

# Intercostal artery perforator flaps for partial breast reconstruction after breast-conserving surgery

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## Introduction

Breast conservative surgery's objectives include a thorough oncologic excision and a satisfactory aesthetic outcome. The greatest strategy to prevent undesirable aesthetic outcomes is to use oncoplastic procedures to do so during conservative surgery in one step. For small to medium-sized breasts (up to C or D cup size), volume replacement treatments are advised, particularly in cases of bigger tumors. This entails inserting tissue into the tumor excision defect from a nearby or distant site. Musculocutaneous flaps, fasciocutaneous flaps, and most recently 'perforator' skin flaps have all been used in autologous tissue restoration. Due to the intercostal artery's strong blood supply, anterior and lateral intercostal artery perforator (LICAP) flaps are dependable tissue sources. These flaps have the benefit of being able to fill the resection cavity, preventing further deformities. The study aimed to assess the feasibility of intercostal artery perforator flaps in partial breast reconstruction following breast-conserving surgery.

## Materials and methods

The study was carried out on 42 breast cancer patients admitted to the surgical oncology unit, at Alexandria Main University Hospital in the duration between January 2021 and December 2022. A modified lateral intercostal artery perforator flap (mLICAP) and anterior intercostal artery perforator flap (AICAP) were used depending on the tumor location within the breast. The postoperative assessment was done by another breast surgeon and by the patient.

## Results

Modified LICAP was used in 37 patients and AICAP was used in 5 patients. 90.5% of patients were satisfied with the aesthetic outcomes (85.7 gave excellent results). 69% of patients had excellent results based on the surgeon's assessment. Complications were encountered in 11 patients in the form of seroma, hematoma, and minimal wound dehiscence.

## Conclusion

Modified LICAP affords excellent access to the axilla and offers an option that facilitates both a pleasing aesthetic result and obviates the need for symmetrizing contralateral surgery to maintain breast symmetry. AICAP is a good option to partially reconstruct the breast following BCS for tumors located in the lower half of the breast.

## Keywords:

breast reconstruction, breast-conserving surgery, cosmetic result, Intercostal artery perforator flap, lumpectomy

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## Introduction

Breast-conserving therapy (BCT) has developed over the past few decades and is now the norm for treating patients with early-stage, localized breast cancer (BC) [1]. To eliminate the microscopic residual disease in the breast, BCT involves breast-conserving surgery (BCS) in the form of a lumpectomy followed by breast irradiation [2]. After lumpectomies, cosmetic outcomes from breast conservation surgery (BCS) using oncoplastic procedures were enhanced, allowing for better aesthetic outcomes after the excision of a large tumor [3]. If a lumpectomy calls for volume replacement, which entails removing more than 20% of the breast's volume (as opposed to volume

displacement), Regional fascio-cutaneous and myo-cutaneous flaps are frequently utilized for autologous reconstruction, and these include the latissimus dorsi (LD), medial Intercostal, lateral, thoracic, and thoracodorsal artery perforator (MICAP, LICAP, TDAP) flaps are examples of perforators of the arteries in the chest wall [4]. For use in breast reconstruction, Hamdi and colleagues invented several flaps that are incredibly adaptable. The

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perforating arteries, which originate in the costal section of the intercostal arteries, were said to provide the basis for his lateral intercostal anterior perforator flap [5]. The benefits of the lateral intercostal artery perforator (LICAP) flap include the ability to reuse local tissue by making use of extra axillary tissue and the maintenance of a consistent tissue source due to its abundant blood supply. By filling the resection cavity, these flaps can prevent further deformities. Because the flap may be harvested without endangering the muscle or nerves at the donor site, the surgical process is very quick and causes little morbidity [5,6]. Carrasco-Lopez and colleagues described a series of 14 patients in 2017 to demonstrate the feasible and beneficial use of the AICAP flap for breast reconstruction following BCS [7]. They also performed cadaver radiological and anatomical studies and defined the anatomical repercussions of the anterior intercostal perforators, which extend along the inframammary fold from the xiphoid process to the anterior axillary line [8]. The aim of the study was to assess the early results of the modified lateral intercostal artery and anterior intercostal artery perforator flaps in partial breast reconstruction after breast conservative surgery.

