

# Extension toward the Trapezius in a Transversely Oriented Latissimus Dorsi Flap for Breast Reconstruction

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**Background:** A transverse paddle latissimus dorsi (LD) flap has the advantage that if the skin paddle is placed in the transverse bra line, the donor site scar is well hidden by underwear. With this transfer, medial back tissues are usually moved to the medial area of the reconstructed breast following 180 degree rotation. Because these tissues are thinner than the lateral thoracic area, the medial part of the reconstructed breast sometimes becomes flatter than expected.

**Methods:** To add bulk in the medial lower quadrant for giving an impression of an outward-expanding breast, we modified the LD flap by adding a part of the trapezius muscle. Seven patients underwent mastectomy and simultaneously received a modified LD flap. To hide the donor site scar beneath underwear, the skin paddle needed to be oriented transversely. The additional harvested tissues were tested for vascularity by fluorescence following intravascular injections of indocyanine green. If this was negative, the tissue was not used for breast reconstruction. Postoperatively, another surgeon judged whether this modification had contributed favorably to the reconstructed medial lower quadrant.

**Results:** Indocyanine green testing was positive in six cases. The shape of the lower medial quadrant was judged as good in five of the seven cases. Complications included an animation deformity of the LD muscle, donor site seroma, and donor site wound dehiscence.

**Conclusion:** This transversely oriented LD flap with extension to the trapezius muscle placed at the bra-line is one option to add bulk to the medial lower quadrant of the reconstructed breast when an additional scar is not desired for cosmetic reasons. (*Plast Reconstr Surg Glob Open* 2021;9:e3695; doi: [10.1097/GOX.0000000000003695](https://doi.org/10.1097/GOX.0000000000003695); Published online 21 July 2021.)

## INTRODUCTION

Breast reconstruction using a latissimus dorsi myocutaneous flap remains a good choice, while reconstructions with silicone implants or free abdominal flaps are widely used. Latissimus dorsi flap reconstructions after mastectomy are considered to be suitable for patients with small- or medium-sized breasts.<sup>1,2</sup> This method is also a good option for those patients who do not wish to have a visible scar at the donor site.

For harvesting a latissimus dorsi flap, several incision options are possible such as vertically, obliquely, transversely, and lower transversely oriented skin paddles.<sup>3</sup> Fat grafting has also been reported.<sup>4</sup> Different size modifications such as extended latissimus dorsi flaps, muscle-sparing, and thoracodorsal artery perforator-based flaps have also been reported.<sup>5</sup> To hide the donor site scar, we usually select a transversely oriented latissimus dorsi flap from under the normal bra line. However, this has a smaller volume than other types of latissimus dorsi flaps.<sup>6</sup>

Transversely oriented skin paddles are usually rotated 180 degrees when transferred to the anterior chest. Latissimus dorsi flaps taken toward the median line of the back cover a transitional area from the muscle belly to the thin thoracolumbar fascia. In this median area, subcutaneous tissues are also thinner than at the lateral back. Because such thin tissues from the median back are transferred to the medial quadrants of reconstructed breasts, these can lack the appearance of an outward projecting breast shape. The outer quadrants of the breast are usually

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filled with thick musculocutaneous tissues. The lower medial quadrant also needs a bulk to mimic the rounded breast that protrudes outward.

Therefore, if we can place more bulk in the lower medial quadrant than with the usual method, the latissimus dorsi flap reconstruction will contribute more to the cosmetic quality of breast reconstruction. Here, we also harvested a caudal part of the trapezius muscle in contact with the cranial edge of the latissimus dorsi flap muscle. We report our experience with such cases. Our aim was to clarify whether flap extensions including the trapezius muscle would provide reliable vascularity, and whether this could enable increased bulk in the lower medial quadrants of reconstructed breasts.

