

A Workhorse Flap for Covering Moderate-sized Defects after Breast-conserving Surgery: Supercharged Lateral Thoracodorsal Flap

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Background: The lateral thoracodorsal (LTD) flap technique is a type of oncoplastic breast surgery that involves transposition of tissue from the lateral aspect of a partial mastectomy defect. It is a relatively simple procedure and shows lower donor morbidity and good aesthetic outcomes. Complications, such as fat necrosis and wound dehiscence due to poor circulation, may occur at the distal part of the flap. We used a supercharged LTD flap to reduce this problem. In this study, the outcomes of the LTD flap over 13 years were reviewed.

Methods: We performed a retrospective study of 86 patients who underwent an LTD flap procedure between 2007 and 2019. We analyzed patient information using medical chart review and classified patients into groups according to lateral thoracic artery perforator supercharging. The incidence of complications, such as fat necrosis and wound dehiscence, was also analyzed.

Results: The mean tumor weight was 83.67 g, and defects had a moderate size, as they represented 25.02% of the total breast volume. Fat necrosis was noted in 19.4% of cases in the group without lateral thoracic artery perforator supercharging and 4% of cases in the group with supercharging, with a significantly lower rate in the supercharged group.

Conclusions: Our findings show that the LTD flap could be used to cover moderate-sized defects after breast-conserving surgery. Careful dissection to preserve the lateral thoracic artery perforator resulted in the reduction of complications, such as fat necrosis, and excellent aesthetic results. (*Plast Reconstr Surg Glob Open* 2021;9:e3381; doi: [10.1097/GOX.0000000000003381](https://doi.org/10.1097/GOX.0000000000003381); Published online 3 February 2021.)

INTRODUCTION

Breast-conserving treatment has been dominantly used in oncoplastic breast surgery, and now, it is considered a standard approach for the treatment of early-stage cancer. As a result of the development of diagnostic technology and mammographic screening, preoperative local or systemic therapy has expanded the indication of breast-conserving surgery (BCS). As BCS is more frequently performed, the importance of post-BCS breast reconstruction with autologous tissue is increasing.

However, Albornoz et al reported that more than 10% of BCSs have been replaced by mastectomy over the last 10

years. The reason is that prophylactic mastectomy is being performed on the contralateral breast to prevent relapse in breast cancer patients with risk factors, such as BRCA mutation. Nevertheless, the importance of reconstructive methods for post-BCS defects that are moderate has been emphasized.¹

For breast cancer patients, undergoing breast reconstruction after surgical removal of a tumor has important meaning both aesthetically and psychologically. In a broad sense, there are 2 types of breast reconstructions (using autologous tissues or implants). Because radiation therapy follows tumorectomy in post-BCS breast reconstruction, it is a more common practice to perform reconstruction using autologous tissues rather than using implants.

Diverse oncoplastic breast surgery has been introduced to optimize the balance between the risk of local recurrence and post-BCS cosmetic outcomes. The surgical method is determined by the location and size of the defect after

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tumorectomy. Most Asian women have small- to moderate-sized breasts, and it is necessary to subdivide the volume displacement and replacement technique according to the location of the mass and the size of the defect after BCS.

For small defects, volume displacement techniques, such as the round block technique and tennis racket method, are used. For moderate-sized defects, regional flaps, such as a rotation flap and lateral thoracodorsal (LTD) flap, and perforator flaps, such as a lateral intercostal artery perforator flap and thoracodorsal artery perforator flap, can be used. In particular, the use of an LTD flap is an effective approach to reconstruct defects occurring after BCS for laterally located breast cancer.²

Our hospital conducted research on the LTD flap, a type of regional flap, for various post-BCS oncoplastic breast surgeries. Our center published a research dissertation in 2013, which demonstrated 20 cases involving the use of the LTD flap between 2008 and 2013.³

All patients who received the LTD flap underwent Radiation therapy at the long-term follow-up; we observed a case involving some hardness and deformity caused by fat necrosis in the distal part of the flap (Fig. 1). In our center, we believed that complications, such as fat necrosis and wound dehiscence, may arise as a result of poor blood circulation in the distal part of the flap when the LTD flap is used. When these complications (fat necrosis and wound dehiscence) arise, they could result in asymmetry of both breasts and unsatisfactory texture. Our center conducted research with a hypothesis that postoperative flap circulation would be improved by supercharging of the lateral thoracic artery perforator (LTAP), which is sacrificed during standard LTD flap use, and that this would contribute to lowering the rates of fat necrosis and wound dehiscence caused by decreased circulation after the conventional LTD flap technique.

