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# Differentiation of benign and malignant breast lesions: A comparison between automatically generated breast volume scans and handheld ultrasound examinations

Hong-Yan Wang[a], Yu-Xin Jiang[a,*], Qing-Li Zhu[a], Jing Zhang[a], Qing Dai[a], He Liu[a], Xing-Jian Lai[a], Qiang Sun[b]

[a] Department of Diagnostic Ultrasound, Peking Union Medical College Hospital, Chinese Academy of Medical Sciences, Beijing, China
[b] Department of Breast Surgery, Peking Union Medical College Hospital, Chinese Academy of Medical Sciences, Beijing, China

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ABSTRACT

*Objective:* To assess the diagnostic value of automated breast volume scanning (ABVS) or conventional handheld ultrasonography (HHUS) for the differentiation of benign and malignant breast lesions.
*Materials and methods:* The study prospectively evaluated 239 lesions in 213 women who were scheduled for open biopsy. The patients underwent ABVS and conventional HHUS. The sensitivity, specificity, accuracy, false positive rate, false negative rate, and positive and negative predictive values for HHUS and ABVS images were calculated using histopathological examination as the gold standard. Additionally, diagnostic accuracy was further evaluated according to the size of the masses.
*Results:* Among the 239 breast lesions studied, pathology revealed 85 (35.6%) malignant lesions and 154 (64.4%) benign lesions. ABVS was similar to HHUS in terms of sensitivity (95.3% vs. 90.6%), specificity (80.5% vs. 82.5%), accuracy (85.8% vs. 85.3%), positive predictive value (73.0% vs. 74.0%), and negative predictive value (93.3% vs. 94.1%). The area under the receiver operating characteristic (ROC) curve, which is used to estimate the accuracy of the methods, demonstrated only minor differences between HHUS and ABVS (0.928 and 0.948, respectively).
*Conclusions:* The diagnostic accuracy of HHUS and ABVS in differentiating benign from malignant breast lesions is almost identical. However, ABVS can offer new diagnostic information. ABVS may help to distinguish between real lesions and inhomogeneous areas, find small lesions, and demonstrate the presence of intraductal lesions. This technique is feasible for clinical applications and is a promising new technique in breast imaging.



## 1. Introduction

The detection and treatment of breast cancer at an early stage has been shown to improve outcomes and reduce morbidity. Therefore, early detection is an important goal for radiologists and surgeons. Mammography is accepted as the only means of reducing breast cancer mortality. However, the reduced sensitivity of mammographic screening for dense breasts and women younger than 50 years of age remains a major limitation [1]. Therefore, there is a demand for advanced breast imaging methods to supplement mammography [2].

Ultrasonography (US) has emerged as the most important adjunct to mammography for diagnosing breast disease [3]. Most radiologists performing breast US now use handheld systems to image symptomatic lumps and predict the nature of indeterminate masses discovered through mammography [4]. Several advantages of handheld US are widely recognized; for instance, it allows real-time imaging, is relatively inexpensive, and is well tolerated by patients [3]. However, it has some disadvantages because it is operator-dependent and therefore suffers from a lack of reproducibility. In contrast to mammography, the lack of standardization of sonographic documentation prevents the possibility of a second evaluation [2,5]. Therefore, automated three-dimensional (3D) ultrasound was developed [6]. Initially, this method did not play an important role in diagnostics because of its inferior sensitivity for small solid lesions with low-frequency transducers (3.9–4.5 MHz).

* Corresponding author at: Department of Diagnostic Ultrasound, Peking Union Medical College Hospital, Chinese Academy Medical Sciences, No. 1 Shuai Fu Yuan, Dong Cheng District, Beijing 100730, China. Tel.: +86 10 65295491; fax: +86 10 65295402.
*E-mail address:* yuxinjiangxh@126.com (Y.-X. Jiang).