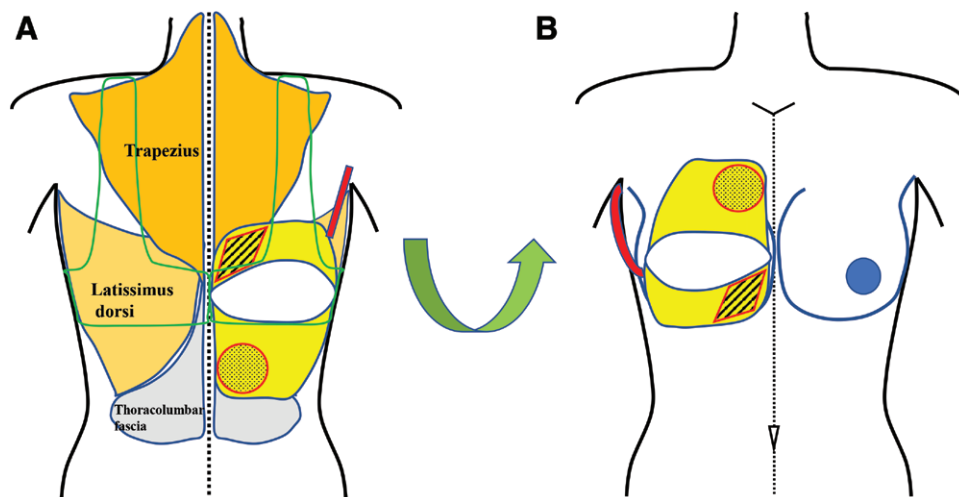
### PATIENTS AND METHODS

This was a retrospective study on patients who underwent transversely oriented latissimus dorsi flap reconstruction after mastectomy for treating breast cancer. The inclusion criteria were as follows: patients prefer latissimus dorsi flap as donor site, scarring of the donor site is hidden by a bra, breast volume is low-to-medium sized, and a slight deficit especially medial lower area is anticipated if conventionally reconstructed. Thus, patient selection was not random. Latissimus dorsi flap reconstructions were carried out at the same time as the mastectomy. The latissimus dorsi muscle originates from the dorsal vertebrae, where it does not have a true muscle belly but thoracolumbar fascia. When performing such a transfer, thin caudal fascial tissue is moved to the upper medial quadrant of the reconstructed breast, and cranial tissue close to the trapezius muscle is transferred to the lower medial

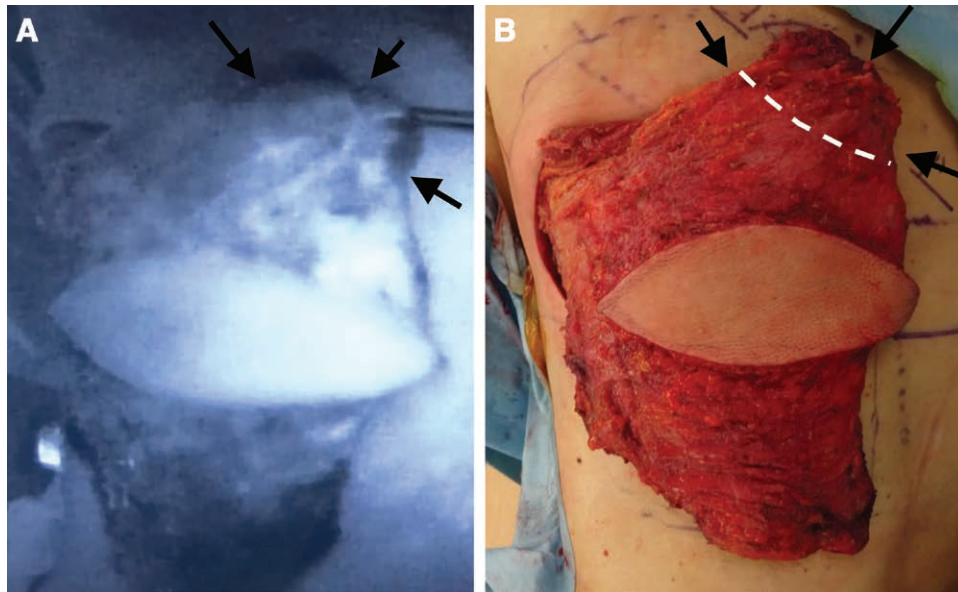
quadrant (Fig. 1). To increase the volume of the reconstructed breast in the lower medial quadrant, we planned to harvest a small part of the trapezius muscle facing the cranial and medial borders of the latissimus dorsi flap in addition to the latissimus dorsi flap.

The transverse skin paddle size width was determined by finger pinching of the patient's back skin—ie, the maximum amount of skin that could be pinched up defined the width of the paddle. The paddle extended from medial to lateral positions, and the axis was located in the bra line. A caudal part of the full-thickness trapezius muscle (approximately 5 × 5 cm) was also harvested. The thickness varies from 5 mm to 10 mm approximately. This was not detached from the latissimus dorsi flap muscle. Overlying subcutaneous tissue was also attached. If this subcutaneous tissue was very thin and scarce, only the muscle belly was harvested.

