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ORIGINAL ARTICLE BREAST SURGERY

Skin-Reducing Mastectomy and Pre-pectoral Breast Reconstruction in Large Ptotic Breasts

Michele Maruccia[1] · Rossella Elia[1] · Angela Gurrado[2] · Marco Moschetta[3] · Eleonora Nacchiero[1] · Alberto Bolletta[4] · Mario Testini[2] · Giuseppe Giudice[1]

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Abstract

Objectives Pre-pectoral breast reconstruction is increasingly offered to breast cancer patients, as the one-stage technique has proved surgical and oncological safety and aesthetic effectiveness. Nevertheless, there are limited data on outcomes after pre-pectoral breast reconstruction in large and ptotic breasts. The aim of the paper is to present the authors' experience in performing Wise pattern mastectomy with pre-pectoral implant and complete acellular dermal matrix (ADM) coverage as a single-stage procedure in patients with large ptotic breasts.

Materials and Methods A retrospective review of protective collected data from January 2017 to June 2019 of patients who presented with large and ptotic breasts undergoing skin-reducing mastectomy and immediate pre-pectoral breast reconstruction with complete ADM coverage and inferior dermal sling was performed. Oncological and surgical outcomes were collected. Satisfaction with reconstruction and related quality of life were evaluated through BREAST-Q questionnaire.

Results Nineteen patients met the inclusion criteria. The average patient age was 55.6 years, and the mean body mass index was 31.2. Mean follow-up was 23.2 months from the initial reconstruction. One patient experienced seroma, and two cases of wound dehiscence at the T junction were observed and treated conservatively with no implant loss. All patients were satisfied with the final reconstruction.

Conclusion The Wise pattern skin-reducing mastectomy and pre-pectoral breast reconstruction could be offered to patients presenting with large and ptotic breasts. Future studies should better define long-term outcomes.

Level of Evidence IV This journal requires that authors assign a level of evidence to each article. For a full description of these Evidence-Based Medicine ratings, please refer to the Table of Contents or the online Instructions to Authors www.springer.com/00266.

Keywords Pre-pectoral breast reconstruction · ADM · Breast cancer

Introduction

Skin-sparing mastectomy with simultaneous pre-pectoral implant reconstruction is increasingly offered to breast cancer patients and to women opting for risk-reducing mastectomies. Changing the position of the reconstruction from the subpectoral to the pre-pectoral plane has offered the opportunity to negate several effects seen with subpectoral implant positioning, such as animation deformity, reduction in function and strength due to partial or complete loss of normal muscle fiber architecture [1–6] and postoperative pain [7].

✉ Rossella Elia
rossellaelia4@gmail.com

[1] Division of Plastic and Reconstructive Surgery, Department of Emergency and Organ Transplantation, University of Bari Aldo Moro, Piazza Giulio Cesare, 11, 70124 Bari, Italy

[2] Department of Biomedical Sciences and Human Oncology, University of Bari Aldo Moro, Piazza Giulio Cesare, 11, 70124 Bari, Italy

[3] Interdisciplinary Department of Medicine, Section of Diagnostic Imaging, University of Bari Aldo Moro, Piazza Giulio Cesare, 11, 70124 Bari, Italy

[4] Department of Plastic and Reconstructive Surgery, China Medical University Hospital, Taichung, Taiwan

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Despite the promising results, patients with macromastia and ptotic breast remain a challenging group to treat. They often require corrective procedures and can experience a high failure rate with unsatisfactory outcomes [8, 9]. In patients with large ptotic breasts, the preservation of the entire skin envelope results in long and often unreliable mastectomy skin flaps and tends to have aesthetically displeasing qualities secondary to skin flap redundancy and blunting of the breast contour. A Wise mammoplasty pattern with a de-epithelialized dermal sling and submuscular direct-to-implant has been described by Nava et al. [10] to optimize implant-based reconstruction in this patient population.

The combination between a skin-reducing mastectomy (SRM) through a Wise pattern incision and ADM–implant reconstruction has been recently proposed by a few authors to offer pre-pectoral breast reconstruction also in patients with large ptotic breasts. Caputo et al. [11] suggested creating a complete pre-pectoral pocket with a dermal flap along with ADM for lower- and upper-pole coverage, respectively. Thuman et al. [12] demonstrated that a pre-pectoral, two-stage breast reconstruction with Wise pattern skin reduction can be a suitable option in patients who have a high BMI.

The authors present their experience in performing a Wise pattern SRM with pre-pectoral implant and complete ADM coverage as a single-stage procedure in patients with large ptotic breasts.

Materials and Methods

A prospective data collection of the all the Wise pattern mastectomies pre-pectoral breast reconstructions performed over a 29-month period (January 2017–June 2019) was carried out by the authors. This study followed the Declaration of Helsinki on medical protocols and ethics, and the ethical review board of our institution had already approved the use of acellular dermal matrix for breast reconstruction. A written informed consent with detailed information concerning its advantages, disadvantages and complication rates was given, supported by scientific data present in the medical literature. Patients that declined to have the pre-pectoral procedure had traditional breast reconstruction techniques. The work has been reported in line with STROBE guidelines [13].

