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ORIGINAL ARTICLE

The traditional versus endoscopic-assisted latissimus dorsi harvest in oncoplastic surgery: A long term comparison of breast volume, aesthetics, and donor site outcomes

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ABSTRACT

Background/Objective: Volume replacement with the latissimus dorsi (LD) is an option for patients after partial mastectomy. Although potential benefits of using the endoscopic technique have been previously described, previous studies have not assessed long term volume and aesthetic outcomes compared to traditional methods. In this study, we aim to compare the endoscopic, latissimus only harvest to the traditional latissimus with skin paddle method.

Methods: Eleven patients underwent breast reconstruction with the traditional LD flap harvesting method; 9 underwent endoscopically assisted LD flap reconstruction. The difference between preoperative and >1 year postoperative volumes were recorded. Patient satisfaction and surgeon-based observer assessment of the breast aesthetic and donor site scar were compared between the two techniques.

Results: Compared to the traditional group, there was a significant mean volume reduction in the endoscopic group (70.3 vs 21.7 cc, $p = 0.0023$). Operative time was also longer in the endoscopic group than in the traditional group (368 vs 257 min, $p < 0.001$). In observer assessment criteria, the result of the donor site scar assessment was superior in the endoscopic group in terms of vascularity ($p = 0.0038$), relief ($p = 0.0023$), and pliability ($p = 0.053$).

Conclusion: Patients' attitudes and feelings about the scar were better in the endoscopic group than in the traditional group. However, compared to the endoscopic group, the traditional group achieved a better breast cosmetic result and better retention of volume postoperatively, possibly due to incorporation of the skin flap and adipo-fascial tissue.

1. Introduction

Breast conservation therapy (BCT) has become widely employed for women with early-stage breast cancer. The advantages of preserving native parenchyma include maintaining cosmesis, sensation, and native breast architecture. However, residual deformity and asymmetry are common, and reported in up to 20% of patients.[1,2] Particularly when more than 20% of breast volume is to be excised, early management is necessary to avoid breast distortion, asymmetry, and nipple malposition. Of the options available, the latissimus dorsi (LD) is able to restore volume in after partial mastectomy defects.[3–6]

Use of these techniques are critical, particularly in the small breasted patient where contralateral symmetry procedures may not be feasible. Although elevation of the LD flap is technically reliable, the traditional LD muscle harvest requires a long incision that often results in an undesirable scar.[7] In order to minimize incisional burden, endoscopically assisted free LD muscle transfer was introduced in 1997.[8] The endoscopically assisted flap harvest aims to improve donor site morbidity through small incisions; its successful application has been reported in several case studies.[1,3,9–12] When comparing endoscopically assisted harvest over the traditional technique, Chih-Hung et al found decreased pain, earlier mobility of donor site arm, and improved satisfaction with the scar appearance in the endoscopic group.[13]

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Other touted benefits of the endoscopically assisted latissimus harvest include improved magnified visualization for intraoperative hemostasis, better wound healing, and less postoperative pain at the donor site [9]. In this study, we compare the endoscopic, latissimus only harvest to the traditional latissimus with skin paddle method. This is the first study, as far as the authors are aware, that objectively quantifies the difference in long term volume outcomes between endoscopic and traditional methods. We additionally seek to compare patient satisfaction, results of observer scar and breast assessments, and donor site morbidity. Direct comparison of the two techniques performed by one reconstructive surgeon in a single institution may serve to clarify the advantages and disadvantages between the techniques.

2. Methods

Twenty patients underwent immediate latissimus dorsi harvest for volume replacement after partial mastectomy by a single surgeon using either the endoscopic or traditional method from October 2013 to December 2016. Patients were given the choice of the endoscopic method only after the endoscope was first incorporated into the surgical procedure on November 2013. Only after this period, the patients were given the consent form to choose between the traditional and the endoscopic method. When the patient chose to undergo the surgery by the endoscopic method they were included in the endoscopic arm. Their charts were retrospectively reviewed with institution review board approval of Severance Hospital, Yonsei University Health System (IRB No. 4-2018-0971). Informed consent was obtained from all 20 patients. In all cases, breast size ranged from 150 to 480 cc in volume. Patients met oncologic criteria for breast conservation therapy. Eleven patients underwent breast reconstruction with the traditional LD flap harvesting method, and 9 underwent endoscopically assisted LD flap reconstruction.

