Clinical Utility of Automated Breast ultrasonography in detecting and diagnosing breast lesions compared to handheld ultrasonography

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Aims and objectives

Ultrasonography (US) is introduced as a useful method in the diagnosis of breast disease in addition to mammography, especially in young patients with dense breasts\textsuperscript{1-5}. Hand-held ultrasonography (HHUS) is operator dependent and non-reproducible. Recently, Automated breast US with high-resolution transducer is one method to improve on the weak points of HHUS. Although many studies have demonstrated that it shows similar diagnostic performance compared with HHUS, various results came out. So, further studies are required to support the use of automated breast US in clinical setting}\textsuperscript{5-11}.

In this study, we collected patients scheduled to take biopsies and then, prospectively underwent the automated breast US for that patients. These collected patients were composed of both asymptomatic screening patients and symptomatic patients as the same situation of daily clinical setting. For comparing the detection rates and diagnostic performances of two US system, we evaluated images of HHUS and automated breast US for these pathologically confirmed breast lesions.
Methods and materials

Patients

Between March and August of 2012, automated breast US images were obtained in 173 consecutive patients who were scheduled to undergo US-guided or stereotactic biopsy for the breast lesions. A total of 206 lesions were included and the patients, aged 20-80 (mean age: 48 years). All are underwent both hand-held US and mammography examinations before automated breast US and were set to be taken biopsies.

US examinations

Automated breast US images were obtained using an ACUSON S2000 Automated Breast Volume Scanner (ABVS; Siemens Medical Solutions, Mountain View, CA, USA) by a single trained radiographer. The ABVS acquired 15.4 x 16.8 x maximum 6 cm volume data sets of the breast in one sweep with a 5-14 MHz wide-aperture linear probe. The breast was initially scanned in the anterior-posterior view with the patient in the supine position. The lateral and medial views were then scanned with the patient in the oblique positions. After the acquisition, the data were automatically sent from the ACUSON S2000 ABVS to the workstation and were reviewed in multiple orientations using an MPR display. The scan thickness was displayed at intervals of 1 mm without overlap.

The HHUS examinations were randomly performed by several radiologists with more than 4 years of experience in breast imaging, using a 7-15 MHz linear transducer (iU22 Ultrasound System, Philips Ultrasound, Bothell, WA, USA) and a 6-14 MHz linear transducer (EUB-8500 scanner, Hitachi Medical, Tokyo, Japan).

Imaging assessments

Three radiologists with more than 6 years of experience in breast imaging participated in assessing imaging data of this study.

Two radiologists who did not know the results of the HHUS, reviewed the images from the automated breast US after examining mammography.

The third radiologist who also did not know the results of the HHUS, automated breast US or pathology, reviewed the HHUS independently after checking the mammographic imaging. This third radiologist then evaluated whether the biopsied lesions were detected on HHUS and/or ABVS. If the lesions were detected by at least one radiologist, it was thought to be identified. If neither radiologist found the lesion, that lesion was not identified as discovered by automated breast US.

Statistical analysis
Demographic data about patients are presented as the mean ± SD or n (%). We compared the detection rates between ABVS and HHUS using a chi-squared test. The agreements between the two ABVS readers were examined using the coefficient for inter-rater agreement (Cohen kappa). The sensitivity, specificity, accuracy, positive predictive value, and negative predictive value for ABVS performed by the two readers and for HHUS were calculated as the reference of the histopathologic results. Receiver operating characteristic (ROC) analysis was performed, and the area under the curve (AUC) was assessed to compare the diagnostic performance of ABVS with HHUS. The diagnostic parameters of the HHUS and of each reader of the ABVS were compared using the chi-squared test or Fisher’s exact test.

In addition, we used simple logistic regression to test the association between risk factors and detection for ABVS of the two readers combined. We considered a two-sided p-value<0.05 to be statistically significant. All the statistical analyses were performed using SAS 9.2 software (SAS Institute, Inc., Cary, NC).
Results

Of the 206 lesions, 46 lesions were malignant, and 160 were benign.

All the 194 lesions (94.2%) detected by HHUS, and 171 lesions (83.0%) were detected by ABVS. Of these lesions, 169 lesions were visible on both HHUS and ABVS. The 2 lesions, only observed on ABVS, were biopsied and the results were benign. The 25 lesions that were only observed on HHUS were also benign lesions. One malignancy that was detected on neither ABVS nor HHUS was microcalcifications without a mass. Its biopsy result was DCIS.

Detection on ABVS was more frequent for large lesions. The more malignant features the lesions contained (BI-RADS category 4, 5), the more frequently they were detected on automated breast US (Fig 1-3).

