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Original Research Article

Breast Mass Evaluation with Strain Elastography: A Prospective Cohort Study

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Abstract

Introduction: Breast cancer is the most common cancer in the world and is one of the most common causes of morbidity and mortality. Hence, early detection by non- invasive technique is required without causing discomfort to patients which brings forth the role of real time breast elastography, a new method to assess the stiffness of any breast mass.
Among different Elastographic methods we have used the strain ratio which is a semiquantitative method.

Aims and Objectives: To differentiate benign breast masses from malignant ones , to correlate it with pathological investigations done and to know the sensitivity, specificity , positive predictive value, negative predictive value and accuracy of real time elastography for breast lesions.

Material and Methods: Sample of 100 patients presenting with breast lump on which Elastographic sonography was done in Radiology department during the period, January 2018 to December 2018 at SDM Medical College and Hospital, Dharwad, Karnataka.
Strain ratio were calculated and a cut off ratio of 3 was taken. A ratio above 3 was considered positive for malignancy and below 3 was considered to be benign. These findings were correlated with pathological investigations findings.

Results: Out of 100 patients examined sonographically with breast lumps, 45 were malignant cases and 55 were benign cases. Sensitivity, specificity, PPV and NPV were 87%, 91% and 89% and 89% respectively. Significant correlation between Strain ratio and pathological outcome were found. Mean strain ratio for malignant lesions was 3.55 +\-1.46 m\s and that for benign lesions were 1.86 +\-1.32m\s.

Conclusions: In our studies sensitivity, specificity, PPV, NPV and accuracy of strain elastography were good. So we can conclude that Strain elastography is very helpful in screening and diagnosing the malignant breast lesions, hence decreasing the need of biopsies to diagnose malignant lesions.

Keywords: Strain elastography, PPV, NPV, semiquantitative etc.

Introduction

Breast cancer is the most common cancer in the world accounting for 36.4 % and 35.3% of all cancers in the world and India respectively. In India, it is the most common cause of mortality among cancer related deaths (10.3 %). Hence awareness is needed for detecting breast cancer in its early stages without causing much discomfort to the patient, to decrease morbidity and mortality. [1]

Breast cancer is initially evaluated by palpation, mammography and sonography, but these are neither sensitive nor specific as they do not differentiate between benign and malignant solid breast lesions. Biopsies too are needless in many cases as the cancer detection rate among all breast masses is only 10-30%. [2]

Considering the fact that malignant breast tissue is stiffer compared to surrounding fatty and fibro-glandular tissue, real time breast elastography is a newer non-invasive technique for their differentiation. [3]

The different elastographic methods available are compression or static elastography and dynamic elastography. Dynamic elastography is used in shear wave imaging and compression elastography is used in strain imaging in which case, external force is applied to displace the tissue and assess its stiffness. [4]

Strain elastography give three parameters:

- Elasticity score-qualitative method
- Distance ratio-qualitative method
- Strain ratio-semi quantitative method.

Breast elastography can significantly reduce the incidence of biopsies.

Aims & Objective of Study

1. To differentiate breast lesions as benign or malignant.
2. To correlate the results with pathological investigations done on those patients later.
3. To evaluate sensitivity, specificity, positive predictive value, negative predictive value, and accuracy of real time elastography for breast lesions.

Material and Methods

Philips affinity 50G USG machine equipped with Elastography software (compression) with linear high frequency transducer was used.

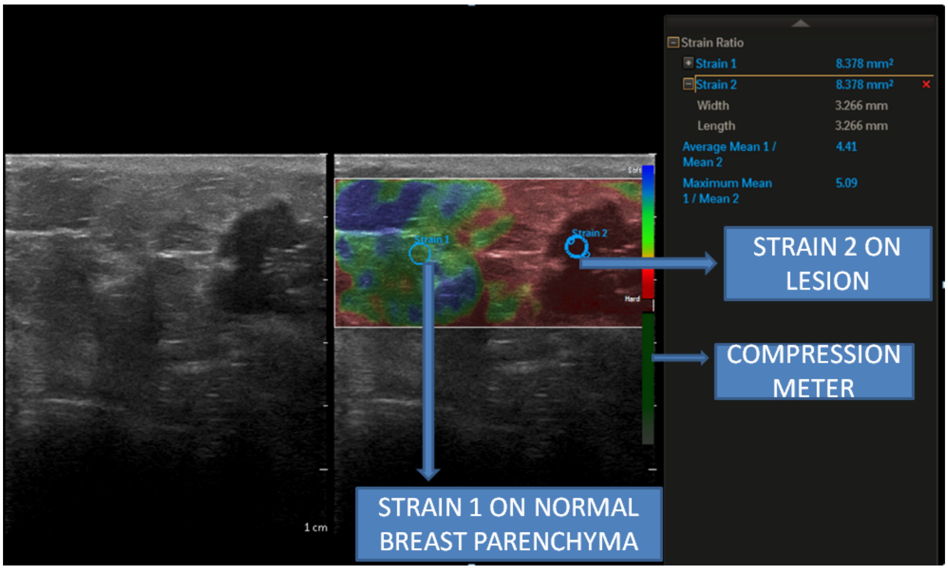
The study population consisted of 100 patients of breast lump attending Surgery outpatient department of SDM College of Medical Sciences and Hospital, Dharwad and had been sent to the department of Radiology for investigation of the lesion during the period of one year (from January 2018 to December 2018).