2.1. Surgical techniques

2.1.1. Endoscopic technique

After partial mastectomy, the patient was positioned in the lateral decubitus position with an arm rest and an axillary roll. The borders of the LD were marked on the patient. A 6-cm axillary incision and two additional port sites were marked. The inferior aspect of the axillary incision is utilized as the first port site. The second port site is placed 6 cm inferior to the end of the axillary incision and in line with the axillary line vertically. The third and final port was placed 5–6 cm below the second port site. Skin paddles were not used in the endoscopic cohort. Placement of the three ports is shown in Fig. 1.

Using the axillary incision, the thoracodorsal pedicle was identified. The thoracodorsal nerve was ligated. A subcutaneous space anterior to the anterior border of the muscle was dissected using long-tip electrocautery in order to place the additional ports. A camera port (12 mm) was introduced to the second port after making a 1-cm incision. An endoscope (Karl Storz, Tuttlingen, Germany) was also placed through this port. Next, a 5-mm incision was made on the most inferiorly marked 8-mm port. The axillary incision was temporarily closed around the other 8-mm port to maintain insufflation. A monopolar scissor and grasping forceps (Ethicon, Blue Ash, OH, USA) were introduced to the 8-mm ports. Submuscular dissection of the borders was performed first, the grasper was used to direct the anterior edge of the muscle toward the chest wall; and then dissection over the superficial surface of the LD was performed. Next, submuscular dissection was continued. Once dissections of both sides were complete, the muscle was disinserted from the predesigned marked area (Fig. 2).

Fig. 1. Placement of the three ports.
With the patient in the decubitus position, the endoscope is placed through the 12 mm port situated between the 8 mm ports.

Negative suction drains were inserted through the trocar insertion site. The patient's position was changed to supine for breast reconstruction. The vessel was identified (Fig. 3), and the muscle was tunneled via the axillary incision and used to fill the defect in the breast.

2.1.2. Traditional technique

While the patient was in the supine position, the thoracodorsal pedicle was identified, and the thoracodorsal nerve was ligated. Then the patient was positioned in the lateral decubitus position. A horizontal incision was made along the brassiere line, incorporating a skin paddle. The skin island was incised down to the subcutaneous plane, and the adipose tissue below the superficial fascia was harvested together along with the appropriate amount of LD. Mobilization of the muscular origin and insertion was done, and negative suction drains were inserted. Finally, the patient's position was changed to supine again, and the harvested flap was used to fill in the defect left by partial mastectomy.

2.2. Data collection

Patients' age, type of mastectomy, tumor location, weight of the excised tumor, tumor histology, and preoperative and postoperative adjuvant treatments received were recorded. Patients' body mass index (weight [kg]/height [m^2]) was calculated. Total operative time, postoperative hospital stay, intraoperative

Fig. 2. Endoscopic-assisted latissimus dorsi harvest.
The muscle is shown after disinsertion from the posterior and inferior origins.

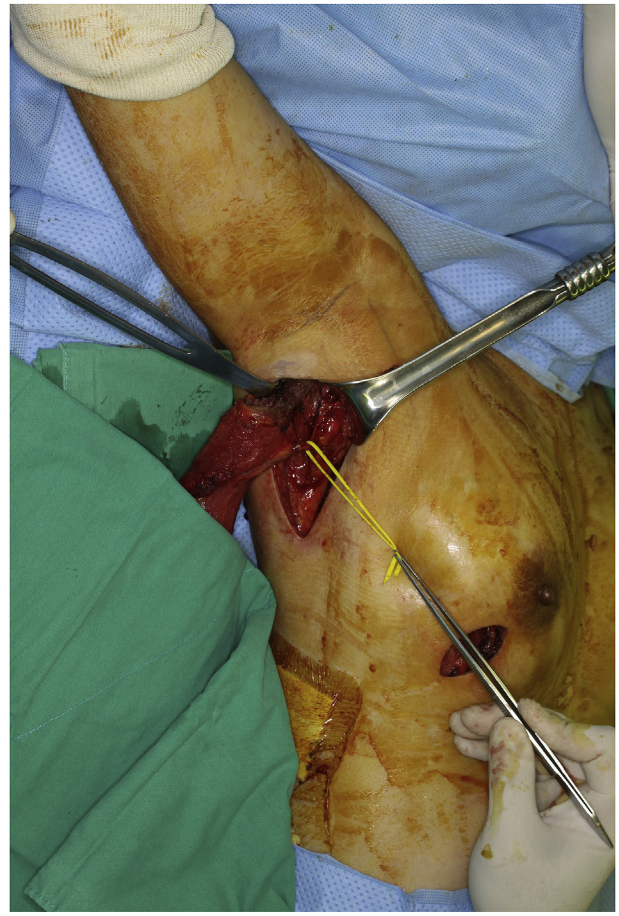

Fig. 3. Vessel identification after changing the patient's position.
The vessel is identified while the patient is in the supine position and tagged with a vessel loop. Then, the muscle is tunneled via the axillary incision and used to fill the defect in the breast.

