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ORIGINAL ARTICLE BREAST SURGERY

Comparative Study of Nipple–Areola Complex Position and Patient Satisfaction After Unilateral Mastectomy and Immediate Expander–Implant Reconstruction Nipple-Sparing Mastectomy Versus Skin-Sparing Mastectomy

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Abstract

Background Major surgical concerns associated with nipple-sparing mastectomy (NSM) are partial or total nipple–areola complex (NAC) loss, decreased sensation, and nipple malposition. Patient satisfaction and NAC outcomes including malposition in patients who have undergone unilateral expander–implant reconstruction after NSM as compared with skin-sparing mastectomy (SSM) remain unclear. Therefore, the aim of this study was to assess patient satisfaction and NAC outcomes of breast cancer patients who underwent spared or reconstructed NAC after unilateral NSM as compared with unilateral SSM.

Methods Patients who underwent immediate expander–implant breast reconstruction following unilateral NSM or SSM were included. Medical records of patients from April 2010 to February 2014 were retrospectively reviewed. Reconstruction-related complications such as infection, seroma, haematoma, delayed wound healing, and reconstruction failure were recorded. NAC outcome analysis was performed using preoperative and postoperative digital photographs for each patient. Patient satisfaction with the reconstructed breast and NAC was assessed using a study-specific questionnaire.

Results Delayed wound healing occurred in 18 of 55 NSM patients and 15 of 85 SSM patients ($p = 0.040$). Final reconstruction failure occurred in 0 NSM patients and 6 SSM patients ($p = 0.043$). The mean photography analysis score of total aesthetic outcome was 13.12 ± 2.39 in the NSM group and 14.06 ± 2.75 in the SSM group ($p = 0.052$). The mean questionnaire score of NAC position was 2.88 ± 0.85 in the NSM group and 3.80 ± 0.84 in the SSM group ($p = 0.001$). The mean questionnaire score of NAC sensitivity was 2.12 ± 0.58 in the NSM group and 1.84 ± 0.46 in the SSM group ($p = 0.003$). Satisfaction with the reconstructed breast was similar ($p = 0.913$) after NSM and SSM.

Conclusions We observed no significant difference in breast reconstruction satisfaction between the NSM and SSM groups. Although overall satisfaction with breast reconstruction is high, patients in the NSM group often report dissatisfaction with nipple position. With a favourable score for NAC position, skin-sparing mastectomy followed by NAC reconstruction can be considered as a balanced alternative to NSM for properly selected patients with breast cancer.

Level of Evidence III 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 Nipple-sparing mastectomy · Skin-sparing mastectomy · Breast reconstruction · Nipple malposition · Patient satisfaction

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Introduction

Nipple-sparing mastectomy (NSM) has become a major surgical method that can achieve improved cosmetic outcomes for patients with breast cancer [1, 2]. An increasing number of patients are candidates for NSM and immediate breast reconstruction. Recent studies have indicated that NSM provides aesthetic advantages with psychological improvement [3–5]. In a therapeutic setting, an NSM could be considered for properly selected patients with smaller tumours far from the nipple and favourable pathological features [1, 2, 6, 7]. For risk-reducing mastectomy, NSM cohorts in several studies have suggested its oncological safety [6, 8–10].

Major surgical concerns associated with NSM are mastectomy skin flap necrosis, partial or total nipple–areola complex (NAC) loss, decreased sensation, and nipple malposition [2, 11–14]. The reported incidence of mastectomy skin flap necrosis and partial or total NAC loss following NSM ranges from 0 to 38% in the literature [11, 15–19]. Using implants in breast reconstruction might have a higher chance to experience mastectomy skin flap necrosis than without using implants. Lee et al. [15] reported that prosthesis reconstruction patients show higher rates of mastectomy flap necrotic complications than autologous tissue reconstruction patients (23.3% vs. 10.0%, $p = 0.034$). Postoperative nipple malposition is also an aesthetically devastating problem associated with NSM. In a series of 54 NSM with predominantly lateral incisions, Wagner et al. [20] reported that 69.2% of patients experienced lateral malposition, whereas 75.0% experienced vertical malposition.

Previous studies have reported bilateral prophylactic mastectomy and immediate implant breast reconstruction. For example, van Verschuer et al. [21] reported no significant differences in body image or NAC-specific satisfaction between NSM and SSM groups. However, no studies have reported patient satisfaction or NAC outcomes including malposition in patients who have undergone unilateral expander–implant reconstruction after NSM as compared with SSM. Therefore, the aim of this study was to assess patient satisfaction and NAC outcomes of breast cancer patients who underwent spared or reconstructed NAC after unilateral NSM as compared with unilateral SSM.

Patients and Methods

After obtaining approval from the institutional review board, a retrospective medical record review was conducted for patients who underwent breast reconstruction from April 2010 to February 2014. This study examined cases of female patients who underwent unilateral breast reconstruction using tissue expanders and breast implants. All mastectomies were performed first by general surgeons including nipple-sparing mastectomy (NSM) and skin-sparing mastectomy (SSM) followed by expander–implant breast reconstruction. Mastectomies were done by four general surgeons, while breast reconstructions were done by three reconstructive surgeons. Patients who underwent autologous reconstruction (i.e. abdominal flap, latissimus dorsi flap) cases were excluded from this study. Any patient who had undergone surgery that could affect nipple position (i.e. breast conserving surgery, reduction mammaplasty) before mastectomy was excluded. Bilateral reconstruction, delayed reconstruction, and one-stage implant insertion cases were also excluded. A total of 140 patients underwent unilateral immediate expander–implant breast reconstruction, including 55 patients with NSM and 85 patients with SSM. Patient data were collected from medical records, including patients' age, body mass index (BMI), smoking history, medical comorbidities, and other details related to breast reconstruction. Reconstruction-related complications such as infection, seroma, haematoma, delayed wound healing, and reconstruction failure were recorded. Delayed wound healing represented skin flap necrosis or postoperative NAC necrosis in this study. It was defined as development of wound disruption, dehiscence, or ulceration that was managed with prolonged wound dressing or surgical intervention. Implant-related complications such as rippling, capsular contracture, and double bubble were collected through medical photos, physical examination, and chart reviews.

NAC outcome analysis was performed using preoperative and postoperative digital photographs for each patient. Follow-up photographs were taken at least 3 months postoperatively. These photographs were evaluated using a blinded panel consisting of two board-eligible plastic surgeons and two surgical residents, none of whom was involved in this study. For photograph evaluation, total aesthetic outcome, vertical position score, and horizontal position score of the nipple were evaluated. Patient photographs were evaluated with the patient standing in frontal, three-quarter oblique, and lateral views. Total aesthetic outcome was scored on a 5-point Likert scale ranging from 1 as very poor to 5 as very good. NAC vertical position was scored along the line from the nipple to the midpoint of clavicle. NAC horizontal position was scored along the perpendicular line from the nipple to the midline. NAC position was scored from 1 to 5. A score of 1 signified malposition and severe asymmetry of NAC, whereas a

score of 5 indicated no asymmetry with good aesthetic outcome.