PATIENTS AND METHODS

This was a retrospective study that included 86 patients with early-stage breast cancer from January 2007 to June 2019 at our hospital. These patients were managed by BCS at the Department of Breast Surgery, followed by LTD flap surgery in the Department of Plastic and Reconstructive Surgery immediately. The Institutional Review Board of Kyungpook National University Hospital (KNUH;

Kyungpook National University Medical Center No. 2020-01-023) approved the study, and all patients provided informed consent. To exclude bias related to the surgical technique, BCS and breast reconstruction were performed by the same surgeons in each department. Patients' medical records were collected, and data pertaining to unique comorbidities, age, body mass index (BMI), weight, adjuvant treatments, and complications, such as fat necrosis and wound dehiscence, were obtained. These data were compiled for comparative analyses. Patient satisfaction surveys were conducted 12 months after breast reconstruction using the KNUH Breast Satisfaction Survey.

In this research, there were 2 groups of patients who received the LTD flap. Group A received an LTD flap without lateral thoracic artery perforator (LTAP) supercharging, and group B received an LTD flap with LTAP supercharging.

Design

All patients with lateral breast tumors are potential candidates for LTD fasciocutaneous flap reconstruction. A majority of patients possess excess skin and subcutaneous fat in the lateral thoracic region. This is important because the LTD flap relies on redundancy of skin and subcutaneous fat in this region. Before the oncologic surgery starts, the patient is seated in a position with opened arms to the sides, so that 3 lines can be drawn (inframammary sulcus, central meridian of the breast, and anterior axillary line). A wedge-shaped flap is designed in the lateral thoracic region, and the amount of usable tissue can be predicted by performing a pinching test on the skin between the surgeon's thumb and index finger. The flap's base ranges from 5 cm to 10 cm and is determined by the pinching test. For small defects, the flap is designed in a triangular shape only in the lateral aspect of the thorax. For moderate and large breast defects, the distal limit can be up to the posterior thoracic region, and a superior and inferior design is more curvilinear. A curved design helps in easing the tension of the donor site and allows the use of more skin and subcutaneous fat.⁴⁻⁸

Surgical Technique

Tumor resection is carried out along the incision line as co-planned by the general surgeon and plastic surgeon.

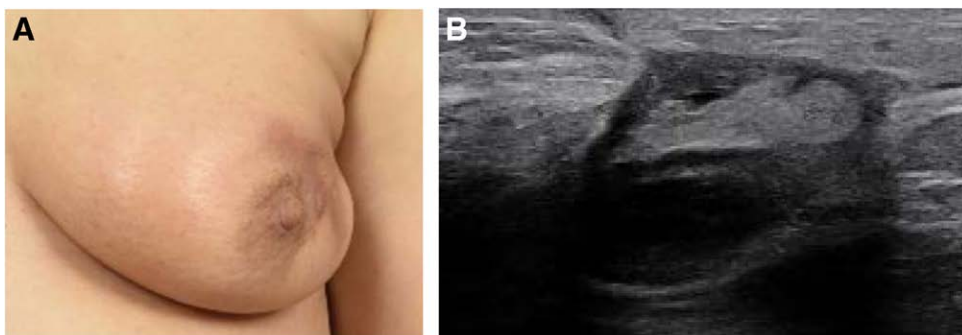


Fig. 1. Fat necrosis at 20 months after reconstruction with a lateral thoracodorsal flap. A, 20 months postoperative outcome. B, fat necrosis ultrasonography.

