Comparison of Mastoscopic and Conventional Axillary Lymph Node Dissection in Breast Cancer: Long-term Results From a Randomized, Multicenter Trial

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Abstract

Objective: To compare the long-term results of mastoscopic axillary lymph node dissection (MALND) and conventional axillary lymph node dissection (CALND).

Patients and Methods: From January 1, 2003, through December 31, 2005, a group of 1027 consecutive patients with operable breast cancer were randomly assigned to 1 of 2 study groups: MALND and CALND. The median follow-up was 63 months. The primary end points of the study were operative outcomes, complication reduction, function conservation, and cosmetics. The secondary end points were disease-free and overall survival.

Results: The mean operative blood loss in the MALND group was less than in the CALND group ($P < .001$). The patients who underwent MALND had less axillary pain, numbness or paresthesias, and arm swelling ($P < .001$). The aesthetic appearance of the axilla in the MALND group was much better than that in the CALND group ($P = .001$ at 6 months and $P = .002$ at 24 months). A significant difference was found between the 2 groups in distant metastasis ($P = .04$). The disease-free survival rate was 64.5% in the MALND group and 60.8% in the CALND group ($P = .88$). The overall survival rate was 81.7% in the MALND group and 78.6% in the CALND group ($P = .95$).

Conclusion: Compared with CALND, MALND has advantages in operative outcomes, complication reduction, function conservation, and cosmetics.

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The traditional operation performed for the treatment of breast cancer is conventional axillary lymph node dissection (CALND). This procedure has some inherent shortcomings that can result in morbidities, such as arm functioning problems and lymphedema, that can seriously affect the quality of life of patients. These complications are a result of injury to the blood vessels, lymphatic tube, and nerves in the axillary fossa during dissection.¹⁻³ During axillary lymph node dissection (ALND), an incision is made in the axilla from the anterior chest wall up to the axilla, as in radical or modified radical mastectomy, or an additional incision is made, as in breast-conserving surgery. The incision scar results in a cosmetically unattractive appearance, which can also restrict range of motion of the shoulder joint.^{4,5} Furthermore, because in the conventional operation breast or tumor is first operated on and axillary lymph node is then dissected, squeezing and pulling the breast during the operation are unavoidable. As a result, the blood vessels and lymphatic tubes of tumor drainage, which are

still patent and draining, can result in the mechanical stimulation of tumor cell metastases via blood or lymph.⁶⁻⁸ Finally, patients are placed supine during breast cancer surgery, and the operating view of surgeons is from up to down in CALND, which restricts the axillary exposure. Although this approach is still convenient for dissecting the outer part of the axillary vein in the lateral side of the minor pectoral muscle (level I lymph node), the thoracodorsal nerve and vessels, and the long thoracic nerve, it is difficult to manipulate the major and minor pectoral muscles inward for dissecting level II lymph nodes, which are located behind the minor pectoral muscle, and level III lymph nodes and Ratter lymph node, which are between the major and minor pectoral muscles. Therefore, CALND can lead to a large surgical scar.

Another aspect of breast cancer surgery depends on sentinel lymph node biopsy, which is the current standard of care in diagnosing early-stage breast cancer. If the sentinel lymph node biopsy result is positive, a CALND must be performed, even though its timing and accuracy in patients who may

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have received neoadjuvant chemotherapy for breast cancer remain controversial.⁹⁻¹¹

In recent years, these inherent limitations of CALND have provoked interest in finding new surgical approaches that can reduce complications, preserve better arm function, and improve the post-operative appearance of the chest and axilla without compromising the thoroughness of ALND. Mastoscopic axillary lymph node dissection (MALND) is a new surgical approach to treating breast cancer.¹²⁻¹⁹ Several single-center and small studies have explored the feasibility and safety of MALND.²⁰⁻²⁶ We performed a multicenter, randomized trial in breast cancer patients from China comparing MALND and CALND. The primary aims of this trial were to compare the operative outcomes, complication reduction, function conservation, and cosmetics of MALND and CALND and to verify the effects of ALND on tumor recurrence, metastasis, and survival rate.

