Breast Cancer Res Treat (2013) 140:545–555
DOI 10.1007/s10549-013-2634-7

EPIDEMIOLOGY

Clinical outcomes following nipple–areola-sparing mastectomy with immediate implant-based breast reconstruction: a 12-year experience with an analysis of patient and breast-related factors for complications

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Received: 29 March 2013 / Accepted: 7 July 2013 / Published online: 30 July 2013

Abstract Nipple-sparing mastectomy (NSM) is increasingly offered to women for therapeutic and prophylactic indications. Although, clinical series have been described, there are few studies describing risk factors for complications. The objective of this study is to evaluate the incidence of complications in a series of consecutive patients submitted to NSM and differences between clinical risk factors, breast volume, and different incision types. In a cohort-designed study, 158 reconstructed patients (invasive/in situ cancer and high risk for cancer) were stratified into groups based on different types of incision used (hemi-periareolar, double-circle periareolar, and Wise-pattern). They were matched for age, body mass index, associated clinical diseases, smoking, and weight of specimen. Also included were patients treated with adjuvant chemotherapy and postoperative radiotherapy. Mean follow-up was 65.6 months. In 106 (67 %) patients, NSM was performed for breast cancer treatment and in 52 (32.9 %) for cancer prophylaxis. Thirty-nine (24.6 %) patients were submitted to hemi-periareolar technique, 67 (42.4 %) to double-circle periareolar incision, and 52 (33 %) to Wise-pattern incision. The reconstruction was performed with tissue expander and implant–expander. Local recurrence rate was 3.7 % and the incidence of distant metastases was 1.8 %. Obese patients and higher weight of specimen had a higher risk for complications. After adjusting risk factors (BMI, weight of specimen), the complications were higher for patients submitted to hemi-periareolar and Wise-pattern incisions. This follow-up survey demonstrates that NSM facilitates optimal breast reconstruction by preserving the majority of the breast skin. Selected patients can have safe outcomes and therefore this may be a feasible option for breast cancer management. Success depends on coordinated planning with the oncologic surgeon and careful preoperative and intraoperative management. Surgical risk factors include incision type, obesity, and weight of breast specimen.

Keywords Breast reconstruction · Skin-sparing mastectomy · Nipple-sparing mastectomy · Outcome · Complications · Silicone breast implants

Abbreviations

SSM	Skin-sparing mastectomy
NSM	Nipple-sparing mastectomy
NAC	Nipple–areola complex
LDMF	Latissimus dorsi myocutaneous flap
TRAM	Transversus rectus abdominis myocutaneous flap
BMI	Body mass index

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Introduction

In recent years, a debate has developed about the opportunity of extending preservation of the skin to include the nipple–areola complex (NAC) [1–18]. Thus, the NAC-sparing mastectomy (NSM) can be an alternative, which aims at avoiding the removal of the NAC and the positive consequences for immediate reconstruction.

The objectives of NSM are resection of the breast tissue while restoring the breast volume and minimal deformity. To achieve these goals, numerous approaches have been proposed by a variety of designs incorporating a periareolar incision, or other variations in the shape and size around the NAC [3, 4, 8–11, 13–16]. Although incision designs vary with configuration, these approaches are frequently combined with immediate reconstruction and options are based on patient preference, body habitus, and surgeon experience. However, the impasse of the access incision without complications has drawn attention in the literature [9, 14–16, 18].

Although immediate NSM reconstruction has been previously discussed [1–18], the literature provides little evidence of the influence of possible risk factors on the chance of complications following reconstruction. In addition, incision selection is debated owing to the lack of high-level evidence, as few clinical trials have been carried out. Thus, this study was designed to review a series of immediate reconstruction of NSM deformities and assesses the incidence of complications to identifying risk factors for an unfavorable outcome. We, therefore, assessed patient-related and breast-related characteristics as potential risk factors for these complications.

Patients and methods

Between January 2000 and July 2012, all cases submitted to NSM and immediate implant-based reconstruction at the University of São Paulo Medical School, Hospital Sírio-Libanês and the senior author's (A.M.M) private practice were reviewed. Oncological information on tumor size/location, axillary surgery, and adjuvant therapy were obtained. The indications for NSM and reconstruction included prophylactic mastectomy, in situ and invasive carcinoma. The primary endpoint was the development of one or more perioperative complications and is defined as those occurring at any time from initiation of reconstruction up to 1-month postoperative. Complications were evaluated and included wound dehiscence, partial skin flap loss, infection, hematoma, and implant extrusion.

Patient evaluation, incision, and reconstructive procedure selection

All patients were first seen by a multidisciplinary team and based on the breast volume/ptosis patients were evaluated by the plastic surgeon who indicated the incision and reconstruction with the appropriate technique. NSM was stratified into sub-types based on the type of incision used (hemi-periareolar, double-circle periareolar[10], and Wise-pattern) (Fig. 1a). The inclusion and exclusion criteria for each group has been developed based upon surgical experience and has evolved over time (Fig. 1b). The NSM involved patients with tumors measuring less than 3 cm and located more than 5 cm from the NAC. The mastectomy specimen is removed en bloc, preserving the subdermal nipple ductal tissue. The nipple tissue is marked with a suture, removed, and cytological evaluation of the undersurface of the areolar flaps is performed. The areola tissue is then evaluated before reconstruction to assess viability. If there is any inadequate perfusion, the procedure is converted into a standard SSM and not included in the present study.

