Anterior intercostal artery perforator flap as a method of reconstruction of lower pole defects in patients with breast cancer: Ain Shams University Hospital experience

Omar Z.A. Elmouty Mohammed, Osama A.A. Atrash, Ahmed G.E.-D. Othman, Amiera Maher Reyad Mohamed, Abdallah Hamed

Department of General Surgery, Faculty of Medicine, Ain Shams University, Cairo, Egypt

Correspondence to Omar Z.A. Elmouty Mohammed, M.B.B.CH., MS in General Surgery Faculty of Medicine, Ain Shams University. Tel: 01092370427, 0227624089; e-mail: elahy_raby@yahoo.com

Received: 30 August 2022
Revised: 06 September 2022
Accepted: 26 September 2022
Published: 05 April 2023

The Egyptian Journal of Surgery 2023, 41:1386–1394

Background
Surgical management of breast cancer has shown considerable evolution in the past few decades. Conservative breast surgery has become an accepted option to radical procedures as a consequence of its equivalent overall survival rate with a better quality of life. The use of Doppler for perforator vessel localization allows the use of anterior intercostal perforator (AICAP) flap as a volume-replacement option in breast-conserving surgery in small-sized and medium-sized breasts for lower pole lesions.
Aim
To evaluate the feasibility and outcome of AICAP flap as a volume-replacement technique in breast-conservative surgery in Egypt.
Patients and methods
This was a prospective study carried out at Ain Shams University hospitals that included 40 patients with early-stage breast cancers who underwent breast-conservative mastectomies between November 2018 and November 2021.
Results
The mean operative time was 64 min. Overall, two cases with complications were reported with fat necrosis and mild wound infection, which were managed conservatively. No flap loss occurred, and all patients were satisfied with the cosmetic outcome.
Conclusion
The AICAP flap is a safe and cost-effective method as a volume-replacement breast conservative surgery with excellent outcomes for small-sized and medium-sized beast, with a large-volume resection giving high satisfaction rate and minimal morbidity, and it is an acceptable option for lower pole breast lesion in a large breast size if the patient refuses reduction and contralateral symmetrization.

Keywords:
anterior intercostal perforator flap, breast-conservative surgery, oncoplastic surgery, volume-replacement breast surgery

Egyptian J Surgery 2023, 41:1386–1394

1110-1121

Introduction

Decision making in surgical oncology of the breast has increased in complexity over the past 20 years. There are a lot of techniques for breast reshaping, multiple reconstructive options, and different lines of systemic therapy, which mandate a multidisciplinary care approach before planning for surgery [1].

The decision-making pathway includes the assessment of patients' characteristics, disease characteristics, and social and economic issues [1].

Breast-conserving therapy is an acceptable option in the local control of breast cancer [2] as a consequence of its equivalent overall survival (OS) rate and breast preservation [3].

NSABP B-06 trial showed equivalent disease-free survival and OS among women who underwent a partial mastectomy with radiation compared with radical mastectomy [4]. Recently, increasing attention has been focused on conservative breast surgery reconstructive techniques [5].

The oncoplastic surgery has brought new dimensions to breast-conserving surgery and included the esthetic principles of breast surgery to cancer management [6]. Among the technical options, volume-displacement and volume-replacement techniques are the most commonly used procedures [7]. Regardless of the fact that there is no consensus concerning the best approach, the decision is determined by the surgeon's

experience and the size of the defect in relation to the size of the remaining breast tissue [8].

Earlier when mastectomy was the main surgical option, it made sense to look for flaps with large volumes of tissue and muscle bulk such as the TRAM or the extended LD flaps. The harvest of these flaps often causes significant morbidities such as the abdominal wall weakness, hernia, and the seroma in the back.

Nowadays, the breast surgeon is more than often faced with smaller defects, for which such bulky flaps offer a surplus of tissue with unacceptable morbidities compared with the smaller defects these flaps have to reconstruct. Improvements in our knowledge of the vascular anatomy have enabled the design of a new type of fasciocutaneous flaps, which are based on perforating vessels only [9]. Thus, donor-site morbidity is markedly reduced.

Koshima and Soeda [10] introduced the concept of 'perforator flaps' in 1989, when they reported the use of a flap consisting of paraumbilical skin and fat based on a muscular perforator to reconstruct defects in the groin and the tongue.

In terms of esthetic results and surgical morbidity, volume-replacement techniques have positive and negative aspects. These procedures can maintain the volume/shape of the breast and avoid contralateral breast surgery [8].

However, volume-replacement techniques can be more complex procedures and sometimes are associated with donor site and flap morbidity [11].