Women were asked to participate in this study during an outpatient clinic visit or by telephone. To assess patient satisfaction with the reconstructed breasts, spared or reconstructed NAC and subjective NAC sensitivity, a NAC-specific questionnaire comprising 9 items was used. Each item was scored on a 5-point Likert scale (Table 1).

Statistical Analyses

To verify statistically significant differences among basic variables, surgery-related variables, first surgery and second surgery variables, photography analysis, and questionnaire evaluations between NSM and SSM groups, the Pearson's Chi-square test was applied by using crosstabs analysis for categorical variables and Student's *t* test for continuous variables. To identify variables affecting photography analysis and questionnaire satisfaction scores, an initial screening process was done to identify possibly influencing variables rather than making every variable as an independent variable. To achieve this, in the case of categorical variables, a *t* test was applied to two categories of variables, whereas ANOVA (analysis of variance) was applied to three or more categories of variables. In the case of continuous variables, correlation coefficient analysis between photography analysis and questionnaire satisfaction score was applied to determine relatively relevant variables.

By assigning variables chosen by the above methods as independent variables and assigning photography analysis and questionnaire satisfaction score as dependent variables, regression analysis was applied to identify statistically significant variables affecting photography analysis and questionnaire satisfaction score. Outcomes were adjusted for differences in baseline characteristics with $p \leq 0.10$ for categorical variables and $p \leq 0.20$ for continuous variables using multivariable linear regression. The authors compared the identified parameters and set the level of significance at 0.05 alpha level. All statistical analyses were performed using the Statistical Package for the Social Sciences version 19.0 (SPSS Inc., Chicago, IL, USA).

Results

Nipple-sparing mastectomy (NSM) was performed in 55 cases, whereas skin-sparing mastectomy (SSM) was performed in 85 cases. The mean age of patients was 42.70 years in the NSM group and 45.62 years in the SSM group. The mean body mass index (BMI) was 21.15 kg/m^2 in the NSM group and 21.38 kg/m^2 in the SSM group. At the time of operation, five patients were active smokers, two patients had diabetes mellitus (in SSM group), and three patients had hypertension. Eighteen patients had undergone radiation therapy in the post-reconstruction period (6 in the NSM group and 12 in the SSM group). One patient had undergone neoadjuvant chemotherapy (1 in the SSM group). Sixty-three patients had undergone adjuvant

Table 1 Nipple–areola complex questionnaire on satisfaction of the reconstructed or spared NAC

	1	2	3	4	5
1. Satisfaction with reconstructed breast	Very unsatisfied	Unsatisfied	Neither satisfied nor unsatisfied	Satisfied	Very satisfied
Would choose the same operation again	Certainly not	Probably not	Maybe	Probably	Certainly
Wound advise this operation to other women	Certainly not	Probably not	Maybe	Probably	Certainly
2. NAC sensitivity compared with before the operation	Insensitive	Less sensitive	The same	Very sensitive	Hypersensitive
Touching of the NAC is	Very unpleasant	Unpleasant	Neither pleasant nor unpleasant	Pleasant	Very pleasant
Change of nipple reaction to cold or touch	No reaction	A lot weaker	Weaker	Hardly changed	Unchanged
3. Satisfaction with reconstructed NAC	Very unsatisfied	Unsatisfied	Neither satisfied nor unsatisfied	Satisfied	Very satisfied
Satisfaction with vertical position of NAC on the breast	Very unsatisfied	Unsatisfied	Neither satisfied nor unsatisfied	Satisfied	Very satisfied
Satisfaction with horizontal position of NAC on the breast	Very unsatisfied	Unsatisfied	Neither satisfied nor unsatisfied	Satisfied	Very satisfied

NAC nipple–areola complex

chemotherapy (20 in the NSM group and 43 in the SSM group), while 114 patients had undergone hormone therapy (47 in the NSM group and 67 in the SSM group). There was no statistically significant difference in height, weight, BMI, or other underlying medical conditions between the NSM group and SSM group except patient age (42.70 vs. 45.62, $p = 0.029$) and breast width (12.48 vs. 13.08, $p = 0.013$) (Table 2). No patient developed local recurrence of cancer during the follow-up period.

There was no statistically significant difference in cancer stage ($p = 0.281$) or reconstructive surgeon ($p = 0.464$) between the NSM group and the SSM group. However, there was a statistically significant difference in oncologic surgeon between the two groups ($p = 0.005$). A variety of incisions were performed for NSM. The most common NSM incisions were radial ($n = 32$, 58.2%), followed by radial with upper periareolar extension ($n = 9$, 16.4%), radial with lower periareolar extension ($n = 11$, 20%), vertical ($n = 1$, 1.8%), inframammary fold ($n = 1$, 1.8%), and lateral ($n = 1$, 1.8%) incisions (Fig. 1). The mean resected breast tissue weight was 288.57 g in the NSM group and 302.27 g in the SSM group ($p = 0.497$). Acellular dermal matrix was used for lateral coverage of the expander in 24 cases (10 in the NSM group and 14 in the SSM group, $p = 0.718$).

No intraoperative complications were observed. Tissue expander-associated complications occurred in 21 NSM patients and 27 SSM patients ($p = 0.435$). There were five cases of wound infection that needed wound irrigation and antibiotic treatment in the SSM group ($p = 0.067$). Seroma occurred in two NSM patients and six SSM patients ($p = 0.394$). It subsided with a few aspirations. Delayed wound healing occurred in 18 NSM patients and 15 SSM patients ($p = 0.040$). There were two cases of haematoma in the SSM group (none in the NSM group, $p = 0.250$) that needed haematoma evacuation. Removal of expander was needed in five SSM patients (none in the NSM group, $p = 0.067$). Implant-associated complications occurred in 10 NSM patients and 10 SSM patients ($p = 0.361$). There were two cases of wound infection that needed wound irrigation and antibiotic treatment (1 in the NSM group and 1 in the SSM group, $p = 0.788$). Rippling occurred in six NSM patients and four SSM patients ($p = 0.198$). Final reconstruction failure occurred in six SSM patients (none in the NSM group, $p = 0.043$). Breast augmentation mostly used modification on the contralateral breast (23 in the NSM group and 25 in the SSM group), followed by mastopexy (1 in the NSM group and 1 in the SSM group) and breast reduction (1 in the SSM group).

