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ORIGINAL ARTICLE – BREAST ONCOLOGY

Single-Axillary-Incision Endoscopic-Assisted Hybrid Technique for Nipple-Sparing Mastectomy: Technique, Preliminary Results, and Patient-Reported Cosmetic Outcome from Preliminary 50 Procedures

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ABSTRACT

Background. A new hybrid technique for single-axillary-incision endoscopic-assisted nipple-sparing mastectomy (E-NSM) was introduced. Preliminary results are reported.

Methods. Patients who received single-axillary-incision E-NSM from August 2013 to August 2017 were searched from a single institution. Data were analyzed to determine the effectiveness and oncologic safety of single-axillary-incision E-NSM. Patient-oriented cosmetic outcome report was also obtained.

Results. During the study period, a total of 50 E-NSM with single-incision procedures were performed in 41 female patients with breast cancer, including 11 (26.8%) patients with bilateral disease. Their mean age was 45.3 ± 8.4 years. The mean size of tumors encountered during the 50 single-incision E-NSM procedures was 2.3 ± 1.8 (0.1–7.3) cm for invasive tumors and 2.6 ± 1.7 (0.2–5.7) cm for carcinoma in situ lesions. Six (12%) of those tumors were multifocal/multicentric. Lymph node metastasis was found during 12% of the procedures. Forty-five (90%) received immediate breast reconstruction with gel implant. Mean operating time was 244.3 ± 82.8 min. The overall complication rate was 6%, and no total nipple necrosis or implant loss was observed. No locoregional recurrence or distant metastasis was found during mean follow-up of 21.6 months. About 94.4% of patients were satisfied with the postoperative scar location and wound length. All patients who responded would choose the same operation again.

Conclusions. The proposed single-axillary-incision endoscopic hybrid technique for nipple-sparing mastectomy was a safe procedure with low morbidity and associated with high patient satisfaction.

Nipple-sparing mastectomy (NSM), a procedure that combines skin-sparing mastectomy (SSM) with preservation of the nipple–areola complex (NAC), is now increasingly performed in patients with breast cancer without evidence of NAC invasion due to high patient satisfaction rate and acceptable oncologic safety.[1–5] According to patient characteristics and surgeon preference, diverse types of skin incision and techniques have emerged for NSM.[1–9] These techniques are associated with

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different NAC ischemia/necrosis risk from 0 to 81.8% and varied patient satisfaction.[1–10]

Endoscopy-assisted breast surgery (EABS), which is performed through minimal axillary and/or periareolar incisions,[8,9,11–15] has been shown to be an effective alternative for resection of malignant breast tumors.[8,12–14,16] Endoscopic-assisted NSM (E-NSM)[8,9,14,17] alone or followed by immediate breast reconstruction (IBR) with implants[8,18–20] or autologous flaps[8,9,21] has been reported to be associated with small, inconspicuous incision and good cosmetic outcome.

Conventional E-NSM is performed with two separate incisions over axilla and periareolar regions.[8,9,14,15] E-NSM with areolar incision, just like NSM with areolar-related incision (NAC ischemia/necrosis rate ranging from 7 to 81.8%[6,7,10]), is associated with increased NAC ischemia/necrosis (reported range 9.1–19%[8,9,14,15,22]). New technique modifications of E-NSM have emerged, focusing on single-axillary-incision NSM,[20,23,24] sparing the periareolar incision and thereby decreasing compromise of bloody supply from mastectomy skin flap, with low reported NAC necrosis rate (0%).[20,23,24]

In the current study, we propose a new hybrid technique for single-axillary-incision E-NSM, which was safe, efficient, and with good esthetic result. The technique details, clinical outcomes, and patient-oriented cosmetic outcome are reported.

PATIENTS AND METHODS

Patients

Patients who received single-axillary-incision E-NSM from August 2013 to August 2017 were searched from the endoscopic breast surgery database at Changhua Christian Hospital (CCH), a tertiary medical center in central Taiwan. Data collected from the database included patient clinicopathologic characteristics, type of mastectomy, method of breast reconstruction (implant or flap), operative time, blood loss, hospital stay, complications, and recurrence and survival status at last follow-up. All data were collected by chart review by specially trained nurses (Y.-L.L. and S.-L.C.) and were confirmed by the principle investigator (H.-W.L.). The study was approved by the Institutional Review Board of Changhua Christian Hospital (CCH IRB No. 141224). Written informed consent for use of clinical records was obtained from each participant. This current report includes photos of several patients, who agreed and signed consent for publication of their pictures. Data reported in the current analysis also include patient data reported in earlier publications.[8,9,11]

Preoperative sonograms and mammograms were used to determine eligibility of patients for EABS. Liver sonogram, chest X-ray, and whole-body bone scan were used to exclude the possibility of distant metastasis. Indications for E-NSM included early-stage breast cancer [ductal carcinoma in situ (DCIS), stage I or II], tumor size less than 5 cm, no evidence of multiple lymph node metastasis, and no evidence of skin or chest wall invasion.[8,9] Patients for whom E-NSM was contraindicated included those with apparent NAC involvement, inflammatory breast cancer, breast cancer with chest wall or skin invasion, locally advanced breast cancer, breast cancer with extensive axillary lymph node metastasis (stage IIIB or later), and severe comorbid conditions, such as heart disease, renal failure, liver dysfunction, and poor performance status as assessed by primary physicians. Breast size is also suggested to be a selection consideration for E-NSM. Patients with small to medium-sized breast (A, B, or C cup) would benefit most from E-NSM. Patients with large (> E cup) and ptosis breast are not good candidates for E-NSM due to technique difficulty, high risk of NAC necrosis, and suboptimal cosmetic result. The inclusion and exclusion criteria were based on those reported previously.[8,9,13–15]

The perioperative safety, postoperative complications, and oncological safety of single-axillary-incision E-NSM were evaluated. Surgical margin involvement was defined as presence of tumor on the ink.[25] Total incidence of recurrence or death due to breast cancer was ascertained at the most recent follow-up, which ended on 30 September 2017.