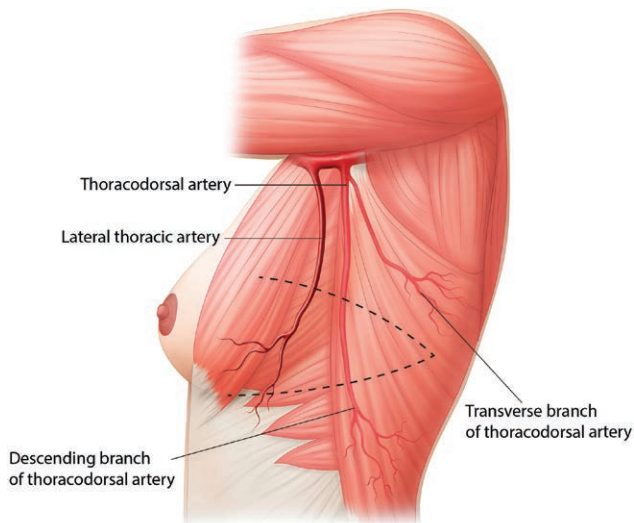


Fig. 2. Lateral thoracic artery anatomy.

If the tumor is located close to the skin or skin invasion exists, an additional incision line is made on top of the tumor. When carrying out axillary dissection, an initial incision is used for small-to-medium breasts, and a donor site incision is used for large breasts. The flap's margin extends below the serratus anterior muscle and above the latissimus dorsi muscle. Dissection of skin and subcutaneous fat is carried out along the underlying muscle from the lateral direction toward the medial direction. As the flap's vascular supply is derived from the lateral intercostal artery perforator and muscular fascia, our purpose is to include the fascia and to avoid wide undermining of the inframammary sulcus.^{3,9-14}

Among the 2 groups in the study, group B used a method to conserve the LTAP to carry out flap dissection (Fig. 2). Subsequently, flap rotation was performed at the defect site, and then, suture was performed according to the layer at the donor site. At the recipient site, after the flap and defect skin were secured with skin staplers, we evaluated the flap's molding and breast shape with the patient kept in the sitting position (Figs. 3-4). Depending on the size of the defect, 1 or 2 drains were placed. All patients received intravenous antibiotics while a drain was

placed. (See Video [online], which displays the surgical technique for supercharged thoracodorsal flap.)

Evaluation

After the end of the follow-up periods, we conducted a chart review regarding the incidents of complications, such as wound dehiscence, infection, and linear necrosis. Postoperative clinical images were taken at 1, 3, 6, and 12 months. To confirm fat necrosis, we examined ultrasound results in those with a 2-cm palpable solid mass-like lesion along the breast contracture and margin (Fig. 1). We assessed patient postoperative satisfaction using the modified KNUH Breast-Q at 12 months following surgery. The modified KNUH Breast-Q consists of 11 questions, and each correct answer per question adds 5 points, with a total of 55 points (perfect score).⁸⁻¹¹

We conducted a statistical survey on the difference in the rates of fat necrosis and patient satisfaction between Groups A and B. Statistical analysis was performed with the Chi-Squared Test, independent two sample *t*-test using SPSS, version 22.0 (IBM Corp., Armonk, N.Y.). *P* < 0.05 was considered statistically significant.

RESULTS

The study included a total of 86 LTD flap procedures in 86 patients between January 2007 and December 2019. Groups A and B were divided on the basis of LTAP supercharging. Group A did not have LTAP supercharging, and it included 36 cases. Group B had LTAP supercharging, and it included 50 cases.

In Group A, the mean age was 46.3 years, BMI was 23.32 kg/m², breast volume was 324 mL, excised tumor weight was 82 g, and volume loss was 24.5%. In Group B, the mean age was 45.91 years, BMI was 24.1 kg/m², breast volume was 305 mL, excised tumor weight was 84.2 g, and volume loss was 25.3%. No significant differences were found between these 2 groups in terms of age, BMI, breast volume, tumor weight, smoking, neoadjuvant therapy, previous radiation therapy history, and volume loss (Table 1).

We examined the difference in the occurrence of complications between the 2 groups.

There were no complications, except fat necrosis, after surgery. The complication rate in Group A was 19.4% (7 cases of fat necrosis among 36 cases) and that in Group B

