Preoperative mapping of source blood vessels for custom-made flaps in oncoplastic breast surgeries

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Background
Breast reconstruction after breast cancer excision is becoming increasingly important owing to changes in patient expectations and demand. There is growing recognition that immediate reconstruction in appropriately selected women can combine an oncological and esthetic procedure in one operation with excellent results. In some oncoplastic techniques or in patients with severe macromastia undergoing reduction, surgeons might not be able to use traditional pedicles because the blood supply of the nipple–areolar complex (NAC) may be altered or destroyed, necessitating the urge to locate an alternative adequate feeding vessel for NAC away from the resected tissues to avoid postoperative vascular compromise. This would improve NAC survival, wound healing, and rapid full recovery, permitting early administration of radiotherapy or chemotherapy if needed.
Aim
This study aimed to characterize NAC blood supply using magnetic resonance angiography (MRA) to locate available alternative and adequate feeding vessels to design a custom-made NAC flap away from the proposed resected area in patients with breast cancer to avoid postoperative vascular compromise.
Patients and methods
This prospective randomized study was performed on 15 patients presented to plastic, burn, and maxillofacial surgery department, Ain Shams University Hospitals, with breast tumors amenable to NAC preservation from January 2018 to June 2022. Bilateral breast MRA was performed using an MRI scanner locating the different adequate pedicles that supply the NAC. Based on MRI results, a custom-made NAC flap was designed and used in oncoplastic reconstruction after tumor excision.
Results
MRI could delineate multiple feeding vessels of variable diameters. Based on these results, different flaps could be used for NAC transposition and breast remodeling. All cases went uneventful regarding NAC vascularity, and six patients showed minimal wound complications that did not delay the administration of postoperative adjuvant tumor therapy.
Conclusion
Preoperative marking of the available feeding vessels of the NAC using MRA played a central role in designing untraditional NAC flaps that can be used in oncoplastic surgery or severe macromastia reduction with minimal complications.

Keywords:
custom-made breast flaps, nipple–areolar complex blood supply, oncoplastic breast surgeries

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Introduction

Breast reconstruction after cancer breast excision is becoming increasingly important owing to changes in patient expectations and demand. There is growing recognition that immediate reconstruction in appropriately selected women can combine an oncological and esthetic procedure in one operation with excellent results [1].

Oncoplastic techniques are divided into volume replacement and displacement techniques. Both depend on bringing tissues with adequate vascularity to reconstruct the defect left after excision. In volume displacement techniques, the reconstruction depends on the remaining breast tissues that are supplied by perforators derived from the main supplying vessels of the breast [2].

Immediate reconstruction can be achieved through many procedures that vary according to the site, size, and type of the tumor and the remaining breast tissue after tumor excision. Tumor size in comparison with breast size is an important factor to determine the timing and the type of reconstruction [2].

Small-sized tumors in moderate or large breasts can be excised with safety margin and reconstructed immediately with volume displacement techniques that allow reshaping of the remaining breast tissues to reconstruct the defect after tumor excision [2].

If the tumor size is large in a small-size or moderate-size breast, volume replacement techniques are usually used for reconstruction. Reconstruction with volume replacement may be delayed to allow patient to recover as it is more complicated [2].

The blood supply to the breast skin depends on the subdermal plexus, which is in communication with deeper underlying vessels supplying the breast parenchyma. The blood supply is derived from the internal mammary perforators (most notably the second to fifth perforators), the thoracoacromial artery, the vessels to serratus anterior, the lateral thoracic artery, and the terminal branches of the third to eighth intercostal perforators. The superomedial perforator supply from the internal mammary vessels is particularly very powerful and accounts for ~60% of the total breast blood supply. This rich blood supply allows for various reconstruction (volume displacement) techniques, ensuring the viability of the skin flaps after surgery [3]. Breast cancer may cause damage to these pedicles either by invasion or by being involved in the excision during surgery, so preoperative mapping of all available pedicles is needed to provide an alternative option for reconstruction [3].

Handheld Doppler ultrasound was used to attempt to locate perforating vessels. A Doppler ultrasound is portable and simple to use but cannot differentiate perforating vessels from superficial and deep axial vessels or large perforators from small ones. It cannot accurately determine the location where perforators exit the fascia, nor provide information on the anatomic course of a vessel. In comparison, color Duplex sonography provides more detailed information about the anatomy, course, and size of the vessels but requires highly trained technicians with knowledge of perforator anatomy and is time consuming. Its main drawback is its inability to produce anatomic images in a format that a surgeon can easily and independently view [4].

Computed tomographic angiography (CTA) has been considered the 'gold standard' in preoperative vascular perforator imaging. It can show a complete profile of the preoperative breast vascular map with satisfactory resolution. CTA can provide a good idea about the changes in supplying perforators. Unfortunately, CTA carries a mild risk of causing nephrotoxicity and anaphylaxis owing to use of iodinated contrast. It also has increased risks of developing breast and ovarian cancers owing to exposure to ionizing radiation [5].

Owing to these drawbacks, magnetic resonance angiography (MRA) became the investigation of choice in preoperative planning in breast reconstruction surgery. MRA provides valuable accurate data about the site and size of the breast tumor and its relation to the surroundings, possible resection margins, breast vascular pedicles, and volume of the flaps that can be raised depending on these pedicles, which can be used for immediate breast reconstruction.

MRA is safer than CTA and provides more data regarding breast parenchyma [6] after lumpectomy. Resection margins can affect various blood vessels that give supply to multiple flaps, especially if the tumor is large or located in the upper medial or upper lateral quadrants of the breast. This problem can be addressed through using preoperative MRA through which we can design a flap that can be used for immediate reconstruction away from the resection margins, insure its vascularity, and decrease local wound complications. The current knowledge about the blood supply of the flaps used in oncoplastic breast surgeries comes from previous cadaveric studies; these traditional pedicles can be damaged in oncological procedures. Therefore, there is a need for mapping of other nipple–areolar complex (NAC) blood supply to allow preoperative planning of various custom-made flaps with dependable perfusion [6].