Inclusion criteria: Age group 11 to 90 years with breast lump. Patients giving consent for evaluation of breast examinations.

Exclusion criteria: Patients who had biopsy done of breast lesions. Patients previously operated for breast conditions.

A brief history with physical examination was done. Both the breasts were scanned using gray scale ultrasonography to localise and quantify the lesion/lesions. After switching the strain elastography on, and positioning the ultrasound probe on the lesion of interest, gentle compression followed by retraction was given. The image was captured when compression meter at the left side of monitor (green) reached its highest point.

Based on computer aided calculation, ratio of average mean of strain 1 to average mean of strain 2 was calculated, and the result was noted.



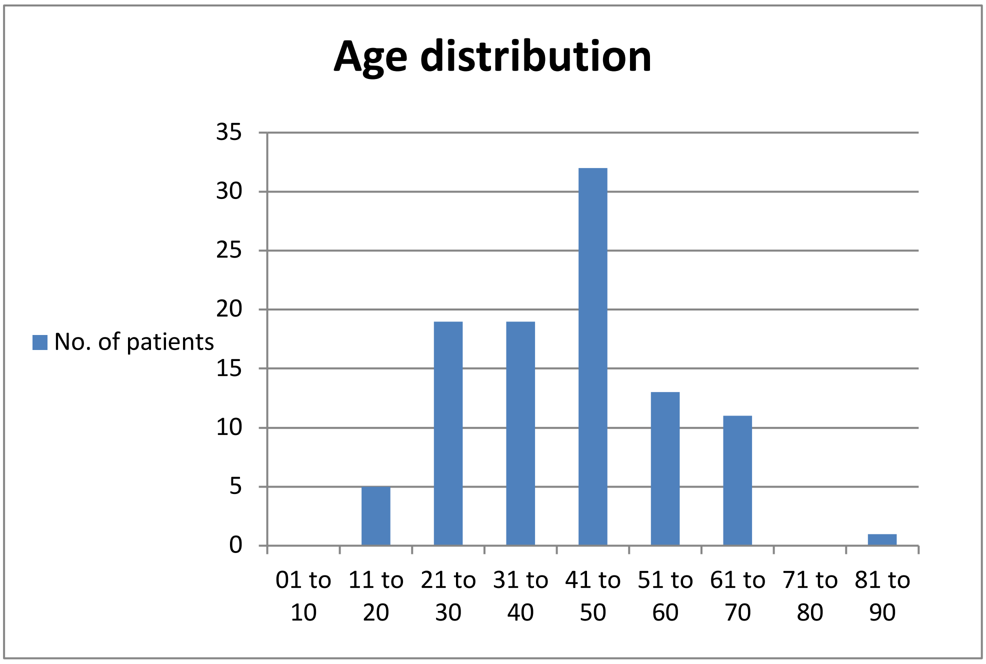
Picture 1: Method of data collection

Results of pathological investigations (Fine needle aspiration cytology/ histopathological examination/true cut biopsy) were noted and compared with results of USG strain Elastographic results of breast mass lesions.

Results

The evaluated parameters were interpreted as follows:

Age Distribution:



Picture 2: Bar diagram depicting age distribution

The patients in our study group ranged from 11 to 90 years, mean age being 41.4 ± 0.98 years. The patients were mostly in fifth decade of life followed by third and fourth decades.

