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Case Series: Elastography an adjuvant modality to X-ray mammography and sonomammography in evaluating breast lesions.

KEYWORDS: Elastography, mammography, breast.

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ABSTRACT *A prospective study of 50 subjects was carried out from those referred to the Department of Radiodiagnosis for breast imaging after being clinically diagnosed with breast lesion and for screening mammography during the study period. Elastography as an adjuvant imaging modality to conventional x-ray mammography and sonomammography was used in characterising benign and malignant breast lesions, with cytology results as the reference standard and final diagnosis. The most common lesions in present study are benign lesion fibroadenoma.*

Breast cancer is the most common malignancy in women and the second most common cause of cancer-related mortality (1). Breast biopsy, the current method used to distinguish between benign and malignant breast abnormalities seen at imaging, yields a benign result in more than 75% of patients, making it a costly component of a breast cancer screening program (2). Imaging features on ultrasonographic (US) images could be used to classify benign and malignant solid breast lesions and thus decrease the numbers of biopsies performed (3). However, the sonographic features for benign and malignant lesions have been shown to override each other substantially (3, 4). Thus, a method to reliably differentiate benign from malignant breast lesions on radiological imaging would be valuable. Elastography is a non invasive imaging technique which exploits the theory that benign and malignant breast lesions have inherent difference in firmness (6, 7).

Objectives:
To radiologically characterise various breast lesions as benign and malignant using elastosonography in addition to the X-ray mammography and Sonomammography and to correlate categorized lesions with histopathological diagnosis and assess the diagnostic accuracy of elastosonography in distinguishing between benign and malignant lesions of the breast.

MATERIALS AND METHODS
- In this hospital based prospective study minimum 50 subjects will be selected from those referred to the Department of Radiodiagnosis of Smt. Kashibai Navale Medical College and Research Centre Narhe, Pune for breast imaging after being clinically diagnosed with breast lesion and for screening mammography during the study period.
- Inclusion Criteria: Female patients diagnosed with breast lesion clinically and on screening mammography.

Exclusion Criteria: Women who are pregnant

Methodology:
- A detailed history will be documented at the time of initial visit with breast specific history including menstrual history, history of mastalgia, lactational history and relevant past and family history.

- General examination along with local breast examination will be conducted.

- Mammography will be performed with ALLENGERS MAM 4035 Venus Series.

- Ultrasonography and elastosonography will be performed with SIEMENS ACUSON S2000 using high frequency 9L4 linear probe.

- Lesions will be categorised based on the American College of Radiology Breast imaging reporting and data system (BIRADS) (9). Sonographic interpretation will be done according to the Stavros criteria (19). Elastographic images will be assigned an elasticity score of 1 to 5 (1-3 benign; 4 and 5 malignant) (20).Strain ratio and Elasticity/B-mode ratio will be calculated. Cohn's study and Barr's study will be used for strain ratio and EL/B- mode ratio cut-off point references respectively (21, 22). Histopathology in the form of fine needle aspiration cytology (FNAC) or fine needle aspiration biopsy (FNAB) or excisional biopsy or post operative histopathologic review; whichever is applicable will be undertaken.

- Concordance between the imaging findings and histopathological diagnosis will be documented, histopathology being the gold reference standard.

- The sensitivity and specificity along with positive predictive value, negative predictive value for the characterisation of breast lesions by elastography adjuvant to conventional mammography and sonomammography will be evaluated.

Data will be entered in Microsoft Excel sheet and analysed using statistical software. Data will be depicted in the form of tables and charts wherever required. Statistical tests like chi square test, sensitivity, specificity, positive predictive value and negative predictive value will be used.

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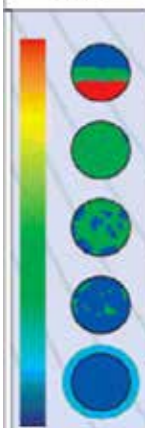
Sonoelastographic classification by the Italian Multi-Center Team of Study

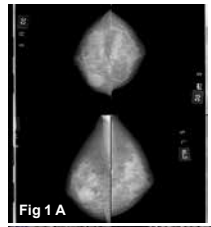
CHROMATIC CODE	ELASTOSONOGRAPHIC SCORE	ITALIAN TEAM OF STUDY
	SCORE 1: Presence of chromatic tri-stratification (blue /green / red)	Prevalently in the liquid forms
	SCORE 2: Prevalence of green, with in case some blue point, inconstant seat	PREVALENTLY ELASTIC: prevalently in the benign forms
	SCORE 3: Prevalently green, but with some blue spot.	
	SCORE 4: Almost completely blue, with in case some green point, most of all in periphery	PREVALENTLY RIGID: prevalently in the malignant forms
	SCORE 5: Completely blue, also with a blue peripheral glow around the nodule	

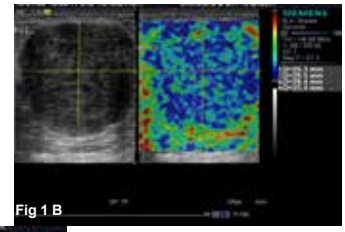
Facilities in equipment:

- Mammography will be performed with ALLENGERS MAM 4035 Venus Series.
- Ultrasonography and elastosonography will be performed with SIEMENS ACUSON S2000.