### Patients and methods

The study was carried out on 42 breast cancer patients admitted to the surgical oncology unit, at Alexandria Main University Hospital in the duration between January 2021 and December 2022. Patients included in the study were diagnosed with early-stage breast cancer and fit for BCT and patients who received neoadjuvant chemotherapy and became amenable to BCT. After a full explanation of the process, all patients who decided to participate in this study signed an informed consent statement. The Ethics Committee and the Institutional Review Board of the Alexandria Faculty of Medicine authorized the study.

### Surgical techniques

The tumor site was located preoperatively. In cases who had nonpalpable tumors, wire-localization was used. (Fig. 1) The patient was positioned supine, with the ipsilateral arm abducted to 90 degrees. The perforator branches (lateral or anterior) of the intercostal artery were correctly localized and marked using a handheld Doppler probe. The flap was designed by drawing a semilunar incision parallel to the lateral or inferior mammary sulci according to the flap choice, making the flap a sickle shape and including the skin harboring the previously marked perforators. (Fig. 2) Depending

Figure 1

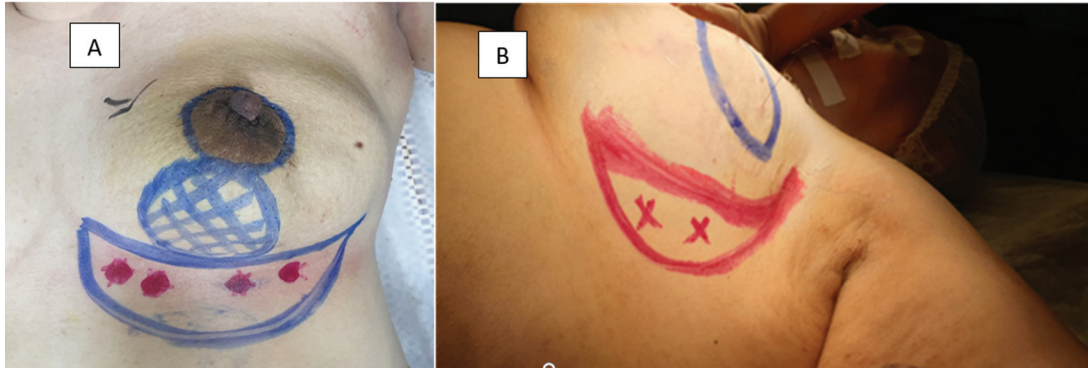


Wire localization of nonpalpable tumor following neoadjuvant chemotherapy.

on the distance of the tumor from the overlying skin, a skin ellipse was excised (if the distance between the tumor and the overlying skin was less than 1 centimeter), (Fig. 3a and b) or an incision was placed in the lateral or inferior mammary sulci depending on tumor location (Fig. 3c and d). If the tumor was in the periareolar region, a round block (Fig. 3e) or modified round block technique was used for tumor excision. Tumor margins were assessed by the intraoperative frozen section. Axillary surgery (axillary dissection or sentinel lymph node biopsy) was done through the same incision or a separate incision. The flap was harvested, and the perforator (s) was (were) identified (Fig. 4a and b) and mobilized to fill the resection cavity where it was fixed to the breast tissue using absorbable suture material. If the lumpectomy was done through a separate skin incision, the flap dimensions were tailored to keep a skin island to bridge the gap, with de-epithelialization reserved only for the edges if they exceeded the gap length (Fig. 5a–d). A closed suction drain was inserted in the resection cavity and in the axilla only if axillary lymph node dissection was performed. The wound is then closed in layers. Patients were discharged on the same or the next day and scheduled for outpatient followed up at 1, 2, 4, 8, and 12 weeks postoperative.