In photography analysis, scores ranged from 4 to 20. The mean vertical position score was 12.34 in the NSM group and 13.73 in the SSM group ($p = 0.036$), while the mean horizontal position score was 14.55 in the NSM group and 15.65 in the SSM group ($p = 0.011$). The mean total aesthetic score was 13.12 in the NSM group and 14.06 in the SSM group ($p = 0.052$). In the study-specific questionnaire patient satisfaction results, scores ranged from 1 to 5. The mean satisfaction score of breast reconstruction was 3.48 in the NSM group and 3.51 in the SSM group ($p = 0.913$). The NAC sensitivity score was 2.12 in the NSM group and 1.84 in the SSM group ($p = 0.003$). The NAC position score was 2.88 in the NSM group and 3.80 in the SSM group ($p = 0.001$) (Table 3).

Photography Analysis in NSM and SSM Groups

Age (B regression coefficient = − 0.103, $p = 0.082$ in SSM group), smoking history ($B = -3.842$, $p = 0.058$ in all patients, $B = -4.448$, $p = 0.057$ in NSM group), and contralateral breast augmentation ($B = 1.248$, $p = 0.074$ in all patients) showed associations with the vertical position score of photography analysis, although these associations were not statistically significant (Table 4). Regression analysis demonstrated a statistically significant association between contralateral breast augmentation ($B = 1.692$, $p = 0.023$ in NSM group, $B = 1.124$, $p = 0.009$ in all patients) and horizontal position score of photography analysis (Table 5). Contralateral breast augmentation ($B = 4.102$, $p = 0.034$ in all patients) also showed a statistically significant association with total aesthetic outcome score of photography analysis (Table 6).

Study-Specific Questionnaire in NSM and SSM Groups

Infection ($B = -1.238$, $p = 0.023$ in SSM group, $B = -1.054$, $p = 0.027$ in all patients), reconstruction-associated complications ($B = -0.895$, $p = 0.041$ in SSM group, $B = -0.750$, $p = 0.012$ in all patients), implant volume ($B = 0.004$, $p = 0.003$ in all patients), and rippling ($B = 1.124$, $p = 0.005$ in all patients, $B = 1.332$, $p = 0.027$ in NSM group, $B = 1.399$, $p = 0.032$ in SSM group) showed statistically significant associations with breast reconstruction satisfaction score (Table 7). Mastectomy radial incision ($B = 0.322$, $p = 0.006$ in all patients), textured round implant ($B = 0.344$, $p = 0.024$ in all patients, $B = 0.516$, $p = 0.005$ in SSM group), smoking history ($B = -0.669$, $p = 0.033$ in all patients, $B = -0.851$, $p = 0.043$ in NSM group), and adjuvant radiotherapy ($B = -0.455$, $p = 0.013$ in SSM group, $B = -0.357$, $p = 0.024$ in all patients) showed statistically significant associations with the NAC sensitivity satisfaction score (Table 8).

Oncologic surgeon A,D ($B = 1.018$, $p = 0.001$ in all patients), oncologic surgeon B ($B = 0.690$, $p = 0.019$ in all patients, $B = 0.681$, $p = 0.094$ in NSM group), mastectomy

Table 2 Patient demographics

Demographics	All patients (N = 140)	NSM patients (n = 55)	SSM patients (n = 85)	p*
Age, year	44.52 ± 7.53 (25–66)	42.70 ± 7.64 (25–57)	45.62 ± 7.33 (30–66)	0.029**
Height, cm	159.51 ± 5.12 (147.0–170.7)	159.85 ± 4.63 (148.4–169.8)	159.28 ± 5.45 (147.0–170.7)	0.514
Weight, kg	54.05 ± 6.91 (37.7–86.0)	53.97 ± 7.20 (38.2–72.4)	54.22 ± 6.73 (37.7–86.0)	0.727
BMI, kg/m^2	21.26 ± 2.52 (15.10–31.36)	21.15 ± 2.51 (16.32–27.79)	21.38 ± 2.51 (15.10–31.36)	0.496
Smoking history (%)	5 (3.6)	4 (7.3)	1 (1.2)	0.058*
Diabetes mellitus (%)	2 (1.4)	0 (0)	2 (2.4)	0.252
Hypertension (%)	3 (2.1)	2 (3.6)	1 (1.2)	0.326
Operation side (%)				
Left	79 (56.4)	32 (58.2)	47 (55.3)	0.736
Right	61 (43.6)	23 (41.8)	38 (44.7)	
SN-N, cm	19.90 ± 2.27 (15–29)	19.80 ± 2.41 (15–28.5)	19.99 ± 2.18 (15–29)	0.557
MC-N, cm	20.06 ± 2.41 (14.5–28.5)	19.90 ± 2.48 (14.5–28)	20.18 ± 2.38 (15–28.5)	0.454
Midline-N, cm	8.87 ± 1.20 (3–11)	8.62 ± 1.30 (3–11)	9.02 ± 1.12 (5–11)	0.058*
Breast width, cm	12.82 ± 1.55 (9–17)	12.48 ± 1.61 (9–17)	13.08 ± 1.43 (9–16.5)	0.013**
IMF-NS, cm	7.08 ± 1.61 (3.5–12.5)	7.15 ± 1.57 (5–12.5)	7.03 ± 1.65 (3.5–11.5)	0.679
IMF-N, cm	5.91 ± 1.40 (3–12)	6.08 ± 1.50 (3–12)	5.80 ± 1.34 (3–10)	0.232
Breast ptosis (%)				
Normal	129 (92.1)	50 (90.9)	79 (92.9)	0.511
Grade 1	9 (6.4)	5 (9.1)	4 (4.7)	
Grade 2	1 (0.7)	0 (0)	1 (1.2)	
Grade 3	1 (0.7)	0 (0)	1 (1.2)	
Pseudoptosis	0 (0)	0 (0)	0 (0)	
Adjuvant radiotherapy (%)	18 (12.9)	6 (10.9)	12 (14.1)	0.588
Neoadjuvant chemotherapy (%)	1 (0.7)	0 (0)	1 (1.2)	0.420
Adjuvant chemotherapy (%)	63 (45.0)	20 (36.4)	43 (50.6)	0.098*
Hormone therapy (%)	114 (81.4)	47 (85.5)	67 (78.8)	0.324

NSM nipple-sparing mastectomy, *SSM* skin-sparing mastectomy, *BMI* body mass index, *SN-N* distance from sternal notch to nipple, *MC-N* distance from midclavicle to nipple; *Midline-N* distance from midline to nipple, *IMF-NS* distance from inframammary fold to nipple (stretched), *IMF-N* distance from inframammary fold to nipple, *Grade 1* mild sagging, *Grade 2* moderate sagging, *Grade 3* significant sagging, *Pseudoptosis* lower breast sagging

