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ORIGINAL ARTICLE
Breast

Minimal Scar Autologous Breast Reconstruction with Skin-sparing Mastectomy

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Background: A skin paddle severely impairs the appearance of the reconstructed breast. We have established a new technique called "minimal scar autologous breast reconstruction" involving delayed nipple reconstruction using a local flap designed on the skin paddle and simultaneous resection of the residual skin paddle.
Methods: We analyzed 20 patients with unilateral breast cancer who underwent skin-sparing mastectomy followed by immediate breast reconstruction using a free flap (deep inferior epigastric perforator flap in 13 patients and profunda artery perforator flap in seven). Approximately 1 year after primary reconstruction, nipple reconstruction using an arrow flap designed on the skin paddle and resection of the residual skin paddle were performed. Several months later, medical areola tattooing was performed. Bilateral breast symmetry scores, obtained from the distances between anatomic landmarks, were compared before and after breast reconstruction.
Results: Postoperative complications such as necrosis of the reconstructed nipple were not observed after two-stage reconstruction, and all procedures including total resection of the skin paddle, nipple reconstruction, and medical tattooing were performed successfully in all cases. Aesthetic outcomes were excellent: comparison of symmetry scores showed no significant differences in any parameters between before surgery and after reconstruction of the nipple-areola complex.
Conclusions: We have established step-by-step strategies for mastectomy, autologous breast reconstruction, and then nipple reconstruction, keeping in mind that the skin paddle would later be totally resected in nipple reconstruction, and thereby achieved breast reconstruction with markedly reduced postoperative scarring compared with conventional autologous breast reconstruction. *(Plast Reconstr Surg Glob Open 2023; 11:e5176; doi: 10.1097/GOX.0000000000005176; Published online 7 August 2023.)*

INTRODUCTION

With recent advances in microsurgical techniques, autologous breast reconstruction after total or partial mastectomy is widely recognized as a standard procedure for breast cancer.[1,2] Compared with implant-based breast construction, autologous breast reconstruction yielded higher satisfaction and quality-of-life scores in patient-reported outcomes measured by the BREAST-Q.[3–6]

Among the free flaps used for autologous breast reconstruction, deep inferior epigastric perforator (DIEP) flaps are most commonly chosen worldwide because the donor site (ie, the lower abdomen) offers abundant fat tissue and there are fewer variations in the vasculature of the deep epigastric artery that serves as the feeding vessel.[7,8] Meanwhile, profunda artery perforator (PAP) flaps, harvested from the medial thigh region with use of perforators branched from the deep femoral artery as feeding vessels, have been used for breast reconstruction in several recent studies because they are easy and less invasive to harvest.[9–11] The flap weight is more restricted for PAP flaps than commonly used DIEP flaps because of the availability of adipose tissue at the donor sites,[12] but PAP flaps are thought to be suited for use in slim Asian women with a low body mass index (BMI) and relatively small breasts.[13,14]

However, in any free flap surgery, a skin paddle is exposed after immediate autologous breast reconstruction, and becomes a factor severely impairing the final appearance of the reconstructed breast after completion of nipple-areola complex (NAC) reconstruction.[15]

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Meanwhile, skin-sparing mastectomy (SSM) used for immediate breast reconstruction was first described by Toth and Lappert in 1991,[16] and around the same time, Kroll et al reported 100 cases, where the same technique was used.[17] SSM removes all mammary gland tissue, including the NAC, previous biopsy incisions, and skin overlying superficial tumors, but preserves the skin envelope of the breast as much as possible, thereby minimizing the exposure of the unsightly skin paddle in immediate breast reconstruction. Further, because the anatomical breast structure, including the natural skin envelope and inframammary fold (IMF), is preserved as much as possible, it achieves excellent aesthetic outcomes and bilateral symmetry of the breasts.[18] A previous study of breast reconstruction using a free flap showed that the rate of contralateral breast correction and that of secondary correction of the reconstructed breast were lower in an SSM group than in a non-SSM group.[19]

We have developed a new surgical technique that is able to avoid the largest disadvantage of immediate autologous breast reconstruction (ie, skin paddle persistence). This technique, called "minimal scar autologous breast reconstruction," involves immediate autologous breast reconstruction after total SSM in the first step, and delayed nipple reconstruction using a local flap designed on a minimally exposed skin paddle and simultaneous resection of the residual skin paddle in the second step. Here, we retrospectively examined bilateral symmetry of the breasts in patients who had undergone minimal scar autologous breast reconstruction.