After raising the flap, vascularity was evaluated by intravenous injections of indocyanine green (ICG). ICG was injected at a dose of 5 mg, followed by a wait of at least 3 minutes. When ICG fluorescence was positive (Fig. 2), this additional tissue was included in the transfer. Otherwise, the tissue was debrided and discarded. Then, this additional tissue was transferred to the lower medial aspect of the reconstructed breast. It was usually folded to increase bulk and anchored to the medial part of the inframammary fold. After a minimum of 7 months postoperatively, clinical photographs were taken. Whether the reconstructed volume was good enough in the lower medial quadrant was judged by an experienced plastic surgeon who was not involved in the surgery. The judgment gave three rankings: good, fair, or poor. Other variables included complications, patient age, resected tissue weight, and size of the skin



**Fig. 1.** The scheme for how tissues are transferred from back to the front. The scheme for selecting the tissue donor site in the back area (A). The anterior aspect of the trunk is shown after transfer of the flap (B). The red rhomboid area shows the caudal part of the trapezius muscle. The red circle shows the transitional area of the thoracolumbar fascia from the belly of the LD muscle. The yellow area shows the size of the LD myocutaneous flap. When such a transverse island latissimus dorsi flap is harvested, the flap is usually rotated 180 degrees. The area of the red circled area is transferred to the upper medial quadrant, and the red rhomboid area is moved to the lower medial quadrant of the reconstructed breast. To enlarge the bulk of the lower medial quadrant, part of the trapezius muscle was also harvested in this series.



**Fig. 2.** How can we confirm whether the trapezius has vascularity? A superficial view of the LD muscle combined with a part of the trapezius muscle (B). Black arrows show the area of the trapezius muscle. The white dotted line shows the border between the two muscles. Indocyanine green (ICG) fluorescence imaging (A) showed that the tissues overlying the trapezius muscle had good vascular perfusion. Because the surface of the trapezius muscle is covered with the adipofascial tissue that is continuous with the skin paddle of the LD muscle, it is considered that the harvested trapezius muscle has a reverse vascular flow from the overlying adipofascial tissue.

paddle. These variables were collected from the medical records. Because the number of cases was limited, statistical analysis was not done. The patients gave informed consent in all cases.

### RESULTS

The number of patients was seven. The mean patient age was 47.7 years (range 40–64 years). The mean skin paddle size was 6.3 × 17.4 cm (range 6.0–21 cm), and the mean resection weight was 258.7 g (range 135–495 g). ICG positive staining was seen in six cases, whereas one case was negative. There was one case of animation deformity of the latissimus dorsi muscle. Shoulder and upper extremity functions were not impaired in any case. The shape of the lower medial quadrant was judged by an expert as good in five, fair in one, and poor in one (Table 1).

