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Evaluation of Perforator Fasciocutaneous Flaps for Oncoplastic Immediate Reconstruction Following Breast Conservative Surgery in Lower and Lateral Breast Quadrant Lesions Perforator Fasciocutaneous Flaps for OBCS

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ABSTRACT

Objective: To compare the oncological safety and the cosmetic outcome of the techniques anterior intercostal artery perforator (AICAP), lateral intercostal artery perforator (LICAP) and thoracodorsal artery perforator (TDAP) flap as a volume replacement technique to eliminate deformity and preserve breast cosmesis by filling the excised defect.

Materials and Methods: This prospective study included women with lower outer quadrant, lower inner quadrant, and upper outer quadrant tumors who underwent upfront or post-neoadjuvant chemotherapy breast conserving surgery with immediate volume replacement surgery. Patients were allocated into three groups at a ratio of 1:1: Group A (n = 10): women who underwent LICAP flap, group B (n = 10): Women who underwent AICAP, and group C (n = 10): Women who underwent TDAP flap procedures.

Results: Regarding postoperative complications, wound infection took place in only one (10%) patient in LICAP group and one (10%) patient in the AICAP group; seroma occurred in only one (10%) patient in LICAP group and one (10%) patient in the TDAP group; and fat necrosis occurred in only one (10%) patient in the TDAP group. Incidence of wound infection, seroma, and fat necrosis was insignificantly different among the studied groups. Breast distortion occurred in one (10%) patient in the AICAP group and not observed in the other groups, and partial flap necrosis occurred in one (10%) patient in the LICAP group and one (10%) patient in the AICAP group and was not observed in the TDAP group. Incidence of distortion and partial flap necrosis were insignificantly different between the studied groups. The conservative treatment of breast cancer core results, surgeon's assessment, patient's satisfaction and breast Q scores did not differ between the three groups.

Conclusion: A better cosmetic outcome than level II oncoplastic techniques, the perforator fasciocutaneous flaps, LICAP, AICAP, and TDAP, were effective and safe options for immediate breast reconstruction after breast-conserving surgery. All three techniques showed similar surgical outcomes, low complication rates, and good aesthetic results. Patient satisfaction was high, with no significant differences between the groups.

Keywords: Perforator fasciocutaneous; oncoplastic; breast conservative surgery; breast quadrant lesions

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Key Points

- Perforator fasciocutaneous
- Oncoplastic
- Breast conservative surgery
- Breast quadrant lesions

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Introduction

Breast-conserving surgery (BCS) is now universally acknowledged as a standard method for treating early-stage breast cancer, demonstrating a disease-free survival rate similar to that of mastectomy. The impact of BCS on patients' psychological well-being and overall quality of life is evident (1). However, BCS may be associated with deformities, such as depression of or nipple-areolar complex (NAC) deviation, especially when the resulting lumpectomy defect is large in relation to small breast size or if the tumor is situated in cosmetically sensitive areas (2). Oncoplastic breast-conserving surgery (OBCS) uses plastic surgical procedures for breast cancer management. This expands the scope of BCS and avoids the associated deformities leading to improvement in the quality of life of the patients and optimal cosmesis (3). These methods use the typical breast reduction surgery markings to direct tumor removal and involve carefully choosing local flaps to replace the lost volume (4).

OBCS can be categorized into two methods: Volume displacement and volume replacement. Volume displacement often necessitates the balancing of the opposite breast by transferring a section of glandular or dermo-glandular breast tissue to replace the deficiency (5).

Over the years, various methods have been developed to maintain breast aesthetics while ensuring effective tumor removal. A relatively new method for partial breast reconstruction following cancer surgery is the use of pedicled local perforator flaps (LPF) that are attached to the chest wall. This includes methods like the lateral thoracic artery perforator (LTAP) and the intercostal artery perforator (ICAP) flaps (6).

The use of a skin-muscle flap with its intercostal neurovascular pedicle was first introduced in 1931. This method has been applied consistently over the years to treat various surface defects (7). The principle of using the intercostal neurovascular pedicle or its perforators is now applied in partial breast reconstructions, especially for large defects. By employing this technique, the underlying muscle is preserved, which aids in effective reconstruction and reduces the need for muscle removal (8). This approach minimizes the complications related to muscle dissection. The ICAP flap is categorized according to its nutrient artery and the location of its perforators. When the perforators arise from the vertebral segment of the intercostal vessels, the flap is called a dorsal ICAP (DICAP) flap. If the perforators are from the costal segment, it is referred to as a lateral ICAP (LICAP) flap. Alternatively, when the perforators come from the anterior intercostal artery and pass through the rectus abdominis or external oblique muscles, the flap is designated as an anterior ICAP (AICAP) flap (9).