The introduction of perforator flaps in total breast reconstruction has enabled surgeons to spare muscle function and reduce the surgical morbidity [11].

Intercostal artery perforator flaps, in fact, have already been presented for chest and trunk oncologic reconstruction [12], but until now, few authors have mentioned their use to repair immediate or delayed breast defects following breast cancer conservative surgery [12].

On the contrary, both anterior and lateral intercostal artery perforator flaps can easily reach the breast, with a good match in terms of skin texture, as well as provide a small amount of subcutaneous tissue. In particular, the anterior intercostal artery perforator (AICAP) flap, supplied by a greater number of perforators, offers superior mobility compared with the lateral intercostal artery perforator flap and may be successfully used for reconstruction of the lower and medial breast quadrants [13].

Aim

The aim of this study was to evaluate the feasibility and outcome of AICAP flap as a volume-replacement technique in breast-conservative surgery in Egyptian patients with a lower pole breast lesion.

Patients and methods

This is a prospective study carried out in Ain Shams University hospitals, including 40 patients diagnosed with breast cancers who were offered breast-conservative surgery with breast volume reconstruction using AICAP flap between November 2018 and November 2021.

Inclusion criteria

The following were the inclusion criteria:

(1) Pathologically proven breast cancer cases of stages I–II located at the lower half of the breast that were candidates for conservative breast surgery and the patient refused reduction of the breast.
(2) Patients with breast cancer with unfavorable breast/tumor ratio after neoadjuvant chemotherapy.
(3) Patients requiring skin excision owing to close or attached tumors to the skin.

Exclusion criteria:

The following were the exclusion criteria:

(1) Old age more than 60 years.
(2) Medical comorbidities (atherosclerosis, diabetes mellitus, and severe cardiac disease).
(3) Smoker.
(4) Skinny patients.

Informed consent process

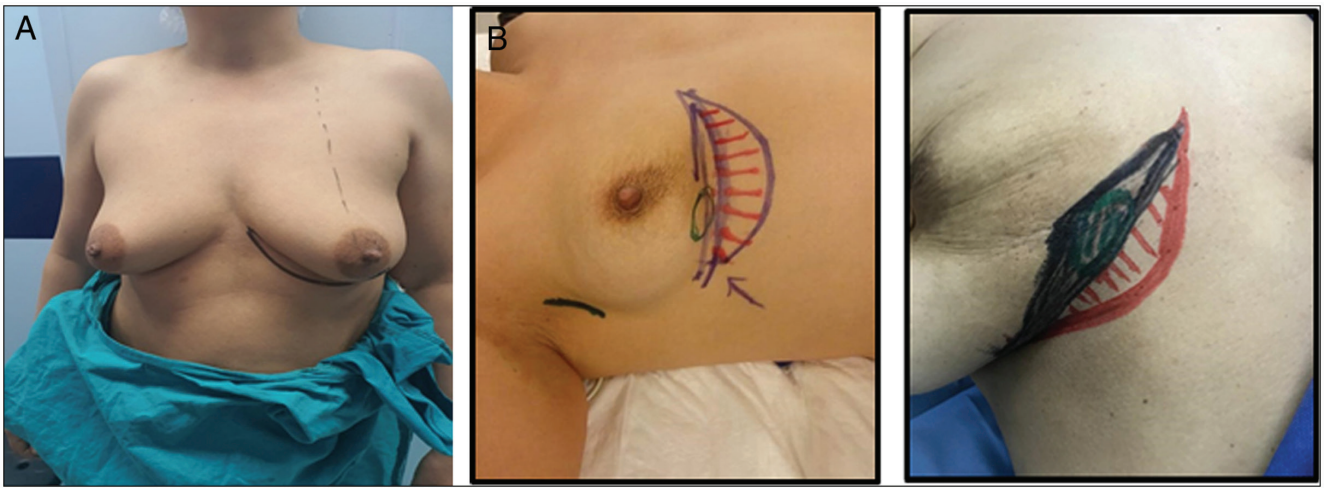
An informed consent was obtained from all participants for the surgical procedure performed. All patients participating in the study received a detailed explanation of the purpose, methods, and the value of the study. They were counseled about the procedure, its possible sequelae, and its complications. Ethical approval was obtained from the institutional research and ethics committee at Ain Shams University.

Preoperative

All patients included in the study were subjected to the following:

(1) Clinical assessment at the breast clinic with careful history taking, general condition assessment, and local breast examination.

Figure 1



Preoperative drawings (a) at standing position and (b) at supine position.