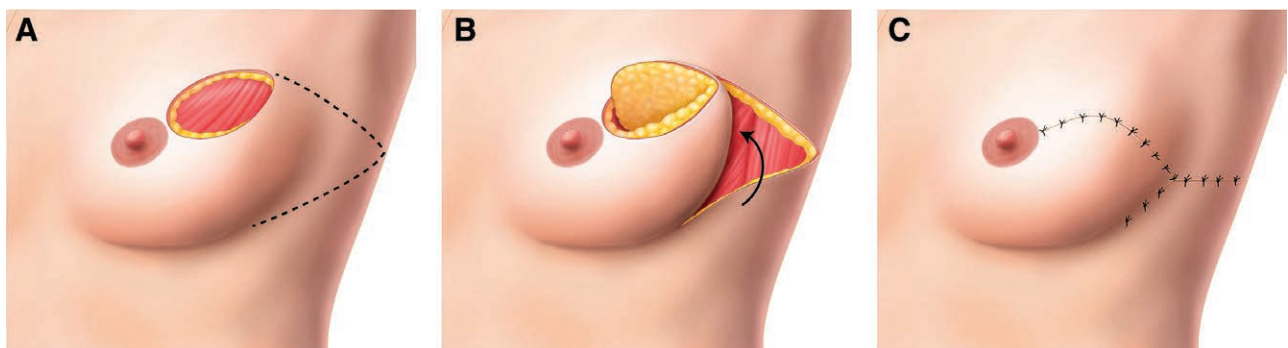


Fig. 3. Schematic of the lateral thoracodorsal (LTD) flap. A, Defect and LTD flap design. B, De-epithelization is performed for the recessive skin, and the flap is rolled inward to fix it to the defect. C, postoperative scar.

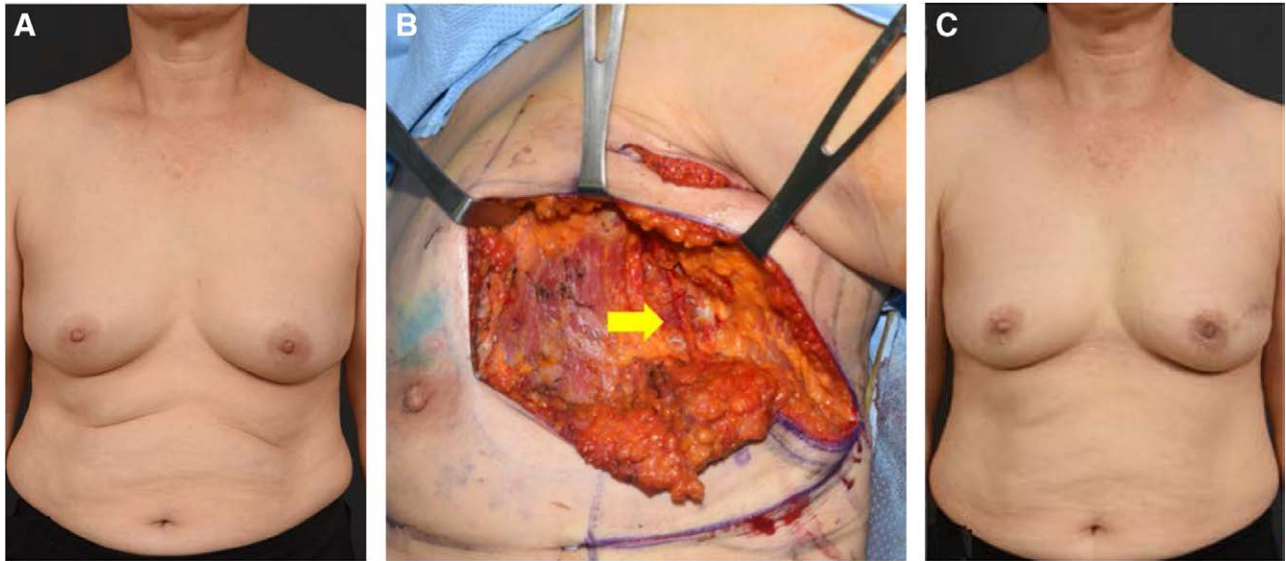


Fig. 4. A 64-year-old woman was diagnosed with a 0.8-cm IDC at 3 cm away from the nipple in the 3 o'clock direction, and the defect after BCS (31% of the total volume) on the lateral side was reconstructed with a supercharged lateral thoracodorsal flap. A, Preoperative view. B, Intraoperative view, dissected LTAP: yellow arrow. C, One-year postoperative outcome.

