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ORIGINAL PAPER

Usefulness of nerve-sparing pedicled segmental latissimus dorsi muscle flap combined with lateral thoracic skin flap for partial volume reconstruction in laterally located breast cancer

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Abstract

Background The latissimus dorsi muscle (LDM) is a flexible muscle that is frequently employed in various reconstructive operations. Breast-conserving surgery is widely acknowledged as an effective treatment for breast cancer, and the latissimus dorsi muscle flap is a straightforward, dependable technique for partial breast reconstruction.

Methods A pedicled segmental latissimus dorsi muscle flap was employed in 20 patients with laterally situated breast cancer treated at our institution from January 2018 to December 2021. During a 6-month postoperative follow-up period, patients were polled on their overall satisfaction and cosmetic satisfaction. Plastic surgeons assessed the aesthetic and functional outcomes in terms of breast shape and symmetry, as well as muscular function.

Results The mean operative time was 120 ± 35.2 min while the mean postoperative hospital stay was 2.5 days (range, 1.5–3 days). There were no donor site complications such as intraoperative bleeding, postoperative hematoma, or infection, and postoperative drain removal was done on average after 5 days. The average weight of specimens was 50–160 gm with a mean of 100 gm, and the locations of the masses were the upper lateral quadrant ($n = 15$), the lower lateral quadrant ($n = 2$), and the central lateral area ($n = 3$). Complications developed in 6 of the cases, hematoma in 2 cases, wound seroma developed in the donor site in 2 cases, and weakness in shoulder movement in 2 cases, and the majority of the patients were satisfied with their cosmetic outcomes. No tumor recurrence was reported.

Conclusion Replacement of 20 to 40% of breast volume in the upper and the lower outer quadrants with a latissimus dorsi muscle flap as nerve-sparing pedicled segmental flap that can be harvested from the same axillary incision of lymphadenectomy is a good alternative reconstruction technique after partial mastectomy. This resulted in an acceptable postoperative scar, less pain, and early upper extremity movement, so this technique is considered a useful and reliable technique in correcting breast deformity after breast-conserving surgery, especially in laterally located breast cancer.
Level of evidence: Level IV, therapeutic study.

Keywords Latissimus dorsi muscle flap · Pedicled island flap · Conservative mastectomy

Introduction

For most breast cancer patients, breast-conserving surgery (BCS), which includes tumor excision with safety margin, axillary management and radiotherapy has become the standard of care, with long-term survival rates comparable to those of radical mastectomy [1, 2].

Breast cancer can now be detected early because of advancements in diagnostic technology and widespread breast cancer screening efforts [3].

However, after excision of some amount of breast volume resulting in severe breast deformities, skin retraction, nipple-areola complex (NAC) distortion, breast

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asymmetry, bad cosmesis, and poor patient satisfaction, so for the best cosmetic effects, volume displacement or volume replacement could be performed to compensate for the deformity [4, 5].

In selected patients, oncoplastic breast surgery (OBS) procedures were developed to provide an advantage over traditional breast-conserving treatment, via greater breast resection for cancer therapy with fewer deformities [6, 7].

The conventional procedure for replacement is to use the latissimus dorsi muscle (LDM) flap, although this flap is dependable and its elevation is technically simple, the donor site is left with a lengthy horizontal scar. A minimally harvest approach has been developed to maximize cosmetic satisfaction. Video-assisted skin-sparing partial mastectomy and immediate reconstruction with a latissimus dorsi pure muscle flap were first offered in Japan in 1997 [8].

According to several reports, partial breast reconstruction after a breast-conserving operation does not guarantee satisfactory aesthetic results; many patients had breast asymmetry, and roughly 20 to 30% of patients had poor aesthetic results [9].

LDM on its primary vascular pedicle, could be used as a pedicled flap to reconstruct the breast following radical or modified radical mastectomy. It is also utilized to cover deficiencies in the anterior chest wall, shoulder, and upper arm, as well as defects in the head and neck up to the temporoparietal area [10].

