make the name more understandable for patients<sup>[9-12]</sup>. In this technical note, we will discuss the LTP flap with important clinical considerations, preoperative planning, relevant anatomy, operative technique, postoperative considerations, and clinical outcomes.

## CLINICAL CONSIDERATIONS

The LTP flap is seen as an alternative to the DIEP flap for autologous breast reconstruction. Reconstruction with an LTP flap may be considered for breast reconstruction when a DIEP flap is not possible, not recommended, or upon patient preference. The indications are, therefore, dependent on the clinical considerations and expertise of the plastic surgeon.

There are several absolute and relative contraindications for the LTP flap. The absolute contraindications are a lack of sufficient thigh tissue or a medical history that could compromise the eventual blood supply to the free flap, such as a history of surgery or injury on the thigh region. Relative contraindications for the LTP flap are comparable to those for other microvascular free flap reconstructions. Examples of these are comorbidities possibly influencing blood flow to and from the flap, such as cardiovascular disease, smoking, obesity, and hypercoagulability by any cause. Another relative contraindication is previous liposuction of the lateral thigh, as it may have harmed the local vasculature. Radiological imaging of the perforators through computed tomography angiography or magnetic resonance angiography examination is advised and can contribute to insights into the availability and quality of perforators at the level of the lateral thigh.

The ideal patient for an LTP flap has a so-called pear-shaped body contour. However, it is a feasible donor site for a much larger number of women than only these. One of the main advantages of the LTP flap is that many women, regardless of their body contour, have sufficient tissue in the lateral thigh area to utilize for safely harvesting the LTP flap.

## PREOPERATIVE PLANNING

A decent preoperative physical examination is important to estimate the amount of tissue available for reconstruction of the breast. At the lateral thigh, the widely used 'pinch test' is used for estimation of the

volume of tissue that can be harvested for reconstruction, but the test frequently overestimates the amount of tissue that can be safely taken while still attaining adequate donor site closure. Accordingly, caution should be taken during preoperative markings and the reconstructive surgeon should be cautious when choosing the specific flap size based solely on clinical examination, as relying only on the pinch test may increase the chance of wound dehiscence.

For preoperative markings, the following steps can be followed [Figure 1]:

1. A straight vertical line is drawn from the anterior superior iliac spine (ASIS) to the lateral border of the patella: this indicates the anterior border of the flap and also the course of the lateral femoral cutaneous nerve (LFCN).
2. A second line is drawn horizontally, perpendicular to the first line and at the height of the pubic bone.
3. These lines can be used as guidance to indicate the location of the perforators, as they can usually be identified lateral to the vertical line, surrounding the horizontal line, and therefore located on the lateral thigh.
4. A handheld Doppler ultrasound is used to preoperatively identify suitable perforators, guided by previous perforator mapping through radiological imaging. The distance of the perforator from the SIAS is then noted.

The perforator is often located more anteriorly than the preoperatively marked location due to the curvature of the thigh [Figure 2]. As such, this should be kept in mind during flap dissection as the pedicle will be encountered earlier than expected.

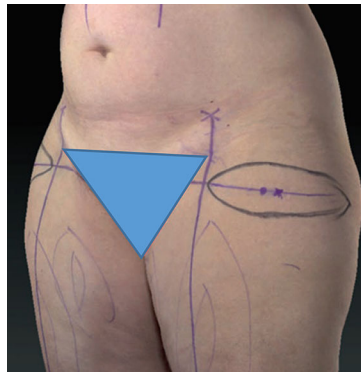
## RELEVANT VASCULAR ANATOMY

Initially, the TFL flap was based on musculocutaneous perforators<sup>[9]</sup>. Following more investigation of its clinical anatomy, septocutaneous perforators have been introduced for microsurgery. These septocutaneous perforators are located either in the anterior septum or in the posterior septum between the TFL and the surrounding muscles. The anterior septum is located between the rectus femoris/vastus lateralis muscle and the TFL. The posterior septum is located between the TFL and the gluteus medius muscle. The septocutaneous perforators originate from the ascending branch of the lateral circumflex femoral artery. In our clinic, we use the septocutaneous perforators located in the posterior septum.

