Original Article

Influence of Breast Density on Patient's Compliance during Ultrasound Examination: Conventional Handheld Breast Ultrasound Compared to Automated Breast Ultrasound

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Abstract

Background: Our aim was to study the influence of breast density on patient's compliance during conventional handheld breast ultrasound (US) or automated breast US (ABUS), which could be used as adjunct screening modalities. **Methods:** Between January 2019 and June 2019, 221 patients (mean age: 53; age range: 24–89 years) underwent both US and ABUS. All participants had independently interpreted US and ABUS regarding patient compliance. The diagnostic experience with US or ABUS was described with a modified testing morbidity index (TMI). The scale ranged from 0 (worst possible experience) to 5 (acceptable experience). Standard statistics was used to compare the data of US and data of ABUS. Breast density was recorded with the Breast Imaging Reporting and Data System (BI-RADS) score. **Results:** The mean TMI score was 4.6 ± 0.5 for US and 4.3 ± 0.8 for ABUS. The overall difference between patients' experience on US and ABUS was statistically significant with $P < 0.0001$. The difference between patients' experience on US and ABUS in women with BI-RADS C and D for breast density was statistically significant with $P < 0.02$ in favor of US (4.7 ± 0.4) versus 4.5 ± 0.6 for ABUS. Patients' experience with breast density B was better for US (4.7 ± 0.4) versus 4.3 ± 0.6 for ABUS with $P < 0.01$. Pain or discomfort occurred during testing, especially in patients >40 years. **Conclusion:** Patient age (>40 years) is a significant predictor of decreased compliance to ABUS. Compliance of ABUS resulted lower that of US independently for breast density.

Keywords: Automatic breast ultrasound, breast density, ultrasound

Introduction

Mammographic screening programs helped to reduce the mortality of patients with breast cancer in the last three decades around the world, but the performances of mammography are typically limited in women with dense breast.[1-3]

Radiologically, dense breasts are associated with decreased mammography sensitivity and increased risk of an interval cancer in screened women, and density is also an independent risk factor for breast cancer.[4-6]

Women with extremely dense breasts also have a 4.7-fold increased risk of developing breast cancer compared with women with fatty-replaced breasts.[6-9]

Various breast imaging modalities have been evaluated as an adjunct screening for women with mammography-dense breasts, such as breast ultrasound (US).[5,10]

US has no radiation, is fast, has high sensitivity and accuracy, and is relatively of low cost.[11]

However, US is much more operator dependent than mammography; reading US images requires well-trained and experienced radiologists and US has several false positives.[12,13]

A new generation of three-dimensional automated breast US (ABUS) was designed for potential use in breast cancer

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imaging with the goal to overcome some limitations of handheld US (HHUS).[14,15]

ABUS is a volumetric sonographic technique in which the whole breast volume is acquired, providing multiplanar reconstruction of the breast. The main advantage of ABUS over the standard HHUS is the standardized acquisition, with a decrease in both operator dependency and physician workload. In this technique, the moment of image acquisition is separated from image interpretation.[16]

Most of the research that has been done with ABUS showed promising results in screening, especially in women with dense breast tissue.[14,17]

Recently, many published research studies have also evaluated ABUS in the diagnostic setting such as breast cancer staging neoadjuvant chemotherapy and second look after magnetic resonance imaging.[17-19]

However, studies are currently lacking as to how patients perceive ABUS. there is no data on the effect on short-term quality of life[16,20] related to the ABUS procedure.

There have also been no studies evaluating the initial levels of anxiety, pain or discomfort, fear, and embarrassment of women presenting for ABUS and the influence of breast density on patient's compliance during US and ABUS.

No studies have also described the possible discomfort in women with extremely dense breast tissue due to compression for the correct execution of ABUS.

Our aim was to study the influence of breast density on patient's compliance during conventional breast HANDHELD US or ABUS, which could be used as adjunct screening modalities.

Materials and Methods

This research has been carried out in accordance with the standards set out in the Declaration of Helsinki for experiments involving humans. This research involving human subjects has been approved by the Regional Ethics Committee(102REG2016), and written informed consent was obtained from all the participating women.

From January to June 2019, 221 female patients (mean age: 53, age range: 24–89 years) were enrolled in a single-academic institutional, prospective comparative trial comparing digital breast tomosynthesis and US, who underwent both US and ABUS.