PATIENTS AND METHODS

Study Design

This study was a phase 3, multicenter, randomized study of the clinical effects of CALND vs MALND. Male and female patients younger than 80 years with operable breast cancer were eligible for enrollment. To be included in the study, patients had to have no axillary lymph node disease on preoperative clinical examination or lymph nodes less than 1 cm by color ultrasonic inspection. Exclusion criteria included a previous history of another cancer, preexisting limb disease causing swelling, or previous surgery in the ipsilateral axilla.

Surgical Procedures

Either type of ALND consisted of a level I to II and/or III (if the swollen node with suspected metastasis was found in level II) axillary dissection. Contemporary surgical treatment includes a modified radical mastectomy or breast-conserving treatment. In the CALND group, breast surgery and ALND were performed by the traditional open method. In the MALND group, the patients first underwent MALND and then breast surgery. The MALND operation was performed according to the method reported previously.^{9,18,27}

Patients were treated with systemic therapy and radiation therapy according to the same standard institutional protocols (National Comprehensive Cancer Network Breast Cancer Practice Guideline).

Quality Control

Participation in this trial was limited to 16 credentialed surgeons at 15 institutions. Each surgeon had

performed at least 20 MALNDs. All surgeons in this study used the same standardized operative technique. (Supplemental video, available online at <http://www.mayoclinicproceedings.org>). Surgeons submitted a video of themselves performing an MALND. The videos were reviewed to assess the surgeons' surgical technique, including main operative stages and the identification and dissection of critical adjacent structures. The videos were reviewed by an external monitoring committee. Maneuvers to prevent port-site metastasis (ie, non-touch technique with the extraction of tissues dissected and washing with warm to hot distilled water) were used routinely.

Statistical Analyses

Statistical analysis was performed for the primary and secondary efficacy parameters based on an intent-to-treat population. All tests were conducted at the 2-sided .05 level of significance for treatment effects. Analysis was performed after the last randomized patient completed a minimum treatment period of 180 weeks. Randomization was allocated and controlled centrally using sealed opaque envelopes containing computer-generated random numbers. The randomized data set was recorded and maintained until all study data collection was complete. A sample size for the current investigation was determined for the primary end points, which were the operative effects of CALND compared with MALND, including operative time (ALND time, from the beginning to the end of ALND), blood loss, node harvest, drainage flow, drainage duration, subcutaneous liquid accumulation, axillary infection, and mobility, using the assumption that there would be no dropout. Under this assumption, assuming 5-year follow-up with a CALND event rate of 50% and an MALND event rate of 50%, a sample size of 1000 was required to provide statistical power (2-tailed $\alpha = .05$) of 95%.

For time-to-event end points, Kaplan-Meier plots were presented, and log-rank tests were used to test the null hypothesis of no MALND effect. Secondary end points were compared between groups using the 2-sample *t* test for continuous outcome variables and the χ^2 test for categorical variables. For secondary end points, the analysis was performed with missing data left missing. Continuous variables were summarized as mean $\pm$ SD, and categorical variables were summarized as number (percentage).

All calculations were performed using SPSS statistical software, version 15.0 (SPSS Inc). Informed consent was obtained from the participating patients. The protocol was approved by the institutional review boards of all institutions and in com-

pliance with the Declaration of Helsinki and guidelines for good clinical practice.

The evaluation of arm morbidities included a subset of 100 consecutive patients from the CALND group and 100 consecutive patients from the MALND group. These 200 patients were interviewed by physicians 6 and 24 months after surgery and were asked to complete a questionnaire concerning the intensity of pain (evaluated as continuous [lasting >50% of the day], sporadic, or absent), the presence or absence of numbness or paresthesias (assessed by comparing skin sensitivity on the inner and outer upper arms, axillae, and chest wall on the treated side with that on the untreated side), the extent of arm morbidity (on a scale of 0 [severe restriction] to 100 [no restriction]), and the aesthetic appearance of the axilla (judged by asking the patient if the result was good or bad). At the same evaluation, the circumference of the treated arm was measured (treated arm 15 cm above the lateral epicondyle) and compared with that of the contralateral arm.²⁸⁻³³

RESULTS

Demographic Characteristics

From January 1, 2003, through December 31, 2005, 1267 consecutive patients with operable breast cancer treated by 16 surgeons at 15 centers in China were contacted. Of these patients, 161 were deemed ineligible, and 79 were not randomly assigned to a study group. The remaining 1027 patients were randomized, although 31 of these patients were not able to be evaluated (Table 1). Baseline characteristics of the 996 evaluable patients are listed in Table 2.