Reconstructive procedures

The reconstruction techniques were performed with one of two surgical options: tissue expander (133 style MV, Allergan Inc., Irvine, Calif.) and biodimensional implant–expander (150 style, Allergan Inc., Irvine, Calif.). Implants/expanders were selected preoperatively, according to the width, height, and projection of the normal breast. This is confirmed by measuring the linear dimension of the pocket at the widest point of the anatomical implant position during surgery. At the time of the implant–expander placement, the devices were placed totally submuscularly (subpectoral/subserratus) or in a partial submuscular pocket depending upon the patient's anatomy and the condition of the muscle/skin flaps after the mastectomy.

Statistical analysis

To compare groups regarding quantitative variables (age, breast weight, and BMI), the analysis of variance (ANOVA) was performed followed by *Tukey's* multiple comparison tests. Binary variables (complication, smoker, hypertension, and diabetes) were compared using the Chi square or Fisher's exact test. The associations between the complications with age, body mass index (BMI), smoking history, and breast weight were analyzed. The continuous variable weight of the specimen was reduced to whether or not it was over their mean value (380 g). Univariate and multivariate analyses were performed using logistic regression models taking the occurrence of complications as outcome. Variables with significant differences between groups or with $p < 0.10$ in univariate analysis were included in the multivariate model. Results are presented as odds ratios and 95 % confidence intervals as a measure of

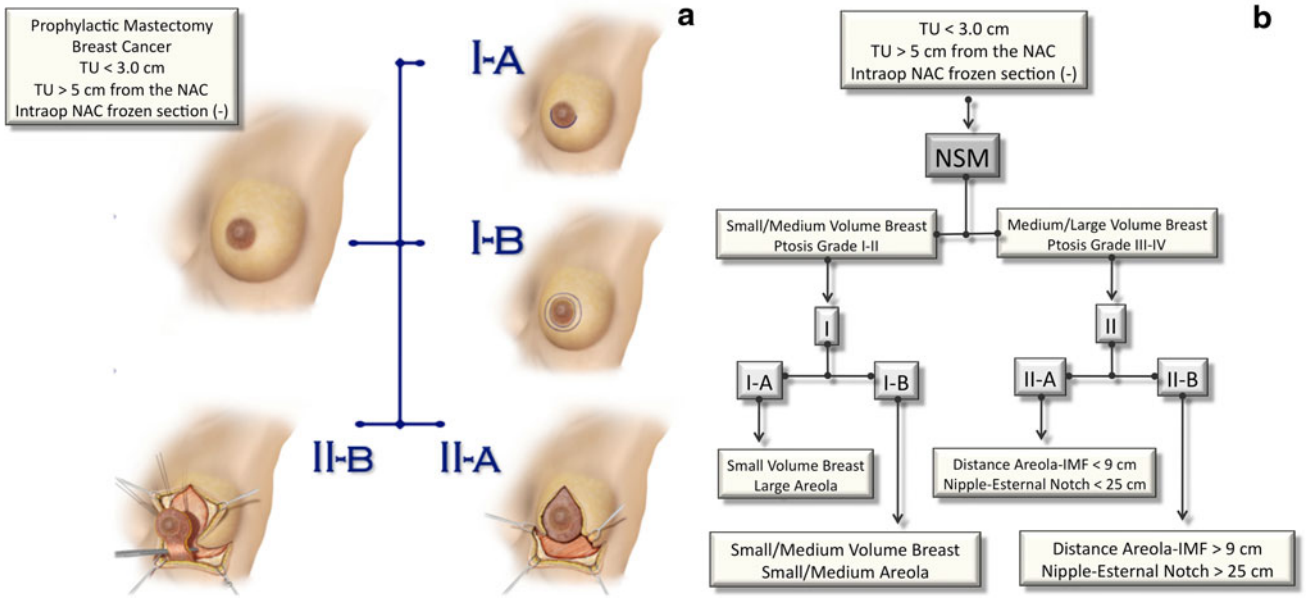

Fig. 1 **a** Schematic representation of NSM algorithm. *I-A* hemi-periareolar incision. *I-B* double-circle concentric periareolar incision. *II-A* Wise pattern by a superior pedicle technique. *II-B* Wise pattern by an inferior pedicle technique. **b** Algorithm for immediate NSM reconstruction and indications based on the breast volume, presence of ptosis, tumor location and characteristics. *I-A* hemi-periareolar incision. *I-B* double-circle concentric periareolar incision. *II-A* Wise pattern by a superior pedicle technique. *II-B* Wise pattern by an inferior pedicle technique

association. A value of $p < 0.05$ was considered statistically significant. The SPSS™ for Windows software package was used (SPSS Inc. Chicago, Illinois).

Results

Over a period of 12 years, a total of 158 patients were included (Figs. 2, 3, 4, 5). In 106 (67 %) patients, NSM was performed for breast cancer treatment and in 52 (32.9 %) for cancer prophylaxis. Thirty-nine patients (24.6 %) were submitted to hemi-periareolar technique, 67 (42.4 %) to double-circle periareolar incision, and 52 to Wise-pattern incision (28 (17.7 %) with a superior pedicle and 24 (15.1 %) with an inferior pedicle technique) (Figs. 2, 3, 4, 5). Mean age was 51.4 years (range 33–78 years). Sixty-six (41.7 %) patients underwent bilateral reconstruction. Median weight of the breast specimens was 416.2 g (range 145–720 g). Minimum follow-up after surgery was 9 months, with an average of 65.6 months (range 6–130 months). Details of patient demographics according to each group are provided in Table 1.