Patients' Selection

All patients that fit the following criteria were considered candidate for the proposed procedure. Inclusion criteria include (1) immediate breast reconstruction; (2) immediate delayed breast reconstruction following neoadjuvant therapy; (3) risk-reducing surgery; and (4) patients with grade 3 breast ptosis and anticipated breast weight more than 500 g. Exclusion criteria include (1) patients affected by stage IV disease or any patients deemed at high risk of recurrence; (2) history of preoperative radiation; and (3) patients with comorbidities such as uncontrolled diabetes, morbid obesity, chronic immunosuppression or active tobacco use. Patients expected to receive postoperative radiation were not excluded from the study.

Surgical Technique

All the procedures were performed jointly by oncological and reconstructive surgeons. The oncological surgeons first undertook the Wise pattern skin-reducing mastectomy with de-epithelialization of the inferior dermal sling and any necessary axillary surgery through a separate skin incision. When performing the mastectomy, the key to deciding to proceed with single-stage reconstruction with pre-pectoral implant was based entirely on adequacy of mastectomy skin flap perfusion with a temporary sizer in place. This requires maintaining the superficial circulation of the breast by preserving the subcutaneous breast layer by precise dissection at the level of the superficial breast fascia. Intraoperative evaluation of a reasonable subcutaneous layer over the breast tissue (> 1 cm) was mandatory, and indocyanine green dye laser-induced fluorescence imaging represented an adjunctive tool to assess for tissue perfusion. If perfusion was marginal, an under-filled expander was inserted in a submuscular pocket. If skin perfusion was adequate, the mastectomy pocket and skin were prepared. The pocket was rechecked with a sizer in place to ensure the correct shape and position of the implant.

A pre-shaped, 0.6-mm-thick, porcine, noncross-linked ADM Braxon® (MBP Biologics, Neustadt-Glewe, Germany, license holder Decomed, Marcon, Venezia, Italy) was used in our study. The ADM was soaked in normal saline for 5–10 min to rehydrate, and then, the selected implant was placed and wrapped within the matrix with the edges sutured together with interrupted absorbable sutures (2–0 polyglactin) to form a tight pocket. The implant was irrigated with 80 mg gentamicin before insertion into the acellular dermal matrix. The preparation of ADM and prosthesis was performed on a separate sterile desk, and a smooth implant was chosen in all cases.

The ADM containing implant was subsequently placed onto the pectoralis and anchored with apical, medial and lateral absorbable sutures (3–0 polyglactin) directly on to the chest wall, allowing for neovascularization to occur and incorporating the biomaterial into the surrounding tissues for a stable, permanent cover. The inferior dermal sling was then positioned over the implant/ADM. A quilting absorbable suture was performed between the frontal part

of the ADM and the subcutaneous layer superiorly and the dermal sling inferiorly in order to remove dead spaces and locate the matrix in close contact with the vascularized tissue. The pocket was closed laterally to define the inframammary fold by suturing the dermal flap to the fascia of the serratus anterior.

Two suction drains (Blake's size 10) were inserted in the subcutaneous and axillary pockets, if lymph node dissection was performed. Deep dermal and subcuticular closure was subsequently achieved with 3/0 polyglactin and 3/0 poliglecaprone sutures, respectively, in an inverted T fashion. The drains were maintained until drainage was less than 20–25 cc/daily for 2 days.

When oncologically possible (i.e., fresh-frozen retroareolar biopsy results were negative), the nipple–areola complex was preserved and it was either superiorly pedicled or harvested as a full-thickness skin graft and grafted to the new position, depending on the preoperative sternum–nipple distance and the intraoperative ICG findings. Perioperative antibiotics (teicoplanin 800 mg) were given 30 min before the surgical incision (Fig. 1).

Data Collection and Outcome Evaluation

Patients demographics, medical history, family history and surgical details were collected from our prospectively designed databases. Details regarding postoperative complications were examined during the periodic checks at 7, 15, 30 and 90 days and at 6, 12 and 24 months.

Operative complications were ranked according to the Clavien–Dindo classification [14].

Records were reviewed for the following complications: surgical site infection (SSI), defined as culturally proven infection and/or removal of the implant without immediate replacement per the Centers of Disease Control and Prevention (CDC) guidelines for SSI [15]; early and late seroma, defined as palpable fluid collection on clinical examination with or without imaging confirmation; mastectomy skin flap necrosis; wound dehiscence; capsular contracture (Baker scale); hematoma, red breast syndrome; and rippling implant extrusion. The rates of unplanned readmissions, unplanned return to the operating room and