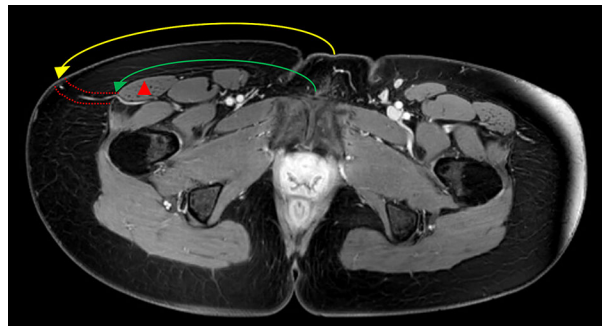
Previous studies have found the mean number of septocutaneous perforators to be approximately 1.5-1.8, ranging from 1-3 perforators per thigh. More than half of the perforators were found between 8-12 cm from the ASIS on imaging<sup>[8,9]</sup>. The perforators are considered suitable when they have a sufficient caliber, and their length is a minimum of 6 cm. This is feasible, as the pedicle length often ranges between 6-12.4 cm<sup>[8-10]</sup>. The mean diameter of the septocutaneous perforators is approximately 1.5 mm, ranging between 0.5-3 mm<sup>[11-14]</sup>.

## OPERATIVE TECHNIQUE

Throughout the entire procedure, the patient is positioned in the supine position with the arms tucked. A two-team approach is advisable. In this way, the plastic surgeon can harvest the flap while the resident or the second plastic surgeon performs dissection of the internal mammary vessels in the meantime. In



**Figure 1.** An example of preoperative markings at the donor site for the lateral thigh perforator (LTP) flap.



**Figure 2.** Preoperative perforator mapping by magnetic resonance angiography (MRA). As illustrated, the calculated distance from the anatomical landmark (in this case, the symphysis) to the perforator on MRA (green arrow) is shorter than the distance based on preoperative assessment by the plastic surgeon on the outside (yellow arrow), due to the curvature of the thigh. In between red dotted lines = septocutaneous perforator; red triangle = tensor fascia latae (TFL) muscle. Preoperative imaging and perforator mapping are important for the selection of a suitable perforator and are strongly advisable. CTA and MRA are the most commonly used methods<sup>[8,10]</sup>. In our clinic, we prefer MRA imaging as it provides high-quality imaging with no exposure of ionizing radiation to the patient. We use the scanning protocol introduced by Vasile and Levine<sup>[13]</sup>. Based on MRA imaging, the distance between an anatomical landmark, such as the pubic bone, umbilicus, or ASIS, is marked, and the position of the perforator emerging from the fascia in the subcutaneous tissue is measured and identified on the patient's skin. Due to the convex shape of the gluteal-thigh region, the distance of the perforator from the midline that is calculated on the MRA is not always reproducible [Figure 2]. However, the perforator always runs through either the dorsal (between the rectus femoris/vastus lateralis muscle and TFL muscle) or the ventral septum (between the TFL muscle and gluteus medius muscle). The septa can be identified using color Doppler, and thus, the perforators can be identified<sup>[8]</sup>.

bilateral cases, the same two-team approach can be applied. Below, we will explain the surgical steps for the LTP flap. An instructional and stepwise video of the full dissection can also be found in the digital content of the referenced paper by Tuinder *et al.*<sup>[15]</sup>.

#### Recipient site – mammary vessel dissection

Dissection of the internal mammary vessels is performed in the second intercostal space and, if possible, in a rib-sparing manner, equivalent to mammary vessel preparation for other microsurgical breast reconstructions<sup>[16,17]</sup>.