The aim of the work is to evaluate the usefulness of nerve-sparing pedicled segmental latissimus dorsi muscle flap combined with lateral thoracic skin flap (rotational or V–Y) for partial volume reconstruction in laterally located breast cancer and this aiming to maximize the soft tissue coverage provided by the flap while minimizing the magnitude of donor site defect and donor site complications.

Patients and methods

The subjects of this study were 20 patients who underwent partial breast reconstruction with nerve-sparing segmental pedicled latissimus dorsi muscle flap combined with a lateral thoracic skin flap done from the same wound of axillary lymphadenectomy. These patients were selected from among patients who underwent breast-conserving surgery in our department of surgery Benha University Hospital between January 2018 to December 2021.

Inclusion criteria were cases with localized tumor in the lateral half of the breast of moderate size not huge to exclude the contralateral reduction of the other breast, the tumor diagnosed preoperatively by tru-cut biopsy and no metastasis was found elsewhere by the preoperative workup. After obtaining approval from the local ethical committee and after fully informed written consents from patients as regard photographing and contribution in the study.

Early stage (I or II) patients, with no contraindications for radiotherapy, were enrolled in this study. Patients with advanced cases (stages III and VI) were excluded. Also, exclusion was decided when complete tumor ablation could not be achieved (either due to multicentric tumors, diffuse malignant appearing microcalcifications, or with contraindication of radiotherapy). When margin negativity was not possible after three attempts as guided by frozen section, mastectomies were done with exclusion from the study.

Proper history was taken including age, body mass index, and history of smoking or radiation treatment. Routine investigations were done also to assess the histology, grade, and biologic markers as ER, PR, Her2 neu, Ki67, operability, and presence of contraindication of breast-conserving techniques. After surgery we documented complications, weight of the mass and surface area of skin excised during surgery a satisfaction survey, including breast symmetry and shape, and overall aesthetic effects.

Surgery was performed under general anesthesia. If no cancer cells were detected in the marginal area of the tumor on frozen section analysis of the excised tissues and normal tissues surrounding the initial tumor location. Meanwhile, total excision of the axillary lymph nodes was performed if cancer cells were found in the sentinel lymph nodes in the same axilla.

Technique

The subscapular artery arises in general as a branch of the third part of the axillary artery, average length to the origin of the circumflex scapular artery is about 2.2 cm the average caliber was 5.0 mm (Fig. 1). Usually, the circumflex scapular artery (average length 4 cm) is found to be the first branch of the subscapular artery but in about 3% the circumflex scapular artery is a direct branch of the axillary artery. The second major branch of the subscapular artery is the thoracodorsal artery. The thoracodorsal artery runs on the underside of the muscle, and the main pedicle divides into two main branches after giving an angular branch to the scapula angle and serratus muscle branch then divide into the upper horizontal branch that travels medially along the superior border of the muscle and a descending oblique branch that runs inferiorly, parallel to the anterior border of the muscle about 2.5 cm from the edge. The bifurcation is predictably found 4 cm distal to the inferior scapular border and 2.5 cm medial to