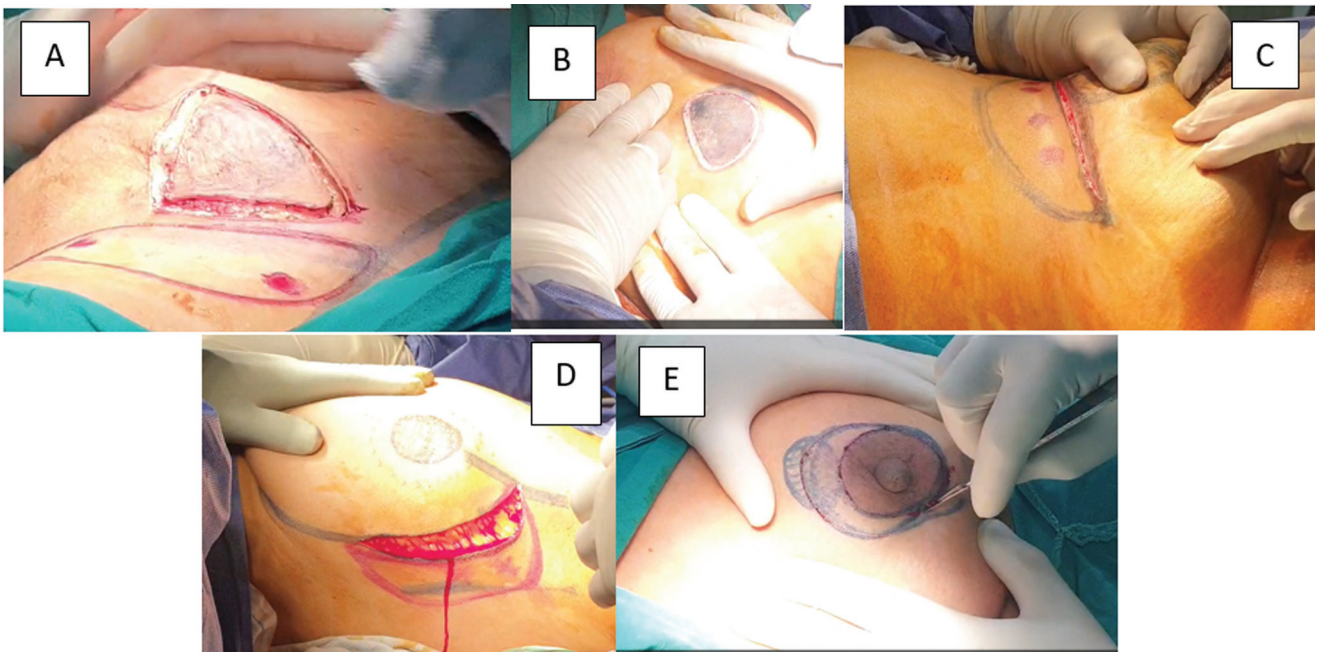
Patients' demographic information, preoperative clinical and imaging information, intraoperative details for the breast, and axilla, time for frozen section, total operative time (from first skin incision to last skin stitch), tumor histopathologic information, postoperative morbidity and mortality, and cosmetic

Figure 2



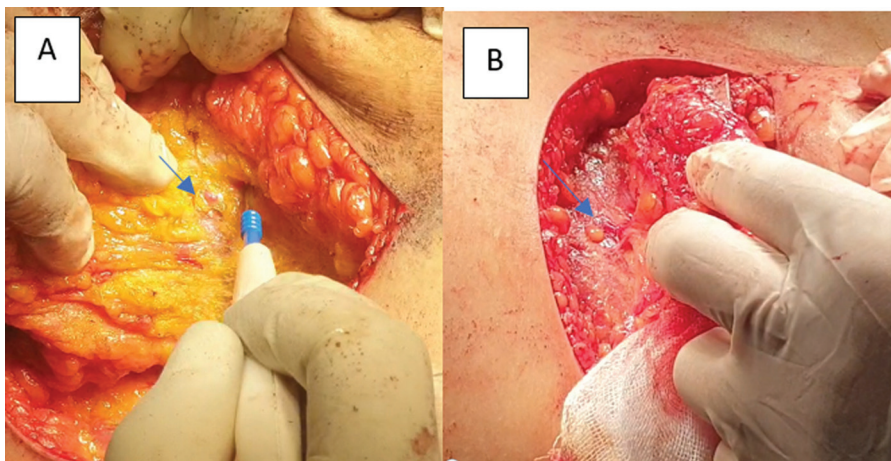
(a). Anterior intercostal artery perforators. (b). Lateral intercostal artery perforators. The flaps were designed to include the perforators.