Primary End Point Analysis

The mean operative blood loss in the MALND group was 12.82 mL vs 128.29 mL in the CALND group ($P<.001$). No statistically significant differences were found between the 2 groups with respect to operative time (31.18 vs 40.63 minutes in the CALND and MALND groups, respectively; $P=.09$), number of lymph nodes dissected, drainage flow, drainage duration, or subcutaneous seroma. No axillary infection occurred in either group (Table 3). There were no trocar implantations in the MALND group.

The procedure was converted to CALND in 27 of 496 patients (4.8%) assigned to the MALND group. Ten of these conversions were due to lack of visualization of the critical structure because of unsatisfactory liposuction during MALND. The operative view became unclear because of bleeding of the lateral thoracic vessels in 6 cases. The axillary vein could not be dissected conveniently because the

TABLE 1. Randomization of Patients in the Study

Patients	No. of patients
Initially considered for enrollment	1267
Not eligible	161
Lymph node diameter >1 cm	110
History of another cancer	43
Previous surgery in ipsilateral axilla	8
Eligible for enrollment	1106
Not randomly assigned to a study group	79
Patient's decision	44
Bilateral breast cancer	18
Other	17
Randomly assigned to a study group	1027
Not able to be evaluated	31
Patients canceled follow-up	19
Patients refused assigned treatment	12
Able to be evaluated	996
CALND	500
MALND	496

CALND = conventional axillary lymph node dissection;
MALND = mastoscopic axillary lymph node dissection.

swollen lymph nodes surrounding the axillary vein adhered tightly to the axillary vein in 11 cases. No injury to the axillary vein occurred in either group.

Arm Morbidity

Arm morbidities are listed in Table 4. The patients who underwent MALND had less axillary pain ($P<.001$ at 6 months and $P<.001$ at 24 months), numbness or paresthesias ($P=.14$ at 6 months and $P<.001$ at 24 months), and arm swelling on the treated arm ($P<.001$ at 6 months and $P<.001$ at 24 months). The aesthetic appearance of the axilla in the MALND group was much better than that in CALND group ($P=.001$ at 6 months and $P=.002$ at 24 months). No difference in arm mobility was found between the 2 groups ($P=.14$ at 6 months and $P>.99$ at 24 months).

Secondary End Point Analysis

The final cohort of 996 patients were followed up for a median of 63 months (range, 42-78 months), during which time 320 unfavorable events other than death occurred (173 in the CALND group and 147 in the MALND group). No statistically significant differences in disease-free survival or overall survival between the 2 groups were observed ($P=.88$ and $P=.95$, respectively; Figure 1 and Figure 2);

TABLE 2. Baseline Characteristics of the 2 Study Groups^a

Characteristic	No. (%) of patients ^b			P value
	CALND (n=500)	MALND (n=496)	Total (N=996)	
Age (y), mean	47.9	52.2		.05
Histologic type				.75
Invasive ductal	395 (79.0)	390 (78.6)	785 (78.8)	
Invasive lobular	49 (9.8)	44 (8.9)	93 (9.3)	
Other	56 (11.2)	62 (12.5)	118 (11.9)	
Tumor grade				.85
I	143 (28.6)	150 (30.2)	293 (29.4)	
II	245 (49.0)	237 (47.8)	482 (48.4)	
III	112 (22.4)	109 (22.0)	221 (22.2)	
Estrogen receptor				.68
Positive	456 (91.2)	456 (91.9)	912 (91.6)	
Negative	44 (8.8)	40 (8.1)	84 (8.4)	
Rate of proliferation				.82
<20%	322 (64.4)	316 (63.7)	638 (64.1)	
≥20%	178 (35.6)	180 (36.3)	358 (35.9)	
Peritumoral vascular invasion				.77
Yes	129 (25.8)	132 (26.6)	261 (26.2)	
No	371 (74.2)	364 (73.4)	735 (73.8)	

