



# The versatile latissimus dorsi flap: old and reliable or outmoded— with or without an add on?

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*Contributions:* (I) Conception and design: Both authors; (II) Administrative support: Both authors; (III) Provision of study materials or patients: Both authors; (IV) Collection and assembly of data: Both authors; (V) Data analysis and interpretation: Both authors; (VI) Manuscript writing: Both authors; (VII) Final approval of manuscript: Both authors.

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**Abstract:** Latissimus dorsi (LD) myocutaneous flap has long been the golden standard for breast reconstruction. Although free flaps have overrun pedicled flaps as the autologous reconstruction modality of choice for many patients, the LD flap is a good option when microsurgical reconstruction is not suitable or available. Many variations of the flap exist, some aiming to add volume and others to spare muscle function. The traditional LD flap for breast reconstruction has some drawbacks and controversies. The shoulder-related donor site morbidity and the extent of its severity, as well as the optimal management of the thoracodorsal nerve are still debated. To achieve a sufficient size, the LD flap was traditionally combined with implants or expanders. This practice has been questioned during the last decades due to implant-related complications. Instead, large volume fat grafting has become a valuable add-on for the LD flap, renewing the LD as a primary total autologous reconstructive alternative. Cost-effectiveness analyses support the use of autologous reconstructive modalities, slightly favoring pedicled flaps. With an increasing number of reconstructive options available, patients and their reconstructive surgeons will need to collaborate in a shared decision-making process. The LD reconstruction warrants thorough patient counselling, but is still a reliable choice for a selected group of patients, especially those for whom other alternatives are not suitable.

**Keywords:** Latissimus dorsi flap; breast reconstruction; fat grafting

Received: 16 February 2021; Accepted: 25 May 2021; Published: 30 June 2022.

doi: 10.21037/abs-21-29

View this article at: <http://dx.doi.org/10.21037/abs-21-29>

## Introduction

Today's plastic surgeons and post-mastectomy patients are collaborating closely on reconstructive options. In fact, breast reconstruction has become an integral facet on the breast cancer treatment algorithm. Plastic surgeons have several reconstructive methods to choose from. Traditionally, the myocutaneous latissimus dorsi (LD) flap has been considered one of the workhorse flaps for autologous breast reconstruction. It is a reliable reconstructive option with a consistent vascularity, and it

is easy to learn as no microvascular anastomosis is needed (1,2). The LD can be used in both immediate and delayed settings (1), in partial breast reconstructions (3-6), in uni- or bilateral cases (7-9), together with implants or expanders, or as an autologous flap—alone or with fat grafting (10).

The LD flap was first described by Iginio Tansini. In 1896, he published a dorsal cutaneous flap to cover the defect after breast cancer surgery, and in 1906 he redesigned the procedure to include the LD muscle in the flap (11-13). His method, a radical mastectomy with the LD flap, was popular throughout Europe between 1910 and 1920 (11).

The flap was reintroduced for breast reconstruction in the 1970's (14-16). In northern Europe, Finland has been one of the forerunners using the LD flap (17). This paper is a narrative review of the different aspects of using the LD flap for breast reconstruction.

### Variations of the LD flap

Numerous variations and refinements to the conventional LD flap exist. Some modifications, such as the extended LD, aim to add volume by including fat extensions above or below the muscle, for example the subcutaneous, lumbar and subseratal fat, and parascapular and scapula "fat fascia" (1,18-21). In addition, a fleur-de-lis skin paddle version has been used to carry additional fat on the surface of the LD muscle (22). Other variations aim to decrease donor site morbidity, such as the muscle sparing versions (23-26) and the thoracodorsal artery perforator (TAP) flap (27), to name a few. In addition, endoscopic (28-32) and robotic (33,34) LD muscle harvesting has been introduced.

### When to consider an LD?

Although free flaps have overtaken pedicled flaps as the primary autologous reconstruction modality, there are cases when a microsurgical reconstruction is not suitable or available. For example, the lack of other suitable soft tissue, comorbidities, obesity, smoking, prior major abdominal surgery, or unavailability of microsurgical services advocate other autologous reconstructive modalities (10,35,36). In these cases, the LD flap offers a good option. In addition, fat grafting has given this traditional flap a new resurgence in popularity as the primary total autologous reconstructive method (10).

