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Overview

New Horizons in Breast Imaging

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Abstract

The imaging of breast cancer has undergone significant progression in recent years. A multimodality approach is often required, with ongoing developments in mammography, ultrasound, magnetic resonance and nuclear medicine all contributing to breast cancer imaging. Here we review the literature to assess how advances in well-established technologies, such as mammography, have brought added benefits both in terms of diagnostic and practical benefits, as well as allowing the application of derived technologies, such as tomosynthesis and contrast-enhanced mammography. We consider how these newer technologies may fit into clinical practice, both in terms of general population screening as well as use as problem solving tools in specific patient groups, and where the limitations for these may lie. We aim to highlight some of the promising advances in imaging that are still in earlier stages, such as magnetic resonance elastography, as well as reviewing techniques that are already becoming incorporated into clinical practice.

Key words: Breast cancer; breast-specific gamma imaging; diffusion-weighted imaging; dual-energy mammography; elastography; tomosynthesis

Statement of Search Strategies Used and Sources of Information

The published literature was searched using the PubMed online database and Medline from 2005 to 2012, with search terms including: breast cancer imaging, digital mammography, tomosynthesis, contrast-enhanced digital mammography, dual-energy mammography, spectral mammography, three-dimensional breast ultrasound, automated breast ultrasound, whole breast ultrasound, sonoelastography, elastography, diffusion-weighted imaging, magnetic resonance elastography, magnetic resonance spectroscopy, breast-specific gamma imaging, positron emission mammography. Language; English. The search also included the reference list for these articles. In addition we searched *Clinical Radiology* for relevant published randomised controlled studies in the last 3 years, and abstracts from proceedings from the Radiological Society of North America 2010–2011.

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Introduction

Since the introduction of the mammogram over 30 years ago, breast imaging has undergone considerable evolution. New modalities are emerging, and advances in the use of well-established modalities are being continually developed. Technological progression has helped to individualise the evaluation and treatment of breast lesions [1], improving diagnostic efficiency while minimising patient morbidity and mortality.

Here we provide an overview of the latest developments in breast imaging, highlighting the evidence behind them and their potential future applications in the diagnosis and management of breast cancer.

Mammography

Film/screen mammography has been the gold standard in breast cancer imaging for many years. However, there are well-recognised limitations, most notably in the detection of cancers in women with radiographically dense breasts [2]. The subsequent introduction of digital mammography has led to many benefits. These include more practical aspects, such as easier storage, retrieval and transfer of images, as well as diagnostic benefits with increased cancer

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detection rates, particularly in younger women with denser breast tissue [3].

Digital mammography has allowed the development of several derived technologies, including digital tomosynthesis and contrast-enhanced digital mammography (CEDM) [4].

Digital Breast Tomosynthesis

Digital breast tomosynthesis (DBT) is a technique that involves the rotation an X-ray tube through a limited arc angle while obtaining a series of exposures through a compressed breast. Raw projection image data sets are reconstructed into slices of variable thickness for the radiologist to view, providing three-dimensional information on the breast. Each exposure is only a fraction of the dose used in conventional digital mammography, so that the overall dose is similar to conventional digital mammography. The potential benefits of tomosynthesis include superior detection of mammographic masses, with lesions that may otherwise be obscured by superimposed breast tissue made more visible in the thin section reconstructed slice. Mammographic sensitivity is improved, as well as possible improved lesion characterisation and a reduction in false-positive screening recalls.

Recent research has shown that DBT can more accurately assess breast cancer size and stage than conventional mammography [5]. It has been shown to improve the detection rate of cancers in women with dense breasts when using supplemental tomosynthesis in addition to standard digital mammography (Figure 1) [6] and has comparable sensitivity in the detection of non-calcified breast lesions when compared with digital mammography carried out with additional views [7]. Other studies have shown the benefit of equal or even superior detection of calcifications when compared with conventional mammography, with the possibility of improved interpretation of calcific lesions [8]. The use of tomosynthesis when combined with digital mammography has been reported to reduce recall rates of up to 30% in the USA (Figure 2) [9]. However, recall rates after screening mammography in the USA are about 10%, as opposed to around 3% in screening programmes in Europe, so this effect is probably reduced in European screening practice.