bleeding, duration of postoperative drainage less than 30 cc, and complications were reviewed from the patients' medical records. Preoperative and postoperative breast volumes were measured using a three-dimensional (3D) axis scanner (Axis Three, AX3 Technologies, Miami, FL, USA).[14] The preoperative volume was measured 1 day preoperatively, and postoperative volume was measured at least 1 year postoperatively in both groups; final postoperative volume of all patients was measured between December 2017 and January 2018. The difference between preoperative and final postoperative volumes were calculated and recorded.

At final follow up, patients assessed their own postoperative scar using a survey and the scars were also evaluated by the Observer Scar Assessment Scale. Patients were asked to record their score for scar length, general appearance, and discomfort on a 5-point Likert scale; photographs of patients' scars were taken and shown to them on the day of the survey. Similarly, the observer scale was assessed by three different board-certified plastic surgeons. Each item of the scale had a 10-point score, with 10 indicating the worst imaginable scar or sensation and 1 corresponding to the situation of normal skin.

Similar to the donor site scar, breast shape and symmetry were assessed by patients and observers. In the patient-assessed survey, a 5-point scale was used, and in the observer scale, a 10-point scale was used. A score of 1 represented most dissatisfied and 10 represented most satisfied.

2.3. Three-dimensional scan

The 3D breast imaging was performed using the Axis 3 (Axis Three, AX3 Technologies). Markers on the floor of the scanner are used to indicate where the patient's feet should stand. After scanning, anatomically precise models were generated within seconds using Color Coded Triangulation™, a patented Siemens (Berlin, Germany) and Axis Three technology. The 3D image was marked using imaging software (Axis Three) on the lowest border, nipple, areola margin, sternal notch, and medial and lateral margins. The scanner extracts the breast volume using the designated points that the examiner selects.

2.4. Statistical analysis

Statistical analyses were performed using SAS (version 9.4, SAS Inc., Cary, NC, USA). The mean, median, standard deviation, and quadrant of parameters were calculated. If data were assumed to be normally distributed, continuous data were analyzed with an independent samples two-tailed t test, and the results are presented as a mean ± standard deviation. For data assumed not to be normally distributed, results are presented as a median (quadrant 1, quadrant 3), and the *p*-value was determined using the Mann–Whitney U test. The Fisher exact or Pearson chi-square test was used to analyze categorical data. A p-value <0.05 was considered significant.

Table 1
Characteristics of patients in the endoscopic group.

Patient no.	Age (years)	BMI (kg/m^2)	Type of mastectomy	Tumor location	Weight of the excised tumor (g)	Tumor histology	Postoperative RTx	Postoperative adjuvant Tx	Complication
1	45	24.99	PM + ALND	RUO	52	IDC	+	CTx	none
2	56	20.78	PM + SLNB	LLM	70	DCIS	+	letrozole (AI)	none
3	49	19.68	PM + SLNB	RLO	33	IDC	+	TAM	none
4	48	24.88	PM + SLNB	LUO	160	Mucinous Ca.	+	TAM	none
5	51	22.75	PM + SLNB	RUO	270	IDC	−	CTx	wound dehiscence
6	40	22.95	PM + SLNB	LLO	42	IDC	+	CTx	none
7	50	25.64	PM + SLNB	RUO	63	IDC	+	CTx, TAM	seroma
8	68	26.18	PM + SLNB	LLM	64	IDC	+	letrozole (AI)	seroma
9	43	20.17	PM + SLNB	RUO	44	ILC	+	TAM	none

BMI, body mass index; RUO, right upper outer; RLO, right lower outer; LUO, left upper outer; LLO, left lower outer; LLM, left lower medial; IDC, invasive ductal carcinoma; DCIS, ductal carcinoma in situ; Mucinous Ca., mucinous carcinoma; CTx, chemotherapy; AI, aromatase inhibitor; TAM, tamoxifen; RTx, radiotherapy; Tx, treatment; PM, partial mastectomy; ALND, axillary lymphadenectomy; SLNB, sentinel lymph node biopsy; ILC, Invasive lobular carcinoma.

