Role of chest wall perforator flaps in breast-conserving surgery as a volume-replacement oncoplastic procedure

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Background
Partial breast reconstruction using chest wall perforator flaps (CWPF) is a recent technique used by breast surgeons, mainly for lateral defects with a relatively large volume of excision in small-sized to medium-sized breast. We report our experience of CWPF in breast reconstruction with surgical details, complications, different locations of the tumor, and outcomes.
Patients and methods
This was a prospective observational cohort study on 20 patients who had undergone breast-conservation surgery plus CWPF reconstruction [lateral intercostal artery perforator (LICAP) flap, lateral thoracic artery perforator (LTAP) flap, anterior intercostal artery perforator flap, and thoracodorsal artery perforator flap]. A survey was done to analyze patient satisfaction at about 6 months after completion of radiotherapy.
Results
LICAP flap was used in 30% of the patients, anterior intercostal artery perforator flap was used in another 30%, whereas thoracodorsal artery perforator flap was used in 25% of the patients. A combination between LTAP and LICAP was used in 10% of the studied patients, and LTAP alone was used in only 5% of the cases. Regarding the complications, there was no incidence of total or partial flap loss in this series. Only minor complications were reported. Patients' satisfaction was assessed by a questionnaire, which showed acceptable patient satisfaction.
Conclusion
CWPF procedures show good outcomes in partial breast reconstruction in terms of oncological safety and patient satisfaction, extending the options for breast conservation to many patients who would otherwise require mastectomy.

Keywords:
oncoplastic breast surgery, partial mastectomy, perforator flaps

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Introduction

Breast-conserving surgery (BCS) with whole breast irradiation is equivalent to mastectomy in terms of survival and local control. In addition, it has the advantage of achieving an excellent cosmetic outcome, high patient satisfaction, and improved quality of life [1–3].

Approximately 30–60% of patients who were diagnosed with breast cancer and managed with BCS complained of residual deformities, including a deficiency of glandular tissue, overlying skin retractions, delayed adverse effects of radiotherapy, retraction/displacement of the nipple–areola complex, and asymmetry of both breasts [1,4].

The development of oncoplastic breast surgery (OBS) in the last decade has broadened the general indications for BCS to reduce the risk of these deformities and to ensure optimal cosmesis without compromising the oncological safety [2,4,5].

For patients with small-sized to moderate-sized breasts, excision of more than 20% of breast tissue has unacceptable cosmetic outcomes. In such cases, some forms of oncoplastic volume replacement rather than displacement techniques are required to achieve an esthetic appearance of the breast [1,2].

For many years, latissimus dorsi (LD) myocutaneous and or mini-LD flaps were used to cover these defects in small breasts with disadvantage of increasing donor site morbidity, like seroma formation and functional impairment of the shoulder [2].

One of the main substitutions to avoid the complications of LD flaps and improve the results of

BCS is the use of chest wall perforator flaps (CWPF) as a volume replacement for partial breast defect reconstruction. They are able to fill the resection defects, thus avoid subsequent deformity [6,7].

These flaps may be based on perforator of thoracodorsal artery perforator (TDAP), lateral thoracic artery perforator (LTAP), lateral intercostal artery perforator (LICAP), or anterior intercostal artery perforator (AICAP) [4]. They are used for partial breast reconstruction mainly lateral and lower halves of the breast [4,8].

Although described a long time ago, these flaps have not been adopted widely in clinical practice. Additionally, they are often criticized for the long chest wall scar that they create [2,8].

They have their pros and cons. They can maintain the volume and/or shape of the breast, spare the underlying LD muscle, and avoid contralateral breast surgery. However, they have more complex procedures and sometimes are associated with donor site morbidity and flap-related complications [9–11].

Patients and methods

This study was designed as a prospective single-arm open-label study. The study recruited 20 patients admitted to the surgical oncology unit or the plastic reconstructive surgery unit between December 2020 and October 2021.

All patients were female patients with breast cancer and candidates for volume-replacement OBS.

Inclusion criteria

The following were the inclusion criteria:

(1) Operable breast cancer.
(2) Small to moderate-sized breast with tumor breast ratio more than 20–30%.