Single-Axillary-Incision E-NSM Technique

Details of the surgical technique for EABS used at CCH have been described previously[8,9,11]; the current report focuses on techniques for single-axillary-incision E-NSM (Fig. 1). Briefly, after preoperative marking, the patient was placed in supine position with the arm abducted 90° to avoid disturbance of the operative procedure. Endoscopic video monitors (Olympus Optical Co., Tokyo, Japan) were set up on both sides of the patient's head and watched by two surgeons. An oblique-ended ridged endoscope measuring 5 mm in diameter with viewing angle of 30° was used in all procedures (Fig. 2a).

Physiological saline solution containing lidocaine 0.05% and epinephrine 1:1,000,000 was injected subcutaneously into the whole breast to minimize bleeding (Fig. 1a). Then, an approximately 2.5–5-cm oblique axillary incision (length depending on the size of the breast to be removed) was made over the extramammary region (Fig. 2b), and sentinel lymph node biopsy (SLNB) was performed if indicated. After SLNB, dissection was carried out to the lateral border of the pectoralis major muscle. If the SLN

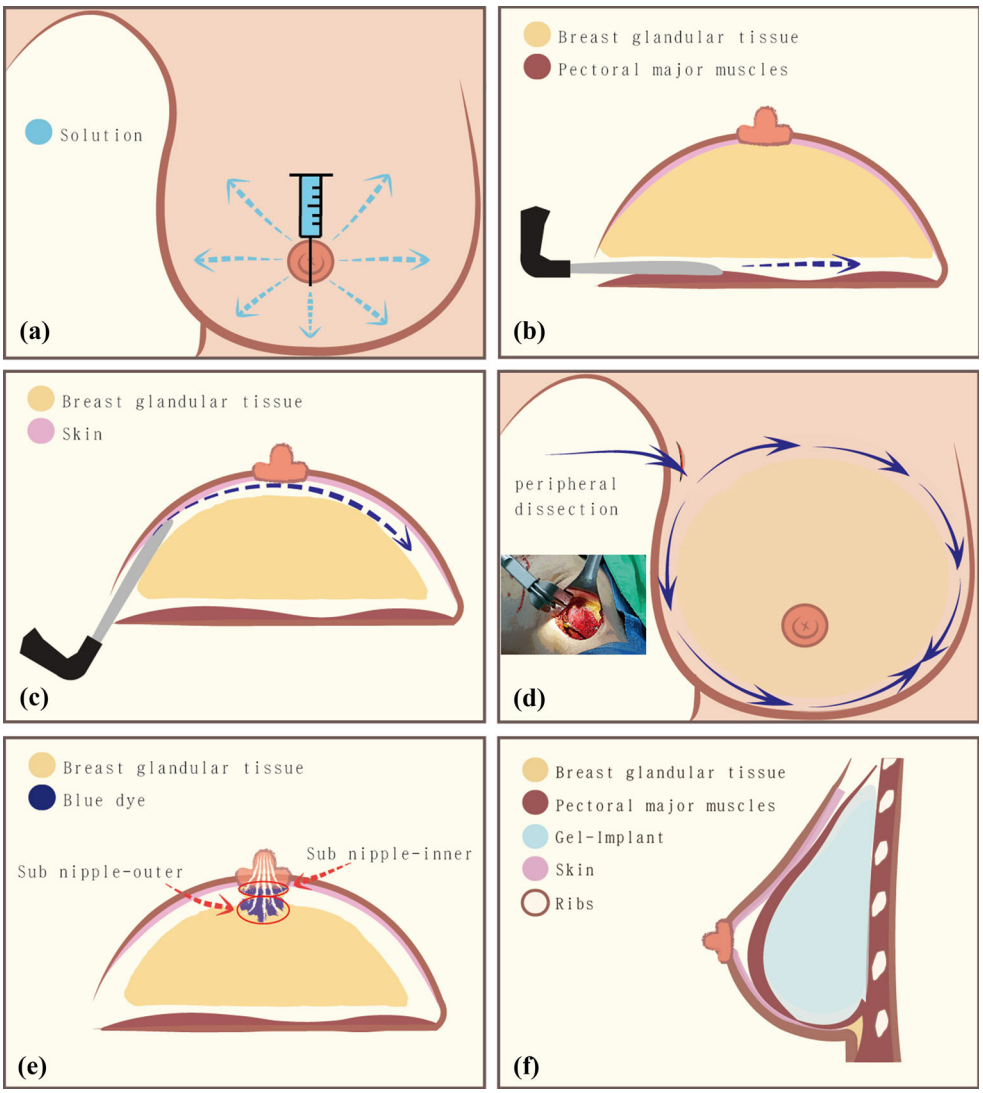

FIG. 1 Cartoons depicting single-axillary-incision endoscopic hybrid technique for nipple-sparing mastectomy (E-NSM) and immediate breast reconstruction with gel implant: **a** hydrodissection with subcutaneous injection of saline solution (containing adrenaline and lidocaine) performed in the whole breast to minimize bleeding, **b** posterior subglandular dissection performed by inserting an endoscopic Ultra Retractor (Karl Storz) vein harvester for dissection of the plane between pectoral muscle fascia and deep (inferior) part of breast parenchyma, **c** anterior skin flap dissection performed by dissection between skin flaps and breast glandular tissue with endoscopic guidance, **d** peripheral dissection performed with handle-light retractors to assist dissection of breast tissue to detach from peripheral skin flap and chest wall, **e** intraoperative subnipple biopsy performed by taking two separate specimens (inner and outer part) under the nipple–areolar complex and sent for frozen section for pathologic analysis, **f** breast reconstruction after single-axillary-incision E-NSM performed using cohesive gel implant insertion placed subpectorally in the muscular pocket formed by pectoralis major, serratus anterior, and fascia of external oblique muscle