The objective of this study was to evaluate the cosmetic outcome and the oncological safety of these techniques (AICAP, LICAP) and thoracodorsal artery perforator flaps (TDAP) as a volume replacement technique to eliminate deformity and preserve breast cosmesis by filling the excised defect.

Materials and Methods

This prospective randomized study was performed with women who had upper outer quadrant (UOQ), lower inner quadrant (LIQ) and lower outer quadrant (LOQ) tumors and who underwent immediate volume replacement surgery with upfront or post-neoadjuvant chemotherapy BCS, at the General Surgery Department of the Faculty of Medicine, Cairo University. The study was conducted from October 2023 to March 2024 and received approval from the Research Ethics Committee of the Faculty of Medicine, Cairo University, approval code MS-500-2023, date 04.04.2024. Patients gave their informed consent before taking part in the study.

Inclusion criteria were women diagnosed with UOQ, LOQ and LIQ tumors, carcinoma *in situ*, of any age group or invasive breast cancer who were candidates for breast OBCS with the need for volume replacement technique (either upfront or post neo adjuvant surgery).

Exclusion criteria were: Refusal of patients to participate; patients not meeting the criteria for BCS, such as having locally advanced tumors, inflammatory breast cancer, pregnancy, or lactation, women who had received radiation therapy to the affected side, metastatic breast cancer, and/or vasculitis.

The patients were assigned to one of three groups at a ratio of 1:1. The patient's assignment to each group was based on the tumor location and the size of suitable flap.

Group A (n = 10): Women who underwent LICAP flap.

Group B (n = 10): Women who underwent AICAP flap.

Group C (n = 10): Women who underwent TDAP flap.

Preoperative evaluations were performed for each patient. Demographic data collection included name, age, residence, marital status and occupation. In addition, a complete medical history was obtained including parity, menstrual history, contraceptive history, onset, lactation history, past history of breast cancer, breast or chest trauma, complaint, course and duration of the mass. A complete clinical examination was performed including general and local examination. Routine laboratory investigations were liver function test, complete blood count, kidney function test, coagulation profile, and random blood sugar. Imaging investigations included preoperative marking via Doppler, mammography, ultrasound, fine needle aspiration, bone scintigraphy, and chest X-ray. Breast volume assessment used the method with the preoperative mediolateral oblique to calculate the breast volume as an elliptical cone using the formula breast volume = $1/3\ \pi\ r^2\ h$ (10).

For lymph node surgery, which included dissection and/or sentinel node biopsy (SNB), The patient was positioned supine with the arm elevated to a 90-degree angle. The flap design was adjusted based on this positioning. It is important to highlight that we consistently employed the perforator that was closest to the anticipated defect. The introduction of the entire flap into the breast was facilitated by the meticulous and precise dissection of the perforator.

Surgical Technique

Axillary surgery was done through an axillary incision. The incision was deepened down till reaching the clavipectoral fascia, which was exposed and opened to enter the axillary space. Each patient underwent either axillary dissection or SNB in accordance with the preoperative decision. Axillary dissection was implemented in case of a positive SNB. Special attention was taken not to harm the thoracodorsal pedicle which should be spared. A single drain was left in the axilla if axillary dissection was performed. The standard quadrantectomy technique for tumor resection was done, the breast skin flap was created, and dissection continued overlying the whole tumor and the surrounding safety margin, the tumor was then, excised down to the pectoral fascia

with at least a 1-cm safety margin from all directions. 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 would be performed. The epidermis would be included in the removal of the tumour if it was located in close proximity.

AICAP Flap

To achieve precise anatomical marking, the patient was marked while standing. The infra-mammary fold (IMF) served as the alignment point for the upper edge of the flap, while a pinch test was used to determine the flap's width and establish its lower boundary. For defects located away from the medial side of the breast, the medial edge of the flap extended to the medial end of the IMF near the xiphoid bone. The lateral boundary was drawn between the front and back axillary lines, ensuring that the top and bottom lines met correctly to avoid creating "dog-ears" at closure. The perforator location was more accurately assessed on the OR table using a hand-held Doppler in both the sitting and supine positions, as their locations typically fluctuate with position changes. We estimated the flap size using the pinch test to assure the donor site's wound closure feasibility.

