

Direct to Implant Reconstruction in Nipple Sparing Mastectomy: Patient Selection by Preoperative Digital Mammogram

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Background: Digital mammography clearly distinguishes gland tissue density from the overlying nonglandular breast tissue coverage, which corresponds to the existing tissue between the skin and the superficial layer of the fascia superficialis surrounding the gland (i.e., dermis and subcutaneous fat). Preoperative digital imaging can determine the thickness of this breast tissue coverage, thus facilitating planning and reducing the rate of necrotic complications after direct to implant (DTI) reconstruction in nipple sparing mastectomy (NSM).

Methods: Thirty NSMs in 22 patients with type 3 tissue coverage (subcutaneous tissue thickness of 2 cm or more) were selected for DTI reconstruction after NSM to evaluate immediate skin flap/nipple areola complex ischemic complications and patient satisfaction.

Results: We experienced no wound healing problems or ischemic complications immediately after surgery in our population. Only 1 seroma was observed as a short-term complication. Quality of life and patients' satisfaction level were optimal at 3 and 6 months follow-up, respectively. The aesthetic results have been evaluated as good/excellent in all cases.

Conclusions: DTI immediate reconstruction with silicone implants following NSM appears to be a safe option in selected cases with enough tissue coverage, also providing a high level of patient satisfaction. The possibility of selecting cases for this procedure according to the preoperative digital mammogram showing more than 2 cm of superficial tissues thickness may help reducing the risk of immediate ischemic complications. (*Plast Reconstr Surg Glob Open* 2017;5:e1369; doi: 10.1097/GOX.0000000000001369; Published online 20 June 2017.)

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Henry Moore Oncologic Institute-Argentina, Institutional Review Board approved trial (2016—234 DTI—NSM), conforming to Helsinki declaration.

This prospective study was performed at Instituto Oncologico Henry Moore, University of Buenos Aires, between May 2011 and December 2015. The study protocol was approved by the Institutional Revision Committee.

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INTRODUCTION

Direct to implant (DTI) immediate breast reconstruction following nipple sparing mastectomy (NSM) represents a reliable therapeutic option. However, 3–15.3% of patients undergoing this procedure could experience flap necrosis that may involve the nipple areola complex (NAC) as an immediate complication.^{1–6}

Several recommendations have been proposed to avoid necrosis of the mastectomy flaps and/or the NAC.^{7,8} Preservation of adequate flap thickness during mastectomy significantly reduces skin necrosis. However, this is not always possible, depending on the breast characteristics of each patient.⁹ Performing an oncologically safe mastectomy requires dissection below the superficial layer of the fascia superficialis.¹⁰ The distance between the skin and the gland determines the subcutaneous tissue or "gland envelope" thickness (Fig. 1).

Larson et al.¹¹ reported differences in the thickness of the subcutaneous breast tissue not related to breast