Takeaways

Question: Development of nonskin paddle autologous breast reconstruction.

Findings: Breast reconstruction using a free flap is now a standard procedure. However, a skin paddle, a patch-like skin flap exposed after surgery, severely impairs the appearance of the reconstructed breast. We have established a new technique called "minimal scar autologous breast reconstruction," involving delayed nipple reconstruction using a local flap designed on the skin paddle and simultaneous resection of the residual skin paddle.

Meaning: We have established a new technique, minimal scar autologous breast reconstruction, involving delayed nipple reconstruction using a local flap designed on the skin paddle and simultaneous resection of the residual skin paddle.

PATIENTS AND METHODS

This study was approved by the ethics committee of Tokyo Women's Medical University (approval no. 2020-0088) and was carried out in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments. All patients provided written informed consent to participate in the study. We retrospectively reviewed patients who underwent SSM and immediate unilateral breast reconstruction with a DIEP flap or vertical PAP (v-PAP) flap at Tokyo Women's Medical University Yachiyo Medical Center between 2019 and 2021. Twenty patients were included in the analysis. Mean age was 47.2 (range: 34–61) years, mean BMI was 22.6 (range: 17.1–32.1), and mean mastectomy specimen weight was 389 (range: 75–786) g (Table 1). Exclusion criteria were (1) recurrent breast cancer, (2) bilateral breast cancer, (3) partial mastectomy, (4) skin fragility and/or central obesity due to long-term steroid use, (5) inflammatory breast cancer, (6) locally advanced breast cancer, (7) advanced mastoptosis, (8) congenital breast anomalies, and (9) preoperative radiation.

Table 1. Clinical and Surgical Characteristics

Variable	Summary Statistic (Range or %)
Total no. patients	20
Mean age, y	47.2 (34–61)
Mean BMI, kg/m^2	22.6 (17.1–32.1)
Mean mastectomy specimen, g	389 (75–786)
Mean harvested flap weight, g	614 (177–1902)
Mean transplanted flap weight, g	443 (158–837)
ASA score	
I	9 (45%)
II	11 (55%)
Smoking history	3 (15%)
Hypertension	3 (15%)
Previous adjuvant therapy	
Chemotherapy	0 (0%)
Radiotherapy	0 (0%)
Lymphadenectomy	
SLNB	19 (80%)
ALND	1 (10%)

ALND, axillary lymph node dissection; ASA, American Society of Anesthesiologists physical status.

Skin-sparing Mastectomy

Figure 1 shows the schema of the first operation. In all cases, SSM was performed by the same breast surgeon (N.J.). The smallest possible symmetric elliptical skin incision (blue line) comprising a top curve (line a) and a bottom curve (line b) of the same length was designed around the NAC. An important point was that the long axis of the elliptical incision be parallel to the long axis of the oval areola (green arrows), or to the Langer lines (black dotted lines) when the areola was of the round type.

Free Flap Surgery

The type of free flap was decided based on the preoperative estimation of the breast weight using the Vectra H2 system (Canfield Scientific, Parsippany-Troy Hills, N.J.), in combination with the PAP flap weight estimation by our previously reported method using preoperative computed tomography of legs.[20] More precisely, a v-PAP flap was chosen when the mastectomy specimen weight was smaller than the estimated weight of the PAP flap, whereas a DIEP flap was chosen when a v-PAP flap would not provide sufficient tissue. Both types of flaps were harvested using standard techniques. The skin flap was weighed and trimmed, so that the flap weight

