

Oncoplastic immediate reconstruction using lateral thoracic wall perforator flaps after breast-conserving surgery: a prospective study of the oncological safety and cosmetic outcomes

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Background

Breast-conserving therapy comprising wide local excision and postoperative irradiation is now believed to be an established technique in managing breast cancer. Breast-conserving therapy is now replacing mastectomy with equivalent survival. Lateral intercostal artery perforator flaps are innovative volume replacement techniques that expand the role of breast-conserving therapy, particularly in small-sized to medium-sized breasts with better aesthetic results. In our study, we aimed to evaluate the results of those flaps for immediate reconstruction of breast defects.

Patients and methods

This study included 40 patients who underwent wide local excision with immediate reconstruction using lateral thoracic wall perforator flaps in the period from June 2018 to June 2021. The operative duration, technique and modification of flap design, and postoperative complications were recorded. The cosmetic outcome and patient satisfaction were assessed. Follow-up was at least 1 year.

Results

Lateral intercostal artery perforator flap technique was performed in 40 patients. The mean operative time was 148 ± 13.6 min. The flap length ranged from 11 to 15 cm and its width from 5 to 9 cm. Postoperative complications were seen in 10% of cases. Local recurrence occurred in 5% of cases. The average cosmetic assessment was observed to be either excellent or good in 95%.

Conclusions

Lateral thoracic wall perforator flaps are reliable and oncologically safe reconstructive procedures in laterally located breast cancers. The technique is simple and easy to learn. The modifications in the technique shorten the operative time and minimize the donor site complications. The postoperative complications are low. The overall cosmetic results and patient satisfaction are satisfactory.

Keywords:

breast reconstruction, breast-conserving surgery, flap, oncoplastic, perforator

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Introduction

Breast-conserving surgery (BCS) has become an established treatment of the early stages of breast cancer with a disease-free survival rate equivalent to that of mastectomy. The effect of BCS on patients' psychological well-being and a better quality of life is remarkable. BCS may be associated with deformity in the form of depression or nipple–areolar complex (NAC) deviation, especially when the resulting tumor defect is large in relation to small breast size and cosmetically sensitive areas (the NAC, lower outer and upper inner quadrants) [1–5].

Oncoplastic breast surgery incorporated plastic surgery techniques in managing breast cancer, expanding the role of BCS and avoiding associated deformities leading to improved quality of life and optimal cosmesis [6,7].

Oncoplastic breast surgery techniques can be either volume displacement or volume replacement techniques. Volume displacement involves tissue rearrangement using dermoglandular pedicles and breast reduction skin excision patterns. Those techniques are believed to be better in large-sized breasts with adequate breast volume and excision of 10–20% of breast volume [8].

Volume replacement techniques involve using local flaps in cases of large tumors to the breast volume, especially in small-sized to medium-sized breasts. Replacement techniques may offer excision of more

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than 20% of breast volume. The pedicled Latissimus dorsi (LD) myocutaneous flaps were the most commonly implicated in such cases [9,10].

Recently, many studies have reported the use of lateral intercostal artery perforator (LICAP) flaps in challenging trunk defects, in addition to complex immediate and delayed breast reconstruction procedures [11–14].

They had many benefits, sparing the LD muscle and decreasing the morbidity and functional impairment using the traditional LD flaps. In addition, they result in more hidden scars, avoid contralateral symmetrization procedures, and could be done as an immediate single-stage reconstruction done at the same time as tumor resection especially in laterally located breast lesions [15].

However, they are not free from complications that could occur including hematoma, seroma, wound infection, delayed wound healing, fat necrosis, partial or complete flap loss, and the need of re-excision or secondary completion mastectomy in case of positive excision margins [16].

Hamdi *et al.* [17] thoroughly described the anatomy, classification, surgical technique, and outcomes of LICAP flaps in partial breast reconstruction as versatile local fascio-cutaneous flaps based on the lateral thoracic artery perforators (LTAP) and the LICAP.