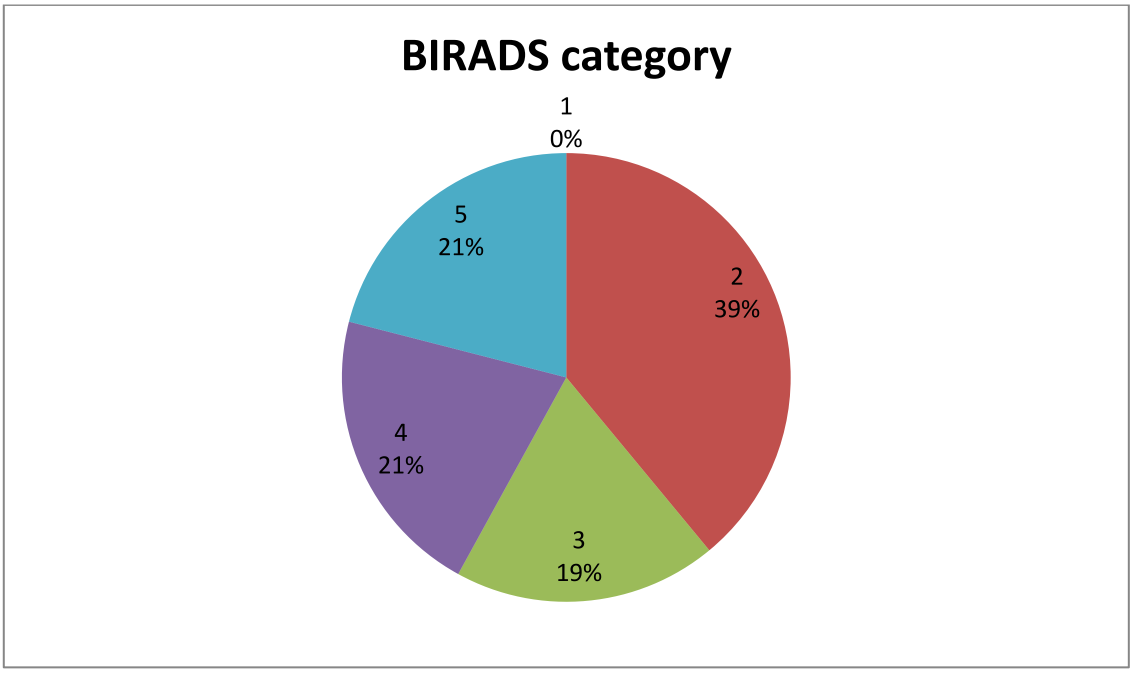
Sex distribution: we had no male patients.

Quantification of lesions: single lesions were encountered in 77% and multiple lesions in 23%.

Side of breast affected: 52% lesions were found in left breast and 48% in right. Bilateral lesions were not found in our study.

Nature of lesions found: A large portions of lesions found in our study were solid (88%) trailed by mixed types (8%) and cystic types (4%).Elastography is most helpful in portrayal of solid lesions and has a restricted job in cystic types as stated by previous studies.

BI-RADS distribution of breast mass lesions :



Picture 3: Pie Diagram depicting BIRADS distribution of Breast mass lesions.

Based on Grey Scale features of lesions (shape, orientation, margins, echo pattern, posterior features, calcifications and vascularity), individual lesion was assigned a BI-RADS score. Category of the lesions was as follows and as stated by ACR BIRADS 5th edition:

BI-RADS category 1 (Negative): 0 %

BI-RADS category 2 (Benign): 39 %

BI-RADS category 3 (Probably benign): 19 %

BI-RADS category 4 (Suspicious): 21 %

BIRADS category 5 (Highly suggestive of malignancy): 21 %

BI-RADS category 6 (Known biopsy-proven malignancy): Not included in our study.