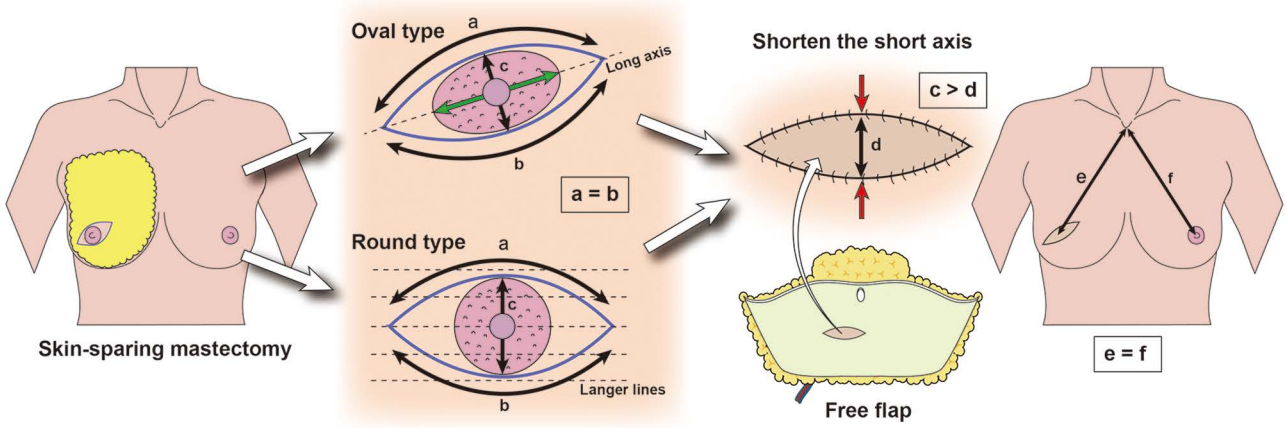

Fig. 1. Schema of skin-sparing mastectomy and immediate breast reconstruction with free flap surgery. The smallest possible symmetric elliptical skin incision (blue line), comprising a top curve (line a) and a bottom curve (line b) of the same length, was designed around the NAC. The long axis of the elliptical incision was set to be parallel to the long axis of the oval areola (green arrows) or parallel to the Langer lines (black dotted lines) when the nipple was round. The center of the skin paddle was placed at a position that gave the smallest difference between the right and left sternal notch to nipple distances (line e and f). The length of the short axis of the skin paddle (line d) was set as short as possible (to ~2 cm) to be smaller than the short axis of the skin resected during mastectomy (line c), thereby minimizing the exposure of the skin paddle (red arrow lines).

approximately equaled the mastectomy specimen weight. A round-shaped breast mount was formed after suturing the skin flap using an absorbable suture, and was placed in the subcutaneous pocket. The patient was brought to the sitting position, and the position of the skin paddle was determined and marked while checking the breast shape. One of the conditions for determining the position of the skin paddle was that we selected a location where the cutaneous Doppler signal could be confirmed for postoperative blood flow monitoring. To ensure that the skin paddle was placed at an appropriate position for the future nipple reconstruction, the center of the skin paddle, assumed to be the position of the nipple on the affected side, was set at a position symmetric to the position of the contralateral nipple. The clavicle to nipple (C-N) distance and the sternal notch to nipple (SN-N) distance on the affected side were the same as the corresponding distances on the contralateral side (SN-N: lines e and f in Fig. 1). The length of the long axis of the skin paddle was set to be the same as that of the skin resected in mastectomy, and the length of the short axis (line d) was reduced as much as possible (to ~2 cm) to be shorter than that of the skin resected in mastectomy (line c), thereby minimizing the exposure of the skin paddle (red arrow lines). The skin flap was removed from the subcutaneous pocket, and the skin, except the area of the skin paddle, was deepithelialized. The vascular pedicles were anastomosed to recipient vessels under the microscope, the skin flap was re-placed in the subcutaneous pocket, and the skin was closed by suturing around the skin paddle.

Local Flap Nipple Reconstruction with Total Skin Paddle Resection

Nipple reconstruction was performed under local anesthesia in principle 0.5–1 year after immediate breast reconstruction. The position symmetric to the contralateral nipple was marked accurately. Nipple reconstruction using an arrow flap was performed in all cases (Fig. 2A).[21] The pedicle of the skin flap was at the cranial or caudal side of the skin paddle, whichever was closer to the mark. The local flap size, which was in principle approximately 4 cm for the long axis and approximately 1.5 cm for the short axis, was adjusted according to the size of the contralateral nipple. A skin incision mark was made a few millimeters outside the scar surrounding the skin paddle except the region of the flap pedicle. A skin incision was made to the depth of the mid-dermis along the marking line; the skin paddle, except the arrow flap area, was deepithelialized; and the resulting dermis component was placed at the position where the nipple would be reconstructed to prevent future nipple retraction (Fig. 2B). A further incision to the subcutis was made along the marking lines of the arrow flap (Fig. 2C), a skin flap with sufficient subcutaneous fatty tissue for blood supply was elevated and sutured to reconstruct the nipple (Fig. 2D). Then, peripheral undermining was performed for approximately 2 cm at the side opposite to the arrow flap pedicle to prevent deviation of the reconstructed nipple in the longitudinal direction, and the wound was closed by simple suturing in the horizontal direction (Fig. 2E). At this step, a semicircle area opposite to the arrow flap pedicle was deepithelialized and inserted into the area under the reconstructed nipple to prevent postoperative retraction of the reconstructed nipple (Fig. 2F and G).