### CASE REPORTS

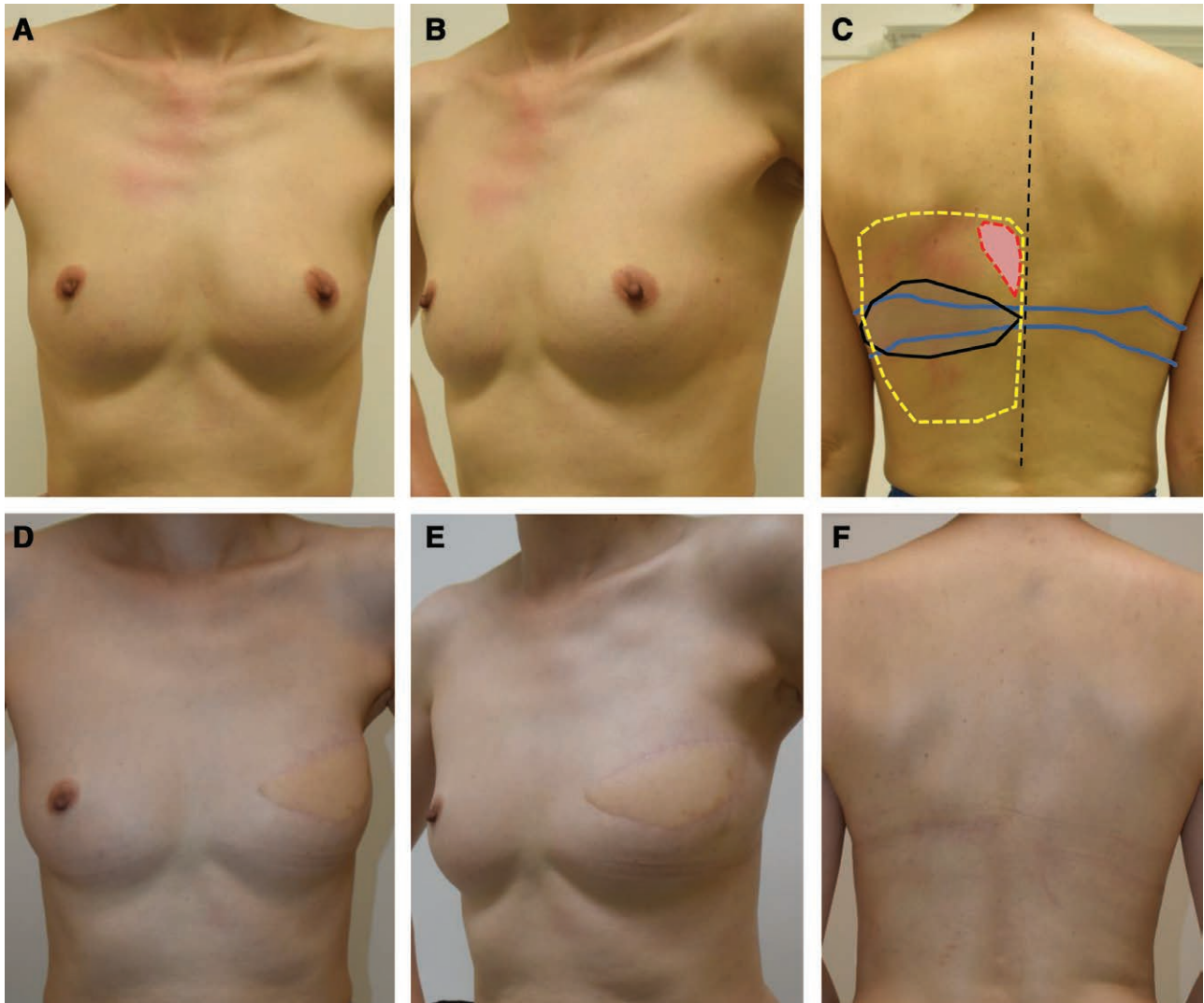
#### Case 1

A 44-year-old woman without any other significant medical history underwent mastectomy for breast cancer. Simultaneously, breast reconstruction using a latissimus dorsi musculocutaneous flap with a bra-line transversely oriented skin paddle was performed. To increase the bulk of the lower medial area of the breast, the cranial and medial parts of the latissimus dorsi flap were harvested together with a part of the trapezius muscle. This area was enhanced by ICG fluorescence (Fig. 2) and included the transferred tissue. This additionally harvested tissue was folded to give a round appearance. The patient’s postoperative course was uneventful, and the tissue volume of the lower medial quadrant was judged as good one year later (Fig. 3).

**Table 1. Summary of the Seven Cases**

Case	Diagnosis	Age	Excision Weight	Skin Paddle (cm)	ICG	Evaluation	Follow-up (mo)	History	Complications
1	T1bN0	44	247 g	6 × 21	+	Good	15	–	–
2	T1cN0	40	238 g	6 × 18	+	Good	52	–	–
3	TisN0	42	166 g	6.5 × 16	+	Good	7	–	Latissimus dorsi muscle animation deformity
4	T1cN0	50	270 g	6 × 16	+	Good	60	–	Donor site seroma
5	T1bN0	64	495 g	6.5 × 15	–	Poor	18	–	–
6	T1bN0	40	260 g	6.5 × 15.5	+	Fair	49	–	Donor site wound dehiscence
7	TisN0	54	135 g	6.5 × 20	+	Good	8	–	–

Women with a mean age of 47.7 years received LD flap transfer with 6.3 × 17.4 cm skin paddles, including part of the trapezius muscle. The mean resection weight was 258.7 g. ICG fluorescence indicating a healthy blood flow was detected in six of the seven cases. The lower medial quadrant volume of the reconstructed breast was maintained and judged “good” by an independent plastic surgeon in five of the seven cases.



**Fig. 3.** A typical case of this procedure: pre-op and post-op images. Case 1: preoperative views (A–C) and 1-year postoperative views (D–F). The transverse skin paddle (black line) was harvested along the bra line (blue lines). The caudal part of the trapezius muscle (red dotted line) was also harvested together with the subcutaneous tissues and LD muscle (yellow dotted line).

### Case 3

The patient was a 42-year-old woman with no other significant medical history. Two months before referral, she had undergone partial mastectomy in the upper lateral quadrant for breast cancer at a different hospital. As the pathological findings showed that the margins were positive for tumor cells, ipsilateral mastectomy was scheduled. Although the former operative procedure was unclear, we surmised that some overlying skin must have been removed because the nipple areola complex had been shifted laterally.