tested positive, complete axillary lymph node dissection (ALND) with removal of level I and II lymph nodes was performed. The margin between the pectoralis muscle and breast parenchyma was clearly identified. An endoscopic Ultra Retractor (Karl Storz) vein harvester was used for dissection of pectoral muscle fascia and the inferior part of breast parenchyma (Fig. 2a). Penetrating vessels were coagulated and cut with bipolar scissors (PowerStar, Johnson & Johnson KK) to ensure clear visual field and maintain hemostasis (Figs. 1b, 2c). The surrounding tissue was pulled up with the Ultra Retractor under endoscopic guidance to create sufficient working space, and a suction tube was used to evacuate mist and smoke.

After completion of the posterior dissection, anterior skin flap dissection was performed. An approximately 3–5-mm-thick skin flap was created using an optical bladeless trocar (Xcel, Johnson & Johnson, Tokyo, Japan) under endoscopic guidance (tunneling method) or blindly with tunneling of Metzenbaum scissor (Fig. 2a). The septa between the skin flap and parenchyma were dissected

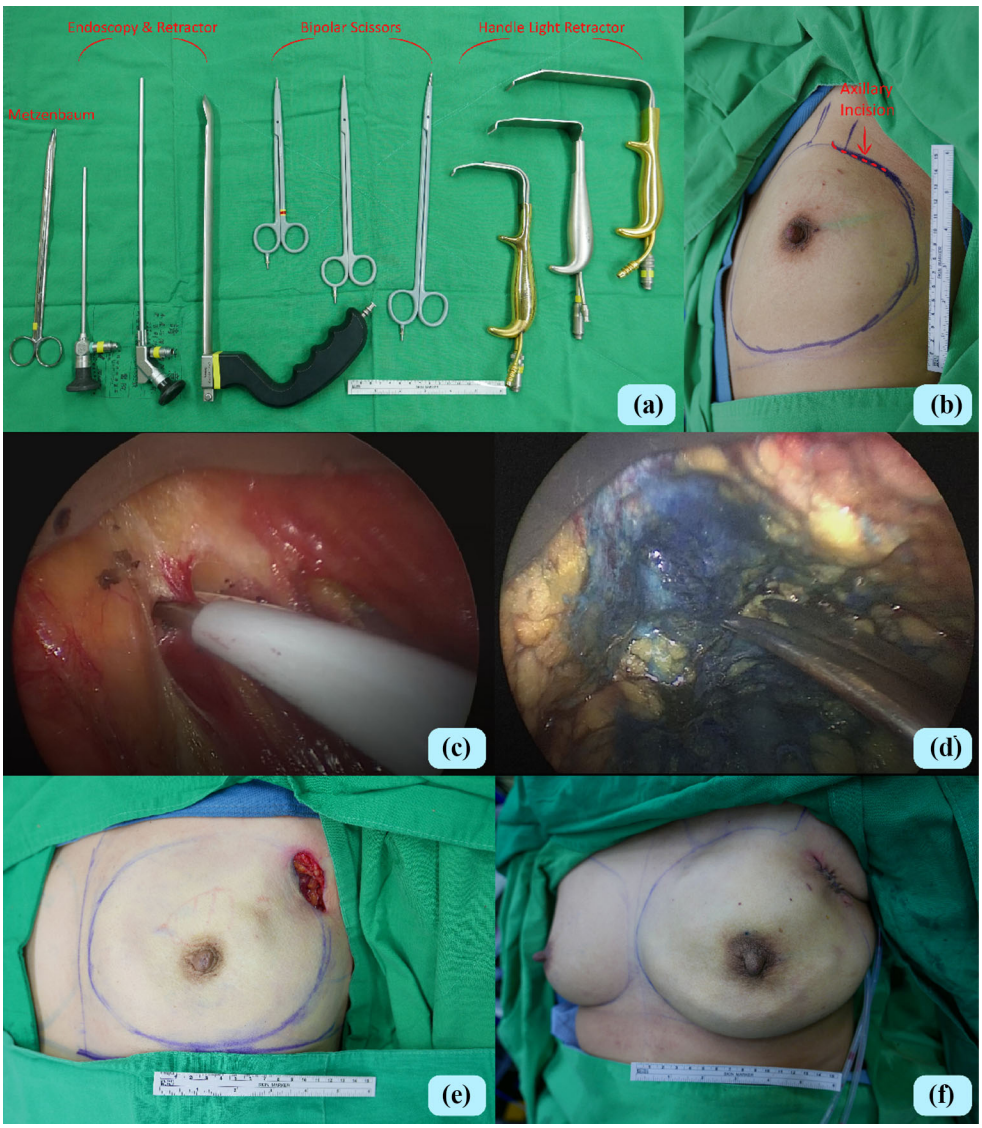

FIG. 2 Operative pictures showing representative techniques for single-axillary-incision endoscopic hybrid technique for nipple-sparing mastectomy: **a** instruments for single-axillary-incision endoscopic hybrid technique for nipple-sparing mastectomy, **b** approximately 2.5–5-cm (length depending on size of breast to be removed) oblique axillary incision made over extramammary region, **c** posterior subglandular dissection performed by inserting an endoscopic Ultra Retractor (Karl Storz) vein harvester for dissection of the plane between pectoral muscle fascia and deep (inferior) part of breast parenchyma, **d** anterior skin flap dissection performed by dissection between skin flaps and breast glandular tissue with endoscopic guidance, **e** immediate postmastectomy image before reconstruction, showing small and hidden wound in axillary region, **f** immediate post-gel-implant breast reconstruction outcome, later view