Aim

This study aims to characterize NAC blood supply using MRA to locate available alternative and adequate feeding vessels to design a custom-made NAC flap away from the proposed resected area in patients with breast cancer to avoid postoperative vascular compromise.

Patients and methods

This prospective randomized study was performed on 15 patients presented to plastic, burn, and maxillofacial surgery department, Ain Shams University Hospitals, with breast tumors amenable to NAC preservation from January 2018 to June 2022.

Bilateral breast MRA was performed using an MRI scanner locating the different adequate pedicles that supply the NAC. Based on MRI results, a custom-made NAC flap was designed and used in oncoplastic reconstruction after tumor excision.

Patient selection was achieved through a number of inclusion and exclusion criteria.

Inclusion criteria were as follows: adult females 18–65 years of age, with early breast cancer amenable to NAC preservation, first or second stage proved by biopsy, in a medium-sized or large breast or with severe macromastia.

Exclusion criteria were as follows: pregnant patients, small-sized breast, inflammatory tumor, late breast cancer (stages III–IV), multicentric tumor, not a candidate for NAC preservation, history of previous ipsilateral breast cancer, previous irradiation of breast, contraindication for MRA (cardiac pace-maker), vascular disease, chronic illness, patients not convinced with the proposed procedure after adequate explanation, and patients refusing postoperative adjuvant radiotherapy.

Preoperative evaluations: all patients were subjected to detailed history taking, analysis of their disease, medical and family history taking, and complete clinical examination.

Preoperative investigations were performed, including radiological examination, bilateral digital mammography, and metastatic work-up protocol.

Magnetic resonance angiography examination

The patient is placed in the supine position on the MRI table. Bilateral breast MRAs were performed using a 1.5-T MR scanner (Achieva; Philips Medical Systems, Best, the Netherlands). Precontrast images were obtained, followed by postcontrast (gadolinium) images at 70 s after a 20 s delay. Axial, coronal, and sagittal images were evaluated in addition to maximum intensity projection images. The determination of the dominant blood supply was based upon the timing of contrast filling (maximum fill at 90 s). The dominant arterial supply to NAC on each side was demonstrated and documented, and results were conveyed to us. Axial maximum intensity projection was created for each breast and was very informative to trace the dominant arterial supply to NAC from its origin till NAC.

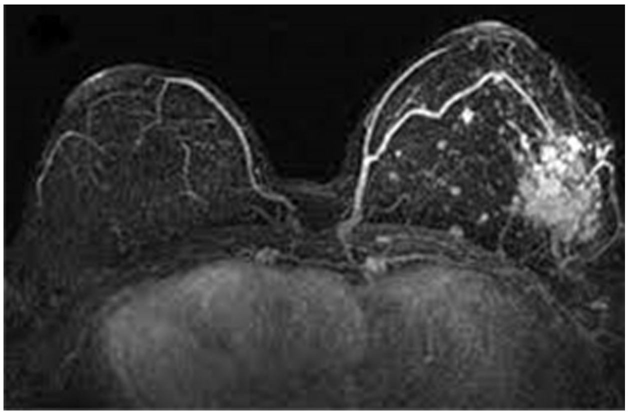
Measures were taken for the dominant vessel at this point and were registered for each nipple. Figures 1–4 show multiple MRA scans taken by the MRI scanner.

Operative procedure

All patients were evaluated by our team before surgery, where designs of planned incision, excision, and the mapped vessels preoperatively are marked (Fig. 5).

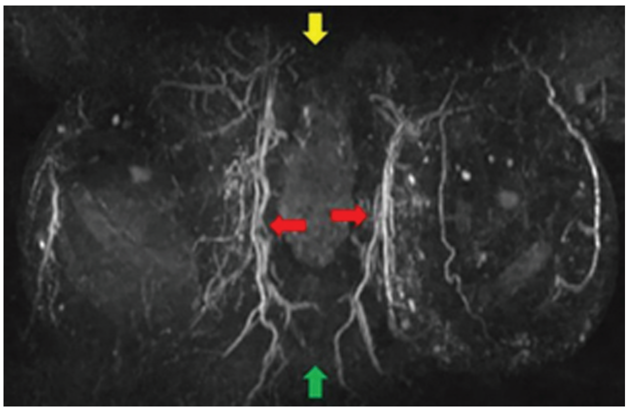
Preoperative marking: all markings were done preoperatively with the patient standing, with arms at the side. The midline and inframammary crease were marked. The highest point of the new NAC would be at the breast meridian along a line passing this point. In tumor cases, the excision was marked and guided by

Figure 1



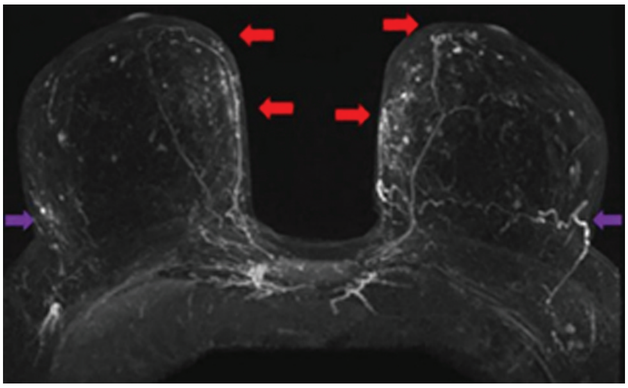
Axial MRI maximum intensity projection (MIP) images. The pectoralis major perforators originating from the internal mammary vessels. The vessels can be traced heading toward the nipple–areolar complex on the left side with the mass on the lateral side destroying the lateral pedicle.