Exclusion criteria

The following were the exclusion criteria:

(1) Nonmotivated patients refusing reconstruction.
(2) Multicentric breast tumors.
(3) Patients with persistent positive margins.
(4) Large breasts with a small tumor size.

Patients were first evaluated by a multidisciplinary team (the breast surgeon, the plastic surgeon, and the medical oncologist), which confirmed the breast cancer diagnosis and indicated the plan for management depending on the breast volume, tumor size, and tumor location.

Procedure

(1) Preoperative photographing and marking of the breast were performed with the patient in standing position. Identification of the breast borders, site of the tumor, and planned excision tissue was done.
(2) Marking the site of the perforator aided with hand-held Doppler (8 MHz) was done.
(3) Excision of the tumor with safety margin (confirmed by intraoperative pathological assessment) was done.
(4) Axillary staging by axillary nodal dissection or sentinel node biopsy was done according to protocol.
(5) Evaluation of the defect size and its site was done.
(6) Clipping of the tumor bed to guide the booster radiation dose was performed.
(7) Marking of the planned flap was based on the perforator that will replace the excised breast tissue.
(8) Dissection of the designed flap was performed until the site of the perforator starting from lateral to medial raising it as fasciocutaneous flap.
(9) Then, de-epithelialization of part or whole of the flap was done.
(10) Flap mobilization was performed to reach and fill the defect site without tension or kinking of the perforator.
(11) Flap in-setting was done at its new location and sutured to the surrounding mammary tissue by absorbable sutures.
(12) Insertion of a closed system negative suction drain was done whenever needed in either/both tumor bed and flap donor area.
(13) Closure was done in layers after ensuring hemostasis.
(14) Operative time was calculated for both excision and the reconstruction.
(15) Assessments of the breast size, shape, symmetry with the contralateral breast, and the position of the scar of the flap were done at the end of the operation.
(16) Patients were followed up during the early postoperative period for detection of any postoperative complications such as wound dehiscence, infection, hematoma, and flap necrosis. We extended this follow-up monthly for a minimum of 6 months.

Assessment of cosmetic outcome was done as follows:

(1) Independent reviewers (another separate team that did not take part in the operation) were asked to assess clinically the breast size, shape, symmetry of the other breast, and the position of the scar of the flap.
(2) The patients also were asked to give a score of satisfaction after completion of the radiotherapy using a four-point Likert scale.
(3) Standardized postoperative digital photographs were taken in different views as done preoperatively for comparison and follow up.

Statistical analysis of the data

Data were fed to the computer and analyzed using IBM SPSS software package, version 20.0. (IBM Corp., Armonk, New York, USA). Qualitative data were described using number and percent. The Kolmogorov–Smirnov test was used to verify the normality of distribution. Quantitative data were described using mean±SD. *F* test (analysis of variance) was used for normally distributed quantitative variables. Significance of the obtained results was judged at the 5% level.

Ethical approval

This research was performed at the Department of General Surgery, Alexandria University Hospitals. Ethical Committee approval and written, informed consent were obtained from all participants.

Results

In our study, most cases [eight (40.0%)] had upper lateral tumor, five (25.0%) had lower lateral tumor, three (15.0%) had lower medial tumor, two (10.0%) had upper medial tumor, and two (10.0%) had central tumor. Regarding the perforator location, LICAP flaps were performed in six (30.0%), AICAP flaps in six (30.0%), TDAP flaps in five (25.0%) (the classic TDAP not the muscle-sparing LD flap), combined in two (10.0%), and LTAP flaps in one (5.0%) case (Table 1).

The mean procedure time was 111.85±17.92 min, ranging from 90 to 150 min; the procedure time in the majority of cases (75.0%) was less than 120 min, whereas it was more than 120 min in only five (25.0%) cases.

