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TECHNICAL NOTE

Accuracy of determining preoperative cancer extent measured by automated breast ultrasonography

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Abstract
Purpose. The aim of this study was to determine the accuracy of measuring preoperative cancer extent using automated breast ultrasonography (US).
Materials and methods. This retrospective study consisted of 40 patients with histopathologically confirmed breast cancer. All of the patients underwent automated breast US (ABVS; Siemens Medical Solutions, Mountain View, CA, USA) on the day before the surgery. The sizes of the lesions on US were measured on coronal multiplanar reconstruction images using the ABVS workstation. Histopathological measurement of tumor size included not only the invasive foci but also any in situ component and was used as the gold standard. The discrepancy of the tumor extent between automated breast US and the histological examination was calculated.
Results. Automated breast US enabled visualization of the breast carcinomas in all patients. The mean size of the lesions on US was 12 mm (range 4–62 mm). The histopathological diagnosis was ductal carcinoma in situ (DCIS) in seven patients and invasive ductal carcinoma in 33 patients (18 without an intraductal component, 15 with an intraductal component). Lesions ranged in diameter from 4 to 65 mm (mean 16 mm). The accuracy of determination of the tumor extent with a deviation in length of <2 cm was 98% (39/40).
Conclusion. Automated breast US is thought to be useful for evaluating tumor extent preoperatively.

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Introduction

Breast-conserving surgery has become the standard operation for early-stage breast cancer. To avoid local recurrence caused by residual tumor, it is important to obtain precise information regarding the tumor extent. Ultrasonography (US) has emerged as the most important adjunct to mammography in the diagnosis of breast cancer.[1] In addition, several investigators have reported the usefulness of breast US in the evaluation of the extent of intraductal carcinoma.[2,3] However, the most significant drawback of hand-held US, which is the standard method used currently, is that it is operator-dependent.

To overcome this disadvantage, the ACUSON S2000 Automated Breast Volume Scanner (ABVS; Siemens Medical Solutions, Mountain View, CA, USA) was developed recently.[4] Originally, ABVS was a diagnostic US system developed for breast cancer screening. The scanned data are preserved as three-dimensional (3D) volume data, and the lesions are evaluated using multiplanar reconstruction (MPR) images after scanning. Therefore, it was thought that this method might also have the potential for evaluating tumor extent in patients with breast cancer.

The aim of this study was to determine the accuracy of measuring preoperative cancer extent by automated breast US.

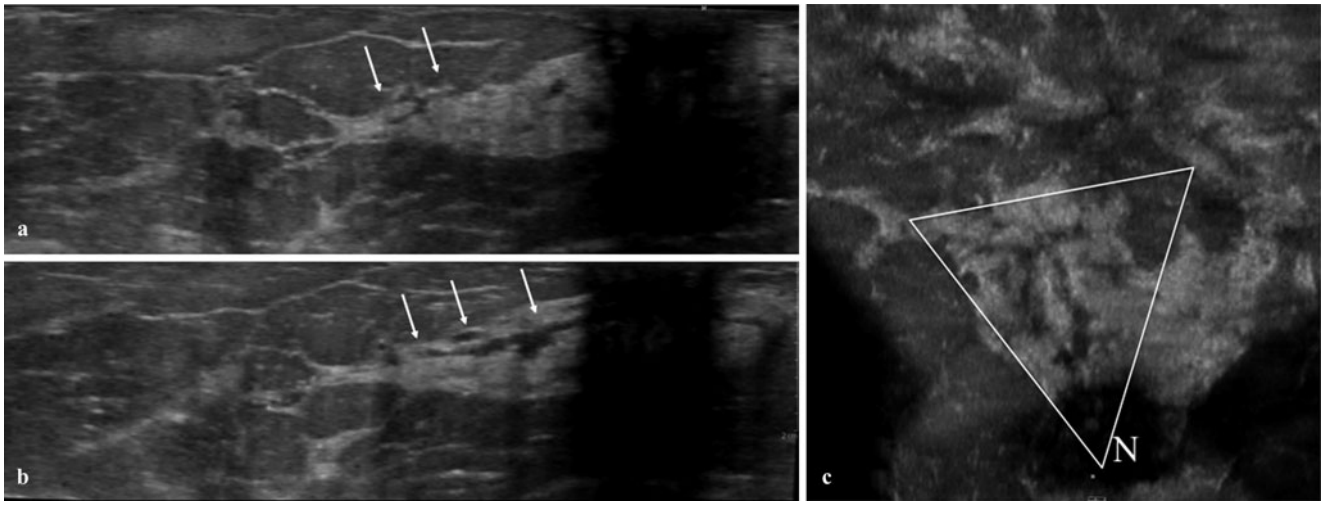

Fig. 1. A 39-year-old woman had invasive ductal carcinoma with an extensive intraductal component. **A** Axial reconstruction image of automated ultrasonography (US) shows arborization of the ducts (*arrows*) in the upper-outer quadrant of the right breast. **B** Axial reconstruction image of automated US shows ductal extension (*arrows*) in the subareolar area. **C** Coronal reconstruction image of automated US shows arborization of the ducts in the upper-outer quadrant of the right breast. *N*, nipple. The tumor extent was recognized as segmental distribution (*triangle*). Quadrantectomy specimens revealed an invasive ductal carcinoma measuring 5 mm in diameter with a surrounding extensive intraductal component

Materials and methods

Patients

This retrospective study was conducted with the approval by the institutional review board. From January 2010 to April 2010, automated breast US was performed in 40 consecutive patients (ages 31–76 years; mean 54 years) with pathologically proven breast cancer.