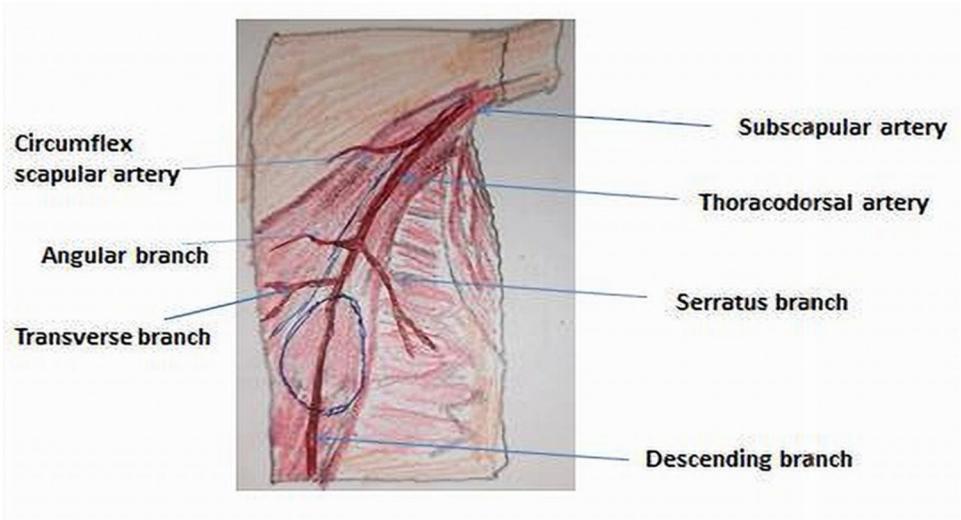

Fig. 1 Diagram showing branches of the subscapular and thoracodorsal arteries and highlighting the segment of LDM to be transferred with its vascular pedicle

the anterior border of the muscle. Twenty patients were reviewed in this study. All the tumors were located in the upper-outer or the lower-outer quadrant, and all of the patients underwent partial mastectomy with variable part of overlying skin. In intraoperative frozen section analysis for margin assessment, free margins were defined as no tumor cells at the inked margin of the specimen for invasive carcinoma and a 2 mm margin for ductal carcinoma in situ [11].

Sentinel lymph nodes biopsy was performed in all cases by the aid of methylene blue dye. After partial mastectomy and lymphadenectomy, while patients were remained in a supine position, the thoracodorsal pedicle was identified and sparing the thoracodorsal nerve to prevent unwanted postoperative twitches and to allow the rest of the muscle to function. The latissimus dorsi muscle was dissected via mastectomy and lymphadenectomy incisions. Then, in order to determine the volume needed, laparotomy sponges were packed into the defect and trimmed off to match the symmetry with the opposite breast. Next, with the gentle traction of the latissimus dorsi muscle using Allis clamps, suprafascial dissection was performed between the skin and the latissimus dorsi muscle, followed by submuscular dissection. After, identification of the neurovascular bundle with the concept that the thoracodorsal nerve starts to branch about 4 cm proximal to the superior border of the LD muscle and, thus, careful dissection of the nerve branch as proximally as deemed safe has been recommended. As this is technically arduous, preoperative counseling of the patient that dynamic motion may return years postoperatively is advised [12] (Fig. 2).

After complete dissection above and below the latissimus dorsi muscle, an appropriately sized muscle flap was designed. Mobilization of the muscle specimen pedicled

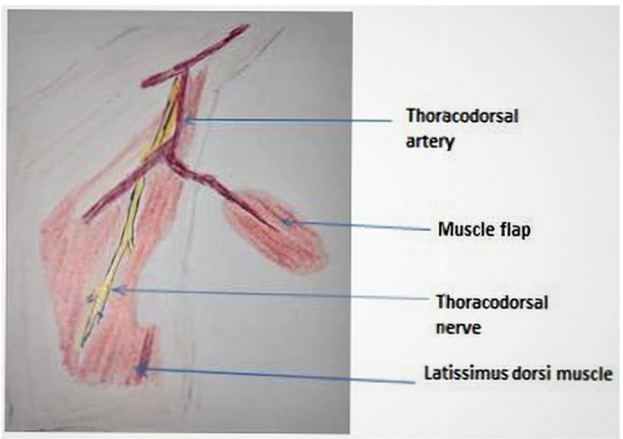

Fig. 2 Diagram showing a segment of (LD) muscle flap with the vascular pedicle and sparing the thoracodorsal nerve

on the thoracodorsal vascular pedicle, ligation and cut of the serratus muscle branch and angular branch to increase the mobility of the flap, then the flap was inset into the defect area followed by refashioning of the skin cover if needed by lateral thoracic skin flap in a rotational (superiorly based or inferiorly based) or V–Y advancement pattern, after that, a drain was applied to the axillary field and closure was done layer by layer.