Figure 3



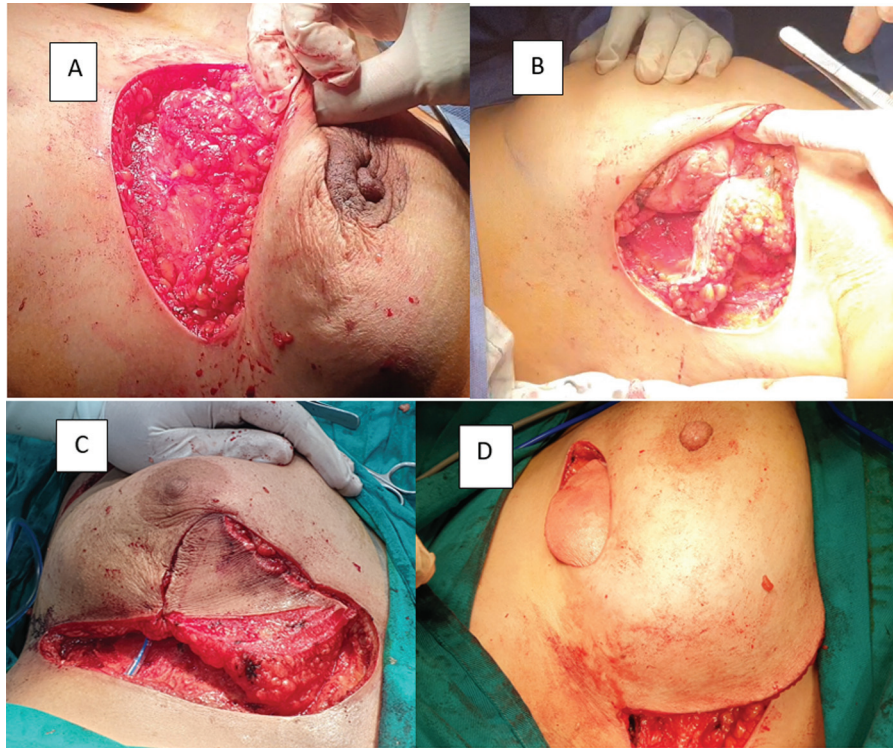
(a) and (b) show excision of the skin that overlies the tumor. (c): a skin incision in the inframammary sulcus. D: lateral mammary sulcus incision. E: Round block technique.

Figure 4



(a) and (b): perforators were identified (arrowed).

Figure 5



(a) and (b) show AICAP and modified LICAP flaps were completely de-epithelialized and moved to fill the resection cavity. (c) and (d) show AICAP and modified LICAP flaps were partially de-epithelialized and moved to the resection cavity.

outcomes were all documented. The Harvard Scale (four-point Likert Scale) was used to assess cosmetic results by both an independent surgeon and the patient using the following definitions [9,16]

- (1) Excellent: the treated breast is virtually identical to the untreated one.
- (2) Good: the treated breast differs somewhat from the untreated one.
- (3) Fair: the treated breast differs significantly from the untreated one but is not significantly deformed.
- (4) Subpar: the treated breast is severely deformed.

#### Statistical analysis

For the entire cohort, descriptive statistics were provided. Means, standard deviations (SD), and ranges were used to describe continuous data, whereas numbers and percentages were used to represent categorical variables. IBM SPSS Statistics version 26 was used for all analyses (IBM Corporation, Armonk, NY).