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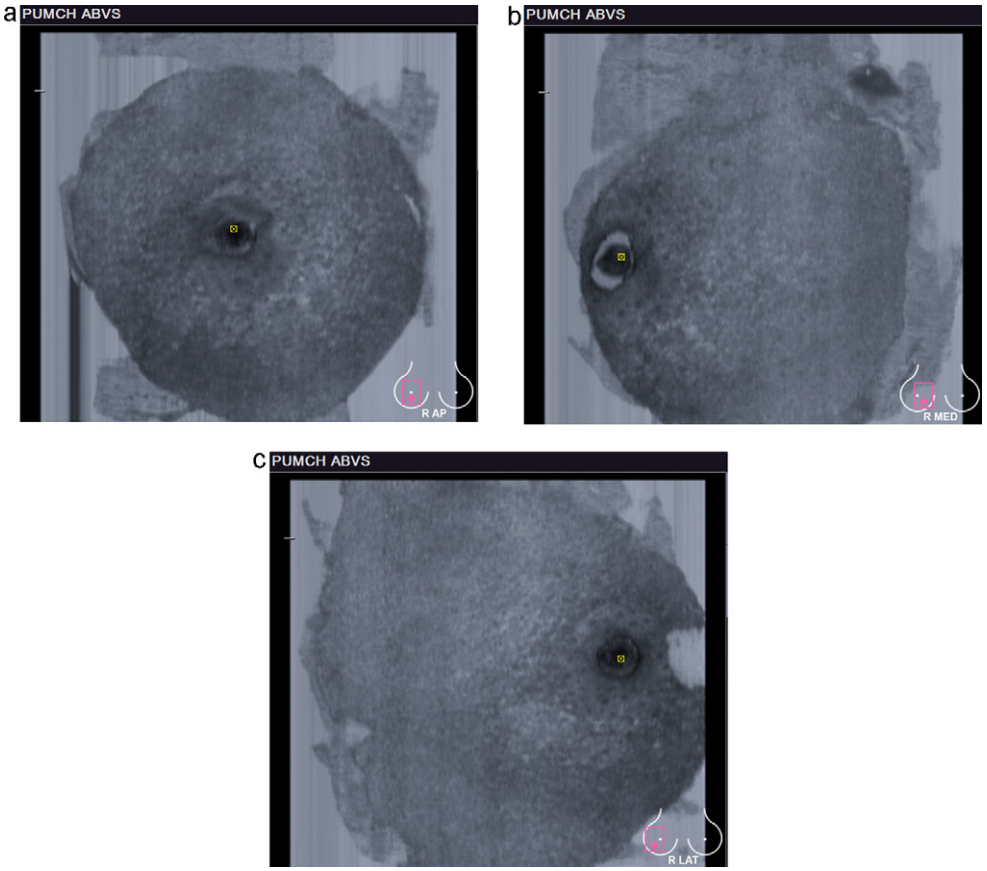


**Fig. 1.** The regular ultrasound appearance of human breast tissue on automatic breast volume scanning: anterior–posterior view (AP), medial view (MED) and lateral view (LAT).

Additionally, it involved an uncomfortable examination technique that required immersion of the patients' breasts in water [7]. Recently, an automated breast US system with a high-resolution (12 MHz) transducer was introduced. However, the challenge with this new system is the acquisition of complete coverage of the breast, with a particular focus on covering parts of the lesions [3,8]. Recently, an automated breast volume scanner (ABVS), which is a high-end ultrasound scanner that is operator independent, was developed to cover the whole breast [6].

However, the diagnostic value of this new technique was not fully discussed in previous studies because they had relatively small patient populations that were enriched for cancer patients [1,4,8,9]. Therefore, further studies are needed to examine the diagnostic accuracy of this new technique in a larger number of patients.

Thus, the purpose of our study was to assess the diagnostic value of an ABVS in comparison to handheld ultrasonography (HHUS) for differentiating between benign and malignant breast lesions.

## 2. Materials and methods

### 2.1. Patients

We prospectively evaluated 239 lesions in 213 women (age range 11–81 years, average 43.0 ± 12.5 years) who were scheduled for open biopsy at Peking Union Medical College Hospital between August 2010 and December 2010. For inclusion in the study, the lesions had to be morphologically classified as solid tumors or complex cysts and have a margin of normal tissue. Histopathological examination based upon excisional biopsy confirmed the presence of 239 lesions. The institutional review board approved the study, and all patients provided informed consent for the study.

### 2.2. Conventional hand-held ultrasound (HHUS)

HHUS was performed using a GE LOGIQ 7 ultrasound system (GE Healthcare, Milwaukee, WI, USA) with an M10L probe and a ACUSON S2000 (Siemens Medical Solutions, Mountain View, CA, USA) 18L6 probe. The breasts were examined in overlapping anti-radial scans (perpendicular to the ducts) and duct parallel (mammillo-radial) scans. All examinations were performed by a single radiologist (H.Y.W.), who has performed breast US for 8 years. The radiologist was blinded to the final pathological diagnosis. The radiologist documented the images for each detected lesion and described the locations and features of the lesions according to the American College of Radiology Breast Imaging Reporting and Data System (ACR BI-RADS) final assessments. After the conventional HHUS examination, 213 patients underwent ABVS examination according to the following procedure.

### 2.3. ABVS

Automated breast US was performed using the ACUSON S2000 automated breast volume scanner (Siemens Medical Solutions, Mountain View, CA, USA) ultrasound system. AVBS is a high-end ultrasound scanner that employs frequencies of 5–14 MHz and consists of a flexible arm with the transducer at the end, a touchscreen and a 3D workstation. ABVS automatically acquires 15.4 cm × 16.8 cm × 6 cm volume data sets of breasts after one sweep with a wide-aperture linear array transducer (5–14 MHz bandwidth). The scan is performed with the patient in a supine position. Depending on the breast size (A–D and DD cups), various preselected settings are available, and the examiner may select the most appropriate. The system automatically adjusts the