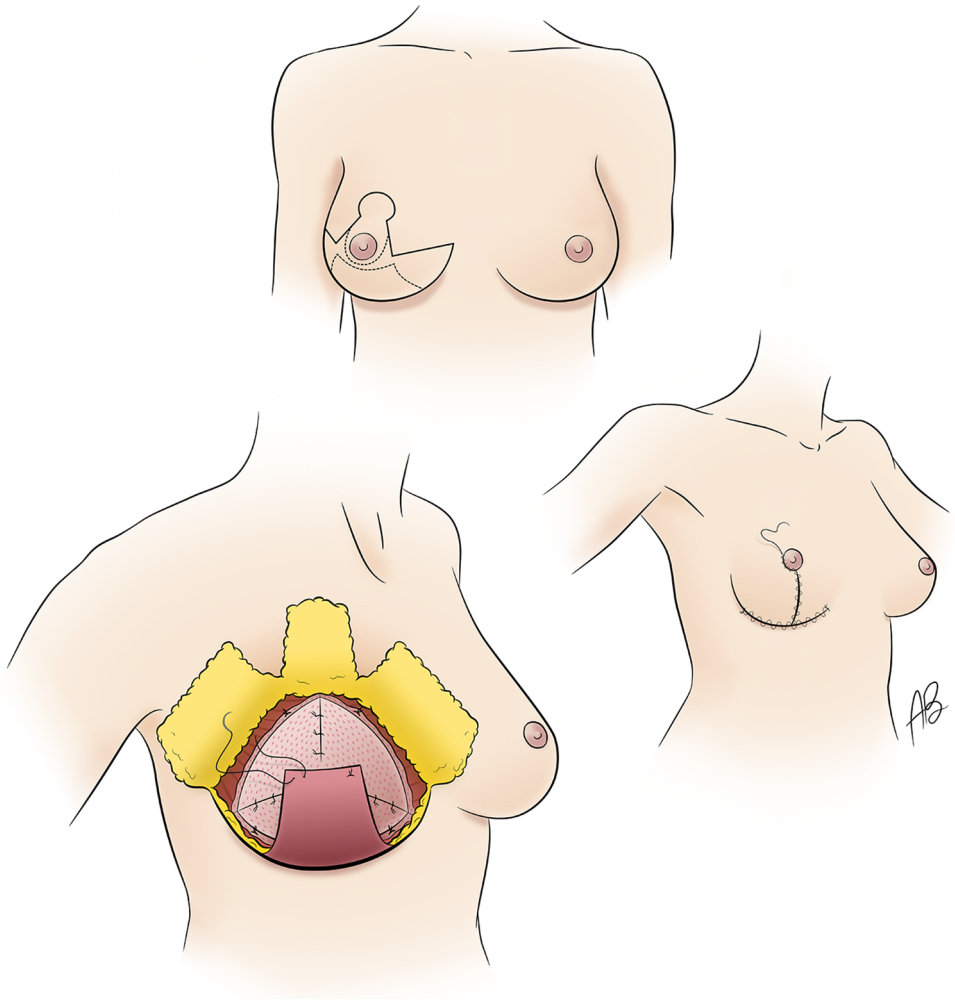

Fig. 1 Surgical technique. The upper panel shows the preoperative markings. The intraoperative view clarifies the key suture points, namely the anchor sutures of the ADM to the chest wall (apical, medial and lateral). The inferior dermal flap is sutured on the anterior surface of the ADM, before the final closure of the mastectomy flaps in an inverted *T*-shaped fashion

status of the implant after return to the OR were obtained. Rates of local and distant recurrence were also recorded.

Health-related quality of life (HRQOL) evaluation was conducted using the preoperative and the postoperative BREAST-Q modules for reconstructive surgery [16]. Patients received the preoperative questionnaire 1 month before surgery. The BREAST-Q postoperative module was administered 1 year after the completion of the reconstruction during a clinic visit.

Statistical Analysis

Statistical analysis was conducted using SPSS 25.0 software (IBM Corp., Armonk, NY). Continuous variables were described as mean ± standard deviation (SD) and range. The Shapiro–Wilk test was used to verify for normal distribution of continuous variables. Consequently, BREAST-Q scores were analyzed as continuous variables using the Student t test. *P* values less than 0.05 were considered statistically significant.

Results

Wise pattern and pre-pectoral breast reconstruction was performed in 23 cases in 19 women (15 unilateral, 4 bilateral). Mean follow-up was 23.2 months from the initial reconstruction. The average patient age was 55.6 years, and the mean body mass index was 31.2.

All patients were affected by stage II or III breast cancer. Eight patients underwent adjuvant chemotherapy. Three patients were candidate to PMRT. The resected breast weight ranged from 750 to 1300 g. Two NACs were positive for cancer; seven NACs were immediately grafted with complete attachment but small areas of dyschromia. The remaining 14 were left attached to the superior pedicle, and 1 of them developed partial loss healed by second intention. Mean permanence of drains was 4.7 days (range 3–7 days).

Contralateral adjustments were performed for 9 patients at the same time of the breast reconstruction and for the other 5 patients as a delayed procedure. All women underwent a medial–central septum-based mammoplasty [17, 18]. Mean hospital stay was 2.48 days. There was no local recurrence or distant disease during the follow-up period. A summary of patients' demographics, oncological and reconstructive data is presented in Table 1.