Tumor and oncological characteristics

Of the 106 patients with breast cancer, 78 (73.5 %) had tumors measuring 2 cm or less (T1), and 28 (26.4 %) had tumors between 2 and 4 cm (T2). Tumor location was unilateral in 98 (92.4 %) and bilateral in 8 (7.5 %) patients. In these patients, 15 contra-lateral surgeries were prophylactic. 58 patients (60.4 %) were submitted to a sentinel lymph node biopsy, 28 patients (26.4 %) underwent chemotherapy, and 10 (9.4 %) had adjuvant radiotherapy. Local recurrence rate was 3.7 % (4/106 cancer patients) and the incidence of distant metastases was 1.8 % (2/106 patients). Local-regional recurrences were observed in the skin or subcutaneous tissue of the breast as palpable masses. There were no recurrences involving the spared NAC.

Overall complication rates

Thirty-five (22.1 %) local complications occurred in 22 of the 158 patients (13.9 %). Five patients (3.1 %) presented more than one complication and four (2.5 %) presented three complications. Wound dehiscence was observed in 13 patients (8.2 %), partial skin flap necrosis in 12 (7.5 %; 4 in the mastectomy flap and 8 in the NAC), infection in 4 (2.5 %), and hematoma in 1 (0.6 %). Five patients (3.1 %) had implant loss with 3 (1.8 %) secondary to wound dehiscence associated to partial flap loss, 1 (0.6 %) secondary to partial flap loss, and 1 (0.6 %) following a local infection in the peri-implant space. All cases of dehiscence except three were treated by a conservative approach with a good result. Eight of the 12 skin flap necroses around the incision healed after local wound care. The wound was re-excised in the remaining five cases. In three patients, the NSM had been carried out through the elliptical excision;

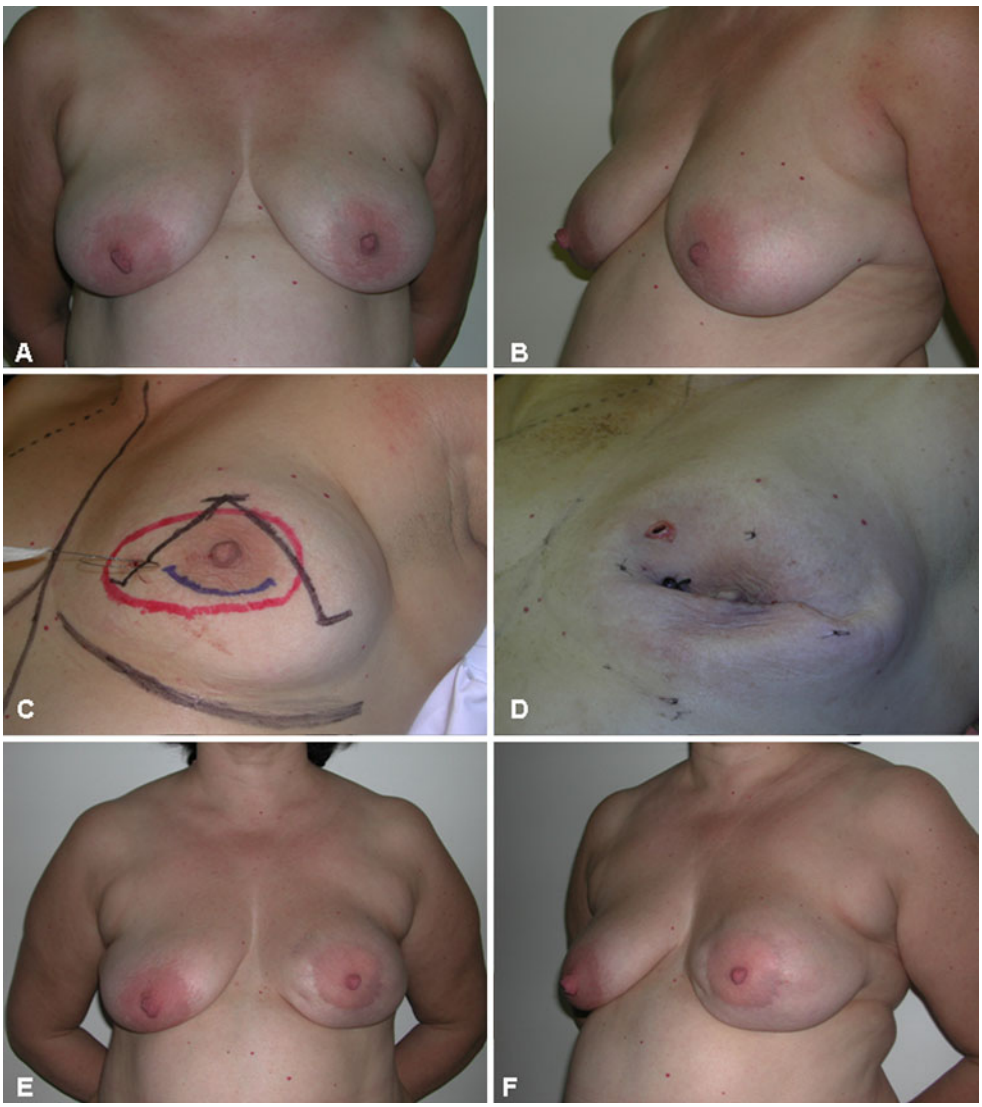

Fig. 2 **a–f** NSM/hemi-periareolar incision: a 49-year-old patient with an invasive ductal carcinoma in the left breast (3.8 cm) (**a–b** above *left* and *right*). Preoperative planning was based on a left conservative breast surgery through a periareolar approach and immediate reconstruction with mammaplasty. Intraoperative frozen sections diagnosed a multifocal disease. Thus, the patient underwent a left NSM mastectomy with the initial hemi-periareolar incision and axillary dissection (**c–d**, center-above *left* and *right*). The oncological procedure was immediately followed by a left implant–expander (Allergan 150 SH, 285 cm^3) reconstruction. One year postoperative appearance with a very good outcome (**e–f**, below *left* and *right*)

