OPEN

PRS GLOBAL OPEN

ORIGINAL ARTICLE

Breast

Breast Reconstruction in Obese Patients: The Fat Grafted Latissimus versus Abdominal Free Tissue Transfer

Matthew D. Novak, MD
Jordan T. Blough, MD
Jasson T. Abraham, MD
Hope D. Shin, MD
Tai Yasuda, BS
Donna Ayala, BS
Andrew M. Altman, MD
Michel Saint-Cyr, MD

Background: Immediate fat grafting to the pedicled myocutaneous latissimus dorsi (LD) flap has recently gained in popularity as a means to supplement volume for breast reconstruction. The aim of this study is to compare complication rates of the immediately fat-grafted LD to free tissue transfer in the obese population.

Methods: In this retrospective cohort, 82 patients (149 breasts) from 2015 to 2019 were included. Patients underwent either unilateral or bilateral breast reconstruction with either LD with immediate fat grafting or abdominal-based free tissue transfer. Included patients had a body mass index ≥ 30 kg/m^2 at the time of surgery. Complication data were recorded as minor, major, and medical complications. Procedure characteristics and postoperative data were also studied.

Results: Minor complication rates between the LD with immediate fat grafting and free tissue transfer cases were similar (26.9% versus 26%, respectively). The free tissue transfer group had a significantly higher rate of major complications (20.3% versus 3.8%; $P = 0.048$) and medical complications (10.6% versus zero). Finally, the LD with immediate fat grafting group had significantly shorter operating room times, hospital length of stay, and fewer donor-site revisions.

Conclusions: LD with immediate fat grafting offers the benefit of a totally autologous reconstruction without the risks of abdominal-based microvascular free tissue transfer or an implant. Favorable complication rates, shorter operative times, and shorter hospital length of stay make this reconstructive option a safe alternative to free tissue transfer in the obese population. *(Plast Reconstr Surg Glob Open 2020;8:e2668; doi: 10.1097/GOX.0000000000002668; Published online 17 March 2020.)*

INTRODUCTION

Obesity and its related comorbidities have been associated with increased complication rates in patients undergoing autologous breast reconstruction.[1–13] Of the autologous options, the pedicled myocutaneous latissimus dorsi (LD) flap has lower complication rates compared with free tissue transfer, particularly in the obese population.[14–18] However, a traditional LD flap is limited in the volume it can achieve in reconstruction. Modifications such as implant placement or extended dissection have improved volume but add additional risks.[14,19–23] Implant placement negates a totally autologous reconstruction and is subject to infection, malposition, capsular contracture, and extrusion.[24] Extended dissection is associated with higher rates of donor-site wounds, seroma, and lumbar hernia.[25,26]

Recently, immediate fat grafting has been described to improve the volume that can be achieved with the LD flap.[20,27–32] However, no study has looked specifically at the results of breast reconstruction in the obese population undergoing LD with immediate fat grafting. The aim of this study is to identify whether a difference exists in complication rates among obese patients (body mass index [BMI] > 30 kg/m^2) undergoing LD with immediate fat grafting versus abdominal-based free tissue transfer for breast reconstruction. To our knowledge, this is the first

From the Division of Plastic and Reconstructive Surgery, Department of Surgery, Baylor Scott and White Health, Texas A&M College of Medicine, Temple, Tex.

Received for publication November 19, 2019; accepted November 22, 2019.

Presented at Plastic Surgery the Meeting (ASPS) 2018; Chicago, Ill.; Texas Society of Plastic Surgery (TSPS) Meeting 2018; San Antonio, Tex.; Baylor Scott and White Department of Surgery Research Day 2019; Temple, Tex.; and Baylor Scott and White Department of Research Scholars Day 2019; Temple, Tex.

DOI: 10.1097/GOX.0000000000002668

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

study directly comparing these autologous breast reconstruction options in obese patients.

PATIENTS AND METHODS

A retrospective review was approved by the institutional review board at Baylor Scott & White Medical Center—Temple to identify patients who underwent autologous breast reconstruction from January 2015 through January 2019. Surgeries were performed by 2 surgeons with uniform surgical and postoperative protocols. Patients were identified by Common Procedural Terminology codes 19361 for LD flaps and 19364 for free tissue transfer.

Patient-identifiable intrainstitutional National Surgical Quality Improvement Program data were used to obtain patient demographics and comorbidities, and chart review was conducted when these data were unavailable. Demographic data included age and BMI. Comorbidities included diabetes (insulin and noninsulin dependent), smoking status within the last year, pulmonary disease, hypertension requiring medication, chronic steroid use, presence of a bleeding disorder, and American Society of Anesthesiologists' (ASA) classification. Timing of breast reconstruction was recorded as either immediate or delayed. Delayed reconstruction also included patients who may have had a tissue expander placed at the time of mastectomy, otherwise known as delayed-immediate reconstruction (Fig. 1).[33] Data regarding abdominal flap classification, mastectomy type, nonhormonal neoadjuvant chemotherapy, and perioperative requirement of radiotherapy were also collected.

The World Health Organization's definition of obesity (BMI ≥ 30) was used as the inclusion criteria. Chart review was conducted to identify which LD cases included immediate fat grafting and exclude all others. Free tissue transfers that were not abdominal-based were excluded.

