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Breast tissue bulge and lesion visibility during stereotactic biopsy – A phantom study

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ABSTRACT

Background: During mammography guided stereotactic breast biopsy a bulge of tissue can form in the paddle needle biopsy aperture. This bulge has been estimated to have a height of up to 30% of the breast itself. During clinical biopsy we have noticed that lesions can appear to be less visible when tissue bulges are evident. This can make biopsy more difficult in some cases.
Objectives: This experiment investigates how lesion visibility varies with breast bulge magnitude.
Method: Using a phantom to represent breast and breast bulge, lesion visibility was assessed using a two alternative forced choice methodology. To mimic clinical conditions, imaging was performed on a full field digital mammography system with the biopsy paddle attached using an automatic exposure device. Organ dose (breast) was estimated.
Results: As breast bulge increases lesion visibility decreases; organ dose increases as breast bulge magnitude increases.
Conclusion: Consideration should be given to the impact of breast bulge magnitude and lesion visibility when performing image guided biopsy.
Advances in knowledge: The authors found no similar studies and the results of this study demonstrate a potential clinical risk.

Introduction

Associated with the establishment of the National Health Breast Screening Program (NHSBSP) and continuing technological advancements in mammographic imaging systems, smaller and more subtle breast abnormalities are being detected, however various factors confound this.[1,2] The ability to achieve an accurate histopathologic diagnosis is fundamental, and often this involves tissue sampling through ultrasound or mammography guided biopsy. Stereotactic (mammography) guided needle core biopsy is a well-established technique for sampling nonpalpable breast lesions and sensitivity/sensitivity rates can be very high.[3,4]

In stereotactic biopsy we have noticed perceivable differences in lesion visibility between the full field digital mammographic (FFDM) views obtained during diagnostic work-up and the small field images used during stereotactic biopsy. Lesions seen on small field images during biopsy procedures can be harder to see in the clinical room compared with the same lesions acquired using FFDM in the reporting room. This reduction in lesion visibility can make biopsy harder in some cases. Image quality is dependent on many factors; these include type, design and performance of the imaging equipment. Differences also exist between FFDM and small field images for biopsy. Display differences also exist – lower resolution screens tend to be used for biopsy, whereas higher resolution screens are used for diagnosis. A further confounding factor could be related to breast tissue bulge.[5]

In 2013 Hackney et al. described a bulge of breast tissue which can form within the aperture of the paddle during biopsy procedures.[5] An average of 18.7% (range 11.3–30%) increase in breast thickness over the bulge region occurred compared to the surrounding compressed breast. Hackney hypothesised that breast bulge might diminish lesion visibility during stereotactic biopsy procedures. Despite an intensive literature search no other publications were found on this phenomenon.

Using a phantom, this paper builds on Hackney's tissue bulge work to determine whether an association does exist between bulge magnitude and lesion visibility.

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Materials and methods

A phantom study was conducted to simulate clinical conditions. Phantom design was informed by an audit of compressed breast sizes.[5] Perceptual measures of lesion visibility were used to assess the effect of tissue bulge across a range of breast phantom/breast bulge thicknesses.

Breast phantom

To inform breast phantom size, breast thickness readout from an FFDM mammography machine (Siemens Inspiration system (Siemens PLC, Berkshire)) was noted on a convenience sample of 100 female clients for right Medio-Lateral Oblique (MLO), left MLO, right Cranio-Caudal (CC) and left CC (Table 1). Minimum breast thickness was 21 mm, maximum 95 mm, mean 56.6 mm, SD 13.47.

Perspex has similar scattering and attenuation characteristics to human soft tissue.[6,7] Perspex was therefore used for breast phantom and breast bulge construction. Four Aluminium disks of different thicknesses (5 mm diameter; thicknesses – 0.001, 0.002, 0.004 and 0.009 μm) were used to simulate lesions, as these imitate high density lesions.[8,9]

Using data from Table 1, the breast phantom was constructed. The phantom comprised of Perspex blocks measuring 205 mm (L) × 105 mm (W) × 10 mm (D). These could be stacked to represent different breast thickness. The four aluminium discs were encased between the two Perspex blocks (Fig. 1).

Data from Hackney's study[5] were used to determine phantom bulge magnitudes. Perspex, measuring 53 mm × 41 mm × 5 mm (the size of the biopsy paddle aperture), were placed directly over the aluminium disks located within the biopsy compression paddle aperture (Image 1).