Regarding complications, 'upon follow-up, there were no significant complications that necessitated operative intervention.' It was found that most cases [13 (65.0%)] did not have complications, two (10.0%) had seroma, two (10.0%) had hematoma, two (10.0%) had partial wound dehiscence, and one (5.0%) had venous congestion diagnosed clinically (Fig. 4). Regarding the scars, it was found that 12 cases were satisfied, six were highly satisfied, and two were unsatisfied. Regarding the return of the patient to their normal life, it was found that 13 cases were highly satisfied and seven were satisfied. In comparison with the other side, it was found that 15 cases were satisfied, four were highly satisfied, and one was unsatisfied. When the patients were asked about doing conservative breast surgery vs. mastectomy, it was found that 16 cases were satisfied, three were highly satisfied, and one was unsatisfied in doing conservative surgery (Table 2).

The mean procedure time in LICAP was 100.67 ±8.02 min, which ranged from 90 to 113 min; in AICAP was 103.67±5.28 min, which ranged from

Table 1 Distribution of the studied cases according to tumor and perforator location (*N*=20)

	n (%)
Tumor location	
Upper lateral	8 (40)
Upper medial	2 (10)
Lower lateral	5 (25)
Lower medial	3 (15)
Central	2 (10)
Perforator location	
LICAP	6 (30)
AICAP	6 (30)
LTAP	1 (5)
TDAP	5 (25)
Combined	2 (10)

Upon follow-up, there were no significant complications that necessitated operative intervention. AICAP, anterior intercostal artery perforator; LICAP, lateral intercostal artery perforator; LTAP, lateral thoracic artery perforator; TDAP, thoracodorsal artery

Table 2 Distribution of satisfaction (*N*=20)

Patient satisfaction	Highly unsatisfied (%)	Unsatisfied (%)	Satisfied (%)	Highly satisfied (%)
Scar	0	10	60	30
Self confidence	0	0	35	65
Comparison to other side	0	5	75	20
Conservative breast surgery vs. mastectomy	0	5	80	15
Independent reviewers score	Poor	Fair	Good	Excellent
Breast symmetry (size and shape)	0	10	60	30
Scar and scar location	0	5	80	15

98 to 110 min; in LTAP was 115 min; in TDAP was 139.60±8.56 min, which ranged from 128 to 150 min; and in combined was 99.0±1.41 min, which ranged from 98 to 100 min, with a statistically significant difference between the perforator location and procedure time (P=0.012).

The relations between defect sizes and perforator locations to flap sizes and different types are demonstrated in Tables 3–5.

Table 3 Descriptive analysis of the studied cases according to flap and resection size (*N*=20)

	Mean±SD
Flap size	
Length (cm)	17.80±3.74
Width (cm)	7.05±1.43
Area	129.30±46.78
Resection size	
Length (cm)	9.70±2.13
Width (cm)	5.75±1.02
Area	56.55±18.36

In Figs 1–4, we present the different used flaps preoperatively, intraoperatively, and postoperatively.

Discussion

The optimal oncological outcome of conservative breast surgery entails complete excision of malignant tumor with negative resection margins [12].

However, wide resection alone may compromise the cosmetic outcome and result in breast deformity or bilateral asymmetry, especially in small-sized and moderate-sized breasts. OBS mainly the volume replacement techniques has the advantage of achieving both wide resection and acceptable cosmetic outcome by partial breast reconstruction [1,13].

For many years, LD myocutaneous/mini-LD flaps have been considered as the gold standard for partial breast reconstruction and were used to fill large defects

Table 4 Relation between perforator location and flap and resection size (*N*=20)

	Length Mean±SD	Width Mean±SD	Area Mean±SD
Flap size			
Perforator location			
LICAP (*N*=6)	17.50±4.72	6.83±1.17	123.67±49.65
AICAP (*N*=6)	17.67±2.42	7.0±1.67	125.67±41.47
LTAP (*N*=1)	23.0	9.0	207
TDAP (*N*=5)	15.80±3.35	6.80±1.79	111.80±49.29
Combined (*N*=2)	21.50±2.12	7.50±0.71	162.0±31.11
F (*P*)	1.481 (0.257)	0.529 (0.716)	1.184 (0.358)
Resection size			
Perforator location			
LICAP (*N*=6)	9.17±2.56	5.33±0.52	49.83±18.40
AICAP (*N*=6)	9.0±1.67	5.67±1.21	50.0±9.53
LTAP (*N*=1)	10.0	7.0	70.0
TDAP (*N*=5)	10.60±2.51	5.60±1.14	61.6±24.93
Combined (*N*=2)	11.0±1.41	7.0±0.0	77.0±9.9
F (*P*)	0.616 (0.658)	1.591 (0.228)	1.326 (0.305)