(2) Investigations (radiological and pathological):
   (a) Routine preoperative investigations.
   (b) Sonomammography or MRI.
   (c) True-cut needle biopsy under ultrasound guidance.
(3) Metastatic workup was done according to case-by-case characteristics based on NCCN guidelines.

All of the included cases were discussed at the multidisciplinary meeting with the attendance of breast oncologist, breast surgeon, radiologist, and pathologist on a weekly meeting for proper consultation about the management of patients.

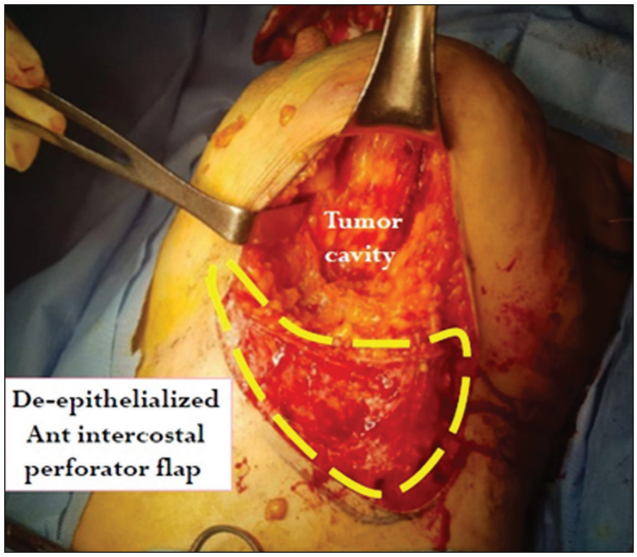
Operative procedure

Duplex ultrasound was used to ensure the existence of a proper perforator on the day of surgery or the day before as scheduled with the Radiology Department with preliminary marking of the site of perforators.

Patient marking and drawing

(1) Marking of the inframammary crease was done while the patient was standing.
(2) The tumor site and expected resection volume were marked while the patient was in a supine position, and the AICAP flap was marked as well (Fig. 1).
(3) Hand-held Acoustic Doppler assessment was performed to reconfirm the presence of adequate perforator vessels along the inframammary fold, which were then marked. The dimensions of the flap are determined by the volume of breast tissue resection as well as soft tissue availability and laxity.
(4) The patient was positioned for surgery in the supine position, with the arm raised to allow for lymph node dissection and/or sentinel node biopsy.

Figure 2



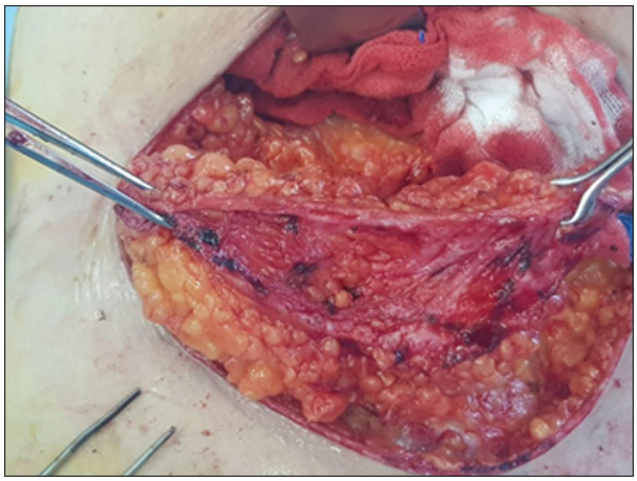
WLE of the tumor was done, and flap de-epithelialization was done.

(5) We registered the following variables: breast size, tumor size, location, and the flap size.
(6) After anesthesia and sterilization of the skin, an incision was made along the inframammary fold. WLE of the tumor was done (Fig. 2).
(7) Stitches were used for orientation of the specimen margins and sent for frozen section to ensure the surgical margins were free and to determine if re-excision was needed.
(8) Following the excision, the cavity was clipped with surgical clips in the tumor bed for radiotherapy planning.
(9) A thin strip of skin showing the marked perforators in the inframammary fold was de-epithelialized. A croissant-shaped flap of adipofascial tissue, attached to the marked perforators, was separated

from the underlying tissue medial and lateral to the marked perforators (Figs 2 and 3).