Use of the LD flap is also relative to cultural beliefs and geographical constraints. In some countries, the LD has gone almost extinct and is mainly saved for tertiary or palliative purposes, such as for irradiated patients, delayed reconstructions or for the salvage after failed primary or secondary reconstruction (37,38). In other countries, however, the LD is part of the standard repertoire. The LD flap is a good option when microsurgical techniques are not available. In some countries, few patients have access to a practicing microsurgeon (39). Furthermore, a survey showed that only one fourth of practicing US plastic surgeons perform any microsurgical breast reconstruction (40). In addition, the proportion of post mastectomy non-autologous, implant-based reconstructions have grown in the US, whereas the number of autologous reconstructions

generally have declined (41). This is, in part, due to the increase in the number of contralateral prophylactic mastectomies, and may, in part, reflect the reimbursement trends (41). Patient education and awareness, leading to a fear of adverse effects in the donor sites, may also contribute to the decline in the use of the LD.

### Obesity and the LD

Obesity is considered a risk factor for extensive surgery, including microsurgery. Convincing meta-analyses have shown a clear increase in overall complications, recipient and donor-site complications, and partial flap failure in patients with a body mass index (BMI)  $\geq 30$  kg/m<sup>2</sup> (42). According to the recent studies, the LD flap seems to be a safer option in overweight patients. Yezhelyev *et al.* evaluated the influence of BMI on the complications after postmastectomy LD flap reconstruction (43). They concluded that the incidence of both flap and donor site complications after LD reconstruction was not significantly different in overweight (BMI 25–29.9 kg/m<sup>2</sup>) and obese (BMI  $\geq 30$  kg/m<sup>2</sup>) patients compared to the normal weight population. However, obese patients were more likely to develop mastectomy skin flap necrosis (43). In addition, Novak *et al.* compared complication rates between immediately fat-grafted LD and free tissue transfer in obese (BMI  $\geq 30$  kg/m<sup>2</sup>) population, and found out that the free tissue transfer group had a significantly higher rate of major and systemic complications (44).

Although LD reconstruction appears to be a safer option for overweight patients, one could assume that in breast reconstruction surgeries of approximately the same duration and recovery, the same systemic complications tend to be present—microsurgery or not. Currently, in our own practice, immediate or delayed elective LD-based breast reconstruction, is not recommended for patients with a BMI of 30 or more.

### Donor site sequelae

The harvest of the LD flap comes with some drawbacks. The contour deformity of the back after the harvest, together with a long and visible scar, may be undesirable by some (2,45). Seroma formation in the back is the most common complication (46). It is treated with a prolonged suction drainage followed by outpatient aspirations after the drain has been removed (1). To prevent this problem, different solutions have been attempted. A recent prospective randomized controlled trial compared the efficacy of fibrin

glue, triamcinolone acetonide, and quilting sutures in the seroma prevention after LD reconstruction. This study showed that the use of quilting sutures significantly decreases the incidence of donor-site seromas, leads to earlier drain removal and maintains a low complication profile (46).

The shoulder-related donor site morbidity and the extent of its severity is debated. The literature on this subject is quite controversial (47-49). Some state that the effect of the LD harvest on the shoulder function is negligible and minimal, whereas others have found that the impairment of the function is significant (47). A recent systematic review and meta-analysis of functional shoulder impairment after LD breast reconstruction, including 26 articles published until 5/2017, concluded that although the LD flap transfer appears to affect shoulder function, these limitations seem to be minimal. However, many of the studies comprised of small series, and some had a rather short follow-up period. Thus, the authors stated that the existing literature on the long-term shoulder function impairment is insufficient to draw any firm conclusions (47). Lohana *et al.* studied the functional recovery after bilateral extended autologous latissimus dorsi (EALD) breast reconstruction (50). They stated that bilateral EALD breast reconstruction does not appear to cause significant long-term impairment of shoulder function. However, they concluded that women should be appropriately counselled and preoperatively screened, and intensive physiotherapy might be needed.