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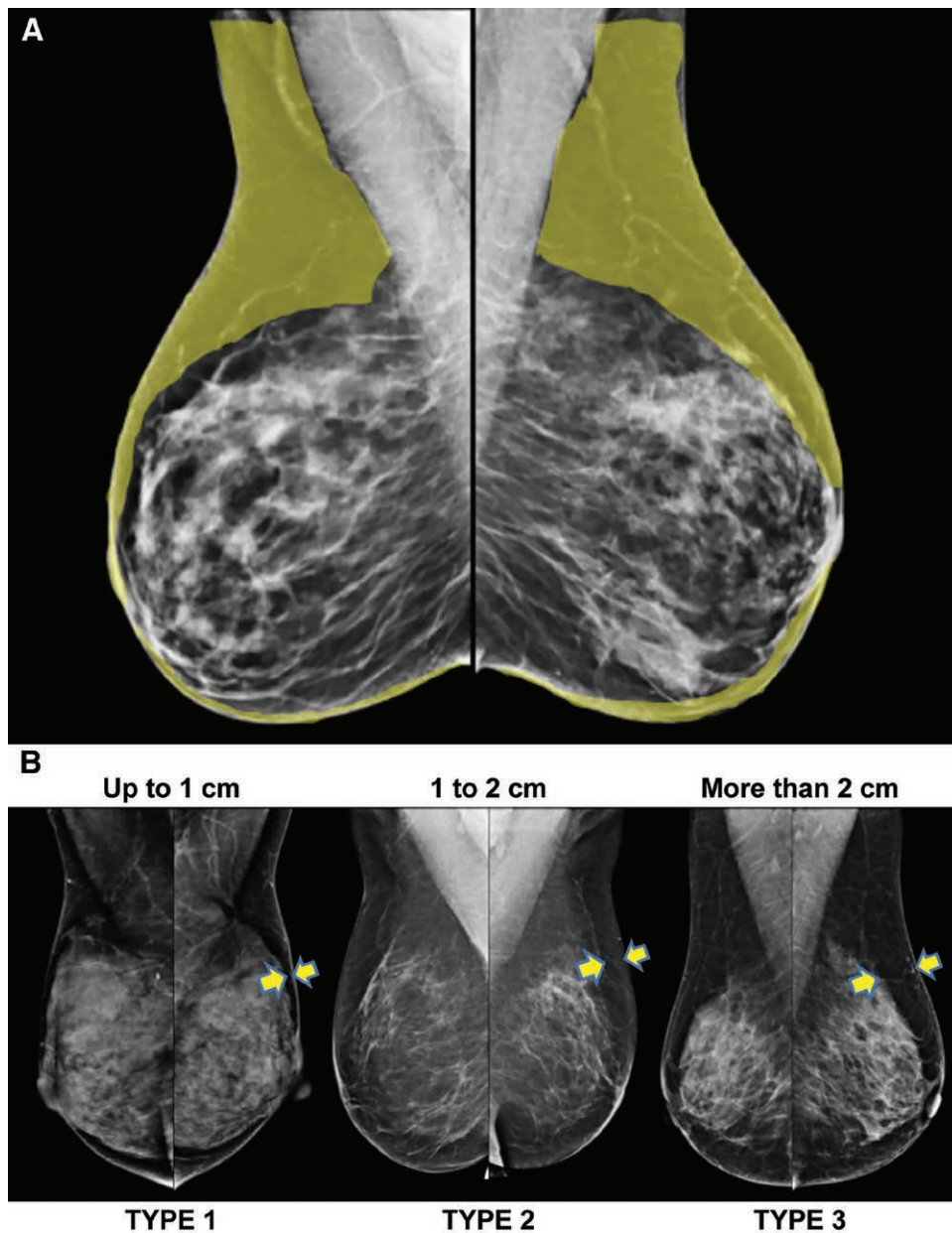


Fig. 1. Digital mammograms showing tissue coverage to be maintained during mastectomy (A) and different types of tissue coverage in different patients with the same breast volume (B).

volume. Therefore, it could be advantageous to know the thickness of the subcutaneous breast tissue before considering a DTI reconstruction following an NSM.

Preoperative digital mammogram allows an accurate evaluation of the breast coverage and a preview of the resulting flap thickness, with a consequent possible prevision of flap quality and vascularization.

A more comprehensive indication for a reconstructive method could be evaluated considering this preoperative information over the possible resulting flap thickness after mastectomy.

We reported that the thickness of the breast subcutaneous tissue can be determined preoperatively by digital mammogram and proposed a breast tissue coverage

classification (Table 1) according to the mammographic evidences.¹²

We hypothesized that the selection of patients with breast subcutaneous tissue coverage above 2 cm, as an evidence at preoperative digital mammography, would determine an adequate flap after NSM, directly representing the distance between the superficial layer of the fascia superficialis (the mastectomy “safe” surgical plane) and the skin: immediate DTI reconstruction could be safely indicated in these cases.

The purpose of this study was to describe the incidence of skin flap/NAC necrotic complications in patients eligible for NSM and immediate DTI reconstruction with type 3 tissue coverage according to the preoperative digital mammogram.

Table 1. Breast Tissue Coverage Classification According to Digital Mammogram

Type 1	Up to 1 cm	Poor coverage
Type 2	Between 1 and 2 cm	Medium coverage
Type 3	More than 2 cm	Good coverage

MATERIALS AND METHODS

This prospective study was performed at the University Hospital, between May 2011 and December 2015. The study protocol was approved by the institution's ethical committee, and patients provided written informed consent.