Medical Tattooing for NAC

Medical tattooing of the NAC was performed approximately 6 months after nipple reconstruction, using a Permark UltraEssence handpiece (PMT, Chanhassen, Minn.), #18 needles (PMT), and various pigments (PMT).

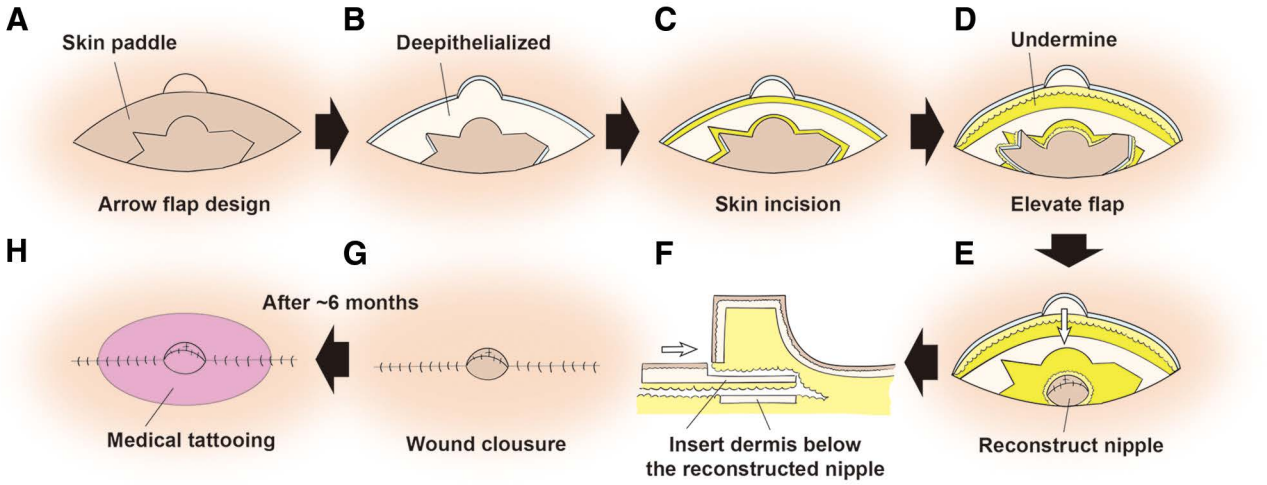

Fig. 2. Schema of nipple-areola complex reconstruction with a local flap and medical tattooing using a skin paddle. A, An arrow flap was designed within the skin paddle. B, The remaining area in the skin paddle was deepithelialized. C, A further incision in the subcutis was made along the marking lines of the arrow flap. A skin flap with sufficient subcutaneous fatty tissue to ensure blood supply was elevated (D) and sutured (E) according to the design to reconstruct the nipple. F, Peripheral undermining (F) was performed for approximately 2 cm at the side opposite to the arrow flap pedicle, and the remaining wound surface was closed by simple suturing in the horizontal direction (G). In these steps (F and G), a semicircle area opposite to the arrow flap pedicle was deepithelialized and inserted into the area under the reconstructed nipple. (H) Medical tattooing was performed to hide the postoperative scar as much as possible.

The position of the affected areola was determined in relation to the reconstructed nipple position, its shape was designed to be a mirror image of the areola on the contralateral side (Fig 2H).[22]

Evaluation of Breast Symmetry Using a 3D Camera before and after Reconstruction

Bilateral symmetry of the breasts before immediate reconstruction surgery and after NAC reconstruction were compared using the Vectra H2 system. Bilateral symmetry of the breasts was assessed using a previously reported method based on the ratio of measurements on one side to those on the other side.[23] The SN-N distances, C-N distances, nipple to IMF (N-IMF) distances, and breast widths on both sides were measured on the constructed 3D images to calculate symmetry scores (shorter distance divided by the longer distance). Wilcoxon signed-rank test was performed using Prism version 7.02 for Windows (GraphPad Software, La Jolla, Calif.) to statistically compare the symmetry scores before immediate reconstruction surgery and those after NAC reconstruction, and to evaluate the influence of this technique on the bilateral symmetry of the breasts.