After skin incision, the dissection began from the lower most point of the flap and the dissection continued in a direction from inferior to superior including the underlying fascia of the abdominal wall muscles, guided intraoperative by hand held Doppler. We relocalized the perforators sites and ensured their integrity during dissection; usually we needed to skeletonized the perforators to ensure additional length of flap rotation. Following the flap's complete mobilization. The flap was rotated to cover the breast gap following tumor resection.

We selected the perforators that were closest to the defect. The perforator was meticulously dissected to ensure that the entire flap was inserted into the breast without any tension or deformation of the pedicle. No aggressive isolation or dissection of the perforators is needed if the flap attains sufficient mobility. Other perforators were sometimes sacrificed, especially if they were not related to the defect.

The skin that overlies the excised flap was de-epithelized and its vascularity was ensured. If the skin overlying was removed with the tumor, then a skin paddle would be marked and designed to match the defect size and the remaining flap would be de-epithelized. The entire flap was placed into the breast defect, and its edge was secured to the pectoral fascia using 2/0 Vicryl sutures. Typically, only one surgical drain was left in the breast area. The lower edge of the incision was then elevated and attached to the chest wall with interrupted 2/0 PDS sutures, while the IMF was marked to prevent downward scar migration and distortion. The incision was then closed in layers (Figure 1).

TDAP Flap

After standing with their arms at their sides and their palms rested on their midsection, the patient proceeded to construct the flaps. After asking each patient to actively tense their back muscles, a cutaneous trace was used to outline the Latissimus dorsi muscle contraction leading edge. A point 8 centimeters below the axillary crease was identified using this trace. The proximal perforator branch of the descending thoracodorsal artery penetrates the muscle at a location that is 8 centimeters or more from the axillary fold. The descending branch of the proximal perforator artery is located about 2 centimeters laterally from this trace. The muscle might not be penetrated by this direct cutaneous branch; but it might pass immediately anterior to the muscle's lateral border. Consequently, to guarantee this branch's position in the elevated flap, the flap's design must transcend the muscle's edge. The flap's breadth was determined by the potential for site closure of direct donor. The planned width was determined by pinching the skin and underlying subcutaneous tissue.

The perforators' location was identified through preoperative Doppler ultrasonography and subsequently verified intraoperatively with a hand-held Doppler. The latissimus dorsi fascia was examined and lifted from the distal end towards the proximal end. Meticulous observation of the perforator arteries was monitored by the hemorrhage quality which was continuously and progressively controlled from the end portion of the flap and by continuous reassessment of the perforator sites and status using intra operative handheld Doppler. The flap's blood supply was evaluated when it was halfway detached from the dorsal muscle to confirm that the perforator was sufficient (with a diameter greater than 0.5 mm) and that the perfusion was optimal. Conversely, if a substantial reduction in perfusion was observed following the section of the intercostal perforators and the partial elevation of the flap, we elected to postpone the procedure.

Identifying the lateral edge of the muscle was necessary because the descending branch of the thoracodorsal artery runs parallel to it, within 2 to 4 centimeters. Consequently, the proximal perforator was located at a similar distance from this edge. This level was located at the margin of the muscle in cases involving a direct cutaneous branch. An accompanying vein was also present in the proximal perforator artery. After the artery was identified, we conducted a thorough dissection of the epidermis surrounding the island. In order to free the muscle and allow the flap to spin along this axis, the minimal dissection around the perforating artery forms the "flap helix" (propeller).

LICAP Flap

The choice of flap was guided by factors such as breast size, defect location and size after tumor removal, and individual patient needs. Prior to surgery, patients were marked in both standing and lying positions. For effective reconstruction, accurate assessment of the tumor and resection area was essential. A pinch test was used to evaluate excess skin in the axilla and back. LTAP were located with a preoperative color Doppler ultrasound while the patient was in both supine and

Figure 1. Preoperative marking for AICAP flap for 41 years old female patient, upfront surgery for 4*3 cm mass occupying lower outer surface of rt breast with scattered microcalcification

AICAP: Anterior intercostal artery perforator

sitting positions. To ensure effective closure and accommodate the defect size, the flap was designed to include one or more perforators, with its width tailored to the defect and the need for discreet closure along the bra line. Patients were intubated and placed supine with both arms abducted. Harvesting of the LICAP flap was performed either in the supine or lateral position, starting from the distal tip. An incision was made at the superior edge of the skin using a #15 blade, and dissection proceeded to the chest wall. The lateral border of the latissimus was identified, and dissection continued above the muscle fascia from lateral to medial, followed by incision of the inferior edge of the skin. The fascio-cutaneous flaps were then carefully elevated off the chest wall in the suprafascial plane towards the anterior axillary line. Preservation of the 5th and 6th intercostal artery perforators, which are located within 6–8 cm of the anterior axillary line, was confirmed using an intraoperative handheld Doppler. After rotating the flap and verifying bright red bleeding from the edges, it was placed into the breast pocket and secured to the anterior chest wall with interrupted 3–0 Vicryl sutures. The flap was fully de-epithelialized, and both the breast and skin incisions were closed with interrupted dermal sutures and a running subcuticular stitch. To minimize the risk of re-excision, intraoperative frozen section analysis was performed. If needed, a tube drain was placed into the breast cavity to prevent seroma formation.