Incidents of postoperative complications were identified by chart review and were divided into minor or major surgical complications (recorded per breast and respective donor site) and medical complications (per patient). Minor complications were defined as those of the donor site and reconstruction site that required management in the outpatient setting: donor-site complications, breast wound healing issues, infection requiring oral antibiotics, and seroma requiring aspiration. Major complications were those that required return trips to the operating room: donor-site complications, hematoma, flap loss, infection/abscess, breast wound debridement, and flap thrombosis. Medical complications were included if they required inpatient admission but no surgical intervention. A pooled variable was generated to include major complications requiring reoperation or medical complications

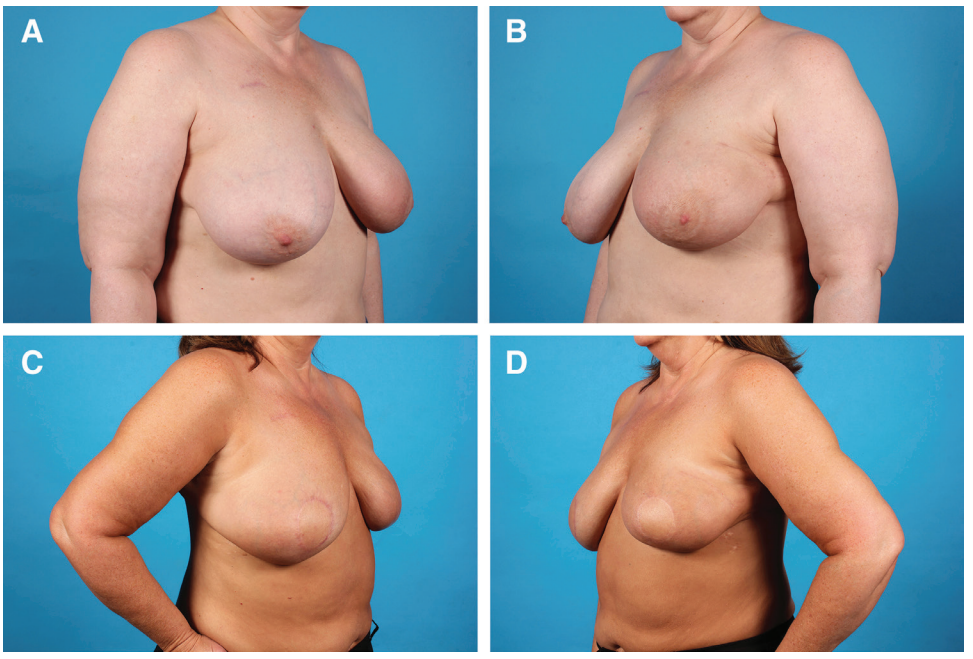

Fig. 1. A 48-year-old woman with BMI 36 kg/m^2. ASA class 2. The patient had a remote history of left breast invasive ductal carcinoma, for which she underwent lumpectomy and radiation. The patient was subsequently found to be BRCA1 positive and underwent bilateral prophylactic skin sparing mastectomies with immediate placement of bilateral pre-pectoral tissue expanders. (A and B) Right and left oblique views before bilateral prophylactic mastectomies and tissue expander placement. The patient underwent delayed immediate reconstruction with bilateral LD flaps and 460 mL (230 mL right, 230 mL left) immediate fat grafting 3 months post-mastectomy. The patient required 1 revision procedure with fat grafting (200 mL right; 200 mL left). Within this revision, the patient also underwent bilateral brachioplasty, right lateral thoracic dermatolipectomy, and dermatolipectomy to the bilateral breasts for symmetry. The patient did not desire nipple-areolar reconstruction. (C and D) Right and left oblique views of the 9-month final reconstruction result.

requiring admission. Abdominal bulge or hernias requiring surgical intervention during the follow-up period were also noted for free tissue transfers.

Additional data were collected to characterize the procedures and perioperative period. Outcomes of interest included mean operative duration, volume of fat grafted immediately to LD flaps, number of breast and donor-site revisions, volume of revision fat grafting, mastectomy weight, requirement of implant during revision, hospital length of stay, and time of drain in situ.

Surgical Technique

The included LD with immediate fat grafting patients were marked preoperatively with the patient in an upright position. The skin paddle was designed transversely to lie within natural creases in the back and maximize the skin paddle's size and volume. Fat harvest donor sites for LD with immediate fat grafting commonly included the abdomen, flanks, and medial and lateral thighs and were based on each patient's individual body habitus and fat distribution. Details of the flap harvest have been described previously.[34] The LD donor site was closed directly with the use of progressive tension sutures to obliterate empty space, and 2 drains were routinely placed at each donor site. Fat grafting recipient sites for LD with immediate fat grafting included the LD muscle, flap skin paddle, pectoralis major and serratus muscles, and mastectomy skin flaps. Selection of fat grafting recipient sites has also been described previously.[32]

For patients who underwent free tissue transfer, abdominal flap markings were made preoperatively with the patient in sitting, standing, and flexed positions. The majority of flaps were deep inferior epigastric artery perforator flaps. Flaps were converted to muscle-sparing transverse rectus abdominis myocutaneous flaps or transverse rectus abdominis myocutaneous flaps as needed based on each patient's vascular anatomy. Free tissue transfer donor sites were closed with progressive tension sutures to obliterate empty space, and 1 drain was routinely placed on each side of the abdomen. Fascial defects were closed with permanent sutures, and a synthetic mesh was used as needed for fascial defects.

For postoperative analgesia, donor sites for the LD with immediate fat grafting and the free tissue transfer groups were routinely injected with an analgesic cocktail consisting of 60 mL of 0.25% bupivacaine, 50 mcg dexmedetomidine, 30 mg ketorolac, and 4 mg dexamethasone mixed in 250 mL of normal saline. This was injected in a transversus abdominis plane for abdominal donor sites and in a subcutaneous, peri-incisional plane for back donor sites.