RESULTS

The engraftment rate of the 20 free flaps (DIEP flap: 13; PAP flap: 7) was 100% after immediate breast reconstruction. The mean harvested flap weight was 614 g (range, 177–1902 g) and the mean transplanted flap weight was 443 g (range, 158–837 g). No postoperative complications (eg, necrosis of the reconstructed nipple) were observed after the second operation, and the NAC reconstruction involving total resection of the skin paddle, nipple reconstruction, and medical tattooing were successfully performed in all patients. Aesthetic outcomes of breast reconstruction were excellent, and nipple retraction and a shift in the position of the reconstructed nipple requiring correction was not observed in any case. In addition, nipple projection was maintained in all cases, and no case required a second nipple reconstruction surgery.

The symmetry scores of two groups (preoperative versus postoperative) were 0.97 (0.84–0.99) versus 0.95 (0.83–0.99) for the SN-N distance ($P = 0.294$), 0.96 (0.84–1) versus 0.93 (0.77–1) for the C-N distance ($P = 0.076$), 0.93 (0.81–0.99) versus 0.89 (0.71–1) for the N-IMF distance ($P = 0.114$), and 0.97 (0.91–1) versus 0.95 (0.85–1) for breast widths ($P = 0.332$). None of these measures showed significant postoperative impairment in symmetry. Recurrent breast cancer was not observed in any patients during 6 months (or more) of follow-up after the second operation.

Clinical Case

A 50-year-old woman with cancer of the right breast underwent SSM and sentinel lymph node biopsy (SLNB). The size of resected skin (including the NAC) was 7 × 4 cm, and the mastectomy specimen weighed 543 g (Fig. 3A and B). A flap (40 × 13 cm) was designed on the lower abdomen, harvested with a DIEP arising from the DIEA as a vascular pedicle (Fig. 3C). The harvested flap weight was 959 g. The skin flap was placed in the subcutaneous pocket, the volume of the skin flap was reduced, and the area (except the skin paddle) was deepithelialized whereas checking the shape of the breast in the sitting position (Fig. 3D). The transplanted flap weight was 637 g (Fig. 3E). Nipple reconstruction was performed