REVIEW OF LITERATURE

Breast cancer is the most common malignancy in women and the second most common cause of cancer-related mortality (1). Non-invasive diagnosis of breast cancer remains a major clinical problem. Breast biopsy, the current method used to distinguish between benign and malignant breast abnormalities seen at imaging, yields a benign result in more than 75% of patients, making it a costly component of a breast cancer screening program (2). Imaging features on ultrasonographic (US) images could be used to classify benign and malignant solid breast lesions and thus decrease the numbers of biopsies performed (3). However, the sonographic features for benign and malignant lesions have been shown to override each other substantially (3, 4). Furthermore, the Agency for Healthcare Research and Quality recently asserted that current US examinations are neither sufficiently sensitive nor adequately specific to be used in place of breast biopsy for the diagnosis of mammographically identified abnormalities (5). Thus, a method to reliably differentiate benign from malignant breast lesions on radiological imaging would be valuable. Elastography is a non invasive imaging technique which exploits the theory that benign and malignant breast lesions have inherent difference in firmness (6, 7). Elastographic images display the relative stiffness of lesions compared with the stiffness of surrounding tissue where malignant masses typically appear dark and have high contrast with background breast tissue during deformation. Benign masses typically appear lighter and have lower contrast with background breast tissue during deformation (8). The modality provides structural information about the lesion in addition to the morphologic features shown by conventional sonography (9-11). In addition, malignant lesions tend to be larger on elastographic images than on corresponding B-mode US images, perhaps because of the desmoplastic reaction commonly associated with malignancy (8, 12-15).





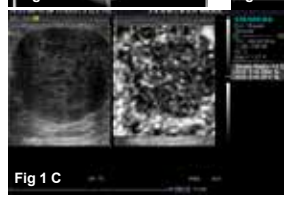
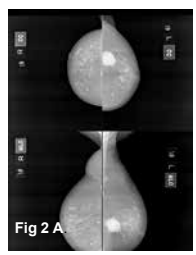


Figure 1 A. Mammogram reveals a well defined round to oval soft tissue density lesion is seen in the lower inner quadrant of right breast.

Figure 1 B. US elastographic image shows the entire lesion as green and blue, indicating a relatively soft lesion with elasticity score of 3

Figure 1 C. The strain ratio was 1.3 indicating a benign lesion, histopathological of which reveals a benign lesion fibroadenoma.



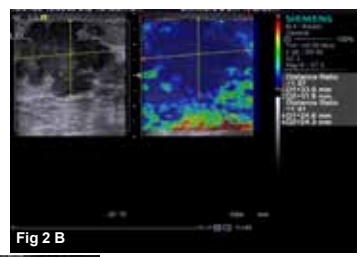


Figure 2 A. Mammogram reveals a well defined soft tissue density lesion with spiculated margin is seen in the lower inner quadrant of left breast.

Figure 2 B. US elastographic image shows the entire lesion as blue, indicating a relatively hard lesion with elasticity score of 5

Figure 2 C. The strain ratio was 10 indicating a malignant lesion, histopathological of which reveals a carcinoma.

OBSERVATIONS:

ELASTOGRAPHY SCORE	NUMBER OF LESIONS
1	0
2 (Benign)	5
3(Benign)	16
4(Malignant)	3
5(Malignant)	14
TOTAL	30

TYPE OF LESION	STRAIN RATIO	ELASTOGRAPHY/B MODE RATIO
BENIGN	LESS THAN 3 (21 number of lesions)	LESS THAN 1 (20 number of lesions)
MALIGNANT	MORE THAN 3 (17 number of lesions)	MORE THAN 1 or 1 (18 number of lesions)

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DISCUSSION:

Breast cancer is the most common malignancy in women and the second most common cause of cancer-related mortality (1). Non-invasive diagnosis of breast cancer remains a major clinical problem. Mammography and sonography are currently the most sensitive modalities for detecting breast cancer. However, the sonographic features for benign and malignant lesions have been shown to override each other substantially (3, 4). These limitations of mammography and sonography lead to aggressive biopsy, but the biopsy rate for cancer detection is only 10% to 30% (16, 17). This means that 70% to 90% of breast biopsies are performed for benign diseases, which induce unnecessary patient discomfort and anxiety in addition to increasing costs to the patient.

In 1990s, Ophir et al described a technique called elastography (18). This non invasive imaging procedure assesses the strain of soft tissues (displacement or elongation of tissue during manual compression) and provides structural information about the lesion in addition to the morphologic features shown by conventional sonography (9-11). This physical feature is related to the elasticity coefficient (6) which in fact is also the basis of clinical breast palpation, because, the malignant lesions tend to be stiffer than benign ones. However, palpation is not very accurate due to its poor sensitivity as well as its limited accuracy in terms of different locations of lesions.

Elastography exploits the theory that benign and malignant breast lesions have inherent difference in firmness (6, 7). Elastographic images display the relative stiffness of lesions compared with the stiffness of surrounding tissue. Stiffer areas deform less easily than do their surroundings and are depicted as dark on elastographic images, whereas softer areas deform more easily and are depicted as light. Malignant masses typically appear dark and have high contrast with background breast tissue during deformation. Benign masses typically appear lighter and have lower contrast with background breast tissue during deformation (8). In addition, malignant lesions tend to be larger on elastographic images than on corresponding B-mode US images, perhaps because of the desmoplastic reaction commonly associated with malignancy (12-15). The purpose of the study is to prospectively evaluate the role of elastography as an adjuvant imaging modality to conventional x-ray mammography and sonomammography in characterising benign and malignant breast lesions, with cytology results as the reference standard.

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