The patients' body mass index (weight (kg)/height (m2)) was calculated, and the total operation time was recorded. The postoperative hospital stay was also recorded, and the postoperative complications were reviewed. The postoperative scar was assessed by using the Vancouver Scar Scale (Tables 4, 5, Fig. 3). The patients were asked to record

their score on a questionnaire of the Patient and Observer Scar Assessment Scale 3 months after the operation. The observer scale was scored using photographs. Patient's satisfaction was evaluated using a Likert scale of patient satisfaction including 4 items (shape, irregularities, scars, symmetry) and ranging from very satisfied, satisfied, fair unsatisfied to very unsatisfied (Table 6, Fig. 4).

The LD muscle functions of operated and non-operated sides were evaluated clinically and with electro-neuro-myography (ENMG). In clinical examination, ranges of adduction, extension, and internal rotation of the shoulders at the operated and non-operated sides which are the main functions of the LD muscle were compared to each other. The evaluation of the

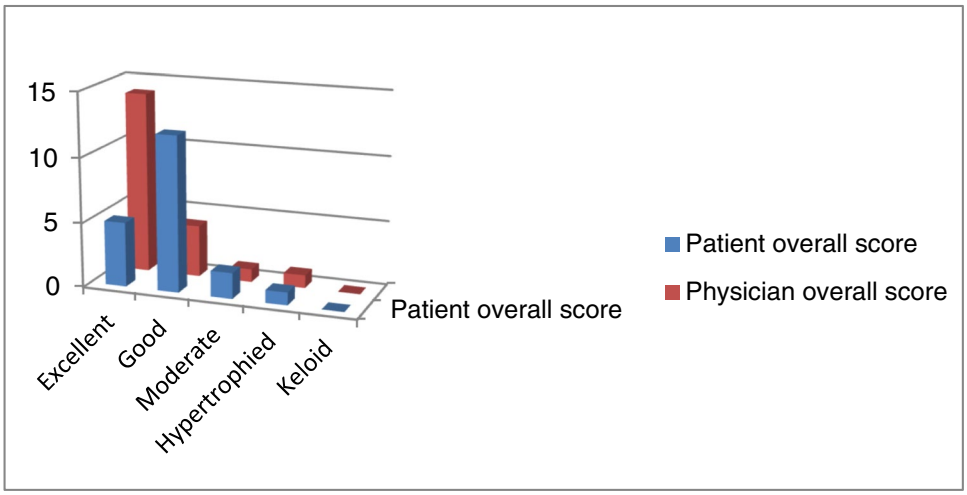

Fig. 3 Results of Vancouver Scar Scale

Fig. 4 **A** upper outer quadrant right breast mass marked with a red circle with marking of lateral thoracic skin flap inferiorly based. **B** Excised breast mass with overlying skin island. **C** The defect of the skin and breast tissue down to the pectoralis major muscle

