

Comparison of outcomes of surgeon-performed intraoperative ultrasonography-guided wire localization and preoperative wire localization in nonpalpable breast cancer patients undergoing breast-conserving surgery

A retrospective cohort study

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Abstract

This study aimed to determine the efficacy of intraoperative ultrasonography-guided wire localization guided breast-conserving surgery (BCS) for nonpalpable breast cancer and compare it to conventional preoperative wire localization (PWL) guided surgery.

We retrospectively analyzed the medical charts of 214 consecutive nonpalpable breast cancer patients who underwent BCS using intraoperative ultrasonography-guided wire localization by a surgeon (IUWLS) and PWL, between April 2013 and March 2017. Positive surgical margins, reexcision rates, and resection volumes were investigated.

Of the total cohort, 124 patients underwent BCS with IUWLS and 90 patients with PWL. The following did not differ between the IUWLS and PWL groups: positive margin status, re-excision rate, conversion rate, permanent positive margin status, reoperation rate, median optimal resection volume (ORV), median total resection volume (TRV), and median closest tumor-free margin. Rather, median (range) widest tumor-free margin was significantly smaller in the IUWLS group (9 mm [5–12]) than in the PWL group (14 mm [9–20]; $P = .003$). Median (range) calculated resection ratio (CRR) was significantly lower in the IUWLS group (1.67 [0.87–9.38]) than in the PWL group (4.83 [1.63–21.04]; $P = .02$).

In nonpalpable breast cancer patients undergoing BCS, IUWLS showed positive resection margins and reexcision rates equivalent to those of the conventional PWL method. Additionally, excision volume and widest tumor-free margin were smaller with IUWLS, confirming that healthy breast tissue is less likely to be resected with this method. Our results suggest that IUWLS offers an excellent alternative to PWL, while avoiding PWL-induced patient discomfort.

Abbreviations: BCS = breast-conserving surgery, CRR = calculated resection ratio, DCIS = ductal carcinoma in situ, IUWLS = intraoperative ultrasonography-guided wire localization by a surgeon, ORV = optimal resection volume, PWL = preoperative wire localization, ROLL = radioguided occult lesion localization, RSL = radioactive seed localization, TRV = total resection volume.

Keywords: breast carcinoma, intraoperative ultrasonography, resection margin, resection volume, wire localization

1. Introduction

Breast cancer is the most common cancer in women worldwide, and in Korea, is the 2nd most common female cancer.^[1,2] Because

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of the development of nationwide health and social insurance systems in Korea, the rate of early diagnosis of breast cancer is increasing. This is primarily due to expansion of health screening to encompass the entire population, the emergence of self-examination as an important screening tool, and improvement in diagnostic techniques by increased utilization of high-resolution ultrasound and breast magnetic resonance imaging.

The outcome of a large-scale randomized clinical trial has positioned breast-conserving surgery (BCS) as a primary, curative treatment approach among surgical treatments for breast cancer.^[3] According to the 2014 statistical data of the Korean Breast Cancer Society, BCS constitutes 64.9% of all surgeries performed on breast cancer patients.^[4] Moreover, 55% of all newly diagnosed breast cancer patients in 2014 had T0–T1 breast cancer.^[4] Accordingly, the rate of BCS for nonpalpable breast cancer is gradually increasing.

As more cases of nonpalpable breast cancer are diagnosed, various methods have been introduced and used to determine tumor location, secure an appropriate margin, and increase accuracy in BCS for nonpalpable or suspected nonpalpable breast cancer. They include wire localization, radioguided occult lesion localization (ROLL), radioactive seed localization (RSL), and

intraoperative ultrasonography.^[5] Preoperative wire localization (PWL) under mammography and ultrasonography guidance have long been considered gold standard methods for localization and guidance during BCS for nonpalpable breast cancer.^[6] In numerous studies, ROLL and RSL showed similar success rates to that of wire localization as the standard method.^[5] However, all the approaches mentioned above are expensive and require coordination with radiologists or nuclear medicine physicists, and additional procedure time. Additionally, the procedure needs to be performed prior to surgery, which can increase patient anxiety and discomfort. Further, problems such as wire or seed migration and dislocation during the time between procedure and surgery are causes for concern. Ultrasonography-guided BCS can overcome such problems, but it may miss the location of a small tumor during surgery. Pros and cons of the aforementioned approaches have been reported in many comparative studies.^[7,8]