Patients were screened for eligibility according to the results of a preoperative digital mammogram. The mammography was performed using a 3D Selenia Dimensions Full Field Digital Mammograph (Hologic, Bedford, Mass.). Breast tissue coverage measurements were reported in centimeter and millimeter. A single operator evaluated all mammograms, and measurements were obtained with OSIRIX Software (available at www.osirix-viewer.com) from digital imaging and communications in medicine format. The patients have been classified as type 1 to type 3 tissue coverage according to the thickness of the breast subcutaneous tissues. Only type 3 patients (subcutaneous tissue thickness of 2 cm or more) with small-to-moderate sized breasts (cup size A–B, 200–500 g) have been included.

The inclusion criteria were as follows: large or multicentric ductal carcinoma in situ (DCIS), invasive carcinoma 2 cm from the nipple without skin involvement, multifocal or multicentric invasive carcinoma, BRCA 1–2 mutated patients, medium or small breast with < 8 cm of NAC-inframammary fold distance, patients' preference for contralateral risk reducing mastectomy, no more than grade 1 ptosis according to the Regnault classification,¹³ patients' desire of breast reconstruction with a volume no larger than the preoperative one, and a type 3 preoperative tissue coverage at digital mammogram. The exclusion criteria were as follows: inflammatory carcinoma, skin involvement, pathologic NAC secretion, previous radiotherapy, hypertrophic and ptotic breasts, and recent (last 12 months) peri- or subareolar surgery.

Surgical Procedure and Implant Selection

The same surgical team operated on all the patients. A 10-cm radial lateral incision was performed without reaching the areola, over the pectoralis major border. The skin incision lasted few millimeters from the areolar margin to preserve the aesthetics of the NAC without scar retraction of the areola. This lateral incision allowed complete access to the whole breast. A separate axillary incision was performed for the sentinel lymph node biopsy or axillary lymph node dissection (ALND). The internal mammary fat and perforators have been carefully preserved. Intraoperative frozen section pathology of the remaining subareolar tissue and the corresponding tissue over the surgical specimen was always performed for oncological mastectomies. Based on the result of the frozen section, the NSM procedure was continued or changed to a skin sparing mastectomy with an elliptical resection of the NAC in continuity with the original incision. Careful he-

mostasis was performed, and the subpectoral plane was approached by the lateral pectoral border and dissected following the dual plane technique.¹⁴ A 2-mm skin resection of the incision borders was always performed. No acellular dermal matrices have been used in this series.

Three types of silicone implants have been used: Allergan Anatomical FX (full height, extra-full projection; Allergan Inc., Santa Barbara, Calif.), Mentor Anatomical CPG (medium height, maximum projection 323 - maximum height, maximum projection 333; Mentor Inc., Tex.), and Mentor round high projection (Mentor Inc.). Implants have been chosen on the basis of preoperative assessment of breast width and height. Chosen devices were 0.5 cm shorter than the breast measurements in each of these dimensions. Implant projection was selected according to skin stretch and patients' desire, varying only between medium and maximum projections.

A drain was placed in the mastectomy pocket and another one in the axilla when ALND was performed. The drains were removed when less than 30 cc of drainage fluid per day was obtained.

Follow-Up Evaluation

All the patients were evaluated immediately after the surgery and scheduled for a monthly follow-up clinical examination every 30 days up to 6 months. After this period, they were followed up every 6 months to evaluate complications. The follow-up period ranged from 6 to 42 months (mean, 18 months).

Patient Satisfaction and Quality of Life

The 36-item short-form health survey (SF-36) questionnaire was administered 3 months after surgery for quality of life assessment.¹⁵ The SF-36 evaluates health status with 2 separate components: mental health and physical health. The physical health component includes 4 scales comprising 10 questions about physical functioning, 4 questions about role limitation due to physical problems, 2 questions about body pain, and 5 questions about general health. The mental health component also includes 4 scales. These comprise 4 questions about vitality, 2 questions about social functioning, 3 questions about role limitation due to emotional problems, 5 questions about mental health, and 1 question about general health perception. Each of these 8 subscales is scored separately, from 0 to 100. A higher score in each subscale indicates a better condition.