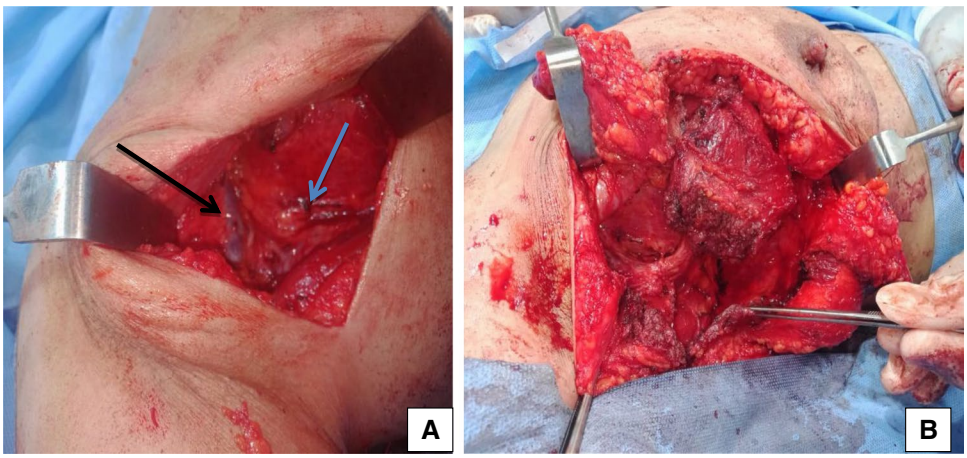

Fig. 5 **A** Axilla after lymphadenectomy note the axillary artery black arrow and neurovascular bundle blue arrow. **B** A segment of latissimus dorsi muscle with its pedicle

Fig. 6 **A** Early postoperative view after insetting of lateral thoracic skin flap inferiorly based. **B** Late postoperative view

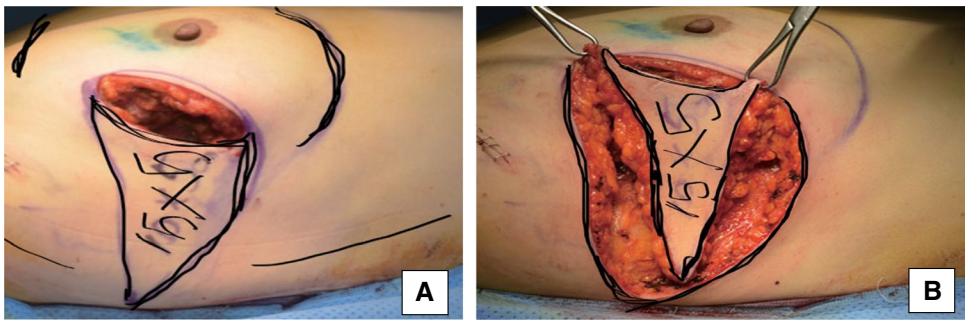

Fig. 7 **A** Upper outer quadrant right breast mass during excision. **B** V–Y lateral thoracic flap before insetting

thoracodorsal nerve and LD muscle functions must be 6 months after the surgery.

Descriptive statistics were used to present numerical and categorical data. Stratification of results was done according to the age and gender. Post-stratification chi square test was used for statistical significance. *P* value of < 0.05 was taken as significant (Figs. 5, 6 and 7).

Results

The mean follow-up period was 6 months. The patients' mean age was 50.2 ± 10.8 years, and their body mass index was 22.5 ± 4.6 kg/m^2. All the tumors were located in the lateral side of the breast with the upper lateral quadrant ($n = 15$), the lower lateral quadrant ($n = 2$), and the central lateral area ($n = 3$) (Table 1), and the nipple-areolar complex and the overlying skin were preserved during the mastectomy. The intraoperative frozen section analysis of the tumor margin was all negative. And the sentinel lymph nodes were positive in all patients so axillary lymphadenectomy level one and level two was done in all cases. The mean operative time was 120 ± 35.2 min. The mean postoperative hospital stay was 2.5 days (range, 1.5–3 days). The average weight of specimens was 50–160 gm with a mean of 100 gm. There were no donor site complications such as (Table 2) intraoperative bleeding, postoperative hematoma, or infection, and postoperative drain removal was done on average after (5 ± 2) days with average seroma collection in the donor area of about 150, 120, 75, 20, and 10 mL in 5 days with a total of about 375 mL except for seroma collected after drain removal in 3 cases and was treated with aspiration ultrasonic guided, and one case developed hypertrophied scar treated with silicon sheeting (Table 3).

The patients scored the overall shape as 7.1 ± 0.82, and the observer scored it as 8.8 ± 0.65, on average. Donor site deformity was also acceptable, with a score of 8.5 ± 0.73 by the patients and 9.2 ± 0.3 by the observer. During the follow-up period, no evidence of tumor recurrence was reported (Tables 4, 5, 6).