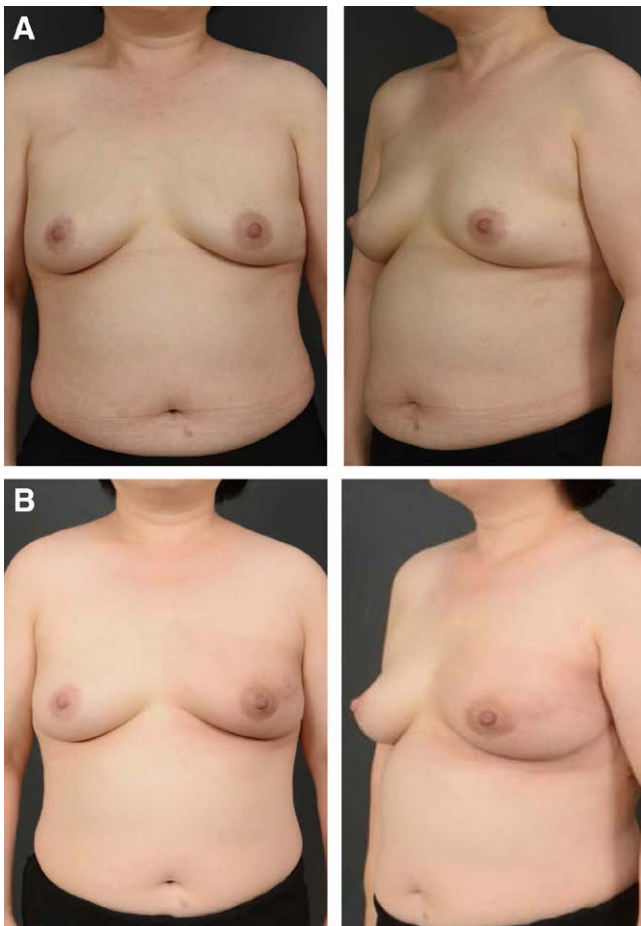


Fig. 5. A 50-year-old woman was diagnosed with a 2-cm DCIS at 3 cm away from the nipple in the 3 o'clock direction, and the defect after BCS (30% of the total volume) on the superolateral side was reconstructed with a supercharged lateral thoracodorsal flap. A, Preoperative view. B, One-year postoperative outcome.

was 4% (2 cases of fat necrosis among 50 cases). The rate of fat necrosis was different between the two groups ($P = 0.015$) (Table 2) (Fig. 5).

At 12 months after the surgery, we conducted a survey to measure postoperative satisfaction using the modified KNUH Breast-Q. No significant statistical differences were found in each question score and the total score between the 2 groups. However, it was confirmed that Group B showed a higher satisfaction level on average (Table 3).

DISCUSSION

With the development of diagnostic technology and mammographic screening, local or systemic therapy before surgery has expanded the indication of BCS. Consequently, the demand for oncoplastic breast surgery after BCS is consistently increasing. The LTD flap is one of the best oncoplastic breast surgery options to resolve post-BCS lateral side defects in Asian women whose breast size is small to moderate.

The LTD flap was first introduced in 1986 by Holmstrom and Lossing. It was applied to a patient who underwent delayed reconstruction after radical mastectomy. This wedge-shaped transposition flap was introduced by Cronin in 1977 as a modification of the thoracoepigastric flap located in the lateral aspect of thorax.¹⁵

In 2000, Garcia et al from a Swedish group initially suggested the clinical implementation of the LTD flap for immediate conservative breast surgery reconstruction. In this research, 28 patients with a tumor in the upper outer quadrant received immediate reconstruction using the LTD flap after tumor resection, and 90% of patients showed satisfactory outcomes.¹⁶ Later, in 2004, Woerdeman et al published a research dissertation regarding the potential complications of LTD flap use (18.3% had flap-related complications, 11.6% had partial necrosis, and 3.3% had fat necrosis).¹⁷

Table 1. Characteristics of the LTAP Non-supercharged (Group A, n = 36) and Supercharged (Group B, n = 50) Groups

Variable	Group A	Group B	Total	P
Patients (n)	36	50	86	
Age (y)	46.3	45.91	43.13	0.82
BMI (kg/m ²)	23.32	24.1	23.85	0.79
Smoking	0	0	0	1
Comorbidities				
DM	2	3	5	0.85
HTN	3	5	8	0.74
Neoadjuvant therapy	1	1	2	0.82
Previous radiation	0	0	0	1
Breast volume (mL)	324	305	313.05	0.65
Tumor weight (g)	82	84.2	83.67	0.91
Volume loss (%)	24.5	25.3	25.02	0.88

Age, BMI, breast volume, tumor weight, and volume loss showed no statistically significant differences between the 2 groups.