Those flaps are based on the cutaneous branches of anterior and posterior intercostal arteries that arise from the arcade between the aorta posteriorly and internal mammary artery anteriorly. The arcade is divided into vertebral, costal, and muscular segments. The LICAPs arise from the costal segment of the arcade. The LTAPs arise directly from axillary artery and less frequently from the thoracodorsal vessels. LTAP flaps can be used exclusively or in combination with LICAPs in reconstruction of laterally situated breast defects [17–23].

We aimed in our study to evaluate the use of LICAP flaps regarding their indications, patient selection, modifications in the flap design, and the surgical technique, as well as the oncological safety and the esthetic outcomes.

Patients and methods

Study design

From June 2018 to June 2021, 40 female patients with early stages of laterally located breast cancer were

prospectively recruited. The study sample was determined with a cutoff point of 40 patients according to availability of cases and suitability for inclusion and exclusion criteria. The least period of follow-up of the patients was planned to be 12 months. All of the patients were subjected to wide local excision and immediate reconstruction with lateral perforator flaps. The study was conducted in the breast unit in the Department of General Surgery in Ain Shams University. The study design was approved by the ethical committee. A written informed consent was obtained from all patients participating in the study.

Patient selection

Patients included in our study were diagnosed with early stages of breast cancer (T1,T2/N0,N1/M0) located in the lateral upper and lower breast quadrants. In patients with large tumors in relation to small-sized to medium-sized breasts, in which wide local excision is anticipated to leave large defects and inadequate breast tissue suitable for dermoglandular reconstruction, volume replacement is more appropriate. Patients with large breasts who are unwilling to undergo oncoplastic breast reduction techniques or contralateral symmetrization were also included in the study.

Exclusion criteria included patients with advanced stages of breast cancer, patients having their lesion within 2 cm from the nipple, and inflammatory breast cancer. Patients with previous chest radiotherapy for any reason, autoimmune disease, collagen disease (which may impair skin elasticity), and previous surgery in the flap donor site were excluded from the study. Patients with skin affection (tethering or retraction) or patients with tumors in close proximity to skin (tumors to skin distance <1 cm) were also excluded.

All of the patients were assessed by our multidisciplinary team (MDT) for in-depth discussion and decision-making process to select patients suitable for the procedure and to plan resection with anticipated defect and flap design (whether in an upfront surgery or after neoadjuvant therapy).

All of the patients were subjected to full history taking and physical breast and axillary examination. Investigations included mammography and ultrasound and core needle biopsy to confirm the histopathological diagnosis and hormonal status. Routine metastatic workup was done to exclude the presence of distant metastasis.

Patients' demographic data including age, body mass index, and presence of comorbidities were recorded. Tumor characteristics including side, location, size and tumor stage, biology, histopathological type, and need for neoadjuvant chemotherapy were also recorded (Table 1).

Preoperative assessment and flap design

Routine preoperative investigations and blood tests were performed. Before the MDT meeting, hand-held Doppler ultrasound was performed to localize the sites of lateral perforators along the lateral margin of the breast, while the patient is in the lateral decubitus position, delineating at least two to three perforators. Skin elasticity is tested using the pinching test. During the MDT meeting, the site of the tumor, and anticipated defect size were reported with the patient in a standing position. Choosing the corresponding lateral perforators and the flap design is then planned.

Concerning the flap design, we adopted a modification that is different from that described in the literature. In our study, the flap was vertical, elliptical wedge-shaped with two limbs rather than transverse [17] or lazy-S-

shaped flaps [23]. The axis of the flap was nearly along the axillary pyramid. The anterior (proximal) limb was in line along the lateral extension of the inframammary fold running along the anterior axillary line. The anterior limb is planned to incorporate the maximum number of perforators and facing the corresponding tumor. The posterior (distal) limb was in line along the anterior border of LD muscle running along the posterior axillary line. The size (width) of the flap corresponds to the anticipated tumor defect and degree of skin elasticity (Fig. 1).