The crude overall complication rate was 21%. No major implant-related complications were observed, and no unplanned return ton operating room or readmission was required. One patient experienced early breast seroma, while two patients had wound dehiscence at the *T* junction. All cases of wound dehiscence were managed conservatively, and no implant loss was observed (Table 2).

All the patients adequately filled the five domains of the questionnaire and were included in the analysis. Table 3 accounts for the self-reported measures of HRQOL, evaluated with BREAST-Q questionnaire. Patient scored high level of satisfaction with outcome. Overall satisfaction with breasts, psychosocial well-being and sexual well-being were all significantly increased after surgery ($p < 0.05$) (Figs. 2 and 3).

Discussion

Wise pattern skin-reducing mastectomies and immediate breast reconstruction for large breast volumes are inherently associated with the risk of mastectomy skin flap necrosis and "*T*" junction breakdown, besides the fact that larger breasted individuals requiring skin reduction may carry other contributory patient risk factors, such as an elevated BMI [19]. Actually, *T* junction healing complications, with subsequent implant exposure, have been reported in up to 27% of cases [10, 20].

Initially, the reason for this complication stemmed from the fact that the inferior portion of the implant was located directly under the inverted "*T*" incision line, which frequently experiences malperfusion and break down [21]. The technique was further modified by Bostwick who utilized the de-epithelialized inferior breast skin to enhance the coverage of the implant under the troublesome skin juncture [22]. In this approach, the superior edge of the de-epithelialized skin flap was sutured to the inferior edge of the raised pectoralis major muscle, creating thus a separate well-vascularized implant pocket [20, 22]. Although the risk of implant exposure decreased with the use of the inferior mastectomy skin flap, the drawbacks associated with subpectoral implant placement persisted.

Considering the benefits of the pre-pectoral breast reconstruction and willing to offer one-stage pre-pectoral breast reconstruction also to women who presented with large and ptotic breasts, we thought to combine the use of skin-sparing mastectomy (SSM) with pre-pectoral implant and complete ADM coverage with the harvest of the inferior dermal sling [9]. The benefits of the pre-pectoral breast reconstruction have been deeply discussed in the literature [4, 6, 8, 23–30] and include less patient pain and discomfort, no need for postoperative expansion, less tissue flap edema and virtually no subjective negative impact on upper extremity function. Additionally, animation deformity has been completely eliminated and a protective effect against radiotherapy and capsular contracture has been postulated. ADM does not contain fibroblast or myofibroblast and does not lay down abnormal collagen as

Table 1 Patient's data

No. of patients	19
Monolateral breast reconstruction	15
Bilateral breast reconstruction	4
No. of breasts	23
Average age, years (SD) (range)	55.6 (3.62) (38–65)
Average BMI (kg/m^2) (SD) (range)	31.2 (2.9) (26.5–43.1)
Diabetes	
Yes	2
No	19
Indication for surgery (*n*)	
DCIS	3
IDC	9
ILC	8
Prophylactic	3
Lymph node management (*n*)	
SLNB	14
ALND	9
Radiation (*n*)	
Before reconstruction	0
During or after reconstruction	3
None	15
Chemotherapy (*n*)	
Neoadjuvant	0
Adjuvant	8
Time of reconstruction (*n*)	
Immediate	19
Delayed	0
Tertiary reconstruction	0
Average nipple-to-sternum nock distance (SD) (range)	29.8 (3.6) (26–35)
Mean hospital stay (SD) (range)	2.48 (0.9) (2–4)
Average follow-up, months (SD) (range)	23.2 (3.4) (18–29)
Average permanent implant volume, mL (SD) (range)	414.5 (55.5) (375–500)

Table 2 Surgical complications

Complications	N° (%) (CD grade[a])
Rippling	0
Red breast syndrome	0
Hematoma	0
Wound dehiscence	2 (10.5) (I)
Seroma	1 (5.3) (I)
Mastectomy skin flap necrosis	0
NAC necrosis	
Partial	1 (5.3) (I)
Complete	0
Surgical site infection	0
Implant loss	0
Capsular contracture	0

[a]Clavien–Dindo classification

a response to radiation therapy, avoiding implant migration [31, 32]. As a matter of fact, all patients reported satisfaction with the final results, as reflected in the significant improvement of the scores in all the domains of the BREAST-Q.

The main difference between our technique and the one presented by Caputo et al. [11] is to place the implant in a subcutaneous plane totally wrapped with a pre-shaped ADM as originally described by Berna in 2014 [6]. On the one hand, ADM-reinforced direct-to-implant reconstruction offloads direct pressure on the mastectomy flaps with the weight being taken almost entirely by the ADM [1]. This is achieved supporting the implant with fixation of the ADM/mesh to the chest wall and no other ADM available on market, except from the one used in our study, can wrap entirely the implant.