under endoscopic guidance using bipolar scissors electrocauterization or harmonic scalpel (Fig. 1c). Two separate subnipple biopsy specimens (inner and outer part) were taken from under the NAC (Figs. 1e, 2d), and the intraoperative frozen section was analyzed.[26] If cancer cell invasion was found in the subareolar area, the entire NAC was removed, and SSM was performed instead of NSM.[8,9,26] After posterior and anterior dissection, the surgical procedure proceeded to peripheral dissection. Handle-light retractors were used to assist for dissection of breast tissue to detach from peripheral skin flap and chest wall (peripheral dissection) (Fig. 1d). The entire breast specimen was removed through the axillary wound (Fig. 2e).

Breast reconstruction was performed immediately or at a later time depending on the patients' desire for breast reconstruction. Breast reconstruction after single-axillary-incision E-NSM was performed using implant (cohesive gel implant or tissue expander, Figs. 1f, 2f) insertion placed subpectorally in the muscular pocket formed by pectoralis major, serratus anterior, and fascia of external oblique muscle. (Video for single-axillary-incision E-NSM

and IBR with gel implant is provided as supplementary file.)

Esthetic Outcome Evaluation

Postoperative esthetic result was evaluated by comparing pre- and postoperative cosmetic results (Fig. 3). A self-reported questionnaire to evaluate the psychosocial status of breast cancer patients with mastectomy following breast reconstruction was conducted 3–6 months after the operation when surgical wounds had healed. Patients were asked to compare the pre- and postoperative breast shape, nipple position, and volume symmetry of both breasts. The self-report questionnaire comprised 10 questions (Table 3) on four-item scales graded as "very satisfied," "satisfied," "fair," and "unsatisfied." Patients who reported "very satisfied" or "satisfied" result were defined as being satisfied with the outcome.

Statistical Analyses

Differences in continuous variables were tested by independent t test and are reported as mean ± standard deviation (SD). Chi square test was used for comparisons of categorical data when appropriate. p Value < 0.05 was considered to indicate statistical significance; all tests were two-tailed. All statistical analyses were performed using the statistical package SPSS (version 19.0, SPSS, Chicago, IL).

RESULTS

During the study period, a total of 50 E-NSM with single-incision procedures were performed in 41 female patients with breast cancer, including 11 (26.8%) patients with bilateral disease. Their mean age was 45.3 ± 8.4 (31–62) years. The mean size of tumors encountered during the 50 single-incision E-NSM procedures was 2.3 ± 1.8 (0.1–7.3) cm for invasive tumors and 2.6 ± 1.7 (0.2–5.7) cm for carcinoma in situ lesions. Six (12%) of those tumors were multifocal/multicentric. Lymph node metastasis was found during 12% of the procedures. Of the 50 E-NSM procedures conducted during the study period, the majority were performed for pathologic stage I cancer ($n = 12$, 24%) and DCIS (stage 0, $n = 12$, 24%), followed by stage II cancer ($n = 11$, 22%) and stage III breast cancer ($n = 2$, 4%). The demographic and clinical characteristics associated with the 50 EABS procedures are summarized in Table 1.

Among these 50 procedures operated by single-axillary-incision hybrid E-NSM, 40 (80%) also received intraoperative subnipple biopsy, all of which showed lack of invasion by malignancy. Of the 50 procedures operated by single-incision E-NSM procedures, 45 (90%) received