Surgical technique

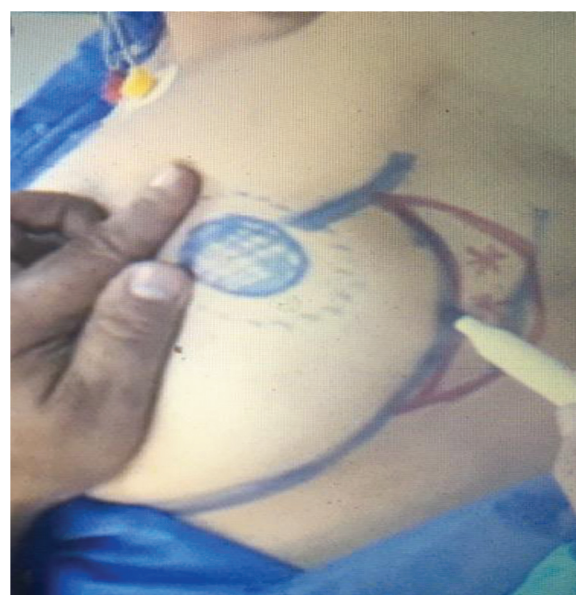
On the morning of the operation, the preoperative markings and flap design were repeated. After induction of general endotracheal anesthesia and muscle relaxation, the patient was placed in a supine position with the arm abducted 90° on the arm of the operating table with a degree of tilt to the contralateral side. The operating surgeon stood on the ipsilateral side, the first assistant stood at the head of the patient, and the second assistant stood on the opposite side. The operation was done in three stages.

The first stage was tumor excision. The incision corresponding to the anterior limb of the flap was opened and deepened down through the subcutaneous tissue to the level of the glandular tissue. The upper breast skin flap was created, and dissection continued overlying the whole tumor and the surrounding safety margin. The tumor was then

Table 1 Patients' demographic data and tumor characteristics

Mean age (SD) (range) years	47.6±5.6 (28–60)
Mean BMI (range) (kg/m ²)	28.7 (26–38)
Breast cup size [n (%)]	
B	24 (60)
C	12 (30)
D	4 (10)
Comorbidities [n (%)]	
Diabetes mellitus	4 (10)
Hypertension	4 (10)
No comorbidities	32 (80)
Tumor side [n (%)]	
Right	26 (65)
Left	14 (35)
Tumor location [n (%)]	
Upper lateral	24 (60)
Lower lateral	16 (40)
Mean tumor size (SD) (range) (mm)	31±2.1 (9–40)
Pathological tumor type [n (%)]	
Invasive ductal carcinoma	34 (85)
Invasive lobular carcinoma	6 (15)
TNM classification [n (%)]	
T1	22 (55)
T2	18 (45)
N0	16 (40)
N1	24 (60)
N2	0
M0	40 (100)
M1	0
Neoadjuvant chemotherapy [n (%)]	6 (15)

Figure 1



Preoperative marking of the lateral intercostal artery perforator flap for a mass in the upper lateral quadrant of the left breast; sites of perforators marked red in color.

excised down to the pectoral fascia with at least a 1-cm safety margin from all directions. The tumor bed was marked by clips. The margins of the specimen were marked by threads and sent to the frozen section for histopathological examination for radial marginal assessment. In the case of certain margin infiltration, a wider re-excision was performed (Fig. 2).

The second stage was axillary surgery. At the superior margin of the flap, the incision was deepened down till reaching the clavi-pectoral fascia, which was exposed and opened to enter the axillary space. Sentinel lymph node biopsy or axillary dissection was done according to the preoperative decision for each patient. In the case of positive sentinel lymph node biopsy, axillary dissection was performed. Special attention was taken not to harm the thoracodorsal pedicle, which should be spared if future reconstruction using LD flap is needed (Fig. 3).