Table 1 Patients demographic and specimen data

Patients numbers	Age per years	BMI kg/m^2	Site of the tumour (all in lateral side)	TNM stage	Weight of specimen(g)	Axillary dissection	Results of pathology
1	52	21.7	LT UQ	T1N0M0	54	Done	Invasive duct carcinoma
2	46	22.4	LT UQ	T2N0M0	60	Done	Invasive duct carcinoma
3	59	19.9	LT LQ	T1N0M0	74	Done	Invasive duct carcinoma
4	45	23.7	LT UQ	T1N0M0	86	Done	Invasive duct carcinoma
5	54	23.4	RT UQ	T3N0M0	89	Done	Invasive duct carcinoma
6	56	20.2	LT LQ	T1N0M0	65	Done	Invasive duct carcinoma
7	55	23.7	RT UQ	T1N0M0	100	Done	Invasive duct carcinoma
8	46	26.1	RT UQ	T2N0M0	123	Done	Invasive duct carcinoma
9	52	25.7	RT UQ	T1N0M0	105	Done	Invasive duct carcinoma
10	48	23.4	LT UQ	T2N0M0	89	Done	Invasive duct carcinoma
11	47	26.1	LT UQ	T1N0M0	66	Done	Invasive duct carcinoma
12	48	22.3	RT LQ	T3N0M0	79	Done	Invasive duct carcinoma
13	53	27.1	RT UQ	T1N0M0	100	Done	Invasive duct carcinoma
14	58	17.9	LT UQ	T1N0M0	98	Done	Invasive duct carcinoma
15	61	19.6	LT UQ	T2N0M0	120	Done	Invasive duct carcinoma
16	45	25.4	LT LQ	T1N0M0	140	Done	Invasive duct carcinoma
17	49	23.5	RT UQ	T1N0M0	143	Done	Invasive duct carcinoma
18	49	22.5	RT UQ	T1N0M0	77	Done	Invasive duct carcinoma
19	56	22.2	RT UQ	T1N0M0	95	Done	Invasive duct carcinoma
20	48	24.5	LT LQ	T3N0M0	150	Done	Invasive duct carcinoma

BMI body mass index, *LT* left, *RT* right, *UQ* upper quadrant, *LQ* lower quadrant *T* tumour, *N* node, *M* metastasis

Table 2 Operative and postoperative data

Patients numbers	Operative time for reconstruction(min)	Hospital stay(day)	Complications	State after radiotherapy
1	85	1.5	None	None
2	90	2	None	None
3	120	2	None	Superficial skin burn
4	110	2	None	None
5	120	2.5	None	None
6	85	2.5	None	None
7	150	3	Seroma in donor site	None
8	110	1.5	None	None
9	90	2	None	Superficial volume loss
10	100	3	None	none
11	155	1.5	Hypertrophied scar	None
12	125	2	None	None
13	90	1.5	None	None
14	90	2	Seroma in donor site	None
15	140	2.5	None	None
16	145	2	None	Mild volume loss
17	90	3	None	None
18	85	1.5	None	Superficial skin burn
19	120	2.5	None	None
20	110	2	Seroma in donor site	None

Table 3 Hospital stays and drains removal

	Mean ± SD
Length of hospital stay (days)	2.5 ± 1
Time of drain removal (days)	5 ± 2

After radiotherapy, 2 cases developed dimpling and volume loss of the reconstructed quadrant; these cases were treated by fat grafting after radiotherapy, and also 2 cases developed mild skin burn after radiotherapy managed conservatively.

Discussion

Breast cancer is the most frequent malignancy in women of all races and the second leading cause of cancer death. Early identification of breast cancer has become easier due to advancements in testing tools and increased public awareness of the disease, and breast conservation therapy (partial or segmental mastectomy/lumpectomy followed by adjuvant radiation) is also becoming more common for the treatment of early-stage breast cancer [13].

The goal of oncoplastic surgery is to get the greatest cosmetic result while avoiding any oncological complications, in terms of oncological safety, a randomized trial comparing breast conservation surgery against radical mastectomy for breast cancer found that the survival rates were identical [14].