Patient satisfaction was assessed at 6 months after surgery. Patients were asked to rate 4 domains based on their perceptions of several aesthetic aspects as follows: (1) satisfaction in unclothed appearance, (2) satisfaction in clothed appearance, (3) body image appearance, and (4) overall satisfaction with surgery (Table 2). A 5-point Likert

Table 2. Breast Reconstruction Satisfaction Questionnaire

Satisfaction in unclothed appearance	1 2 3 4 5
Satisfaction in clothed appearance	1 2 3 4 5
Body image appearance	1 2 3 4 5
Overall satisfaction with surgery	1 2 3 4 5

1, Not at all satisfied; 5, very satisfied.

Table 3. Preoperative and Postoperative Patients' Characteristics

Patient No.	Age (y)	Implant Characteristics	Mastectomy	Axilla	Drains	Disease	Complications	Previous Implants	Postoperative Radiotherapy	Capsular Contracture	Patient Complaints
1	43	Mentor CPG 333 320 cc	Unilateral	ALND	Axilla/breast 1/1	Invasive carcinoma			Yes		
2	36	Allergan 410 FX 300 g	Bilateral	No	Breast 2	BRCA + DCIS					
3	41	Mentor CPG 323 255 cc	Unilateral	No	Breast 1	DCIS			Yes		
4	49	Mentor CPG 333 320 cc	Unilateral	ALND	Axilla/breast 1/1	Multifocal					
5	51	Mentor CPG 333 350 cc	Unilateral	No	Breast 1	DCIS					
6	44	Mentor CPG 323 300 cc	Bilateral	No	Breast 2	Multifocal 2 breast		Yes	Yes	Yes	
7	20	Mentor CPG 323 350 cc	Unilateral	ALND	Axilla/breast 1/1	Invasive carcinoma					
8	33	Mentor Round HP 400 cc	Bilateral	ALND 1	Axilla/breast 1/2	BRCA +	Bilateral hypertrophic scar				
9	53	Mentor Round HP 400 cc	Bilateral	ALND 2	Axilla/breast 2/2	Invasive carcinoma bilateral	Seroma				
10	54	Mentor CPG 333 360 cc	Unilateral	No	Breast 1	DCIS		Yes			
11	38	Mentor CPG 323 350 cc	Unilateral	ALND	Axilla/breast 1/1	Invasive carcinoma			Yes	Yes	
12	53	Mentor CPG 333 320 cc	Unilateral	No	Breast 1	Multifocal					Lack of volume upper pole
13	42	Mentor Round HP 400 cc	Bilateral	No	Breast 2	BRCA +		Yes			
14	55	Mentor CPG 333 360 cc	Unilateral	ALND	Axilla/breast 1/1	Invasive carcinoma					
15	42	Mentor CPG 323 345 cc	Bilateral	No	Breast 2	DCIS; BRCA +	Incision accidentally reached nipple on left breast				
16	41	Mentor Round HP 460 cc	Unilateral	ALND	Axilla/breast 1/1	Multifocal					Yes
17	40	Mentor CPG 323 320 cc	Unilateral	No	Breast 1	Invasive carcinoma					
18	48	Mentor Round HP 460 cc	Bilateral	No	Breast 2	BRCA +					
19	36	Allergan 410 FX 300 g	Unilateral	ALND	Axilla/breast 1/1	Invasive carcinoma					Yes
20	56	Mentor Round HP360 cc	Bilateral	No	Breast 2	Multifocal 2 breast					
21	47	Mentor CPG 333 350 cc	Unilateral	No	Breast 1	Invasive carcinoma		Yes			
22	45	Mentor CPG 323 195 cc	Unilateral	No	Breast 1	Invasive carcinoma					

ALND, axillary lymph node dissection.

scale was used (5, excellent; 4, very good; 3, good; 2, fair; and 1, bad) to rate each domain.

RESULTS

Twenty-two consecutive female patients who underwent 30 NSMs with immediate DTI reconstruction with silicone implants were included (Table 3). In this series, 8 patients received NSM as risk-reducing surgery. We performed 8 bilateral and 14 unilateral mastectomies. The mean patient age was 44.1 years (range, 20–56). The preoperative diagnosis was unifocal invasive carcinoma in 9, multifocal invasive carcinoma in 5, DCIS in 4, and BRCA 1/2 mutation in 4 patients.