^aCALND = conventional axillary lymph node dissection; MALND = mastoscopic axillary lymph node dissection.^bData are presented as number (percentage) of patients unless otherwise indicated.

however, a significant difference between the 2 groups in the distant metastasis rate was demonstrated in favor of the MALND group ($P=.04$).

Axillary relapse occurred in 11 patients: 5 in the CALND group and 6 in the MALND group ($P=.75$). Supraclavicular metastasis developed in 10 patients (4 in the CALND group and 6 in the MALND group [$P=.51$]). Breast cancer recurred in 12 patients: 7 in the CALND group and 5 in the MALND group

($P=.57$). Fourteen patients experienced contralateral breast cancer (8 in the CALND group and 6 in the MALND group [$P=.60$]). Other primary tumors developed in 19 patients (8 in the CALND group [ovary, colon, colon, and brain] and 11 in the MALND group [stomach, bile duct cancer, and bladder carcinoma] [$P=.48$]). No port-site metastasis occurred in the MALND group. A total of 146 deaths due to breast cancer occurred: 82 in the CALND group and 64 in the MALND group ($P=.12$). Fifty-two other patients died of other causes: 25 in the CALND group and 27 in the MALND group ($P=.75$) (due to pancytopenia during chemotherapy, heart disease [myocardial infarction and acute heart failure], intestinal obstruction, acute pancreatitis, motor vehicle crash or other unintentional event, or other primary tumors [colon cancer, stomach cancer, brain tumor, or bile duct cancer]). No other postoperative complication information was collected.

DISCUSSION

The MALND technique provides an excellent view of the various important anatomic structures that can be easily preserved during the intervention. Bleeding can be stopped precisely, incisions are smaller, and thus trauma to the tissue is re-

TABLE 3. Operative Efficacy Comparison Between the 2 Study Groups^a

Item	Mean $\pm$ SD ^b		P value
	MALND	CALND	
Intraoperative blood loss (mL)	12.82 $\pm$ 5.46	128.29 $\pm$ 52.82	<.001
Operative time (min)	40.63 $\pm$ 14.27	31.18 $\pm$ 10.78	.09
Lymph node harvested (No.)	17.65 $\pm$ 5.38	16.18 $\pm$ 4.38	.35
Drainage flow (mL)	120.91 $\pm$ 39.22	150.29 $\pm$ 66.92	.08
Drainage duration (d)	4.04 $\pm$ 1.29	5.29 $\pm$ 2.01	.23
Subcutaneous seroma (%)	4.8 (24/496)	6.2 (31/500)	.11
Axillary infection (No.)	0	0	.46

^aCALND = conventional axillary lymph node dissection; MALND = mastoscopic axillary lymph node dissection.^bData are presented as mean $\pm$ SD unless otherwise indicated.

TABLE 4. Arm Morbidities in the 2 Study Groups^a

Arm morbidity	6 mo		<i>P</i> value	24 mo		<i>P</i> value
	CALND (No.) (n=100)	MALND (No.) (n=100)		CALND (No.) (n=100)	MALND (No.) (n=100)	
Axillary pain ^b			<.001			<.001
No	12	80		59	91	
Yes, sporadic	71	18		34	8	
Yes, continuous	17	2		7	1	
Numbness or paresthesias ^c			<.001			<.001
No	13	78		30	95	
Yes	87	22		70	5	
Arm mobility ^d			.14			>.99
80%-100%	79	92		100	100	
60%-79%	19	7		0	0	
40%-59%	2	1		0	0	
20%-39%	0	0		0	0	
<20%	0	0		0	0	
Arm swelling ^e			<.001			<.001
No difference	28	90		23	95	
<1 cm	46	8		36	4	
1-2 cm	20	2		26	0	
>2 cm	6	0		15	1	
Aesthetic appearance of axilla ^f			.001			.002
Good	89	100		91	100	
Bad	11	0		9	0	

^aCALND = conventional axillary lymph node dissection; MALND = mastoscopic axillary lymph node dissection.