in two, a secondary flap was indicated (one TRAM flap and one LDMF). In the entire series of 158 NSM, the NAC survived in 150 cases (95 %), partially survived in seven cases (4.4 %), and was lost in one case (0.6 %).

Effect of clinical patient-related and breast-related factors on outcome of surgery

There were no significant differences between groups in terms of age ($p = 0.776$), BMI ($p = 0.274$), hypertension ($p > 0.999$), diabetes ($p > 0.999$), and smoking history ($p > 0.999$). Difference was observed between the groups in relation to the weight of the breasts. The average breast weight in patients submitted to hemi-periareolar incision was lower than the average weight in patients submitted to Wise-pattern superior pedicle ($p = 0.008$) and Wise-pattern inferior pedicle ($p = 0.002$). Results are listed in Table 1. Regarding the incidence of complications and the different incisions, there were no statistically significant differences between groups. Results are listed in Tables 2 and 3. Univariate analyses were performed to identify risk factors for complications. There was a significantly higher incidence of complications in the obese (odds ratio 1.328; $p < 0.001$), larger specimens group (odds ratio 1.007; $p < 0.001$), and hypertension (odds ratio 7.867; $p < 0.001$). Neither a history of diabetes ($p = 0.635$), nor

Fig. 3 a–f NSM/double-circle concentric periareolar incision: a 49-year-old patient with invasive lobular carcinoma in the right breast (1.8 cm) and atypical hyperplasia in the left breast (**a–b** above *left* and *right*). The patient underwent a bilateral NSM mastectomy with a double concentric periareolar incision and sentinel lymph node biopsy (**c–d** center-above *left* and *right*). The oncological procedure was immediately followed by a bilateral implant–expander (Allergan 150 SH, 385 cm^3) reconstruction. Two years postoperative appearance with a very good outcome (**e–f** below *left* and *right*)

age ($p = 0.678$), nor smoking history ($p = 0.127$) was a significant predictor of complications. Regarding the type of incision, there was no statistically significant effect, however, some comparisons had p values close to the significance level of 0.05, suggesting that the double-circle incision is less likely to have complications than hemi-periareolar and Wise-pattern incision groups (Table 4). Variables with $p < 0.10$ in the univariate analysis were selected for the multivariate model. As the weight and BMI are highly correlated ($r = 0.92$), the BMI was chosen. In the multivariate model, we found that when the BMI, breast weight, and hypertension are controlled, some differences between groups became significant. With this model, we observed that the double-circle incision has less chance of complications than hemiperiareolar and Wise-pattern superior pedicle incisions.

Reoperation/revisional surgeries/contralateral procedures

Fourteen patients (8.8 %) required reoperation. Reasons for unanticipated return to the operating room included the following: implant loss in five (3.1 %) patients, debridement of NSM flap in five (3.1 %), wound dehiscence in three (1.8 %), and evacuation of hematoma in one (0.6 %) patients. Sixty-nine percent of all patients who underwent unilateral procedure and completed their reconstruction (63 of 92) had a contralateral breast symmetry procedure.