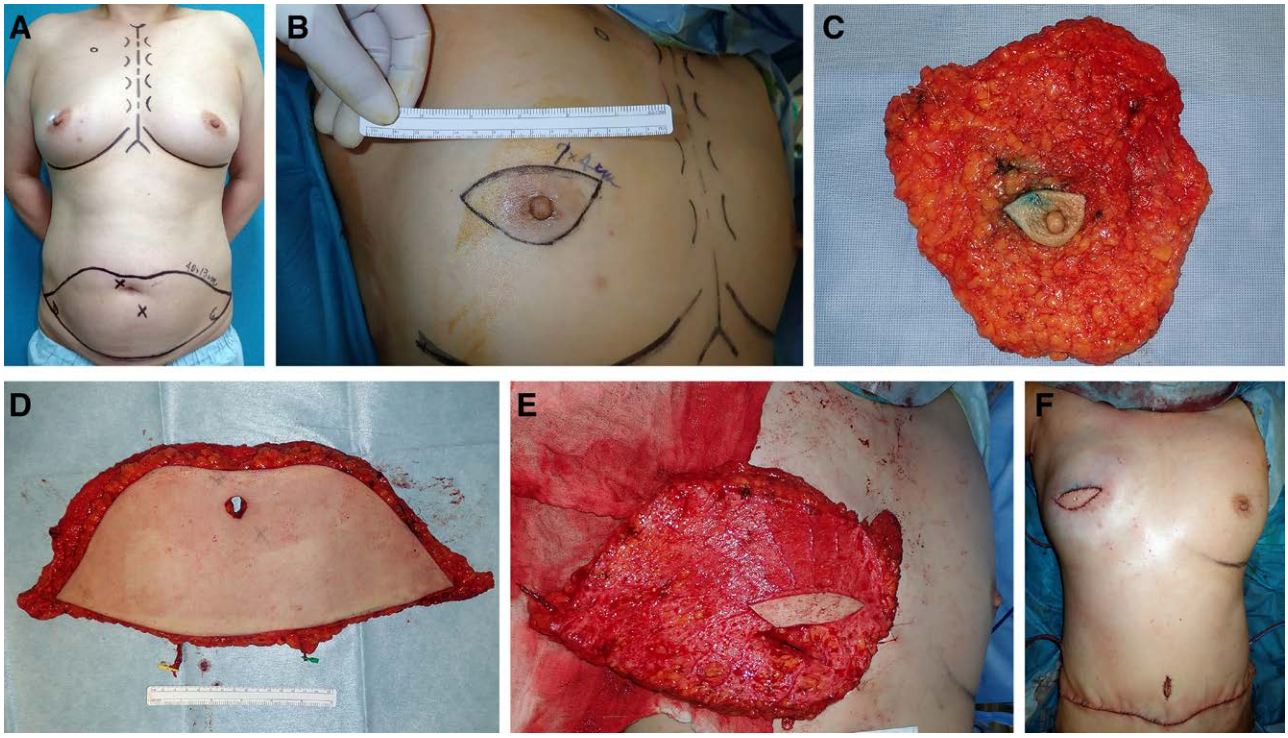

Fig. 3. Clinical case: a 50-year-old woman who underwent SSM and SLNB for cancer of the right breast. The size of resected skin was 7×4 cm (A), and the mastectomy specimen weighed 543 g (B). A DIEP flap (40×13 cm) was harvested from the lower abdomen (C), and volume reduction and deepithelialization (except the area of the skin paddle) was performed (D). E, Postoperative appearance. F, The transplanted flap weight was 637 g.

10 months after the first operation. The arrow flap was designed within the skin paddle to have the flap pedicle at the caudal edge of the skin paddle (Fig. 4A), and nipple reconstruction using the arrow flap and deepithelialization of the residual skin paddle were performed (Fig. 4B, C). The residual raw surface was closed by simple suturing. At this stage, a semicircle area at the cranial side was deepithelialized and inserted into the area under the reconstructed nipple (Fig. 4D, E). Medical tattooing was performed on the reconstructed NAC 6 months after the second operation (Fig. 5).

DISCUSSION

The following two points can explain the excellent aesthetic outcomes of minimal scar autologous breast reconstruction. The first is the modified skin incision design in SSM. Among four types of incision patterns (periareolar, tennis racquet, elliptical, and reduction pattern),[24] we opted for the elliptical design, which gives the longest incision line in the transverse direction because this allows us to expose the internal mammary artery easily by traction, to finely adjust the position of nipple reconstruction in the transverse direction in the second operation, and to access the sentinel lymph nodes for SLNB.

An oblique orientation of the elliptical SSM incision toward the axilla was previously recommended to reduce flattening of the central breast mount[18]; however, we designed an elliptical incision along the Langer lines so that the skin paddle could be easily resected during nipple reconstruction in the second operation. The resulting elliptical incision was in oblique orientation toward the caudal-lateral direction in many cases. This incision design facilitated access to the internal mammary artery and vein at the location of the third costal cartilage for use as a graft bed vessel. Also, we made the short axis of the skin paddle to be shorter than that of the breast skin resected in SSM, achieving no obvious impairment in bilateral symmetry of the breasts after total mastectomy followed by breast reconstruction.

The second point is the modification of nipple reconstruction using a local skin flap. The strong dermal tissue was preserved by deepithelialization of the skin paddle except the local skin flap area, and the deepithelialized semicircle area opposite to the flap pedicle was inserted under the reconstructed nipple. Thus, two layers of strong dermis supported the reconstructed nipple, thereby successfully preventing nipple retraction. SSM with immediate autologous breast reconstitution and immediate nipple reconstruction has previously been reported but has several possible disadvantages, including difficulties in detecting anastomotic thrombosis by monitoring capillary refill of the skin paddle, and the possibility of additional scars if bilateral symmetry of the NAC is impaired and correction of the reconstructed nipple position is required.[25] In the circular skin paddle method, it is necessary to reconstruct the NAC in the center of skin paddle; so NAC reconstruction is difficult in cases where the paddle position is not symmetric with the healthy side.[26]