Automated breast US

Automated breast US was performed using the ABVS, which consists of the ABVS module with the core components of flexible arms, touch screen monitor, and scanner (transducer, scan box, and screen-membrane for contact). ABVS acquires 15.4 × 16.8 × maximum 6 cm volume data sets of breast automatically, in one sweep, with a wide-aperture linear array transducer (5- to 14-MHz bandwidth) that utilizes Siemens' proprietary Hanafy lens technology. For the ABVS scanning, customized presets were used to optimize the depth, gain, frequency, and view.

Automated breast US was performed on the day before the surgery. One radiologist and one radiographer obtained one or two views of the affected breast. In this study, the typical scanning time of ABVS was 60 s per scan, and the system captured the volume data at slice intervals of 0.5 mm. The scanning direction was from the periphery of the mammary gland to the nipple; the procedure was stopped after the nipple was scanned completely. After 3D volume data acquisition, the data were automatically sent from the ACUSON S2000 ABVS to the ACUSON S2000 ABVS workstation and reviewed in multiple orientations using an MPR display.

Data evaluation

In the interpretation of automated breast US, ductal dilatation radiating from the main tumor,[2,3] ductal extension, or arborization[5] was regarded as positive for intraductal carcinoma (Fig. 1). All 3D volume data were evaluated by a radiologist with 17 years of experience in breast US who was unaware of the mammographic and hand-held US findings. The maximum sizes of the lesions on US were measured on coronal MPR images using the ACUSON S2000 ABVS workstation (Fig. 1).

At our institution, tumors are usually resected with a 2-cm surgical margin. The tumor specimens after breast-conserving surgery were sliced into contiguous 5-mm sections. Cases with cancer foci at the margin were classified as showing a positive surgical margin. Histopathological measurement of tumor size included not only the invasive foci but also the in situ component and was used as the gold standard. The largest dimension of the tumor was taken as that perpendicular to the plane of the section of the specimen. The discrepancy of the tumor extent between automated breast US and the histological examination was calculated.

Results

Mastectomy was performed in 16 patients and breast-conserving surgery in the remaining 24. There was no case with a positive surgical margin. The histopathological diagnosis was ductal carcinoma in situ (DCIS) in seven patients and invasive ductal carcinoma in 33 patients (18 without an intraductal component, 15 with an intraductal component). Lesions ranged in diameter from 4 to 65 mm (mean 16 mm).

Automated breast US enabled visualization of the breast carcinomas in all patients. The mean size of the lesions on US was 12 mm (range 4–62 mm). The accuracy of determining tumor extent with a deviation in length of <2 cm was 98% (39/40). In one case, the tumor extent was underestimated by >2 cm in length, and the mastectomy specimen revealed scattered intraductal components.

Discussion

Recently, an automated breast US system with a high-resolution (8 MHz) transducer has been introduced.[6] Wenkel et al.[6] demonstrated the possibility of using it in the clinical setting for patients with breast lesions. The ABVS with a higher-resolution (14 MHz) transducer was subsequently developed. These systems are designed to examine patients in the supine position. The probe is moved in a straight line, and a certain level of compression is required to scan the breast. The advantages of automated US are not only that it performs automated scanning of the breast, it allows evaluation of US images using a dedicated workstation after scanning.

Hand-held breast US has the potential for detecting intraductal carcinoma[2,3,5] and is expected to be useful for planning breast-conserving surgery. However, one of the disadvantages of hand-held breast US is that evaluation of the breast cancer extent is not easy. In particular, it is difficult to apprise the surgeons of the presence of widespread intraductal components and of the precise locations of such components. Under this circumstance, we examined the breast cancer extent using automated US. Our results showed that the accuracy of determining tumor extent with a deviation in length of <2 cm was 98% (39/40).

Thus, using the 3D volume data obtained by automated US, tumor extent can be assessed accurately. In addition, coronal MPR images are thought to be useful for surgeons because the ABVS is designed to scan patients in the supine position. Automated US, which was originally designed for breast cancer screening, appears to have a potential role in planning breast-conserving surgery.

Conclusion

Automated breast US is thought to be useful for evaluating tumor extent. Further investigation is needed to assess the diagnostic performance of automated breast US in comparison with that of conventional hand-held US.

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