Figure 2



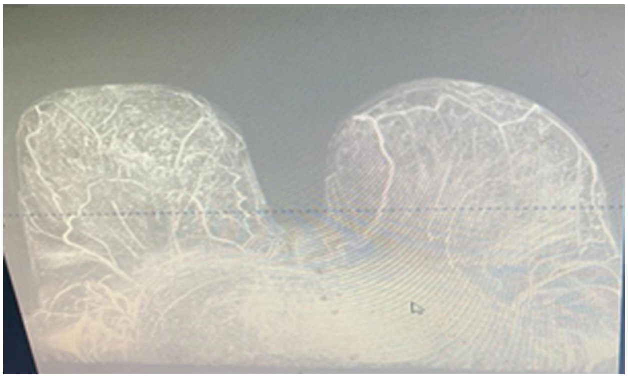
Coronal MRI maximum intensity projection (MIP) images. The manubrium of the sternum is at the top of the image (yellow arrow), and the xiphoid is at the bottom of the image (green arrow). The internal mammary vessels can be seen coursing on either side of the sternum with pectoralis major perforators originating from the internal mammary vessels (red arrows).

Figure 3



Axial MRI maximum intensity projection (MIP) images. The pectoralis major perforators originating from the internal mammary vessels (red arrows). The vessels can be traced heading toward the nipple–areolar complex. The lateral vessels (purple arrows) do not quite reach the nipple–areolar complex on either side. Therefore, in this case, the medial blood supply was selected to keep the nipple–areolar complex alive.

Figure 4



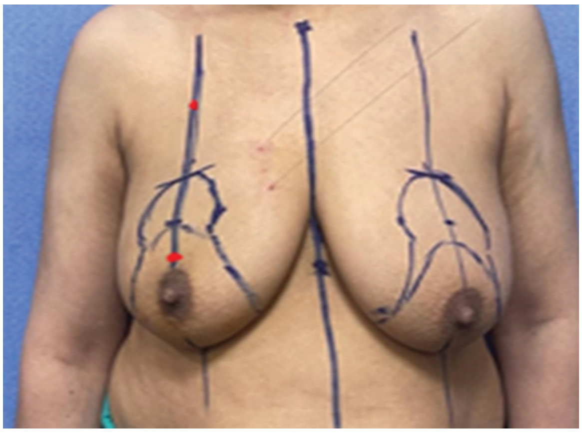
MRA breast showing lt breast dominant vessel of the NAC coming from perforator of lt internal thoracic artery measuring 3.1 ml, while the rt breast NAC is supplied by both lateral thoracic perforator measuring 1.7 ml and internal mammary measuring 1.5 ml. MRA, magnetic resonance angiography; NAC, nipple–areolar complex.

wires inserted in the tumor by a radiologist. The dominant vessels are marked and the pedicle is designed accordingly and to coincide with a final scar as vertical or inverted T, as shown in Fig. 5.

The designed pedicle was de-epithelialized starting from the outer margin of the NAC to the edge of the skin that will not be excised, as keeping this part of the dermis around the nipple will preserve the superficial veins. The dermis of the pedicle was divided just at the junction of the de-epithelialized area with the remaining breast skin, and then subcutaneous dissection of the skin was performed keeping the skin thickness around 1–2 cm and stopping before the marked site of the previously marked perforators to preserve the arterial perforators of the pedicle (Fig. 6).

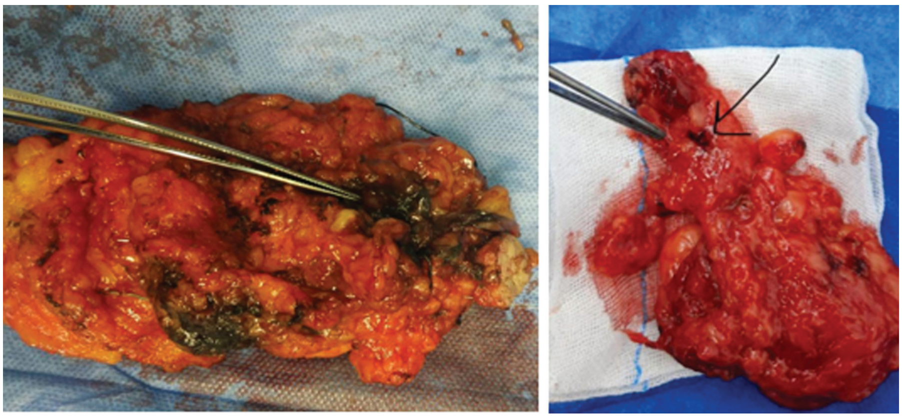
We did our incisions allowing good exposure of the tumor, and general surgeons did the excision and

Figure 5



Preoperative marking and wiring of the mass and preoperative marking of the vessel.

Figure 6



Superior inferior pedicle of NAC after excision of mass. NAC, nipple–areolar complex.

sentinel lymph node study intraoperatively (Fig. 7). The cavity is clipped for postoperative surveillance and radiation boosting. Axillary lymph node dissection was done when indicated.

Skin flap dissection was stopped 1 cm before the site of the preoperative detected vessel with MRA to avoid its injury. Then, resections proceeded around the pedicle as needed to achieve the required breast size (Fig. 8).