Statistical Analysis

Sample characteristics were described using descriptive statistics. Frequencies and percentages were used to describe categorical variables, while means, SDs, medians, and ranges were used for continuous variables. Nonparametric univariate analysis was conducted using Fisher exact test for categorical variables and Mann–Whitney *U*-test for continuous variables. Mastectomy type and obesity were analyzed using the χ^2 test. All analyses were 2-tailed and statistical significance was considered at $P \leq 0.05$.

RESULTS

Patients and Characteristics

A total of 149 breasts in 82 obese patients met final inclusion criteria. Patients' mean age was 51 years and mean BMI was 35.7 kg/m^2. It should be noted that while the BMI between groups was similar, the BMI ranged widely. The highest BMI in the LD with immediate fat grafting group was 52.6 kg/m^2, while the highest BMI in the free tissue transfer group was only 35.2 kg/m^2.

Procedure-specific patient characteristics are reported in Table 1. Sixteen patients (26 breasts) underwent LD with immediate fat grafting, while 66 patients (123 breasts) underwent free tissue transfer. Patients undergoing LD with immediate fat grafting tended to be older. Mean BMIs were comparable between the LD with immediate fat grafting and free tissue transfer patients. The majority of patients in both groups underwent skin-sparing mastectomy and delayed reconstruction (Figs. 2, 3). Of these patients, 2 who received LD with immediate fat grafting underwent delayed-immediate reconstruction with tissue expander placement at the time of mastectomy (Fig. 1). No significant difference was observed in the number of patients receiving neoadjuvant chemotherapy or radiotherapy. All radiation was completed before definitive autologous reconstruction.

Importantly, patients in the LD with immediate fat grafting group tended to be significantly more comorbid according to ASA class (ASA class > 2; 87.5% versus 56.1%; $P = 0.023$). No significant differences existed in prevalence of diabetes, hypertension, smoking status, pulmonary disease, chronic steroid use, or bleeding disorders. All patients had a minimum follow-up of 6 months, but the duration was longer in the free tissue transfer cohort (mean [SD], 36.1 [13.8] versus 23.2 [11.0] months; $P = 0.002$).

Procedure characteristics appear in Table 2. Average operative durations for bilateral free tissue transfers were 2.1 hours longer ($P = 0.018$), and those for unilateral transfers were 2.6 hours longer than LD with immediate fat grafting ($P = 0.019$). Mean hospital stay of 2.05 days was significantly ($P < 0.001$) longer for free tissue transfers. No significant difference for duration of drains (donor site or breast) in situ was observed between groups. Mastectomy weight was similar between groups. Of note, in the LD with immediate fat grafting group, a mean of 188.9 mL of autologous fat was grafted immediately during primary reconstruction. Both groups required a similar number of subsequent breast revisions, with a median of 1 revision each. The free tissue transfer donor site required significantly more subsequent revisions than the donor site for LD with immediate fat grafting (0.78 [0.82] versus 0.23 [0.59] times; $P < 0.001$). The LD with immediate fat grafting group required a larger volume of fat grafting during subsequent revisions (194.3 [168.4] versus 108.8 [135.1] mL; $P = 0.01$). This trend was also noted for the total

Table 1. Patient Demographics and Comorbidities

	LD + Immediate Fat Grafting		Free Tissue Transfer		
	Number or Mean ± SD	Percentage or Median (Range)	Number or Mean ± SD	Percentage or Median (Range)	*P*
Patients ϕ	16		66		
Breasts	26		123		
Age	56.8 ± 12.4	54 (37–79)	49.9 ± 9/9	50 (29–74)	0.060
BMI*	37.6 ± 5.5	36.8 (30.0–52.6)	35.2 ± 3.2	34.8 (30.0–35.2)	0.109
WHO class I	4	25.0%	34	51.5%	0.161
WHO class II	10	62.5%	27	40.9%	
WHO class III	2	12.5%	5	7.6%	
Laterality					0.064
Bilateral	10	62.5%	57	86.4%	
Unilateral	6	37.5%	9	13.6%	
Reconstruction timing§					< 0.001
Immediate†	1	3.8%	58	47.2%	
Delayed‡	25	96.2%	65	52.8%	
Flap classification					—
TRAM	—	—	1	0.8%	
MS-TRAM	—	—	59	47.9%	
DIEP	—	—	63	51.2%	
Mastectomy type					0.622
Partial	0	0%	2	1.9%	
NSM	0	0%	4	3.7%	
SSM	19	86.4%	93	86.9%	
MRM	3	13.6%	7	6.5%	
Radical	0	0%	1	0.9%	
Neoadjuvant chemotherapy	6	42.9%	14	22.6%	0.177
Radiotherapy	4	16.7%	16	13.3%	0.747
Diabetes	7	43.8%	16	24.2%	0.133
Insulin-dependent	3	4.5%	0	0%	1.000
Smoker	2	12.5%	10	15.2%	1.000
COPD	0	0%	3	4.5%	1.000
Hypertension	10	62.5%	31	47.0%	0.404
Chronic steroid use	2	12.5%	2	3.0%	0.169
Bleeding disorder	0	0%	2	3.0%	1.000
ASA class > 2	14	87.5%	37	56.1%	0.023
Follow-up time (months)	23.2 ± 11.0	23 (6–41)	36.1 ± 13.8	34 (13–62)	0.002

* WHO obesity classification: class 1, 30–34.9kg/m^2; class 2, 35–39.9 kg/m^2; class 3, >40 kg/m^2.
† Immediate reconstruction includes reconstructions performed within the same operation as the mastectomy.
‡ Delayed reconstruction includes reconstructions performed in an operation subsequent to the mastectomy.
§ Reconstruction timing, mastectomy type, and radiotherapy data points expressed per breast.
LD, latissimus dorsi; BMI, body mass index; WHO, World Health Organization; TRAM, transverse rectus abdominis myocutaneous; MS-TRAM, muscles sparing transverse rectus abdominis myocutaneous; DIEP, deep inferior epigastric perforator; NSM, nipple sparing mastectomy; SSM, skin sparing mastectomy; ASA, American Society of Anesthesiologists.

sum of fat grafting volume received, including during the index procedure for the LD with immediate fat grafting group (P = 0.01). Eight free tissue transfer patients required augmentation with implants compared with zero LD with immediate fat grafting patients.