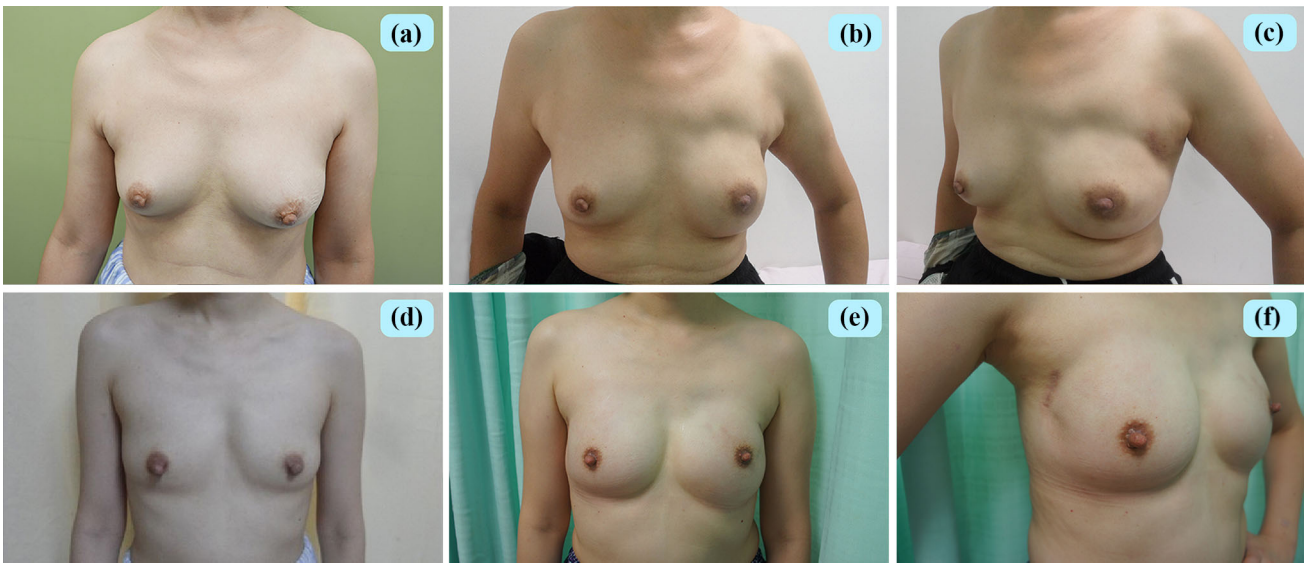

FIG. 3 Pre- and postoperative pictures of patients who received single-axillary-incision endoscopic hybrid technique for nipple-sparing mastectomy (NSM): **a** preoperative front view of 58-year-old female with left breast cancer prepared for operation, **b** postoperative front view of the patient after 3 months (nipple well perfused without sign of ischemia, wound well hidden in axilla), **c** postoperative lateral view (wound small and well hidden in the inconspicuous axilla region), **d** front view of 24-year-old female with right breast cancer (planned for right NSM, decided to receive contralateral prophylactic NSM due to family history of breast cancer), **e** postoperative front view of the 24-year-old female (received bil. E-NSM and augmentation-type breast reconstruction with gel implants), **f** right lateral view showing that the wound was small and well hidden in inconspicuous axillary region

TABLE 1 Clinicopathologic characteristics of patients

All 50 EABS (41 patients)	
Age (years, mean)	45.3 ± 8.4 (31–62)
Location	
Right/left	22 (44%)/28 (56%)
Unilateral/bilateral	30 (73.2%)/11 (26.8%)
Tumor size (cm)	
Invasive tumor	2.3 ± 1.8 (0.1–7.3)
In situ tumor	2.6 ± 1.7 (0.2–5.7)
Multifocal	
Yes	6 (12%)
No	44 (88%)
Lymph node metastasis	
N0	44 (88%)
N1	5 (10%)
N2	1 (2%)
Clinical stage	
DCIS	15 (30%)
I	10 (20%)
IIa	10 (20%)
IIb	4 (8%)
*Not malignant	11 (22%)
Pathology stage	
DCIS	12 (24%)
I	12 (24%)
II	11 (22%)
III	2 (4%)
*Not malignant	13 (26%)
Grade	
I	4 (8%)
II	22 (4%)
III	8 (16%)
NA	16 (32%)
ER	
Positive	26 (52%)
Negative	9 (18%)
NA	15 (30%)
PR	
Positive	25 (50%)
Negative	10 (20%)
NA	15 (30%)
HER-2	
Overexpressed	3 (6%)
Negative	25 (50%)
NA	22 (44%)
Ki-67	
< 14%	10 (20.4%)
> 14%	14 (28.6%)
NA	25 (50%)
Margin involved	
Yes	0 (0%)
N0	50 (100%)
Subtype (NA = 17)	
Luminal A	20 (40%)
Luminal B	7 (14%)
HER-2 type	2 (4%)
TNBC	4 (8%)
NA	17 (34%)
Breast reconstruction	
Yes	45 (90%)
No	5 (10%)
Adjuvant therapy	
Chemotherapy	
Yes	12 (29.3%)
No	29 (70.7%)
Radiotherapy	
Yes	5 (12.2%)
No	36 (87.8%)
Hormone therapy	
Yes	23 (56.1%)
No	18 (43.9%)
Follow-up (months)	21.6 ± 11.3 (1–42.4)

NA not available, *ER* estrogen receptor, *PR* progesterone receptor, *HER-2* human epidermal growth factor receptor 2, *TNBC* triple-negative breast cancer

IBR. All of them received implant-based (cohesive gel implant) reconstruction (Fig. 3). Mean operating time was 244.3 ± 82.8 min (210.1 ± 51.9 min for single side, 354.4 ± 66.3 min for bilateral procedures). Mean blood loss was 74.5 ± 47.7 (25–250) ml, and mean hospitalization was 5.5 ± 1.3 (3–8) days. Data on perioperative parameters associated with the 50 single-incision E-NSM procedures are summarized in Table 2.

In the postoperative morbidity evaluation, the overall complication rate associated with single-incision E-NSM was 6%. There were no major or life-threatening complications. Two patients were found to have seroma, which resolved after repeat sonography-guided aspiration. One patient suffered from transient partial nipple ischemia, recovering after conservative treatment. The rate of total NAC necrosis for single-axillary E-NSM was 0%. No implant loss was observed in the 45 single-incision-hybrid E-NSM with IBR procedures (Table 2).

In the oncologic safety evaluation of E-NSM, no (0%) surgical margin involvement was observed on final pathologic checkup. Postoperative adjuvant hormone therapy, chemotherapy, and radiotherapy were given to

TABLE 2 Perioperative safety evaluation for single-incision endoscopic-assisted nipple-sparing mastectomy

