



# Stiffness at shear-wave elastography and patient presentation predicts upgrade at surgery following an ultrasound-guided core biopsy diagnosis of ductal carcinoma in situ



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**AIM:** The aim of this study is to establish predictors of invasion in lesions yielding an ultrasound-guided biopsy diagnosis of ductal carcinoma in situ (DCIS).

**MATERIALS AND METHODS:** Patients subjected to ultrasound-guided core biopsy yielding DCIS were studied. At shear-wave elastography (SWE) a threshold of 50 kPa was used for mean elasticity ( $E_{\text{mean}}$ ) to dichotomise the elasticity data between invasive and non-invasive masses. Data recorded included the mammographic and ultrasound features, the referral source, and grade of DCIS in the biopsy. The chi-square test was used to detect statistical significance.

**RESULTS:** Of 57 lesions, 24 (42%) had invasion at excision. Symptomatic patients and patients with stiff lesions were more likely to have invasion than patients presenting through screening and with soft lesions (58% [14 of 24] versus 30% [10 of 33],  $p=0.03$ ) and (51% [20 of 39] versus 22% [4 of 18],  $p=0.04$ ). No other factors showed a relationship with invasion. Combining the two predictors of invasion improved risk stratification with symptomatic and stiff lesions having a risk of invasion of 67% (12 of 18) and soft lesions presenting at screening having only a 17% (2 of 12) risk of invasion ( $p=0.02$ ).

**CONCLUSION:** Stiffness on SWE and the referral source of the patient are predictors of occult invasion in women with an ultrasound-guided core biopsy diagnosis of DCIS.

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## Introduction

Breast lesions yielding an image-guided biopsy diagnosis of ductal carcinoma in situ (DCIS) may contain invasive foci

when the entire lesion is removed at surgery. Such an upgrade may lead to further surgery, especially to the axilla.<sup>1</sup> Predicting the likelihood of upgrade to invasion is useful as it may change options for initial surgery, particularly with regard to sentinel node biopsy. Factors predicting an upgrade of DCIS lesions diagnosed with stereotactic biopsy have been well established in the literature and include mammographic extent, palpability, and grade of DCIS diagnosed on percutaneous biopsy<sup>2–4</sup>; however, factors predicting an upgrade following an ultrasound-guided

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biopsy of DCIS have not been well established and only two previous studies have studied shear-wave elastography (SWE) in this context.<sup>5–8</sup> A number of reports of SWE of the breast have shown that DCIS lesions are less stiff than invasive cancers.<sup>9,10</sup> These findings suggest that SWE may be useful in predicting the presence of invasion. The aim of this study was to establish the role of mammography, ultrasound, SWE, and other preoperative features in predicting invasion at surgical excision in lesions yielding an ultrasound-guided 14 G core biopsy diagnosis of DCIS.

## Materials and methods

SWE has been part of the routine breast ultrasound examination at Ninewells Hospital since November 2009. Quantitative data are routinely extracted prospectively within a few days of the examination and before biopsy results were known. In accordance with the applicable National Research Ethics Service guidance, ethical approval for this retrospective study of prospectively acquired anonymised data was not required (National Research Ethics Service, 2008<sup>11</sup>); however, written informed consent to use images was obtained, according to routine practice.

All patients with ultrasound visible lesions were scanned using the Aixplorer ultrasound system (SuperSonic Imagine, Aix-en-Provence, France) between December 2010 and December 2015. Those patients with lesions visible on greyscale ultrasound and subjected to ultrasound-guided 14G core needle biopsy yielding a biopsy diagnosis of DCIS were included in this study. Patients with biopsies from elsewhere in the ipsilateral breast showing invasive disease were excluded.

All patients were scanned and biopsied with ultrasound guidance by one of five breast radiologists or an advanced radiography practitioner trained to perform and interpret breast ultrasound. These practitioners had between 7 and 22 years of breast ultrasound experience and had at least 3 months experience of performing SWE of solid breast lesions prior to the commencement of the study. Greyscale and SWE images were obtained during the standard ultrasound appointment. Four SWE images in two orthogonal planes were obtained. The region of interest (ROI) utilised in all cases was 2 mm in diameter. A threshold value of 50 kPa was used for mean elasticity ( $E_{\text{mean}}$ ) to dichotomise the elasticity data. This threshold has been validated in previous studies using SWE to differentiate between benign and malignant masses.<sup>12,13</sup> The average of the four values from the four images was used for analysis. Additionally, the mean SWE value across the entire study group was also used as a possible cut-off value.

The size and Breast Imaging-Reporting and Data System (BIRADS) classification of the greyscale ultrasound abnormalities were recorded as was the presence or absence of an ultrasound visible mass or calcification (some lesions were visible as textural change with or without ultrasound visible calcifications). The dominant mammographic feature was also recorded as was the BIRADS classification of any mammographic abnormality.

The source of the patient from either mammographic screening or the symptomatic referral service was noted as was the palpability of the lesion. The histological grade of DCIS present on the ultrasound-guided 14 G core biopsy was recorded. Regarding subsequent surgical excisions, micro-invasion was included in the DCIS group as such lesions do not routinely warrant an axillary nodal procedure. The size, grade, vascular invasion, and nodal status of any invasive foci were collected from the surgical pathology report.

The significance of differences between groups was established using the chi-square test with  $p < 0.05$  taken to indicate statistically significant differences.

## Results

Analysis of 1954 ultrasound visible masses with histological correlation yielded 57 (3%) patients with an ultrasound 14G core biopsy diagnosis of DCIS who had subsequent surgical excision. The mean age of the patients was 60 years (range 23–82 years). Thirty-three (58%) lesions were screen-detected, whereas 24 (42%) resulted from investigation of symptoms. At surgical excision, 24 (42%) patients had invasive foci, whereas 33 had DCIS only. The features of the 24 invasive cancers are shown in Table 1. Twelve of 24 (50%) invasive foci were <10 mm in diameter and two of 24 (8%) were node positive. The mean histological whole tumour size (i.e., extent including DCIS) was 28 mm for the pure DCIS lesions and 53 mm for those containing an invasive focus.

The relationship between preoperative factors and the presence of invasion are shown in Tables 2–4. Patients presenting with symptoms were more likely to have invasive foci than patients presenting through screening (58% [14 of 24] versus 30% [10 of 33],  $p = 0.03$ ). Patients whose lesions had a mean stiffness at SWE of >50 kPa were more likely to have an invasive focus than women with lesions whose mean stiffness was <50 kPa (51% [20 of 39] versus 22% [4 of 18],  $p = 0.04$ ). The mean stiffness value in the entire study group was 84 kPa. Using this as a cut-off value did not aid the identification of those women with invasive foci. The mean stiffness values for women with and without invasion were 89 and 78 kPa, respectively, whereas the median values were 74 and 56 kPa. Trends towards younger women and women with high greyscale ultrasound suspicion

**Table 1**

Pathological characteristics of invasive carcinomas identified on surgical excision ( $n = 24$ ).

Invasive features ( $n = 24$ )	Variable	$n$ (%)
Invasive size, mm	<10	12 (50%)
	10–20	6 (25%)
	>20	6 (25%)
Grade	1	1 (4%)
	2	17 (71%)
	3	6 (25%)
Nodal status	Node positive	2 (8%)
Lymphovascular invasion	LVI present	3 (12%)

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