All patients were discharged on the first postoperative day, provided that no early complications, such as hematoma or skin flap necrosis were detected. Discharge instructions were explained to each patient and follow-up schedule for all patients was to review the patient through our multidisciplinary team. Any complications including wound dehiscence, infected hematoma, adherent scar or any distortion to the breast shape or major asymmetry or any postponement to the start of adjuvant radiation therapy, together with donor site complications were documented. The cosmetic results were evaluated by having the patient rate the surgery outcome in terms of breast symmetry, scarring, and overall satisfaction using the Harvard 4-point Likert scale, which includes the categories poor, fair, good, and excellent (11).

Five criteria were used for surgical assessment including breast symmetry, defects in breast tissue, position and deformity in NAC, scarring, and retraction. The drains were removed postoperatively when discharging less than 50 cc/24 hours. Patients were evaluated for the presence of postoperative complications in the outpatient clinic at one- and two-weeks post-surgery and adjuvant therapy was planned according to the multidisciplinary team decision (Figure 2).

Patient self-evaluation: Aesthetic status of patient related outcome PROM (breast Q) questionnaire was completed by all patients, after informed discussion and understanding of the following items. The final score was converted to a score out of 100 using the equivalent Rash transformed score table. The objective aesthetic assessment was conducted using frontal 2D digital photos that were captured by a single photographer using a 64-megapixel digital camera. The single light source was positioned at equal distances from both breasts, and a light-colored non-reflective background was used to prevent the use of flash and asymmetric illumination. The Conservative Treatment of Breast Cancer (BCCT) core software® was employed in a semi-automated way, which used for assessment of the aesthetic outcome and it is a good and reliable tool to measure objective asymmetries, and was also complemented by physicians' assessment and patients' self-assessment (12).

Outcomes

The study outcomes included evaluation the cosmetic outcome using three fasciocutaneous flaps, the LICAP, AICAP and TDAP flap as a method for volume replacement in patients who underwent breast cancer surgery. All enrolled patients were subjected to the following different assessment methods in the outpatient clinic after 2–3 months postoperative before starting radiotherapy. The secondary outcomes included were: Handheld Doppler advantages in detection of perforators location and for follow-up; comparing the accuracy of the preoperative radiological perforator mapping with the intraoperative findings; and expanding the volume of choices for the volume replacement options and to avoid the morbidities that occur secondary to use of myocutanous flaps for volume replacement (Figures 3-5).

Statistical Analysis

Statistical analysis was performed with SPSS version 26 (IBM Inc., Armonk, NY, USA). To compare quantitative variables between the three treatment groups, we used pairwise comparison with the ANOVA (F) test, reporting results as means and standard deviations. For qualitative variables, the chi-square test was employed, with results expressed as frequencies and percentages (%). A two-tailed p value <0.05 was deemed to indicate "statistical significance".

Figure 2. Preoperative marking for LICAP flap for upper outer quadrant multifocal breast mass

LICAP: Lateral intercostal artery perforator

Figure 3. Postoperative results of AICAP flap with good cosmetic outcome and symmetry

AICAP: Anterior intercostal artery perforator

Results

Out of the 59 patients initially assessed for eligibility in this study, 18 did not fulfill the inclusion criteria, and 11 declined to participate. The remaining 30 patients were randomly assigned to three groups, each consisting of ten patients. Statistical analysis and follow-up were carried out for all patients who were allocated to the study groups (Figure 1).

The baseline characteristics and comorbidities of the analyzed groups, such as weight, age, height, and body mass index (BMI), as well as associated conditions such as hypertension and diabetes mellitus, were not different (Table 1). Table 2 shows that the cup size, tumor size, TNM staging (T/N), pathological findings, luminal classification, and ptosis degree were insignificantly different among the studied groups. Regarding the tumor location, all patients in LICAP group had tumors in the LOQ, in AICAP group; 5 (50%) patients had tumor in the UOQ, and 5 (50%) patients had tumor in the LIQ, an all patients in TDAP group had tumor in the UOQ.