#### Donor site – flap dissection

Dissection of the flap at the thigh starts at the medial side of the preoperative markings. The medial side of the flap is incised in a perpendicular fashion without beveling. Dissection then continues in a medial to lateral fashion, where the LFCN is identified at the anterior border of the flap to prevent damaging it. The TFL and its overlying fascia can then be identified. The dissection proceeds over the fascia of the TFL

muscle toward the posterior septum, which is located between the TFL muscle and the gluteus medius muscle. The perforators, often numerous, emerge through the septum toward the superficial subcutaneous tissue underlying the flap skin. The aforementioned posterior septum is easily identified and distinguished from the fascia of the gluteus medius muscle, as the former is very thin and translucent enough to be able to see the TFL muscle fibers underneath, while the latter is thick and much whiter. After opening the posterior septum in a longitudinal fashion, the septocutaneous perforators can be followed between the TFL and gluteus medius muscle. [Figure 3](#) shows a schematic representation of the harvesting of the LTP flap after opening the posterior septum, where the perforators can be seen emerging from behind the posterior septum between the TFL muscle and gluteus medius muscle. The most cranially located perforator with the largest caliber is chosen. Careful dissection of the chosen perforator follows. A small cuff of fascia is taken surrounding the perforator, preventing unnecessary harm to it. The perforator is bluntly dissected until its origin at the ascending branch of the lateral circumflex femoral artery. Meanwhile, muscular branches are carefully ligated when encountered. The pedicle is clipped at its maximum length. The dissection is completed toward the lateral side of the flap and again, incisions are made without beveling. The flap is now ready for transplantation.

### **Anastomosis and flap inset**

When the flap has been harvested, an end-to-end anastomosis is made to the internal mammary vessels. The venous anastomosis is made with a coupler device. Avoiding kinking and compression of the pedicle during flap inset is important, because this occurs more easily with septocutaneous perforators, as these are less flexible than musculocutaneous perforators. Ideally, the flap is positioned perpendicular to the thoracic wall to reduce the risk of pedicle compression.

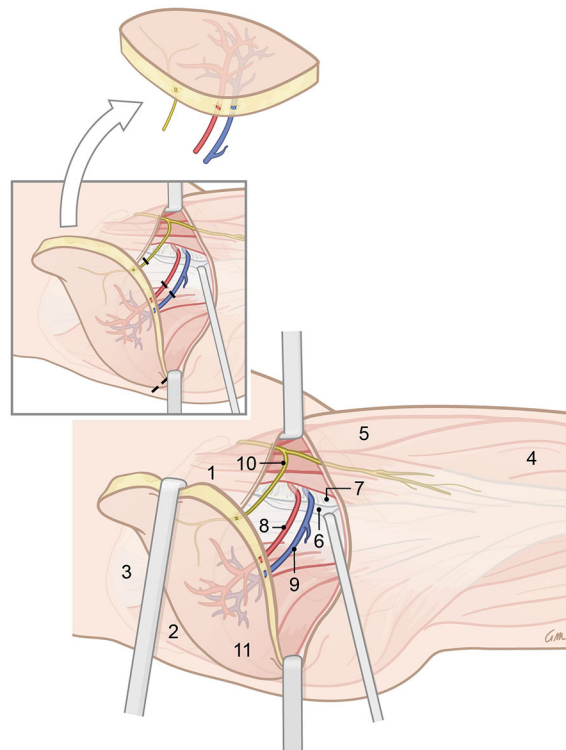
The recipient site is closed after locating the arterial Doppler and marking it on the skin paddle of the flap. The donor site is closed after caudal undermining, with quilting sutures used to securely approximate the subcutaneous tissue to the underlying fascia. To correct inconsistencies and increase donor site aesthetics, liposuction can be performed to minimize contour defects. The fat tissue acquired can be used for lipofilling of the upper pole of the breast to optimize the breast shape. This can also be done in a secondary surgery. One suction drain is placed at the donor site and one at the recipient site. The drains at the donor site will be kept in place for several weeks and often until the patient's discharge at the outpatient clinic. Having the suction drains in situ for an extended amount of time is important to prevent seroma formation.