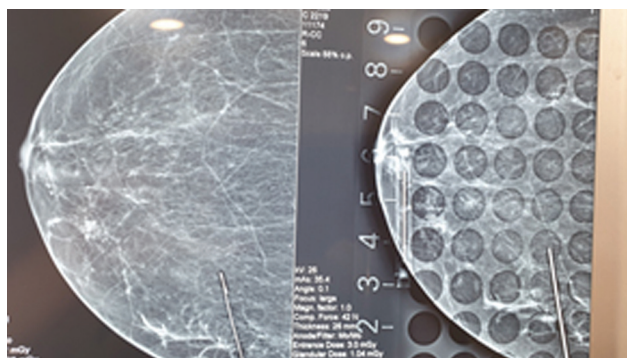
#### Results

42 female patients diagnosed with breast cancer and had small to medium-sized breasts were enrolled in the

study. All patients were amenable to breast-conserving therapy. A modified LICAP was performed in 37 patients while AICAP was done in 5 patients. Table 1 shows the demographic and preoperative data of the studied patients. 11 (26.2%) patients used oral contraceptive pills during their child-bearing period. 6 (14.3%) patients had a positive family history of breast cancer. Breast mass was the commonest presentation (41 patients) while one patient had no symptoms and was discovered accidentally during a screening mammogram (a localized area of microcalcification in the lower outer quadrant of the right breast as shown in Fig. 6. The size of the mass ranged between 1 and 5 cm. Neoadjuvant chemotherapy was received in 9 (21.4%) patients, those either had a large tumor-breast ratio or had Her2-positive or triple-negative diseases. 50% of cases had tumors located in the upper outer quadrant of the breast. Core-needle biopsy was the diagnostic biopsy in all cases. The preoperative pathology was invasive ductal carcinoma in 41 cases and *in-situ* ductal carcinoma in one patient. Grade II was the most common (73.8% of cases). Table 2 shows the operative details and the postoperative aesthetic outcomes and complications. The commonest sequela of the procedure was seroma which occurred in 6 patients. Hematoma occurred in 2 patients, one of

**Table 1 Demographic, pathologic, and postoperative results (aesthetic and complications)**

	Total (n=42)
Age (years)	
Mean±SD.	47.1±9.16
BMI (kg/m <sup>2</sup> )	
Mean±SD.	26.9±2.36
Neoadjuvant chemotherapy	9 (21.4%)
Breast size	
A	6 (14.3%)
B	24 (57.1%)
C	12 (28.6%)
Tumor size	
Median (Min. – Max.)	3 (1–5)
Suspicious Axillary LNs	
Clinically	11 (26.2%)
Mammographically	15 (35.7%)
Site	
Supra-areolar	8 (19.0%)
LIQ	3 (7.1%)
UIQ	2 (4.8%)
UOQ	21 (50.0%)
LOQ	8 (19%)
Micro calcification	5(11.9%)

**Figure 6**

Microcalcification in the LIQ of the right breast.

them required operative evacuation. Minimal wound dehiscence was encountered in 3 patients, all were treated by frequent dressing and topical antibiotic spray. The aesthetic results of the procedure were excellent in most of the cases (69% as assessed by other breast surgeons and 85.7% as assessed by patients). The difference in the values was attributed to the difference between the expectations of the surgeons and those of the patients. Figures 7 and 8 show preoperative and postoperative photos of some cases.