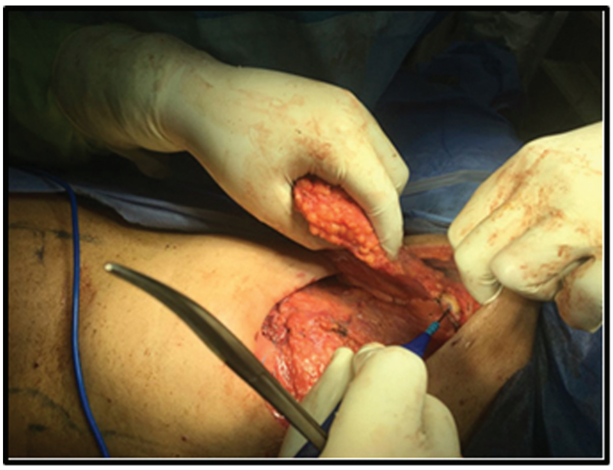
After excision, the mass was sent for frozen section examination. After making sure that the whole tumor was excised, reconstruction was carried out using the remaining breast tissues and based on the previously designed flap (Fig. 9).

The NAC was then transferred to the new site (Fig. 10). Adequate hemostasis was done, and pillars were sutured together and drains were inserted. The

Figure 7

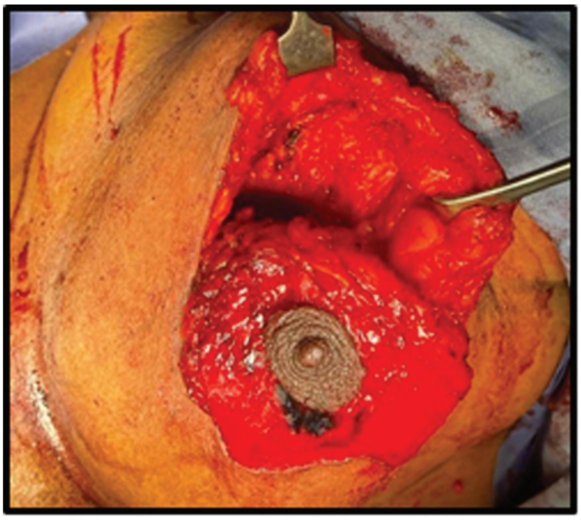
LN excision. LN, lymp node.

Figure 8



Tumor excision.

Figure 9



Breast after tumor excision.

Figure 10

NAC new position and dealing with dog ears. NAC, nipple–areolar complex.

Figure 11

After skin closure and drain insertion.

vertical and periareolar incisions were closed in two layers. A horizontal limb may be added to eliminate the dog ear formed at the lower end of the vertical incision (Fig. 11).

Prophylactic broad-spectrum antibiotic and routine postoperative analgesia were give. Patients are advised to wear well-fitting sport bra for 1 month.

Drains were removed after 48 h, and stitches were removed after two weeks. Patients were instructed to undergo arm and shoulder mobilization and a set of exercises to avoid stiffness of the shoulder joint and decrease arm edema after axillary surgery. Our patients were all followed up for both oncologic and cosmetic grading and were referred to receive suitable adjuvant chemotherapy and or radiotherapy where indicated. Figures 12 and 13 show postoperative results.

Documentation of radio-necrosis, breast edema, and inflammation was done and managed according to its severity for the first 6 months after the surgery.

Cosmetic outcome was evaluated through a scoring system and graded from 1–5, with one indicating poor results and five indicating excellent results. It was evaluated by the breast MDT and the BREAST-Q questionnaire filled by the patient (Table 1).

A multidisciplinary team at the breast unit at General Surgery Department of Ain Shams University reviewed

Figure 12

First dressing before discharge.

Figure 13

Result after 3weeks compete healing.

Table 1 BREAST-Q questionnaire [7]

	Very dissatisfied	Somewhat dissatisfied	Somewhat satisfied	Very satisfied
a. How you look in the mirror clothed?	1	2	3	4
b. The shape of your reconstructed breast(s) when you are wearing a bra?				
c. How normal you fell in your clothes?	1	2	3	4
d. The size of your reconstructed breast(s)?	1	2	3	4
e. Being able to wear clothing that is more filled?	1	2	3	4
f. How your breasts are lined up in relation to each other?	1	2	3	4
g. How comfortably your bras fit?	1	2	3	4
h. The softness of your reconstructed breast(s)?	1	2	3	4
i. How equal in size your breasts are to each other?	1	2	3	4
j. How natural your reconstructed breast(s) looks?	1	2	3	4
k. How naturally your reconstructed breast(s) siss/hangs?	1	2	3	4
l. How your reconstructed breast (s) feels to touch?	1	2	3	4
m. How much your reconstructed breast (s) feels like a natural part of your body?	1	2	3	4
n. How closely matched your breast are to each other?	1	2	3	4
o. How your look in the mirror unclothed?	1	2	3	4

every single case independently, with a decision that is tailored for every case.

Ethical approval

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

Results

This study was conducted on 15 patients diagnosed with breast cancer suitable for breast oncoplastic surgery. They were admitted to the department of plastic, burn, and maxillofacial surgery, Ain Shams University Hospital, between 2018 and 2022.

For all patients, preoperative planning using MRA was done, and patients underwent oncoplastic breast surgery, which included two major technical steps: excision of the tumor with a wide safety margin through a predesigned incision with frozen section examination for margins along with formal axillary dissection if indicated, followed by immediate reconstruction using predesigned NAC flap based on MRA findings.

MRA was very useful in detection of the breast mass, the amount of excision, pedicles destroyed by masses or by possible excision, and the possible available vessels supplying nipple and areolar that can be used in immediate reconstruction after tumor excision.

Demographic data: the average age was 40.3 years (range, 30–52 years). The majority of patients on final pathologic evaluation had infiltrating ductal [n=10 (60.9%)]. Stage I disease was the most common [n=13 (86%)], and wire localization was required in 12 (80%). A total of two (13.3%) patients were diabetics with good control and two (13.3%) with hypertension also with good control.