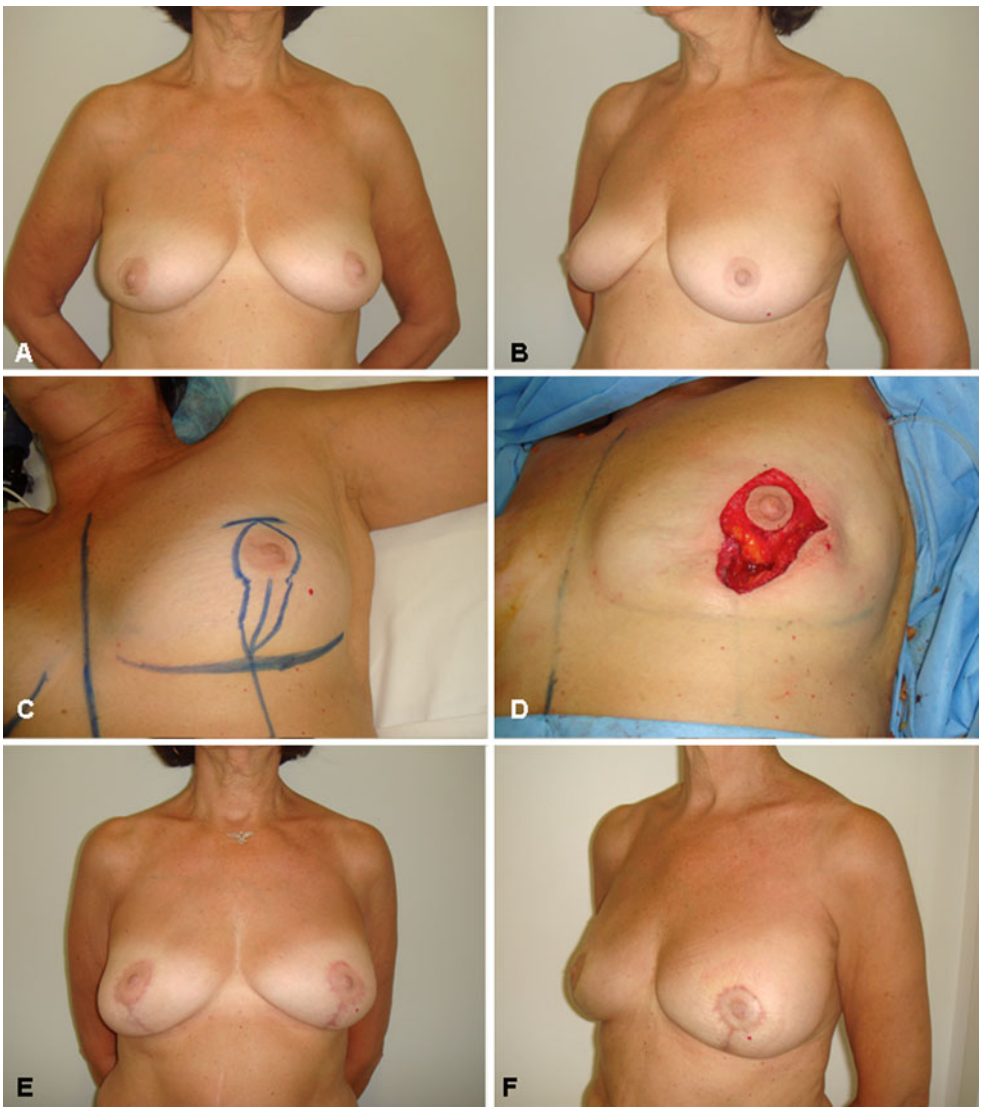

Fig. 4 **a–f** NSM/Wise pattern by a superior pedicle technique: a 57-year-old patient with invasive lobular carcinoma of the left breast (3 cm) and familial history of breast cancer (**a–b** above *left* and *right*). The patient underwent a bilateral NSM mastectomy with a modified Wise pattern by a superior pedicle technique and sentinel lymph node biopsy (**c–d** center-above *left* and *right*). The oncological procedure was immediately followed by a bilateral implant–expander (Allergan 150 SH, 385 cm^3) reconstruction. Seven months postoperative appearance with a very good outcome (**e–f** below *left* and *right*)

Twenty-five percent of all patients who underwent bilateral procedure and completed their reconstruction (16 of 66) had a secondary breast symmetry procedure. Concerning the revision surgeries, six patients (3.7 %) underwent repositioning by rotation of the remote filling port. The surgery was a minor procedure (office surgery under local anesthesia) and performed 3 weeks after NSM reconstruction.

Discussion

SSM (skin-sparing mastectomy) is currently indicated for early breast cancer treatment [19–28]. In spite of the controversies involving risk of local relapse, some recent investigations have shown that the NSM is a safe procedure for selected patients [1, 3, 4, 13–16]. In fact, some studies have considered NSM safe in women with small, peripherally located tumors, without multicentricity, or for prophylactic mastectomy [13]. In our sample, in almost 35 % of patients the NSM was indicated for cancer prophylaxis including high-risk lesions, prophylactic, familial history, and carriers of the *BRCA1* or *BRCA2* mutation. In the remaining breast cancer patients, almost 75 % of tumors measured 2 cm or less (T1) and the majority were stage 0 and I. Additionally, we have excluded patients with NAC infiltration, NAC bleeding or with the tumor at less than 5 cm from the NAC. Considering these