For the past 4 years, our institution has been using intraoperative ultrasonography-guided wire localization by a surgeon (IUWLS) for nonpalpable breast cancer. An advantage of this method is that it uses both ultrasonography and wire localization for guidance during BCS for nonpalpable breast cancer, without preoperative help from a radiologist or a nuclear medicine physicist. This method also reduces patient anxiety by eliminating a preoperative procedure and prevents complications such as wire migration. The purpose of the present study was to compare the 2 methods of IUWLS and PWL in a consecutively treated series of patients with nonpalpable and suspected nonpalpable breast cancer at the time of BCS. We investigated whether the oncologic outcomes of IUWLS were similar to those of PWL and whether this localization method could leave healthy breast tissue intact by excising a small and appropriate amount of breast tissue.

2. Patients and methods

2.1. Patients and study design

This study adhered to the ethical tenets of the Declaration of Helsinki and was approved by the institutional review board (IRB) of Chungbuk National University Hospital, Republic of Korea (approved number CBNUH 2017-07-004-001). The informed consent requirement was waived by the IRB. The records of patients diagnosed with invasive breast cancer at our institution from April 2013 to March 2017 were retrospectively reviewed. We included all consecutive patients who scheduled BCS for nonpalpable or difficult to palpable breast cancer. Patients presented as microcalcification only without mass were excluded and accordingly, patients who underwent mammography guided wire localization were excluded from the study. Patients diagnosed with ductal carcinoma in situ (DCIS) prior to the surgery as well as those who had received neoadjuvant chemotherapy were excluded from the study.

During the study period, 214 patients with invasive breast cancer fulfilled the study. Of those, 124 patients underwent BCS using IUWLS and 90 patients underwent BCS using conventional PWL. In all study participants, the diagnosis of invasive breast cancer was confirmed with core needle biopsy. In addition, no mass was present in a different quadrant of the breast, it was confirmed on preoperative magnetic resonance imaging.

After surgery, radiation therapy was performed in all patients who underwent BCS and adjuvant systemic therapy was performed according to the National Comprehensive Cancer

Network consensus available at the time of treatment. Patients were followed up at least once every 6 months in the first 3 years after diagnosis. In the 3 to 5 years after diagnosis, the frequency of follow-up was reduced to once every 6 to 12 months. All patients were followed up to October 31, 2017.

2.2. Localization procedures and operation methods

Before being sent to the operating room, patients in the PWL group underwent ultrasonography-guided wire localization in the radiology department, which was performed by a breast imaging radiologist using a 5, 7.5, 10, or 12 cm Hawkins II needle-wire localization device (Angiotech Pharmaceuticals, Inc, Gainesville, FL). Patients in the IUWLS group underwent wire localization performed by a single surgeon after the wound was disinfected and draped following general anesthesia. After the mass was localized using intraoperative ultrasonography, a long wire was placed within a 23-gauge syringe needle, and the needle was inserted to the breast mass under ultrasonography guidance. Then, the syringe needle was removed to leave only the wire behind. The appropriacy of wire localization was evaluated by using ultrasonography (Fig. 1).

All BCS procedures were performed by a single surgeon who had 14 years of experience as a breast specialist, and all patients underwent axillary surgery including sentinel lymphadenectomy. Each BCS specimen consisted of wide local excision of breast parenchyma around the tumor and included overlying skin in cases of tumors that were close to the skin. A representative digital photograph of a resected BCS specimen with an intraoperative inserted wire was shown in Fig. 2. After excision, the specimen was examined *ex vivo* by using ultrasound to determine whether the tumor was completely excised (Fig. 3). If ultrasonography indicated an insufficiently resected margin, an additional margin was resected in the area and sutured with the BCS specimen on the corresponding side.

After the location of the resection plane was indicated with suture marking, cavity resection margins were shaved in 8 directions (12', 1'30", 3', 4'30", 6', 7'30", 9', and 10'30", radially) and sent to the pathology department for frozen biopsy. The presence of invasive carcinoma or *in situ* carcinoma in these resection margins was determined using frozen biopsy, and the result was reported as either positive or negative for each margin. If a margin was positive on frozen biopsy, additional excision was performed. If re-excision was required ≥ 3 times or if a positive finding was observed in several margins, the surgery plan was converted to total mastectomy.