## Discussion

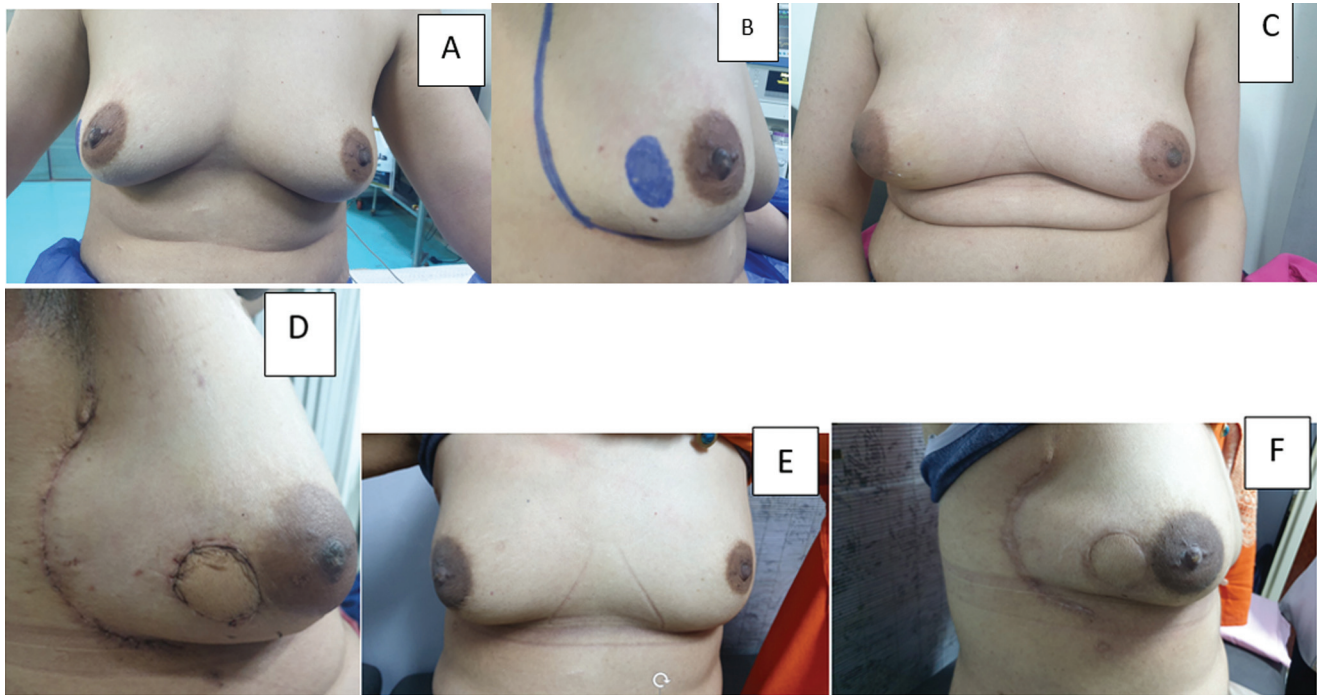
The mainstay treatment for nonmetastasizing BC is surgery, either BCS or modified radical mastectomy. Oncoplastic breast-conserving surgery (OBCS)

**Table 2 Operative and postoperative results**

Operative time in min	
Frozen	
Median (Min. – Max.)	45 (20.0–90)
Total time of surgery	
Median (Min. – Max.)	105 (65–260)
Weight pf the specimen	
Mean±SD.	55±0
Median (Min. – Max.)	55 (55–55)
Procedure of reconstruction	
Modified LICAP	37 (88.1%)
AICAP	5 (11.9%)
Biological subtype	
Luminal A	33 (78.6%)
Luminal B	2 (4.8%)
Her 2 enriched	2 (4.8%)
Triple-negative	5 (11.9%)
Postoperative Surgeon's assessment	
Fair	4 (9.5%)
Good	9 (21.5%)
Excellent	29 (69.0%)
Postoperative Patient Satisfaction	
Fair	4 (9.5%)
Good	2 (4.8%)
Excellent	36 (85.7%)
Complication	
Seroma	6 (14.3%)
Hematoma	2 (4.8%)
Wound dehiscence	3 (7.1%)

evolved to combine plastic surgery and oncologic safety. While volume displacement oncoplastic procedures may necessitate symmetrizing surgery on the contralateral breast, volume replacement procedures do not. In the literature, various algorithms have been reported to determine the best partial breast reconstruction mode based on the volume of excision, breast size, and degree of ptosis [10–12]. Pedicled perforator flaps can be used for partial breast reconstruction when the defect is less than 30% of the breast volume. For patients with (T1-T2) tumors, the technique is recommended as part of a multidisciplinary treatment plan. Because the latissimus dorsi muscle is spared, the concept can be safely applied to a wide range of clinical indications with lower complication rates and donor site morbidity Hamdi and colleagues [5]. With their firsthand knowledge, Hamdi and colleagues published extensively on pedicled perforator flaps, with a particular emphasis on ICAP flap reconstructions. They described the original LICAP in partial breast reconstruction, where intraoperative patient repositioning was required Hamdi and colleagues, Hamdi and colleagues [13,14]. Unlike us, Hamdi and colleagues [14] relied on anatomical landmarks to define the perforators intraoperatively. This