^bAxillary pain was evaluated as continuous (lasting >50% of the day), sporadic, or absent.

^cNumbness and paresthesias were assessed by comparing skin sensitivity on the inner and outer upper arms, axillae, and chest wall on the treated side with that on the untreated side. Sensitivity was recorded as either the presence or absence of numbness.

^dArm mobility was judged by asking the patient to assign the restriction in motion on the treated arm a value on a scale of 0% (severe restriction) to 100% (no restriction).

^eArm swelling and edema were assessed by comparing the circumference (in centimeters) of the treated arm 15 cm above the lateral epicondyle with that of the untreated arm.

^fThe appearance of the axilla was judged by asking the patient whether the result was good or bad.

duced.³⁴⁻³⁸ Our study found that bleeding during MALND was minimal (12.82 ± 5.46 mL) compared with bleeding during CALND (128.29 ± 52.82 mL; $P < .001$). Our previous study¹⁹ concluded the bleeding occurred readily in 5 key operative points during MALND: (1) injecting lipolysis solution, (2) liposuctioning, (3) dissecting the axillary vein, (4) dissecting the thoracodorsal vessels, and (5) dissecting the lateral thoracic vessel. However, if MALND is performed carefully, it does not increase the bleeding risk.

Some investigators have stated that the operative time for MALND is longer (approximately 60-150 minutes) compared with CALND. Although in our study MALND initially required more time to perform, the operative time shortened gradually to less than 1 hour after we had performed approximately 10 operations. If the surgeon and the camera

operator are experienced, the operation can be accomplished in a half hour, which is even shorter than the time required for CALND. Of course, an efficient operation depends on the selection of an appropriate endoscope, complete liposuction, accurate operative procedures, the surgeon's familiarity with the axillary anatomy, and an understanding of the complex operative technique. If the lipolysis and aspiration of the fat are accurately performed during the resection of the breast tissue before dissecting the axillary lymph nodes, time can be saved during the procedure. In this multicenter trial, the operative times were 40.63 ± 14.27 minutes and 31.18 ± 10.78 minutes in the MALND and CALND groups, respectively (no statistically significant difference between the 2 groups).

The number of lymph nodes harvested was repeatedly reported to be equal to the number har-

FIGURE 1. Disease-free survival in the 2 study groups. CALND = conventional axillary lymph node dissection; MALND = mastoscopic axillary lymph node dissection.

vested during traditional CALND and could provide adequate information on the lymph node status. In this study, the number of lymph nodes harvested during MALND was 17.65 ± 5.38 , which is statistically comparable to the number harvested during CALND (16.18 ± 4.38 , $P = .35$). This finding is similar to those in other reports.^{21,23,25}

Suzanne et al³⁹ described a daily postoperative lymph flow of only 23.4 mL, leading them to reject wound drainage. An overall mean drainage flow of 372 mL was observed in another series, over a period of 5 to 6 days. Other groups have reported similar results, and most surgeons will not omit axillary drainage after MALND.^{5,7} The drainage flow of CALND is reported to be 322 to 447 mL (range, 23-1100 mL).^{40,41} In the present study, the overall flow in the MALND group was 120.91 ± 39.22 mL over 4.04 ± 1.29 days, slightly lower than that in the CALND group (150.29 ± 66.92 mL over 5.29 ± 2.01 days; $P = .08$ for drainage and $P = .23$ for duration).

Some reports have described seroma rates of 2.8% to 25% for the endoscopic technique. After CALND, seromas are reported in 2% to 59% of patients.^{35,39,42} In the current literature, subcutaneous seroma occurs in 4.8% of patients during MALND and 6.2% during CALND ($P = .11$) (Table 3). Therefore, there is no clear advantage of MALND over CALND in terms of reducing postoperative lymphorrhea.