Table 2. Complications in the LTAP Non-supercharged (Group A, n = 36) and Supercharged (Group B, n = 50) Groups

	Group A	Group B	P
Patients (n)	36	50	
Fat necrosis, % (n/N)	19.4 (7/36)	4 (2/50)	0.015*
Wound dehiscence	0	0	1
Wound infection	0	0	1

There was a significant difference in the fat necrosis rate between Group A and Group B.

*Statistically significant at $P < 0.05$.

Table 3. Patient Satisfaction at 12 Months after Surgery Evaluated Using the Modified KNUH Breast-Q in the LTAP Non-supercharged (Group A) and Supercharged (Group B) Groups

Question	Very Satisfied	Group A	Group B	P
1. Overall, are you satisfied with your breast reconstruction?	5	4.1	4.4	0.235
2. Are you satisfied with breast symmetry achieved after reconstruction?	5	3.9	4.4	0.325
3. Are you satisfied with the size of your breast after reconstruction?	5	4.1	4.3	0.451
4. Are you satisfied with the shape of your breast after reconstruction?	5	3.9	4.5	0.12
5. Are you satisfied with how your breasts feel after reconstruction?	5	4.2	4.6	0.281
6. Are you satisfied with the level of pain you had to endure after reconstruction?	5	4.1	4.6	0.275
7. Are you satisfied with the scar resulted after breast reconstruction?	5	4	4.4	0.254
8. Are you satisfied with the donor site scar (back, flank, or abdomen)?	5	4.1	4.6	0.283
9. Are you satisfied with the donor site pain (back, flank, or abdomen)?	5	4	4.6	0.108
10. Have you experienced a loss of confidence or self-esteem after breast reconstruction?	5	3.9	4.5	0.115
11. Are you satisfied with your sexual attractiveness after breast reconstruction?	5	3.9	4.5	0.105
Total	55	44.2	49.4	0.121

The average was 44.2 points for Group A and 49.4 points for Group B. Although the average score tended to be higher in Group B than in Group A (indicating higher patient satisfaction in Group B), there was no statistically significant difference between the groups.

We do not have much information about the postoperative condition of patients who have undergone conservative breast surgery reconstruction. It is very difficult to find clinical reports about the postoperative condition and complications after immediate reconstruction using LTD flaps.

Our center has been using the LTD flap for over a decade. We acknowledge that complications, such as fat necrosis, which might occur after the LTD flap technique, could greatly affect breast symmetry and satisfaction levels. To reduce the occurrence of fat necrosis, a study was conducted with the hypothesis that flap circulation is better with an LTAP supercharging technique than a standard LTD flap technique.

We confirmed that the supercharged group had only 2 cases of fat necrosis out of the 50 cases, whereas the non-supercharged group had 7 cases of fat necrosis out of 36 cases, with a significant difference between the groups. Moreover, we evaluated patient satisfaction at 12

months after surgery using the modified KNUH Breast-Q. We found that mean outcomes were better in the supercharged group than in the non-supercharged group, but it was not statistically significant.

In 2005, the Macmillan research team applied a method involving the use of a turnover flap for reconstruction, combining a thoracodorsal flap and lateral intercostal artery (LICAP) flap, during breast reconstruction surgery after external partial resection. Additionally, they reported performing flap harvest of an LICAP flap-sized flap, using a pure LTAP flap.¹⁸

The LTD flap technique with LTAP supercharging could possibly exhibit some restrictions in flap movement. When flap movement was restricted, we improved flap mobility by performing dissection with a maximized perforator, and there was no case of LTAP sacrifice owing to flap mobility restriction during surgery.

In 2013, our research team published a dissertation that explained the outcomes of LTD flap use after BCS.³

At the long-term follow-up, we found that patient satisfaction levels varied depending on the occurrence of complications, such as fat necrosis and wound dehiscence, and LTAP supercharging provided better outcomes with regard to the rates of fat necrosis and patient satisfaction. LTAP supercharging is an effective approach to lower the rate of fat necrosis and increase patient satisfaction. LTAP supercharging only during surgery is not difficult, and it can be an effective way to increase patient satisfaction without adding a learning curve.