With regard to the LD flap types, it seems that sparing the LD muscle can result in less functional implications than other types of LD flaps used (47-49). A recent prospective randomized controlled trial compared shoulder function after delayed breast reconstruction by either a LD flap or a TAP flap with assessment at baseline and 3, 6, and 12 months postoperatively. The study showed that patient-reported shoulder-related pain was significantly lower in the TAP group at 12 months after surgery when adjusting for pain at baseline, and the patients had better function of the shoulder 1 year after the reconstruction (51). In addition, patients reconstructed with the LD flap had a higher level of shoulder related pain and a reduced ability to perform normal daily functions while the range of movement and the strength of the shoulder did not seem to be influenced significantly. However, they stated that a longer follow-up period is needed to establish whether the observed difference change with time.

### Should we cut the thoracodorsal nerve?

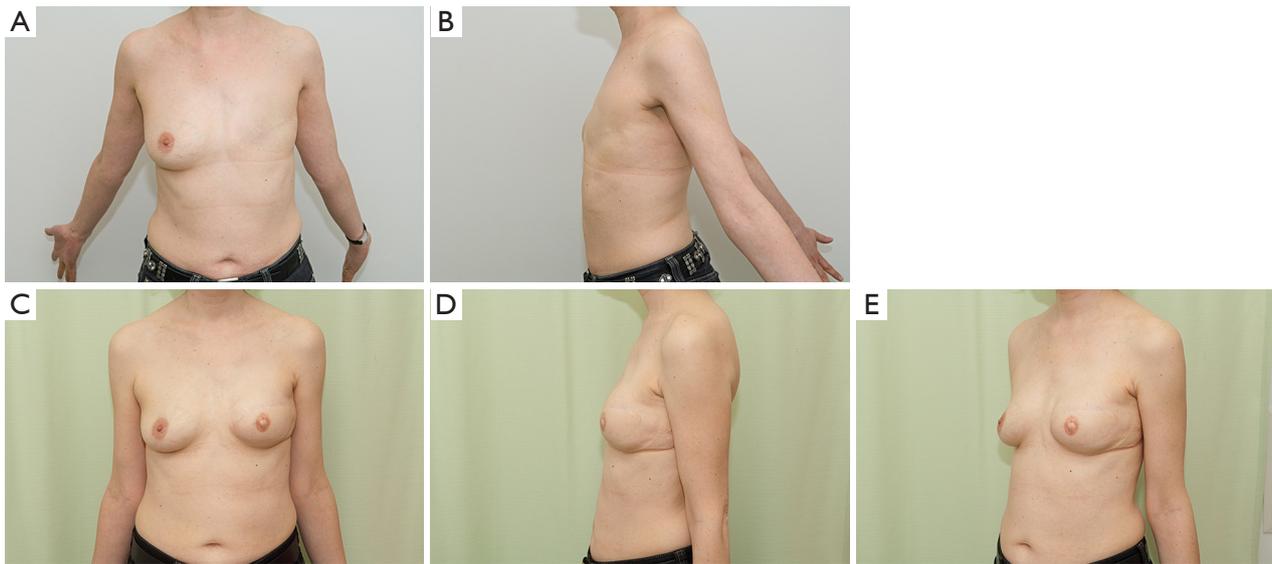
Optimal management of the thoracodorsal nerve in pedicled

LD flaps for mastectomy reconstruction is controversial. Animation deformity due to contraction of the muscle may cause a functional and aesthetic problem as well as be distressing for patients (1). To solve this issue, division of the thoracodorsal nerve has been proposed. However, flap denervation has been suggested to cause muscle atrophy leading to poor soft tissue coverage of a possible implant. Kääriäinen *et al.* challenged the idea that the resection of the nerve leads automatically to a volume loss and protects from pain and untoward muscle movement (52,53). Histology of the LD flaps with resected nerves showed that muscle atrophy was replaced with fatty degeneration 1 year post operatively while the volume of the flap was preserved on magnetic resonance imaging (MRI). Furthermore, patients with denervated LD flaps presented with a variety of animation and pain symptoms. The authors concluded that for the interest of operation time and simplicity, there is no need to cut the nerve. However, the possibility of the nerve resection having been too distal in the study subjects was not discussed. A recent retrospective clinical and anatomical study strongly suggests that reanimation does eventually occur despite nerve transection and is often symptomatic. Persistent late onset animation deformity is attributable to anatomical differences in the thoracodorsal branching patterns, rather than patient (age, BMI, smoking) or the therapeutic (oncology or surgery related) factors (54). Other studies may have failed to monitor this, due to short- or nonsystematic follow-up of patients. The thoracodorsal nerve starts to branch about 4 cm proximal to the superior border of the LD muscle and thus careful dissection of the nerve branch as proximally as deemed safe has been recommended. As this is technically arduous, preoperative counselling of the patient that dynamic motion may return years postoperatively is advised (54).