Complication data are demonstrated in Table 3. The total number of minor complications between groups was similar. In contrast, free tissue transfers resulted in significantly more major complications (20.3% versus 3.8%; P = 0.048). Delayed wound healing of the breast requiring in-office debridement was the most common individual minor complication in both groups. Breast wound healing issues requiring operative debridement were the most common (6.5%) major complication for free tissue transfers. The only major complication for LD with immediate fat grafting was a hematoma necessitating reoperation. More than 10% of free tissue transfer patients were readmitted for nonoperative medical complications in contrast to zero LD with immediate fat grafting patients (P = 0.336). Medical complications included venous thromboembolism, myocardial infarction, opioid overdose (requiring reversal with Naloxone), and pneumonia. Free tissue transfer patients were significantly more likely to experience either a reoperation due to a major surgical complication or readmission due to a medical complication (36.4% versus 6.3%; P = 0.031). Finally, 4 (6.5%) patients who underwent muscle-sparing transverse rectus abdominis myocutaneous flaps required repair of donor-site-related hernias.

DISCUSSION

The effects of obesity on breast reconstruction have been well described. However, a consensus on the best reconstructive modality for the obese population has not been reached. In a national review of 12,986 patients who underwent breast reconstruction, Hanwright et al.[35] demonstrated that obese patients who underwent tissue expander reconstruction experienced fewer surgical and medical complications as well as fewer reoperations than those who underwent autologous reconstruction. Conversely, in a single-center review of 700 patients, Garvey et al.[36] demonstrated that obese patients experience higher failure rates with implant reconstruction than with autologous free-flap techniques. Nonetheless, obesity has been shown to significantly increase perioperative,

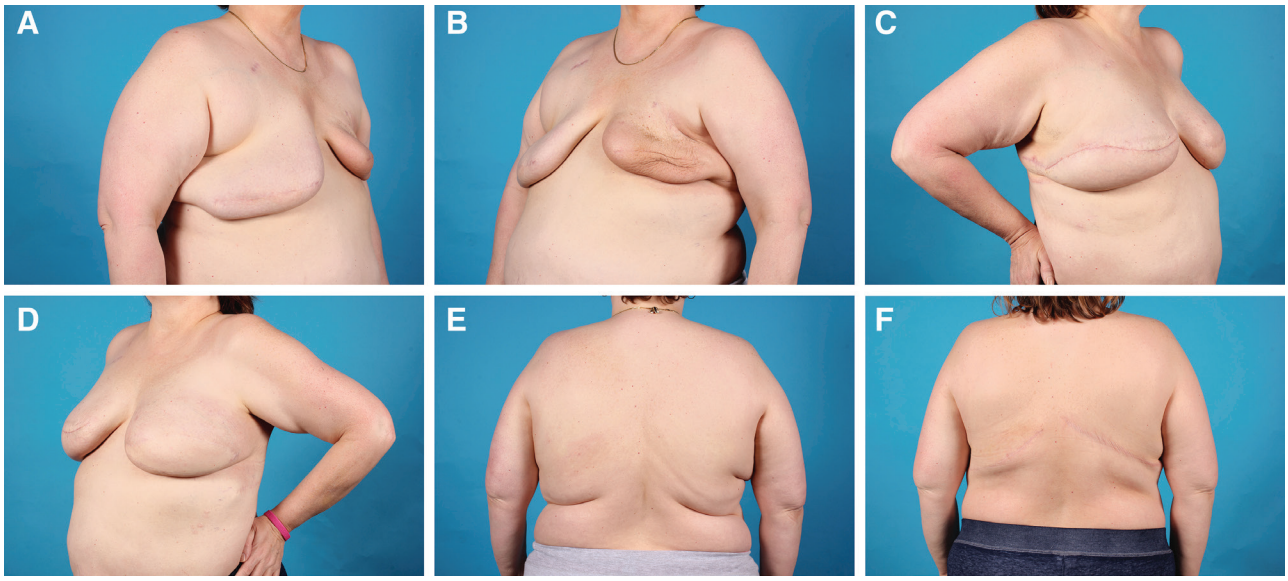

Fig. 2. A 49-year-old woman with BMI 37 kg/m^2 and past medical history of diabetes mellitus and hypertension. ASA class 3. The patient underwent bilateral skin sparing mastectomies with left axillary lymph node dissection and adjuvant chemoradiation for invasive ductal carcinoma of the left breast. (A and B) Right and left oblique views post-mastectomy and post-radiation to the left breast. The patient underwent delayed reconstruction with bilateral LD flaps and 500 mL (200 mL right, 300 mL left) immediate fat grafting 9 months after completing radiation. The patient required 2 revision procedures with fat grafting (total 580 mL right; 350 mL left) and dermatolipectomy to the bilateral breasts for symmetry. The patient did not desire nipple-areolar reconstruction. (C and D) Right and left oblique views of the 1-year final reconstruction result. (E and F) LD donor site—preoperative and 4 months postoperative.

