Modified Lateral Intercostal Artery Perforator Flap: Is it Technically Feasible and Cosmetically Sound?

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Introduction: When possible, breast conserving surgery (BCS) is used to treat breast cancer rather than mastectomy. Asymmetry and abnormalities of the breast's shape have been linked to the removal of malignancies in the breast's lateral region. One volume replacement procedure with favorable cosmetic results is lateral intercostal artery perforator flaps (LICAP). Our adaptation of the traditional LICAP does not require the patient to be moved, provides adequate access to the axilla, and leaves a less noticeable scar.
Patients and methods: Twenty patients who received BCS with immediate reconstruction utilizing modified lateral intercostal artery perforator flaps were included in this study. Ultrasonography was used to mark the perforators. The defect was filled using a flap after a thorough local excision and axillary dissection.
Results: We performed modified LICAP flaps on 20 patients. The follow-up period was six to twenty-four months. Four individuals had tumors measuring less than 2 cm (T1), and 13 patients had tumors in the lower-outer quadrants. Three patients experienced complications, including fat necrosis in one and wound dehiscence in two. Conservative treatment was used in all complications, with positive outcomes. There were no reports of wound infections or flap loss. No signs of tumor metastasis or recurrence were found during our follow-up.
Conclusion: Because it has minimal donor site morbidity and eliminates the need for muscle transfer, the modified LICAP is beneficial. Selecting the right patient, working with the oncological team to plan, and intraoperative caution during surgery are all essential to success.
Key words: Breast conserving surgery, LICAP, mastectomy, perforator flap, volume replacement.

Introduction

The most common malignancy to strike women worldwide is breast cancer. The chance of survival has increased since breast cancer early diagnosis and treatment have improved in recent years.[1,2] Significant changes have been made to the surgical treatment of breast cancer in the 20th century.[3]

According to research, regarding oncological survival, mastectomy and breast-conserving surgery (BCS) are similar, and better patient-reported outcomes (PROs) after radiation therapy.[4,5] BCS results in superior cosmetic outcomes with less drawbacks and increased patient satisfaction. As a result, BCS is now the preferred surgical technique for treating early-stage breast cancer.[5]

However, BCS has its limits. An abnormal breast shape may result from increased resection volumes.[6] Larger tumors can be excised using oncoplastic breast-conserving surgery (OPBCS) while still achieving the best possible functional and esthetic results.[7] OPBCS can be divided into two primary categories: volume replacement, which involves reconstructing the breast using tissue from elsewhere,[7] such as a perforator flap, and volume displacement, which fills the defect with the breast's remaining tissue.

One volume replacement oncoplastic technique that can be applied to repair challenging abnormalities in a tumor to breast ratio that is moderately large after breast cancer surgery is perforator flaps.[8] Compared to the standard latissimus dorsi (LD) flap, these fascio-cutaneous flaps preserve muscle function and reduce morbidity.[9] Lateral chest wall perforator flaps may be based on the lateral intercostal artery or the lateral thoracic artery perforator (LTAP). To increase perfusion, the LTAP flap can be integrated into the more popular LICAP flap or it can be raised on its own pedicle to allow for more mobilization.[10]

Hamdi et al. provided a thorough description of the architecture of lateral intercostal artery perforators as well as the traditional LICAP flap technique.[11] Meybodi et al. made a few small adjustments to get over the drawbacks of the traditional LICAP flap, saving the patient from having to be moved from a supine posture to a lateral position in order to harvest the flap. Additionally, they changed the flap form to a more vertical elliptical, which produced a better and more concealed scar.[12] Following breast cancer surgery, we at our institution began providing such flaps to patients who had difficult breast outer quadrant tumors. This study aims to assess the flaps' safety and dependability in partial breast reconstruction.

Patients and methods

Twenty patients who had BCS followed by immediate reconstruction with a lateral intercostal artery perforator flap were the subjects of this prospective study, which was carried out at Tanta University Hospital's Surgical Oncology Unit, General Surgery Department, Faculty of Medicine, between January 2020 and December 2022. Then, patients had adjuvant therapy in the medical Oncology Department, at our hospital.