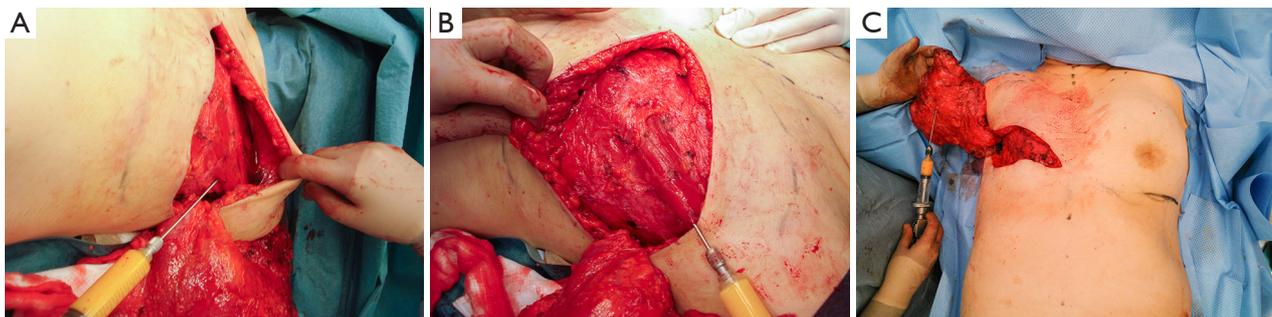
### Does the LD flap need an add-on?

To ensure sufficient size, the LD flap was traditionally quite routinely combined with implants or expanders, representing the classical use of the LD myocutaneous flap (*Figure 1*). During the last decades this practice has been questioned due to implant-related complications, such as infection, extrusion, periprosthetic contraction, rupture, and more recently, the suggested association with the anaplastic large cell lymphoma (55,56). Multiple operations related to the implant-based problems seemed overwhelming for the patient and the healthcare system.

Improved technical skills and equipment have led to large volume fat grating (57) resulting in a sufficient, and in



**Figure 1** This 60-year-old patient, still disease free, underwent mastectomy and axillary clearance for a bifocal ductal carcinoma in 2005, followed by adjuvant therapy. She had a delayed latissimus dorsi (LD)-reconstruction with an add on of a Mc Ghan ST410 125 cc implant, the custom at the time. (A,B) Preoperative antero-posterior (AP) and side view. (C-E) In 2010, at her so-called final check-up: AP, side and oblique views.