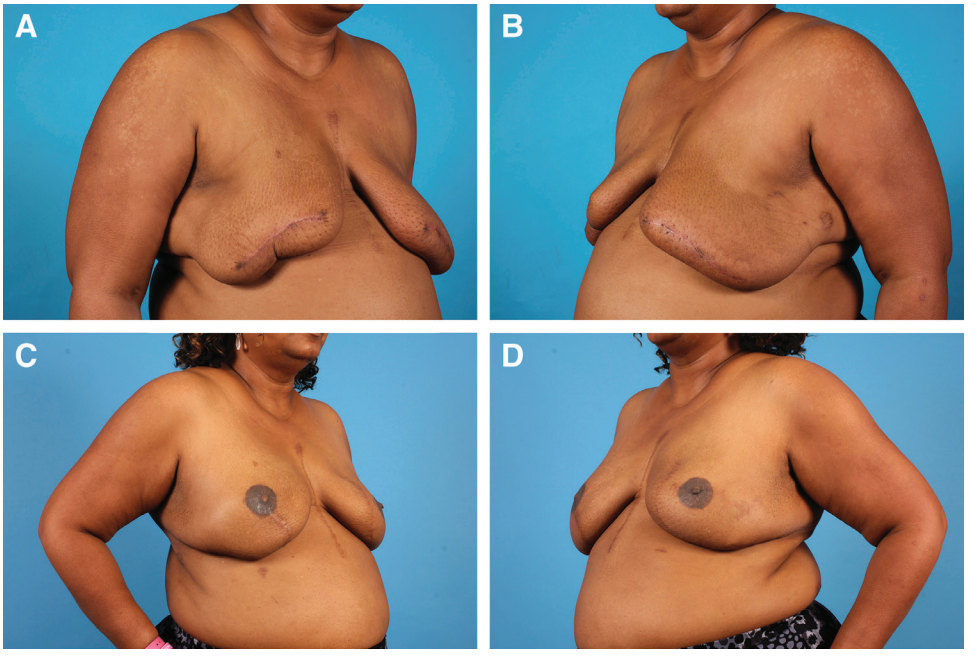

Fig. 3. A 47-year-old woman with BMI 38 kg/m^2 and past medical history diabetes mellitus, hypertension, and pulmonary disease. ASA class 3. The patient underwent bilateral skin sparing mastectomies for left breast IDC. The patient did not require adjuvant radiation. (A and B) Right and left oblique views 3 months post-mastectomy. The patient underwent bilateral LD flaps and 200 mL (100 mL right, 100 mL left) immediate fat grafting 5 months post-mastectomy. The patient required 1 revision procedure for dermatolipectomy to the bilateral breasts for symmetry. The patient did not require any additional fat grafting after the primary reconstruction. (C and D) Right and left oblique views of the 2-year final reconstruction result after nipple areolar reconstruction.

Table 2. Procedure Characteristics

	LD + Immediate Fat Grafting		Free Tissue Transfer		
	Number or Mean ± S.D.	Percentage or Median (Range)	Number or Mean ± S.D.	Percentage or Median (Range)	*P*
Operative duration (minutes)*					
Unilateral cases	294.4 ± 80.3	282 (205–403)	448.1 ± 76.6	474 (299–533)	0.019
Bilateral cases	482.4 ± 104.7	477 (329–666)	608.0 ± 154.3	596 (342–933)	0.018
Length of stay (days)	2.6 ± 1.4	2 (1–6)	4.65 ± 1.6	4 (2–9)	< 0.001
Drain time (days)	17.3 ± 5.8	16 (10–29)	16.3 ± 6.3	14 (4–34)	0.341
Mastectomy weight (g)	956.7 ± 286.8	921 (590–1642)	864.1 ± 336.9	817 (183–1788)	0.161
Volume immediate fat graft (mL)	188.9 ± 92.2	200 (60–420)	—	—	—
Presence of breast revision	20	76.9%	88	71.5%	0.638
No. breast revisions†	1.15 ± 0.881	1 (0–3)	1.19 ± 1.035	1 (0–4)	0.916
No. donor-site revisions	0.23 ± 0.59	0 (0–2)	0.78 ± 0.82	1 (0–3)	< 0.001
Volume subsequent fat graft (mL)	194.3 ± 168.4	178 (0–580)	108.8 ± 135.1	80 (0–675)	0.01
Total fat graft volume (mL)	383.2 ± 174.8	355 (100–780)	108.8 ± 135.1	80 (0–675)	0.01
Requirement of implant	0	0%	8	6.5%	0.351

* Operative duration and length of stay expressed per patient.
† Number of breast revisions excludes nipple reconstruction procedures.
LD, latissimus dorsi.

Table 3. Minor, Major, and Medical Complications

	LD + Immediate Fat Grafting		Free Tissue Transfer		
	Number	Percentage	Number	Percentage	*P*
Minor surgical complication, per breast*	7	26.9%	32	26.0%	1.000
Donor site‡	1	3.8%	9	7.3%	1.000
Delayed wound healing (breast)	3	11.5%	19	15.4%	0.767
Infection (breast)	1	3.8%	4	3.3%	1.000
Fluid collection (breast)	2	7.7%	1	0.8%	0.079
Major surgical complication requiring reoperation, per breast	1	3.8%	25	20.3%	0.048
Donor site§	0	0.0%	5	4.1%	0.587
Hematoma (breast)	1	3.8%	3	2.4%	0.540
Flap loss (breast)	0	0.0%	4	3.3%	1.000
Infection/abscess (breast)	0	0.0%	4	3.3%	1.000
Wound (breast)	0	0.0%	8	6.5%	0.351
Flap thrombosis	0	0.0%	1	0.8%	1.000
Medical complication requiring readmission†	0	0.0%	7	10.6%	0.336
Patients experiencing any major medical or surgical complication	1	6.3%	24	36.4%	0.031
Hernia requiring surgical repair†	—	—	4	6.50%	