The third stage is flap harvesting. The posterior limb of the flap incision is opened to the level of glandular tissue. The dissection is done from lateral to medial direction till reaching the important landmark of the anterior border of LD muscle. Dissection is continued at the level of muscle fascia till reaching a point of 1 cm from the expected perforator site. At this point, meticulous dissection is important to avoid injury to the perforators (Fig. 4).

Apart from the Doppler marking of the sites of the perforators, the knowledge of the anatomical sites of lateral perforators is of great importance. LTAP and LICAP perforators are usually located in the intercostal spaces in areas 2–3 cm anterior to the anterior border of LD muscle and posterior to the lateral border of the breast. LTAP perforators are located from the third to fifth intercostal spaces, whereas the LICAP perforators are located from the fourth to seventh intercostal

Figure 2



Opening of the skin of the anterior limb of the flap for wide local excision of the tumor.

spaces. It is worth mentioning that at least two perforators should be preserved to maximize the vascularity of the flap. The flap is continuously manipulated into the defect in combination with dissection till reaching the desired length of the flap to fill the cavity, and the length of the flap was measured (Fig. 5).

The perforators of the flap rest on a mesentery of the tissue rather than being skeletonized for additional protection, though they may be occasionally identified during dissection. The skin paddle overlying the flap is de-epithelialized, and the

Figure 3



Sentinel lymph node dissection at the superior border of the flap after tumor excision.

Figure 4

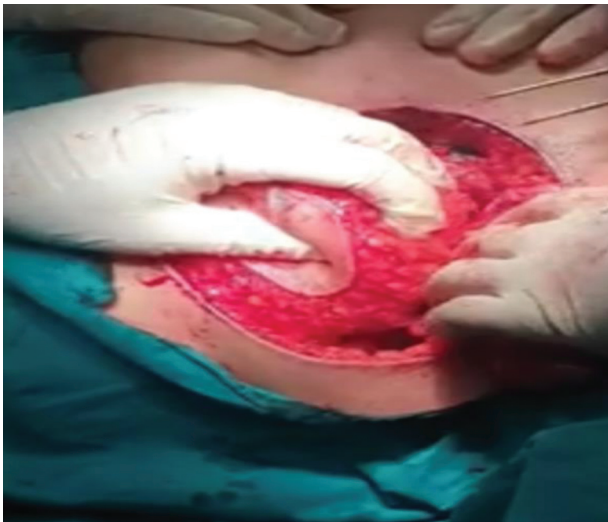


Lateral to medial dissection of the flap and identification of perforator vessels.

vascularity is confirmed. The flap is turned over into the defect and fixed with two absorbable vicryl 2/0 sutures between the de-epithelialized paddle and the pectoral fascia at the proximal extremity of the defect (Fig. 6).

The incision is closed in layers with a drain left with two limbs on at the cavity and the other in the axilla in case of axillary dissection (Fig. 7).

Figure 5



Manipulation of the flap to fill the defect before de-epithelialization.

Figure 6



De-epithelialized flap with confirmed vascularity and its turnover into the defect before fixation.

No intraoperative Doppler or magnification was needed to identify the perforators. The position of the patient was not changed during the operation.

The operative data including positive margins and need for re-excision, the weight of the specimen, type of axillary surgery, length of the flap, type of perforators used, and the operative time were recorded and assessed.

All of the patients were discharged on the first postoperative day with a drain in place. The drains were removed when discharge became less than 50 ml/24 h. Patients were reviewed in the outpatient clinic after 1 week and 2 weeks for assessment of the presence of postoperative complications (wound infection, hematoma, seroma, and flap necrosis) and to plan the adjuvant therapy.

The follow-up schedule for all patients was reviewing the patient through our MDT every 4 months for the first 3 years and every 6 months for the next 2 years. Bilateral sonomammography was requested every year.