Tumor removal, on the other hand, can result in breast deformity, putting the patient at risk psychologically; to avoid surgery on a scarred and constricted breast, the usual trend is to restore the flaws promptly after mastectomy and before irradiation [15].

Breast shape, tumor size, tumor location, and postoperative radiation all play a role in unfavorable cosmetic outcomes after breast conservation surgery [14].

Those having parenchymal resections greater than 70–100 cm^3 or patients who have more than 20% of the breast removed had lower cosmetic satisfaction, according to studies by Losken [14].

Furthermore, it has long been assumed that women with large breasts had more problems, more radiation-induced fibrosis, and poor cosmetic outcomes following breast conservation therapy as regard to the effect of the large doses of radiation on breast tissue and this is in contrast to oncoplastic procedures which accommodate both breast to the average of normal breasts [16, 17].

For reconstruction, the volume replacement approach is often advised. Depending on the size and location of the tumor, this can be accomplished through local tissue rearrangement or flap surgery. Only around 30% of a lateral breast defect can be repaired with local fasciocutanous flaps. Patients with high tumor-to-breast ratios, on the other hand, have insufficient left breast tissue after a partial mastectomy, necessitating the use of non-breast tissue to bridge the gap, for those individuals, the latissimus dorsi muscle flap is now a conventional reconstructive procedure [5, 18].

Table 4 Vancouver Scar Scale

Items	Data	Scores	Excellent	Good	Moderate	Hypertrophied	Keloid
Pigmentation (0–2)	Normal	0	0	0 ~ 1	0 ~ 2	0 ~ 2	0 ~ 2
	Hypopigmentation	1					
	Hyperpigmentation	2					
Vascularity (0–3)	Normal	0	0	0 ~ 1	0 ~ 2	0 ~ 2	0 ~ 2
	Pink	1					
	Red	2					
	Purple	3					
Pliability (0–5)	Normal	0	0	0	0	0 ~ 1	0 ~ 3
	Supple (flexible)	1					
	Yielding(give way to pressure)	2					
	Firm (inflexible)	3					
	Banding (rope like, not limit range of motion)	4					
	Contracture(permanent shorting of the scar, limiting movement, produce deformity)	5					
Height (0–3)	Normal (flat)	0	0	0	0	0 ~ 1	1 ~ 2
	0–2 mm	1					
	2–5 mm	2					
	> 5 mm	3					

Table 5 Results of Vancouver Scar Scale

VSS	Patient overall score	Physician overall score
Excellent	5	14
Good	12	4
Moderate	2	1
Hypertrophied	1	1
Keloid	0	0

The latissimus dorsi muscle has an excellent blood supply, wide dimensions, and long pedicle, and muscle harvesting is relatively easy. However, classic latissimus dorsi muscle harvesting leaves a long horizontal scar on the donor site with bad cosmesis and scar complications, longer operative time and blood loss, necessity to change the position of the patient with increased incidence of infections, the patient loses the muscle bulk and action of the LD muscle on the back with hollowness and shoulder mobility affection and more pain, increased manipulation in the axilla and loses in lymphatics in the area with subsequent increase in the amount of seroma formation and delay in drain removal, also increase in nursing management, these drawbacks may increase the convalescent period and delay in radiotherapy and increases medical cost for postoperative wound care.

Procedures that decrease postoperative scars have increasingly become more popular among reconstructive surgeons as a reaction to concerns regarding scarring reduction. Friedlander and Sundin were the first to report endoscopic latissimus dorsi harvesting [19].