* Minor, major, and individual surgical complications analyzed per breast.
† Medical complications and hernia formation analyzed per patient.
‡ Minor donor-site complications included infection, seroma, and wound separation.
§ Major donor-site complications included infection, hematoma, and wound separation.

postoperative, and medical complications, regardless of reconstructive modality.[11,36]

Whether chosen by surgeon selection or patient preference, autologous breast reconstruction should aim to minimize complications, achieve an esthetic result, and offer an acceptable postmastectomy quality of life. A patient-individualized approach is necessary to choose the best autologous option. Microsurgical advances have led to a variety of flap options for free tissue transfer.[28,37–42] Despite these advances, surgeons need to proceed judiciously and on a case-by-case basis because a variety of patient characteristics may be relative contraindications to free tissue transfer.[13,43,44] These contraindications include obesity, diabetes, smoking history, bleeding or clotting disorders, and prior abdominal surgeries.

The pedicled LD has been described as an excellent autologous alternative to free tissue transfer.[7,14–18,35] The versatility and reliability of the LD flap make it a reasonable option for nearly any patient.[14] However, the LD is limited by the volume it can achieve. In the past, this constraint was addressed by extending the flap dissection and, if needed, placing an implant. To avoid these modifications and their associated morbidity, immediate fat grafting has been described to augment the volume.

The present study demonstrated multiple advantages of LD with immediate fat grafting over abdominal-based free tissue transfer for obese patients. Despite the LD with immediate fat grafting group having a higher ASA class, similar minor complication rates were observed between groups. These complications, all managed in the outpatient setting, occurred at similar rates in other large retrospective studies.[1–3,6,11,16]

Donor-site morbidity in LD with immediate fat grafting was also favorable as compared to the free tissue transfer donor site. Dissection and transfer of the LD muscle is generally well tolerated with minimal to no long-term loss of shoulder function.[45–47] Of note, seroma is the complication most frequently encountered in LD donor sites.[26]

The absence of this complication in our cohort is likely related to the authors' flap design, use of progressive tension sutures to eliminate empty space, and placement of 2 drains at each LD donor site.[19,32] On the contrary, 14 (11.4%) free tissue transfer patients in the present study developed donor-site complications, 5 (4.1%) of which required reoperation. Donor-site complications, hernia, or abdominal bulge following free tissue transfer are significant and associated with increased health care costs, which are even higher among obese patients.[2,48]

Collectively, patients in the free tissue transfer group were nearly 6 times more likely to require a reoperation or inpatient admission for medical complications. Medical complications add significant morbidity to breast reconstruction and highlight another important contrast in safety profile between procedures. The discrepancy may be related to the longer exposure to general anesthesia (2.1 hours longer in bilateral and 2.6 hours longer in unilateral), longer hospital stays (2.05 days longer), delayed return to activity, or the anatomy of the surgical dissection itself. In a review of autologous breast reconstruction in the United States that corroborated this finding, Pien et al.[49] demonstrated longer hospital stays and higher costs in free tissue transfers.

One concern that surgeons may have with volume augmentation through fat grafting is the consideration of fat graft resorption. Nonetheless, in our study, both procedures required a similar number of revisions. The type of revision procedure did, however, differ between groups. LD with immediate fat grafting revisions were to a greater extent directed at continuing to improve volume with additional grafting (194 mL of additional fat on average) versus free tissue transfer (109 mL on average). The free tissue transfer patients required more than 3 times the number of subsequent revisions to the donor site compared with the LD with immediate fat grafting group. This difference was likely related to the impact of delayed wound healing on scar cosmesis and the more conspicuous location of an abdominal scar versus a back scar. Finally, 8 patients who underwent free tissue transfer actually required augmentation with implants, while zero LD with immediate fat grafting patients required implants.

Prior reports of LD with immediate fat grafting have described flap harvest, fat grafting, inset, and donor-site management techniques, all with favorable complication rates. Santanelli et al.[31] first described the LD with immediate fat grafting to the flap skin paddle and LD muscle. In 2015, Zhu et al.[32] reported on LD with immediate fat grafting and presented an algorithm for selecting recipient sites (LD skin paddle, LD muscle, pectoralis major and serratus, and mastectomy skin flaps) as part of the procedure. Economides et al.[28] described volumes up to 359.6 mL and a multilayer injection technique without major complications. In comparison, the amount of fat grafted simultaneously with flap harvest in the present study averaged 186.19 mL per breast. However, importantly, the authors' technique involves harvesting the LD with a large transverse skin paddle. Additional authors have also described their experience with LD with immediate fat grafting.[20,27,29,30] However, no prior studies have directly compared the LD with immediate fat grafting to its autologous counterpart, free tissue transfer, in the obese population. This patient population requires larger reconstruction volumes, is at a higher surgical risk, and generally experiences a higher rate of surgical complications with breast reconstruction. LD with immediate fat grafting addresses the issue of volume while offering shorter hospital length of stay, lower costs, and lower rate of flap loss, making it an attractive option for obese patients requiring autologous breast reconstruction.

This study demonstrates significant advantages of LD with immediate fat grafting over free tissue transfer in the obese population. It is however, limited by its retrospective nature. Furthermore, while follow-up time in each group is adequate to fully capture complications data, it is important to acknowledge that follow-up time for the LD with immediate fat grafting group was shorter. Therefore, the number of revisions required may differ with longer-term follow-up, especially considering fat graft resorption. Finally, the study design does not allow for the true impact of the mastectomy on the reconstructive outcomes to be elucidated. Future directions entail expanding the sample size for further review of safety, assessing esthetic and patient satisfaction scores, and analyzing cost-effectiveness.