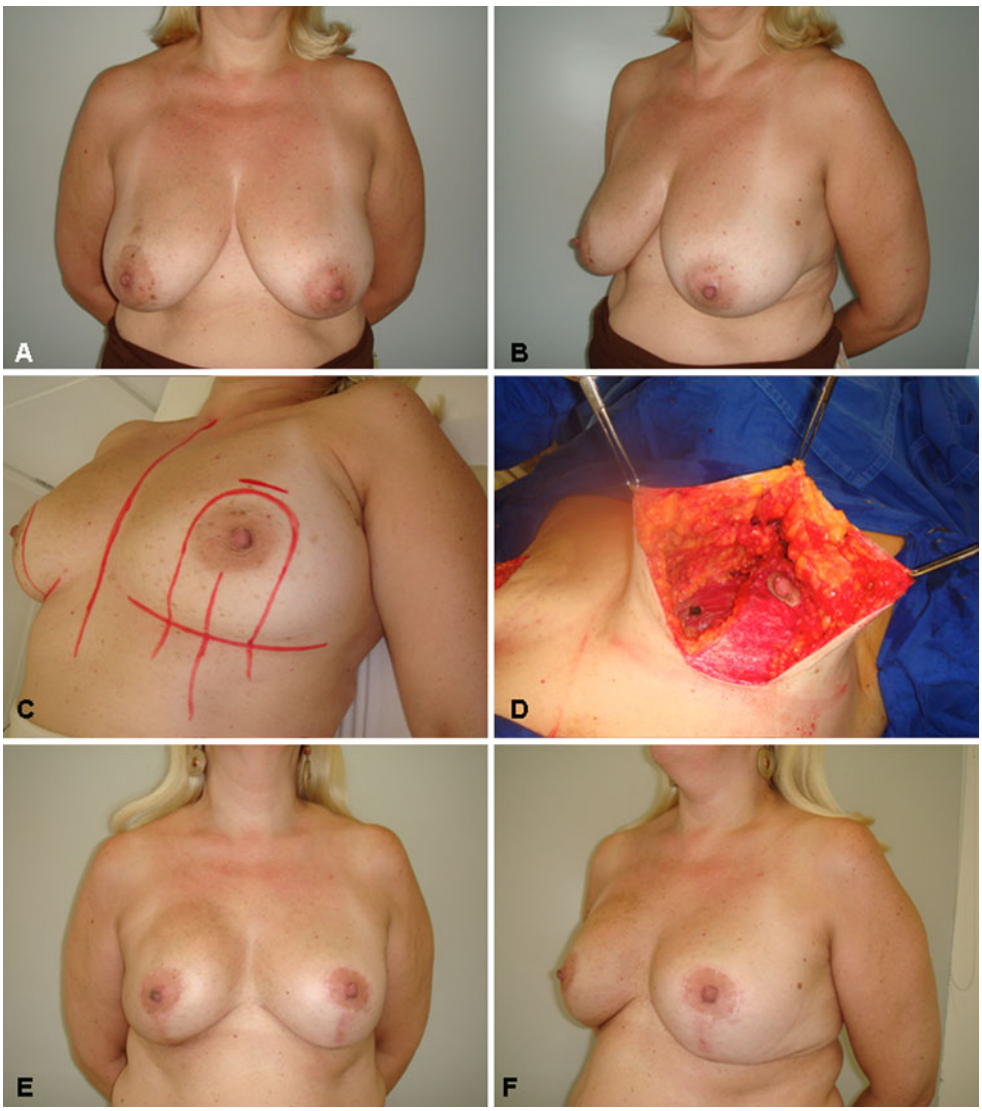

Fig. 5 a-f NSM/Wise pattern by an inferior pedicle technique: a 51-year-old patient with invasive ductal carcinoma of the right breast (3.0 cm) and familial history of breast cancer (**a–b** above *left* and *right*). The patient underwent a bilateral NSM mastectomy with a modified Wise pattern by an inferior pedicle technique and sentinel lymph node biopsy (**c–d** center-above *left* and *right*). The oncological procedure was immediately followed by a bilateral implant–expander (Allergan 150 FH, 350 cm^3) reconstruction. One year postoperative appearance with a very good outcome (**e–f** below *left* and *right*)

parameters, we believe that NSM is feasible with low local recurrence.

In a recent review, Tokin et al. [13] observed that the local recurrence following NSM was between 0 and 20 %, with studies varying widely in patient size, inclusion criteria, and follow-up. Boneti et al. [15] reported in a series of 281 NSMs with 25.3 months mean follow-up, a 4.6 % local recurrence rate. Jensen et al. [16] published results from 149 patients without any locoregional recurrences in a series of NSMs at a mean 5-year follow-up. We found similarly low rates of locoregional recurrence in our series, with median follow-up of 65 months, all detected as palpable masses in the skin flaps.

Combined incision planning for NSM has been described [5, 7, 8, 15–19, 21, 23, 29–32]. Habitually, the technique differs among surgeons and is dependent on the type of reconstruction and the size of the breast. A critical survey shows that the procedure is normally performed by numerous approaches, but the greater part is related to the areolar incision [1, 3–5, 10]. In our experience, we avoid the inframammary fold incision due to the technical limitation to dissect the upper pole breast tissue and inadequate resection. Additionally, in some cases, we believe that it is difficult to place the incision in the right position once the final implant volume is decided upon at the end of the surgery. Besides these limitations, some authors believe

Table 1 Patients, groups, and clinical characteristics ($n = 158$)

Characteristic	Hemi-periareolar ($n = 39$)	Double-circle ($n = 67$)	Wise pattern/superior pedicle ($n = 28$)	Wise pattern/inferior pedicle ($n = 24$)	p value
Mean age (SD) (years)	50.4 (10.6)	51.9 (8.7)	52.5 (8.0)	51.3 (7.8)	0.776
Weight (SD) (kg)	69.2 (8.3)	71.8 (10.5)	69.8 (8.3)	70.2 (8.7)	0.539
BMI (SD), (kg/m^2)	25.9 (3.9)	27.2 (4.3)	25.8 (3.7)	26.0 (3.9)	0.239
Normal (BMI < 25), *n*	19 (48.7 %)	24 (35.8 %)	13 (46.4 %)	10 (41.7 %)	–
Overweight (>25; <30), *n*	14 (35.9 %)	29 (43.3 %)	10 (35.7 %)	9 (37.5 %)	–
Obese (BMI >30), *n*	6 (15.4 %)	14 (20.9 %)	5 (17.9 %)	5 (20.8 %)	–
Smoking, *n* (%)	8 (20.5 %)	13 (19.4 %)	5 (17.9 %)	5 (20.8 %)	>0.999
Hypertension, *n* (%)	5 (12.8 %)	9 (13.4 %)	3 (10.7 %)	3 (12.5 %)	>0.999
Diabetes mellitus, *n* (%)	3 (7.7 %)	5 (7.5 %)	2 (7.1 %)	1 (4.2 %)	>0.999
Mean weight of breast, g	333.6	392.2	458.8	480.6	0.001
Weight of breast, *n* (%)					<0.001
<380 g, *n* (%)	29 (74.4 %)	30 (44.8 %)	7 (25.0 %)	5 (20.8 %)	
>380 g, *n* (%)	10 (25.6 %)	37 (55.2 %)	21 (75.0 %)	19 (79.2 %)	