Our study had some limitations. We performed a retrospective study on patients who underwent LTD between 2007 and 2019. No ultrasound was performed in all patients. This may have been an additional fat necrosis that the surgeon could not check with the physical examination. A more extensive study is necessary for complications caused by LTAP supercharging.

CONCLUSIONS

For post-BCS breast reconstruction using the standard LTD flap, we supercharged the LTAP during surgery to prevent fat necrosis and wound dehiscence, which could occur owing to poor circulation. This is a simple and reproducible method, which can be performed.

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REFERENCES

- Albornoz CR, Bach PB, Mehrara BJ, et al. A paradigm shift in U.S. Breast reconstruction: increasing implant rates. *Plast Reconstr Surg.* 2013;131:15–23.
- Yang JD, Kim JB, Eom JR, et al. Utility of two surgical techniques using a lateral intercostal artery perforator flap after breast-conserving surgery: a single-center retrospective study. *Plast Reconstr Surg.* 2019;143:477e.
- Yang JD, Ryu DW, Lee JW, et al. Usefulness of a lateral thoracodorsal flap after breast conserving surgery in laterally located breast cancer. *Arch Plast Surg.* 2013;40:367–373.
- Schwabegger AH, Bodner G, Ninković M, et al. Thoracodorsal artery perforator (TAP) flap: report of our experience and review of the literature. *Br J Plast Surg.* 2002;55:390–395.
- Stephanie LK, Yoav B, Martin IN, et al. Perfusion zones of extended transverse skin paddles in muscle-sparing latissimus dorsi myocutaneous flaps for breast reconstruction. *Plast Reconstr Surg.* 2019;143:920e–926e.
- Kim JT. Two options for perforator flaps in the flank donor site: latissimus dorsi and thoracodorsal perforator flaps. *Plast Reconstr Surg.* 2005;115:755–763.
- Hwang JH, Lim SY, Pyon JK, et al. Reliable harvesting of a large thoracodorsal artery perforator flap with emphasis on perforator number and spacing. *Plast Reconstr Surg.* 2011;128:140e–150e.
- Yang JD, Kim MC, Lee JW, et al. Usefulness of oncoplastic volume replacement techniques after breast conserving surgery in small to moderate-sized breasts. *Arch Plast Surg.* 2012;39:489–496.
- Hamdi M, Van Landuyt K, Hijjawi JB, et al. Surgical technique in pedicled thoracodorsal artery perforator flaps: a clinical experience with 99 patients. *Plast Reconstr Surg.* 2008;121:1632–1641.
- Hamdi M, Rasheed MZ. Advances in autologous breast reconstruction with pedicled perforator flaps. *Clin Plast Surg.* 2012;39:477–490.
- Yang JD, Lee JW, Cho YK, et al. Surgical techniques for personalized oncoplastic surgery in breast cancer patients with small- to moderate-sized breasts (part 2): volume replacement. *J Breast Cancer.* 2012;15:7–14.
- Lee J, Jung JH, Kim WW, et al. Oncologic outcomes of volume replacement technique after partial mastectomy for breast cancer: a single center analysis. *Surg Oncol.* 2015;24:35–40.
- Santanelli F, Longo B, Germano S, et al. Total breast reconstruction using the thoracodorsal artery perforator flap without implant. *Plast Reconstr Surg.* 2014;133:251–254.
- Hamdi M, Wolfli J, Van Landuyt K. Partial mastectomy reconstruction. *Clin Plast Surg.* 2007;34:51–62.
- Holmström H, Lossing C. The lateral thoracodorsal flap in breast reconstruction. *Plast Reconstr Surg.* 1986;77:933–943.
- Garcia EB, Sabino M, Ferreira LM, et al. Thoracic-axillary flap immediate breast reparation after upper lateral quadrantectomy. *Rev Bras Mastol.* 2000;10:185.
- Woerdeman LA, van Schijndel AW, Hage JJ, et al. Verifying surgical results and risk factors of the lateral thoracodorsal flap. *Plast Reconstr Surg.* 2004;113:196–203.
- Macmillan RD, McCulley SJ, Schaverien MV, et al. Lateral thoracic artery perforator (LTAP) flap in partial breast reconstruction. *J Plast Reconstr Aesthet Surg.* 2015;68:686–691.