

Automated Breast Volume Scanning Versus Conventional Ultrasound in Breast Cancer Screening

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Rationale and Objectives: To assess the diagnostic value of automated breast volume scanning (ABVS) versus conventional ultrasound (US) in breast cancer screening.

Materials and Methods: This study retrospectively analyzed the ABVS and US images from 200 women who underwent breast examination and were recommended for biopsy in our health management centers between July 22, 2011, and October 20, 2013. We retrospectively assessed whether breast lesions from 200 women, which were detected and classified by US, could be detected and classified by an independent examiner using only ABVS findings. The sensitivity and specificity of ABVS versus US in determining lesion malignancy were calculated using biopsy as the gold standard.

Results: In the 200 cases, 273 and 194 individual lesions were detected by ABVS and US, respectively. All 194 US-detected lesions were detected by ABVS. Pathologic examination determined that, of the 273 total lesions, 251 lesions were benign and 22 lesions were malignant. US detected 21 of the 22 malignant lesions and ABVS detected all 22 malignant lesions. The sensitivity and specificity of ABVS relative to biopsy (gold standard) were 28.95% and 100%, whereas the sensitivity and specificity of US relative to biopsy were 43.06% and 98.36%.

Conclusions: US displays superior sensitivity to ABVS across all Breast Imaging Reporting and Data System (BI-RADS) density categories while displaying equivalent specificity with the exception of BI-RADS density category 1, in which ABVS displayed a slightly superior specificity. As ABVS possesses several advantages and limitations with respect to US, ABVS may serve as an effective, adjunct, screening tool to mammography and conventional sonography.

Key Words: Automated breast volume scanning; ultrasound; breast cancer.

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Mammography has long been the mainstay of breast cancer detection and is the only screening test proven to reduce mortality (1). Although mammography remains the gold standard of breast cancer screening, mammography has limitations. First, the sensitivity of mammography is decreased in dense breasts (2,3). Second, mammography displays high false-positive rates, resulting in high callback rates and unnecessary biopsies that increase cost, radiation dose, and patient anxiety (4). Third, mammographic radiation exposure may contribute to an increased incidence of breast cancer in high-risk populations (4). These concerns may decrease compliance with breast cancer screening recommendations.

As mammographic sensitivity is adversely affected by dense breast tissue, mammography is not particularly suited to women whose breasts are typically more dense (2,3). Breast ultrasound (US) has been shown to be an effective adjunct imaging modality in the evaluation of women with dense breast tissue (American College of Radiology's Breast Imaging Reporting and Data System criteria [ACR BI-RADS] density categories 3 and 4), and mammography combined with US can increase tumor detection rates over mammography alone (5–7). However, conventional breast US has provided little practical benefit in cancer detection because of the poor conspicuity of some cancers, the significant operator time and experience necessary for a high-quality screening, and the lack of standardization due to variability in operator skill and experience (8). Thus, other sonographic methods that adequately address these limitations are needed.

Although it has not yet been established as a routine screening modality, bilateral whole breast US has demonstrated diagnostic advantages over conventional US in screening asymptomatic women (9). In this study, we aimed to comparatively evaluate the latest technical advance in bilateral whole breast US—the Automated Breast Volume Scanner (ABVS) that acquires a series of consecutive B-mode pictures

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and reconstructs three-dimensional (3D) data sets of the entire breast volume (10)—against conventional breast US. Specifically, we retrospectively assessed whether breast lesions from 200 women, which were detected and classified by US, could be detected and classified by an independent examiner using only ABVS findings. The sensitivity and specificity of ABVS versus US in determining lesion malignancy were calculated using biopsy as the gold standard.

MATERIALS AND METHODS

Subject Selection

We randomly selected 200 cases matching the following criteria: 1) aged 18 years or older, 2) underwent routine breast examination during the period spanning July 22, 2011, to October 20, 2013, 3) underwent US, 4) underwent ABVS, and 5) underwent biopsy for histopathologic assessment of detected breast lesions.