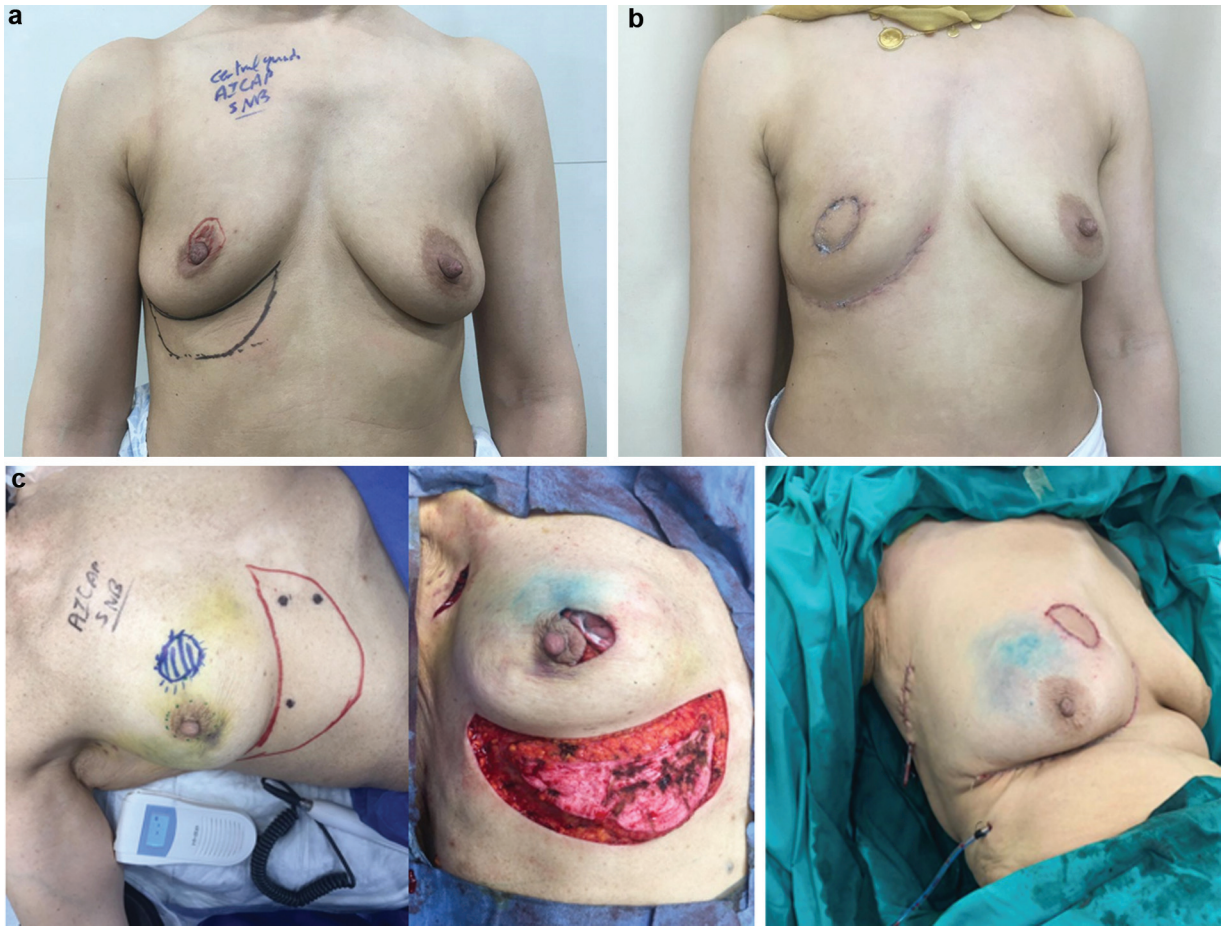
AICAP, anterior intercostal artery perforator; *F*, analysis of variance test; LICAP, lateral intercostal artery perforator; LTAP, lateral thoracic artery perforator; TDAP, thoracodorsal artery perforator. *P*: *P* value for comparing between the studied categories.