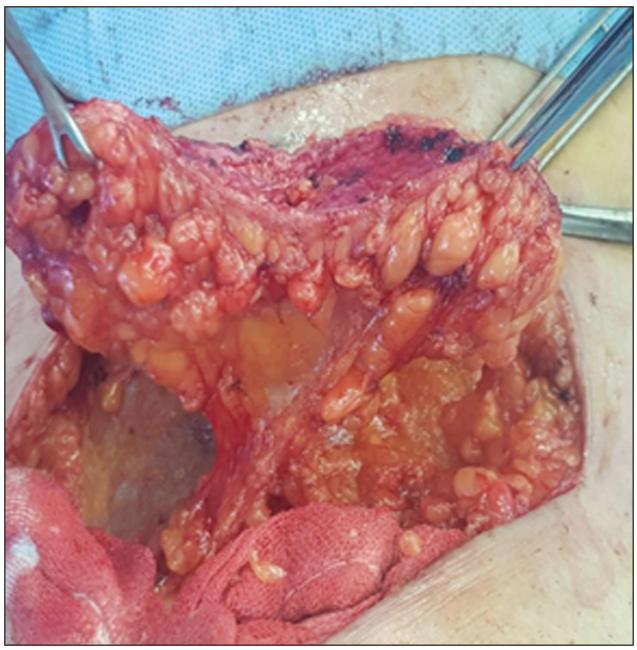
(10) The intraoperative vascularity of the flap was generally assessed by its color and adequate bleeding from the flap periphery. Often, the perforators could be visualized at the level of the inframammary fold.
(11) The flap was then flipped superiorly to fill the inferior pole breast cavity.
(12) The flap was then secured using two anchoring sutures to the breast tissue (Figs 4 and 5).
(13) A suction drain was placed at the donor site and was removed when its outcome was less than 50 ml per day.
(14) The mean operative time was recorded.

Figure 3



A croissant-shaped flap of adipofascial tissue separated from underlying tissue medial and lateral to the perforates.

Figure 4



The perforators visualized at the level of the inframammary fold.

Follow-up

All patients were followed up clinically for cosmetic outcome and patient satisfaction, and MDM opinion was assessed by grading Likert scale from very poor to excellent. Any flap complications for a period of 6 months postoperatively, including seroma, wound infection, hematoma, flap congestion, fat necrosis, or any flap loss, were recorded. Assessment of local recurrence in 6 months up to 1 year in some patients was done.

Results

A total of 40 patients were included in this study undergoing BCS with AICAP flap. The mean age was 46.70 years, and the mean BMI for the included patients was 32.18 ± 2.95 (Table 1).

Most of our cases were presented with left-sided breast cancer, staged T2N0. A total of 15 cases received

Figure 5

The flap was then flipped and secured using two anchoring sutures to the breast tissue.

Table 1 Data and history of the studied patients

	N=40 [*n* (%)]
Age	
Mean±SD	46.70 ± 7.64
Range	32–60
FH	
No	36 (90.0)
Yes	4 (10.0)
BMI	
Mean±SD	32.18 ± 2.95
Range	28–43
Medical history	
Free medical	31 (77.5)
HTN	9 (22.5)

neoadjuvant chemotherapy either for downgrading the size of the mass or for positive LN.

Most of the cases were found to have a single tumor (77.5%), and ~22.5% were diagnosed with multifocal breast cancer, which may need a wider volume excision.

The included cases' breast size was cup B in 25 (62.5%) cases and cup C in 13 (32.5%) cases.

All cases underwent sonomammography, and 17 of our cases were recommended to perform MRI for either dense breast or multicentric tumor (Table 2).

A total of 13 (32.5%) patients underwent axillary clearance, whereas most of the cases underwent SLN (62.5%), and only two cases underwent targeted axillary dissection as the LN status was positive before neoadjuvant (Table 3).

The ICAP technique was done by an oncoplastic trained surgeon with mean operative time of 64.30 ± 4.80, which was better than other perforator flaps and myocutaneous flaps. Most of the patients were discharged after 1 day only (82.5%) (Table 4).

All patients were assessed regarding cosmetic outcome on a grading scale ranging from very poor to excellent (subjective) based on patients'opinion and breast MDT opinion not including any flap complications for a period of 6 months postoperatively.

Patient opinion ranged from fair to excellent as seen in the previous table, with 82.5% showing excellent results.

MDT cosmetic outcome assessment was done regarding the contralateral symmetrization and the preservation of the IMF, reporting excellent results in 80% of cases (Fig. 6 and Table 5).

All of the included patients were kept on follow-up of about 11.43 ± 3.28 months to assess possible complications such as fat necrosis, which was seen in two (5%) cases only, associated with infection, which was managed conservatively with intravenous antibiotics (Table 6).

The relation between cosmetic outcome assessed by the patients and the MDT members regarding tumor size, number, cup size, BMI, and flap dimension was investigated; however, there was no statistically significant difference (P>0.05), as detailed in Tables 7 and 8.