Table 2
Characteristics of patients in the traditional group.

Patient no.	Age (years)	BMI (kg/m^2)	Type of mastectomy	Tumor location	Weight of the excised tumor (g)	Tumor histology	Postoperative RTx	Postoperative adjuvant Tx	Complication
1	49	25.59	PM	LLM	146	Phyllodes tumor	−	none	wound dehiscence
2	53	24.22	PM + ALND	LLM	97	IDC	+	TAM	none
3	59	27.27	PM + SLNB	LLC	70	ILC	+	CTx, trastuzumab	none
4	42	29.06	PM + SLNB	RLO	75	IDC	+	TAM	none
5	36	20.82	PM + SLNB	RUO	148	IDC	+	CTx, TAM	radiation dermatitis
6	36	20.67	PM + SLNB	LUC	26	Mucinous Ca.	+	CTx, trastuzumab, TAM	none
7	44	28.72	PM + SLNB	RUC	86	DCIS	+	none	none
8	43	22.76	PM + SLNB	LLM	40	Mucinous Ca.	+	TAM	none
9	52	21.5	PM + SLNB	RLO, RLC	100	DCIS	+	trastuzumab	seroma
10	40	22.58	PM + SLNB	LLM	45	IDC	+	TAM	none
11	39	20.45	PM + ALND	LLC	17	IDC	+	TAM	none

BMI, body mass index; RTx, radiotherapy; Tx, treatment; RUO, right upper outer; RLO, right lower outer; RUC, right upper center; RLC, right lower central; LUO, left upper outer; LLM, left lower medial; LLC; left lower central; LUC, left upper central; IDC, invasive ductal carcinoma; DCIS, ductal carcinoma in situ; Mucinous Ca., mucinous carcinoma; CTx, chemotherapy; AI, aromatase inhibitor; TAM, tamoxifen; PM, partial mastectomy; ALND, axillary lymphadenectomy; SLNB, sentinel lymph node biopsy; ILC, Invasive lobular carcinoma; o, no; x, yes; no., number.

Table 3
Comparison of surgical outcomes between the two groups.

Variable	Endoscopic group (n = 9) Mean ± SD/median (Q1, Q3)	Traditional group (n = 11) Mean ± SD/median (Q1, Q3)	*p*-value
Volume difference (cc)[a]	70.3 ± 43.5	21.7 ± 12.5	0.0023
Operative time (min)	368 ± 61	257 ± 59	0.0006
Postoperative hospital stay (days)	7 (7, 10)	9 (7, 11)	0.6159
Intraoperative bleeding (cc)	100 (50, 200)	100 (50, 200)	0.8783
Duration of drainage less than 40 cc postoperatively (days)	9.11 ± 4.81	11.30 ± 4.52	0.3209
Complication			
Donor site wound dehiscence	1/9	1/11	0.881
Donor site seroma	2/9	1/11	0.189

SD, standard deviation; Q1, quadrant 1; Q3, quadrant 3.
[a] The volume difference accounts for the change in volume of the reconstructed breast preoperatively and postoperatively (minimum 1-year follow-up).

3. Results

Mean follow-up periods were 39 months and 24 months for the endoscopic and traditional groups, respectively. Patients' ages were 50 and 44.8 years, and body mass indexes were 23.1 and 23.9 kg/m^2 in the endoscopic and traditional groups, respectively. The nipple–areolar complex were preserved for all patients during breast conserving surgery (Tables 1 and 2). Almost all patients, except for one from each group, received postoperative radiotherapy.

Mean operative times were 368.4 ± 61.1 min and 257.3 ± 58.8 min for the endoscopic and traditional groups, respectively ($p = 0.0006$). The total operative time was significantly longer in the endoscopic group than in the traditional group. Mean values for postoperative hospital stay were 7 days and 9 days for the endoscopic and traditional groups, respectively, but this difference was not statistically significant. Complications, such as donor site wound dehiscence and donor site seroma, were noted, but the differences between the two groups were not statistically significant (Table 3). No major complications as a result of the traditional and endoscopic technique were noted.