For outcomes, 1 (10%) patient in LIICAP group, 3 (30%) patients in AICAP group and 2 (20%) patients in TDAP group received neoadjuvant chemotherapy, with no significant difference within the groups that were examined. The operative time was insignificantly different between the studied groups. The operative time was calculated starting from skin incision to skin closure including the time of waiting for the frozen section result (Table 3).

Table 4 shows that regarding postoperative complications, wound infection took place in only one (10%) patient in LICAP group and one (10%) patient in the AICAP group; seroma occurred in only one (10%) patient in LICAP group and one (10%) patient in the TDAP group; and fat necrosis occurred in only one (10%) patient in the TDAP group. Incidence of wound infection, seroma, and fat necrosis was insignificantly different among the studied groups. Breast distortion occurred in one (10%) patient in the AICAP group and not observed in the other groups, and partial flap necrosis occurred in one (10%) patient in the LICAP group and one (10%) patient in the AICAP group and was not observed in the TDAP group. Incidence of distortion and partial flap necrosis were insignificantly different between the studied groups.

The BCCT core results, surgeon's assessment, patient's satisfaction and breast Q scores did not differ between the three groups (Table 5 and Figure 2).

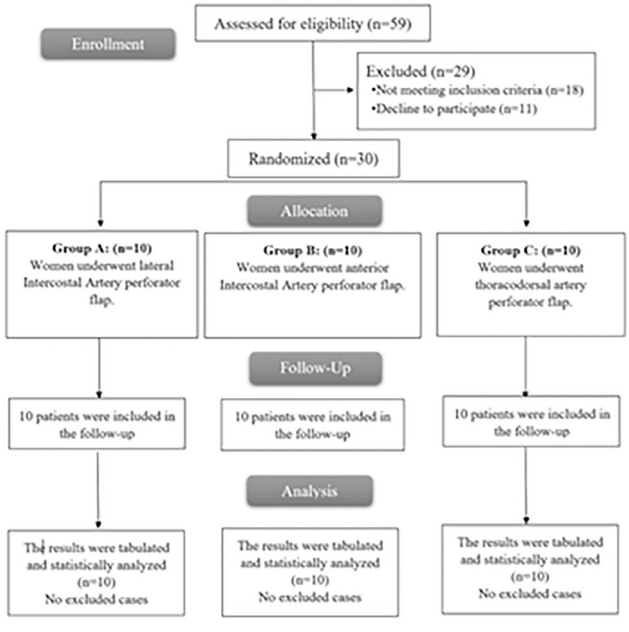

Figure 4. CONSORT flowchart of the enrolled patients

Figure 5. (A): Female patient 46 years old with grade 2 breast ptosis presented with luminal A RT breast UOQ cT2 N0 invasive duct carcinoma with extensive microcalcifications occupying the whole UOQ reaching the retro areolar area. She underwent a very wide local excision with negative margins and immediate reconstruction using a LICAP flap with good cosmetic outcome, (B): Female patient 52 years old female with grade 3 breast ptosis presented with cT3 N0 TNBC RT UOQ invasive duct carcinoma, with extensive microcalcifications affecting the whole outer half of the breast parenchyma, underwent neo adjuvant chemotherapy followed by upper outer and lower outer quadrantectomy with immediate reconstruction using advancement pedicled TDAP flap with poor cosmetic outcome with major breast distortion and asymmetry most probably due to marked breast ptosis with short pedicle arc of rotation, (C): Female patient 37 years old with grade 1 breast ptosis, presented with cT2 N0 RT 6 o'clock luminal A invasive breast carcinoma with close proximity to the overlying skin, underwent upfront wide local excision with immediate reconstruction using AICAP flap with excellent cosmetic outcome, (D): Female patient 65 years old with grade 3 breast ptosis underwent LICAP flap immediate reconstruction with excellent cosmetic outcome, (E): The scar at the donor site after a LICAP flap

UOQ: Upper outer quadrant; LICAP: Lateral intercostal artery perforator; TDAP: Thoracodorsal artery perforator; TNBC: Triple negative; AICAP: Anterior intercostal artery perforator

Table 1. Demographic characteristics and comorbidities among the studied group

	LICAP (*n* = 10) Mean ± SD	AICAP (*n* = 10)	TDAP (*n* = 10)	*p* value
Age (years)	43.8±5.2	39.2±9.57	44.8±6.88	0.218
Weight (kg)	79.7±8.65	81.1±5.84	78.7±6.09	0.744
Height (m)	1.68±0.01	1.66±0.05	1.64±0.07	0.221
BMI (kg/m²)	28.1±3.18	29.5±2.91	29.2±2.8	0.530
HTN	3 (30%)	1 (10%)	5 (50%)	0.149
DM	2 (20%)	3 (30%)	4 (40%)	0.621