Table 2 Clinical data of the studied patients

	n (%)
Clinical examination	
Laterality	
Right	15 (37.5)
Left	25 (62.5)
Size	
T1	11 (27.5)
T2	20 (50.0)
T3	9 (22.5)
Number	
Single	31 (77.5)
Multifocal	9 (22.5)
Cup size	
B	25 (62.5)
C	13 (32.5)
D	2 (5.0)
LN	
N0	25 (62.5)
N1	11 (27.5)
N2	4 (10.0)
Radiology	
Sonomammography	
No	0
Yes	40 (100.0)
MRI	
No	23 (57.5)
Yes	17 (42.5)
Histopathological examination	
IDC	36 (90.0)
ILC	2 (5.0)
IDCIS with microinvasion	2 (5.0)

Table 3 Axillary management and flap dimension of the studied patients

	N=40 [*n* (%)]
Axillary management	
Axillary clearance	13 (32.5)
SLN	25 (62.5)
Targeted axillary's LN	2 (5.0)
Flap dimension (L)	
Mean±SD	10.69 ± 1.19
Range	9–13
Flap dimension (T)	
Mean±SD	5.40 ± 0.47
Range	4.5–6

Table 4 Operative time and Hospital stay of the studied patients

	N=40 [*n* (%)]
Operative time	
Mean±SD	64.30 ± 4.80
Range	55–75
Hospital stay	
1 Days	33 (82.5)
2 Days	7 (17.5)

Figure 6

Pre (left) and post (right) operative photography was taken for assessment of cosmetic outcome.

Table 5 Cosmetic outcome according to patients and MDT of the studied patients

Cosmetic outcome	*n* (%)
Patient	
Fair	2 (5.0)
Good	5 (12.5)
Excellent	33 (82.5)
MDT	
Fair	2 (5.0)
Good	6 (15.0)
Excellent	32 (80.0)

Table 6 Follow-up and postoperative complications of the studied patients

Follow-up	Mean±SD	11.43±3.28
	Range	6–20
Complications	*n* (%)	
Infection		
No	38 (95.0)	
Yes	2 (5.0)	
Fat necrosis		
No	38 (95.0)	
Yes	2 (5.0)	

Discussion

There have been various algorithms reported in the literature to decide the best technique of partial breast reconstruction based primarily on the volume of excision, breast size, and ptosis [14,15].

Inferior pole breast defects have traditionally represented a significant surgical challenge, as obtaining adequate tumor clearance risks compromising acceptable cosmoses. Volume-displacement techniques such as vertical T-scar mammoplasty have been previously used to correct defects in patients with inferior pole breast tumors, with reported tumor clearance rates of up to 90%. Although this approach enables resection of larger tissue volumes, it is limited to patients with a larger breast size (i.e. D-cup and above), and contralateral symmetrizing surgery is often required [16,17].

In our country, we follow different cultural thought and rules; the majority of patients tend to refuse any surgical intervention in the healthy contralateral breast seeking breast symmetrization in case of the use of mammoplasty reducing technique in the diseased side. This was reported in two cases in our study with cup D breast size, where it was feasible to use superior pedicle reduction mammoplasty technique removing the tumor with safety margin with contralateral symmetrization, but regarding patients wish, AICAP was the technique of choice for those patients without touching the healthy breast.

The majority of the cases included in our study were cup B (62.5%) and cup C (32.5%), and ~22.5% were presented with multifocal disease, which mandates larger resection volume. Implant-based reconstruction with subcutaneous mastectomy in this situation can provide us with both oncological safety and good cosmoses, but the main issue we faced in those patients was financial and traditional problems, so the autologous reconstruction provided them a reasonable substitution.

A lot of factors affect the decision making in breast cancer management nowadays. We have to put in mind the racial differences that are obvious in breast size, tumor behavior, and prognosis. Culture and awareness of the patients may interfere with our decision, which is why we have to tailor the management case by case.

A good benefit of the AICAP flap procedure is that it enables resection of relatively large volumes of breast tissue from the inferior pole without compromising cosmoses. Furthermore, the incision is well concealed in the inframammary fold, contributing to a satisfactory cosmetic outcome [18].