In this study, we introduced the pedicled segmental nerve-sparing latissimus dorsi muscle flap method after partial mastectomy preserving the overlying skin envelope, with the same supine position of the patient, and without adding further incision on the back of the patient with subsequent scaring and bad cosmesis as this technique is done from the same incision of sentinel lymph node biopsy incision or axillary sampling or axillary lymph nodes dissection also we did not harvest the hole muscle but segment of the muscle was harvested leaving the rest of muscle tissue with its nerve supply for proper function so avoiding the hollowness of the back after total harvest of the muscle also sparing thoracodorsal nerve to prevent unwanted postoperative twitches in the flap segment and to allow the rest of the muscle to function finally less subcutaneous lymphatics and subdermal vascular plexus is injured unlike the conventional technique. Patients experience less pain and may experience easier movement of the ipsilateral upper extremity of the donor site unlike conventional total muscle harvest, shorter incision requires less nursing care to the wound site and less dressing material. Therefore, the medical cost for postoperative wound care should be reduced.

As regard shoulder movement maintenance results in our study, this supported by the study done by Wibke M. S. et al. who compare shoulder strength and range of motion between conventional and muscle-sparing harvesting technique of a latissimus dorsi flap and concluded that harvesting the muscle-sparing latissimus dorsi flap leads to less functional impairments of the shoulder than harvesting the complete latissimus dorsi flap [20].

A previous study by Chae et al. reported that atrophy of the reconstructed quadrant like our study 2 cases developed decrease in the volume but that occurred after the cases completed radiotherapy courses and they were treated by autologous fat grafting [21]. In our study, less seroma was collected in the donor area about 150, 120, 75,20, 10 mL in 5 days with a total of about 375 mL in other studies as Guven et al. [19] reported a total postoperative drainage volume averaging 950 mL [22]. Also in this technique no need to change in the patient's position, which elongates the operation time and increases the chances of infection as in the lateral decubitus position required in conventional latissimus muscle or thoracodorsal perforator flaps harvesting, also no additional scars are added in the patients back without change in back contour so good cosmesis with high satisfaction rates in contrast to conventional LD muscle flap or thoracodoral perforator flap.

For tumors located in the lateral half of the breast; the lateral thoracic flap either rotational or V–Y technique according to Rezai is an oncoplastic alternative to larger resection with dermoglandular rotations like 'tennis racket' or 'Dufour coat' technique [23].

Table 6 Likert scale of patient satisfaction

Likert scale	Very satisfied	Satisfied	Fair	Unsatisfied	Very unsatisfied	*P* value*
Shape	8 (40%)	9 (45%)	1 (5%)	1 (5%)	1 (5%)	0.033
Irregularities	7 (35%)	9 (45%)	2 (10%)	1 (5%)	1 (5%)	0.061
Scar	12 (60%)	5 (25%)	1 (5%)	1 (5%)	1 (5%)	0.033
Symmetry	6 (30%)	10 (50%)	1 (5%)	1 (5%)	1 (5%)	0.072

*Data are presented as mean ± SD & numbers, ranges and percentage are in parenthesis

Conclusions

Immediate reconstruction of a partial mastectomy defect extends the role of breast-conserving surgery by enabling complete excision of a greater range of tumors without compromising cosmesis, Further studies should be performed with more patients and a longer period of follow-up to produce more generalizable results evaluating the functional, oncological, and aesthetic outcomes of the operation, further studies can be conducted to add better methods to separate the muscle segment attachment from the whole muscle as Harmonic (ultrasonic) or LigaSure (radio frequency) scalpel or Thunderbeat (hybrid system combines ultrasonic and radio frequency) also Further study is needed to determine the appropriate volume of overcorrection.

Author contribution Concept, design, operative management and technique, supervision, followed-up and photographed the patients, resources, data collection and/or processing, literature search, writing manuscript—All authors read and approved the final manuscript.

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Declarations

Ethics approval All procedures performed in studies were in accordance with the ethical standards of the institutional and/or national research committee under the number (RC 3-2-2022) and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants included in the study. The participant has consented to the submission of the data to the journal.

Patient consent Patients signed informed consent regarding publishing their data and photographs.

Conflict of interest Ayman M. Abdelmofeed, Mohammed A. Fadey, Ola Seif, Mohamed H. Abdelhalim, and Mohamed T. Younes declare no conflict of interest.

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