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Analysis of eighty-one cases with breast lesions using automated breast volume scanner and comparison with handheld ultrasound

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ABSTRACT

Objectives: This study aims to evaluate the clinical utility of automated breast volume scanner (ABVS) against handheld ultrasound in detecting and diagnosing breast lesions.
Methods: Eighty-one patients were subjected to both automated breast volume scanner and handheld ultrasound examination in the supine position. The number of lesions detected and the average scanning time (both device-specific and user-specific) for each device were compared. The diagnostic accuracy, sensitivity and specificity were calculated for each method. The maximum diameters of the lesions based on handheld ultrasound and ABVS were compared with the final pathological sizes.
Results: Of the 81 patients, both automated breast volume scanner and handheld ultrasound detected 95 breast lesions. Compared with the pathological diagnosis in 35 lesions, both ABVS and handheld ultrasound exhibited high sensitivity (both 100%) and high specificity (95.0%, and 85.0%, respectively). In addition, ABVS had a higher diagnostic accuracy (97.1%) than handheld ultrasound (91.4%) for breast neoplasms. More importantly, ABVS was capable of displaying the retraction phenomenon in coronal plane. All the invasive ductal carcinomas (12 lesions) presented the retraction phenomenon. In contrast, intraductal carcinomas (3 lesions) and benign lesions did not display such features. Thus, retraction phenomenon had a high specificity (100.0%) and high sensitivity (80.0%) in detecting breast cancer while it also had high accuracy (91.4%) in determining malignant from benign lesions. There was no significant difference in maximum diameters of pathology, 2D and ABVS ($p > 0.05$), however the correlation coefficient revealed that ABVS had better correlation with pathology ($r = 0.616$) than 2D ($r = 0.468$). The user scanning time for the ABVS demonstrated no difference between two examiners (11.7 ± 1.3 min and 12.1 ± 1.4 min; $p > 0.05$). However, device-specific scanning time was longer for ABVS than handheld ultrasound (11.9 ± 1.4 min vs. 6.8 ± 1.1 min, respectively; $p < 0.01$).
Conclusions: Automated breast volume scanner provides advantages of high diagnostic accuracy, better lesion size prediction, operator-independence and visualization of the whole breast. It is a promising modality in breast imaging.

1. Introduction

Handheld ultrasound is an operator-dependent examination for lesion detection and diagnosis. The knowledge and experience of the operator who controls the ultrasound transducer and characterizes a breast lesion will ultimately affect the accuracy of the diagnosis. Furthermore, it is difficult to localize a two-dimensional (2D) image plane and reproduce the same image plane at the same location later down the track [1]. Therefore automated three-dimensional (3D) ultrasound was developed. Due to its digital character, each sectional plane of the saved volume can be visualized, thereby avoiding the investigator-dependence and non-standardized documentation. In addition, the generated coronal plane, which cannot be generated by 2D ultrasound, offers new diagnostic information. Initially, the frequencies used by 3D ultrasonic transducer were in the range of 3.9–4.5 MHz and the detectability of lesions was unsatisfactory [2–4]. More recently, automated breast ultrasound systems with higher frequency probe have been introduced with detectability and image quality of breast lesions scanner significantly improved [5,6]. However, the main limitation of these systems was the coverage of the breast due to the small field of view (5 cm^2), leading to incomplete coverage of lesions [6,7]. Nowadays an automated breast volume scanner (ABVS) which is operator independent system has been developed