Hamdi and colleagues have reported extensively on ICAP flap reconstructions with their initial series

Table 7 Relation between cosmetic outcomes for patients with tumor criteria among the studied patients

	Cosmetic outcome patient [*n* (%)]			Test value	*P* value	Significance
	Fair	Good	Excellent			
	N=2	*N*=5	*N*=33			
Size						
T1	0	1 (20.0)	10 (30.3)			
T2	0	4 (80.0)	16 (48.5)	9.150*	0.057	NS
T3	2 (100.0)	0	7 (21.2)			
Number						
Single	1 (50.0)	5 (100.0)	25 (75.8)	2.376*	0.305	NS
Multifocal	1 (50.0)	0	8 (24.2)			
Cup size						
B	0	4 (80.0)	21 (63.6)			
C	2 (100.0)	1 (20.0)	10 (30.3)	5.019*	0.285	NS
D	0	0	2 (6.1)			
BMI						
Mean±SD	34.50±0.71	32.00±3.39	32.06±2.97	0.642•	0.532	NS
Range	34–35	28–36	28–43			
Flap dimension (L)						
Mean±SD	12.00±0.00	11.00±1.00	10.56±1.20	1.640•	0.208	NS
Range	12–12	10–12	9–13			
Flap dimension (T)						
Mean±SD	5.75±0.35	5.30±0.76	5.39±0.43	0.660•	0.523	NS
Range	5.5–6	4.5–6	4.5–6			

*χ^2 test. *P* value more than 0.05: nonsignificant (NS); *P* value less than 0.05: significant (S); *P* value less than 0.01: highly significant (HS).

Table 8 Relation between cosmetic outcomes for MDT with tumor criteria among the studied patients

	Cosmetic outcome MDT [*n* (%)]			Test value	*P* value	Significance
	Fair	Good	Excellent			
	N=2	*N*=6	*N*=32			
Size						
T1	0	1 (16.7)	10 (31.3)			
T2	0	4 (66.7)	16 (50.0)	7.933*	0.094	NS
T3	2 (100.0)	1 (16.7)	6 (18.8)			
Number						
Single	1 (50.0)	5 (83.3)	25 (78.1)	0.992*	0.609	NS
Multifocal	1 (50.0)	1 (16.7)	7 (21.9)			
Cup size						
B	0	5 (83.3)	20 (62.5)			
C	2 (100.0)	1 (16.7)	10 (31.3)	5.449*	0.244	NS
D	0	0	2 (6.3)			
BMI						
Mean±SD	34.50±0.71	30.67±2.88	32.31±2.97	1.474•	0.242	NS
Range	34–35	28–36	28–43			
Flap dimension (L)						
Mean±SD	12.00±0.00	10.75±0.61	10.59±1.26	1.358•	0.270	NS
Range	12–12	9.5–11	9–13			
Flap dimension (T)						
Mean±SD	5.75±0.35	5.33±0.41	5.39±0.49	0.610•	0.549	NS
Range	5.5–6	5–6	4.5–6			

*χ^2 test. *P* value more than 0.05: nonsignificant (NS); *P* value less than 0.05: significant (S); *P* value less than 0.01: highly significant (HS).

including 20 patients. They further reported on 119 patients of partial breast reconstructions with a 4-year follow-up period. Of these, 93 patients had pedicled flap reconstructions, which included muscle-sparing LD, TDAP flaps, serratus anterior perforator flaps, superior epigastric flaps, and ICAP flaps. All procedures were one-stage reconstructions [19,20].

Carrasco-Lopez *et al.* [21] conducted a parallel cadaveric and clinical study on AICAP flaps and concluded that AICAP flap has a consistent vascularization with good perforators.

The use of hand-held Doppler to identify adequate intercostal artery perforator vessels was initially

advocated by Hamdi and colleagues and has since been routinely and successfully applied in volume-replacement oncoplastic breast reconstruction.

In our study, intraoperative localization of the perforator with a handheld Doppler was done in all cases for confirmation of the preoperative marking sites and patency of the perforator.

In the study by Agrawal and coolleagues, intraoperative Doppler was used to confirm perforator patency and position. However, intraoperative Doppler was not used in the study by Kollias and Kollias, and they showed that preoperative and perioperative hand-held Doppler appeared to be safe and effective in identifying adequate perforator vessels, which could often be visualized at the time of surgery [18,22].

In our study, the AICAP flap procedure enabled wider resection volume with frozen section assessment till we reach free resection margins in all cases included in our study without the need for completion mastectomy. Unlike the reported data from Soumian and colleagues, frozen section was helpful in lowering the overall re-excision rates reported in their perforator flap study, which was 45.45% needed a margin revision, and one patient required a completion mastectomy after a persistent positive margin on re-excision [23].

Due to the frozen section used in our study, the operative time was increased relatively as the mean operative time in our study was 64.30 min as the flap preparation and deepithelialization was done while the frozen section was processed. This operative time did not include the time needed for axillary management.