The cosmetic outcome was assessed by asking the patient herself to rate the result of surgery regarding breast symmetry, scarring, and degree of satisfaction using the Harvard four-point scale (excellent, good, fair, or poor). Objective assessment was done by two

Figure 7



Immediate postoperative view after incision closure and fixation of suction drain.

specialized breast surgeons not participating in the study and also rated on a four-point scale (excellent, good, fair, or poor). The surgeon's evaluation is based on five criteria: breast symmetry, breast tissue defects, position and deformity in NAC, scarring, and retraction.

Statistical analysis

All of the data were analyzed using the Statistical Package for the Social Sciences (SPSS). Quantitative data were expressed as mean and SD. Qualitative data were expressed in frequencies and percentages.

Results

In our prospective study, 40 female patients diagnosed with invasive breast cancer in the lateral breast quadrants were subjected to wide local excision and immediate reconstruction with lateral thoracic wall perforator flaps. The mean age of the study group (SD) was 47.6±5.6 years (range, 28–60). The mean BMI was 28.6±4.2 kg/m² (range, 26–38). Four patients were diabetic, four patients were hypertensive, and four patients were smokers. The breast cup sizes were B, C, and D in 24, 12, and four patients, respectively. Majority of the tumors were located in the right breast in 26 (65%) patients. The tumors were in the lateral breast quadrants, 24 in the upper lateral quadrant, and 16 in the lower lateral quadrant. The mean size of the tumors (SD) was 31±21 mm and ranged between 9 and 40 mm. According to the TNM classification, T1 tumors were found in 22 cases and T2 tumors in 18 cases. A total of 24 cases had radiologically pathological lymph nodes. The majority of the patients had invasive ductal carcinoma (85%) and six cases had invasive lobular carcinoma. Six patients received neoadjuvant chemotherapy owing to Her2-enriched cancer (Table 1).

The mean operative time of the procedure was 148 ±13.6 min and ranged between 128.3 and 180 min. The surgical margins were free in all cases, and no cases required re-excision. The mean weight of the excised specimen was 85.4±20 g and ranged between 53 and 112 g. All patients with radiologically negative axilla for malignancy (16 cases) had sentinel lymph node biopsy, which proved to be negative. Level I and II axillary dissections were completed in the rest of the patients. No contralateral symmetrization was done in any of the patients.

The mean length of the flap was 13±1.6 cm (range, 11–15 cm). The mean flap width (base) was 6.5±1.3 cm

(range, 5–9 cm). The average flap size was 13×6.5 cm. No cases of isolated LTAP flap were used in our study. A combined LTAP/LICAP flap was used in 10 cases, and an isolated LICAP flap was used in 30 cases.

No significant complications were encountered in the postoperative period apart from two cases of wound infection in the form of wound hyperemia, which were managed conservatively. Another two cases developed fat necrosis diagnosed clinically as painful localized lump and radiologically by MRI. No partial or total flap loss occurred in any of our patients. All of the patients received their adjuvant therapy according to our institutional protocols.

Two patients developed locoregional recurrence in the ipsilateral breast in the upper inner quadrant and the lower inner quadrant at 12 and 16 months of follow-up, respectively. Both were managed with salvage mastectomy. None of the patients developed distant metastasis along the follow-up course of the study (Table 2).

Concerning cosmetic outcomes, the results assessed by the patients were excellent in 36 patients, good in two patients, fair in two patients, and no poor results. The

Table 2 Operative findings and postoperative sequelae

Mean operative time (SD) (range) min	148(128.3–180)
Intraoperative margins assessment [n (%)]	
Positive	0
Negative	40 (100)
Mean weight of specimen (SD) (range) (g)	85.4±20 (53–112)
Axillary surgery [n (%)]	
Sentinel lymph node biopsy	16 (40)
Axillary dissection (level I and II)	24 (60)
Type of flap perforator [n (%)]	
LTAP/LICAP	10 (25)
LICAP	30 (75)
Postoperative complications [n (%)]	
Wound infection	2 (5)
Hematoma	0
Seroma	0
Partial flap necrosis	0
Total flap necrosis	0
Fat necrosis	2 (5)
Local recurrence[n (%)]	2 (5)
Distant metastasis[n (%)]	0
Adjuvant therapy [n (%)]	
Radiotherapy	40 (100)
Chemotherapy	24 (60)
Hormonal therapy	16 (40)
Targeted therapy	6 (15)

