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Original Article

Radiology Section

Ultrasound Elastography and Strain Ratio Evaluation of Breast Masses

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ABSTRACT

Introduction: Breast masses are most commonly encountered problem in the most of the women population out of which breast cancers are the commonest leading malignancies. Early detection and identification of breast lesions is essential and necessary for the proper treatment either surgical or medical management.

Aim: To assess the role of ultrasound elastography in differentiating benign and malignant breast masses, Also, to study the sensitivity and specificity of ultrasound elastography. To know accuracy of strain ratio in detection and characterisation of breast masses.

Materials and Methods: This study was conducted for a period of one year. Total 50 patients presenting with complaints of palpable breast masses with significant USG and ultrasound elastography abnormality in Department of Radiology at MNR Institute of Medical Sciences using Phillips iU22 USG machine were considered for the study. All the patients were subjected to FNAC/ biopsy for confirmation of ultrasound finding and establishment of final diagnosis is done. Patients who had already being diagnosed by FNAC/biopsy and those with known family history of carcinoma of breast were excluded out from the study.

Results: Most of the patients in our study belonged to age group of between 31 to 40 years of age. Out of 23 histologically proved malignant patients, Elastography accurately detected 17 malignant cases with sensitivity, specificity, positive predictive value, negative predictive value, and accuracy of 73.9%, 88.9%, 85%, 50% and 92% respectively. SR (Strain Ratio) could accurately detect all the 23 histologically proven malignant cases with sensitivity, specificity, positive predictive value and negative predictive values are 100%, 81.5% ,82.% and 100 respectively.

Conclusion: The combined use of elastography and strain ratio can complement conventional B-mode US with improving its diagnostic performance in distinguishing benign from malignant breast lesions.

Keywords: Carcinoma, Malignant breast lesions, rotinue 2D ultrasonography, Real time elastography

INTRODUCTION

Breast masses are one of the most common complaints among females. They range from benign to malignant with varied etiologies. Breast carcinoma is the most common and the second leading cause of deaths in women. The number of breast cancer cases in the world account to up to 1.2 million [1]. Fibroadenoma is the commonest benign whereas, invasive ductal carcinomas are the commonest malignant lesions [2]. At present current trends there is increased incidence of breast carcinoma in urban population of India. One in 20 women is dying from breast cancers in India. With diagnostic advances and introduction of elastography with strain ratio technique helps in early detection of breast cancer accuracy.

MATERIALS AND METHODS

The prospective study was conducted between the period of July 2016 to July 2017. Based on the inclusion and exclusion criteria, 50 cases of breast lesions diagnosed by ultrasound, with the consent of patients were included in the study. The ultrasonography and elastography was performed in the department of Radiology MNR Medical College, Hyderabad, India.

All 50 cases which were found to have breast lesion on ultrasound were subjected to FNAC for confirmation of ultrasound finding and establishment of final diagnosis.

Patients who presented with a palpable breast mass and which are subsequently confirmed by FNAC/biopsy were included in the study. All the confirmed cases and patients with known family history of carcinoma of breast were excluded out from the study.

Procedure: Conventional B-mode US, ultrasound elastography and strain ratios were performed for all patients in the same session by using a 7-12 MHz linear array transducer connected to a real time USG machine iU22 (Vision 2010; Philips, Seattle).

After an informed consent from the patient, the patient was positioned in a supine position with the arms placed behind the head over a pillow. Both breasts were examined and ultrasound images of target lesions obtained.

Simultaneous dual display of color coded elastography images with adjacent routine B-mode images with highlighted region of interest was set manually.

In our study, the SR value was calculated automatically based on the average strain measured in the lesion compared to adjacent adipose tissue in the breast. By keeping the Region of Interest (ROI) at center of lesion, the average strains at lesion as ST-avg lesion and adjacent fatty tissue as ST-avg Fat. SR obtained by ST-avg/ST-lesion. As the stiffness of lesion increases the SR ratio increases.As the SR increases, the likelihood of invasive breast cancer increases [3].

Strain ratio index = ST (strain) avg adj.Fat/ST avg lesion [4].

In our present study based on the strain ratio, we took a cut off of 4 and lesions above the SR value of 4 were considered malignant and below 4 were considered benign.