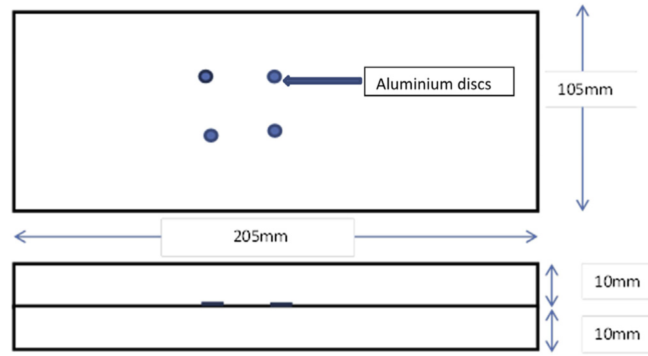

Figure 1. Top – plan view; bottom – side view. Both demonstrate the four aluminium disks encased by the two perspex blocks.

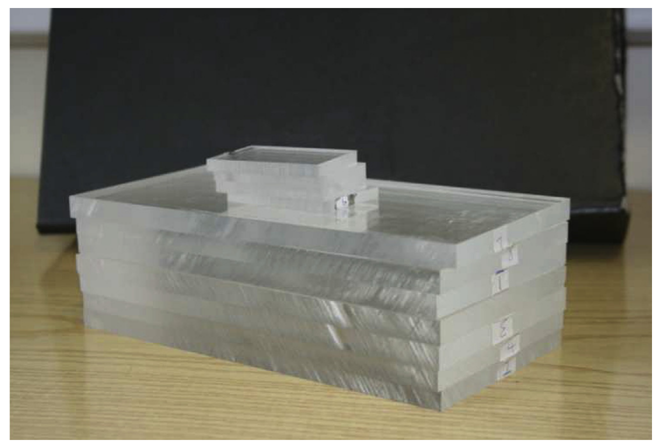

Image 1. Perspex blocks which were utilised for varying breast and tissue bulge thicknesses.

Phantom imaging

Siemens Inspiration (Siemens PLC, Berkshire) FFDM was used in conjunction with a digital X-ray stereotactic breast biopsy system (Siemens PLC, Berkshire). Both met the quality control standards for screening and assessment.[10]

The compression plate used for the stereotactic views was a 3D biopsy compression paddle measuring 100 mm (L) × 94 mm (W) with a 55 mm (W) × 44 mm (L) aperture (Fig. 2); the standard compression paddle measured 245 mm (L) × 175 mm (W).

Normal clinical practice was followed to replicate clinical conditions with the exposure factors being auto-selected by the equipment (Table 2).

Stereotactic scout image

As there are a number of confounding factors influencing image quality, the decision was taken to use the stereotactic scout view for all test images therefore minimising the number of variables. In the scout view the X-ray beam is perpendicular to the phantom whereas the stereotactic image pairs involve a 10° angulation of the tube head to the left and right. This change in beam angulation could result in the beam passing through a variation in bulge thickness, which in turn may affect Aluminium disc visibility. Also, the aluminium discs may be distorted with the change in angle of the X-ray beam, again this may also influence disc visibility.

Images were acquired in the CC plane. The phantom was placed on the detector so the long edge (205 mm) was in line with the chest wall edge and central to the unit. The four aluminium discs were positioned within the biopsy aperture of the compression

Table 1
Breast thickness for all views.

	Right MLO	Left MLO	Right CC	Left CC
Minimum	24 mm	21 mm	27 mm	25 mm
Maximum	95 mm	91 mm	91 mm	86 mm
Mean	57.22	58.21	55.42	55.69
SD	13.88	14.64	12.46	12.91

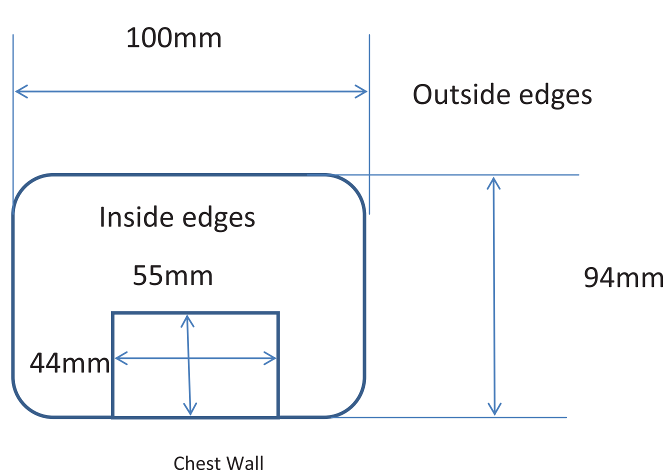

Figure 2. Representation of the biopsy compression paddle.

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