On the other, the de-epithelialized dermal flap purportedly obviates wound complications, protecting the

Table 3 BREAST-Q evaluation

PRO measures	Baseline		1 Year postoperatively		*p* value
	No.	Mean ± SD	No.	Mean ± SD	
Satisfaction with breast	19	65.2 ± 19.6	19	79.3 ± 15.2	< 0.05*
Psychosocial well-being	19	59.3 ± 18.4	19	81.4 ± 13.2	< 0.05*
Physical well-being	19	62.3 ± 19.1	19	80.2 ± 15.8	< 0.05*
Sexual well-being	19	51.7 ± 17.1	19	79.9 ± 14.9	< 0.05*

*means the *P* value is significant

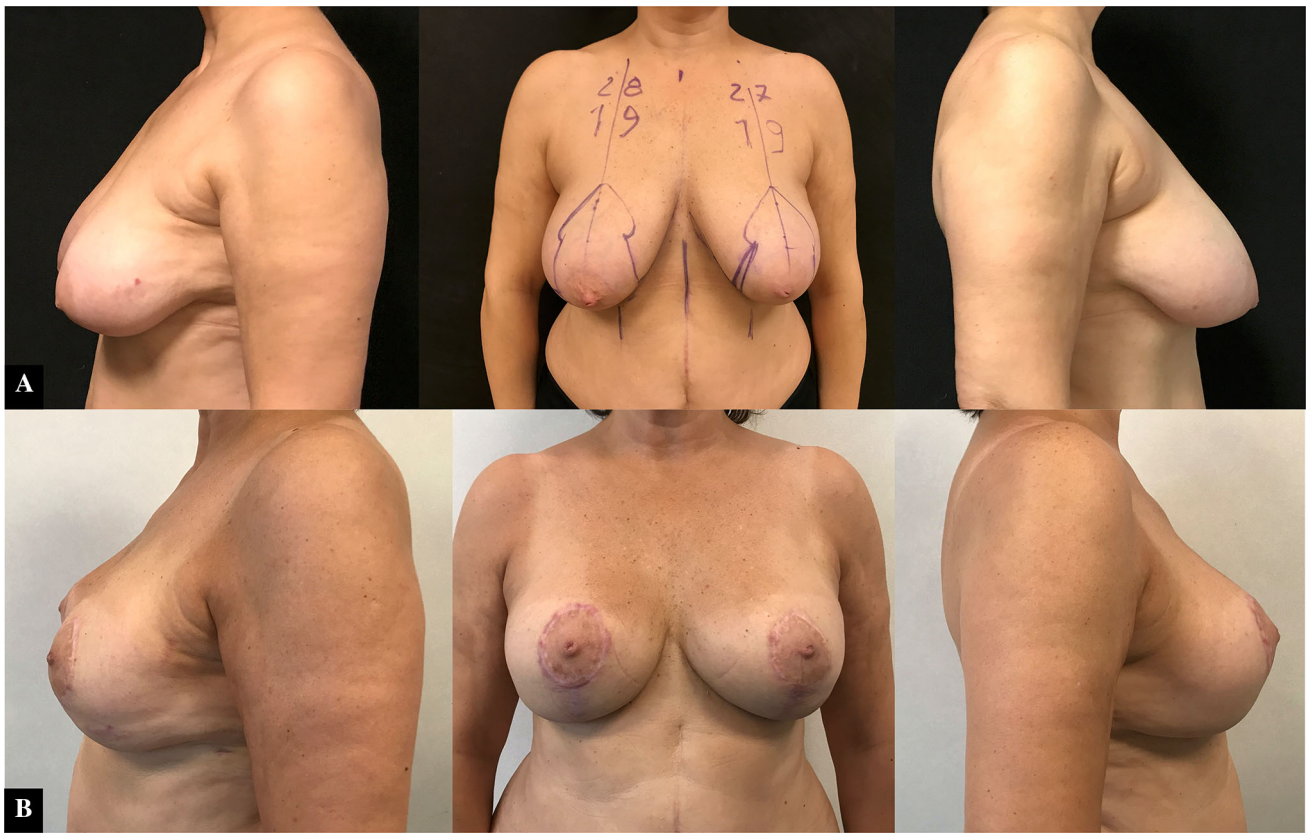

Fig. 2 Forty-nine-year-old patient who underwent bilateral Wise pattern skin and nipple-sparing mastectomy (left invasive lobular carcinoma breast cancer and prophylactic right breast procedure) and ADM–implant pre-pectoral breast reconstruction with inferior dermal sling. **a** Preoperative view. **b** Postoperative photographs (12 months)

underlying implant–ADM and improving the reconstruction reliability. In our case series, two patients experienced wound dehiscence and skin flap necrosis adjacent to the T junction. However, this breakdown did not lead to implant removal, as the implant was not exposed due to the overlying dermal sling and acellular dermal matrix combination. Rippling or clinical evidence of the upper pole of the implant could be problems associated with the pre-pectoral technique, but none of the above-mentioned complications was encountered. This evidence can be arguably explained because of the patients' habit and the short follow-up.