3.1. Pre and postoperative volume differences

The average tumor excised was 88.7 g for the endoscopic group

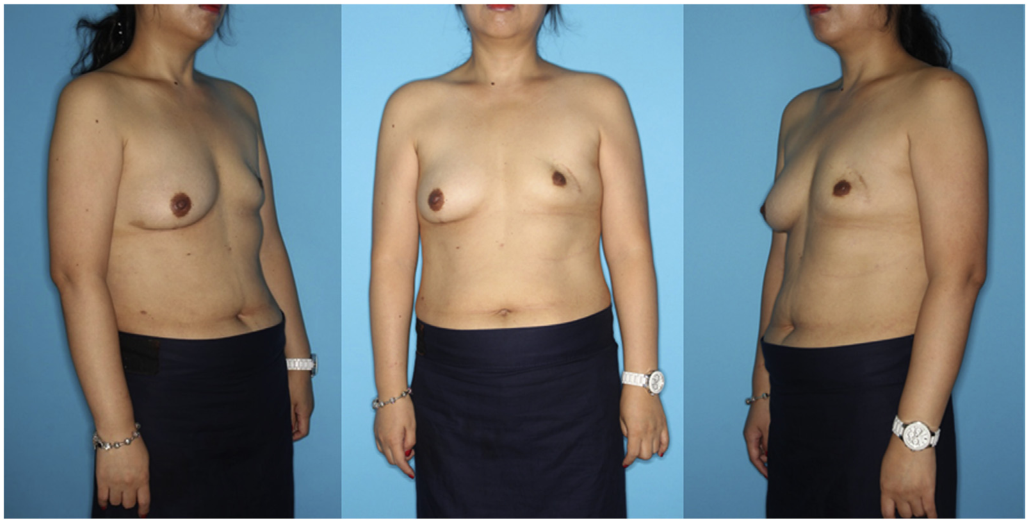

Fig. 4. Postoperative photograph of a patient.
This patient underwent breast reconstruction with the endoscopic method. The photograph was taken 38 months postoperatively. Although the initial volume of the reconstructed breast was 360 cc, it was decreased to 210 cc on the day of follow-up.

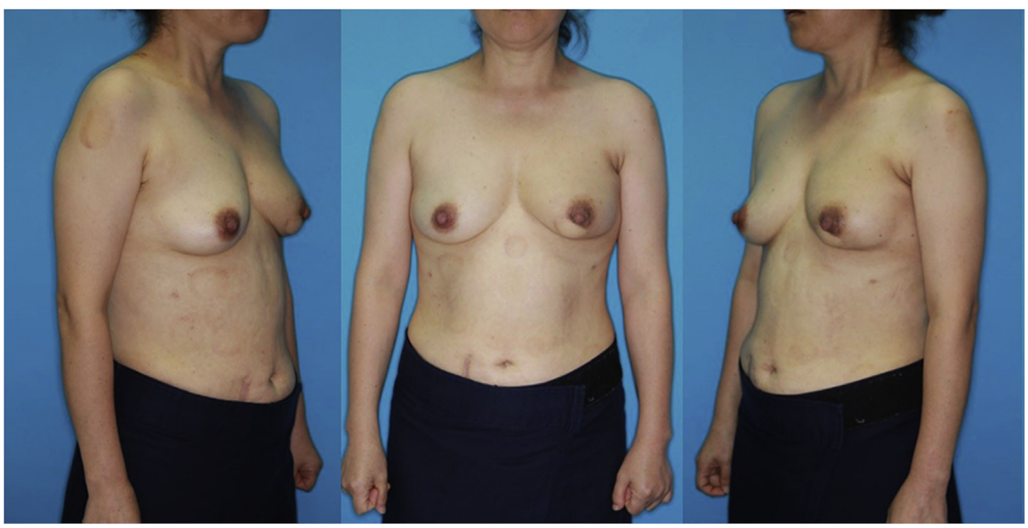

Fig. 5. Postoperative photograph of a patient.
This patient underwent breast reconstruction with the traditional method. The photograph was taken 14 months postoperatively. The initial volume of the reconstructed breast was 357 cc, and on the day of follow-up, it was 320 cc. The skin flap measuring 10 × 3 cm was incorporated on the lower pole.

and 77.3 g for the traditional group ($p = 0.684$). However, a significant statistical difference was identified in the difference between the preoperative and final postoperative volume. In the endoscopic group, there was a mean 70.3 cc decrease in breast volume postoperatively; in the traditional group, there was a mean 21.7 cc decrease in breast volume postoperatively ($p = 0.0023$). In the endoscopic group, patient number 4 had an initial volume of 360 cc preoperatively but showed a volume reduction of 150 cc at 2 years postoperatively (Fig. 4). The greatest volume variation in the traditional group was 37 cc; this patient was satisfied with her breast shape and generally content with the type of surgery she had undergone (Fig. 5). All patients who showed severe volume loss were recommended for a fat graft procedure on the follow up visits, but none of the patients actually underwent supplemental procedure including fat graft.