		N = 50 EABS
Blood loss (ml)		74.5 ± 47.7 (25–250)
OP time all (min)		244.3 ± 82.8 (138–425)
Mean mastectomy time (min)		177.5 ± 72.7 (83–385)
Mean reconstruction time (min)		75.8 ± 24.5 (55–145)
Mean mastectomy weight (g)		281.6 ± 109.8 (72–487)
Reconstruction implant volume (ml)		304.3 ± 70.1 (170–450)
Hospital stay (days)		5.5 ± 1.3 (3–8)
	Single	Bilateral
OP time all (min)	210.1 ± 51.9 (138–385)	354.4 ± 66.3 (210–425)
Mean mastectomy time (min)	157.2 ± 63.2 (83–385)	242.8 ± 64.7 (120–335)
Mean reconstruction time (min)	64.4 ± 18.0 (55–145)	105.0 ± 10.0 (90–120)
Blood loss (ml)	55.5 ± 25.8 (25–140)	135.6 ± 52.0 (80–250)
Mean hospital stay (days)	5.6 ± 1.4 (3–8)	5.3 ± 0.7 (4–6)
Complication		
Yes	3 (6%)	
Nipple partial ischemia	1	
Seroma formation*	2	
Total nipple necrosis	0	
Implant loss	0	
No	47 (94%)	
Recurrence		
Yes	0 (0%)	
No	50 (100%)	

*Seroma formation needed repeat aspiration

patients according to current breast cancer guidelines[27,28]; the type of therapy delivered is summarized in Table 1. During mean follow-up of 21.6 ± 11.3 (1–42.4) months, there was no locoregional recurrence, distant metastasis, or mortality among these 41 patients (Table 2).

A total of 38 (92.7%, 38/41) patients completed the postoperative cosmetic outcome questionnaire; the results are presented in Table 3. Before operation, 91.7% of patients were satisfied with their breast appearance. The postoperative satisfaction rate was 97.2% when dressed with clothes, and 66.7% when naked without clothes. Regarding postoperative symmetry of bilateral breast, 83.3% of patients were satisfied with the size and 75% were satisfied with the shape. About 97.2% of patients were satisfied with the postoperative scar appearance, while the satisfaction for wound length and wound position was 94.4 and 94.4%, respectively. All of the 38 patients who responded expressed that they would choose single-incision E-NSM again if they could choose again.

DISCUSSION

We report herein preliminary results of a single-axillary-incision hybrid E-NSM technique for management of breast cancer or breast disease indicated for mastectomy. From these preliminary 50 procedures, we observe that this technique is a safe procedure, with low perioperative morbidity, resulting in low nipple ischemia/necrosis rate, and with good cosmetic outcome (Table 2). There was no margin involvement in these preliminary cases. Patient-reported cosmetic outcome analysis showed that this technique is well accepted (Table 3).

Due to the limited working space, superficial nature of breast lesions, and usually longer operating time than conventional operations,[8,15,29] EABS is not mainstream treatment for breast cancer. In patients for whom mastectomy is indicated, EABS is an ideal alternative choice for cosmetic reasons, because the wounds required for endoscopic surgery are much smaller than in the conventional approach and are hidden in inconspicuous locations.[8,9,14,15] In the current study, only 2.8% of patients were unsatisfied with the scar incision length and position (Table 3, Q7–9).

TABLE 3 Patient-oriented outcome report

	Unsatisfied	Fair	Satisfied	Very satisfied	Mean ± standard deviation
Q1. Preoperative breast appearance satisfaction	2 (5.3%)	1 (2.6%)	15 (39.5%)	20 (52.6%)	3.39 ± 0.87
Q2. Postoperative breast appearance satisfaction – dressed	1 (2.6%)	0 (0%)	19 (50.0%)	18 (47.4%)	3.42 ± 0.64
Q3. Postoperative breast appearance satisfaction – naked	4 (10.5%)	10 (26.3%)	19 (50.0%)	5 (13.2%)	2.66 ± 0.84
Q4. Postoperative bilateral breast size satisfaction	1 (2.6%)	6 (15.8%)	18 (47.4%)	13 (34.2%)	3.13 ± 0.77
Q5. Postoperative bilateral breast symmetry satisfaction	1 (2.6%)	10 (26.3%)	18 (47.4%)	9 (23.7%)	2.92 ± 0.76
Q6. Postoperative nipple–areola position satisfaction	1 (2.6%)	7 (18.4%)	18 (47.4%)	12 (31.6%)	3.08 ± 0.79
Q7. Scar appearance satisfaction	1 (2.6%)	0 (0%)	19 (50.0%)	18 (47.4%)	3.42 ± 0.69
Q8. Scar length satisfaction	1 (2.6%)	1 (2.6%)	16 (42.1%)	20 (52.6%)	3.45 ± 0.73
Q9. Surgical wound position satisfaction	1 (2.6%)	1 (2.6%)	15 (39.5%)	21 (55.3%)	3.47 ± 0.79
Q10. Would you be willing to undergo single-axillary-incision endoscopy-assisted nipple-sparing mastectomy if you could choose again?					
			Yes	38 (100%)	
			No	0 (0%)	

E-NSM can be performed through a minimal incision without removing the skin envelope and NAC when there is no evidence of cancer cell invasion.[8,9,14,22] This makes immediate, one-stage breast reconstruction feasible in most circumstances,[8,9,17,20] as reflected in the high (90%) IBR rate in the current study. Based on our previous study, E-NSM and IBR with gel implant was the most frequent indication for EABS when mastectomy was needed.[8]

Conventional E-NSM techniques usually involve two separate small incisions.[8,9,14, 15] Initially, one wound is created over the axilla for SLNB/ALND, followed by endoscopic vein harvesting, dissection, and separation of breast gland from pectoralis muscle. After complete dissection of the posterior aspect, a small areolar wound is created for dissection of breast gland and skin flap. Finally, the mastectomy specimen is removed from either areolar incision or axillary wound.[8,9,14,15] After wound healing, the scar is concealed by the axilla and areolar, being inconspicuous, with good cosmetic result usually obtained.