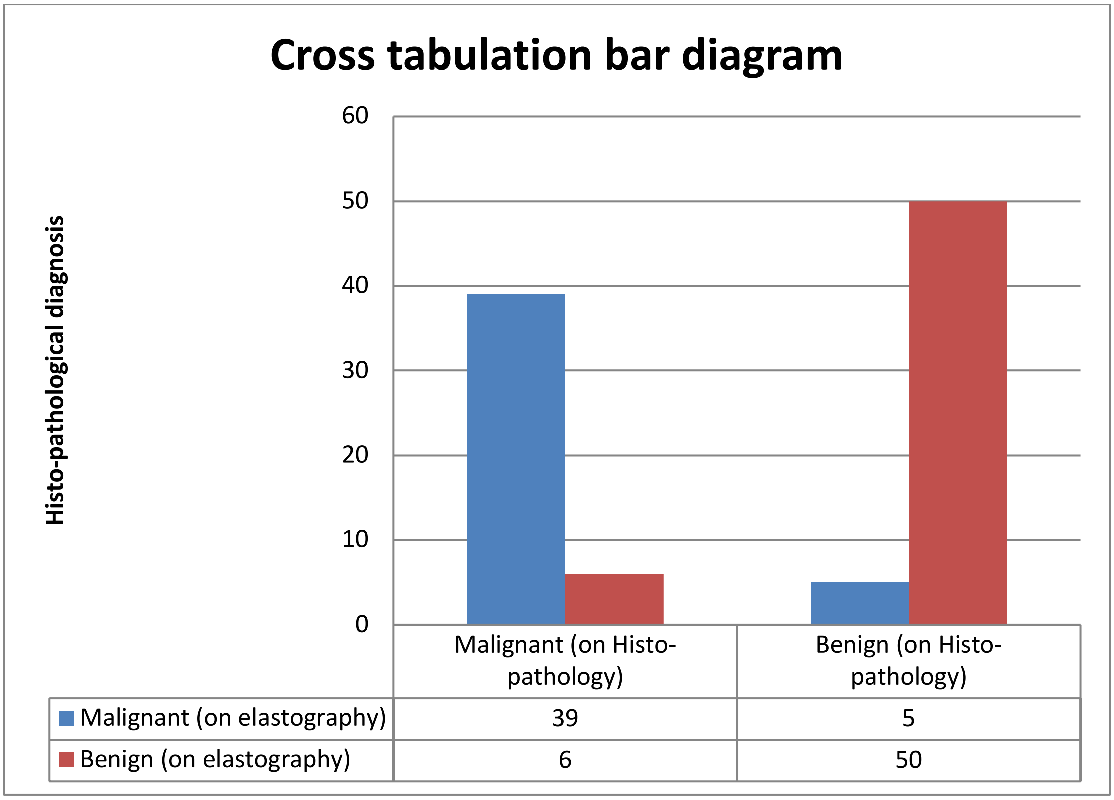
Histopathological distribution of lesions: 55% cases were benign, of which most frequently discovered were fibroadenoma (35 cases) and breast abscess (7 cases).

45% cases were malignant, of which most widely recognised were invasive ductal carcinoma (27 cases) and ductal carcinoma in situ (13 cases).

Correlation between Strain Ratio and histopathological outcome:

After calculating the strain ratio for the lesions, each strain ratio was correlated with the histopathological report for comparison. A ratio of 3.0 and above was considered as positive for malignancy and a ratio of less than 3.0 was considered benign.

Distribution of benign and malignant breast mass lesions:



Picture 4 : Bar diagram depicting Elastography and Histo-pathological distribution of benign and malignant lesions

Out of the 45 malignant lesions in our study, strain elastography was able to correctly detect 39 lesions. Out of the 55 benign lesions in our study, 50 lesions were correctly detected by evaluation of strain ratio.

On the basis of these findings:

sensitivity, specificity, positive predictive value, negative predictive value and accuracy were calculated which were as follows :

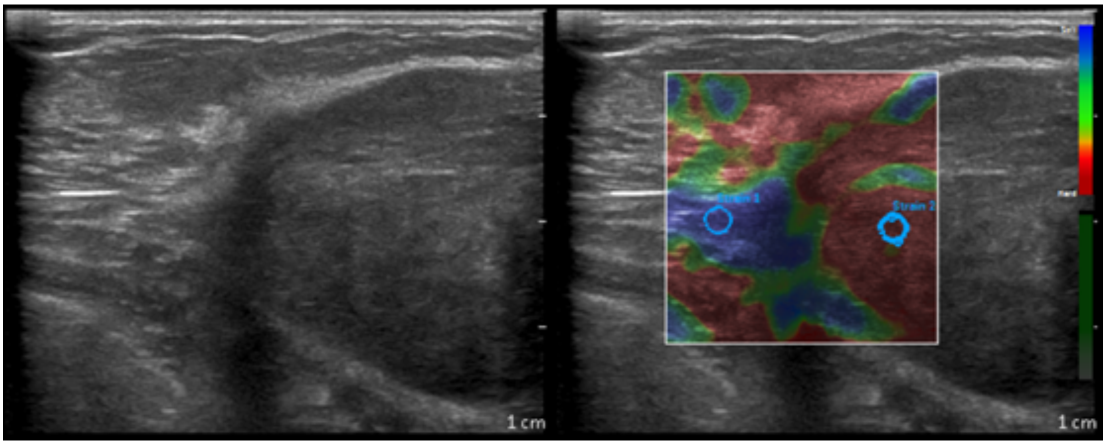
Table no 1 : Sensitivity, Specificity, positive predictive value, negative predictive value and accuracy of Strain Ratio with respect to Histo-pathology