The following criteria were used to determine who was eligible for this study: when it was recognized that a tumor could be removed with clean margins

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and still produce a satisfactory esthetic outcome. As long as the tumors were in the outer aspect, adjuvant radiation can be used for DCIS/Tis and T1-2 tumors if there are no other contraindications.

All patients signed an informed consent, and a cardiologic and anesthetic consultation were done before undergoing any surgical procedure. Following approval by the institutional ethical committee of the Tanta University Faculty of Medicine, any unforeseen concerns that arose throughout the research were disclosed to the participants.

There were adequate provisions to maintain privacy of participants and confidentiality of data. The results of the study were used as a scientific material only and were not be used by any legal authorities.

For complete diagnosis, a complete medical history from all patients, physical examination, routine mammography, breast ultrasound, and core biopsy from the lesion are needed, magnetic resonance imaging (MRI) was considered when there was a need for more information about suspicious mass found on mammogram or ultrasound, and staging investigations were performed, when certain clinic-pathological factors are associated with a higher likelihood of distant metastases. A multidisciplinary team decided on the course of treatment. Standard preoperative blood tests and preoperative flap design labeling using a handheld Doppler in a supine or lateral position. In every instance, an intraoperative frozen section has been performed to evaluate margins.

Patients were released with drains in place after all procedures were completed as day in-patient procedures. One week following surgery, the patients were evaluated by the operating surgeon; post-operative problems were noted and documented; and when less than 50 cc/24 hours were collected, the drain was taken out. Referrals for adjuvant treatment were made following receipt of the final pathology report. The majority of patients had routine follow-ups for at least six months after their radiation treatment.

LICAP surgical procedure

Resection of the tumor in the supine position using the conventional method from the subcutaneous plane to the pectoral fascia. To evaluate the clean resection margins, for frozen sectioning, the specimen was sent.

With a sandbag positioned between the operating table and the chest wall, after that, the patient was placed in the lateral position. An arm board was used to abduct the upper arm 90 degrees while the lower arm rested on the operation table. a pillow was put in between the legs. Care was made to maintain the lateral thoracic artery when doing axillary surgery from either the upper border of the flap or from a separate incision. Following frozen section confirmation of negative margins, flap harvesting was started from the distal end, which separated it from the LD muscle. The lateral intercostal artery perforators, which were normally located 2 to 3 cm from the anterior boundary of the LD muscle (in the intercostal spaces from the 5th to the 8th space), were reached by this process, which established the anterior border of the LD muscle.

locating the dominant perforator and sacrificing the others that would limit the flap's range of motion. To get a longer pedicle, the perforator was further dissected and skeletonized. To reach the defect, the flap was rotated, and vicryl stay sutures were used to fix it. Vicryl 2-0 sutures were used to secure the flap to the defect when the patient was placed back in the supine position. Vicryl 2-0 sutures were used subcutaneously to closure the donor site, whereas subcuticular monocryl 3-0 was used for the skin.

In our study, We began to slightly alter the method. There was no need to move the patient twice because the procedure was performed in the supine position, even though the flap's design and pre-operative markings were unchanged. A vertical adjustment was made to the skin ellipse design axis, moving it away from the back and toward the axilla. We kept the tissues surrounding the perforator vessels functioning as a mesentery for extra security, minimizing the skeletonization of the vessels.

Our surgical procedure

Every patient had a modified LICAP flap operation. The lateral position was used to mark the pre-operative flap design. Using a handheld Doppler, the proximal portion of the flap was delineated depending on the location of the perforators **(Fig. 1)**, and the distal portion was drawn in the direction of the back. The predicted defect size after tumor excision was used to determine the flap's breadth and length.

Prior to surgery, we located the perforators in each patient using the handheld Doppler. Only the first five patients had it administered intraoperatively. In the subsequent fifteen patients, we used the Doppler less frequently throughout the surgical period since we saw nearly constant anatomical locations for the perforators.