BMI body mass index (kg/m^2), *SD* standard deviation

Table 2 Patients, groups, and incidence of complications ($n = 158$)

	Groups (incision)				
	Hemi-periareolar ($n = 39$)	Double-circle ($n = 67$)	Wise pattern/superior Pedicle ($n = 28$)	Wise pattern/inferior Pedicle ($n = 24$)	p value
Total complications—*n* (%)	8 (20.5)	5 (7.5)	6 (21.4)	3 (12.5)	0.144
Dehiscence—*n* (%)	5 (12.8)	3 (4.5)	3 (10.7)	2 (8.3)	0.405
Partial lost—*n* (%)	4 (10.3)	3 (4.5)	4 (14.3)	1 (4.2)	0.320
Infection—*n* (%)	2 (5.1)	1 (1.5)	0 (0)	1 (4.2)	0.441
Extrusion—*n* (%)	3 (7.7)	1 (1.5)	1 (3.6)	0 (0)	0.235
Hematoma—*n* (%)	0 (0)	1 (1.5)	0 (0)	0 (0)	>0.999

Some patients presented more than one complication

that the inframammary incision could impair the inframammary blood supply [29, 30]. Proano and Perbeck compared skin circulation in patients having either an inframammary fold incision or a lateral lazy S incision using laser Doppler and fluorescein flowmetry [30]. In a series of 69 patients, they observed a significant reduction in flow to an area of skin 2 cm below the NAC in the group submitted to inframammary approach.

Similarly, as we observed with the inframammary incision and due to the limited exposure observed with the hemiperiareolar technique, we developed an approach to improve the surgical access. This technique is based on the double concentric periareolar incision and was described elsewhere [10]. The objective was the resection of glandular tissue, while maintaining the vascularization of the NAC via the subdermal plexus. In addition, we de-epithelialize the whole periareolar incision to allow for triple-layer closure of the wound. In some situations, small areas of delayed healing were treated conservatively. Until complete wound healing, the implant–expander is deflated to avoid skin tension and flap congestion. Following recovery, final adjustments in volume are made with a satisfactory outcome [10]. When combined with NSM, the best skin quality match with the contralateral breast and a better symmetry can be achieved. In our sample, an implant cover was performed by the superior two-thirds of the pectoralis muscle and by the cutaneous flap in the remaining inferior third. This positioning allows for improved lower breast projection and better inframammary fold definition [31, 33, 28, 34–36].

The Wise pattern has been previously described for planning SSM/NSM in ptotic breasts [19]. Classified by Carlson et al. [21, 23] as a Type IV, it involves breasts that require a conspicuous reduction of the skin envelope and offers a wide exposure with control of the skin envelope [11, 37–39]. In our study, almost 35 % of the patients were submitted to the Wise incision. The superior pedicle and inferior pedicle techniques were indicated for moderate

Table 3 Results of analyses of patient and breast-related characteristics that may have acted as risk factors for a complicated outcome ($n = 158$)

Factors	Univariate analysis[a]			Multivariate analysis[b]		
	OR	95 % CI	p value	OR	95 % CI	p value
Age (years)	1.011	0.961–1.063	0.678	–	–	–
Weight of specimen	1.007	1.003–1.010	<0.001*	1.000	0.995–1.006	0.871*
BMI	1.328	1.173–1.503	<0.001*	1.366	1.050–1.778	0.020*
HAS	7.867	2.753–22.479	<0.001*	1.854	0.420–8.184	0.415*
DM	0.600	0.073–4.934	0.635	–	–	–
Smoking history	2.178	0.801–5.918	0.127	–	–	–

OR odds ratio, *CI* confidence interval, *BMI* body mass index, *HAS* hypertension, *DM* diabetes. * $p < 0.05$

[a] Odds ratio, p value, and 95 % confidence interval as yielded by univariate logistic regression analysis of each of the six patient-related characteristics in 158 patients that may have acted as risk factors for a complicated outcome

[b] Odds ratio, p value, and 95 % confidence interval as yielded by multivariate analysis of the three patient-related characteristics in 158 patients that proved to be statistically significant risk factors for a complicated outcome by univariate regression analysis

Table 4 Results of analyses of incision-related characteristics that may have acted as risk factors for a complicated outcome ($n = 158$)

Incision	Univariate analysis[a]			Multivariate analysis[b]		
	OR	95 % CI	p value	OR	95 % CI	p value
IB/IA	0.313	0.094–1.035	0.057	0.115	0.024–0.549	0.007
IIA/IA	1.057	0.321–3.478	0.928	1.153	0.242–5.494	0.858
IIB/IA	0.554	0.131–2.332	0.420	0.418	0.071–2.459	0.335
IIA/IB	3.382	0.938–12.195	0.063	10.000	1.678–59.586	0.010
IIB/IB	1.771	0.390–8.055	0.459	3.627	0.559–23.541	0.177
IIA/IIB	1.909	0.422–8.637	0.401	2.757	0.477–115.938	0.257

OR odds ratio, *CI*, confidence interval, *IA* hemi-periareolar incision, *IB* double-circle periareolar incision, *IIA* Wise-pattern superior pedicle, *IIB* Wise-pattern inferior pedicle

ptosis and severe ptosis cases, respectively. The implant–expander is usually placed on a partial submuscular pocket depending upon the condition of the skin flaps. In spite of the main benefits, this technique has some limitations since the lateral and medial skin flaps that close down to the inframammary fold may become ischemic [11]. Thus, for this group of patients the implant–expander concept can be advantageous. During the postoperative period, the implant is totally deflated to avoid skin tension and flap congestion. Following local recovery, final adjustments in volume are made with less risk of skin flap complications [10, 28, 35]. In higher risk patients or severe breast ptosis, we preferred the inferior pedicle technique since the well-vascularized pedicle provides a stable soft-tissue cover for the implant, which protects against exposure.