MRA data: in the medial pedicle (nine cases), one perforator was found to come from the second intercostal space and reach the NAC in four (26.7%) cases, and also one perforator was found to come from the third intercostal space and reach the NAC in three (20%) cases. Two perforators came from the second and third intercostal spaces and reached the NAC in two (13.1%) cases. The average size was 2.7 mm.

In the lateral pedicle (one case), a single perforator (3 mm diameter) was found to originate from the lateral thoracic artery and reach the NAC.

Table 2 Perforators of both breasts

Cases	Ipsilateral	Contralateral
1	2nd intercostal IMA	2nd and 3rd intercostal IMA
2	Thoracoacromial A	Thoracoacromial A
3	2nd and 3rd intercostal IMA	3rd intercostal IMA
4	2nd intercostal IMA	2nd and 3rd intercostal IMA
5	2nd intercostal IMA	2nd intercostal IMA
6	2nd and 3rd intercostal IMA	2nd and 3rd intercostal IMA
7	Thoracoacromial A	2nd and 3rd intercostal IMA
8	3rd intercostal IMA	3rd intercostal IMA
9	Thoracoacromial A – AIA	Thoracoacromial A – AIA
10	3rd intercostal IMA	3rd intercostal IMA
11	3rd intercostal IMA	3rd intercostal IMA
12	Thoracoacromial A	Thoracoacromial A
13	2nd intercostal IMA	2nd intercostal IMA
14	Lateral thoracic	Lateral thoracic
15	Thoracoacromial	Thoracoacromial

AIA, anterior intercostal artery; IMA, internal mammary artery.

At the upper pole of the breast, only a single perforator was found to come from the thoracoacromial artery and reach the NAC in four cases with an average size of 1.5 mm.

At the lower pole of the breast, a single perforator was found to come from the anterior intercostal arteries and reach the NAC in one case with a 2.1-mm size.

Four (26.6%) of our cases had different blood supply for both breasts (Table 2).

There were four cases with different blood supply.

Intraoperative details: the majority of patients did not need an axillary procedure [sentinel node biopsy, n=2 (13.3%), and axillary node dissection, n=2 (13.3%)] at the time of tumor removal. The average lumpectomy specimen weighed 207 g (range, 11.6–354 g), and total reduction weight averaged 909.8 g (range, 264–2511 g). The average contralateral specimen weighed 981.7 g (range, 0–2621 g). The tumor size averaged 2.02 cm (range, 1×1 to 5×4 cm). The positive margin rate with frozen sections was 0 percent, and the average distance to the closest margin was 0.51 cm (range, 0–5.0 cm).

The average meridian was 34.6, with 46 cm the highest.

The average NAC elevation was 10.4 cm, with 20 cm (46–26 cm) the highest (Table 3).

Postoperative follow-up: NAC vascularity was good in 12 (80%) cases. The other three (20%) cases had congestion on the contralateral breast. One needed surgical intervention by repositioning of the flap in the original position before rotation and then reoperated for closure after 2 days. The other two had good vascularity after 2 days. Congestion occurred in one superiorly based flap and two medial flaps. Wound dehiscence occurred in three (20%) cases, where two of them were managed by secondary sutures and the other one was managed conservatively by dressing (Fig. 14). Seroma formation occurred in three (20%) cases and were managed conservatively. Wound site infection occurred in a single case and was managed by antibiotics with no need for drainage. Hematoma occurred in a single case (confirmed by ultrasound) and was managed by conservative management with no need for evacuation. Average follow-up was 6.5 months, with 1–13-month range. All patients recovered completely after 7 weeks from the primary surgery. There was no case of recurrence at the time of follow-up (Table 4).

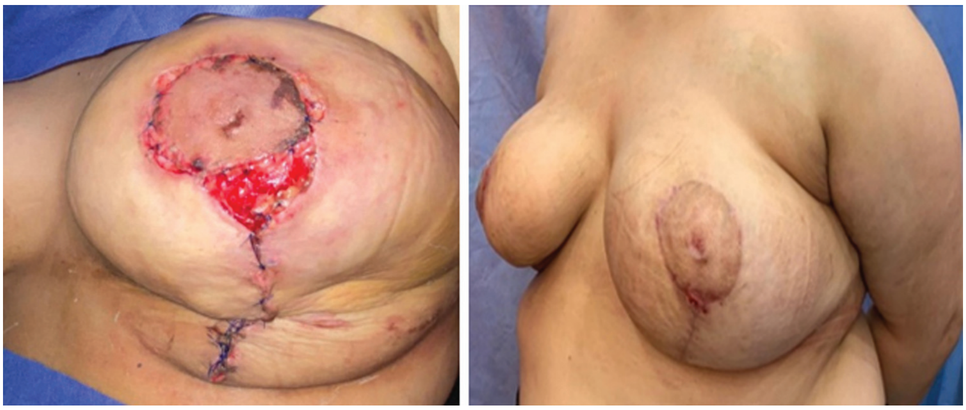
Table 3 Amount of excision of both breasts in each patient

Patient-affected side	Ipsilateral	Contralateral
Right	423 g	0 g
Left	609 g	653 g
Right	556 g	576 g
Left	2612 g	2579 g
Right	527 g	591 g
Left	258 g	236 g
Right	316 g	0 g
Right	2115 g	2386 g
Right	1124 g	1324 g
Left	1153 g	1296 g
Right	1254 g	1348 g
Right	264 g	275 g
Left	1236 g	1342 g
Right	736 g	853 g
Left	464 g	512 g

Figures 15–17 show preoperative and late postoperative photographs of some patients.