### **Nerve coaptation**

The flap can be converted into a sensate autologous breast reconstruction by taking a donor nerve during flap dissection. The donor nerve is a branch of the LFCN or a branch of the anterior cutaneous branch of the femoral nerve and can be identified at the anterior border of the flap, cranially to the septocutaneous perforator. For the recipient nerve, we advise using the anterior cutaneous branch of the third intercostal nerve<sup>[18,19]</sup>. The donor and recipient nerves are directly coapted end-to-end with 9-0 nylon sutures followed by a drop of tissue glue.

### **Flap variations**

The LTP flap on itself can be harvested as a conjoined or stacked flap for more volume, such as in combination with the PAP flap as an L-PAP flap<sup>[20]</sup>. Stacked LTP flaps can be oriented obliquely along the junction between the hip and the upper thigh, in line with the earlier described preoperative markings, with the posterior limit lying along the gluteal crease. The bipediced L-PAP contains the vascularization of both the LTP and the PAP flap and the design includes the midposterior thigh by performing a near-circumferential thigh lift. Both pedicles have to be prepared and the flap can be harvested subsequently. The pedicles can be anastomosed to the internal mammary vessels in an anterograde and retrograde manner for



**Figure 3.** Schematic representation of the harvest of the lateral thigh perforator (LTP) flap: (1) tensor fascia latae muscle; (2) gluteus maximus muscle; (3) gluteus medius muscle; (4) vastus lateralis muscle; (5) rectus femoris muscle; (6) gluteus minimus muscle; (7) posterior septum between the tensor fascia latae muscle and gluteus medius muscle; (8) septocutaneous perforator (artery); (9) septocutaneous perforator (vein); (10) lateral femoral cutaneous nerve; (11) LTP flap.

the LTP and PAP flap pedicles, respectively. The flap can be coned for shaping. In the sample of 23 flaps in six women by Chu *et al.*, there were no reoperations or flap losses described<sup>[20]</sup>.

### POSTOPERATIVE CONSIDERATION

Postoperative treatment is comparable to that of other microvascular reconstructions. During hospital admission, patients will receive thromboprophylaxis and regular flap monitoring, often up until postoperative days 4 or 5 leading up to discharge, depending on local protocols.

In the months following surgery, patients return to the outpatient clinic for regular control visits. When all postoperative wounds have healed and the shape of the flap has reached a stable state, planning of additional procedures is discussed with the patient. Additional procedures can entail correction of contour defects of the flap, symmetrization of the contralateral (healthy) breast, or correction of irregularities at the donor site, such as dog ears. In the case of the LTP flap specifically, liposuction of the contralateral thigh can be considered in unilateral cases to acquire more contour symmetry.

### CLINICAL OUTCOMES AND COMPLICATIONS

In the literature, only one large series of LTP flaps has been described, which was detailed by our team<sup>[15]</sup>. We found a total flap loss rate of 1.4% and a partial flap loss rate of 0.7% in our case series of 138 LTP flaps. Additionally, 8.0% of flaps required reexploration, but all reexplorations resulted in vital flaps. Donor site complications were predominantly wound dehiscence, seroma, and infection, and often observed in the