In order to establish the level of risk associated with patient and incision-related characteristics, we have been including all patients who were referred for implant-based reconstruction following NSM. Our results verified that almost 14 % of patients presented at least one complication. Wound dehiscence and flap necrosis were observed in 8.2 and 7.5 % of the patients, respectively, and the major part were treated conservatively. In our study, the majority of NAC outcomes have demonstrated some degree of immediate ischemia manifested by coolness [10, 40]. However, the NAC skin survived in almost 95 % of cases and partially survived in 4.4 %. In these cases, the NAC developed epidermolysis/partial-thickness necrosis and most of these healed conservatively.

Previous studies have reported some risk of skin flap/NAC necrosis [10, 12–18, 29]. Although comparing NAC necrosis rates between different populations and techniques can be challenging, most studies report rates from 0 to 19.5 % [12, 14]. Thus, our results demonstrate an acceptable rate of NAC complications and support the technical feasibility of performing NSM and immediate reconstruction. In our sample, the type of incision was not significantly predictive of complications in univariate analysis. However, after adjusting for other risk factors (BMI and weight of specimen), the probability of complications tends to be higher for hemi-periareolar and Wise-pattern superior pedicle incision. In addition, the hemi-periareolar approach demonstrated a higher incidence of skin flap necrosis. We believe that besides the restricted access, this approach can

potentially result in vascular impairment to collateral flow due to traction, which can induce partial necrosis. In fact, Regolo et al. [8] in a series utilizing the periareolar incision observed a high rate of necrotic complication of the NAC, which they abandoned in favor of a lateral incision. In our study, we observed a lower incidence of NAC necrosis with the double-circle incision technique. This aspect is probably due to the full access along the inferior border of the NAC without traction, which seems to allow adequate blood supply to the NAC.

Some authors suggest that patient comorbidities are important risk factors for complications [23, 39–44]. In our study, univariate analysis showed a significantly higher incidence of complications in the obese, hypertensive, and larger specimen groups. In fact, the deleterious effect of obesity on breast reconstruction was previously studied [41, 42, 44]. One might suppose that increased BMI may predispose the flap necrosis due to the compromised sub-dermal plexus brought about by the increased surface area of the flap [39]. In addition, obese patients are likely to have additional complications due to associated microvascular disease. Similarly as observed by Wooderman et al. [43], specimen weight more than the mean weight seems to be associated with statistically significant odds ratios to develop complications. This aspect can be partially explained by a decreased perfusion of the relatively large skin flaps that result from SSM in much larger breasts. In spite of the characteristics between groups being similar, there was a difference concerning the weight of the specimen. Patients submitted to the Wise-pattern incision presented the highest averages reflecting our preselection of patients based on algorithm (Fig. 1b).

In addition to the influence of the NSM incision utilized, it has been our impression that NAC complications can also be affected by the reconstructive technique. Thus, we advocated performing only minimal immediate expansion of the thin skin flaps/NAC in order to avoid tissue tension. At present, all of our implant reconstructions are done with an implant–expander system or two-stage expander tissue technique with minimal intraoperative inflation. Similarly as pointed out by other authors, it has been our experience that these procedures not only minimize NAC complications, but also reduce mastectomy skin flap necrosis, which can lead to infection or implant extrusion [18]. In fact, in a series of 428 patients submitted to NSM reconstruction, Peled et al. [18] observed that NAC ischemic complications greatly decreased after the technical refinements of incision selection and performing implant reconstruction in a two-stage fashion.

This study has some limitations that should be recognized. First, we analyzed the risk factors that potentially influenced the short-term surgical outcome rather than the long-term complications. Second, our satisfactory results are due to a close collaboration with the oncologic surgery team in terms of incision selection flexibility and skin flap dissection. We recognized that this aspect is not frequently observed in current clinical practice. It has been our opinion that our results are only attainable if the indication for these techniques and the "team-work together" concept is placed very restrictive. Although we have identified risk factors for NSM complications, one might surmise that the overall incidence of complications was acceptably low. Thus, we believe that patients who have identified potential risk factors, such as large breast and obesity, should not be withheld from undergoing immediate reconstruction. Alternately, care must be taken during the oncological procedure with meticulous surgical technique and gentle handling of tissues to avoid complications.

Conclusion

With careful patient selection and well-planned surgical technique, NSM can provide satisfactory outcomes with acceptable complication rates. Based on the results, the probability of complications tends to be higher for the obese and higher weight of breast specimens. After adjusting for other risk factors (BMI, weight of breast specimen), the probability of complications tends to be higher for hemi-periareolar and Wise pattern with superior pedicle incision approaches.

Acknowledgements We would like to thank Angela Paes for statistical analysis, Teresa Curi for English revision and Rodrigo Tonan for the illustration.

Conflict of interest None.

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