Cosmetic outcome: cosmetic outcome was evaluated by the surgeon, the patient, and the breast multidisciplinary team by postoperative photographs and then photographs at 2 weeks and 1 month of follow-up. Evaluation was done by means of scoring system, which was graded from 1 to 5, with one indicating poor results and five indicating excellent results. Cosmetic outcome was estimated using a scoring system that included two independent

Figure 14



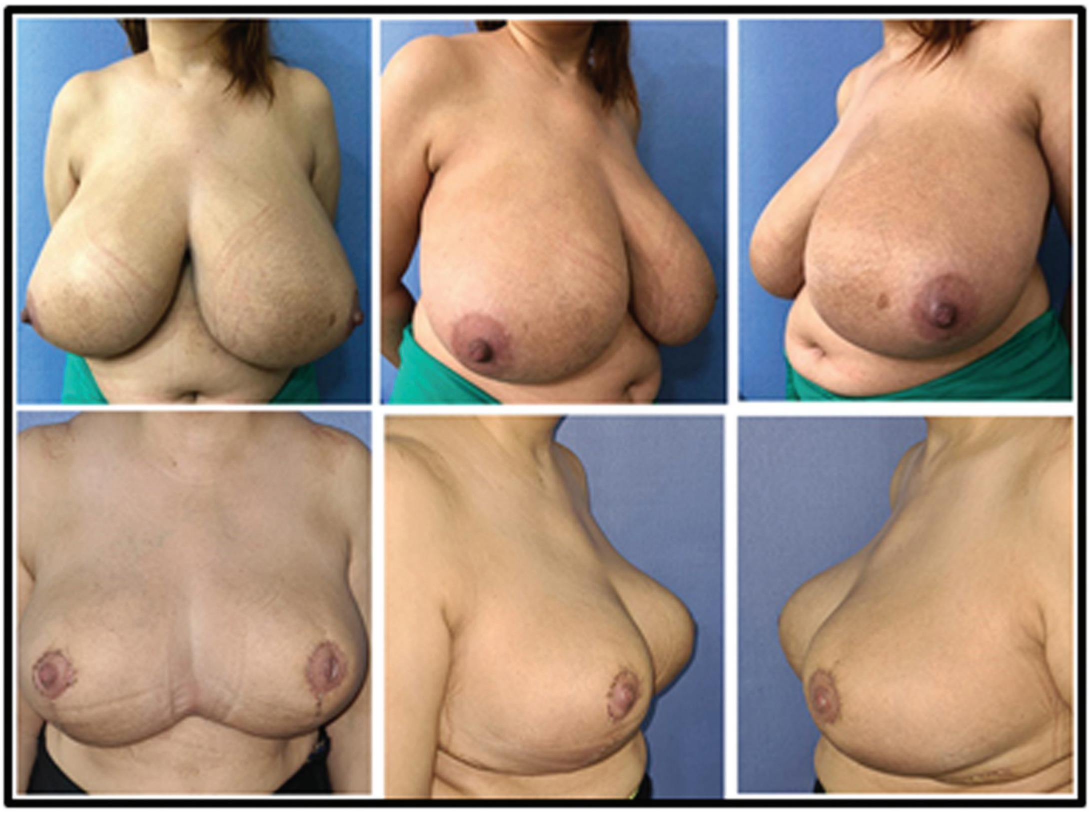
Postoperative disruption of sutures and complete healing with dressing after 6 weeks with no delay for radiotherapy or chemotherapy.

Table 4 Complications for the entire study

Complications	Number of patients	Management
All complications	6	
Wound breakdown	1	Conservative in 1
	2	Secondary sutures
Seroma	3	Conservative
Hematoma	1	Conservative
Wound infection	1	Conservative
NAC congestion	3	1 reoperated to restore vascularity
		2 conservative

NAC, nipple–areolar complex.

Figure 15



Preoperative and postoperative photographs of a 42-year-old female patient with right breast mass (1×1) (IDC) in the upper lateral quadrant who underwent oncoplastic reduction of right breast and reduction of left breast. The medial perforators were the dominant and superiomedial pedicle was used in both sides with excision amount about 1300 g from each breast.

Figure 16

Preoperative and postoperative photographs of a 48-year-old female patient with left breast mass (2×1) (IDC) in the upper medial quadrant who underwent oncoplastic reduction of left breast and reduction of right breast. The lateral thoracic perforators were the dominant and lateral pedicle was used in both sides with excision amount about 2500 g from each breast.

Figure 17

Preoperative and postoperative photographs of a 43-year-old female patient with right breast mass (2×1) (IDC grade 2) in the upper medial quadrant who underwent oncoplastic reduction of right breast only. Based on superior perforator coming from the thoracoacromial artery (1.5 ml in size).

Table 5 Postoperative cosmetic scoring system

5	Excellent
4	Very good
3	Good
2	Fair
1	Poor
0	Ugly

Table 6 Mean cosmetic outcome for our study

	Mean±SD	Minimum	Maximum
Cosmetic outcome	4.23±0.86	2.00	5.00

grading parties (surgeon and patient) by postoperative photographs and then photographs at 2 weeks and 1 month of follow-up. Based on the level of satisfaction, an overall score was given for cosmetic outcome (Tables 5–7). Based on the level of satisfaction to give an overall score, the cosmetic outcome score was made up through a checklist to be evaluated by the grading parties for every single case. This checklist consisted of the overall shape of the breast, the symmetry of both breasts, the site and direction of the nipple, the volume of the breast, and the skin incision shape (Fig. 18).

These elements were discussed for every single case and analyzed to give a scoring system graded from 1 to 5 as follows:

Table 7 Number of cases for every score of cosmetic outcome

Cosmetic outcome	*n* (%)
Score 5	10 (66)
Score 4	3 (20)
Score 3	1 (6)
Score 2	1 (6)
Score 1	0
Score 0	0

The overall mean score of our study was 4.23, which falls between very good and excellent (Table 6).