Figure 7



(a) and (b): preoperative anterior and lateral views. C and D: 2 weeks postoperative anterior and lateral views. E and F shows front and lateral views 6 months after radiotherapy.

maneuver was similar to the one used by Meybodi and colleagues [15] to identify the perforators of the lateral intercostal artery. The entire procedure of lumpectomy, axillary, and lateral intercostal flap surgery was performed in the supine position, as reported by Meybodi and colleagues [15]. Unlike the original LICAP, which required a separate flap incision from the lumpectomy incision Hamdi and colleagues [14], in our work, excision of the breast lump and performing ALND were done through the same flap incision in patients with laterally located and deep tumors that were away from the overlying skin. The entire procedure had a single scar that was hidden in the lateral mammary sulcus, which obviously resulted in a better cosmetic outcome. In our experience, the excised lump was assessed for intraoperative safety margins before proceeding with reconstruction in a single procedure. Others, on the other hand, advocated a two-stage approach, with interval reconstruction performed 2-4 weeks after BCS to ensure clear margins. Roy and Tenovici [9] advocated for this staged approach in a subset of patients with tumor-to-breast ratios greater than 30% to avoid unnecessary mastectomy and ensure adequate tumor safety margin prior to reconstruction. As a first step, they performed a wide local excision, and the resection cavity was filled with saline. After pathological results confirmed an adequate safety margin, a second stage of flap reconstruction occurred 2-4 weeks later. Breast-

Conserving Therapy: A Surgical Technique with Limited Success. Rahman GA, Roy and Tenovici [9]. We did not adopt this two stages procedure as we have the facility of intraoperative frozen section assessment of the margins. Lipman and colleagues [6] performed 16 LICAP procedures for breast augmentation on 12 patients who had previous breast surgery or massive weight loss in their study. All the patients in their study were pleased with the results, and none of them complained about the scar. In our study, most patients ( $n=38$ , 90.5%) had satisfactory scar and cosmesis results (excellent and good) according to both the patient's and the independent surgeon's assessment. We noticed that unsatisfactory results were related to changes in the nipple level and the requirement of a separate incision for lumpectomy. Kim and colleagues performed LICAP flap reconstruction on 40 patients in their study, comparing two methods, the propeller method (29 patients) and the turnover method (11 patients). (16) According to surveys conducted and reported by patients and surgeons, the cosmetic results were satisfactory (excellent and good). Neta Adler and colleagues [3] studied the anterior intercostal artery perforator flaps, they found that the results were good, with no patients complaining about the hard consistency of the restored breast and great satisfaction in all Patients at their most recent check-up. This matches with our patients who had

Figure 8



(a) and (b): preoperative lateral and anterior views. C and D: one month postoperative lateral and anterior views. E and F: three months postoperative and one month after radiotherapy lateral and anterior views.

AICAP flap reconstruction even that patient in whom evacuation of a hematoma was necessary. The complications encountered in our study were all handled conservatively except for one case that required the operative evacuation of hematoma, with no additional surgical intervention required. Meybodi and colleagues [15] reported wound infection in three patients, which they handled conservatively; nevertheless, an infected seroma was discovered in one patient, necessitating surgical reoperation and evacuation.

### Conclusions

Intercostal artery perforator flaps are an effective and simple choice for partial breast reconstruction after breast conservative surgery in small and medium-

sized breasts. Our modification in the LICAP design slowed performing the whole procedure in the supine position and allowed performing the lumpectomy, axillary surgery, and the flap through a single incision. Although we have only five patients who had AICAP, it is considered a good option for partial breast reconstruction when the breast cancer is in the lower inner quadrant of the breast or upper inner quadrant in ptotic breasts.

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Nil.

### Conflicts of interest

There are no conflicts of interest.

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