Data presented as number (%) or mean ± SD. DM: Diabetes mellitus; BMI: Body mass index; HTN: Hypertension; AICAP: Anterior intercostal artery perforator; LICAP: Lateral intercostal artery perforator; TDAP: Thoracodorsal artery perforator; SD: Standard deviation

Table 2. Pre-operative assessment in the three studied group

		LICAP (*n* = 10)	AICAP (*n* = 10)	TDAP (*n* = 10)	*p* value
Cup size	**B**	6 (60%)	2 (20%)	4 (40%)	0.189
	C	4 (40%)	8 (80%)	6 (60%)	
Tumor size (cm)		2.7±0.63	2.4±0.28	2.7±1.35	0.676
TNM staging					
T1		3 (30%)	4 (40%)	3 (30%)	0.861
T2		7 (70%)	6 (60%)	7 (70%)	
N0		2 (20%)	3 (30%)	4 (40%)	0.621
N1		8 (80%)	7 (70%)	6 (60%)	
Tumor location					
LOQ		10 (100%)	0 (0%)	0 (0%)	-
UOQ		0 (0%)	5 (50%)	10 (100%)	-
LIQ		0 (0%)	5 (50%)	0 (0%)	-
Pathology of tumor					
DCIS		0 (0%)	2 (20%)	1 (10%)	0.338
IDC		10 (100%)	7 (70%)	9 (90%)	
ILC		0 (0%)	1 (10%)	0 (0%)	
Luminal classification					
Luminal A		5 (50%)	6 (60%)	4 (40%)	0.974
Luminal B1		1 (10%)	2 (20%)	2 (20%)	
Luminal B2		1 (10%)	1 (10%)	1 (10%)	
TNBC		1 (10%)	0	1 (10%)	
HER2/neu enriched		1 (10%)	1 (10%)	2 (20%)	
Ptosis degree		5.5±2.8	6.4±0.97	4.3±2.67	0.142

Data presented as number (%) or mean ± SD *: statistically significant as *p* value <0.05, LOQ: Lower outer quadrant; UOQ: Upper outer quadrant; LIQ: Lower internal quadrant; DCIS: Ductal carcinoma *in situ;* IDC: Invasive ductal carcinoma; ILC: Invasive lobular carcinoma; TNBC: Triple negative; AICAP: Anterior intercostal artery perforator; TDAP: Thoracodorsal artery perforator; LIICAP: Lateral intercostal artery perforator; SD: Standard deviation; HER2: Human epidermal growth factor receptor 2

Table 3. Outcome and operative time among studied groups

	LICAP (*n* = 10)	AICAP (*n* = 10)	TDAP (*n* = 10)	*p* value
Neoadjuvant chemotherapy	1 (10%)	3 (30%)	2 (20%)	0.535
Operative time (min)	134.4±11.8	133.1±11.5	131.4±11.5	0.846

Data presented as number (%) or mean ± SD *: Statistically significant as *p* value <0.05; SD: Standard deviation

Table 4. Postoperative complications and incidence of distortion among studied groups

	LICAP (*n* = 10)	AICAP (*n* = 10)	TDAP (*n* = 10)	*p* value
Wound infection	1 (10%)	1 (10%)	0 (0%)	0.585
Seroma	1 (10%)	0 (0%)	1 (10%)	0.585
Fat necrosis	0 (0%)	0 (0%)	1 (10%)	0.355
Incidence of distortion				
Distortion	0 (0%)	1 (10%)	0 (0%)	0.355
Partial flap necrosis	1 (10%)	1 (10%)	0 (0%)	0.585

Data presented as number (%), *: Statistically significant as *p* value <0.05; AICAP: Anterior intercostal artery perforator; LIICAP: Lateral intercostal artery perforator; TDAP: Thoracodorsal artery perforator

Table 5. BCCT core, surgeon assessment and patient satisfaction among studied groups

	LICAP (*n* = 10)	AICAP (*n* = 10)	TDAP (*n* = 10)	*p* value
BCCT core				
Excellent	4 (40%)	3 (30%)	4 (40%)	
Good	5 (50%)	3 (30%)	3 (30%)	0.608
Fair	1 (10%)	3 (30%)	1 (10%)	
Poor	0 (0%)	1 (10%)	2 (20%)	
Surgeon assessment				
Excellent	8 (80%)	8 (80%)	7 (70%)	0.830
Good	2 (20%)	2 (20%)	3 (30%)	
Patient satisfaction				
Excellent	8 (80%)	9 (90%)	8 (80%)	0.786
Good	2 (20%)	1 (10%)	2 (20%)	
Breast Q score	83.1±7.13	85.4±9.14	82.5±9.16	0.727