Short-Term Complications

We experienced no wound healing problems or skin flap/NAC ischemic complications immediately after surgery. We only observed 1 seroma. Clinical outcomes are presented in Figures 2 and 3.

Patients' Satisfaction and Quality of Life

Quality of life was optimal at 3 months after surgery (Table 4). Patient satisfaction was optimal at 6 months after surgery, the aesthetic results being evaluated as good to excellent in all 22 cases. General patient satisfaction while dressed was either “very good” or “excellent” in all 22 cases. One patient rated her unclothed appearance as “mildly dissatisfied,” whereas 21 of the 22 patients were either “satisfied” or “very satisfied” with their unclothed appearance. The patient complaint was due to lack of fullness of the upper pole.

Long-Term Complications

At a mean follow-up of 18 months, 2 patients who underwent postmastectomy radiotherapy experienced a

Baker 2 capsular contracture. One patient experienced bilateral scar hypertrophy and 1 scar retraction. No anatomical implant rotation was observed.

DISCUSSION

Several studies demonstrated 2 main sources of neurovascular supply to the nipple: a central and a superficial network.

The central supply travels in a ligamentous septum originating from pectoralis fascia at the level of the 5th rib and inferior border of pectoralis major. Branches of the thoracoacromial, lateral thoracic, and intercostal arteries and the deep branch of the fourth intercostal nerve passed within this septum. Würinger¹⁶ also described a medial ligament arising from the sternum and guiding blood vessels of the internal thoracic artery and anterior cutaneous intercostal nerve branches. A lateral ligament attached to the lateral border of pectoralis minor guides branches of the lateral thoracic and lateral cutaneous intercostal nerves. These ligaments merge and carry a blood supply to the superficial layer of the fascia superficialis.

O'Dey et al.¹⁷ found that the lateral thoracic artery supplies up to 3 separate branches to the nipple-areola complex during its descending course. These branches pass through deep breast tissue before ascending toward the nipple-areola complex to reach the superolateral edge.

These branches are obviously divided during a mastectomy.

The superficial supply consists in a sparse dermal and subdermal plexuses around the nipple-areolar complex¹⁸ and 1 or 2 perforating vessels deriving from the internal thoracic artery (usually emerging in second or fourth intercostal spaces) that have a curved course with superior