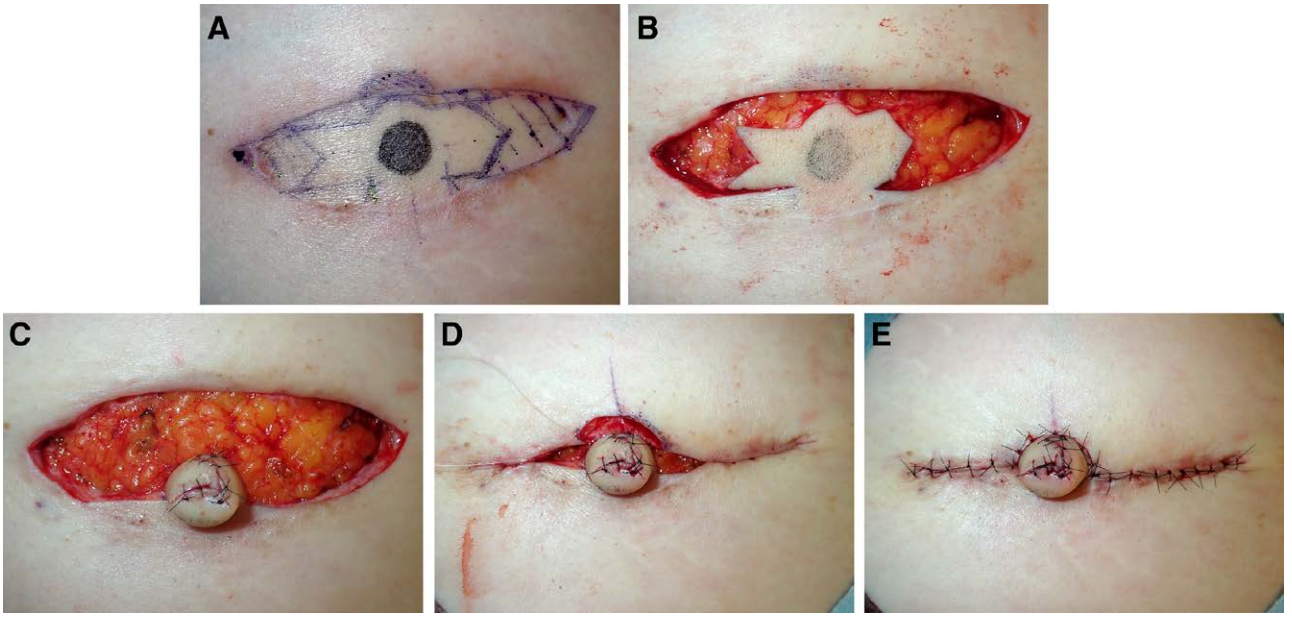

Fig. 4. Clinical case images taken during nipple reconstruction. A, The arrow flap was designed within the skin paddle to have the flap pedicle at the caudal edge of the skin paddle. Deepithelialization of the skin paddle (B) and nipple reconstruction using the arrow flap (C) were performed. D, When closing the wound by simple suturing, a semicircle area at the cranial side was deepithelialized and inserted into the area under the reconstructed nipple. E, Appearance immediately after nipple reconstruction.