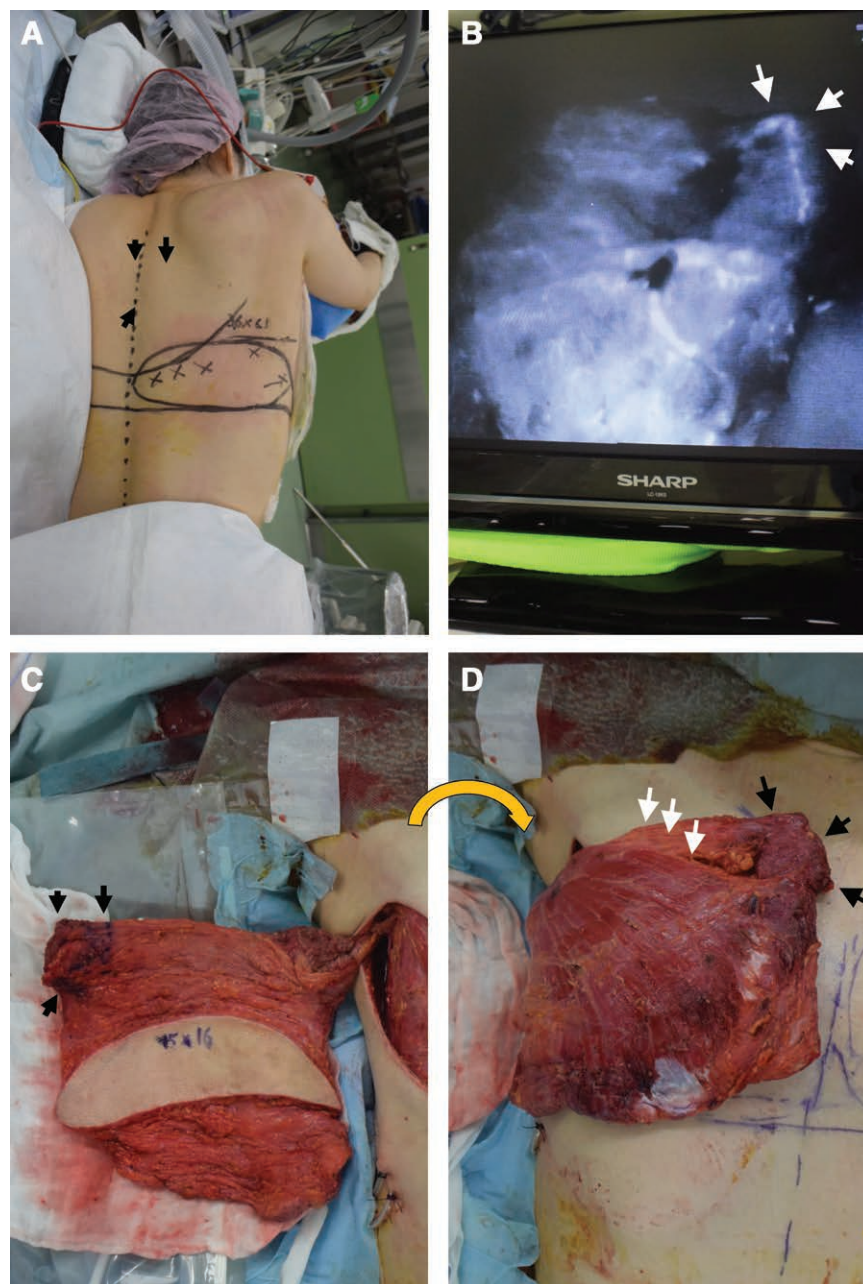
Mastectomy and latissimus dorsi flap transfer were performed. The skin paddle was designed to have a bra-line transverse style. As in Case 1, a small part of the trapezius muscle was combined with the flap. This tissue was transferred to the lower medial quadrant (Fig. 4). Because the subcutaneous tissue above the trapezius muscle in this patient was very thin, subcutaneous tissue was scarcely attached in this area. ICG fluorescence was observed in the trapezius part.

The lateral area of the skin paddle was retained to shift the nipple and areola back to a normal position (Fig. 5). The patient's postoperative course was uneventful, and the lower medial quadrant remained protuberant; this case outcome was later judged as good. Animation deformity in the latissimus dorsi muscle was seen occasionally.

### DISCUSSION

Latissimus dorsi flaps are usually chosen for small- to medium-sized breast reconstructions. To reproduce larger breasts, it is sometimes necessary to add an implant with the flap, as reported in 33% of cases.<sup>7</sup> The amount of tissue obtained with such flaps is limited; so it is desirable to reconstruct the breast-like form for cosmetic reasons.