However, as most studies report,[6–8,10] such wound incision over areolar can greatly increase nipple–areolar complex ischemia necrosis. The reported nipple ischemia/necrosis rate in endoscopic NSM series ranges from 9.1 to 19%,[8,14,15,17,22] higher than that reported for conventional NSM without areolar extension (4 to 11%).[6,7,30] To reduce risk of NAC ischemia/necrosis, we have recommend that the length of the circumareolar incision made during the E-NSM procedure be confined to less than 1/3 circle of areolar.[9] However, even with such a small incision, NAC ischemia necrosis can still occur in some patients predisposed to ischemia/necrosis injury, including those of old age or with large or ptotic breast, history of smoking, or previous radiation exposure.[6,7,10,31]

New techniques to minimize NAC ischemia/necrosis injury have been proposed, mainly focusing on single-incision-axillary E-NSM,[20,23,24] which were associated with extremely low (0%) NAC necrosis rate, as also observed in the current study. Tukenmez et al.[20] reported single-incision E-NSM, incorporating a single port with gas inflation and operating with endoscopic instruments. Toesca et al.[23,24] used a robotic surgery platform to perform NSM and showed superior performance of the robotic approach over endoscopic method. However, these modifications are demanding in terms of instruments (single port, gas inflation, or robotic surgery platform), costly, and increase subcutaneous emphysema risk.[20,23,24]

To prevent surgical margin involvement and inadequate tumor resection, single-axillary-incision hybrid E-NSM is favored in patients with tumors located over the upper outer quadrant and at adequate distance (such as > 0.4 cm) from skin. Tumors located in the lower inner quadrant are relatively not favored for this technique, to prevent inadequate tumor resection. In large and ptotic breast, single-incision over inframammary fold (IMF) is also a good choice for NSM and SLNB, and the scar can usually be well hidden in the IMF. However, in small to medium-sized breast, scar in IMF will be more prominent than in the inconspicuous axillary region. We found that single-axillary-incision endoscopic hybrid technique for NSM is particular useful for women diagnosed with early-stage, clinically node-negative breast cancer indicated for mastectomy, with small to medium-sized breast and minimal ptosis.

We report herein a new concept of single-axillary-incision endoscopic hybrid technique for NSM, which is a safe, practical, and reproducible method. It would be more cost-effective, as instruments such as single port, gas inflation or

robotic surgery platform are not required, and efficient, as shown by the low morbidity (6% overall complication rate) and one-stage operation with mastectomy and IBR. The patient-reported cosmetic outcome results also indicate that this method is associated with good esthetic outcome.