Synthetic meshes have been evaluated as cheaper alternatives to biological matrices in subcutaneous breast reconstruction, but implanting a nonabsorbable device still represents a concern for many surgeons [33]. Actually, no studies known to the authors have directly compared the use of synthetic and biological matrices in breast reconstruction. It is therefore very difficult to make any concrete comparisons between the two types of devices. We avoided to design a comparative study in this context too, because our main objective was to evaluate the safety of a skin-reducing pre-pectoral breast reconstruction with complete ADM coverage and the use of different devices (ADM vs mesh) could have been an obvious bias.

We still consider the intraoperative evaluation of mastectomy flap and NAC perfusion the key to optimize the

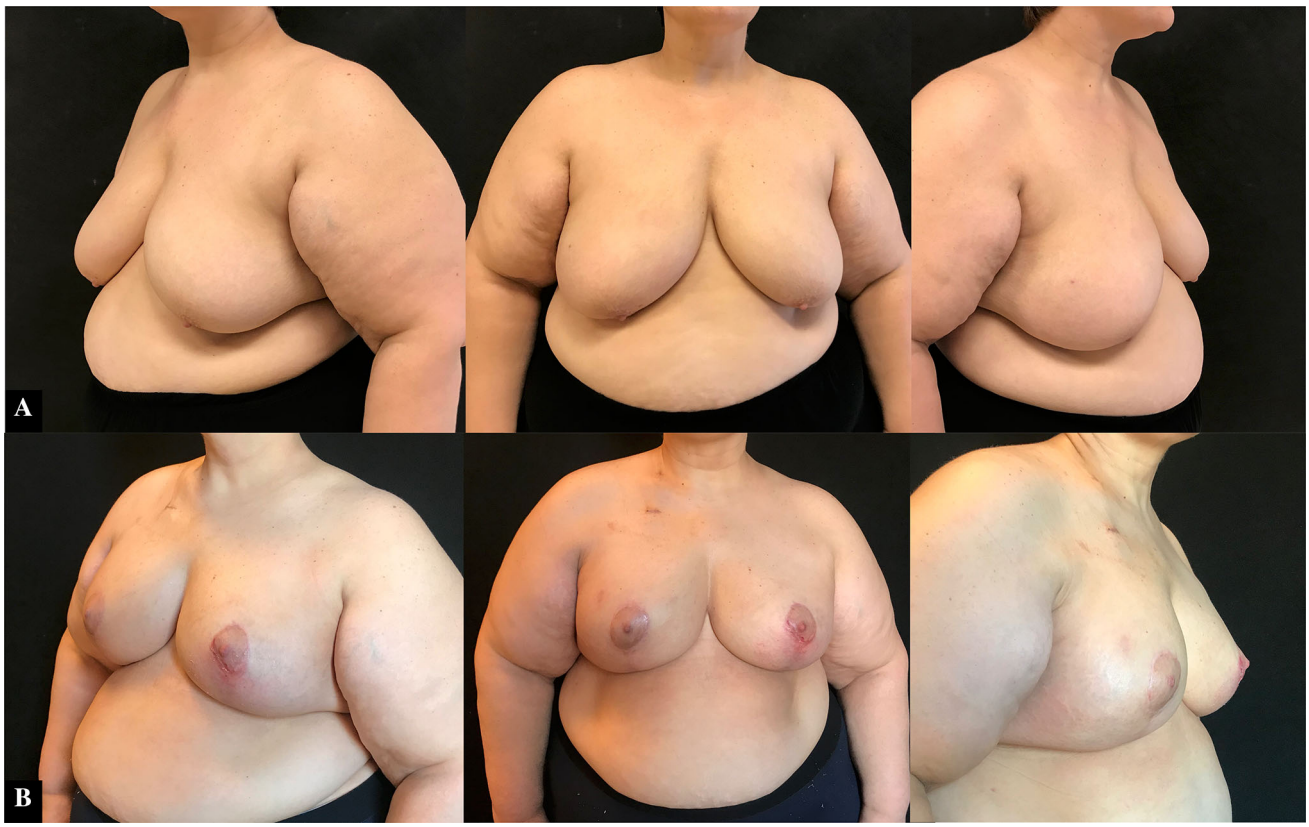

Fig. 3 Fifty-five-year-old patient who underwent bilateral Wise pattern skin and nipple-sparing mastectomy due to bilateral breast carcinoma. **a** Preoperative view (sternum notch to nipple distance: 35 cm). **b** Postoperative view at 6 months of follow-up. The patient experienced partial left nipple necrosis, healed conservatively

operative procedure. Perfusion assessment was, at best, an inexact science during the beginnings of implant-based breast reconstruction, but it has matured into a promising and reliable technology. Surgeons previously were reliant on clinical assessment and use of fluorescein. The advent of indocyanine green laser-induced fluorescence angiography was a turning point in mastectomy skin flap perfusion assessment, and multispectral near-infrared reflectance imaging is further improving perfusion assessment [34, 35].

Conclusion

The Wise pattern skin-reducing mastectomy and pre-pectoral breast reconstruction can be offered to large and ptotic breasts, thereby broadening the suitable population for pre-pectoral implant-based reconstructions and widening patient choices. Harvesting an inferior dermal sling could act as a protector, adding little time to the overall procedure. Additional research is warranted to evaluate long-term outcomes and compare pre-pectoral and subpectoral immediate breast reconstruction in patients with large and ptotic breasts.