The following is the number of cases for each grade of the scoring system for the whole study.

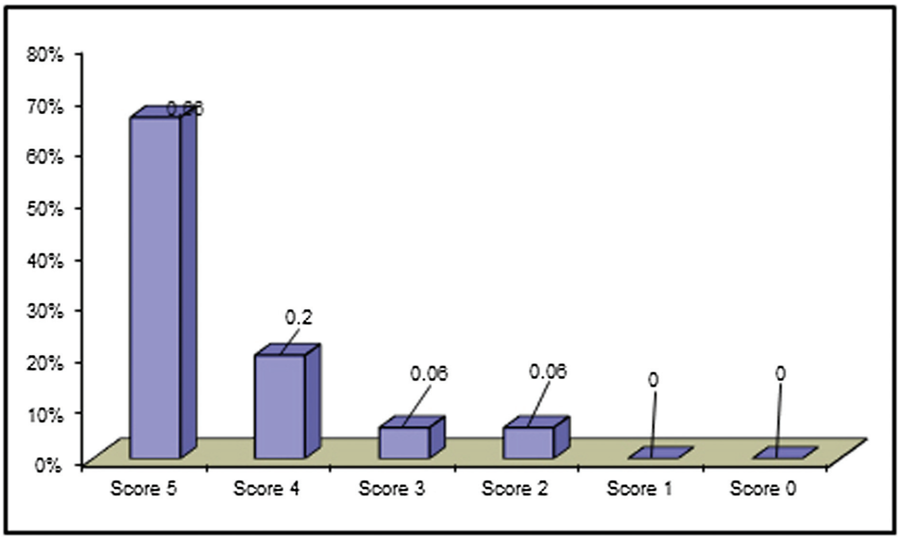
The number of cases given excellent score (score 5) was 10, the number of cases given very good score (score 4) was 3, the number of cases given good score (score 3) was 1, the number of cases given fair score (score 2) was 1, the number of cases given poor score (score 1) was 0, and the number of cases given ugly score (score 0) was 0.

Contralateral breast mammoplasty and symmetrization was done in the same setting except in two patients.

Discussion

Worldwide, breast cancer is the most common cancer in women, accounting for 25% of all cases. Outcomes

Figure 18



Postoperative cosmetic outcome.

for breast cancer vary depending mainly on the cancer type, extent of disease, and person's age. Survival rates in developed countries can be high, reaching 80% for at least 5 years [8].

Oncoplastic breast surgery is based on three basic principles: ideal breast cancer surgery with wider excisions, immediate breast reconstruction, and immediate symmetry of the other breast whenever necessary [9].

The most appropriate approach in women with Brassiere cup size C, D, or larger with coexisting ptosis is a bilateral reduction technique. This approach provides the most desired oncological outcome with attention to the cosmetic result. Additionally, it results in a higher patient satisfaction rate owing to their perception of improved esthetic outcomes. Our study provided a way to do massive oncoplastic reductions with minimal complications, adequate tumor removal, and good cosmetic outcome.

Oncoplastic reductions were able to deal with some patients with severe macromastia with malignancy, but owing to some tumor locations and severe macromastia, the blood supply of NAC may be altered or destroyed necessitating the urge to locate the feeding vessels of NAC to avoid postoperative vascular compromise, which causes delayed wound healing and full recovery which delays administration of radio or chemotherapy needed for completion of full recovery from malignancy [10].

Therefore, in our study, we present a way to locate the feeding vessels with high accuracy to be able to elevate NAC flap with good vascularity with minimal wound complications that would not delay completion of tumor treatment.

Vascular variability and overlap may account for the remarkable safety and diversity of NAC-bearing pedicles. However, in huge breasts with tumors, breast basic vessels are altered by enlarging breast tissues and tumor itself, so many authors suggested using multiple imaging techniques to locate the main and secondary vessels supplying NAC to ensure good outcome regarding healing and esthetic outcome, together with full tumor excision with enough safety margins [11].

In an anatomical study, Chiari found variations in the blood supply of the breast between the left and the right sides of the same cadaver in the form of partial or complete absence of branches to the NAC from the main sources. Consequently, they concluded that it is difficult for a surgeon to suspect the blood supply of the breast that is to be operated upon. This was also our observation during perforator detection, where we found that in five cases, the perforator supplying the NAC differed between the right and left breasts of the same patient. We had four (26.6%) cases with different dominant blood supply of NAC [12].

NAC necrosis was reported to be 6% in the superior pedicle technique of reduction mammoplasty and 1.28% in the superolateral pedicle technique [13].

To decrease the incidence of NAC necrosis, some authors tried a preoperative detection of the course of the arteries supplying the NAC and included them in their pedicles.

Hall-Findlay *et al.* [14] documented 126 breasts in 63 patients with a predictable pattern of internal mammary artery perforators in true superomedial pedicled flaps.

Horta *et al.* [15] reported the preoperative use of Doppler ultrasound for detection of perforators in 22 cases of breast hypertrophy. They reported excellent results with an average resection weight of 820 g per breast, and the incidence of NAC necrosis was nil.

Abdel Aal and Al Mahmoudy [16] did a study on 20 patients who underwent superior pedicle breast mastopexy with augmentation of its blood supply with a medial perforator mapped preoperative MRA. None of the patients had NAC complications (nipple–areolar necrosis or sloughing). Satisfactory long-term results with good upper pole fullness were reported.

A study by Elmelegy and colleagues on 105 patients found that the dominant perforators were found to come from the internal mammary artery in 35 cases, from the lateral thoracic artery only in 20 cases, from both arteries in 30 cases, from anterior intercostal arteries in eight cases, and from the thoracoacromial artery in 12 cases. Therefore, none of the cases of this study experienced NAC necrosis. However, ischemia occurred in seven cases where the supplying perforators were small in size and with low power signals [17].