Data presented as mean ± SD or number (%); TDAP: Thoracodorsal artery perforator; AICAP: Anterior intercostal artery perforator; LIICAP: Lateral intercostal artery perforator; SD: Standard deviation

Discussion and Conclusion

BCS has become the standard approach for managing early-stage breast cancer, aiming to achieve oncologic safety while preserving breast aesthetics. However, excision of tumors in the lower and lateral breast quadrants often results in significant volume deficits, leading to contour deformities and asymmetry (13).

Immediate oncoplastic reconstruction plays an important role in addressing these concerns by restoring breast shape and maintaining cosmetic outcomes. Perforator fasciocutaneous flaps have emerged as reliable options for immediate breast reconstruction following BCS. These flaps provide well-vascularized tissue with minimal donor site morbidity while preserving muscle integrity (14). This study aimed to evaluate the cosmetic outcome and the oncological safety of three techniques (AICAP, LICAP, and TDAP flaps) as a volume replacement technique to eliminate deformity and preserve breast cosmesis by filling the excised defect.

The baseline characteristics and comorbidities of the three analyzed groups, did not differ. Similarly, Hashem et al. (14) who also compared LICAP and TDAP flaps in reconstructing partial breast defects found no statistically significant difference between studied groups regarding age and BMI as well as the prevalence of comorbidities. Awin et al. (15) evaluated the use of ICAP flaps versus LTAP flaps in partial breast reconstruction. These authors reported that the average age was 40.60±8.62 versus 43.07±8.01 years, and the average BMI was

32.19±6.80 versus 33.74±4.60 kg/m^2 for the ICAPs versus LTAP groups, respectively and again these demographics and the prevalence of comorbidities did not differ between the two study groups.

Regarding pre-operative assessment, the cup size, tumor size, TNM staging, pathological findings, luminal classification, and ptosis degree were insignificantly different among the studied groups.

Our results are consistent with Awin et al. (15) who reported that most of the tumors were located in the UOQ in both the ICAP and LTAP groups in their study. However, lesions in the LOQ were present exclusively in the ICAP group, while lesions in the UIQ were present exclusively in the LTAP group, without statistically significant difference.

In terms of tumor characteristics in the present study, there was no statistically significant difference between AICAP and LICAP groups as regard tumor sizes and TNM staging. Similarly, the study by Hashem et al. (14) demonstrated that there was no significant difference between studied groups in terms of TNM staging and tumour size. Zeeshan et al. (8) reported that eight patients underwent a LICAP flap for LOQ tumors (n = 5) and UOQ tumors (n = 3) cases, seven AICAP flaps were done, all for LIQ tumors and 10 LTAP flaps were performed for seven tumors in the UOQ and three tumors at 12 o'clock locations.

Furthermore, Agrawal et al. (16) reported that the LTAP flap was used in 23 patients (57.5%), AICAP in 4 patients (10%), and LICAP in 2 patients (5%), while 11 patients (27.5%) received a combination of LTAP and LICAP. AICAP was used for medial quadrant defects (4/40), whereas lateral quadrant defects (33/40) were reconstructed with LICAP, LTAP, or both.

The operative time was insignificantly different between the three studied groups in the present study. The mean operative time (min) was 134.4±11.8, 133.1±11.5, and 131.4±11.5 in LICAP, AICAP, and TDAP groups respectively. Our operative time results are in concordance with Hashem et al. (14) who demonstrated that there was no significant difference between TDAP and LICAP groups as regard operative time. Mohsen et al. (17) who evaluated the utility of AICAP in immediate reconstruction following BCS in 20 patients with small to medium-sized breasts. The mean operative time of the procedure was 130 minutes and ranged between 122–148 minutes, while the mean reconstruction time was 35 minutes and ranged from 22–40 minutes.

In contrast, Hamdi et al. (9) assessed the versatility of ICAP flaps. There were two DICAP flaps, two AICAP flaps and 16 LICAP flaps. All but two flaps were based on one perforator. Bilateral breast augmentation with LICAP flap necessitated longer operative time of two to three hours (120–180 minutes) depending whether it was combined with or without mastopexy.