Table 5 Relation between tumor location and perforator location (*N*=20)

	Tumor location [*n* (%)]				
	Upper lateral (*N*=8)	Upper medial (*N*=2)	Lower lateral (*N*=5)	Lower medial (*N*=3)	Central (*N*=2)
Perforator location					
LICAP	6 (75)	0	0	0	0
AICAP	0	1 (50)	1 (20)	3 (100)	1 (50)
LTAP	0	0	1 (20)	0	0
TDAP	1 (12.5)	1 (50)	2 (40)	0	1 (50)
Combined	1 (12.5)	0	1 (20)	0	0

AICAP, anterior intercostal artery perforator; LICAP, lateral intercostal artery perforator; LTAP, lateral thoracic artery perforator; TDAP, thoracodorsal artery perforator.

Figure 1



(a) Preoperative AICAP. (b) Postoperative AICAP. (c) Intraoperative AICAP flap. AICAP, anterior intercostal artery perforator.

in small and moderate breasts but with the disadvantage of donor site morbidity and functional impairment of the shoulder [14].

The emergence of perforator flaps and the description of the TDAP flap in 1995 presented a substitute of the LD muscle and has been used in the last decade for reconstruction of laterally placed breast cancers in small-sized to moderate-sized nonptotic breasts. It has been shown to be oncologically safe with low morbidity and good recovery of shoulder function and does not involve muscle morbidity [10].

In 2004, Hamdi *et al.* [15] reported the first use of LICAP and AICAP flaps in partial breast reconstruction. The LICAP flap is based on perforators originating from the intercostal segment of the intercostal vessels, which are commonly found in the fifth to seventh intercostal spaces between 2.5 and 3.5 cm medial to the anterior border of the LD muscle. The LICAP flap is most suitable for defects in the lateral quadrant of the breast [15–17].

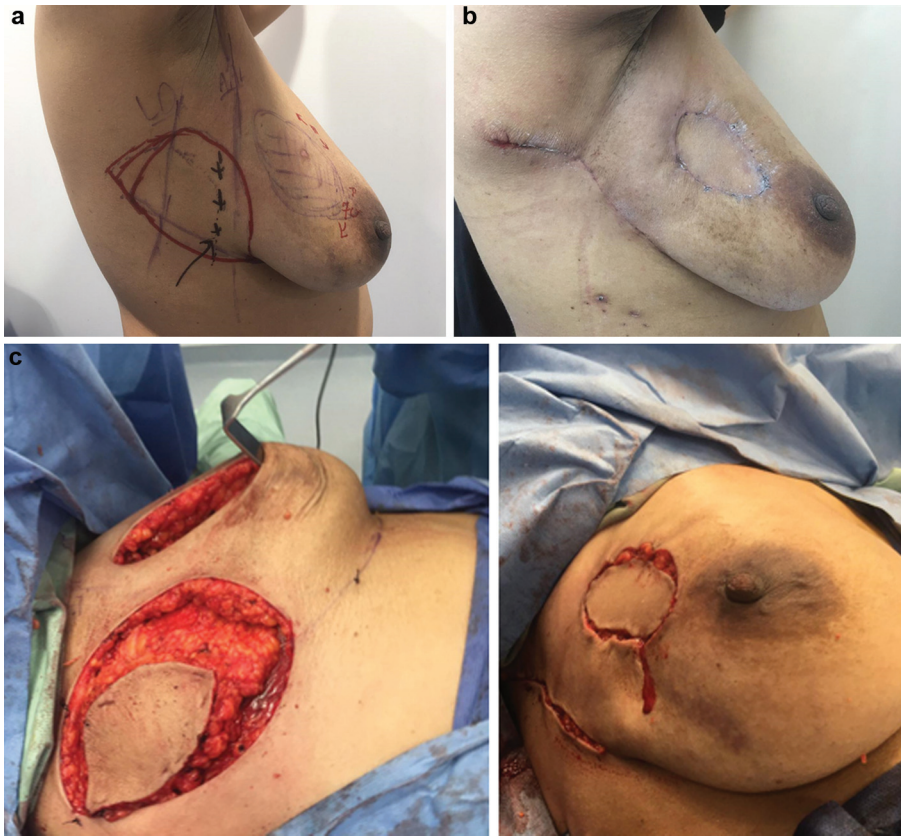
AICAP flaps are composed of tissue beneath the inframammary fold for reconstruction of central and lower medial defects. Benefits of CWPFs include sparing muscle to avoid functional deficits and also leaving the thoracodorsal vessels intact for the possibility of future reconstruction [4].