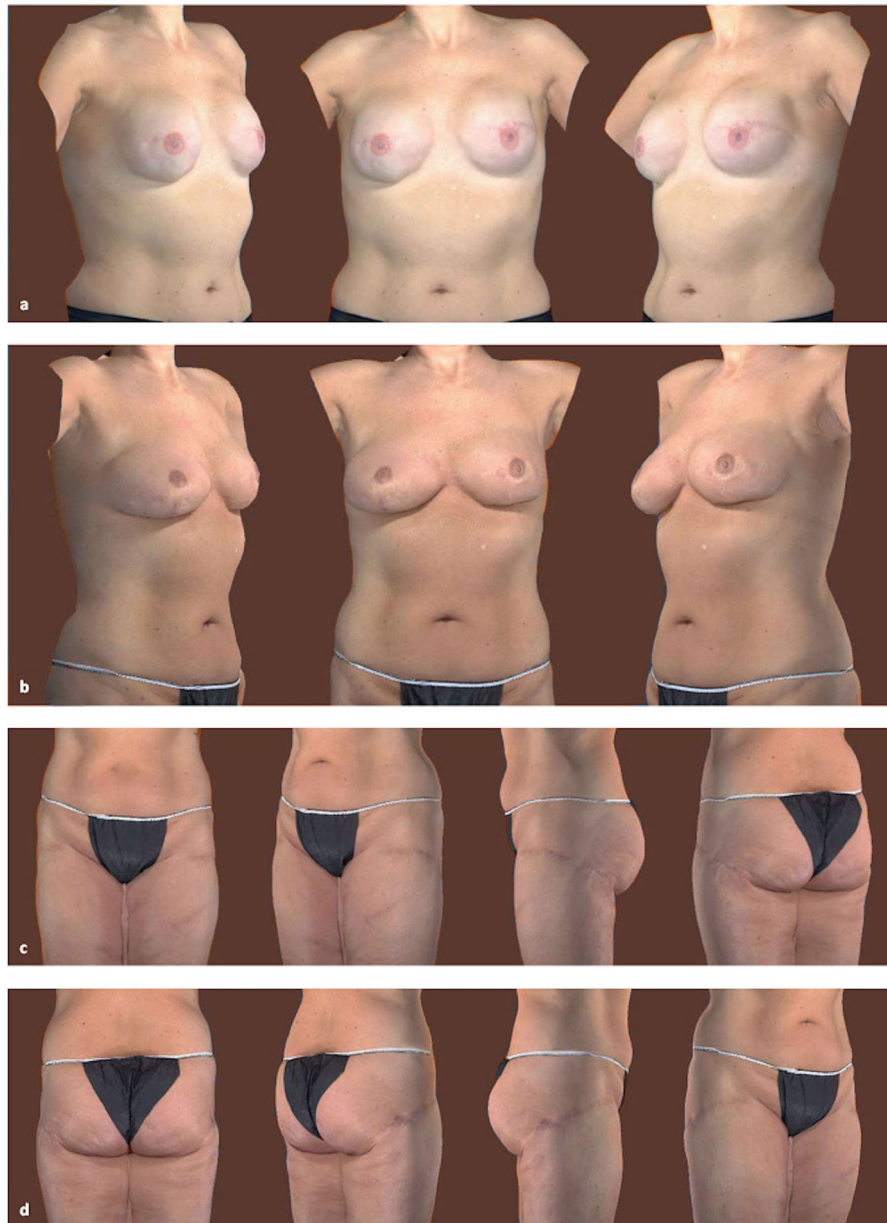
same patients. The incidence of these was significantly reduced after the implementation of improvements, which we will discuss further.

With over a decade of experience using the LTP flap, we have encountered various pitfalls and made several surgical refinements. First, we have decreased our maximum flap width from 9 to 6 cm. We started with a larger flap width to ensure the inclusion of the perforator in the skin island, but with a decrease in flap width, we saw an accompanying decrease in the risk of wound dehiscence at the donor site. As mentioned earlier, the pinch test is suboptimal for deciding flap width at the lateral thigh and decreasing our flap width by adhering to the maximum of 6 cm has decreased the likelihood of these donor site complications. The second paramount improvement is the introduction of quilting sutures at the donor site. Achieving dead space management and approximating the subcutaneous tissue to the fascia has drastically decreased the risk of postoperative seroma. Additionally, quilting sutures reduce the closing tension on the donor site. Third, we have refined aesthetic outcomes through several techniques, such as liposuction of the contralateral side in unilateral cases, reducing contour defects distal to the donor site with liposuction, lipofilling at the pectoralis major muscle to increase upper pole volume, and perpendicular dissection instead of beveling during flap harvest<sup>[15]</sup>. Although satisfied with their reconstructive outcomes, scars at the donor site may impact a patient's satisfaction with the donor site area and are visible when wearing conventional underwear<sup>[21]</sup> [Figure 4]. The average flap weight for the LTP flap is approximately 330-350 grams<sup>[15,19,22]</sup>.