Cytological examination: FNAC was performed with a 23G needle attached to a 2 mL syringe. Cytological results were classified based on the most commonly used categorization which is a five-tier system, with categories ranging from insufficient materials (C1), benign (C2), atypical (C3), suspicious for malignancy (C4) or frankly malignant (C5) [5].

STATISTICAL ANALYSIS

The Statistical software SPSS version 10.0 and Systat 8.0 were used for the analysis of the data and Microsoft word and Excel have been used to generate graphs, tables etc.

RESULTS

In this study, 50 patients were considered to study the sensitivity and specificity of ultrasound elastography and SR in the detection and characterisation of various breast masses and its role in differentiating benign and malignant breast masses and its correlation to histopathology [Table/Fig-1,2]. Out of the total 50 patients included in the study, 27 (54%) was histologically benign and 23 (46%) were histologically malignant [Table/Fig-2].

Of the total 50 subjects, based on USG, 19 (38%) showed features of malignancy. Corresponding elastography performed on these 19 patients, 18 patients (90%) showed malignantcy.

Based on USG, 31 (62%) patients showed benign features, corresponding elastography performed on these 31 patient, 29 patients (96.7%) showed benign features. So comparing the USG findings and the corresponding elastography features on these 50 subjects sensitivity and specificity of malignant lesions was 90% and 96% with an accuracy rate of 94% [Table/Fig-3].

Of the total 50 subjects, based on USG 19 (38%) patients showed features of malignancy. corresponding FNAC performed on these 19 patients, 17 (73%) showed malignant features. Based on USG, 31 (62%) patients showed benign features, corresponding FNAC performed on these 31 patients, 25 (92%) showed benign features. So comparing the USG findings and the corresponding FNAC on these 50

Age	Number	Percentage
≤30	10	20.0%
31-40	17	34.0%
41-50	10	20.0%
51-60	9	18.0%
>60	4	8.0%
Total	50	100.0%

[Table/Fig-1]: Table representing the different age groups involved in this study.
Mean: 41.7000; Std. Deviation:13.44869

Lesions	Number	Percentage
Benign	27	54%
Malignant	23	46%
Total	50	100%

[Table/Fig-2]: Number of benign and malignant lesions in respect to histopathology.

Parameters	Elastography (Malignant)	Elastography (Benign)	Total
USG (Malignant)	18	1	19
USG (Benign)	2	29	31
Total	20	30	50

[Table/Fig-3]: Sensitivity and specificity of usg vs elastography.
Sensitivity=90%; Specificity=96.7%; PPV=94.7%; NPV=93.5%; Accuracy=94%

Parameters	FNAC (Malignant)	FNAC (Benign)	Total
USG (Malignant)	17	2	19
USG (Benign)	6	25	31
Total	23	27	50

[Table/Fig-4]: Representing detection of lesions by USG.
Sensitivity=73.9%; Specificity=92.6%; PPV=89.5%; NPV=0.6%; Accuracy=94%

subjects sensitivity and specificity was 73.9% and 92.6% with an accuracy rate of 94% [Table/Fig-4].

Of the total 50 subjects based on elastography, 20 (40%) patients showed features of malignancy. Corresponding FNAC performed on these 20 patients, 17 (73.9%) showed malignant features. Based on elastography 30 (60%) patients showed benign features, corresponding FNAC performed on these 30 patients, 24 (88.9%) showed benign features.

So comparing the elastography findings and the corresponding FNAC on these 50 subjects sensitivity and specificity was 73.9% and 88.9% with an accuracy rate of 92% [Table/Fig-5].

Of the total of 50 patients, based on SR, 28 patients were malignant. Corresponding FNAC on these same 28 patients, 23 patients were malignant. Total 22 patients were benign based on SR and 22 were benign on FNAC. The sensitivity, specificity, PPV and NPV are 100%,81.5%, 82% and 100% respectively [Table/Fig-6].

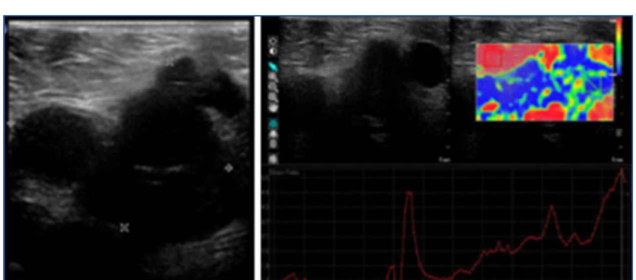
SR value in few cases has been depicted in [Table/Fig-7-10].