In 2015, McCulley *et al.* [18] introduced the LTAP flap as an additional option for the reconstruction of partial breast defects, and this was powered by Roy *et al.* [19].

These techniques offer an excellent opportunity for partial breast reconstruction and may prevent the need for mastectomy or LD flap harvest [18]. As proposed by McCulley *et al.* [18], lateral thoracic artery/vessels are present in ~80% of individuals and lend themselves to easy detection.

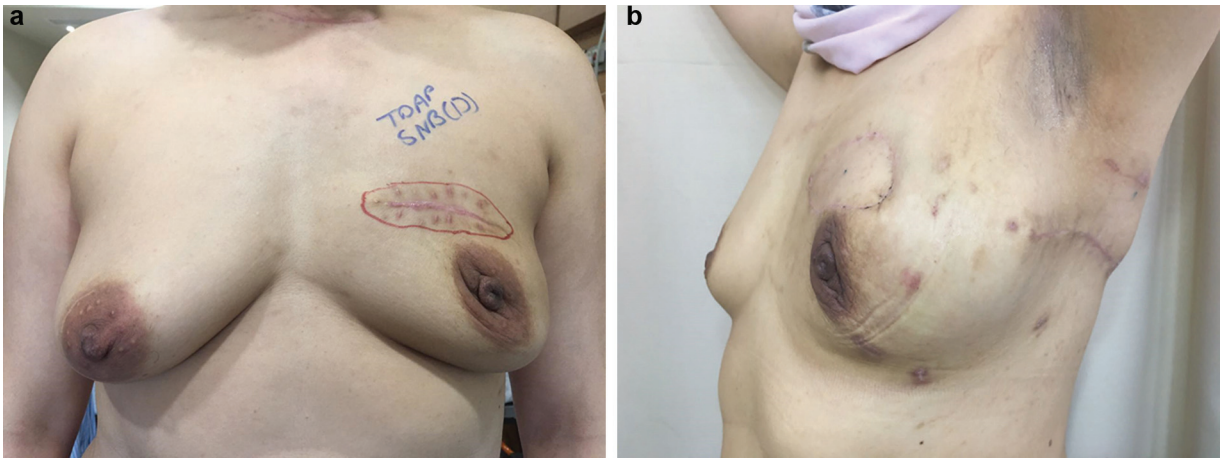
The LICAP and LTAP flaps have limited mobility owing to short perforator size, thus limiting the indications to the lateral quadrant tumors only,

Figure 2



(a) Preoperative LICAP. (b) Postoperative LICAP. (c) Intraoperative LICAP flap. LICAP, lateral intercostal artery perforator.

Figure 3



(a) Preoperative TDAP. (b) Postoperative TDAP flap. TDAP, thoracodorsal artery perforator.

which may explain the small numbers in published series [19].

TDAP flaps have similar mobility to LD muscle and thus have the potential for wider use, but experience in the published literature is rather very limited, probably owing to the expertise required for dissection of the perforator [20].

Tumor location plays an important role in determining the acceptable percentage of breast volume excised for achieving good cosmetic results and so the site of perforator flap used [21].

Our study, in agreement with the studies by Abdelrahman *et al.* [22] and Agrawal *et al.* [2], found that most cases had upper outer quadrant

Figure 4

Congested TDAP flap. TDAP, thoracodorsal artery perforator.

tumor and lower outer quadrant tumor, less cases had upper inner quadrant tumor, and lower inner quadrant tumor.