Values are the mean for continuous variables and number (percentage) for categorical variables. The p values for continuous variables were obtained using Student's t test, and p values for categorical variables were obtained using Chi-square tests. p, p value ($p < 0.1$, **$p < 0.05$)

radial incision ($B = -0.889$, $p = 0.001$ in all patients), radial incision with upper periareolar extension ($B = -0.651$, $p = 0.050$ in all patients), and radial incision with lower periareolar extension, vertical, IMF, lateral incision ($B = -1.217$, $p = 0.001$ in all patients), textured round implant ($B = -0.740$, $p = 0.028$ in SSM group), adjuvant radiotherapy ($B = -0.564$, $p = 0.091$ in SSM group), mastectomy specimen weights ($B = -0.005$,

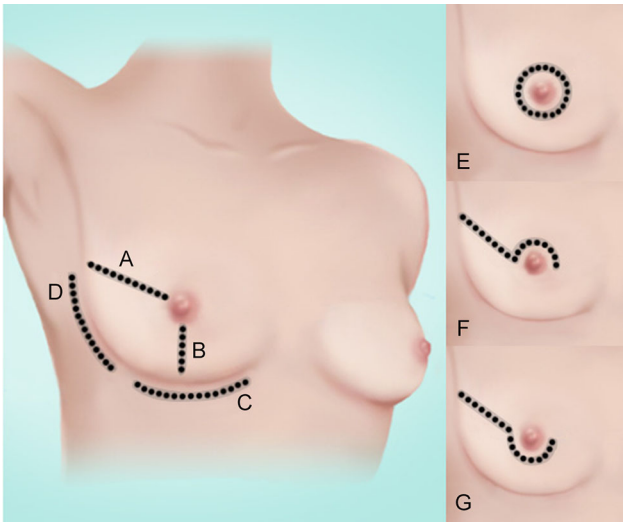

Fig. 1 Diagrammatic display of nipple-sparing mastectomy incisions (A radial, B vertical, C inframammary, D lateral, E periareolar, F radial with upper periareolar extension, G radial with lower periareolar extension)

$p = 0.002$ in NSM group), reconstruction-associated complications ($B = -0.848$, $p = 0.005$ in all patients, $B = -0.892$, $p = 0.046$ in NSM group, $B = -0.960$, $p = 0.020$ in SSM group), implant volume ($B = 0.003$, $p = 0.074$ in all patients, $B = 0.005$, $p = 0.037$ in NSM group), and rippling ($B = 1.197$, $p = 0.003$ in all patients, $B = 1.259$, $p = 0.032$ in NSM group, $B = 1.814$, $p = 0.004$ in SSM group) demonstrated significant associations with the NAC position satisfaction score (Table 9).

Discussion

Nipple-sparing mastectomy (NSM) followed by immediate device-based reconstruction is an oncologically safe procedure in selected patients with breast cancer. It can achieve aesthetically pleasing outcomes [12, 22–24]. NSM has become more widely used, especially in the setting of risk-reduction mastectomy (prophylactic mastectomy) [7]. The most recent advance in mastectomy techniques is the ability to preserve the entire NAC skin through total skin-sparing mastectomy (TSSM), an extension of NSM designed to provide equivalent aesthetic outcomes with preservation of the appearance of the nipple–areola complex (NAC) when resectioning the underlying nipple ductal tissue to ensure all breast tissue is removed at the time of mastectomy [25–28]. For therapeutic indications, NSM has not been widely offered due to concerns of oncological safety and surgical risks. However, recent studies have confirmed the safety of NSM in patients with advanced stage breast cancer [29, 30]. The major concerns associated with NSM are surgical problems including necrotic complications of the mastectomy flap, NAC necrosis, loss of nipple sensation, and nipple malposition [2, 11–14]. Delayed wound healing including postoperative NAC necrosis is one of the significant complications of NSM [14]. This tendency was proved in the present study (32.7% vs. 17.6%, $p = 0.040$). Delayed wound healing in the SSM group might be due to cancer location that is close to the NAC or skin envelope. In this situation, blood circulation of the remaining skin after mastectomy may not be sufficient. The thickness of the skin envelope depending on the mastectomy surgeon may also affect the outcome. More research is needed regarding this issue. In terms of sensation preservation, van Verschuer et al. [21] suggested that NSM should not be recommended for preservation of NAC sensitivity. However, unlike past studies, the NSM group showed a significantly higher NAC sensitivity score than the SSM group in the present study (2.12 vs. 1.84, $p = 0.003$). Also, smoking history ($p = 0.043$ in NSM group, $p = 0.033$ in all patients) and adjuvant radiotherapy ($p = 0.013$ in SSM group, $p = 0.024$ in all patients) showed statistically significant associations with the NAC sensitivity satisfaction score in this study.

Limited scar and nipple–areola preservation can give better aesthetic outcomes, particularly in autologous reconstruction cases. However, nipple malposition sometimes can occur with expander–implant reconstruction [31] which can be perceived as a disastrous result associated with NSM. It is very difficult to correct (Fig. 2). Wagner et al. [20] reported postoperative nipple malposition rates as high as 69%. Several other studies have reported that NSM followed by immediate device-based reconstruction has a risk of nipple malposition [32–35]. Similar to past studies, the NSM group showed significantly lower NAC position scores than the SSM group based on results of the mean photography analysis score of the NAC in vertical and horizontal positions. Concurrently, the mean questionnaire score of the NAC position was also significantly lower than that of SSM (Figs. 3, 4). However, the mean photography analysis score of total aesthetic outcome showed no statistically significant difference between NSM and SSM groups. These results suggest that reconstructed NAC followed by SSM is not inferior to NSM in terms of nipple position.