CONCLUSIONS

LD with immediate fat grafting provides a totally autologous, less morbid reconstruction in patients who are not ideal candidates for microsurgical reconstruction. Obese patients undergoing LD with immediate fat grafting experienced lower rates of major and medical complications, decreased need for donor-site revisions, and shorter operative duration and hospital length of stay. These findings demonstrate that LD with immediate fat grafting is a sound autologous alternative to free tissue transfer in the obese population.

Michel Saint-Cyr, MD, FRCS (C)
2401 S. 31st St
MS-01-E443
Temple, TX 76508
E-mail: Michel.SaintCyr@BSWHealth.org

REFERENCES

1. Schaverien MV, Mcculley SJ. Effect of obesity on outcomes of free autologous breast reconstruction: a meta-analysis. *Microsurgery*. 2014;34:484–497.
2. Lee KT, Mun GH. Effects of obesity on postoperative complications after breast reconstruction using free muscle-sparing transverse rectus abdominis myocutaneous, deep inferior epigastric perforator, and superficial inferior epigastric artery flap: a systematic review and meta-analysis. *Ann Plast Surg*. 2016;76:576–584.
3. Fischer JP, Cleveland EC, Nelson JA, et al. Breast reconstruction in the morbidly obese patient: assessment of 30-day complications using the 2005 to 2010 national surgical quality improvement program data sets. *Plast Reconstr Surg*. 2013;132:750–761.
4. Fischer JP, Nelson JA, Sieber B, et al. Free tissue transfer in the obese patient: an outcome and cost analysis in 1258 consecutive abdominally based reconstructions. *Plast Reconstr Surg*. 2013;131:681e–692e.