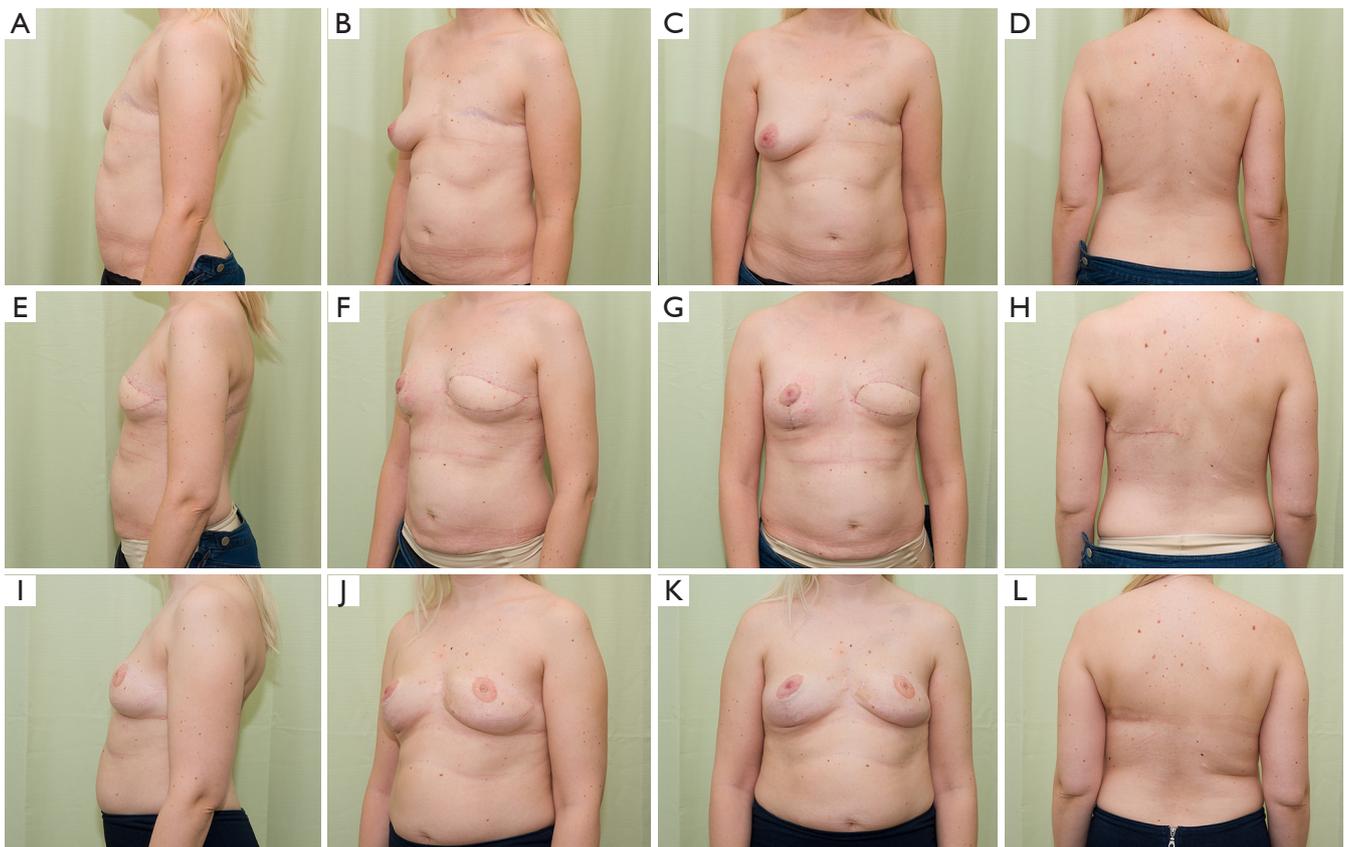
**Figure 2** Intraoperative view of fat grafting in the same setting as a delayed latissimus dorsi (LD) reconstruction. Fat can be injected subcutaneously, into the pectoralis major (A,B) and into the flap (C).

many cases predictable, take rate (58). This has increased the use of fat grafting not only for full breast reconstruction (57,59,60), but also for aesthetic augmentation and, for this review interestingly, as an add on to the LD flap. With the LD flap, free fat grafting can be inserted into the muscular and the subcutaneous part of the flap, into the chest wall surface, under the dermis, and especially into the pectoralis major muscle (*Figure 2, Video 1*). In our series covering the last 10 years, fewer implants have been used as an add on to the LD flap, but fat grafting has become a more frequent adjunct. The fat grafting can be done either during the LD reconstruction (*Figures 2,3*) or at a later timepoint (*Video 1*).

In a study by Leuzzi *et al.* the number and the type of revision procedures, duration of the hospitalization, the complication rate, and the patient satisfaction were evaluated in a retrospective cohort of patients undergoing LD reconstruction, either with an add on of an implant or with fat augmentation. Patient satisfaction was assessed using the patient-reported outcomes instrument BREAST-Q. Findings concerning the total hospitalization time, overall duration of the reconstruction process, and the distribution of supplementary surgical procedures demonstrated no statistically significant differences between the implant and the fat grafting groups. However, patients in the fat grafting



**Video 1** Fat grafting into the latissimus dorsi (LD) flap in a delayed manner due to asymmetry between the autologous LD breast and the contralateral breast. Under the rather scarred circumstances, fat is injected with a blunt cannula into the pectoralis major muscle, into the myocutaneous flap, into the subcutaneous layer and, above all, the very superficial subdermal layer. The videoclip illustrates the angles of approach and teaches the technique.