In our study, regression analysis demonstrated a statistically significant association between contralateral breast augmentation ($B = 1.692$, $p = 0.023$ in NSM group, $B = 1.124$, $p = 0.009$ in all patients) and horizontal position score of photography analysis. Contralateral breast augmentation ($B = 4.102$, $p = 0.034$ in all patients) also showed a statistically significant association with total aesthetic outcome score of photography analysis. Salgarello et al. [36] suggested that simultaneous contralateral symmetrization with tailored augmentation mammoplasty

Table 3 Comparison of surgical variables, photography analysis score and questionnaire score between nipple-sparing mastectomy group and skin-sparing mastectomy group

	All patients (N = 140)	NSM patients (n = 55)	SSM patients (n = 85)	p*
Cancer stage (%)			3	0.281
IA	54 (38.6)	24 (43.6)	0 (35.3)	
IB	6 (4.3)	1 (1.8)	5 (5.9)	
IIA	22 (15.7)	7 (12.7)	15 (17.6)	
IIB	24 (17.1)	6 (10.9)	18 (21.2)	
IIIA	7 (5.0)	3 (5.5)	4 (4.7)	
IIIB	0 (0)	0 (0)	0 (0)	
IIIC	1 (0.7)	0 (0)	1 (1.2)	
Oncologic surgeon (%)				0.005***
A	72 (51.4)	20 (36.4)	52 (61.2)	
B	55 (39.3)	25 (45.5)	30 (35.3)	
C	12 (8.6)	9 (16.4)	3 (3.5)	
D	1 (0.7)	1 (1.8)	0 (0)	
Reconstructive surgeon (%)				0.464
A	77 (55.0)	31 (56.4)	46 (54.1)	
B	35 (25.0)	11 (20)	24 (28.2)	
C	28 (20.0)	13 (23.6)	15 (17.6)	
Mastectomy incision				0.001***
Radial		32 (58.2)		
Radial with upper periareolar extension		9 (16.4)		
Radial with lower periareolar extension		11 (20.0)		
Vertical		1 (1.8)		
Inframammary fold		1 (1.8)		
Lateral		1 (1.8)		
Mastectomy specimen weights, g	295.71 ± 139.99 (40–904)	288.57 ± 150.76 (40–897)	302.27 ± 132.90 (91–904)	0.497
Expander size, cc (%)				0.886
350	107 (76.4)	41 (74.5)	66 (77.6)	
450	22 (15.7)	9 (16.4)	13 (15.3)	
550	11 (7.9)	5 (9.1)	6 (7.1)	
Initial inflation, mL	137.82 ± 72.53 (0–400)	158.52 ± 85.47 (30–400)	125.71 ± 59.85 (0–320)	0.013**
Acellular dermal matrix (%)	24 (17.4)	10 (18.9)	14 (16.5)	0.718
Tissue expander-associated complications (%)	48 (34.3)	21 (38.2)	27 (31.8)	0.435
Infection	5 (3.6)	0 (0)	5 (5.9)	0.067*
Seroma	8 (5.7)	2 (3.6)	6 (7.1)	0.394
Delayed wound healing	33 (23.6)	18 (32.7)	15 (17.6)	0.040**
Haematoma	2 (1.4)	0 (0)	2 (2.4)	0.250
Deflation of expander	7 (5.0)	3 (5.5)	4 (4.7)	0.843
Expander removal	5 (3.6)	0 (0)	5 (5.9)	0.067*
Mean months to tissue expander exchange	8.65 ± 3.43 (2–24)	8.81 ± 3.67 (2–24)	8.54 ± 3.30 (3–17)	0.642
Implant-associated complications (%)	20 (14.8)	10 (18.2)	10 (12.5)	0.361
Infection	2 (1.5)	1 (1.8)	1 (1.2)	0.788
Delayed wound healing	0 (0)	0 (0)	0 (0)	N/A
Rippling	10 (7.4)	6 (10.9)	4 (5)	0.198
Double bubble	2 (1.5)	0 (0)	2 (2.5)	0.237

Table 3 continued

	All patients (N = 140)	NSM patients (n = 55)	SSM patients (n = 85)	p*
Capsular contracture	5 (3.7)	2 (3.6)	3 (3.8)	0.973
Implant rupture	1 (0.7)	1 (1.8)	0 (0)	0.226
Implant change	2 (1.5)	1 (1.8)	1 (1.2)	0.788
Implant removal	1 (0.7)	0 (0)	1 (1.2)	0.405
Final reconstruction failure	6 (4.3)	0 (0)	6 (7.1)	0.043**
Implant volume, cc	305.83 ± 93.00 (90–595)	314.93 ± 101.21 (90–595)	300.00 ± 87.56 (120–500)	0.391
Implant type (%)				0.466
Smooth round	79 (59.0)	32 (59.3)	47 (58.8)	
Textured round	33 (24.6)	11 (20.4)	22 (27.5)	
Anatomical	22 (16.4)	11 (20.4)	11 (13.8)	
Modification of contralateral breast (%)				
Augmentation	48 (34.5)	23 (41.8)	25 (29.8)	0.144
Mastopexy	2 (1.4)	1 (1.8)	1 (1.2)	0.761
Reduction	1 (0.7)	0 (0)	1 (1.2)	0.417
Photography analysis score				
Vertical position	13.18 ± 3.56	12.34 ± 3.57	13.73 ± 3.47	0.036**
Horizontal position	15.19 ± 2.47	14.55 ± 2.21	15.65 ± 2.57	0.011**
Total aesthetic outcome	13.69 ± 2.63	13.12 ± 2.39	14.06 ± 2.75	0.052*
Questionnaire score				
Breast reconstruction satisfaction	3.50 ± 0.84	3.48 ± 0.76	3.51 ± 0.89	0.913
NAC sensitivity	1.95 ± 0.53	2.12 ± 0.58	1.84 ± 0.46	0.003***
NAC position	3.42 ± 0.95	2.88 ± 0.85	3.80 ± 0.84	0.001***

NSM nipple-sparing mastectomy, *SSM* skin-sparing mastectomy, *NAC* nipple–areola complex

Values are the mean for continuous variables and number (percentage) for categorical variables. The p values for continuous variables were obtained using Student's t test, and p values for categorical variables were obtained using Chi-square tests. p, p value ($p < 0.1$, **$p < 0.05$, ***$p < 0.01$)

after unilateral immediate implant reconstruction after NSM can facilitate durable and pleasant symmetric outcomes. Although contralateral breast augmentation might increase the bias, we also obtained satisfactory position results when using contralateral breast augmentation.

Breast reconstruction satisfaction for the patient questionnaire satisfaction score revealed that NAC preservation did not guarantee better results for breast reconstruction satisfaction (3.48 vs. 3.51, $p = 0.913$). This suggests that there is no need to preserve the NAC while risking oncologic risk or expecting to have problems with wound healing in terms of patient satisfaction with breast reconstruction.

Because this study was retrospective in nature and limited cases were included, a larger and well-controlled cohort study would be ideal to draw more solid conclusions. Further research with long-term follow-up and detailed evaluation of clinical outcome is needed to validate the feasibility of SSM following NAC reconstruction.

Conclusions

NSM can achieve good aesthetic outcome for patients who will undergo immediate device-based breast reconstruction. However, immediate breast reconstruction after NSM can cause several complications including mastectomy wound problems and an undesired outcome with nipple malposition in unilateral breast reconstruction using expander–implant.