BCS specimens were delivered to a pathologist for permanent pathology. Each margin was classified as "positive," "close," or "negative" in the permanent pathology reports. A "positive" BCS margin referred to a case in which tumor cells were present on the inked margin, and a "close" BCS margin was defined as tumor cells observed within 1 mm of the inked edge of the BCS specimen. A "negative" BCS margin was defined as no tumor cells seen within 1 mm of the inked edge of the BCS specimen. The precise microscopic distance from the tumor to each of the margins in the 8 directions was recorded in the permanent pathology reports. If a permanent pathology finding was positive, re-excision or mastectomy was performed, and in cases with a close margin, additional boost radiotherapy was considered for the patient. The presence or absence of lobular carcinoma *in situ*, atypical lobular hyperplasia, or atypical ductal hyperplasia was not considered in the final assessment of the surgical resection margin status.

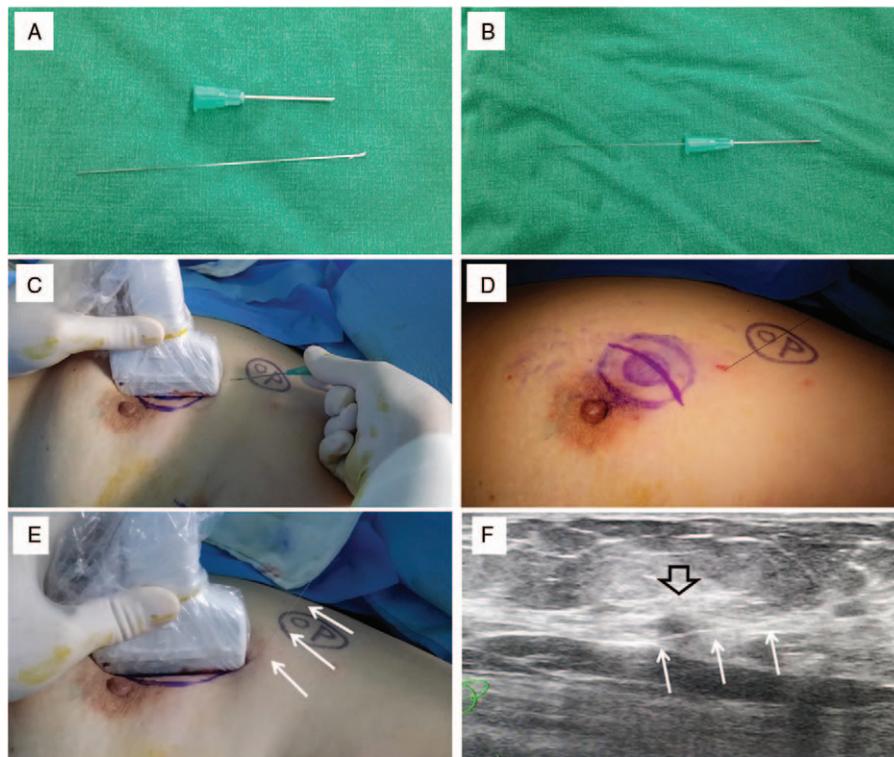


Figure 1. Procedures of intraoperative ultrasonography-guided wire localization by a surgeon. (A) The wire and indigocarmine gel. (B) Wire was placed inside of 23-gauge syringe needle. (C) The syringe needle with wire was inserted under ultrasonography guidance for localization of breast cancer. (D) The syringe needle was removed to leave only the wire behind. (E, F) Determine the locations of cancer (black empty arrow) and wire (white arrows) using intraoperative ultrasonography.

2.3. Calculations of the specimen volumes and the calculated resection ratios

Tumor size and specimen dimensions were retrieved from the pathology reports. Total resection volume (TRV) was calculated using the formula $4/3\pi (1/2a*1/2b*1/2c)$, where a, b, and c represented the 3 specimen dimensions.^[5] Optimal resection volume (ORV) was calculated using the tumor radius plus an arbitrarily chosen optimal tumor-free margin of 1cm by $\frac{4}{3}\pi(r + 1)^3$. The relative amount of excessively excised breast tissue, defined by the calculated resection ratio (CRR), was calculated by dividing the TRV by the ORV (CRR = TRV/ORV).