**Figure 3** At the diagnosis of breast cancer in 2010, this patient was 31 years old and a mother of three. She opted for a delayed latissimus dorsi (LD) reconstruction in 2012 with an immediate fat enhancement (200 cc) and a symmetrizing mastopexy. An autologous solution with a short recovery and no further refinements suited her. The result has lasted. (A-D) Preoperative; (E-H) 1 month postoperatively; (I-L) in 2015. Side, oblique, antero-posterior and posterior view.

group scored higher in the satisfaction with breast domain of the BREAST-Q. Leuzzi *et al.* concluded that the addition of a breast implant with LD reconstruction does not decrease the breast reconstruction time in terms of number of the revision procedures and hospitalization time, yet exposes patients to a higher complication rate and does not improve patient satisfaction (56). This was supported by Demiri *et al.*, who stated that the fat augmented LD flap constitutes an alternative method for delayed autologous reconstruction after post-mastectomy irradiation, avoiding implant-related complications (55). In other studies, the automatic use of an implant as an add on is hardly questioned (51).

### Can contralateral reduction mammoplasty promote health?

Despite appropriate patient selection, extensive flap harvesting, and either fat- or implant enhancement of the LD reconstruction, a massive breast cannot be achieved. In patients with a hypertrophic contralateral breast, opting for a unilateral LD reconstruction, a symmetrizing reduction mammoplasty has several health promoting effects. Cancer survivors undergoing delayed breast reconstruction may have benefited from oncoplastic surgery or a contralateral breast reduction at the time of the mastectomy. However, the option of a contralateral procedure can be considered also at this later stage. Reduction mammoplasty as such rehabilitates neck-, shoulder- and back-related straining problems (61). Notably, even in healthy, non-cancer subjects, abnormal histopathological findings are revealed in 10% of the patients; of the findings 1% are malignant and 5.5% are high-risk lesions (62). In patients with breast cancer, the figures double (63). Therefore, histopathological analysis of the specimens should be thoroughly considered.

### Cost-effectiveness analysis for breast reconstruction; where does the LD flap stand?

Cost-effectiveness analysis guides evidence-based practices of plastic surgeons by quantifying the balance between the risks and the benefits of each treatment strategy from both a patient perspective and a provider perspective (64). If the provider is a public health care facility, the number and the duration of reconstructive procedures, and, above all, the durability of the result plays a major role. On the contrary, if the provider is a private business driven by insurance or industry influences, multiple procedures over the years may give a better profit, enhanced by reimbursement strategies (41). Interestingly,

the cost effectiveness analysis on five widely used breast reconstruction techniques clearly favored autologous reconstruction in both radiated and non-radiated patients. In more detail, the pedicled autologous tissue reconstruction was slightly more cost-effective than the free autologous tissue options in both cohorts (64).

Nevertheless, patient centered solutions should be based on the validated patient-reported outcome measures (PROM), available for breast surgeons in many languages to date, so that decision making can be based on solid data (65). For the patient, every surgery is an investment in time and an exposure to morbidity. Thus, cost-efficiency analyses widely applicable to most institutions should be used with prudence, and they are not to be enforced over individual patient preferences (64).

### Conclusions

The LD flap is still a worthy choice for breast reconstruction in a selected group of patients, especially when other alternatives are not available. Even in good hands, the LD reconstruction warrants thorough patient counselling and information, as some untoward consequences may appear at a later stage. The implant add-on is associated with the potential of further implant-related sequelae. Fat grafting for flap augmentation and scar correction has resurrected the LD flap as a versatile tool for breast reconstruction.

### Acknowledgments

The professional skills and friendly help of our AV-technician Tero Hanski and language editor Pauliina Homsoy are greatly appreciated.

*Funding:* None.

### Footnote

*Provenance and Peer Review:* This article was commissioned by the Guest Editors (Jørn Bo Thomsen and Tine Engberg Damsgaard) for the series “Breast reconstruction - The True Multidisciplinary Approach” published in *Annals of Breast Surgery*. The article has undergone external peer review.

*Conflicts of Interest:* Both authors have completed the ICMJE uniform disclosure form (available at <https://abs.amegroups.com/article/view/10.21037/abs-21-29/coif>). The

series “Breast reconstruction - The True Multidisciplinary Approach” was commissioned by the editorial office without any funding or sponsorship. The authors have no other conflicts of interest to declare.

*Ethical Statement:* The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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doi: 10.21037/abs-21-29

**Cite this article as:** Merkkola-von Schantz PA, Kauhanen MSC. The versatile latissimus dorsi flap: old and reliable or outmoded—with or without an add on? *Ann Breast Surg* 2022;6:13.