Our study corroborates previous findings from smaller studies^{13,15,19,36} that report excellent arm function results after MALND (Table 4). The patients who underwent MALND had less axillary pain, numbness or paresthesias, and arm swelling on the treated side ($P < .001$). Although arm mobility was a little worse in the CALND group than in the MALND group at 6 months after surgery ($P = .14$), mobility was the same 24 months after the operation. The aesthetic appearance of the axilla in the

MALND group was much better than that in the CALND group. Mastoscopic axillary lymph node dissection reduces the arm morbidities associated with ALND, an unsurprising finding given that MALND results in less arm swelling (lymphedema) than CALND. This finding is partly because the operation is minimally invasive but is also because of the procedure's functional conservation and cosmetic effects. A major potential benefit of reducing morbidities of axillary surgery will have both societal and patient economic effects. These advantages of MALND will result in fewer clinic visits, increased patient satisfaction, faster return to normal social and domestic activity, and greatly reduced costs.

The most tedious procedure in CALND is the isolation and dissection of fat tissues in the axilla. The fat tissues must be dissected from the axillary wall, blood vessels, and nerves. If the fat tissues first undergo liposuction and inflation, the parenchymatous axilla becomes the reticular structure, just like a spider web, and the swollen lymph nodes hang to the "web." Therefore, the operation gets simpler. The use of liposuction during MALND has been approved. Nevertheless, whether the liposuction affects the pathologic characteristics of the lymph node and interferes with the pathoanatomic study of the lymph node, whether it increases the risk of exfoliation and implantation of tumor cells from the lymph node with metastasis, and whether it raises the risk of hematogenous dissemination or metastasis have worried surgeons. For this reason, the operative safety of MALND has been investigated in several studies. As early as 1997, Brun et al¹⁵ performed a prospective study of 34 axillary dissections performed from July 1995 to September 1996 in patients with breast cancer to determine the pathologic features of lymph nodes removed by axillary liposuction. After lipolysis, the fat was drained from the axillary cavity by liposuction. A mean of 15

FIGURE 2. Overall survival in the 2 study groups. CALND = conventional axillary lymph node dissection; MALND = mastoscopic axillary lymph node dissection.

lymph nodes (range, 8-31) were removed. A total of 502 lymph nodes were examined: 458 (91%) were not involved and 44 (9%) were involved, including 21 (4%) with rupture of the capsule. No pathologic trauma was seen. The authors concluded that axillary liposuction did not alter the pathologic features of lymph nodes and did not affect the quality of lymph node dissection. Jun et al⁴³ also designed a clinical control study of the histologic alterations seen in lymph nodes damaged by MALND after liposuction and CALND. In 931 nodes harvested by endoscopic dissection after liposuction, 37 metastatic nodes and 58 damaged nodes were found; 8 nodes without carcinomatous metastasis and 2 nodes with metastasis were crushed. In 642 nodes obtained by traditional dissection, 31 metastatic nodes and 41 damaged nodes were found; 2 nodes without carcinomatous metastasis and 2 nodes with metastasis were crushed. Crushing and bleeding in the node were found more frequently in those removed by MALND than those removed by CALND. The percentage of damaged lymph nodes, with or without metastasis, was approximately the same with both techniques. No statistically significant differences in lymph node damage were found between the 2 groups. Compared with CALND, the use of MALND after liposuction did not produce more damage to lymph nodes and did not introduce more exfoliated cancer cells into the surgical field. In addition, MALND did not enhance tumor spread during the operation.⁴⁴ Other related studies have also found MALND to be a safe technique.^{24,36,37}