Parameters	FNAC (Malignant)	FNAC (Benign)	Total
Elastography (Malignant)	17	3	20
Elastography (Benign)	6	24	30
Total	23	27	50

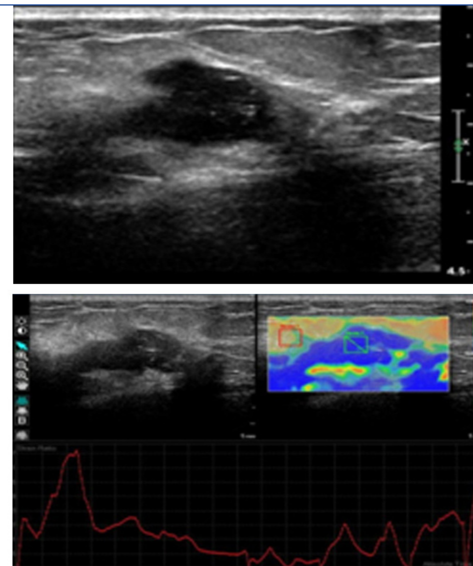
[Table/Fig-5]: Representing Detection of Lesions By elastography.
Sensitivity=73.9%; Specificity=88.9%; PPV=85%; NPV=80%; Accuracy=92%

Parameters	FNAC (Malignant)	FNAC (Benign)	Total
Strain Ratio (Malignant)	23	5	28
Strain Ratio (Benign)	0	22	22
Total	23	27	50

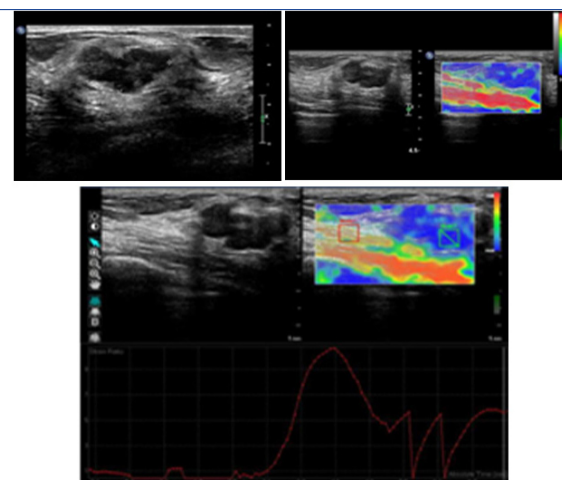
[Table/Fig-6]: Representing detection of lesions by strain ratio (with a cut off).
Sensitivity=100%; Specificity=81.5%; PPV=82%; NPV=100%



[Table/Fig-7a,b]: Shows a well defined hypoechoic mass with regular margins. On the same lesion elastography showed mostly intermediate stiffness corresponding SR of 2.75 is which is significant of benign lesion. Subsequent histopathology confirmed as fibroadenoma.



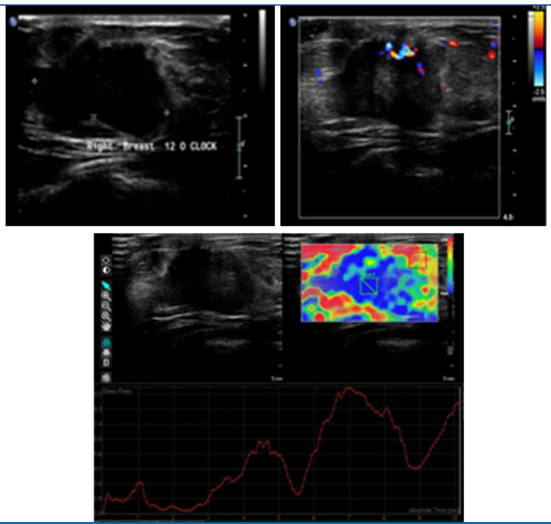
[Table/Fig-8a,b]: A 56 year old patient shows a well defined lobulated hypoechoic mass with irregular margins with few areas of hyperechoic areas within. SR is 5.85 which is highly significant of malignancy. On subsequent histopathology it has been confirmed has invasive carcinoma.