In contrast, other studies have not shown any convincing evidence that the use of DBT alone or in combination with digital mammography results in a substantial improvement in sensitivity. A recent multicentre trial comparing two-view tomosynthesis with digital mammography showed an improvement in the detection of masses and calcification, but only for readers with the least experience and with no differences in classification accuracy when comparing single view tomosynthesis [10]. Research into the use of tomosynthesis in women with abnormal mammograms or clinical symptoms identify that it can be used as an additional technique to mammograms, but it is unlikely to detect cancers that would not otherwise be detected by other methods [11].

In addition, there is a significant increased radiologist reading time for DBT images [12]. Some studies have felt this increased time to be acceptable, even in high volume screening [13], with reported radiologist preference for DBT images [14]. Computer-aided detection (CAD) may play a more significant role with DBT than conventional mammography, given the increased number of images to view as well as the better visualisation of lesion margins. CAD systems have been developed for DBT, which in some instances have proved to be better than those for digital mammography systems [15]. However, as with conventional mammography, CAD will remain a supplemental tool rather than a main reader.

Different proposals for using DBT in clinical practice are being investigated. Although most research has suggested favourable evidence for DBT, the results of large-scale clinical trials currently underway are needed before its role in screening, including the significant additional cost, can be justified.

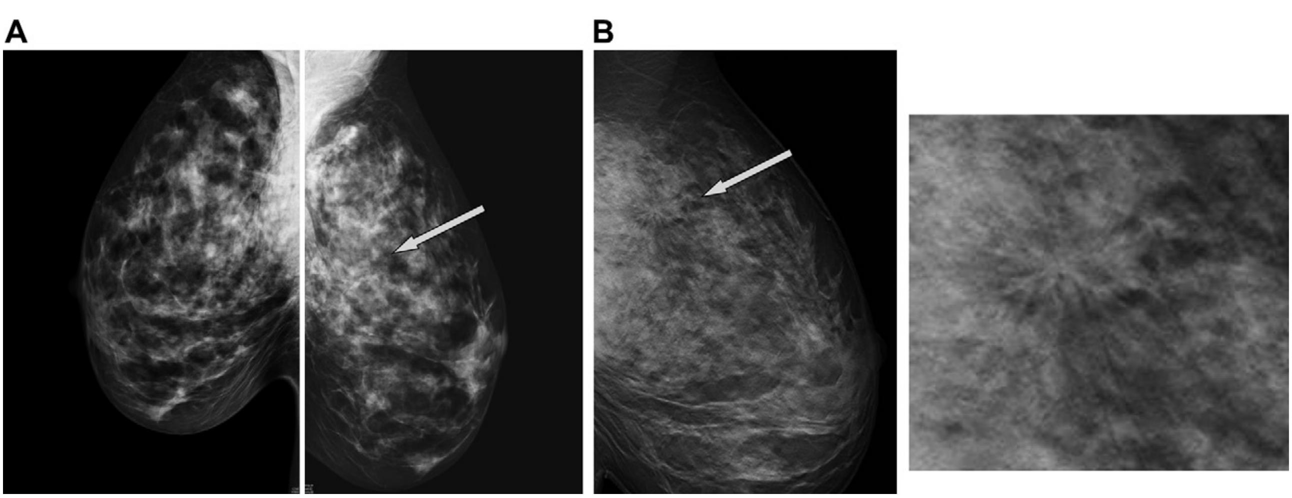

Fig 1. (A) Medio-lateral oblique (MLO) mammograms showing dense breast tissue with a possible area of distortion and asymmetry on the left (arrow). (B) The tomosynthesis clearly shows a spiculate mass.