3.2. Patient assessment and observer surveys

In assessing the donor site scar, the endoscopic group had a scar hidden in the axillary area, and the trocar insertion site scar was barely noticeable (Fig. 6). The overall patient self-assessment scores were 15 and 13 for the endoscopic and traditional groups, respectively (Table 4). In the endoscopic group, the scars were located in a less conspicuous area, and all patients reported maximum satisfaction. However, one patient from the traditional group displayed dissatisfaction and discomfort at the donor site due to the scar. Although the two groups did not have a statistically significant difference in the self-reported assessment score, the surgeon-based Observer Scar Assessment Scale score was statistically significantly different between the two groups in terms of vascularity, pigmentation, thickness, relief, and overall criteria (Table 5). In the self-assessed score of breast shape, less satisfaction was noted in

Fig. 6. Donor site scar of the same patient.
The scar is hidden in the axillary area.

the endoscopic group than in the traditional group, but this difference was not statistically significant (Table 6). In the observer-assessed evaluation, the overall shape and symmetry of the reconstructed breast were superior in the traditional group (Table 7).

4. Discussion

There is a need to fill the defect after partial mastectomy when the patient presents with a large breast-to-tumor ratio. The LD muscle flap is now a standard reconstructive method for these patients.[3] The advantages of using the LD to fill the defect are as follows: it has a reliable blood supply, wide dimensions, and long pedicle, and harvesting is relatively uncomplicated. Nonetheless, traditional LD muscle harvesting leaves a long horizontal scar on the donor site, with poor satisfaction in up to 22% of patients. Beginning with the cadaver proof of concept by Friedlander and Sundin[15] in 1994, several methods of minimally invasive LD harvest have been introduced. In order to maintain a soft tissue space for elevation of the latissimus through a minimally invasive incision, some authors used a tripod system providing upward traction,[15] whereas others used suspended traction sutures.[16] Van Buskirk et al[17] reported endoscopic harvesting of the LD using a balloon dissection. Recently, Yang et al reported a case series using a custom curvilinear retraction device placed through the partial mastectomy incision for LD harvest.[12] Endoscopic latissimus harvest have higher donor site scar satisfaction compared to traditional methods.[13]

We initially refined our endoscopically assisted LD muscle harvesting method after partial mastectomy to reduce scar burden and improve cosmetic outcome. Through a 6-cm axillary incision, the anterior border of the muscle was then dissected using long-tip electrocautery and a lighted retractor used to place additional ports. The optical window was provided by the carbon dioxide gas insufflation method. After placing the additional ports, the axillary incision was temporarily closed around the port to maintain insufflation. An endoscope, grasper, and dissector were used to disinsert the posterior and inferior origins of the muscle. In contrast, our traditional method included skin flap and adipo-fascial tissue with the muscle to fill in the defect resulting from partial mastectomy. When comparing the surgical outcomes of the two methods, volume reduction and surgical time were found to be significantly different. A better donor site scar was noted by observer assessment scale score in the endoscopic group. However, the traditional group achieved better shape of the reconstructed breast due to retention of breast volume.

In our experience, replacement of up to 40% of the breast volume in the upper and lower outer quadrants with an LD muscle flap using endoscopic harvesting is possible in our patient population. Although acceptable immediate results were achieved in most patients, long term follow up demonstrated a nearly 15% volume loss of the origin breast volume when muscle alone was used in the endoscopic technique. The endoscopic method is a reliable and good alternative reconstruction technique after partial mastectomy, as it reduces the incisional burden. However, the endoscopic harvest of the LD, by nature of the procedure, lacks a skin paddle. Furthermore, as a result of denervation, the latissimus volume continued to decrease with time.[18] On mean 39 months follow up, the endoscopic group had a significantly greater decrease in breast volume compared to the traditional method. This resulted in inferior aesthetic outcomes in the endoscopic as assessed by the observer survey when querying breast volume, shape, and symmetry.