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REFERENCES

1. Cense HA, Rutgers EJ, Lopes Cardozo M, Van Lanschot JJ. Nipple-sparing mastectomy in breast cancer: a viable option? *Eur J Surg Oncol.* 2001, 27(6):521–526.
2. Petit JY, Veronesi U, Luini A, Orecchia R, Rey PC, Martella S, Didier F, De Lorenzi F, Rietjens M, Garusi C, et al. When mastectomy becomes inevitable: the nipple-sparing approach. *Breast.* 2005, 14(6):527–531.
3. Petit JY, Veronesi U, Orecchia R, Rey P, Martella S, Didier F, Viale G, Veronesi P, Luini A, Galimberti V, et al. Nipple sparing mastectomy with nipple areola intraoperative radiotherapy: one thousand and one cases of a five years experience at the European Institute of Oncology of Milan (EIO). *Breast Cancer Res Treat.* 2009, 117(2):333–338.
4. Petit JY, Veronesi U, Rey P, Rotmensz N, Botteri E, Rietjens M, Garusi C, De Lorenzi F, Martella S, Bosco R, et al. Nipple-sparing mastectomy: risk of nipple-areolar recurrences in a series of 579 cases. *Breast Cancer Res Treat.* 2009, 114(1):97–101.
5. Crowe JP, Jr., Kim JA, Yetman R, Banbury J, Patrick RJ, Baynes D. Nipple-sparing mastectomy: technique and results of 54 procedures. *Arch Surg.* 2004, 139(2):148–150.
6. Carlson GW, Chu CK, Moyer HR, Duggal C, Losken A. Predictors of nipple ischemia after nipple sparing mastectomy. *Breast. J* 2014, 20(1):69–73.
7. Endara M, Chen D, Verma K, Nahabedian MY, Spear SL. Breast reconstruction following nipple-sparing mastectomy: a systematic review of the literature with pooled analysis. *Plast Reconstr Surg.* 2013, 132(5):1043–1054.
8. Lai HW, Chen ST, Chen DR, Chen SL, Chang TW, Kuo SJ, Kuo YL, Hung CS. Current trends in and indications for endoscopy-assisted breast surgery for breast cancer: results from a six-year study conducted by the Taiwan Endoscopic Breast Surgery Cooperative Group. *PLoS ONE.* 2016, 11(3):e0150310.
9. Lai HW, Wu HS, Chuang KL, Chen DR, Chang TW, Kuo SJ, Chen ST, Kuo YL. Endoscopy-assisted total mastectomy followed by immediate pedicled transverse rectus abdominis musculocutaneous (TRAM) flap reconstruction: preliminary results of 48 patients. *Surg Innov.* 2015, 22(4):382–389.
10. Chirappapha P, Petit JY, Rietjens M, De Lorenzi F, Garusi C, Martella S, Barbieri B, Gottardi A, Andrea M, Giuseppe L, et al. Nipple sparing mastectomy: does breast morphological factor related to necrotic complications? *Plastic Reconst Surg Global Open.* 2014, 2(1):e99.
11. Lai HW, Lin HY, Chen SL, Chen ST, Chen DR, Kuo SJ. Endoscopy-assisted surgery for the management of benign breast tumors: technique, learning curve, and patient-reported outcome from preliminary 323 procedures. *World J Surg Oncol.* 2017, 15(1):19.
12. Lee EK, Kook SH, Park YL, Bae WG. Endoscopy-assisted breast-conserving surgery for early breast cancer. *World J Surg.* 2006, 30(6):957–964.
13. Nakajima H, Fujiwara I, Mizuta N, Sakaguchi K, Hachimine Y. Video-assisted skin-sparing breast-conserving surgery for breast cancer and immediate reconstruction with autologous tissue. *Ann Surg.* 2009, 249(1):91–96.
14. Sakamoto N, Fukuma E, Higa K, Ozaki S, Sakamoto M, Abe S, Kurihara T, Tozaki M. Early results of an endoscopic nipple-sparing mastectomy for breast cancer. *Ann Surg Oncol.* 2009, 16(12):3406–3413.
15. Leff DR, Vashisht R, Yongue G, Keshtgar M, Yang GZ, Darzi A. Endoscopic breast surgery: where are we now and what might the future hold for video-assisted breast surgery? *Breast Cancer Res Treat.* 2011, 125(3):607–625.
16. Tamaki Y, Sakita I, Miyoshi Y, Sekimoto M, Takiguchi S, Monden M, Noguchi S. Transareolar endoscopy-assisted partial mastectomy: a preliminary report of six cases. *Surg Laparosc Endosc Percutan Tech* 2001, 11(6):356–362.
17. Fan LJ, Jiang J, Yang XH, Zhang Y, Li XG, Chen XC, Zhong L. A prospective study comparing endoscopic subcutaneous mastectomy plus immediate reconstruction with implants and breast conserving surgery for breast cancer. *Chin Med J (Engl).* 2009, 122(24):2945–2950.
18. Kitamura K, Ishida M, Inoue H, Kinoshita J, Hashizume M, Sugimachi K. Early results of an endoscope-assisted subcutaneous mastectomy and reconstruction for breast cancer. *Surgery.* 2002, 131(1 Suppl):S324–S329.
19. Ho WS, Ying SY, Chan AC. Endoscopic-assisted subcutaneous mastectomy and axillary dissection with immediate mammary prosthesis reconstruction for early breast cancer. *Surg Endosc.* 2002, 16(2):302–306.
20. Tukenmez M, Ozden BC, Agcaoglu O, Kecer M, Ozmen V, Muslumanoglu M, Igci A. Videoendoscopic single-port nipple-sparing mastectomy and immediate reconstruction. *J Laparoendosc Adv Surg Tech A.* 2014, 24(2):77–82.
21. Nakajima H, Sakaguchi K, Mizuta N, Hachimine T, Ohe S, Sawai K. Video-assisted total glandectomy and immediate reconstruction for breast cancer. *Biomed Pharmacother.* 2002, 56 Suppl 1:205s–208s.
22. Ito K, Kanai T, Gomi K, Watanabe T, Ito T, Komatsu A, Fujita T, Amano J. Endoscopic-assisted skin-sparing mastectomy combined with sentinel node biopsy. *ANZ J Surg.* 2008, 78(10):894–898.
23. Toesca A, Peradze N, Galimberti V, Manconi A, Intra M, Gentilini O, Sances D, Negri D, Veronesi G, Rietjens M, et al. Robotic nipple-sparing mastectomy and immediate breast reconstruction with implant: first report of surgical technique. *Ann Surg.* 2017, 266(2):e28–e30.
24. Toesca A, Peradze N, Manconi A, Galimberti V, Intra M, Colleoni M, Bonanni B, Curigliano G, Rietjens M, Viale G, et al. Robotic nipple-sparing mastectomy for the treatment of breast cancer: Feasibility and safety study. *Breast.* 2017, 31:51–56.
25. Houssami N, Turner R, Morrow M: Preoperative magnetic resonance imaging in breast cancer: meta-analysis of surgical outcomes. *Ann Surg.* 2013, 257(2):249–255.
26. Chan SE, Liao CY, Wang TY, Chen ST, Chen DR, Lin YJ, Chen CJ, Wu HK, Chen SL, Kuo SJ, et al. The diagnostic utility of preoperative breast magnetic resonance imaging (MRI) and/or intraoperative sub-nipple biopsy in nipple-sparing mastectomy. *Eur J Surg Oncol.* 2017, 43(1):76–84.

27. Goldhirsch A, Wood WC, Coates AS, Gelber RD, Thurlimann B, Senn HJ. Strategies for subtypes–dealing with the diversity of breast cancer: highlights of the St. Gallen International Expert Consensus on the Primary Therapy of Early Breast Cancer 2011. *Ann Oncol.* 2011, 22(8):1736–1747.
28. NCCN Clinical Practice Guidelines in Oncology-Breast Cancer. http://www.nccn.org/professionals/physician_gls/PDF/breast.pdf.
29. Ingram D. Is it time for breast cancer surgeons to embrace endoscopic-assisted mastectomy? *ANZ J Surg.* 2008, 78(10): 837–838.
30. Jensen JA, Orringer JS, Giuliano AE. Nipple-sparing mastectomy in 99 patients with a mean follow-up of 5 years. *Ann Surg Oncol.* 2011, 18(6):1665–1670.
31. Algaithy ZK, Petit JY, Lohsiriwat V, Maisonneuve P, Rey PC, Baros N, Lai H, Mulas P, Barbalho DM, Veronesi P, et al. Nipple sparing mastectomy: can we predict the factors predisposing to necrosis? *Eur J Surg Oncol.* 2012, 38(2):125–129.