LICAP, lateral intercostal artery perforator; LTAP, lateral thoracic artery perforator.

results assessed by the surgeons were excellent in 34 patients, good in four patients, fair in two patients, and no poor results. No revisional surgery was performed on a cosmetic basis (Fig. 8).

The average percentage of excellent results was 87.5%, good in 7.5%, and fair in 5% of cases. No poor results were seen (Table 3).

Discussion

Oncoplastic volume replacement techniques have extended the role of BCS. In the case of larger tumors in relation to small-sized or medium-sized breast volumes and inadequate parenchyma suitable for displacement techniques, volume replacement techniques may play a role. Volume replacement techniques may also be helpful in patients with large-sized breasts and unwilling to perform breast reduction or contralateral symmetrization [5,18].

Intercostal perforator flaps had been described for four decades in the reconstruction of challenging defects in the trunk [6].

In our study, we introduce an innovative oncoplastic technique for immediate reconstruction with lateral intercostal perforator flaps with our modifications as a volume replacement technique in laterally located breast tumors. It should be noted that some studies used a delayed technique in cases of incomplete margins or local recurrence but this was out of the scope of our study [19,23].

Table 3 Assessment of cosmetic outcomes

Cosmetic outcome	Patients[n (%)]	Surgeons[n (%)]	Average percentage
Excellent	36 (90)	34 (85)	87.5
Good	2 (5)	4 (10)	7.5
Fair	2 (5)	2 (5)	5
Poor	0	0	0

Figure 8



Postoperative lateral and frontal views 6 months after completion of radiotherapy.

Most of the studies on the technique of using intercostal perforators flap were retrospective cohorts. [11–13,17–20]. In addition, old records in retrospective series were not initially designed to be used in future studies and lack accuracy of data. In the literature, prospective studies concerning the technique are still scarce, with a study sample of around 20 cases [14,16,23].

Reviewing the literature concerning the intercostal perforator flaps for breast reconstruction, few studies have used the technique in centrally located tumors after central quadrantectomy [16,19]. In such cases, a skin paddle is designed on the flap to compensate for the lost skin. Most of the studies (and our study is one of them) applied the technique for laterally located tumors [11–13,17,20,23].

In our study, preoperative assessment involved the localization of the sites of the perforators along the lateral breast margin using the hand-held Doppler and the pinching test for skin elasticity. This agrees with many other studies [11,17,24], whereas some studies used the preoperative 3D computed angiography to localize the perforators [14,20]. No intraoperative Doppler localization was needed in our study, and the dependency upon preoperative Doppler decreased with repeated cases and increased experience, as most of the perforators are constant in position, especially with meticulous technique and avoidance of severe skeletonization of the perforators and preserving a mesentery of tissue in which the perforators lie. The preserved mesentery also gives support for the preserved perforators helping to avoid their torsion and occlusion during flap mobilization while ensuring the preservation of at least two perforator vessels for adequate vascularity of the flap.

Concerning the flap design, we adopted a modification that is different from that described in the literature. In our study, the flap was more vertical, elliptical wedge-shaped with two limbs towards the axilla and away from the back rather than the classical transverse-shaped flap described by Hamdi *et al.* [17] or lazy-S-shaped flaps modification described by Meybodi *et al.* [23]. The procedure is performed while the patient in supine position without the need to change the position of the patient twice intraoperatively (from supine to lateral then to supine position again) sparing time of the operation. Having a vertical incision at the lateral aspect of the breast makes it easy to hide the scar within the lateral breast fold.