As mentioned before, the LTP flap can be accompanied by a nerve coaptation to increase the postoperative return of breast sensation. LTP flaps with nerve coaptation have better sensation in both the native and the flap skin at a median follow-up of 16 months<sup>[19]</sup>. To make this more concrete, after LTP flap breast reconstruction and sensation measurements with the Semmes-Weinstein monofilaments, innervated native skin was found to recover to diminished light touch thresholds, while non-innervated native skin recovered to diminished protective sensation. Innervated flap skin recovered to diminished protective sensation, while non-innervated flap skin kept a postoperative loss of protective sensation. Nerve coaptation seems to stimulate nerve regrowth and sprouting of nerve fibers in both the flap skin, as the nerve is coapted to the flap, but also to the native skin, where no nerve is directly coapted.

## SUMMARY WITH KEY POINTS

1. The LTP flap is a viable option for microvascular autologous breast reconstruction in patients who are not eligible for or do not wish a DIEP flap.
2. Adequate preoperative markings and perforator mapping with radiological imaging are essential for well-prepared surgery.
3. The septocutaneous perforators lie in the posterior septum between the TFL muscle and the gluteus medius muscle.
4. Avoid kinking and compression of the pedicle during flap inset, as septocutaneous perforators are more prone to this happening.
5. Perpendicular incision instead of beveling during flap harvest is essential to reduce contour deformities at the donor site.



**Figure 4.** Postoperative results after a bilateral, tertiary breast reconstruction with a lateral thigh perforator (LTP) flap: (A) preoperative photo with implant-based breast reconstruction; (B) postoperative photo with bilateral, tertiary LTP flap breast reconstruction; (C) postoperative results of lateral thigh scar at the left-sided donor site after bilateral LTP flap breast reconstruction; (D) postoperative results of lateral thigh scar at the right-sided donor site after bilateral LTP flap breast reconstruction. Postoperative photographs were taken 3.5 years postoperatively.

6. Quilting sutures at the donor site are paramount to reduce the risk of seroma formation and wound dehiscence.

7. A sensate LTP flap can be achieved by including a branch of the LFCN or a branch of the anterior cutaneous branch of the femoral nerve from the donor site and coapting it to the anterior cutaneous branch of the third intercostal nerve in proximity to the internal mammary vessels at the recipient site.



8. The flap can be harvested as a conjoined or stacked flap for more volume, such as in combination with the PAP flap, as an L-PAP flap.

9. Additional procedures are often necessary to resolve contour defects and increase symmetry with the contralateral side of both the reconstructed breast and the donor site.

## CONCLUSION

The LTP flap is an excellent alternative to the DIEP flap for autologous breast reconstruction in patients with sufficient tissue at the lateral thigh, which is the case in a large number of women. The plastic surgeon should adequately prepare surgery by using perforator mapping and making decent preoperative markings to effectively find the septocutaneous perforators in the posterior septum between the TFL and gluteus medius muscles at the lateral thigh. Not beveling during flap harvest and donor site closure with additional quilting sutures optimizes donor site outcomes. Several weeks to months postoperatively, additional procedures in secondary stages are regularly required to optimize the aesthetics of the reconstructed breast and donor site. The flap can be performed in a conjoined or stacked manner for additional volume. Altogether, this makes the LTP flap a versatile option for microvascular autologous breast reconstruction.

## DECLARATIONS

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### Authors' contributions

Conceptualization: Tuinder SMH, Van Rooij JAF, Allen RJ

Made substantial contributions in collecting, searching, scanning literature, and writing the manuscript: Tuinder SMH, Van Rooij JAF

Performed a supervisory role of the manuscript: Tuinder SMH, Allen RJ

### Availability of data and materials

Not applicable.

### Financial support and sponsorship

None.

### Conflicts of interest

All authors declared that there are no conflicts of interest.

### Ethical approval and consent to participate

Not applicable.

### Consent for publication

Written informed consent for publication of images of preoperative and postoperative results was obtained.

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