Soumian and colleagues presented a prospective multicenter audit of ICAP-based or LTAP-based partial breast reconstructions. A total of 25 (22.3%) reconstructions were based on the AICAPs. Oncoplastic breast surgeons performed all operations as a single-stage procedure without contralateral symmetrization. Clinician-reported subjective esthetic outcomes based on clinical examination and comparison of preoperative and postoperative photographs were satisfactory or excellent [23].

In our study, all patients were assessed regarding cosmetic outcome on a grading scale ranging from very poor to excellent (subjective) based on patients' opinion and breast MDT opinion not including any flap complications for a period of 6 months postoperatively. Patient satisfaction ranged from fair to excellent, with 82.5% giving excellent results.

MDT cosmetic outcome assessment was done regarding the contralateral symmetrization and the preservation of the IMF, reporting excellent results in 80% of cases.

Carrasco-Lopez and colleagues demonstrated that AICAP flaps have a consistent and reliable vascularization, meaning that they can be successfully utilized despite varying breast sizes and body habitus. The results of this study are a testament to this, with only one (3.3%) patient developing fat necrosis, indicative of inadequate vascularity. This patient was an active smoker at the time of surgery. Although the proportion of active smokers in this patient cohort was small, the authors suggest that active smoking could be a relative contraindication to offering an AICAP flap for lower pole partial breast reconstruction, so that we exclude smoker patients in our study [24].

Two patients in our study were complicated with fat necrosis, and no cases reported with seroma. Although seroma formation and drainage are a frequent occurrence in patients following breast and breast reconstructive surgery, this outcome has not been commonly described following perforator flap reconstruction in the literature. Schaverien and colleagues reported no cases of postoperative seroma among their perforator flap cohort, whereas only one case was reported by Soumian and colleagues. Based on this finding, the authors aim to adopt a more conservative approach to postoperative donor site seroma in future cases [23,25].

Other volume replacement techniques, such as the crescent flap, have also been described in the literature. This is a random flap that uses a fasciocutaneous flap to restore the inferior breast contour. The AICAP flap differs from a random flap (i.e. crescent flap) in that effort is made to identify the vascular supply to the tissue. If perforator vessels are not confidently identified in the preoperative or perioperative Doppler assessment, or visualized intraoperatively, then the crescent flap can be considered. In our study, perforators were identified in all cases, such that use of a random flap was not required [26].

Conclusion

After evaluation of the outcome of AICAP flap as a volume replacement in breast conservative surgery, we found that it is a reliable and safe method that can be added to the large group of oncoplastic surgeries with excellent patient cosmetic outcome and no need for contralateral symmetrization, and it also has a very low rate of donor site morbidity such as seroma.

However, it needs meticulous dissection to avoid injury of the perforators intraoperatively. Preoperative and intraoperative Doppler localization of the perforators aids in its excellent localization.

AICAP flaps appear to be safe in restoring breast contour after wide excision of lower pole breast cancers, with high levels of patient satisfaction reported postoperatively.

Finally, this study limitation is in being conducted in one hospital with a short-term follow-up; thus, multicentric studies with comparisons of the results with longer follow-up period are needed in further studies for better reliable data.

Acknowledgements

The authors thank the participants for their approval and enthusiasm to participate in this study and to share their views and remark on this topic. The authors also thank Ain Shams University General Surgery Department, Breast Surgery Unit especially Professor Dr Reda Abd El Tawab for his guidance and support throughout the study.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1 Catanuto G, Rocco N, Maglia A, Barry P, Karakatsanis A, Sgroi G, *et al*. Text mining and word embedding for classification of decision making variables in breast cancer surgery. Eur J Surg Oncol 2022; 48:1503–1509.

2 van Dongen JA, Voogd AC, Fentiman IS, Legrand C, Sylvester RJ, Tong D, *et al*. Long-term results of a randomized trial comparing breast-conserving therapy with mastectomy: European Organization for Research and Treatment of Cancer 10801 trial. J Natl Cancer Inst 2000; 92:1143–1150.

3 Veronesi U, Cascinelli N, Mariani L, Greco M, Saccozzi R, Luini A, *et al*. Twentyyear follow-up of a randomized study comparing breast conserving surgery with radical mastectomy for early breast cancer. N Engl J Med 2002; 347:1227e32.

4 Mamounas EP. NSABP breast cancer clinical trials: recent results and future directions. Clin Med Res 2003; 1:309–326.

5 Slavin SA, Halperin T. Reconstruction of the breast conservation deformity. Sem Plas Surg 2004; 18:89e94.

6 Audretsch W, Rezai M, Kolotas C, Zamboglou N, Schnabel T, Bojar H. Tumorspecific immediate reconstruction in breast cancer patients. Semin Plast Surg 1998; 11:71–100.