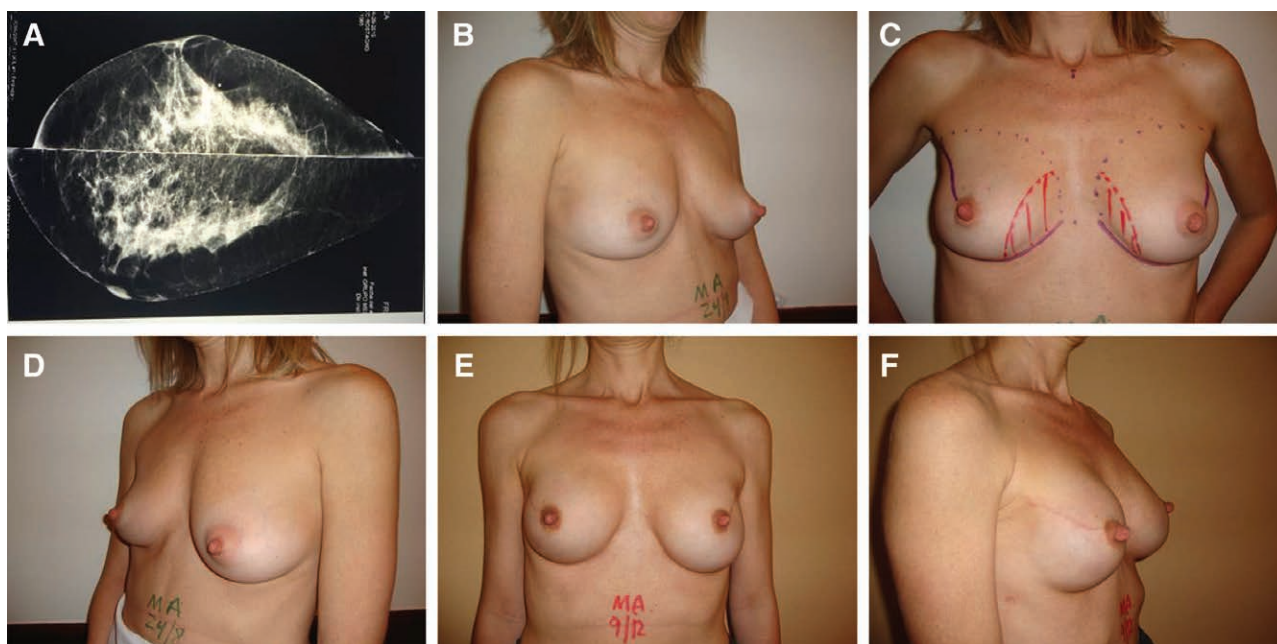


Fig. 2. A 42-year-old patient with DCIS on her right breast (BRCA+). NSM and immediate DTI reconstruction were performed with Mentor CPG shaped implants 323 345 cc. A, Preoperative digital mammogram showing a type 3 breast. B-D, Frontal and oblique preoperative views, showing planned incision and special interest in keeping fat and perforators in the lower inner quadrant. E-F, Frontal and oblique postoperative views after 1 year.

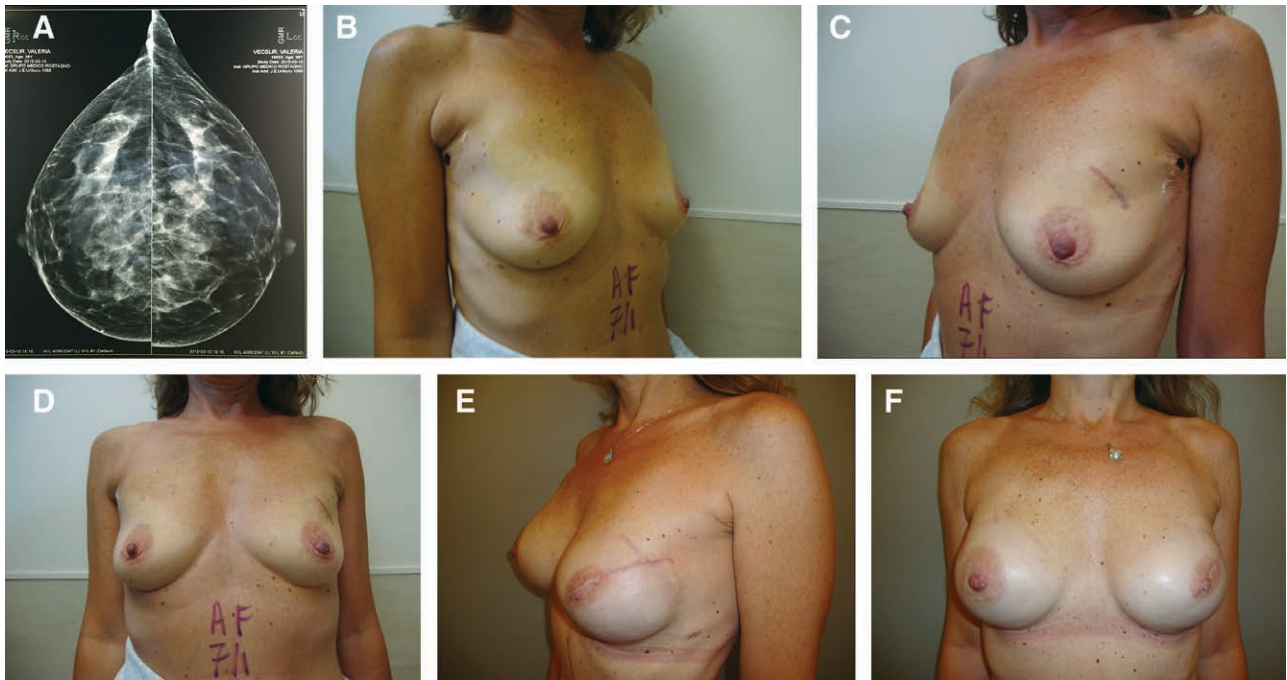


Fig. 3. A 42-year-old patient with DCIS on her left breast, with previous biopsy (BRCA+). Bilateral NSM; immediate bilateral DTI reconstruction was performed with Mentor CPG shaped 323 345cc. A, Preoperative digital mammogram showing a type 3 breast. B–D, Frontal and oblique preoperative views. E–F, Frontal and oblique 10-month postoperative views. The scar running through the NAC was due to a surgical accident by excessive tension with the retractors during surgery (described as a complication in Table 3, patient 15).