The classic medial pedicle without use of any imaging technique in marking may not be vascularized, and as in an anatomical study, the blood supply of superomedial pedicle came from the first and fourth internal mammary artery perforators with the absence of the second and third. The other breast in the same cadaver was supplied with the third perforator of the internal mammary artery, with the first, second, and fourth perforators absent. This is a clear example that demonstrates the basis of our technique and the significant value of preoperative detection of perforators [17].

In our study, we found also that internal mammary artery perforators (mainly second and third) run at distances of 10.3 and 4.2 mm from the skin surface, respectively. The accompanying veins run at 2.6 and 3 mm. Therefore, the incisions we made at the dermal level of the base of the pedicle do not affect the perforators that run in the pedicle and, at the same time, allow for shaping, maximum mobility, and rotation of the pedicle.

In all our 15 cases, we had no one case of NAC necrosis, but three (20%) cases experienced NAC congestion: two of them healed under conservative treatment and the other one needed repositioning of the medial pedicle in the original orientation to relieve congestion and then reoperated for repositioning of the flap.

Fredman and colleagues reported that although more common than arterial insufficiency, venous congestion of the NAC during breast reduction surgery is a relatively uncommon complication. They were confronted with a case of postreduction mammoplasty severe congestion, and they used leeches as treatment with successful results [18].

In our cases, we kept the dermis around the NAC, as well at the medial end of the pedicled flap. This helped to keep the superficial veins, so we had only two cases with mild venous congestion and one case of severe congestion, which was relieved by reposition of the flap.

The operative duration of our study was long at first (155 min) but with progression of our study, the operating time was reduced to 90 min, within an average of 134 min for the affected breast only.

A total of three cases with seroma formation and one case of hematoma formation were managed in a conservative way.

None of the previously stated complications resulted in delay of postoperative adjuvant therapy, and all patients were sent to receive their appropriate therapy according to schedule.

In a large study by Deigni and colleagues on patients treated with oncoplastic breast-conserving surgery using mastopexy/ breast reduction techniques, it was found that immediate symmetrizing mastopexy was not associated with a higher rate of overall or major complications, or delay to any adjuvant therapy, when compared with delayed (or no) mastopexy/ breast reduction for symmetry [19].

In weighing the risks of potential treatment delay against the benefits of a single operative episode and eliminating the duration of asymmetry, there are subtle reconstructive considerations that merit discussion. If the breasts are very large and the planned resection is correspondingly significantly large in volume, the level of asymmetry will be dramatic and the decision to achieve an acceptable level of symmetry in a single operative episode may be clear. If, in contrast, the breasts are small to medium size with minimal to moderate ptosis, and/or the volume of resection is small, the level of asymmetry following breast-conserving therapy may be less obvious, and thus getting the symmetry procedure 'just right' is inherently more subtle and challenging. In such patients, it may also not be entirely clear whether a volume displacement procedure will be of more benefit than a delayed additive procedure such as fat grafting, or volume replacement techniques. These circumstances make the decision to perform an immediate symmetry procedure less clear cut. As with all breast reconstruction, careful consideration of each patient's breast size, tumor size, and location and individual esthetic goals must be factored into a shared decision-making process [19].

In our study, 13 (86.6%) patients underwent symmetrization procedure in the same session with no delay in postoperative adjuvant therapy with good cosmetic outcome.

It is well documented that a delay between lumpectomy for invasive carcinoma and radiation therapy or chemotherapy of more than 8 weeks is associated with an increased risk of disease recurrence, and there is therefore general agreement and support among radiation and medical oncologists that a time interval of greater than 8 weeks constitutes a delay to adjuvant therapy [19].

Delay to adjuvant therapy is an unintended consequence of complications of surgical procedures, and it should always be borne in mind that oncoplastic breast-conserving surgery is an oncologic procedure with cure as the goal of care; efforts should therefore be concentrated on avoiding delays to adjuvant treatments to preserve the survival benefit of these therapies. Careful patient selection regarding the choice of technique and timing of the contralateral symmetrizing mastopexy with consideration of body mass index, diabetes mellitus, and breast size and active cigarette smoking status is therefore prudent to reduce the risk of complications or delay to adjuvant therapy in this complex patient population [19].

In our study, the maximum period needed for complete healing was 7 weeks, and we had no delay for adjuvant therapy for any of our patients.

In our study, we were able to conduct an excellent cosmetic outcome for a relatively large tumor excisions, with 66% of the cases (10 patients) falling in excellent and very good score groups, with mean cosmetic outcome score of 4.23. Another 20% (three cases) fell in the good and fair score groups, as those two patients noticed asymmetry of the two breasts in front of the mirror as they refused bilateral breast reduction mastopexy. None of our cases were in the poor or ugly score groups.

It was published by Jagsi and colleagues that on a five-point satisfaction with reconstruction outcome scale, the satisfaction score was 4.7 for patients receiving autologous reconstruction without radiation, 4.4 for patients receiving autologous reconstruction and radiation therapy, 4.1 for patients receiving implant reconstruction without radiation, and 2.8 for patients receiving implant reconstruction and radiation therapy [20].

Conclusion

The use of MRA preoperatively in oncoplastic reductions helps ensure good blood supply for NAC, especially in huge breasts with malignant tumors.

Therefore, using MRA preoperatively can be a helpful tool in cases of huge oncoplastic reductions with excellent reliable esthetic outcomes. Moreover, it might be of great importance in other studies involving different pedicles or in cases of nonmalignant huge reductions.

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Conflicts of interest

No conflict of interest.

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