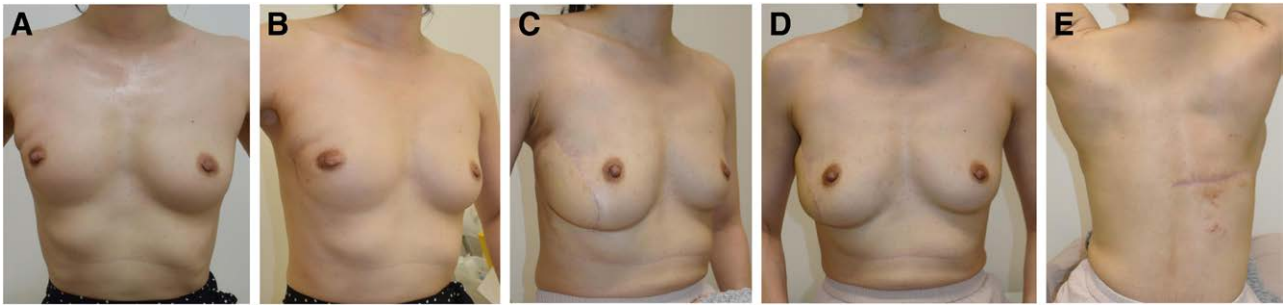
Regarding breast shape, the lower part of the breast has more tissue than the upper part, and the lateral area of the breast has more volume than medial area in most



**Fig. 4.** A typical case of this procedure. Case 3: a transverse island LD flap was planned. Black arrows show the area of the caudal part of the trapezius muscle (A). The lower left image shows the patient's back after harvesting (C). The flap was turned over (yellow curved arrow) and the white arrows show the border between the 2 muscles (D). ICG fluorescence imaging showed that the trapezius muscle (black arrows) had enough blood perfusion (B). In this case, the harvested trapezius muscle did not connect the adipofascial tissue both superficially and submuscularly. The trapezius muscle was considered to have an antegrade vascular flow from the inter-muscular connection between the LD and trapezius muscles.

cases. The outer and lower quadrants of the breast must have the largest volume; however, the medial and lower quadrants should also have adequate volume to recreate the protuberant breast shape. If the latissimus dorsi flap is harvested by a bra-line transverse skin paddle, the cranial and medial parts of the flap are assigned to the lower medial quadrant of the reconstructed breast (Fig. 1). The medial aspect of the back has thinner subcutaneous tissue

than the lateral thoracic area, and the latissimus dorsi muscle is also thin in the medial back region. If there is a need to harvest more tissue volume, it is also recommended to move the harvest area to the more caudal lumbar area, which has thicker subcutaneous fat tissue, or to change the incision style and area to an oblique paddle form.<sup>6</sup> However, we intended to keep the donor scar underneath the bra line in this series; so the maximum



**Fig. 5.** Pre-op and post-op images of the case 3. Case 3: preoperative (A, B) and 7 months postoperative images (C–E).

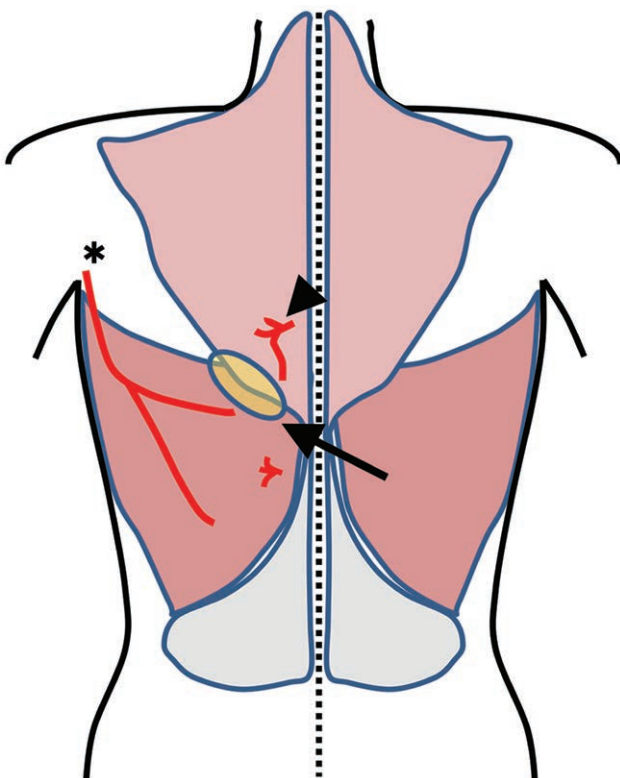
amount of muscle and subcutis was compromised in harvesting the flap. In addition, a part of the trapezius muscle was harvested. Approximately 5 × 5 cm of the caudal trapezius muscle was combined with the latissimus dorsi flap. Trapezius muscle harvest was limited caudally to the horizontal line of the lower edge of the scapula to minimize dysfunction and diminished vascular flow. We did not apply any statistical analysis but bulging in the lower

medial quadrant was enhanced by this addition in five of the seven cases.