Compliance with Ethical Standards

Conflict of interest All authors hereby declare not to have any potential conflict of interests and not to have received funding for this work. Each author participated sufficiently in the work to take public responsibility for the content and agree to its publication.

Ethical Approval This study followed the declaration of Helsinki on medical protocols and ethics, and the ethical review board of our institution had already approved the use of acellular dermal matrix for breast reconstruction.

Informed Consent Informed consent was obtained from all patients.

References

1. Jones G, Antony AK (2019) Single stage, direct to implant pre-pectoral breast reconstruction. Gland Surg 8(1):53–60. https://doi.org/10.21037/gs.2018.10.08
2. Hammond DC, Schmitt WP, O'Connor EA (2015) Treatment of breast animation deformity in implant-based reconstruction with pocket change to the subcutaneous position. Plast Reconstr Surg 135(6):1540–1544. https://doi.org/10.1097/PRS.0000000000001277
3. Gabriel A, Sigalove S, Sigalove NM et al (2018) Prepectoral revision breast reconstruction for treatment of implant-associated animation deformity: a review of 102 reconstructions. Aesthet Surg J 38(5):519–526. https://doi.org/10.1093/asj/sjx261

4. Ter Louw RP, Nahabedian MY (2017) Prepectoral breast reconstruction. Plast Reconstr Surg 140(5S):51S. https://doi.org/10.1097/PRS.0000000000003942
5. Berna G, Cawthorn SJ, Papaccio G, Balestrieri N (2017) Evaluation of a novel breast reconstruction technique using the Braxon® acellular dermal matrix: a new muscle-sparing breast reconstruction. ANZ J Surg 87(6):493–498. https://doi.org/10.1111/ans.12849
6. Vidya R, Masià J, Cawthorn S et al (2017) Evaluation of the effectiveness of the prepectoral breast reconstruction with Braxon dermal matrix: first multicenter European report on 100 cases. Breast J 23(6):670–676. https://doi.org/10.1111/tbj.12810
7. Cattelani L, Polotto S, Arcuri MF, Pedrazzi G, Linguadoca C, Bonati E (2018) One-step prepectoral breast reconstruction with dermal matrix-covered implant compared to submuscular implantation: functional and cost evaluation. Clin Breast Cancer 18(4):e703–e711. https://doi.org/10.1016/j.clbc.2017.11.015
8. Salibian AA, Frey JD, Karp NS (2019) Strategies and considerations in selecting between subpectoral and prepectoral breast reconstruction. Gland Surg 8(1):11–18. https://doi.org/10.21037/gs.2018.08.01
9. Giudice G, Maruccia M, Nacchiero E, Elia R, Annoscia P, Vestita M (2018) Dual plane breast implant reconstruction in large sized breasts: how to maximise the result following first stage total submuscular expansion. JPRAS Open 15:74–80. https://doi.org/10.1016/j.jpra.2017.11.003
10. Nava MB, Cortinovis U, Ottolenghi J et al (2006) Skin-reducing mastectomy. Plast Reconstr Surg 118(3):603–610. https://doi.org/10.1097/01.prs.0000233024.08392.14 **(discussion 611-613)**
11. Caputo GG, Marchetti A, Dalla Pozza E et al (2016) Skin-reduction breast reconstructions with prepectoral implant. Plast Reconstr Surg 137(6):1702–1705. https://doi.org/10.1097/PRS.0000000000002227
12. Thuman J, Freitas AM, Schaeffer C, Campbell CA (2019) Prepectoral wise-pattern staged implant-based breast reconstruction for obese or ptotic patients. Ann Plast Surg 82(6S Suppl 5):S404–S409. https://doi.org/10.1097/sap.0000000000001791
13. von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP (2007) The strengthening the reporting of observational studies in epidemiology (STROBE) statement: guidelines for reporting observational studies. PLoS Med. 4(10):e296. https://doi.org/10.1371/journal.pmed.0040296
14. Dindo D, Demartines N, Clavien P-A (2004) Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. Ann Surg 240(2):205–213
15. Surgical Site Infection (SSI) Event (2016) Centers for disease control and prevention. https://www.cdc.gov/nhsn/pdfs/pscmanual/9pscssicurrent.pdf. Accessed 1 Nov 2019
16. Pusic AL, Klassen AF, Scott AM, Klok JA, Cordeiro PG, Cano SJ (2009) Development of a new patient-reported outcome measure for breast surgery: the BREAST-Q. Plast Reconstr Surg 124(2):345–353. https://doi.org/10.1097/PRS.0b013e3181aee807
17. Giudice G, Maruccia M, Vestita M et al (2019) The medial-central septum based mammaplasty: a reliable technique to preserve nipple-areola complex sensitivity in post bariatric patients. Breast J 25(4):590–596. https://doi.org/10.1111/tbj.13291