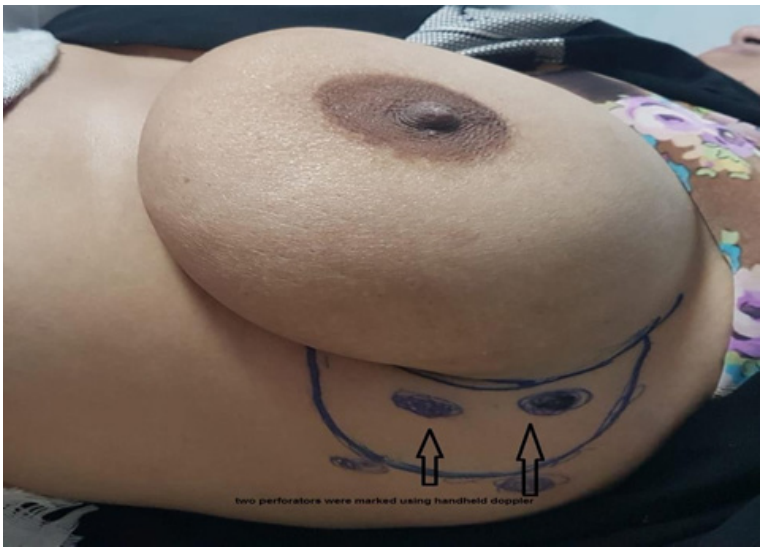

Fig 1: Preoperative flap design based on site of perforators.

Fig 2: Making a "lazy S" incision along the inferior and lateral mammary folds.

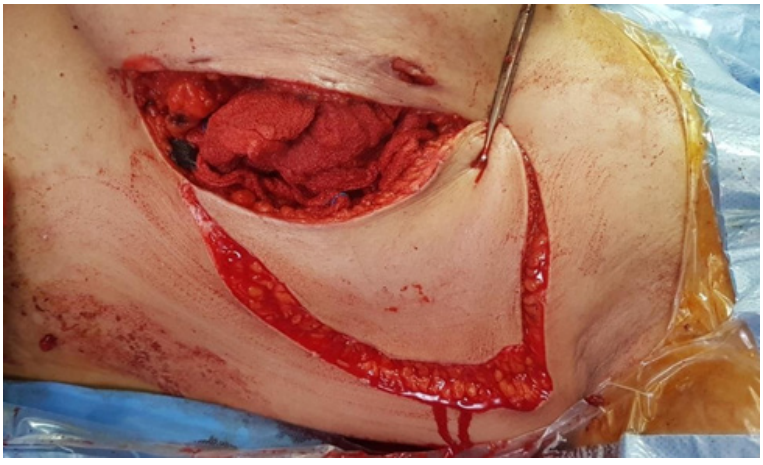

Fig 3: Another lazy s incision inferolaterally.

A "lazy S"-shaped line was drawn toward the lower axilla along the inferior and lateral mammary folds. The flap was finished with an additional inferolateral lazy S line. The primary change to the original method is this shift in the direction of the incision and the flap that results. **(Figs. 2, 3)** De-epithelialization occurred in the area between the two "lazy S" lines. Excellent access to the breast and axilla was made possible by the broad local excision that was carried out from the flap's anterior border and the axillary surgery that was carried out from its superior border.

Following the completion of cancerous resection from the subcutaneous plane to the pectoral fascia, the flap was mobilized in a manner like to the conventional LICAP flap, as detailed by Hamdi et al.[9] By beginning the flap harvesting procedure from the distal end, which separated it from the LD muscle and identified its anterior border, the lateral intercostal artery perforators-which were normally located 2 to 3 cm from the anterior border of the LD muscle (in intercostal spaces, from the 5th to the 8th space)—were reached. We identified the dominant perforator through extensive intraoperative dissection, and we sacrificed the others so as not to limit the flap's movement. **(Figs. 4,5).**

The flap was rotated to reach and enable optimal filling of the defect, preserving the perforators inside a mesentery of tissue **(Fig. 6)**. The flap was secured using vicryl sutures in its new position. The donor site was predominantly closed by subcutaneous vicryl 2-0 sutures and skin-level monocryl 3-0 sutures following the insertion of two drains, one in the axilla and one in the tumor bed. **(Fig. 7).**

Cosmotic outcome

A modified version of the Royal College of Surgeons of England questionnaire was used to evaluate the cosmetic outcome by measuring the patients' reported outcome measures (PROMS). The chief operating surgeon and two other board-certified oncoplastic surgeons evaluated the post-operative photos. They assessed the nipple-areola complex, scar, volume, shape, and symmetry. Every parameter was assigned a score between 1 and 5. A maximum score of 25 was used to compute the overall.