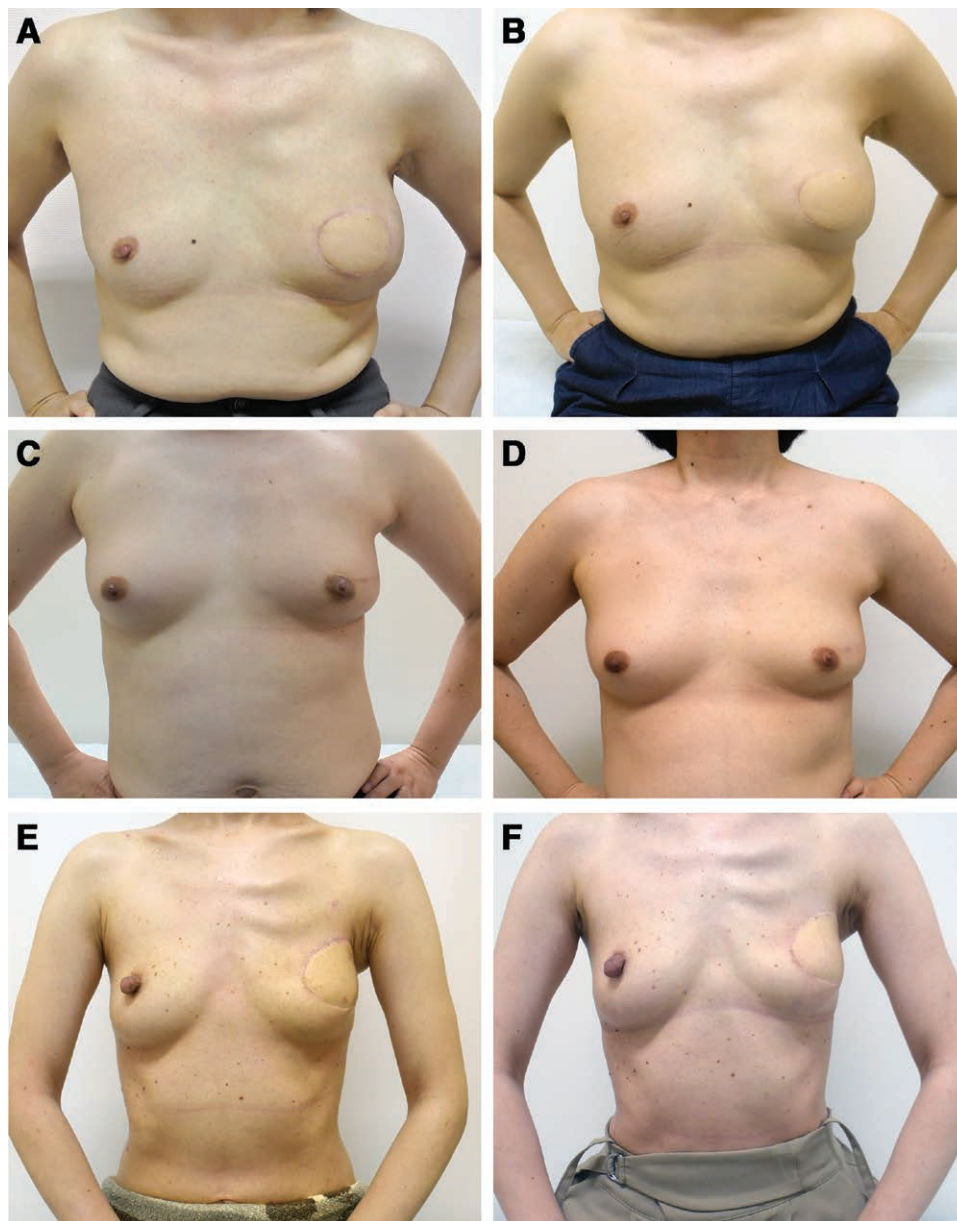
Regarding vascularity, the medial area of the latissimus dorsi flap muscle adjacent to the vertebrae is nourished by transverse branches from the thoracodorsal artery and dorsal perforators of the posterior intercostal arteries.<sup>5</sup> However, the trapezius muscle has a different vascular supply (Fig. 6). Vascular pedicles for this muscle include the transverse cervical artery, the dorsal scapular artery, and the posterior intercostal artery.<sup>8,9</sup> The caudal and medial areas of this muscle are mainly vascularized by dorsal perforators from the posterior intercostal arteries. Because the intercostal arteries each have segmental dorsal perforators, the trapezius, and latissimus dorsi muscle have different segmental perforator arteries.