2.4. Statistical analysis

All data were analyzed with SPSS statistical software, Version 17.0 (SPSS Inc., Chicago, IL). Baseline characteristics and outcomes of the 2 groups were compared with chi-square test or Fisher exact test. Univariate comparisons of continuous variables were performed by 1-way analysis of variance. Differences were considered statistically significant at $P < .05$.

3. Results

3.1. Patient and tumor characteristics

The median follow-up time was 29 months (range 7–54 months). Patient and tumor characteristics of the 214 patients with 2 groups are compared in Table 1. No significant differences were found between the 2 groups in age, body mass index, tumor size, or the rate of metastasis to axillary lymph nodes. In both groups, the proportion of patients with invasive ductal cancer was the highest, while 4 patients had invasive lobular cancer in the IUWLS group. Mixed type, tubular, and mucinous cancer were classified as “other tumors.”

3.2. Procedure duration

Additional procedure time was defined for the IUWLS group as the length of time during which the mass was confirmed using ultrasonography after wound disinfection but before incision, and localization was performed by inserting a wire. For the PWL group, additional time was defined as the time from patient transfer to the radiology department to patient arrival at the operating room. The mean procedure duration was significantly



Figure 2. Photograph of a breast-conserving surgery (BCS) specimen. Intraoperative inserted wire (white arrows) was identified with suture markings.

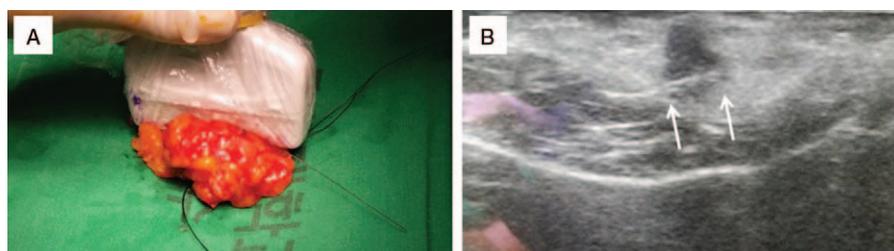


Figure 3. Evaluation of a breast-conserving surgery (BCS) specimen. (A) The specimen was examined ex vivo by using ultrasonography to determine whether the tumor was completely excised. (B) Specimen ultrasonography showed centrally located mass and inserted wire (white arrows) with sufficient homogeneous resection margin.

longer in the PWL group than in the IUWLS group (45 [30–95] vs 8 [5–15] minutes, respectively; $P = .002$).

3.3. Margin status

Table 2 shows the surgical outcomes of the IUWLS and PWL groups. During 1st operation, frozen biopsy was performed in all patients on the radial cavity margins in 8 directions. The results of frozen biopsy were reported only as either positive or negative, and 15 patients (12.1%) in the IUWLS group and 17 patients (18.8%) in the PWL group had positive results. In all of them, re-excision was immediately performed, and the results of repeated frozen biopsy were negative. None of the cases required a change in the surgical plan to total mastectomy during first operation.

The results of postoperative permanent pathology showed that 2 patients in the IUWLS group and 3 patients in the PWL group had a positive margin, while 3 patients each in the IUWLS and PWL groups had close margin. The 5 patients with positive margins underwent reoperation. One patient in the IUWLS group and 2 patients in the PWL group underwent total mastectomy because the finding of a positive margin was confirmed in several margins, and 1 patient each in the IUWLS and PWL groups underwent re-excision. Overall, a 2nd operation was performed

on 2 patients (1.6%) in the IUWLS group and 3 patients (3.3%) in the PWL group.

3.4. Resection volumes and calculated resection ratios

Among patients with a negative margin, the median distance of the closest tumor-free margin did not differ between the IUWLS and PWL groups. However, the median distance of the widest tumor-free margin (range) in the PWL group (14 mm [9–20]) was significantly greater than that in the IUWLS group (9 mm [5–12]). Greater tumor-free margins were resected in the PWL group, although tumor size was similar in patients in both groups.

The median ORV and TRV values did not differ between the IUWLS and PWL groups. However, median CRR was significantly smaller in the IUWLS group than in the PWL group (1.67 vs 4.83, respectively; $P = .02$).