All postoperative complications (wound infection, seroma and fat necrosis) affected only one patient (10%) in each group, if they occurred at all. The incidence of wound infection, seroma, or fat necrosis was insignificantly different among the studied groups. Distortion occurred in one (10%) patient in the AICAP group and was not observed in the other groups, and partial flap necrosis occurred in 1 (10%) patient in LICAP group and 1 (10%) patient in AICAP group and was not observed in TDAP group. Incidence of distortion and partial flap necrosis were insignificantly different among the studied groups. Hashem et al. (14) reported that complications occurred in 8 (17.4%) in the TDAP group while the complication rate was 11% in the LICAP group. There was no statistically significant difference between TDAP and LICAP groups as regard postoperative complications including wound infection, hematoma, seroma and fat necrosis. However, Mohsen et al. (17) reported that the postoperative complications were observed in only one patient (5%) in the form of mild wound infection.

Furthermore, Awin et al. (15) also reported that complications were infrequent, with seroma and wound dehiscence each occurring in five cases across both groups, showing no significant difference. Traumatic fat necrosis was observed in four cases, while flap retraction, partial flap necrosis, and hematoma each occurred in one patient.

In the present study, the secondary outcomes BCCT core results, surgeon's assessment, patient's satisfaction and breast Q score did not differ between the studied groups. This is in agreement with Zeeshan et al. (8) who reported that median postoperative patient satisfaction was 100 (41). They found high satisfaction with breasts and comparable physical well-being among Pakistani women after LPF in oncoplastic breast-conserving surgeries. Hashem et al. (14) demonstrated that cosmetic outcome in the TDAP group as evaluated by the BCCT core software showed 11% (5 cases) to have excellent, 59% (27) good, 28% (13) fair and 2% (1) with poor result. The LICAP group on the other hand had 22% excellent (8 cases), 51% (19) good and 27% (10) fair cosmetic result, although these BCCT ratings did not differ between the TDAP and LICAP groups in their study. Carrasco-López et al. (18) reported that the AICAP technique did not appear to negatively affect patient satisfaction with treatment outcomes. They used the breast Q scores which is a patient-reported outcome measure (PROM) designed specifically to measure patient satisfaction and quality of life in breast cancer patients, and has been widely adopted worldwide as the gold-standard PROM following breast surgery. The scales used in their study were satisfaction with breast that addresses issues such as satisfaction with breast shape, symmetry, feel to the touch, and appearance clothed or unclothed; satisfaction outcomes: Feelings about the breast; psychosocial well-being; sexual well-being that addresses the impact of a woman's breast condition and surgery on her sex life; and physical well-being on how often women experience pain or discomfort in the breast area and upper body. A Q score was obtained for all most the domains and converted to a 0–100 scale. They found that the mean BREAST-Q scores changes were 0 in satisfaction with the breast, 5 in satisfaction with outcome, 0 in psychosocial well-being, 6.15 in sexual well-being, and 34.69 in physical well-being. Awin et al. (15) also reported that most of the cases were very satisfied in (n = 19, 95.0%) versus (n = 12, 85.7%) for the ICAP versus the LTAP flaps respectively, again with no significant difference between the groups (p = 0.455).

Study Limitations

The main limitations of the present study were the small group sizes and the difference between the preoperative duplex marking of the perforators and the intraoperative findings though the perforators have almost fixed sites. Further multicenter studies with larger cohorts and longer follow-up are needed to validate the findings.

The perforator fasciocutaneous flaps, LICAP, AICAP, and TDAP, were effective and safe options for immediate breast reconstruction after BCS. All three techniques showed similar surgical outcomes, low complication rates, and good aesthetic results. Patient satisfaction was high, with no significant differences between the groups. Further

studies with larger sample sizes and longer follow-up are needed to confirm these findings and improve patient selection.

Ethics

Ethics Committee Approval: The study was conducted from October 2023 to March 2024 and received approval from the Research Ethics Committee of the Faculty of Medicine, Cairo University, approval code MS-500-2023, date 04.04.2024.

Informed Consent: Patients gave their informed consent before taking part in the study.

Footnotes

Authorship Contributions

Surgical and Medical Practices: M.A.M.A.E.M., I.A.S., S.H.H.A., M.M.A.; Concept: M.A.M.A.E.M., I.A.S., S.H.H.A., M.M.A.; Design: I.A.S., M.M.A.; Data Collection or Processing: M.A.M.A.E.M., S.H.H.A., M.M.A.; Analysis or Interpretation: I.A.S., S.H.H.A., M.M.A.; Literature Search: M.A.M.A.E.M., I.A.S.; Writing: I.A.S., S.H.H.A., M.M.A.

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