convexity and arrive at the supero-medial border of the NAC at a depth of 1.5 ± 0.4 cm.¹⁷

According to these anatomical considerations, the skin flap thickness remains relevant to prevent and reduce necrotic complications, as preserving a flap thickness of more than 1.5 cm (when oncologically safe according to the information deriving from the preoperative digital mammography and the direct confirmation of the surgical mastectomy plane during the procedure) allows the NAC to base its vascular supply not only on the dermal and subdermal plexus but on the subcutaneous plexus as well.

Several publications noted the relationship between NAC vascularization and subcutaneous tissue preservation. Salgarello et al.¹⁹ and Spear et al.²⁰ concluded that it is critically important to find and follow the plane between the breast gland and subcutaneous fat, to maximize the blood supply to the mastectomy flaps and NAC.

Our extensive survey of 253 digital mammograms revealed that the variation of the thickness of the subcutaneous layer is not related to the body mass index, breast size, or age,¹² in accordance with the conclusions of Larson et al.¹¹ and Beer et al.²¹

To the best of our knowledge, this is the first study to evaluate the usefulness of digital mammograms to choose the best reconstructive option in patients undergoing mastectomy.

In type 3 patients (those with breast subcutaneous tissue thickness of 2 cm or more) with small-to-moderate size breasts, the patients experienced no necrotic complications when undergoing NAC-sparing mastectomy and immediate DTI reconstruction, with high patient satisfaction levels.

Table 4. Patient Satisfaction Scores for the SF-36 Questionnaire

Subscale	Median	Range
Physical health		
Physical functioning	84	82–87
Body pain	78	76–81
Role limitation due to physical problems	77.5	73–82
General health	74	71–76
Mental health		
Social functioning	85.5	83–88
Role limitation due to emotional problems	77	72–80
Mental health	74	70–78
Vitality	60	57–63

SF-36, 36-item short-form health survey.

Preoperative information about the thickness of the subcutaneous tissues could provide valuable data to foresee the postmastectomy flap viability and therefore to choose the best reconstructive technique. Thin flaps may implicate a high risk of tissue suffering, and immediate reconstruction might not be safe. Otherwise, a flap thickness of 2 cm or more provides a reliable coverage. In these cases, DTI reconstruction could represent a good option.

Immediate DTI breast reconstruction represents the best option in patients with small or medium breasts (200–600 g) with minimal or no ptosis, who desire minimal or no change in breast volume.²² Immediate DTI breast reconstruction requires meticulous planning, accurate marking, and accurate implant selection.²³ The use of sizers and the weight of the resected gland could also be helpful. The preservation of the new inframammary fold

is essential for an optimal aesthetic result and should be symmetrical with the contralateral one.²⁴

Implant selection remains a key element with this technique: the operator must match the implant base and height with the breast measurements. This is done simply with a caliper and a measuring tape.

Preoperative evaluation of breast tissue coverage by digital mammogram could provide important information for DTI reconstruction in NSM patient selection. Preoperative communication between the oncoplastic breast surgeon and the patient, based on digital mammogram findings, may improve decision-making concerning the selection of the best reconstructive method.

The present study is limited by the small sample size and relatively short follow-up period. Evaluation of larger population with a longer follow-up will demonstrate whether the information deriving from the preoperative digital mammography could be the driver for choosing an immediate DTI reconstruction following NSM.

CONCLUSIONS

Our findings suggest that NSM and immediate DTI reconstruction in patients with type 3 coverage, according to preoperative digital mammogram, minimizes the risk of skin flap and NAC necrotic complications, achieving high levels of patients' satisfaction.

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