Skin-sparing mastectomy followed by NAC reconstruction has low wound complication rate and favourable scores of NAC outcome and patient satisfaction. It can be considered as a balanced alternative to NSM in properly

Table 4 Regression analysis of the association between the vertical position score of photography analysis and variables

Independent variables	All patients		NSM patients		SSM patients	
	B	*p**	*B*	*p**	*B*	*p**
Constant	15.591	0.000	9.574	0.088	18.557	0.000
Oncologic surgeon A, D	1.708	0.146	− 0.174	0.922	2.007	0.292
B	0.494	0.669	− 0.024	0.988	0.524	0.785
C	–	–	–	–	–	–
Mastectomy incision radial	− 1.228	0.115	− 0.933	0.433	–	–
Radial with upper periareolar extension	0.575	0.629	1.204	0.481	–	–
Radial with lower periareolar extension, vertical, IMF, lateral	− 0.831	0.418	–	–	–	–
SSM	–	–	–	–	–	–
Age	− 0.029	0.505	0.081	0.274	− 0.103	0.082*
BMI	− 0.051	0.741	0.082	0.770	− 0.085	0.648
Smoking history	− 3.842	0.058*	− 4.448	0.057*	0	.
Mastectomy specimen weights	− 0.002	0.405	− 0.007	0.163	0.001	0.762
Reconstruction-associated complications	− 0.038	0.971	2.248	0.421	− 0.397	0.731
Delayed wound healing	− 0.844	0.484	− 2.905	0.323	− 1.086	0.442
Contralateral breast augmentation	1.248	0.074*	1.253	0.282	1.183	0.189

NSM nipple-sparing mastectomy, *SSM* skin-sparing mastectomy, *IMF* inframammary fold, *BMI* body mass index *B*, unstandardized regression coefficient; *p, p* value (*$p < 0.1$, **$p < 0.05$)

Table 5 Regression analysis of the association between the horizontal position score of photography analysis and variables

Independent variables	All patients		NSM patients		SSM patients	
	B	*p**	*B*	*p**	*B*	*p**
Constant	14.742	0.000	14.010	0.000	15.106	0.000
Oncologic surgeon A, D	0.875	0.220	0.290	0.792	1.683	0.137
B	− 0.019	0.979	− 0.485	0.620	0.723	0.526
C	–	–	–	–	–	–
Mastectomy incision radial	− 0.923	0.052*	− 0.145	0.843	–	–
Radial with upper periareolar extension	− 1.050	0.148	− 0.103	0.922	2.570	0.555
Radial with lower periareolar extension, vertical, IMF, lateral	− 0.714	0.252	–	–	–	–
SSM	–	–	–	–	–	–
Age	0.014	0.606	0.065	0.164	− 0.032	0.362
BMI	− 0.009	0.924	− 0.149	0.396	0.070	0.524
Smoking history	− 1.409	0.251	− 1.566	0.271	–	–
Mastectomy specimen weights	0.000	0.887	0.002	0.410	− 0.002	0.440
Reconstruction-associated complications	− 0.496	0.440	− 1.493	0.389	− 0.308	0.652
Delayed wound healing	− 0.051	0.944	1.605	0.378	− 0.869	0.300
Contralateral breast augmentation	1.124	0.009**	1.692	0.023**	0.682	0.200

NSM nipple-sparing mastectomy, *SSM* skin-sparing mastectomy, *IMF* inframammary fold, *BMI* body mass index

B, unstandardized regression coefficient; *p, p* value (*$p < 0.1$, **$p < 0.05$)

Table 6 Regression analysis of the association between the total aesthetic outcome score of photography analysis and variables

Independent variables	All patients		NSM patients		SSM patients	
	B	*p**	*B*	*p**	*B*	*p**
Constant	57.782	0.000	53.343	0.000	18.557	0.000
Oncologic surgeon A, D	4.191	0.195	− 1.493	0.742	2.007	0.292
B	1.435	0.652	− 0.937	0.816	0.524	0.785
C	–	–	–	–	–	–
Mastectomy incision radial	− 2.574	0.229	− 0.563	0.852	–	–
Radial with upper periareolar extension	− 0.267	0.935	2.570	0.555	–	–
Radial with lower periareolar extension, vertical, IMF, lateral	− 2.727	0.334	–	–	–	–
SSM	–	–	–	–	–	–
Age	0.001	0.992	0.383	0.048**	− 0.103	0.082*
BMI	− 0.157	0.709	− 0.712	0.325	− 0.085	0.648
Smoking history	− 6.805	0.221	− 7.322	0.212	–	–
Mastectomy specimen weights	− 0.003	0.707	− 0.004	0.751	0.001	0.762
Reconstruction-associated complications	− 2.740	0.347	− 0.336	0.962	− 0.397	0.731
Delayed wound healing	− 1.633	0.622	− 2.056	0.783	− 1.086	0.442
Contralateral breast augmentation	4.102	0.034**	4.474	0.135	1.183	0.189

NSM nipple-sparing mastectomy, *SSM* skin-sparing mastectomy, *IMF* inframammary fold, *BMI* body mass index

B, unstandardized regression coefficient; *p*, *p* value (*$p < 0.1$, **$p < 0.05$)

Table 7 Regression analysis of the association between the breast reconstruction satisfaction score and variables

Independent variables	All patients		NSM patients		SSM patients	
	B	*p**	*B*	*p**	*B*	*p**
Constant	2.129	0.045	2.492	0.101	1.426	0.440
Oncologic surgeon A, D	0.385	0.164	0.370	0.331	0.173	0.747
B	0.305	0.285	0.590	0.152	0.016	0.977
C	–	–	–	–	–	–
Mastectomy incision radial	0.007	0.969	0.487	0.084*	–	–
Radial with upper periareolar extension	0.496	0.126	0.880	0.043**	–	–
Radial with lower periareolar extension, vertical, IMF, lateral	− 0.588	0.017**	–	–	–	–
SSM	–	–	–	–	–	–
Implant type smooth round	0.093	0.669	− 0.009	0.979	0.162	0.630
Textured round	− 0.273	0.269	− 0.172	0.676	− 0.230	0.511
Anatomical	–	–	–	–	–	–
Age	− 0.017	0.470	− 0.039	0.332	− 0.007	0.845
BMI	0.001	0.985	0.071	0.540	− 0.023	0.786
Smoking history	− 0.552	0.277	− 0.576	0.294	0	–
SN-N	0.019	0.659	0.052	0.482	− 0.003	0.958
Breast width	0.038	0.521	− 0.112	0.301	0.111	0.196
Adjuvant radiotherapy	− 0.463	0.072*	− 0.228	0.606	− 0.525	0.137
Mastectomy specimen weights	− 0.001	0.434	− 0.003	0.064*	0.000	0.861
Initial inflation	0.002	0.175	0.003	0.131	0.003	0.203
Infection	− 1.054	0.027**	0	–	− 1.238	0.023**
Implant volume	0.004	0.003**	0.006	0.011*	0.004	0.095*
Contralateral breast augmentation	− 0.024	0.912	− 0.366	0.338	0.140	0.639
Reconstruction-related complications	− 0.750	0.012**	− 0.718	0.110	− 0.895	0.041**
Rippling	1.124	0.005**	1.322	0.027**	1.399	0.032**