Future study can help delineate which body habitus and breast size are candidates for which procedures. It is conceivable patients with defects in the upper and lower outer quadrants with smaller tumors may be prime candidates for muscle only volume replacement and stand to benefit from paucity of scars. Furthermore, the use of immediate fat transfer may be able to counter loss of muscle volume as a result of denervation and the absence of adipo-fascial tissue. Simultaneous fat grafting with endoscopic harvest may not only yield desired breast volume long term but also have the added benefit of minimizing scar.[19] Our study was limited by the small number of patients evaluated and differing follow-up periods among patients. We also recognize that the complexity of the operating room set-up and learning curve for use of the endoscope may have contributed to an increase in surgical time. Nonetheless, our study is novel in we attempted to objectively and subjectively compare the two methods following partial mastectomy, thereby demonstrating the advantages and disadvantages of each technique.

Generally, patients' attitudes and feelings about the scar and overall satisfaction with the donor site were significantly better in the endoscopic group than in the traditional group. Further, scars were less conspicuous on the back with the endoscopic method because incorporation of a skin flap in the traditional method leaves an undesirable scar at the donor site. Conversely, the

Table 4
Patient satisfaction evaluation of the donor site scar.

Item	Endoscopic group (n = 9) Mean ± SD/median (Q1, Q3) 5 = most satisfactory (5-point scale)	Traditional group (n = 11) Mean ± SD/median (Q1, Q3) 5 = most satisfactory (5-point scale)	*p*-value
Scar length	5 (5, 5)	4 (3, 5)	0.1008
Cosmesis (appearance and conspicuousness of the scar)	5 (5, 5)	5 (4, 5)	0.6544
Discomfort (pain, redness, swelling, and itching)	5 (5, 5)	4.5 (4, 5)	0.5037
Overall	15 (15, 15)	13 (12, 14)	0.1091

SD, standard deviation; Q1, quadrant 1; Q3, quadrant 3.

Table 5
Observer scar assessment scores.

Item	Endoscopic group (n = 9) Mean ± SD/median (Q1, Q3) 1 = normal skin 10 = worst scar imaginable	Traditional group (n = 11) Mean ± SD/median (Q1, Q3) 1 = normal skin 10 = worst scar imaginable	p-value
Vascularity	2 (2, 2)	3 (3, 4)	0.0038
Pigmentation	2 (2, 2)	3.5 (3, 4)	0.0110
Thickness	3.33 ± 1.41	5.60 ± 2.07	0.0134
Relief	2.33 ± 0.87	4.60 ± 1.71	0.0023
Pliability	2 (2, 3)	3 (3, 4)	0.0533
Surface area	2 (2, 2)	3 (3, 4)	0.0776
Total (Added score; maximum 50)	15.00 ± 4.80	24.90 ± 9.35	0.0110

SD, standard deviation; Q1, quadrant 1; Q3, quadrant 3.

Table 6
Patient satisfaction evaluation of the breast shape and symmetry.

Item	Endoscopic group (n = 9) Mean ± SD/median (Q1, Q3) 5 = most satisfactory (5-point scale)	Traditional group (n = 11) Mean ± SD/median (Q1, Q3) 5 = most satisfactory (5-point scale)	p-value
Breast shape	3 (2, 5)	4 (3, 5)	0.6382
Breast symmetry	3 (3, 4)	4 (3, 5)	0.0837
Overall	6.67 ± 2.45	7.90 ± 1.85	0.2297

SD, standard deviation; Q1, quadrant 1; Q3, quadrant 3.

Table 7
Observer breast evaluation.

Item	Endoscopic group (n = 9) Mean ± SD/median (Q1, Q3) 10 = most satisfactory (10-point scale)	Traditional group (n = 11) Mean ± SD/median (Q1, Q3) 10 = most satisfactory (10-point scale)	p-value
Shape	6 (2, 7)	9 (8, 9)	0.0057
Symmetry	5.11 ± 2.42	7.91 ± 1.87	0.0091
Total (Added score; maximum 20)	11 (5, 14)	17 (15, 19)	0.0086

SD, standard deviation; Q1, quadrant 1; Q3, quadrant 3.

traditional group achieved a better breast cosmetic result and better retention of volume postoperatively because of incorporation of the skin flap.

Declaration of competing interest

None declared.

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