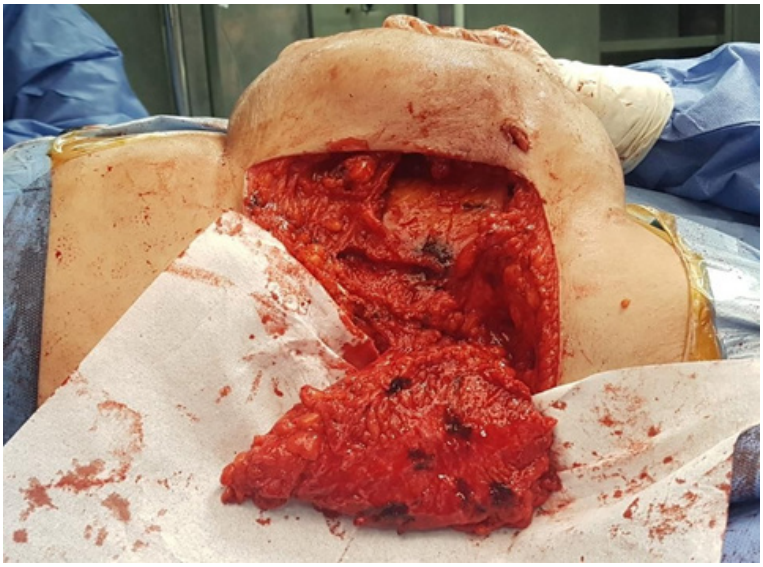

Fig 4: De-epithelialized and harvested flap based on perforators.

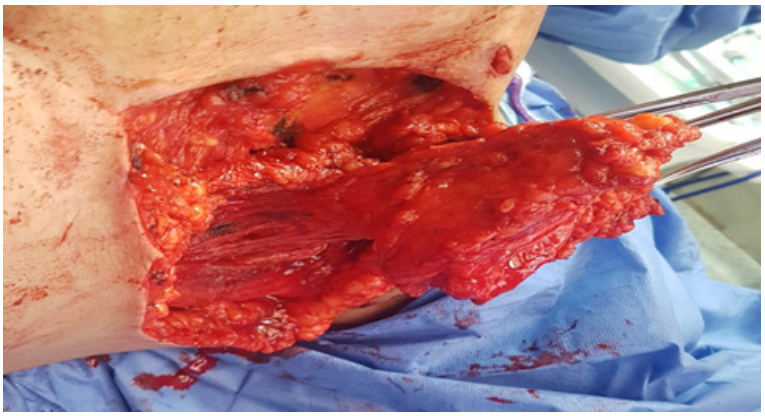

Fig 5: The pedicle of flap was dissected with preservation the dominant perforator.

