Automated whole breast ultrasound

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Introduction

Breast cancer is the most common cancer in women in the UK and the second leading cause of death after lung cancer. Mammography remains the gold standard for breast cancer screening with sensitivity around 85%, however in patients with dense breasts, the sensitivity drops to 68%. Breast density is an independent risk factor for developing breast cancer irrespective of other known risk factors. Women with extremely dense breast (>75% fibroglandular tissue) have a four to five times greater risk of developing breast cancer relative to women with fatty breasts (<25% fibroglandular tissue). It is estimated that up to 50% of women have dense breasts (>50% fibroglandular tissue) on mammography.

In 24 states in the USA, there is legislation enforcing that a woman be informed if she has dense breasts following her mammogram so she can decide whether to have additional imaging. This has contributed towards the need for supplementary screening tools. There is currently no consensus as to which modality to use and the options include ultrasound, MRI and digital breast tomosynthesis. Ultrasound is attractive because it is relatively inexpensive, readily available and requires no injected contrast or ionising radiation. Several studies have shown that supplementary hand-held breast ultrasound (HHBUS) can increase cancer detection rate in women with dense breasts. However, there are limitations to ultrasound, the most important of which are an increase in the false-positive biopsy rate and difficulties with offering and performing the examinations due to lack of adequate personnel, equipment and the time needed to perform and interpret the examination.

Automated whole-breast ultrasound (AWBU)

The concept of AWBU is not new. The idea is to standardise imaging acquisition using an automated transducer and allow visualisation of entire breasts in multiple planes. AWBU is a technology in which ultrasound scanning is performed mechanically, eliminating the effect of operator dependence and reproducibility. There are currently several types of automated breast ultrasound systems including Sono-v ABUS (GE Healthcare), Acuson S2000 ABVS ultrasound system (Siemens Healthcare) and SonoCiné AWBUS (SonoCiné). However only one, the Somo-V ABUS, has been approved by the USA Food and Drug Administration (FDA) for whole-breast screening ultrasound in women with dense breast who have had a negative mammogram.

Equipment/technology

AWBU is usually performed with the patient lying supine and examination times are typically between 10-15 minutes, compared to 20-30 minutes when using HHBUS for whole breast scanning. AWBU is attractive as it can be operated by any trained radiographer, sonographer or technologist. The ultrasound scanner automatically acquires data after one sweep with a wide aperture linear array transducer (5-14 MHz bandwidth) (figure 1). Three image acquisitions, typically in the antero-posterior, lateral and medial planes are usually adequate to image all the breast tissue. In larger women, additional acquisitions in the superior and inferior planes may be needed. After acquisition of a whole series of consecutive axial B-mode images, secondary images of the entire breast volume can be reconstructed in any plane including sagittal, coronal, radial and axial views. These data can be sent to a separate workstation to be independently analysed by the radiologist. Interpretation time varies between five and 15 minutes, depending on the case complexity and reading radiologist’s experience.

AWBU versus HHBUS

Acquisition of coronal plane images

AWBU offers a wider field of view covering the entire breast volume and illustrates anatomic relationships better than single sector scanning in HHBUS. Kuzmiak et al reported a significant increase in reader visualisation confidence in the shape and margin of benign lesions and equal confidence in visualisation of suspicious lesions with AWBU compared to HHBUS. This is most likely the result of more diagnostic information generated by the coronal view. The infiltration and erosion of the surrounding normal breast parenchyma by rapidly growing malignant lesions is also vividly displayed on the coronal plane known as the retraction phenomenon (figure 2).

One potential advantage of AWBU is in obtaining a volume of the breast lesion allowing more accurate monitoring of tumour size, particularly in women with breast cancers who receive neo-adjuvant chemotherapy.

Diagnostic accuracy

The meta-analysis performed by Meng et al showed that the diagnostic accuracy of AWBU for the differentiation of malignant and benign breast neoplasms was high, with the pooled sensitivity and specificity being 92% and 84.9% respectively. Wang et al also reported that the sensitivity of automated breast volumetric screening (ABVS) was superior to that of HHBUS when the masses were less than 1cm in diameter, suggesting that there are benefits to using ABVS for detecting small lesions.

Image quality

The overall image quality of AWBU is relatively similar to...
AWBU and breast screening

There have been several recently published studies that have added support to the use of ABVS as a supplementary screening tool. Kelly et al reported an additional 3.6 cancers detected per 1,000 women screened with no significant increase in the false-positive biopsy rate. There was, however, an increase in the recall rate.6

Guiliano et al performed a study with 3,418 asymptomatic women with dense breasts and no increased breast cancer risk, resulting in the detection of 12.3 per 1,000 breast cancers (AWBU plus mammography), compared with 4.6 per 1,000 by mammography alone.13

The SomoInsight study, where 15,318 were women screened with ABWU and mammography, also reported similar results but highlighted a significant recall rate which increased from 150.2 per 1,000 women screened in the mammography only group, to 284.9 per 1,000 women screened in the combined imaging approach. In addition, the positive predictive value for biopsy in patients undergoing AWBU plus mammography was consistently lower when compared to those undergoing solely mammography (7.21% versus 25-38%).14

Conclusion

AWBU can be a useful supplementary imaging tool particularly in women with dense breasts. However, larger multicentre randomised trials to address whether AWBU can reduce breast cancer mortality and is cost effective are needed.

References

Figure 3
Good demonstration of how useful the coronal plane (bottom left image) can be where in this case the single lumen breast implant had ruptured.

Figure 4
Good example of a fibroadenoma acquired from the ABVS measuring a maximum of 1.9cm located at the 12, 4 position in the right breast (coronal plane – bottom left image; axial plane – top image; and sagittal plane – bottom right image).