Four axillary recurrences and 2 port-site metastases have been reported after MALND in a small series. The 2 failed operations described in the article by Salvat et al¹⁶ occurred in patients with primarily extensive lymph node involvement. One patient was a 33-year-old woman with T2pN1 disease, with 22 of 23 nodes negative for hormonal receptor expression, in whom disease recurred in the axilla and the breast. The other patient had T2pN1 disease, with 3 of 14 nodes negative for hormonal receptor expression, in whom disease recurred in the posterior axillary line and in the pectoralis major muscle. Hussein et al²³ described a 38-year-old patient with stage II, grade II infiltrating duct carcinoma who experienced local and axillary recurrence 2 years after endoscopic dissection of 11 lymph nodes. Notably, in this patient the operation was performed without liposuction. In a smaller randomized study by Langer et al,²² MALND had a low axillary recurrence rate, but the authors reported 2 port-site metastases after MALND. In 2 patients, histologically confirmed port-site metastases were detected at 24 and 49 months after endoscopic ALND. One of these postmenopausal women was node positive at the time of the initial operation (9 of 17

positive lymph nodes) with disease staged as pT2G2 invasive ductal carcinoma. After excision of the port-site metastasis at 24 months, distant metastasis disease to the liver occurred. The patient died 1 year later. In the other patient with pT2G3 invasive lobular carcinoma, all 11 endoscopically removed lymph nodes were free of metastases. Concurrently with a surprising port-site metastasis, this patient experienced the only axillary recurrence. The metastatic lesion was surgically removed. Three years later, the patient is still alive and without evidence of recurrent local or metastatic disease. Nevertheless, with the improvement in the MALND technique, including the endoscope reselection, operation standardization, and management of the operative field, no axillary relapse or trocar implantation has been reported in larger series and nonrandomized studies in recent years.^{9,18,34,39} Our trial found no port-site metastasis in the MALND group. In addition, the axillary recurrence rate is smaller in both our study groups (1.0% [5/500] in the CALND group and 1.2% [6/496] in the MALND group).

Certainly, preventing the occurrence and spread of metastasis during an operation is a systematic undertaking. It includes improving the operating technique of MALND, standardizing the operative procedures, paying great attention during the operation, and washing the axillary cavity with warm distilled water just before the end of the operation (similar to lavage of the peritoneal cavity after removal of malignant tumors of the gastrointestinal tract and other quality control measures).

The conventional procedure for breast cancer surgery is that breast or tumor is operated on first and the axillary lymph node is then dissected. During this procedure, it is difficult to avoid squeezing and pulling the breast. In addition, the blood vessels and tumor-draining lymphatic ducts are still open and the operative exposure is not optimal. Undoubtedly, these factors can increase the risk for tumor metastases.⁴⁵

The most important finding of our study is the significantly lower rate of distant metastases occurring during MALND (22.8% [113/496]) compared with CALND (28.2% [141/500]) ($P=.04$). Moreover, the obvious reduction in distant metastases found in our study may have affected breast cancer-related death rates (16.4% [82/500] in the CALND group vs 12.9% [64/496] in the MALND group) and disease-free survival rates (60.8% after CALND vs 64.5% after MALND), although this difference is not statistically significant. Longer-term follow-up (ie, 10 and 20 years) is still needed before a definite conclusion can be made. The findings of our study raise the question of whether the axillary operation should be performed before the breast operation even in the conventional open procedure, which

may further change the surgical treatment of lymphatic metastasis of the breast.

The special operative view afforded by MALND creates an ideal and convenient preservation of some anatomic structures. As a result, it achieves a 3-fold effect on the minimally invasive, function-preserving, and appearance-enhancing aspects of the operation, with the benefits of improved safety and tumor dissection. Some complications and functional injuries that occurred during CALND decreased during MALND.^{46,47} The MALND technique achieves the double aims of creating physiologically and psychologically minimal invasions. In conclusion, MALND has advantages in operative outcomes, complication reduction, function conservation, and cosmetics. Therefore, MALND should be the preferred approach for breast cancer surgery.

SUPPLEMENTAL ONLINE MATERIAL

Supplemental material can be found online at <http://www.mayoclinicproceedings.org>.

Abbreviations and Acronyms: ALND = axillary lymph node dissection; CALND = conventional axillary lymph node dissection; MALND = mastoscopic axillary lymph node dissection

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