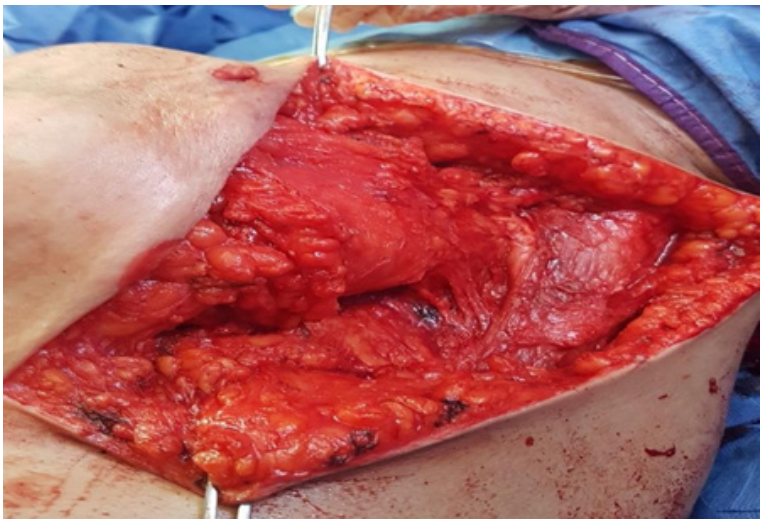

Fig 6: Flap was rotated and fixed in the defect after tumor resection.

Fig 7: Wound was closed after inserting two drains.

Results

Patients characteristics

A modified LICAP flap was performed on twenty patients, in the time of BCS for outer side breast cancer, from January 2020 till the end of December 2022. The mean age of patients was 54.2 years (range 41–65) Table 1. Four patients were type 2 diabetic, and three patients were hypertensive. The body mass index (BMI) mean was 25.1 kg/m.

Tumor characteristics

There were 4 patients with stage I (20 %), 16 patients with stage II (80 %). Nodal status was N1 in all patients (100 %). Left sided tumors were seen in 12 cases. Thirteen patients had a tumor in the lower outer quadrant (LOQ), while seven individuals had a tumor in the upper outer quadrant (UOQ). Initial tumors were invasive ductal carcinoma in all patients **(Table 1).**

Operative data

Mean specimen weight was 111.25 gm (range from 50 to 150 gm). All patients underwent axillary clearance from the same wound. Following the confirmation of negative intraoperative frozen section resection margins, all patients underwent reconstruction right away **(Table 1).**

Modified LICAP flap was used in all patients. The flap length ranged from 9 to 15 cm and its width from 6 to 9 cm. The handheld Doppler was used pre-operatively to locate the perforators in all patients and intra-operatively in first 5 cases only (25%) **(Table 1).**

Our operative time was improved during our study from 2 hours and 35 min. in the first cases reaching one hour and 25 min. in the last case. With mean operative time was 2 hours. Table 1.

Postoperative data

All patients spent a single day in the hospital. Time

needed to remove the drain ranged from 10 to 21 days. All patients received adjuvant treatment according to the final pathology report.

Follow up period in our study ranged from 6 months to 24 months. There were three local problems. One patient had fat necrosis (5%), and two patients (10%) had wound dehiscence. With good results, the two dehiscence instances were managed conservatively with frequent dressings. A firm, tender portion of fat under the perforator flap had to be surgically removed from one patient due to minor fat necrosis (1cm) that developed after radiation therapy. There were no reports of wound infections or flap loss. To date, no tumor recurrence or distant metastasis has been recorded. Among these patients, no deaths have been reported. **(Table 1).**

In our study, the flap was well planned, the breast shape could be preserved without major NAC displacement. Since symmetrization surgery was not required in our study through reduction breast conservative surgery.

Cosmetic outcome

The questionnaire's report on patient satisfaction was excellent (60%), good (20 %), and fair (20%). Surgeons' evaluation of cosmetic results was excellent (70%), good (20%), and fair (10%) **(Figs. 8,9)**.