4. Discussion and conclusion

The results of the present study indicate that, when used during BCS in nonpalpable breast cancer patients, IUWLS and PWL had equivalent oncologic surgical outcomes with respect to the success rate of BCS, and the rates of positive margin, re-excision, and reoperation. In addition, although the surgery was performed on tumors of similar size, resection volume was smaller in BCS with IUWLS than in BCS with PWL, suggesting that a greater amount of healthy breast tissue was preserved in BCS using IUWLS.

In the present study, a positive BCS margin was defined as invasive or in situ tumor cells overlapping with the inked margin, and a close margin was defined as the presence of tumor cells within 1 mm from the margin. Frozen biopsy was performed during surgery in all patients who underwent BCS, and frozen biopsy results were only reported as either positive or negative. Therefore, the final pathological margin reported in other studies where frozen biopsy was not performed should be compared with the current study's frozen biopsy results. The positive margin rate in frozen biopsy was slightly higher in the PWL group than in the IUWLS group, but the difference was not statistically significant. This finding is not markedly different from the positive margin rate reported in other studies where BCS was performed after localization using ultrasonography or wire localization.^[8–10] The localization methods used during BCS for nonpalpable breast cancer include PWL, ROLL, RSL, and intraoperative ultrasonography.^[5] The negative margin rate with PWL, the gold standard method, varies widely from 55% to 91%.^[9–11] RSL and ROLL have been reported to show oncologic outcomes similar to or slightly better than wire localization, but no large differences in

Table 1

Patient and tumor characteristics.

| | IUWLS (n=124) | PWL (n=90) | P |
|--------------------------------|------------------|------------------|-----|
| Age, y; median (range) | 55 (34–80) | 52 (23–76) | .67 |
| Body mass index | 28.6 (17.6–57.5) | 24.5 (13.5–49.6) | .86 |
| Tumor size, cm; median (range) | 1.12 (0.4–1.5) | 1.02 (0.5–1.4) | .66 |
| Histology | | | .09 |
| Invasive ductal | 98 (79.0%) | 80 (88.9%) | |
| Invasive lobular | 5 (4.0%) | 0 (0) | |
| Others* | 21 (17.0%) | 10 (11.1%) | |
| Axilla lymph node status | | | .40 |
| Negative | 111 (89.5%) | 80 (88.9%) | |
| Positive | 13 (10.4%) | 10 (11.1%) | |
| Tumor stage | | | .37 |
| T1a | 10 (8.1%) | 6 (6.7%) | |
| T1b | 49 (39.5%) | 39 (43.3%) | |
| T1c | 65 (52.4%) | 45 (50.0%) | |
| Associated DCIS | | | .27 |
| Present | 18 (14.4%) | 8 (8.9%) | |
| Absent | 106 (85.6%) | 92 (91.1%) | |
| Multifocal mass | 12 (9.6%) | 6 (6.7%) | .09 |

DCIS = ductal carcinoma in situ, IUWLS = intraoperative ultrasonography-guided wire localization by a surgeon, PWL = preoperative wire localization.

* Includes mucinous, tubular, papillary, and mixed type histology.

Table 2**Surgical outcomes: procedure time, margin status, and calculated resection ratio.**

| | IUWLS (n=124) | PWL (n=90) | P |
|---|---------------------|----------------------|------|
| Procedure time, min (range) | 8 (5–15) | 45 (30–95) | .002 |
| Results of 1st operation | | | |
| Margin status (frozen biopsy) | | | .16 |
| Positive | 15 (12.1%) | 17 (18.8%) | |
| Negative | 109 (87.9%) | 73 (81.2%) | |
| Re-excision | 15 (12.1%) | 17 (18.8%) | .16 |
| Conversion to total mastectomy | 0 | 0 | |
| Results of permanent pathology | | | |
| Margin status | | | .59 |
| Positive | 2 (1.6%) | 3 (3.3%) | |
| Close | 3 (2.4%) | 3 (3.3%) | |
| Negative | 119 (96.0%) | 84 (93.4%) | |
| Second operation | 2 (1.6%) | 3 (3.3%) | .68 |
| Re-excision | 1 | 1 | |
| Total mastectomy | 1 | 2 | |
| Closest tumor-free margin in case of clear margin, mm; median (range) | 4 (3–10) | 4 (2–12) | .07 |
| Widest tumor-free margin in case of clear margin, mm; median (range) | 9 (5–12) | 14 (9–20) | .003 |
| TRV, cm ³ ; median (range) | 31.40 (7.85–106.76) | 75.36 (31.40–128.22) | .25 |
| ORV, cm ³ ; median (range) | 17.14 (4.19–22.44) | 14.86 (5.57–22.44) | .62 |
| CRR (TRV/ORV); median (range) | 1.67 (0.87–9.38) | 4.83 (1.63–21.04) | .02 |