Subcutaneous tissues are also nourished by the segmental dorsal perforators. Even if the nourishing perforator is compromised, its cutaneous territory is normally vascularized with the help of choke vessels from adjacent territories. This concept is not usually relevant for intermuscular vascularity. How are muscles nourished or necrotic if the main feeding arteries are severed? In animal studies, Yazar et al reported that reverse vascular flow from a superficial musculocutaneous perforator nourishes muscles.<sup>10</sup> It has not been proved that there was a perforator between harvested trapezius muscle and overlying adipofascial tissue in our cases because we did not divide both tissues, but in most cases the trapezius muscle vascular distribution was confirmed by ICG. We consider that there also was reverse flow from adipofascial tissues to muscles. In addition, we presumed that there should be inter-muscular vascular flow between the latissimus dorsi and trapezius muscles, because we did not separate each muscle to maintain vascular supply. However, it is not clear which contributes more to the vascularity: retrograde musculocutaneous perforator flow, or antegrade inter-muscular flow.

As vascular supply to the trapezius muscle was validated by ICG fluorescence testing in six of the seven cases, part of the muscle was transferred safely in these cases. The subcutaneous tissues were also positive for ICG fluorescence. We do not know why the ICG fluorescence was not detected in one case. The two muscles were not separated physically, and the overlying subcutaneous tissues remained connected. In this case,



**Fig. 6.** Vascularity of the transferred tissue. The caudal part of the trapezius muscle is mainly nourished by the dorsal perforators from the posterior intercostal arteries (arrowhead). A medial part of the LD muscle is perfused by posterior perforators from the posterior intercostal arteries and a transverse branch of the thoracodorsal artery (asterisk). Subcutaneous tissues between both muscles (yellow area, arrow) are considered to be nourished by both perforators and choke vessels between adjacent muscle blocks.



**Fig. 7.** Long-term image of the procedure. Postoperative images (A,C,E: after 1 year, and B,D,F: after 4 years) of the patients are shown (left breasts were reconstructed). Lower medial quadrant volume tends to decrease slightly.

because ICG fluorescence was not seen, the negative-staining tissues were discarded. We recommend that transfer should be done only after confirmation of vascularization using the ICG fluorescence test. Our first choice for breast reconstruction is a transfer of the well-vascularized tissue as a flap, because we believe that well-vascularized tissue transfers lead to early wound healing without complications. Fat grafting seems to be an alternative; however, fat grafting is a kind of free tissue transfer that is not accompanied with any direct vascular supply. Well-vascularized flap is superior to fat grafting in survival. To achieve this goal, we did not use fat grafting in this series.

Because only a small part of the trapezius muscle was harvested, we think that functional deficit did not exceed the tolerance level. Sadigh et al reported none of the patients developed any shoulder weakness, drooping, or winging of the scapula after trapezius flap transfers.<sup>11</sup> Although it is believed that shoulder function is slightly impaired after latissimus dorsi flap harvesting,<sup>12</sup> we did not perform muscle-sparing latissimus dorsi flap transfer or thoracodorsal artery perforator flap transfer. Rather, our aim here was to reconstruct the patient's breast with autologous tissue while concealing the donor tissue scar within the underwear where the patient could not see it directly.

Whether the transferred tissue volume is maintained over the long term with our technique is not clear. In latissimus dorsi flap transfer, the muscle volume is reported to be down to half in 6–8 months.<sup>13</sup> If the obtained  $5 \times 5$  cm portion of the trapezius muscles becomes  $2.5 \times 2.5$  cm in a half year, this procedure will be indicated to the patients with small or medium-sized breasts. Thus, this modification is considered to be one of the options in cases where increased volume is needed in the lower medial quadrant of the reconstructed breast. Kim et al also reported uncertainty about the long-term volume loss of the transplanted tissue, when they transferred adipocutaneous tissue nourished by reverse vascular flow from the latissimus dorsi musculocutaneous perforator.<sup>14</sup> We think muscle denervation is also associated with long-term volume reduction.

As a reference for the postoperative course, three cases of changes in the lower-medial quadrant are shown (Fig. 7). The volume at the lower-medial quadrant tends to decrease slightly; however, most of the volume is maintained. Because the ICG study confirmed the vascular distribution of the trapezius flap in our study, the postoperative volume loss is considered to be mainly due to muscle atrophy after denervation.

The limitation of this study is that this modification might not be accepted generally for breast reconstructions because of the small sample size and the absence of long-term results. Because the actual volume was not measured, there is no objective evidence to clarify the role of the trapezius muscle in breast shape. Therefore, more cases are required.

## CONCLUSIONS

We report a modification of the latissimus dorsi flap transfer for breast reconstruction by adding a part of the trapezius muscle to increase the bulk of tissue in the lower medial quadrant. Five of seven cases showed favorable effects in the short term. This bra-line transversely oriented latissimus dorsi flap with trapezius muscle is one option to add volume when an additional scar is not favored.

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