5. Garvey PB, Buchel EW, Pockaj BA, et al. The deep inferior epigastric perforator flap for breast reconstruction in overweight and obese patients. *Plast Reconstr Surg.* 2005;115:447–457.
6. Jandali S, Nelson JA, Sonnad SS, et al. Breast reconstruction with free tissue transfer from the abdomen in the morbidly obese. *Plast Reconstr Surg.* 2011;127:2206–2213.
7. Massenburg BB, Sanati-Mehrizy P, Ingargiola MJ, et al. Flap failure and wound complications in autologous breast reconstruction: a national perspective. *Aesthetic Plast Surg.* 2015;39:902–909.
8. Momeni A, Ahdoot MA, Kim RY, et al. Should we continue to consider obesity a relative contraindication for autologous microsurgical breast reconstruction? *J Plast Reconstr Aesthet Surg.* 2012;65:420–425.
9. Nelson JA, Chung CU, Fischer JP, et al. Wound healing complications after autologous breast reconstruction: a model to predict risk. *J Plast Reconstr Aesthet Surg.* 2015;68:531–539.
10. Ozturk CN, Kundu N, Bernard S, et al. Breast reconstruction with abdominal-based free flaps in high body mass index population: postoperative complications and impact of weight loss. *Ann Plast Surg.* 2014;72:13–22.
11. Panayi AC, Agha RA, Sieber BA, et al. Impact of obesity on outcomes in breast reconstruction: a systematic review and meta-analysis. *J Reconstr Microsurg.* 2018;34:363–375.
12. Wang XL, Liu LB, Song FM, et al. Meta-analysis of the safety and factors contributing to complications of MS-TRAM, DIEP, and SIEA flaps for breast reconstruction. *Aesthetic Plast Surg.* 2014;38:681–691.
13. Spitz JA, Bradford PS, Aguilar F, et al. How big is too big: pushing the obesity limits in microsurgical breast reconstruction. *Ann Plast Surg.* 2018;80:137–140.
14. Hammond DC. Postmastectomy reconstruction of the breast using the latissimus dorsi musculocutaneous flap. *Cancer J.* 2008;14:248–252.
15. Thorarinsson A, Fröjd V, Kölby L, et al. Patient determinants as independent risk factors for postoperative complications of breast reconstruction. *Gland Surg.* 2017;6:355–367.
16. Yezhelyev M, Duggal CS, Carlson GW, et al. Complications of latissimus dorsi flap breast reconstruction in overweight and obese patients. *Ann Plast Surg.* 2013;70:557–562.
17. Zinzindohoué C, Bertrand P, Michel A, et al. A prospective study on skin-sparing mastectomy for immediate breast reconstruction with latissimus dorsi flap after neoadjuvant chemotherapy and radiotherapy in invasive breast carcinoma. *Ann Surg Oncol.* 2016;23:2350–2356.
18. Bonomi S, Salval A, Settembrini F, et al. Autologous latissimus dorsi flap as an alternative to free abdomen-based flap for breast reconstruction in the morbidly obese [letter]. *Plast Reconstr Surg.* 2012;129:357e–358e. doi:
19. Miller SH. The low transverse extended latissimus dorsi flap based on fat compartments of the back for breast reconstruction: anatomical study and clinical results. *Yearb Plast Aesthetic Surg.* 2013;2013:165–167. doi:
20. Mushin OP, Myers PL, Langstein HN. Indications and controversies for complete and implant-enhanced latissimus dorsi breast reconstructions. *Clin Plast Surg.* 2018;45:75–81.
21. Shay P, Jacobs J. Autologous reconstruction following nipple sparing mastectomy: a comprehensive review of the current literature. *Gland Surg.* 2018;7:316–324.
22. Sood R, Easow JM, Konopka G, et al. Latissimus dorsi flap in breast reconstruction: recent innovations in the workhorse flap. *Cancer Control.* 2018;25:1073274817744638.
23. Denewer A, Setit A, Hussein O, et al. Skin-sparing mastectomy with immediate breast reconstruction by a new modification of extended latissimus dorsi myocutaneous flap. *World J Surg.* 2008;32:2586–2592.
24. Tarantino I, Banic A, Fischer T. Evaluation of late results in breast reconstruction by latissimus dorsi flap and prosthesis implantation. *Plast Reconstr Surg.* 2006;117:1387–1394.
25. Clough KB, Louis-Sylvestre C, Fitoussi A, et al. Donor site sequelae after autologous breast reconstruction with an extended latissimus dorsi flap. *Plast Reconstr Surg.* 2002;109:1904–1911.
26. Jeon BJ, Lee TS, Lim SY, et al. Risk factors for donor-site seroma formation after immediate breast reconstruction with the extended latissimus dorsi flap: a statistical analysis of 120 consecutive cases. *Ann Plast Surg.* 2012;69:145–147.
27. Demiri EC, Dionyssiou DD, Tsimponis A, et al. Outcomes of fat-augmented latissimus dorsi (FALD) flap versus implant-based latissimus dorsi flap for delayed post-radiation breast reconstruction. *Aesthetic Plast Surg.* 2018;42:692–701.
28. Economides JM, Song DH. Latissimus dorsi and immediate fat transfer (LIFT) for complete autologous breast reconstruction. *Plast Reconstr Surg Glob Open.* 2018;6:e1656.
29. Johns N, Fairbairn N, Trail M, et al. Autologous breast reconstruction using the immediately lipofilled extended latissimus dorsi flap. *J Plast Reconstr Aesthet Surg.* 2018;71:201–208.
30. Niddam J, Vidal L, Hersant B, et al. Primary fat grafting to the pectoralis muscle during latissimus dorsi breast reconstruction. *Plast Reconstr Surg Glob Open.* 2016;4:e1059.
31. Santanelli di Pompeo F, Laporta R, Sorotos M, et al. Latissimus dorsi flap for total autologous immediate breast reconstruction without implants. *Plast Reconstr Surg.* 2014;134:871e–879e. doi:
32. Zhu L, Mohan AT, Vijayasekaran A, et al. Maximizing the volume of latissimus dorsi flap in autologous breast reconstruction with simultaneous multisite fat grafting. *Aesthet Surg J.* 2016;36:169–178.
33. Kronowitz SJ, Hunt KK, Kuerer HM, et al. Delayed-immediate breast reconstruction. *Plast Reconstr Surg.* 2004;113:1617–1628.
34. Bailey S, Saint-Cyr M, Zhang K, et al. Breast reconstruction with the latissimus dorsi flap: women's preference for scar location. *Plast Reconstr Surg.* 2010;126:358–365.
35. Hanwright PJ, Davila AA, Hirsch EM, et al. The differential effect of BMI on prosthetic versus autogenous breast reconstruction: a multivariate analysis of 12,986 patients. *Breast.* 2013;22:938–945.
36. Garvey PB, Villa MT, Rozanski AT, et al. The advantages of free abdominal-based flaps over implants for breast reconstruction in obese patients. *Plast Reconstr Surg.* 2012;130:991–1000.
37. Allen RJ, Tucker C Jr. Superior gluteal artery perforator free flap for breast reconstruction. *Plast Reconstr Surg.* 1995;95:1207–1212.
38. Allen RJ, Haddock NT, Ahn CY, et al. Breast reconstruction with the profunda artery perforator flap. *Plast Reconstr Surg.* 2012;129:16e–23e.
39. Arnez ZM, Khan U, Pogorelec D, et al. Breast reconstruction using the free superficial inferior epigastric artery (SIEA) flap. *Br J Plast Surg.* 1999;52:276–279.
40. Yu SC, Kleiber GM, Song DH. An algorithmic approach to total breast reconstruction with free tissue transfer. *Arch Plast Surg.* 2013;40:173–180.
41. Holmström H. The free abdominoplasty flap and its use in breast reconstruction. An experimental study and clinical case report. *Scand J Plast Reconstr Surg.* 1979;13:423–427.
42. Kulkarni AR, Sears ED, Atisha DM, et al. Use of autologous and microsurgical breast reconstruction by U.S. Plastic surgeons. *Plast Reconstr Surg.* 2013;132:534–541.
43. Chang DW, Wang B, Robb GL, et al. Effect of obesity on flap and donor-site complications in free transverse rectus abdominis myocutaneous flap breast reconstruction. *Plast Reconstr Surg.* 2000;105:1640–1648.
44. Chang EI, Liu J. Prospective evaluation of obese patients undergoing autologous abdominal free flap breast reconstruction. *Plast Reconstr Surg.* 2018;142:120e–125e. doi:

45. Russell RC, Pribaz J, Zook EG, et al. Functional evaluation of latissimus dorsi donor site. *Plast Reconstr Surg.* 1986;78:336–344.
46. Fraulin FO, Louie G, Zorrilla L, et al. Functional evaluation of the shoulder following latissimus dorsi muscle transfer. *Ann Plast Surg.* 1995;35:349–355.
47. Laitung JK, Peck F. Shoulder function following the loss of the latissimus dorsi muscle. *Br J Plast Surg.* 1985;38:375–379.
48. Shubinets V, Fox JP, Sarik JR, et al. Surgically treated hernia following abdominally based autologous breast reconstruction: prevalence, outcomes, and expenditures. *Plast Reconstr Surg.* 2016;137:749–757.
49. Pien I, Caccavale S, Cheung MC, et al. Evolving trends in autologous breast reconstruction: is the deep inferior epigastric artery perforator flap taking over? *Ann Plast Surg.* 2016;76:489–493.