CRR = calculated resection ratio, IUWLS = intraoperative ultrasonography-guided wire localization by a surgeon, ORV = optimal resection volume, PWL = preoperative wire localization, TRV = total resection volume.

negative margin rates were detected in large-scale randomized trials.^[12–15] In contrast, several randomized trials found that positive margin rates were lower with intraoperative ultrasonography than with PWL in BCS for nonpalpable breast cancer,^[16,17] but in a large cohort study and Cochrane review, the rate was not significantly different between these 2 methods.^[18] Because localization is dependent upon the surgeon's ability to evaluate ultrasound images accurately, the currently available evidence is insufficient to support the complete replacement of PWL with intraoperative ultrasonography in the localization of nonpalpable breast cancer. An advantage of the present study is that BCS was performed via a localization method combining intraoperative ultrasonography and wire localization, thus taking advantage of the positive aspects of both approaches. The negative margin rates in the present study were similar to those in other studies.

Several factors affect the differences in resection margins during BCS. A higher positive margin rate was reported in invasive lobular carcinoma than in invasive ductal carcinoma,^[19] which suggests that invasive lobular carcinoma tumors may be associated with decreased conspicuity on ultrasound. In the present study, 5 patients, all in IUWLS group, had invasive lobular histology, which could have resulted in the relative low negative margin rate (87.9%) than previous studies. In addition, the unexpected DCIS component can also increase the positive margin rate. In several previous studies, unexpected DCIS was found in 25% to 47.2% of cases after BCS.^[7,20] In the present study, unexpected DCIS was found in 14.4% and 8.9% of patients in the IUWLS and PWL groups, respectively, which were not significantly different. Tumor size is also related to an increase in the positive margin rate. Typically, as tumor size increases, the positive margin rate increases whereas CRR decreases.^[7] We believe that this finding is due to surgeons' tendency to excise a smaller amount of breast tissue in a larger tumor, although they are aided by ultrasonography. In the present study, the mean tumor size was not significantly different between the IUWLS and PWL groups.

In the present study, we compared the variations in the size of the closest and the widest tumor-free margins in the IUWLS and PWL groups, and found that the median widest tumor-free margin was significantly lower in the IUWLS group than in the PWL group (9 vs 14 mm, respectively; $P = .003$). These findings are consistent with the results of a previous study,^[20] in which the mean of surgical margins (ie, the distance from tumor to a margin of normal tissue) measured in several directions in patients with negative margins was significantly smaller in the intraoperative ultrasonography group than in the wire-guided localization group (4 vs 10 mm; $P < .001$). In the present study, the closest tumor-free margin and the widest tumor-free margin were analyzed separately to examine homogeneity in the margin size in the 2 treatment groups. Although the size of the closest tumor-free margin did not show a between-group difference, the widest tumor-free margin was greater in the PWL group than in the IUWLS group. This suggests that normal tissue can be excessively excised in the PWL group relative to IUWLS group, because unnecessarily wide margins were obtained in the former group, much wider than the usual goal of BCS to resect normal tissue 1 cm away from the tumor.

This finding was also confirmed in the comparisons of ORV and TRV between groups. Breast resection volume is one of the absolute cosmetic outcome criteria, and in the present study, the PWL group had a higher TRV than the IUWLS group did, although ORV was similar between groups. Hence, CRR showed that resection volume was 3 times higher in the PWL group than in the IUWLS group. In several previous studies, reduction in resection volume was often not a study objective, but the present study showed that IUWLS reduced BCS specimen volume by enabling the selection of an appropriate margin for oncologic safety, while at the same time, enabling the resection of a minimal amount of healthy breast tissue.