18. Bucaria V, Elia R, Maruccia M, Vestita M, Boccuzzi A, Giudice G (2018) Methylene blue: a color test for a quality de-epithelialization. Aesthetic Plast Surg 42:1434–1435. https://doi.org/10.1007/s00266-018-1126-x
19. Inbal A, Gur E, Lemelman BT et al (2017) Optimizing patient selection for direct-to-implant immediate breast reconstruction using wise-pattern skin-reducing mastectomy in large and ptotic breasts. Aesthetic Plast Surg 41(5):1058–1067. https://doi.org/10.1007/s00266-017-0899-7
20. Hammond DC, Capraro PA, Ozolins EB, Arnold JF (2002) Use of a skin-sparing reduction pattern to create a combination skin-muscle flap pocket in immediate breast reconstruction. Plast Reconstr Surg 110(1):206–211. https://doi.org/10.1097/00006534-200207000-00035
21. Salgarello M, Visconti G, Barone-Adesi L et al (2012) Inverted-T skin-reducing mastectomy with immediate implant reconstruction using the submuscular-subfascial pocket. Plast Reconstr Surg 130(1):31–41. https://doi.org/10.1097/PRS.0b013e3182547d42
22. Carlson GW, Bostwick J, Styblo TM et al (1997) Skin-sparing mastectomy. Oncologic and reconstructive considerations. Ann Surg 225(5):570–575. https://doi.org/10.1097/00000658-199705000-00013 **(discussion 575–578)**
23. Antony AK, Robinson EC (2019) An algorithmic approach to prepectoral direct-to-implant breast reconstruction: version 2.0. Plast Reconstr Surg 143(5):1311–1319. https://doi.org/10.1097/prs.0000000000005519
24. Baker BG, Irri R, MacCallum V, Chattopadhyay R, Murphy J, Harvey JR (2018) A prospective comparison of short-term outcomes of subpectoral and prepectoral strattice-based immediate breast reconstruction. Plast Reconstr Surg 141(5):1077–1084. https://doi.org/10.1097/PRS.0000000000004270
25. Vidya R, Green M (2019) Minimal pain with prepectoral implant-based breast reconstruction. Plast Reconstr Surg 143(1):236e. https://doi.org/10.1097/PRS.0000000000005135
26. Maruccia M, Mazzocchi M, Dessy LA, Onesti MG (2016) One-stage breast reconstruction techniques in elderly patients to preserve quality of life. Eur Rev Med Pharmacol Sci 20(24):5058–5066
27. Maruccia M, Di Taranto G, Onesti MG (2018) One-stage muscle-sparing breast reconstruction in elderly patients: a new tool for retaining excellent quality of life. Breast J 24(2):180–183. https://doi.org/10.1111/tbj.12860
28. Onesti MG, Maruccia M, Di Taranto G et al (2017) Clinical, histological, and ultrasound follow-up of breast reconstruction with one-stage muscle-sparing "wrap" technique: a single-center experience. J Plast Reconstr Aesthetic Surg JPRAS 70(11):1527–1536. https://doi.org/10.1016/j.bjps.2017.06.023
29. Marcasciano M, Frattaroli J, Mori FLR et al (2019) The new trend of pre-pectoral breast reconstruction: an objective evaluation of the quality of online information for patients undergoing breast reconstruction. Aesthetic Plast Surg 43(3):593–599. https://doi.org/10.1007/s00266-019-01311-x
30. Casella D, Di Taranto G, Marcasciano M et al (2018) Subcutaneous expanders and synthetic mesh for breast reconstruction: long-term and patient-reported BREAST-Q outcomes of a single-center prospective study. J Plast Reconstr Aesthetic Surg JPRAS. https://doi.org/10.1016/j.bjps.2018.12.018
31. Elswick SM, Harless CA, Bishop SN et al (2018) Prepectoral implant-based breast reconstruction with postmastectomy radiation therapy. Plast Reconstr Surg 142(1):1–12. https://doi.org/10.1097/PRS.0000000000004453
32. Sbitany H, Gomez-Sanchez C, Piper M, Lentz R (2019) Prepectoral breast reconstruction in the setting of postmastectomy radiation therapy: an assessment of clinical outcomes and benefits. Plast Reconstr Surg 143(1):10–20. https://doi.org/10.1097/PRS.0000000000005140
33. Ellis HL, Asaolu O, Nebo V, Kasem A (2016) Biological and synthetic mesh use in breast reconstructive surgery: a literature review. World J Surg Oncol 14:121. https://doi.org/10.1186/s12957-016-0874-9
34. Moyer HR, Losken A (2012) Predicting mastectomy skin flap necrosis with indocyanine green angiography: the gray area defined. Plast Reconstr Surg 129(5):1043–1048. https://doi.org/10.1097/PRS.0b013e31824a2b02

35. Komorowska-Timek E, Gurtner GC (2010) Intraoperative perfusion mapping with laser-assisted indocyanine green imaging can predict and prevent complications in immediate breast reconstruction. Plast Reconstr Surg 125(4):1065–1073. https://doi.org/10.1097/PRS.0b013e3181d17f80