Similar to our research about the operative time, the study by Orabi *et al.* [23] on the use of lateral CWPFs in partial breast reconstruction reported that the mean operative time was 129.6±13.2 min, but it was shorter than the study by Agrawal *et al.* [2] on the role of CWPFs in partial breast reconstruction after BCS, in which the mean procedure time was 180 min and ranged from 144 to 190 min, and the study by Kim *et al.* [24] on using a LICAP flap after BCS, in which the mean operative time was 249.3±40.1 min.

Moreover, all of the 20 cases had stayed in the hospital only for 1 day. This is similar to the study by Agrawal *et al.* [2] on the role of CWPFs in partial breast reconstruction after BCS, in which all patients were discharged within 24 h following the surgical procedure.

However, in the study by Stocco *et al.* [24] on oncoplastic breast volume replacement with the use of LICAP flaps, the average hospital stay was 3 days.

Regarding complications, it was found that the majority of cases (65.0%) did not have complications. However, as other fasciocutaneous flaps, fibrosis or volume changes might occur as a secondary effect owing to radiotherapy on the reconstructed breasts; such effects might lead to esthetically negative results.

Agrawal *et al.* [2] reported complications in up to 5–10% of cases. Similarly, a study by Abdelrahman *et al.* [22] on the use of TDAP flap in oncoplastic volume replacement for breast cancer reported that 71.3% of patients did not have any complications.

Moreover, a study by Hu *et al.* [25] on BCS and partial breast reconstruction with CWPFs reported that 96% of cases did not have any complications, whereas only 4% of cases had fat necrosis.McCulley *et al.* [18] used LTAP flap in partial breast reconstruction and reported fat necrosis in two cases and superficial necrosis in only one case. Schaverien *et al.* [26] found that 90.5% of the VR-OBCS group did not have complications; the only complication was delayed wound healing in 9.5% of cases. The study by Kim *et al.* [27] on the usefulness of pedicled perforator flap in partial breast reconstruction after BCS in Korean women found linear necrosis in eight cases, wound disruption in four cases, and fat necrosis in four cases.

In the study by Munhoz *et al.* [10] on immediate conservative breast surgery reconstruction with perforator flaps, 15.3% of cases were complicated by wound dehiscence, whereas 7.6% had fat necrosis.

The study by Roy and Tenovici [28] on one-stage versus two-stage approach for partial breast reconstruction with lateral CWPFs reported that two cases had fat necrosis, and only one case had superficial necrosis.

CWPF is often criticized for the long chest wall scar that it creates, but mostly this scar gets hidden in the bra line. However, patient satisfaction with the scar needs to be assessed. Recently, authors have reported that besides functional benefits, CWPFs have the added advantage of minimal donor site morbidity with excellent cosmetic outcomes and better patient satisfaction [18].

In this study, most of the patients were highly satisfied (90%) regarding regaining regular life, and satisfied regarding scar, in comparison with the other side, and conservative breast surgery versus mastectomy. Although we demonstrated a low incidence of flap complications, care must be taken in high-risk patients such as smokers and patients with associated comorbid diseases.

The results of this study demonstrate that the CWPF technique is a simple and consistent procedure and has its place among the main partial breast reconstruction methods available. Most complications were predictable and did not extend hospital stay or interfere with adjuvant treatment. The success of the procedure depends on patient selection, coordinated

planning with the oncologic surgeon, and careful intraoperative management.

Conclusion

This study has demonstrated the clinical utility of CWPFs used for VR-OBCS, extending the options for breast conservation to many patients who would otherwise require mastectomy.

This approach is particularly helpful for patients with small-sized to medium-sized breasts who are not candidates for standard VD-OBCS approaches such as local tissue rearrangement or breast mastopexy/reduction.

CWPF procedures show good outcomes in partial breast reconstruction as the complication rate is low and low time is required to complete the reconstruction.

Wider application of this technique may allow more women to achieve breast conservation, with preservation of nipple–areola complex sensation and reduction of the need for symmetrizing surgery to the contralateral breast.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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