Krekel et al^[21] found that BCS had a lower positive margin rate but a greater resection volume of breast tissue in nonpalpable breast cancer than in palpable breast cancer. Additionally, despite the larger resection volume of breast tissue, the tumor was

often located eccentrically in the surgical specimen, and the margins were positive or focally positive for invasive carcinoma in over 20% of patients. This was likely because obtaining a negative margin was the primary objective in BCS for nonpalpable breast cancer, and the location and orientation of the tumor were unclear during the operation. In the PWL group of the present study, a larger amount of normal breast tissue was resected but the median widest tumor-free margin was greater than that in the IUWLS group, likely because it was impossible to examine the scope of resection continuously in real time through ultrasonography during the operation. A smaller volume of breast tissue could be excised without compromising the oncological margin status. To achieve the highest surgical accuracy, surgeons should attempt to obtain a surgical specimen from a more concentric location of the tumor. However, surgical accuracy is not easy to improve and might require modification of surgical factors. In the case of IUWLS, the surgeon was able to check whether an appropriate margin was selected and to monitor tumor location within the specimen in real time before, during, and after the operation. Therefore, with this localization method, oncologic safety, defined as an acceptable negative margin rate, was attained, and simultaneously, a better cosmetic outcome was attained by resecting a smaller amount of breast tissue.

BCS using intraoperative ultrasonography was first introduced in 1988.^[22] The use of ultrasonography during operation is advantageous because the surgeon can perform the operation while making direct real-time observations. In addition, during operation, the surgeon can continuously monitor whether an appropriate margin is selected, and even after the removal of specimen, ultrasonography can be valuable for confirming excision and checking margin clearance before wound closure. Several studies have reported the outcomes of BCS using intraoperative ultrasonography. For example, Krekel et al^[7] found that intraoperative ultrasonography was more effective than wire localization and ROLL in localizing tumors during BCS for nonpalpable breast cancer. Additionally, other studies reported that the localization method based on intraoperative ultrasonography showed a lower positive margin rate and a smaller excision volume in breast cancer cases than wire localization and palpation guidance did.^[9,23] In many early studies on the use of intraoperative ultrasonography, radiologists performed ultrasonography in the operating room, but recent research has increasingly shown favorable treatment oncologic outcomes when intraoperative ultrasonography is performed directly by the surgeon.^[24]

The localization method based on IUWLS used in the present study offers the advantages of both intraoperative ultrasonography and wire localization. Wire localization is performed by the surgeon during the operation, and thus, it does not require assistance from another department, minimizes patient anxiety and wasted time, and eliminates the likelihood of wire migration because no procedure is performed prior to the operation. Moreover, the surgeon can guide the wire, monitor ultrasonography, and monitor the mass in real time while performing BCS, and maintain oncologic safety without an excessive loss of normal tissue. A limitation of IUWLS is that the surgeon should be well trained in using ultrasonography to enable identification of a small nonpalpable breast cancer tumor. However, we believe that this skill can be improved through sufficient training, especially since surgeons increasingly perform preoperative ultrasonography, including core needle biopsy, when diagnosing breast cancer. The wire used in the present study was not from a

specially designed kit or device. The surgeon utilized a wire typically used for vascular guidance, placing it inside a 23-gauge syringe needle to insert it using ultrasonography. Thus, a pre-existing kit is not necessary and there is little additional cost. The wire is used only for a short period as an intraoperative guide to determine tumor location, and does not require to be positioned for a long time; this characteristic alone makes the IUWLS method optimal for use in BCS.

There are some limitations of our study. First, the number of patients was relatively small and the study period was not long. To understand more about long-term oncologic outcome of IUWLS guided BCS, including ipsilateral breast tumor recurrence, further studies with more patients and a longer period of time for follow-up will be necessary in the future. Second, this study is limited by its retrospective design and the risk of selection bias. However, to date, there is no published study investigating the effects of IUWLS in performing BCS. Moreover, in this study, IUWLS was shown to have superior therapeutic effects to conventional PWL. Considering these, this study seems to have sufficient significance.

The important limitation of the present study is that patient satisfaction and long-term cosmetic outcomes were not compared between the 2 groups. In the future, we hope to compare various localization methods used during BCS for nonpalpable breast cancer in a larger patient sample, and to prospectively compare not only oncologic outcomes but also patient and physician satisfaction, and cosmetic outcomes.

In conclusion, our results indicate that IUWLS-guided BCS is feasible and results in lower excision volumes and resection of less healthy breast tissue in patients with nonpalpable breast cancer, without compromising margin status. In addition, IUWLS can eliminate the need for PWL, a process that may be costly, time consuming, and uncomfortable for patients.

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