NSM nipple-sparing mastectomy, *SSM* skin-sparing mastectomy, *IMF* inframammary fold, *BMI* body mass index, *SN-N* distance from sternal notch to nipple

B, unstandardized regression coefficient; *p*, *p* value (*$p < 0.1$, **$p < 0.05$)

Table 8 Regression analysis of the association between the NAC sensitivity satisfaction score and variables

Independent variables	All patients		NSM patients		SSM patients	
	B	*p**	*B*	*p**	*B*	*p**
Constant	3.368	0.000	4.282	0.001	2.309	0.017
Oncologic surgeon A, D	− 0.252	0.136	− 0.310	0.277	− 0.187	0.497
B	− 0.240	0.170	− 0.200	0.510	− 0.156	0.579
C	–	–	–	–	–	–
Mastectomy incision radial	0.322	0.006**	0.149	0.471	–	–
Radial with upper periareolar extension	0.209	0.292	0.001	0.997	–	–
Radial with lower periareolar extension, vertical, IMF, lateral	0.118	0.424	–	–	–	–
SSM	–	–	–	–	–	–
Implant type smooth round	0.120	0.364	− 0.060	0.807	0.312	0.074*
Textured round	0.344	0.024**	0.191	0.536	0.516	0.005**
Anatomical	–	–	–	–	–	–
Age	− 0.009	0.545	− 0.012	0.679	− 0.001	0.966
BMI	− 0.012	0.753	− 0.058	0.501	0.005	0.909
Smoking history	− 0.669	0.033**	− 0.851	0.043**	0	–
SN-N	− 0.016	0.538	0.040	0.465	− 0.044	0.167
Breast width	− 0.068	0.063*	− 0.118	0.147	− 0.020	0.653
Adjuvant radiotherapy	− 0.357	0.024**	− 0.068	0.835	− 0.455	0.013**
Mastectomy specimen weights	0.000	0.826	− 0.001	0.498	0.001	0.400
Initial inflation	0.000	0.832	0.000	0.908	0.001	0.174
Infection	− 0.235	0.413	0	–	− 0.354	0.193
Implant volume	0.001	0.078*	0.003	0.114	0.000	0.875
Contralateral breast augmentation	0.045	0.735	− 0.050	0.860	0.125	0.414
Reconstruction-related complications	0.192	0.284	0.318	0.336	0.110	0.615
Rippling	− 0.218	0.362	− 0.149	0.729	− 0.022	0.947

NSM nipple-sparing mastectomy, *SSM* skin-sparing mastectomy, *IMF* inframammary fold, *BMI* body mass index, *SN-N* distance from sternal notch to nipple

B, unstandardized regression coefficient; *p*, *p* value (*$p < 0.1$, **$p < 0.05$)

Table 9 Regression analysis of the association between the NAC position satisfaction score and variables

Independent variables	All patients		NSM patients		SSM patients	
	B	*p**	*B*	*p**	*B*	*p**
Constant	2.449	0.024	0.163	0.911	4.700	0.009
Oncologic surgeon A, D	1.018	0.001**	0.529	0.160	0.734	0.151
B	0.690	0.019**	0.681	0.094*	0.319	0.537
C	–	–	–	–	–	–
Mastectomy incision radial	− 0.889	0.001**	0.228	0.401	–	–
Radial with upper periareolar extension	− 0.651	0.050*	0.611	0.145	–	–
Radial with lower periareolar extension, vertical, IMF, lateral	− 1.217	0.001**	–	–	–	–
SSM	–	–	–	–	–	–
Implant type Smooth round	− 0.001	0.998	0.349	0.289	− 0.460	0.151
Textured round	− 0.349	0.165	0.413	0.311	− 0.740	0.028**
Anatomical	–	–	–	–	–	–
Age	0.000	0.990	0.008	0.838	− 0.010	0.755
BMI	− 0.028	0.671	0.008	0.947	− 0.030	0.706

Table 9 continued

Independent variables	All patients		NSM patients		SSM patients	
	B	*p**	*B*	*p**	*B*	*p**
Smoking history	− 0.035	0.946	− 0.314	0.558	–	–
SN-N	0.019	0.666	0.093	0.203	− 0.039	0.500
Breast width	0.024	0.692	− 0.086	0.417	− 0.006	0.943
Adjuvant radiotherapy	− 0.405	0.122	0.068	0.875	− 0.564	0.091*
Mastectomy specimen weights	− 0.001	0.231	− 0.005	0.002**	0.002	0.247
Initial inflation	0.001	0.412	0.003	0.122	0.000	0.838
Infection	− 0.077	0.872	0	–	− 0.197	0.693
Implant volume	0.003	0.074*	0.005	0.037**	0.002	0.412
Contralateral breast augmentation	0.142	0.524	− 0.242	0.517	0.163	0.561
Reconstruction-related complications	− 0.848	0.005**	− 0.892	0.046**	− 0.960	0.020**
Rippling	1.197	0.003**	1.259	0.032**	1.814	0.004**

NSM nipple-sparing mastectomy, *SSM* skin-sparing mastectomy, *IMF* inframammary fold, *BMI* body mass index, *SN-N* distance from sternal notch to nipple

B, unstandardized regression coefficient; *p*, *p* value (*$p < 0.1$, **$p < 0.05$)