Table 1: Patient, tumor, and flap characteristics in our study

patient	Age (year)	Type of tumor	Stage of tumor	Weight of specimen (gm)	Flap size (cm)	Duration of operation hour and (minutes)	Follow up (months)	Complications
1	47	IDC	I	50	10 × 6	2 h and 35 min	24	No
2	52	IDC	II	110	13 × 7	2 h and 35 min	24	No
3	61	IDC	II	100	12 × 7	2 h and 20 min	22	No
4	62	IDC	I	70	10 × 7	2 h and 15 min	20	No
5	47	IDC	II	130	13 × 8	2 h and 30 min	20	No
6	50	IDC	II	120	14 × 9	2h and 20 min	19	Wound dehiscence
7	55	IDC	II	80	10 × 7	2h	18	No
8	60	IDC	I	6 0	9 × 7	1 h and 55 min	16	No
9	48	IDC	II	150	15 × 9	2 h and 10 min	16	No
10	41	IDC	II	130	13 ×8	1 h and 50 min	12	No
11	53	IDC	II	140	14 × 9	2 h and 5 min	12	Fat necrosis
12	60	IDC	II	120	12 × 8	1 h and 45 min	12	No
13	45	IDC	I	75	10 × 7	1 h and 45 min	10	No
14	53	IDC	II	100	13 × 7	1 h and 40 min	10	No
15	63	IDC	II	110	13 × 8	1 h and 40 min	10	No
16	58	IDC	II	150	14 × 8	1 h and 55 min	8	Wound dehiscence
17	65	IDC	II	140	13 × 8	2 h and.5 min	6	No
18	55	IDC	II	130	13 × 7	1 h and 50 min	6	No
19	60	IDC	II	125	12 × 8	1 h and 30 min	6	No
20	49	IDC	II	135	11 × 9	1 h and 25 min	6	No

Fig 8: Scars were healed with primary intension in excellent case after 6 months.

Fig 9: Excellent outcome with symmetry of breasts after LICAP after 6 months.

Discussion

BCS is now the recommended surgical treatment for early-stage breast cancer due to the significant advancements in surgical management of breast cancer during the 20th century.[3,13] Complete tumor excision with negative resection margins and good esthetic outcomes are the ideal oncological outcomes of BCS.[14,15] Tumor location and resection volume have been shown to affect the cosmetic outcome.[16] OPBCS was created to address more significant defects while preserving ideal functional and aesthetic results.[17]

Numerous methods for replacing volume are explained. For lateral and inferior breast abnormalities, The LICAP flap is the most suitable since it is built on perforators that emerge from the costal groove.[12,18,19]

It has been shown since the 1970s that a musculocutaneous flap may be supplied by an intercostal artery perforator,[20] With the benefit of protecting the LD and maintaining its function, LICAP was implemented by Hamdi et al. as a fasciocutaneous flap for reconstructing lateral breast deformities following partial mastectomy. It can also be used as a flap in cases of local recurrence,[21] Multiple authors have documented the benefits and favourable results of the LICAP flap in tackling complex lateral breast deformities.[8,22,23] When it came to changes to the flap design, we followed Meybodi et al.'s instructions and made a slow S-shaped incision toward the axilla.[12]

The key reason this improved procedure has saved so much time was that it didn't require moving the patient. Our mean operative time was 2 hours compared to mean operation time was 249.3±40.1 min as reported by Kim et al.[22] The other noteworthy benefit was the improved cosmetic result that has a lateral scar that is vertical and concurrently improves axillary access.[24] Our initial experience with this novel process has been excellent. The rate of postoperative complications is minimal. Longer term results, like recurrence and appearance after radiation therapy, have not yet been established because of the very short follow-up.

The current procedure has certain advantages over the latissimus flap: it takes less time, doesn't require particular positioning, and doesn't result in any loss of muscle function. Furthermore, by using this procedure in place of latissimus flap, it preserves this option for possible usage in the future in the

event of a local recurrence.[25]

The majority of authors reported locating and marking the perforator pre-operatively utilizing handheld Doppler,[10,11,22] In our investigation, we marked the perforator intraoperatively in the first five patients using a portable doppler and preoperatively in all cases. In a different trial, it was only utilized intraoperatively in the initial five instances. The intraoperative verification of their stable anatomical position became less reliant on the Doppler as they progressed through the learning curve. This study brought attention to the lateral intercostal artery perforators' nearly consistent anatomical placement. They saw that the perforators were situated in a triangle between the anterior axillary line, the lateral mammary fold, and the inframammary fold in each patient. As the team gained more experience, the intra-operative Doppler was less necessary to validate the perforators' position.[24]

Further research on the architecture of the intercostal vessels revealed that the sixth and seventh intercostal spaces are often associated with greater prevalence of a "dominant perforator." (average of 3.5 cm from the anterior border of the latissimus muscle).[21]

Breast reconstruction was performed on thirty three patients using either TDAP (n = 14) or LICAP (n = 19) flaps were shown by Kim et al. They found that 46% of patients expressed "excellent" satisfaction and 36% expressed "good" satisfaction.[26] In this study, we did modified LICAP breast reconstruction on 20 patients, and the patients' satisfaction scores on the questionnaire were excellent (60%), good (20%) and fair (20%). Surgeons evaluated the cosmetic results as excellent (70%), good (20%) and fair (10%).