[Table/Fig-9a,b,c]: shows a lobulated hypoechoic mass with irregular margins with few areas of microcalcification within. Corresponding SR is 5.85 which is highly suggestive of malignancy. subsequent histopathology showed invasive ductal Carcinoma.

DISCUSSION

Routine ultrasonography of breast shows normal glandular and fatty tissue with homogenous echogenicity. With increase in age the glandular and fatty component varies. On rotinue sonography breast lesions appears as hypo to mixed echogenic with minimal or no vascularity can be seen. Routine ultrasonography with strain ratio calculates the compressibility of the lesion, hardness of the lesion such that catagorise the lesion accordingly begnin and malignant. In our studies begnin lesions are most compressable and malignant lesions are



[Table/Fig-10a,b,c]: A 54 year old female presented with a palpable breast mass on which USG was performed and shows a small lobulated hypoechoiec mass with irregular SR is 5.59 which is highly suggestive of malignancy. Subsequent histopathology showed invasive ductal Carcinoma.

hard to compress with high strain value. With combined study of sonoelastography with SR clearly gives the colour coded hard lesions suggestive of malignant lesions. Combined use of sono elastography with SR can detect early detection of malignant masses of breast [6].

SR is a semi quantitative method, yields more objective methods. The differences in the cutoff values explained as a result of pre-compression, especially when the diagnosis has been established by a radiologist with inadequate clinical experience. Pre-compression can substantially change the strain value of fat. As pre-compression is applied, the stiffness of all tissues increases. However, the stiffness variations in fat tissue are more prominent than those in normal breast tissue and masses; therefore, with pre-compression, the SR will decrease. The other reason that could explain the SR results obtained in our and other studies is ROI inconsistency. The ROI for fat measurement should contain only fat, and measurements should be taken at the same depth in the image, as the degree of compression varies with depth. However, this is not always possible in clinical practice. Apart from pre-compression and ROI selection inconsistency, strain elastography as an imaging modality requires external compression. Because external compression is applied manually, strain elastography is operator dependent, which influences its reproducibility [7]. Strain ratio also co-additive factor for identification of breast lesions along with BI-RADS with high PPV and NPV.

The mean elasticity score is significantly higher in malignant (5.7) than benign (2.4) with a p-value of <0.001This is in close conformity with results reported by Schnitt SJ et al., [8] who found that when a cutoff point of between 3 and 4 was used, elastography had 86.5% sensitivity, 89.8% specificity, and 88.3% accuracy.

Also, are results were approximately consistent with studies of Gheonea IA et al., [9] obtained a sensitivity of 86.7% and a specificity of 92.9% for elasticity score. In the study done by Thomas A et al., sensitivity and specificity of 81% and 89% for elastography were observed [10], which is similar to our study.

In our study based on SR with a (cutoff value of 4), the sensitivity, specificity, positive predictive value and negative predictive values are 100%, 81.5%, 82.% and` 100% respectively. The mean SR was significantly higher for malignant lesions (5.1±0.9) than for benign lesions (2.01±1.0) with a p-value of <0.001. This is in close conformity with results reported by Esinger F et al., [11] who had a sensitivity of 93.3% and a specificity of 92.9% for SR (when a cutoff point of 3.67 was used). Comparing all the above mentioned techniques when SR was combined to the study, it increased the sensitivity to 100% with a specificity of 82%.

Hence, SR making newer approach in early identification of malignant lesions and also itself having role in liver imaging (few studies still going on) [12-16].

LIMITATION

The limitations to this study were with the sonoelastographic images aquisition as there were intraobserver and inter observer variability for acquisition of the strain index that has to be calculated.

CONCLUSION

The sensitivity and specificity of ultrasound elastography with strain ratio helps in the detection and characterisation of various begnin and malignant breast masses.

So to conclude for assessing breast lesions, US elastography is the proposed imaging classification, which was simple to compare with that of the Breast Imaging Recording and Data System classification (BIRADS), had almost the same diagnostic performance as conventional US and when strain ratio was included in the study, it increased the specificity and sensitivity in the study.

Thus, ST ratio making new way of early detection of malignancy by tissue hardness and also showing its implications in thyroid and liver elastograhy imaging and also it's a start of new era in detection of malignancy at early stage

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