Asymptomatic or symptomatic women with heterogeneously dense or extremely dense breast (breast density B, C, or D in accordance with the American College of Radiology [ACR] Breast Imaging Reporting and Data System [BI-RADS] density assessment) were included in the study, in particular, B pattern represents scattered areas of fibroglandular density, C pattern represents heterogeneously dense tissue, and D pattern represents extremely dense breasts.

Patients underwent standard breast HHUS, followed by ABUS examination.

US was performed by three dedicated breast radiologists (experience range 7–20 years), and ABUS was performed by radiographers (experience range 15–25 years).

ABUS examinations were performed with ACUSON S2000 automated breast volume scanner systems (Siemens, Erlangen, Germany).

The examination was performed in the supine position with the ipsilateral arm above the head.

A hypoallergenic lotion and a disposable membrane were used to aid an acoustic coupling.

Each breast was examined in three different positions: (1) anteroposterior, (2) lateral including the pectoral muscle, and (3) medial.

In women with larger breasts, additional views were taken to avoid tissue exclusion.

This ABUS system acquires three-dimensional B-mode US volumes over an area of 154 mm × 156 mm using a mechanically driven linear array transducer (14 L5).

Adequate depth and focus can be obtained using predefined settings for different breast cup sizes. The number of acquisitions depends on the size of the breasts and the possibility to compress the breasts. Every acquisition included 318 slices of 0.5-mm thickness.[21]

Bilateral breast HHUS was performed at 10 MHz as the lowest maximum frequency of the transducer.

The diagnostic experience with US and ABUS was described using a modified testing morbidity index (TMI), which is a validated instrument for assessing short-term quality of life related to diagnostic testing. TMI was self-administered immediately after ABUS examination by three radiology residents with 6 and 4 months of experience in breast radiology.

The following attributes were assessed for both techniques: pain or discomfort before, during, and after the testing; anxiety or fear before and after testing; and embarrassment during testing.

The patients used a 5-point scale to report the level of attributes related to the procedure, where 1 = worst possible experience, 2 = severe problems, 3 = moderate problems, 4 = mild problems, and 5 = no problems but an acceptable experience.

The collected demographic and clinical data included breast density with the ACR BI-RADS, breast size, age, personal history of breast pathology, and family history of breast cancer.

All data were recorded immediately by the radiology resident after the execution of HHUS, and breast density was evaluated with patient's last mammography.

Standard statistics was used to compare the categorical variables of ABUS and US: Mann–Whitney U-test was used assuming $P < 0.05$ as statistically significant.

Results

A total of 221 patients were invited to undergo US and the ABUS examinations. All patients satisfied the study's inclusion criteria and were enrolled in the study. The mean age was 53 years (range 24–89 years). None of the patients interrupted the examination.

The mean TMI score was 4.6 (standard deviation [SD] ± 0.5) for US and 4.3 (SD ± 0.8) for ABUS.

Based on Mann–Whitney U-test for independent samples, the overall difference between patients' experience on US and ABUS was found statistically significant with $P < 0.0001$.

The difference between patients' experience on US and ABUS in women with BI-RADS C and D for breast density was statistically significant with $P < 0.02$ in favor of US (4.7 ± 0.4) versus 4.5 ± 0.6 for ABUS.

Patients' experience with breast density B was better for US (4.7 ± 0.4) versus 4.3 ± 0.6 for ABUS with $P < 0.01$ [Table 1].

Pain or discomfort occurred during testing especially in patients aged above 40 years: 25/221 patients aged >40 years had TMI below 3, whereas none of the patients aged under 40 years had TMI below 3.

The difference between patients' experience with breast density B–D and body mass index (BMI) was not statistically significant [Table 2].

Discussion

Mammography is an effective randomized controlled trial-proven method for reducing mortality due to breast cancer.[22] However, the sensitivity of mammography depends on breast density.[23] In addition, breast density has been established as an independent risk factor for breast cancer.[7]

Table 1: Difference between patients' experience on ultrasound and automated breast ultrasound

Breast density	Experience on US	Experience on ABUS
BI-RADS B	4.7±0.4	4.3±0.6
BI-RADS C-D	4.7±0.4	4.5±0.6

BI-RADS: Breast Imaging Reporting and Data System, US: Ultrasound, ABUS: Automated breast US

Table 2: Difference between patients' experience on ultrasound and automated breast ultrasound correlated with body max index

	Experience on US	Experience on ABUS
BMI 18-25		
BI-RADS B	4.8	4.4
BI-RADS C-D	4.6	4.4
BMI 25-30		
BI-RADS B	5.0	5.0
BI-RADS C-D	4.0	3.0
BMI >30		
BI-RADS B	5.0	5.0
BI-RADS C-D	4.8	4.8

BMI: Body mass index, BI-RADS: Breast Imaging Reporting and Data System, US: Ultrasound, ABUS: Automated breast US

Women must be informed of their breast density especially when it is mandatory according to local laws.[24,25] The current supplemental screening options include breast HHUS.