7 Munhoz AM. Tissue replacement methods using local flaps. In: Losken A, Hamdi M, editors. Partial breast reconstruction. St Louis: Quality Medical Publishing; 2009. p. 317e34.

8 Munhoz AM, Montag E, Arruda E, Pellarin L, Filassi JR, Piato JR, *et al*. Assessment of immediate conservative breast surgery reconstruction: a classification system of defects revisited and an algorithm for selecting the appropriate technique. Plast Reconstr Surg 2008; 121:716e27.

9 Saint-Cyr M, Wong C, Schaverien M, Mojallal A, Rohrich RJ. The perforasome theory: vascular anatomy and clinical implications. Plast Reconstr Surg 2009; 124:1529–1544.

10 Koshima I, Soeda S. Inferior epigastric artery skin flaps without rectus abdominis muscle. Br J Plast Surg 1989; 42:645–648.

11 Hamdi M, Spano A, Van Landuyt K, D'Herde K, Blondeel P, Monstrey S. The lateral intercostal artery perforators: anatomical study and clinical application in breast surgery. Plast Reconstr Surg 2008; 121:389e96.

12 Hamdi M, Van Landuyt K, Monstrey S, Blondeel P. Pedicled perforator flaps in breast reconstruction: a new concept. Br J Plast Surg 2004; 57:531–539.

13 Persichetti P, Tenna S, Brunetti B, Aveta A, Segreto F, Marangi GF. Anterior intercostal artery perforator flap autologous augmentation in bariatric mastopexy. Plast Reconstr Surg 2012; 130:917–925.

14 Yang JD, Kim MC, Lee JW, *et al*. Usefulness of oncoplastic volume replacement techniques after breast conserving surgery in small to moderate-sized breasts. Arch Plast Surg 2012; 39:489–496.

15 Levine JL, Soueid NE, Allen RJ. Algorithm for autologous breast reconstruction for partial mastectomy defects. Plast Reconstr Surg 2005; 116:762–767.

16 Noguchi M, Yokoi-Noguchi M, Ohno Y, *et al*. Oncoplastic breast conserving surgery: volume replacement vs. volume displacement. Eur J Surg Oncol 2016; 42:926–934.

17 Nos C, Fitoussi A, Bourgeois D, Fourquet A, Salmon RJ, Clough KB. Conservative treatment of lower pole breast cancers by bilateral mammoplasty and radiotherapy. Eur J Surg Oncol 1998; 24:508–514.

18 Kollias V., Kollias J. Safety and efficacy of anterior intercostal artery perforator flaps in oncoplastic breast reconstruction. ANZ J Surg 2022; 92:1184–1189.

19 Hamdi M, Van Landuyt K, de Frene B, *et al*. The versatility of the intercostal artery perforator (ICAP) flaps. J Plast Reconstr Aesthet Surg 2006; 59:644–652.

20 Hamdi M. Oncoplastic and reconstructive surgery of the breast. Breast 2013; 22(Suppl 2):S100–S105.

21 Carrasco-Lopez C, Julian Ibanez JF, Vila J, *et al*. Anterior intercostal artery perforator flap in immediate breast reconstruction: anatomical study and clinical application. Microsurgery 2017; 37:603–610.

22 Agrawal SK, Shakya SR, Nigam S, Sharma A, Datta SS, Ahmed R. Chest wall perforator flaps in partial breast reconstruction after breast conservation surgery: an additional oncoplastic surgical option. Ecancermedicalscience 2020; 14:1073.

23 Soumian S, Parmeshwar R, Chandarana M, Marla S, Narayanan S, Shetty G. Chest wall perforator flaps for partial breast reconstruction: surgical outcomes from a multicenter study. Arch Plast Surg 2020; 47:153–159.

24 Carrasco-Lopez C, Julian Ibanez JF, Vila J, *et al*. The anterior intercostal artery flap: anatomical and radiologic study. Plast Reconstr Surg 2017; 139:613e–619ee.

25 Schaverien MV, Kuerer HM, Caudle AS, Smith BD, Hwang RF, Robb GL. Outcomes of volume replacement oncoplastic breast conserving surgery using chest wall perforator flaps: comparison with volume displacement oncoplastic surgery and total breast reconstruction. Plast Reconstr Surg 2020; 146:14–27.

26 Renouvel F, Nos C, Clough KB, Lecuru F. Preliminary outcome of breast cancer located at the lower quadrant treated with a thoracomammary flap. Bull Cancer 2008; 95:773–778.