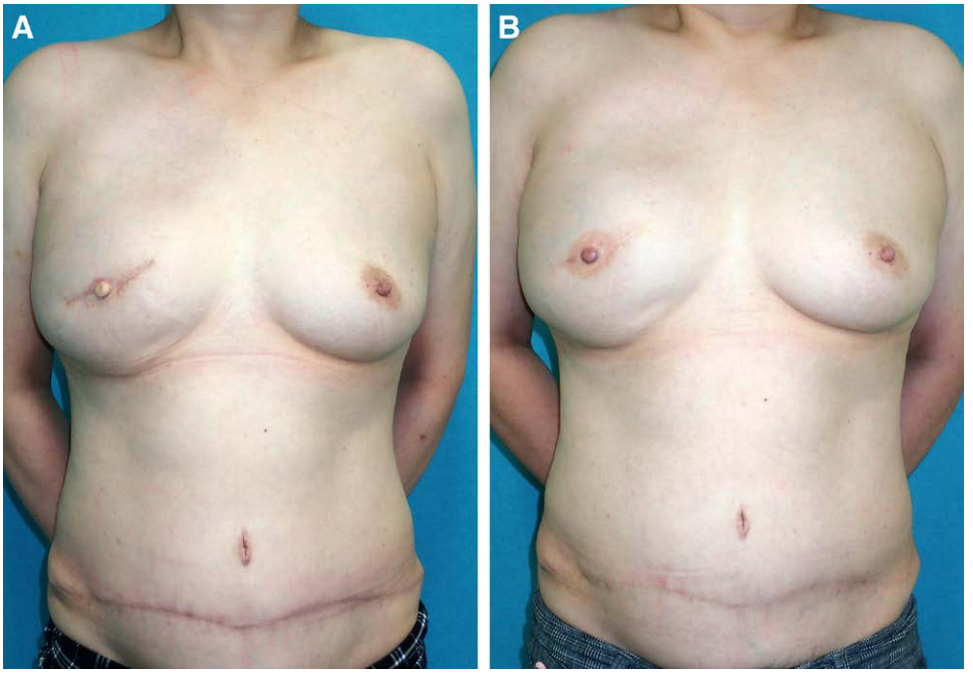

Fig. 5. Clinical case, and appearance after completion of breast construction with medical tattooing. A, Appearance 6 months after nipple reconstruction. B, Medical tattooing was performed to cover the postoperative scars as much as possible.

In contrast, in our method, nipple reconstruction was performed in the second operation, and an arrow flap could be freely designed within the elliptical skin paddle. This enabled safe skin flap monitoring and adjustment of the reconstructed nipple position by a few centimeters in the vertical and transverse directions, thus improving bilateral symmetry after NAC reconstruction. Further, the elliptical skin incision in SSM was obliquely oriented toward the caudal-lateral direction; so the scar formed after complete removal of the skin paddle and simple closure was in the same orientation. Because normal nipples tend to have an elliptical shape and oblique orientation in the

caudal-lateral direction, the scar after NAC reconstruction using our technique was mostly covered by medical tattooing, leaving only a small unaesthetic scar. Contralateral composite nipple grafting is another option for nipple reconstruction after SSM, but we do not usually offer this option unless requested by the patient because of the possibility of invasive ductal carcinoma from grafted nipple.[27]

A technique for comparison with our method is autologous breast reconstruction after nipple sparing mastectomy (NSM). The nipple reconstruction step can be omitted because the NAC of the affected breast is preserved in NSM. However, there are several inevitable disadvantages, including that the nipple necrosis rate is not low (approximately 10%) and an additional step is required to monitor circulation in the free flap.[28] In addition, Kelly et al reported that psychosocial and sexual well-being scores were significantly higher in patients who had undergone NSM compared with SSM at 1–5 years after surgery, but this trend did not persist, and the scores became comparable between the groups at 6 and 10 years after surgery.[29] Further, patients were made aware of the possible outcomes of nipple reconstruction during surgical decision-making, and factors associated with patients' dissatisfaction with breast reconstruction did not involve the nipple.[29] Frey et al reported that NSM with a buried flap can be performed as safely as reconstruction with skin paddles.[30] However, the present technique is considered safer because blood flow monitoring can be performed simply using the cutaneous Doppler signal from the skin paddle. In sum, our method requires more operations, but is likely to be safer and provide similar aesthetic outcomes compared with NSM.

A limitation of this study is that we did not assess patient satisfaction with aesthetic outcomes, and did not compare our technique with other techniques. In the future, we would like to add patient satisfaction surveys such as BREAST-Q and report on the usefulness of this procedure in this regard. In the case series, no cases required secondary revision, but because the number of cases is still small, we would like to accumulate more cases and examine the secondary revision rate in the future. In addition, retention of nipple height was not quantitatively evaluated in this study. In future cases, we would like to measure the nipple height to demonstrate that this procedure can maintain nipple projection over the long term.

CONCLUSIONS

We have established a step-by-step strategy for mastectomy, autologous breast reconstruction, and then nipple reconstruction, keeping in mind that the skin paddle would later be totally resected during nipple reconstruction. As a result, breast reconstruction was achieved with markedly reduced postoperative scarring compared with conventional autologous breast reconstruction.

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DISCLOSURE

The authors have no financial interest to declare in relation to the content of this article.

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