The harvesting and dissection of the flap was done from lateral to medial direction. Some authors advocated dissection of the flap from medial to lateral direction with the use of intraoperative Doppler ultrasound [19]. Apart from the Doppler marking of the sites of the perforators, the knowledge of the anatomical description of lateral thoracic wall perforators is of great importance. This modification allows for easier preservation of the perforators having the border of the LD muscle (our landmark for identification of the perforators intraoperatively) in view while dissection with the near constant location of the LTAP and LICAP perforators (in the intercostal spaces in areas 2–3 cm anterior to the anterior border of LD muscle and posterior to the lateral border of the breast).

At least two perforators should be preserved to maximize the vascularity of the flap. LTAP flaps are rarely used alone and were not used in our study. However, some authors reported the exclusive use of LTAP flaps [16,19]. In our study, combined LTAP/LICAP flaps were used in 10 cases, whereas LICAP flaps were used in 30 cases. This could explain why we did not encounter flap necrosis in our study population. The same principle was followed commonly in the literature, that is, the use of combined LTAP/LICAP flaps and LICAP flaps [11–14,17–20].

The mean size of the flap was 13×6.5 cm. These results are comparable with the results of other studies reported by Yang *et al.* [12] and Hamdi *et al.* [17], reporting a flap size of 15×7 cm and 18×8 cm, respectively.

We used in our study the simple turnover method in flap mobilization avoiding excessive pedicle dissection similar to that illustrated by McCulley *et al.* [19] who advocated the same method and was described as the best option for partial breast reconstruction. Some series described the propeller method for flap mobilization, involving 180° rotation of the flap with the use of a skin paddle in the flap design to compensate for lost skin [14,16,20]. This method, that is, the turnover technique, ensures better vascularity of the flap.

The mean operative time in our study was 148 min and ranged between 128.3 and 180 min. It was observed that the operative time decreased throughout the study with increase in the learning curve and experience with the technique. Some authors reported a mean operative time of 45 and 77 min [17,22]. The increase in the operative time was attributed to intraoperative frozen

section assessment of the margins and sentinel lymph node biopsy. This was more obvious in cases that were performed for axillary dissection with positive sentinel lymph node biopsy. The mean operative time in these cases was 138 min and ranged between 132 and 180 min.

The overall complication rate in a systemic review of 13 studies ranged between 9.4 and 11.7% [24–27]. The complications included flap venous congestion [19,20], partial flap necrosis [23], wound infection [23], fat necrosis [20], hematoma [20], and seroma [20]. In our study, only two patients developed wound infection and two patients developed fat necrosis, and all of them were managed conservatively without the need of surgical intervention. The overall complication rate was 10%. The follow-up period was decided to be at least 1 year (12 months) after completion of the adjuvant therapy for adequate assessment of the cosmetic end results and possibility of early recurrence. Two (5%) patients developed locoregional recurrence in the ipsilateral breast in the upper inner quadrant and the lower inner quadrant at 12 and 16 months of follow-up, respectively. None of the patients developed distant metastasis along the follow-up course of the study. Concerning the cosmetic outcomes, excellent results were observed in 87.5%, good results in 7.5%, and fair in 5%. No poor results were reported. No revisional surgery was required on an esthetic basis. These findings match with many series reporting the advantage of the oncological safety of LICAP flaps in partial breast reconstruction with better cosmetic outcomes [1,8,9].

Conclusion

Lateral thoracic wall perforator flaps are reliable and oncologically safe reconstructive procedures in laterally located breast cancers with acceptable cosmetic outcome.

Limitation

Limiting the study group to early breast cancer goes with the NCCN guidelines. The applicability of the technique of immediate breast reconstruction using intercostal perforator flaps for cases with advanced breast cancer (T3, T4) and those showing good response on neoadjuvant treatment is a scope to be studied in future research.

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Nil.

Conflicts of interest

There is no conflicts of interest.

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