<table>
<thead>
<tr>
<th>HHUS features</th>
<th>ABVS</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No detection</td>
<td>detection</td>
</tr>
<tr>
<td>(n=35)</td>
<td>(n=171)</td>
<td></td>
</tr>
<tr>
<td>Lesion extent (cm)</td>
<td>0.96±0.40</td>
<td>1.52±1.23</td>
</tr>
<tr>
<td>Shape</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oval</td>
<td>14 (58.3)</td>
<td>95 (56.5)</td>
</tr>
<tr>
<td>Round</td>
<td>0</td>
<td>7 (4.2)</td>
</tr>
<tr>
<td>irregular</td>
<td>10 (41.7)</td>
<td>66 (39.3)</td>
</tr>
<tr>
<td>Orientation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parallel</td>
<td>23 (95.8)</td>
<td>7 (4.0)</td>
</tr>
<tr>
<td>Non parallel</td>
<td>1 (4.2)</td>
<td>149 (88.7)</td>
</tr>
<tr>
<td>Margins</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Circumscribed</td>
<td>14 (58.3)</td>
<td>88 (52.4)</td>
</tr>
<tr>
<td>Indistinct</td>
<td>9 (37.5)</td>
<td>40 (23.8)</td>
</tr>
<tr>
<td>Microlobulated</td>
<td>1 (7.2)</td>
<td>18 (10.7)</td>
</tr>
<tr>
<td>Angular</td>
<td>0</td>
<td>10 (6.0)</td>
</tr>
</tbody>
</table>
The sensitivity and positive predictive value of ABVS reader 2 showed statistically significant difference as compared with HHUS. The specificity and accuracy of both readers' ABVS were statistically higher than HHUS. In addition, the area under the receiver operating characteristic curve (AUC) of ABVS was superior to HHUS in both readers. The diagnostic performance between the two readers of automated breast US was not statistically significantly different.
<table>
<thead>
<tr>
<th></th>
<th>(95%CI)</th>
<th>(85.16-99.47)</th>
<th>(85.16-99.47)</th>
<th>(66.09-90.64)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specificity</td>
<td>49.4 (41.39-57.38)</td>
<td>70.6 (62.92-77.55)</td>
<td>&lt;.0001</td>
<td>81.9 (75.02-87.51)</td>
</tr>
<tr>
<td>PPV</td>
<td>35.2 (26.83-43.57)</td>
<td>48.4 (38.08-58.62)</td>
<td>0.0681</td>
<td>56.1 (44.09-68.03)</td>
</tr>
<tr>
<td>NPV</td>
<td>97.5 (91.36-99.70)</td>
<td>98.3 (93.86-99.79)</td>
<td>&gt;.9999</td>
<td>93.6 (88.15-97.02)</td>
</tr>
<tr>
<td>Accuracy</td>
<td>59.7 (53.01-66.41)</td>
<td>76.2 (70.40-82.03)</td>
<td>0.0003</td>
<td>81.6 (76.26-86.85)</td>
</tr>
<tr>
<td>AUC</td>
<td>0.73 (0.68-0.77)</td>
<td>0.83 (0.79-0.88)</td>
<td>&lt;.0001</td>
<td>0.81 (0.75-0.88)</td>
</tr>
</tbody>
</table>
Images for this section:

Fig. 1: ABVS(A) and HHUS(B) images of an about 1.8cm sized irregular hypoechoic lesion in right breast, periareolar region. Transverse plane of ABVS(A, upper) looked similar with HHUS (B). On coronal plane image of ABVS (A, lower left) showed radial folds representing the retraction phenomenon. This lesion was biopsied and confirmed as malignancy, invasive ductal carcinoma.

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Fig. 2: ABVS(A) and HHUS(B) images of an about 1.0cm sized small irregular hypoechoic lesion in right breast. Transverse plane of ABVS(A, upper) looked more prominent as compared with HHUS (B). In spite of its small size, coronal plane image of ABVS (A, lower left) showed the retraction phenomenon. This lesion was confirmed as invasive ductal carcinoma.

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Fig. 3: An about 1.9cm sized, biopsy-confirmed fibroadenoma in right breast, upper outer quadrant. This lesion was presented as an oval, circumscribed, parallel-oriented mass on both ABVS (A) and HHUS (B). On coronal plane image of ABVS (A, lower left) showed no surrounding parenchymal change. This lesion was categorized as probably benign lesion on both ABVS and HHUS according to the BI-RADS system.

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Conclusion

In our study which all analytic lesions were pathologically confirmed, the diagnostic performance of ABVS was significantly higher than HHUS, especially with respect to specificity. All the malignant lesions observed on HHUS could be recognized on ABVS, although some small benign lesions were missed. The larger the size and the higher the BI-RADS category (higher than category 4) of the lesion, the higher the detection rate was on ABVS. With several supplements, the automated breast volume scanner will be a promising diagnostic tool to replace the HHUS.
Personal information

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References