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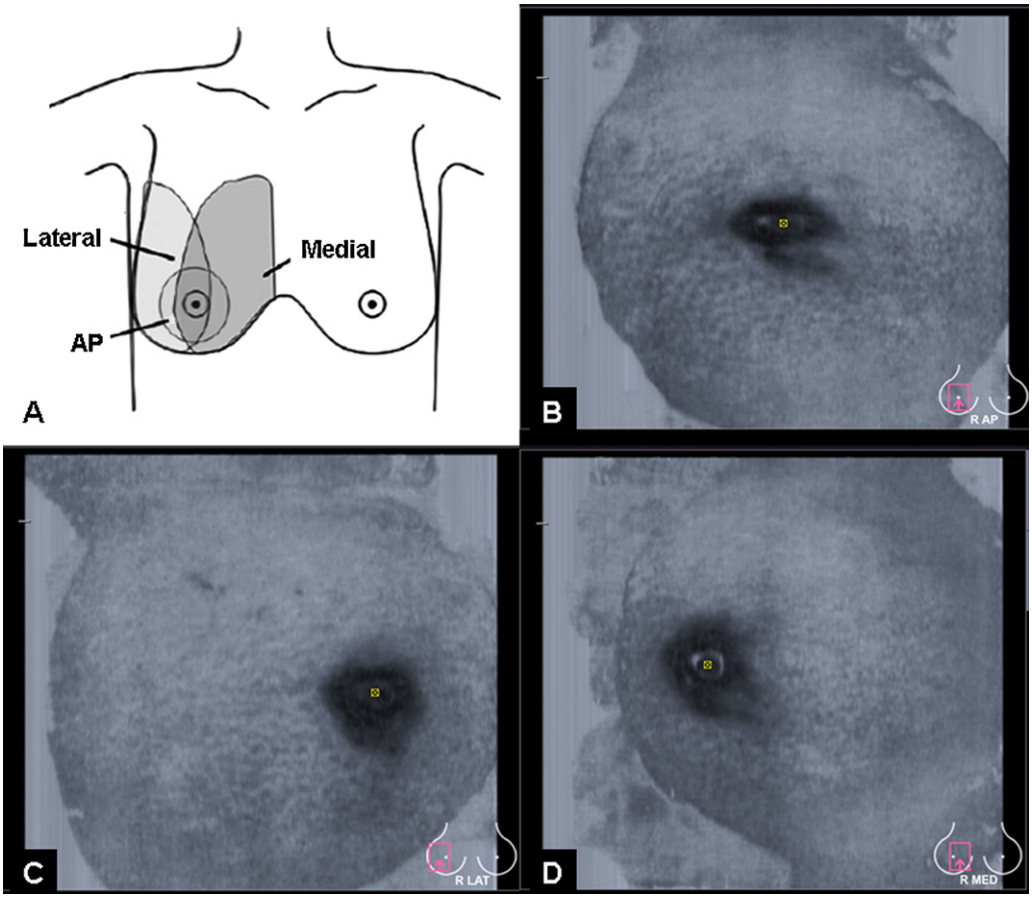

Fig. 1. The whole breast scanning by ABVS including three views: (A) scheme of three breast scanning views (AP: anterior posterior), (B) anterior posterior view, (C) lateral view and (D) medial view.

to cover the whole breast. The purpose of this study was to evaluate the clinical utility of ABVS in the detection and diagnosis of breast lesion in comparison to handheld ultrasound.

2. Materials and methods

This study had been approved by the ethics committee of Sun Yat-Sen University Cancer Center. All patients were given informed consent before ultrasound examination.

Eighty-one patients (in July 2010) who had a clinical reason to undergo sonography – either breast pain, unusual findings on palpation or preoperative diagnosis were recruited. These patients (78 females and 3 males; age 16–78 years; mean 40.7 years) underwent handheld ultrasound and ABVS in the supine position. Thirty-four cases (35 lesions) were confirmed by histopathology. Nine patients were proved by core biopsy. The others had undergone the operations. The locations of the lesions were displayed in Table 1.

Table 1
The location of the lesions.

Location	Benign	Malignant
Upper outer quadrant	6	10
Lower outer quadrant	5	3
Upper inner quadrant	4	1
Lower inner quadrant	1	0
Inframammillary	3	1
Axillary tail	1	0

2.1. Handheld ultrasound

The handheld ultrasound examination was performed by a specialized practitioner with 8 years' experience in breast ultrasound using the ACUSON S2000 ultrasound system (Siemens Medical Solutions, Mountain View, CA, USA). Images were obtained using an 18L6HD linear array transducer at 10 MHz grayscale central frequency. Four segments of each breast were scanned and suspected regions were imaged in two perpendicular scanning planes (sagittal and axial). All images were stored on an offline workstation for review and analysis. The scanning time was recorded.

2.2. Automated ultrasound

ABVS was performed in all the patients after handheld ultrasound by two technologists with 10 years' (examiner A), or 7 years' (examiner B) experience in ultrasound. The total scanning time for the automated breast ultrasound examination was recorded. Automated breast ultrasound examination was carried out using the ACUSON S2000 automated Breast Volume Scanner (ABVS; Siemens Medical Solutions, Mountain View, CA, USA). ABVS acquires 15.4 cm × 16.8 cm × maximum 6.0 cm volume data sets of breast scans automatically in one sweep with a wide-aperture 14L5BV linear array transducer that utilizes Siemens' proprietary Hanafy lens technology. ABVS provides optimized settings (imaging presets) for volume acquisition based on the estimated size of the breast (A is smallest size; D+ is largest size). The system applies imaging parameters during acquisition based on the estimated size of the breast. The central frequency of transducer varied from 9 to 11 MHz. Scanning time of ABVS was 1 min per view, and volume