Acquisition of US Data

All US examinations were performed by licensed physicians with at least 5 years of US operating experience. Baseline US examinations were performed using the ACUSON S2000 system with the integrated Siemens 14L5 linear transducer (5–14 MHz; Siemens Medical Solutions, Inc., Mountain View, CA). ABVS was performed using the ACUSON S2000 Automated Breast Volume Scanner with an integrated Siemens 14L5BV linear transducer (14 MHz; Siemens Medical Solutions, Inc.).

For the US examination, the patient was placed in the supine position (and the hemisupine position when necessary) with both arms elevated above the head to fully expose both breasts. First, the US 14L5 probe was applied to both breasts for routine US scanning. All US examinations were performed with the US probe oriented perpendicular to the chest wall. If a suspicious lesion was detected during the US examination, the color Doppler sampling frame was placed over the region of interest to observe the distribution of blood flow signals. If the region of interest was found to possess a more stable flow signal, the arterial blood flow velocity and resistive index were assessed. During each examination, all necessary B-mode pictures were obtained according to the diagnostic standards. The US examiner assigned the lesions a category according to the ACR BI-RADS US system (0, incomplete; 1, negative; 2, benign finding(s); 3, probably benign; 4A, low suspicion for malignancy; 4B, intermediate suspicion of malignancy; 4C, moderate concern, but not classic for malignancy; and 5, highly suggestive of malignancy). All US images were digitally recorded.

Acquisition of ABVS Data

All ABVS examinations were performed by licensed physicians with at least 3 years of ABVS operating experience. For the ABVS examination, the patient was placed in the

same positions as for the HHUS. We switched to the ABVS 14L5BV probe after setting the appropriate scanning parameters. The standardized scanning technique used in this study has been described elsewhere (11). Depending on the breast size, the examiner chose the number of scans to be taken from each side. Smaller breasts could be fully displayed by performing medial and lateral volume scans. Larger breasts required additional views (eg, a separate view of the apex and axillary process).

Independent Blinded Interpretation of ABVS Data

The independent blinded interpretation of the ABVS data sets was performed by licensed radiologists with at least 3 years of ABVS film-reading experience that specializes in reading ABVS films. The ABVS reader exclusively analyzed the 3D data sets without prior knowledge of the patients' histories, clinical findings, or results of the other imaging modalities. The ABVS reader was able to use a variety of tools for image manipulation, including the standard views (axial, sagittal, coronal, radial, and antiradial); user-defined views; rotation around x, y, and z axes; free rotation around any point of interest; a magnifier and interactive zoom; marking and annotation of areas of interest; and the generation of snapshots.

The ABVS reader used the following standard procedure to analyze the ABVS data sets as previously described. First, the whole volume was analyzed in the coronal plane moving slowly from the skin to the chest wall. Lesions were reviewed for morphologic (including size, shape, and borders) and sonographic (including echogenicity, cystic areas, and calcification) characteristics. Suspicious lesions were marked with the system's default tool. In the next step, all lesions were evaluated by generally reexamining them in the sagittal and axial planes (and optionally in any other plane), using adequate magnification, brightness, and contrast. The ABVS reader moved through the whole volume in the sagittal and axial planes to potentially detect additional lesions that were not seen in the coronal plane. The ABVS reader assigned the lesions a category according to the ACR BI-RADS US system (0, incomplete; 1, negative; 2, benign finding(s); 3, probably benign; 4A, low suspicion for malignancy; 4B, intermediate suspicion of malignancy; 4C, moderate concern, but not classic for malignancy; and 5, highly suggestive of malignancy).

Biopsy (Gold Standard)

All 200 cases underwent biopsy for histopathologic assessment of the breast lesions, which serves as the diagnostic gold standard. Depending on the specific case, biopsy was performed via US-guided, vacuum-assisted, core needle biopsy (Mammotome biopsy) or surgical excision.

Statistical Analysis

The software package SPSS Statistics version 17.0 (SPSS, Inc., Chicago, IL) was used for the statistical analysis. The

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