HHUS is widely available and well tolerated. However, bilateral whole-breast screening using HHUS is time-consuming and has a high number of false positives. In addition, its practicability has been questioned because of the lack of standardized techniques, operator dependence, nonreproducibility, and time required by the radiologist to perform the examinations.

ABUS screening is an option proposed to overcome the time-consuming and costly nature of handheld, physician-performed whole-breast US.

ABUS appears to be a promising adjunct method to mammography in screening programs in women with dense breast.[26]

As known, one of the principles required in a screening program is that the test should be acceptable by the population.

Previous works[18] have compared ABUS to HHUS in terms of clinical performance in the detection and characterization of breast lesions, but very few studies have evaluated patients' perspectives and tolerability of the examination and the influence of breast density on patients' compliance during conventional breast HHUS and ABUS.

In our study, the mean TMI score was 4.6 ± 0.5 for US and 4.3 ± 0.8 for ABUS.

Even though US has better tolerance compared to ABUS, we found that both methods are tolerated by the patient and both could potentially be integrated as adjunct screening tools to mammography.

The main disadvantage of ABUS was the pain or discomfort experienced by individuals during the test, considering the fact that it is necessary to compress the breast in order to obtain a proper acquisition for mammography.

In a previous study, Prosh *et al*.[27] assessed patient comfort using a standardized questionnaire in 76 women undergoing ABUS and US. The ABUS examination was rated as completely painful by 64% of patients. Nearly 25% of the patients indicated minor pain and 10% indicated moderate pain. The HHUS was rated completely painful in 66% of the patients, where 26% indicated minor pain and 8% indicated moderate pain. However, Zintsmaster *et al*.[28] demonstrated that ABUS is perceived to be significantly less painful than digital screening mammography.

A potential limitation of our study is that all women were subjected to HHUS before the ABUS examination. due to the close time interval between the two examinations, it is possible that patient tiredness could lead to a decrease in compliance and pain threshold, potentially lowering the scores related to

ABUS. Furthermore, the patients would have experienced more fear or anxiety prior to HHUS than that of ABUS. This could perhaps be due to the patients' consideration of HHUS as the definitive diagnostic examination, whereas ABUS could have been perceived as just an experimental additional examination.

Our patients preferred HHUS. this is most likely because many of our patients had already received one or more breast US in the past and are accustomed to the standard HHUS technique.

Another possible factor which leads to patients favoring US is that the HHUS is performed by a medical doctor. In part of European countries, US examinations are always performed by a medical doctor, not by a radiographer or sonographer. As a result, patients have direct contact with the radiologist who can answer their questions and concerns in real time, which provides more reassurance to the patient during the examination.

In our study, we did not find a significant association between TMI scores and previous personal history or family history of cancer.

Patient age is a significant predictor of decreased compliance to ABUS, and the compliance of ABUS resulted lower that of US independently for breast density: Women aged above 40 years preferred US, and women with a heterogeneously dense or extremely dense breast were in favor of US. BMI in our study is not a statistically significant predictor to describe the influence of breast density on patient compliance.

The main limitations of this study were as follows: it represented the experience of a single academic institution, the sample size is relatively small, and ABUS was offered to patients as an optional test and was not part of the daily clinical practice.

Conclusion

Our findings indicate that both ABUS and HHUS are well tolerated by patients. US could still be the choice for most of the enrolled patients. Patient age (>40 years) is a significant predictor of decreased compliance to ABUS. Compliance of ABUS resulted lower that of US independently of breast density. Further improvements in the probe architecture will improve the tolerance, and use of US technique and tailored counseling may better prepare women for ABUS and improve their experience when adjunct imaging with ABUS is used.

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Conflicts of interest

There are no conflicts of interest.

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