40% (5 patients from 12 patients) in other series (Kelsey et al) developed issues that needed further care. (2 within the LICAP group),[27] Kim et al. conducted an additional series involving 40 patients who received LICAP flap using either the turnover method (little or non-necessary skin excision during tumor excisions) or the propeller method (if resection necessitated extensive skin excision). Two of the propeller method cases had venous congestion, and three instances needed therapy for fat necrosis,[22] For both methods, cosmetic satisfaction was at least 90%.[22,27] In our investigation, one patient (5%) had fat necrosis and two patients (10%) had wound dehiscence . The two dehiscence instances responded well to cautious treatment. After radiotherapy, one patient experienced a tiny amount of fat necrosis (1 cm), which needed to be surgically removed.

Flap venous congestion,[10,22] partial flap necrosis,[28,29] wound infection,[12,28] fat necrosis,[22,29] hematoma,[29] and seroma,[29] are among the consequences that have been documented in the literature. No significant major postoperative problems were noted in our patients. No flap loss or wound infections were recorded.

Repeat surgery for a broader removal to clear the margins was recorded in certain other series.[29] The ability to perform an intraoperative frozen section at our institution minimised the need for a second procedure and allowed for a safe reconstruction right away.

The LICAP flap was used in a prior study to reconstruct breast tissue with lateral and central inferior skin that had been removed during a CBS. Patients with tiny to medium-sized breasts, whether or not they had ptosis, should consider it. The patients had moderate to severe abnormalities with insufficient breast tissue for reconstruction, and all malignancies were in the lateral and central-inferior breast poles.[25] In the present study, the tumor was found in the lower outer quadrant (LOQ) in 13 patients and the upper outer quadrant (UOQ) in 7 cases. It was noted that the texture and color of the tissue adjacent to the defect matched those of the original breast.

Despite being widely applicable, the location of the tumor may pose certain technical restrictions for the LICAP flap. Individuals who have superior or medial breast tumors are not suitable candidates. In fact, due of its short vascular pedicle, Hamdi et al. found that the LICAP flap's use was restricted to abnormalities in the lateral quadrants of the breast.[21,30]

During their first encounter, the lateral ICAP pedicle typically measured 4-5 cm in length. They advised further Perforator vessel dissection within the costal groove in case a longer pedicle was required. They believe, however, that this operation can be challenging and can jeopardize the perforator vessel's integrity.[30] To prevent pedicle tension, it is crucial to plan the skin island flap in accordance with the location of the tumor.

We acknowledge that our study has numerous limitations. The cohort's limited patient count and the very brief follow-up period are two major limitations. This illustrates the reality of a recently implemented method at our organization. Some patients had a follow-up duration of up to 24 months after surgery, while others had a follow-up period of only 6 months. Since it seemed more appropriate for our patient population, we employed a straightforward instrument to evaluate cosmetic results. Using additional cosmetic results assessment instruments, follow-up will be conducted to evaluate long-term cosmetic outcomes in patients with medium- to large-sized breasts.

Conclusion

A dependable and safe method for reconstructing difficult lateral aspect breast deformities is the LICAP flap. A volume replacement approach for prompt filling of deficiencies in the lateral aspect of the breast following BCS is the modified LICAP flap. Because the anatomical position of the perforator vessels is fixed, the learning curve of the flap is relatively easy. The procedure was further simplified by the modifications reported in this cohort, which resulted in a reduced operating time. It avoids the need to rotate the patient intraoperatively and leaves an excellent access to the axilla. The post-operative complications were negligible and accepted. Larger studies are still needed for further revalidation.

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