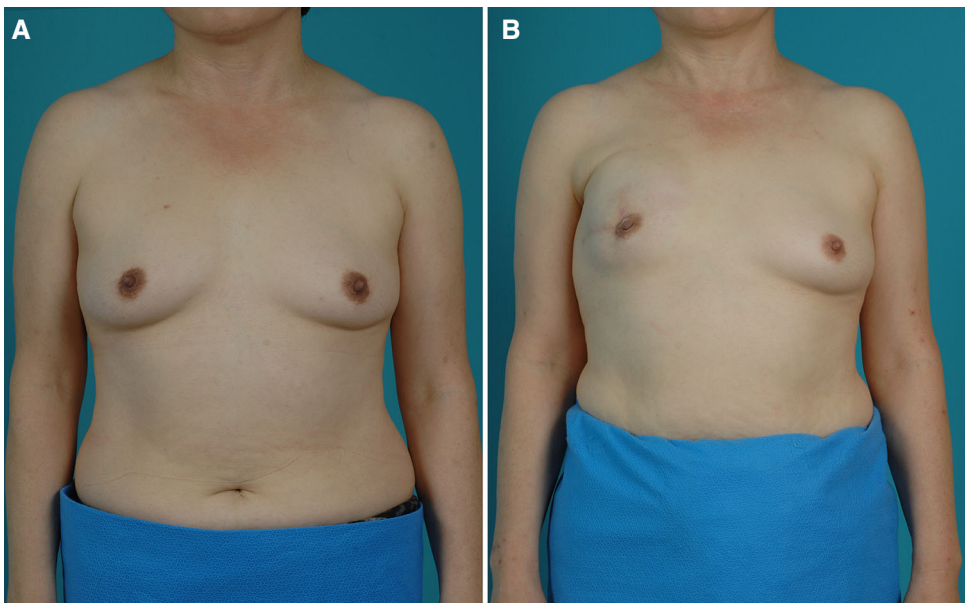

Fig. 2 A 54-year-old patient presenting NSM and immediate breast reconstruction using an expander followed by implant insertion. Mentor medium height textured 450-mL tissue expander was inserted following NSM. Eleven months later, the expander filled with 450 mL saline was removed and an Allergan Natrelle smooth round silicone implant style 10 (moderate profile) 270 mL was inserted. **a** Preoperative picture showing good breast in symmetry and NAC position. **b** Thirteen months after implant insertion picture showing poor nipple position in vertical, horizontal, and total

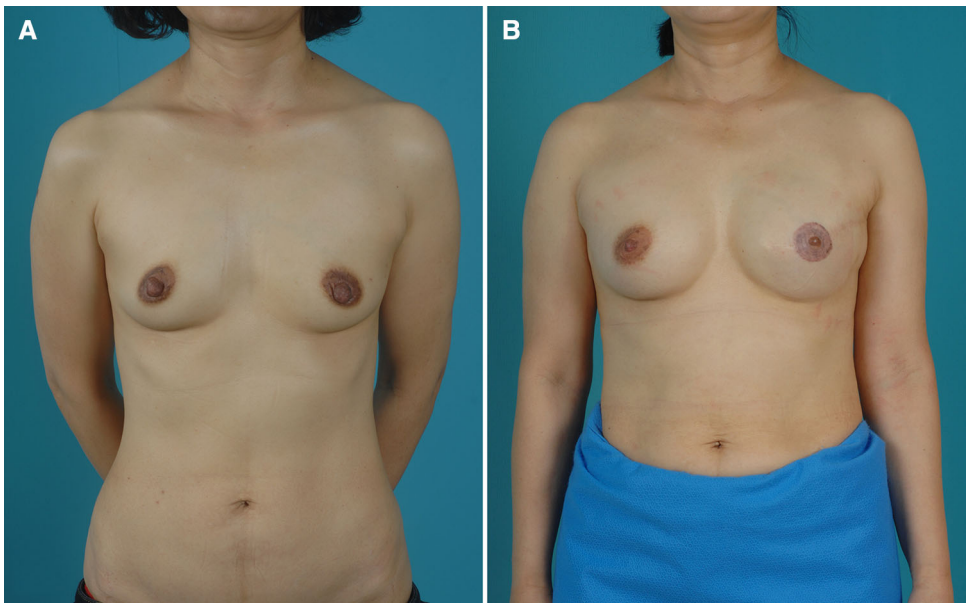

Fig. 3 A 57-year-old patient presenting SSM and immediate breast reconstruction using an expander followed by implant insertion. A Mentor medium height textured 350-mL tissue expander was inserted followed by SSM. After 5 months, a 380-mL saline-filled expander was removed and an Allergan textured round silicone implant style 110 (moderate profile) 300 mL was inserted. Also, contralateral breast augmentation using an Allergan textured round silicone implant style 110 (moderate profile) 180 mL with the inframammary fold approach was performed for bilateral breast symmetrization. **a** Preoperative picture. **b** At 37 months after implant insertion with contralateral breast augmentation and at 7 months after NAC reconstruction. Nipple position seems to be good in vertical, horizontal, and total

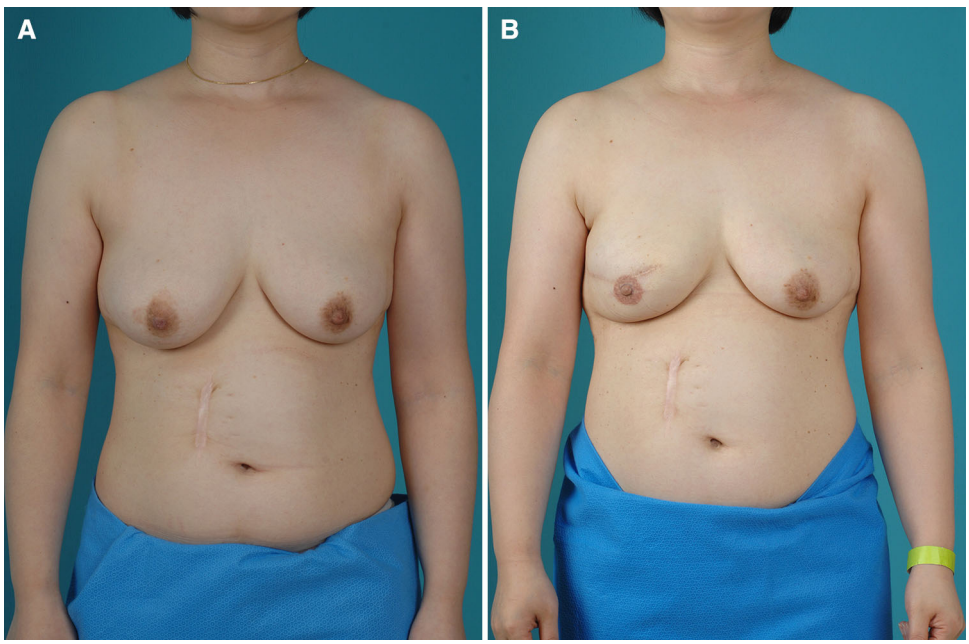

Fig. 4 A 41-year-old female underwent breast and NAC reconstruction after SSM for breast cancer on her right breast. A Siltex medium height contour profile 550-mL tissue expander was inserted followed by SSM. After 7 months, a 590-mL saline-filled expander was removed and an Allergan Natrelle smooth round silicone implant style 10 (moderate profile) 420 mL was inserted. **a** Preoperative picture. **b** Pictures at 14 months after implant insertion, 8 months after nipple reconstruction, and 3 months after tattooing. The reconstructed breast looks symmetrical. It has a fairly satisfactory result. The location and the shape of the reconstructed NAC are also satisfactory

selected patients with breast cancer, especially when significant asymmetry of nipple position is expected following NSM.

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Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

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