Parameters.	Strain elastography vs Histo-Pathology CI (95%)
Sensitivity.	86.7% (73-95 %)
Specificity.	90.9% (80-97 %)
Positive predictive value.	88.6% (77-97%)
Negative predictive value.	89.3 % (80-95%)
Accuracy.	89 % (81-94 %)

The relation between Strain Ratio and Pathological outcomes was of good value as described below:

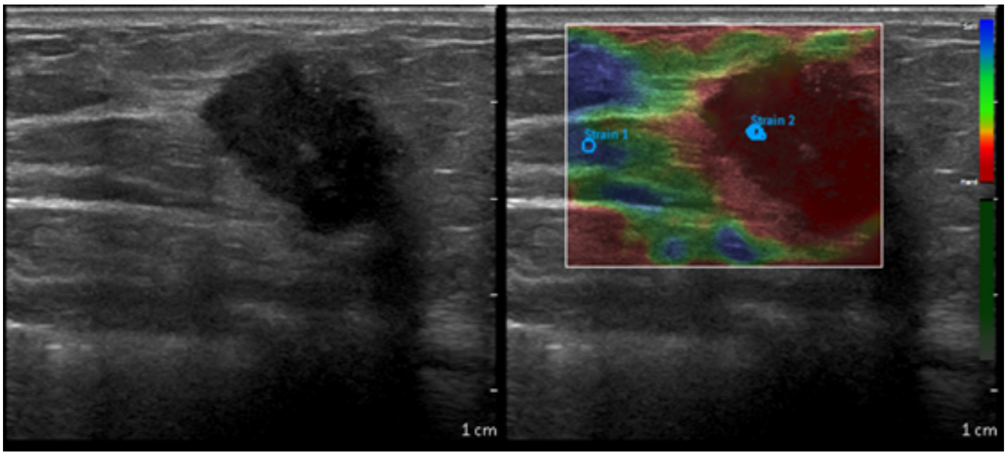
With a p value of <0.001, we found a **significant** co-relation between Strain Ratio and Pathological outcome.

Case 1:



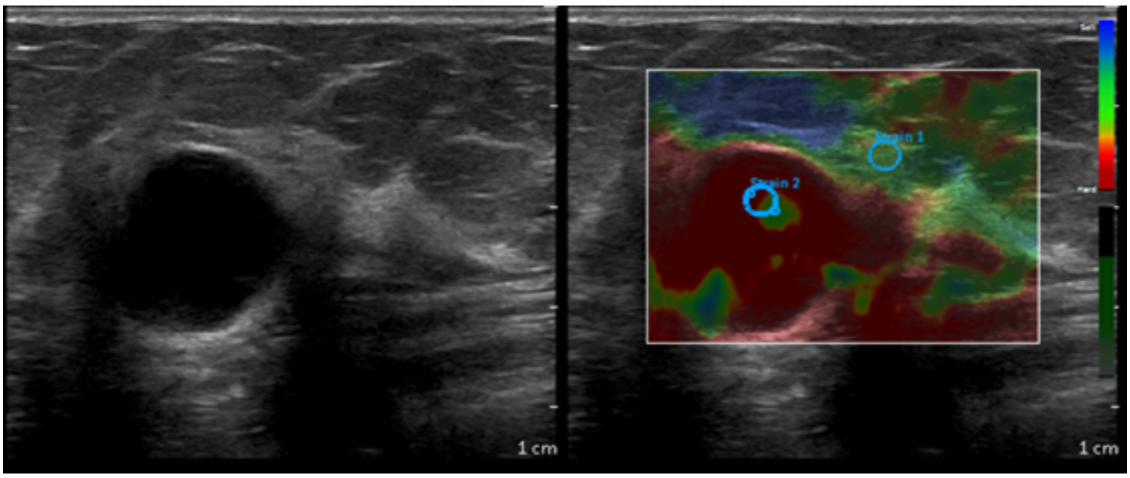
Picture 5: Grey scale appearance and Strain Ratio calculation of fibroadenoma

Case 2:



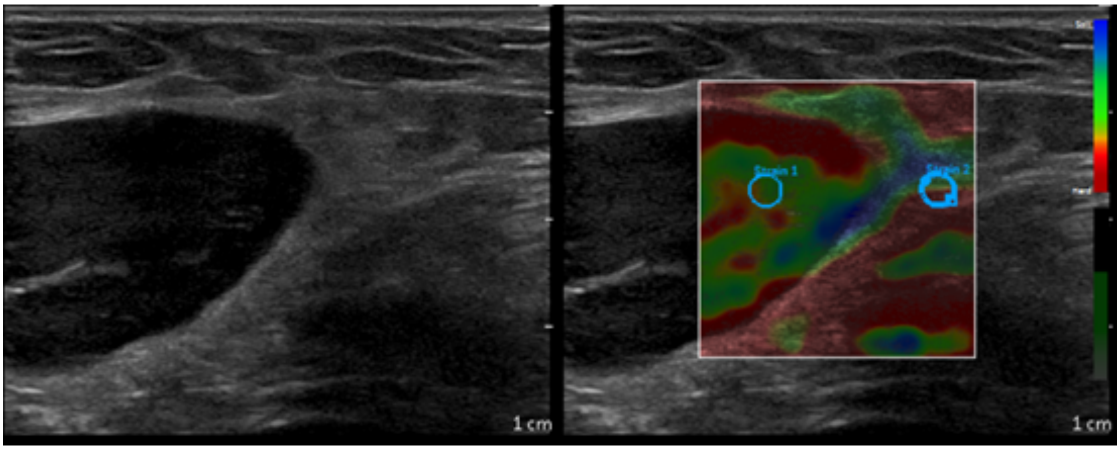
Picture 6: Grey scale appearance and Strain Ratio calculation of Invasive Ductal Carcinoma

Case 3:



Picture 7: Grey scale appearance and Strain Ratio calculation of benign cyst

Case 4:



Picture 8: Grey scale appearance and Strain Ratio calculation of Tuberculous lymphadenitis

Discussion:

Manual palpation of tissue is an irreplaceable diagnostic tool in modern medicine, but it is limited to tissues that are accessible to examining hands. Here comes the role of medical imaging that converts the sense of touch into a digital image. [5]

The techniques of elasticity imaging that are focussed on estimating static or dynamic tissue strain are called techniques of strain imaging. In 1983, Fujimoto demonstrated the use of ultrasonic dynamic experiments to determine breast tumour compressibility and mobility by applying USG transducer. [6]

In 1997, Garra showed that elastography can be performed when the patient lies down by pressing against the chest wall. He also proved that malignant lesions were harder than benign ones and the adjacent breast tissue. Current trend includes strain ratio measurement between the mass and surrounding normal tissue. [7]

Hui Zhi conducted a study in 2004 -2005 to assess the role of ultrasound elastography (UE) in differentiating benign versus malignant lesions in breast and compare it with conventional sonography and mammography. They compared the results with histopathological findings, and concluded that UE was the most specific (95.7%) and had lowest false positive rate (4.3%)of the three modalities. They concluded that a combination of UE and sonography had the best results in detecting cancer and potentially could reduce unnecessary biopsy. [8]

A study done by Thomas showed that real time elastography improves the specificity of breast lesion diagnosis.

Navarro conducted a study in 2010-2011 to evaluate the diagnostic utility in differentiating benign from malignant breast lesions and comparing it with sonography. [9]

American College of Radiology Breast Imaging Reporting and Data System came out with a result that elastography may be useful as a complementary technique in addition to sonography in diagnosing breast lesions.

Cho et al concluded that combined UE and colour Doppler US increases sensitivity and specificity in diagnosing benign and malignant breast masses.

Yagtu et al (2013-14) reported that elastography is not a method that can replace conventional breast ultrasound for detecting breast cancer; it may be an adjunct to it by increasing its diagnostic power.

Owvass Hamied et al (2014) concluded that UE can be used in early diagnosis and differentiation of breast masses into benign and malignant and can be influential in reducing the number of breast biopsies.

A significant co-relation between Strain ratio and Pathological outcome was noted in our study with sensitivity and NPV of 86.7% and 89.3 % respectively. Specificity and PPV of 82% and 91% were noted respectively. Accuracy of the test was established as 89.0%. This goes on to underline the fact that strain ratio elastography is a good modality for breast cancer screening.

The findings from our study are consistent with the studies done before.

Conclusion :

Breast cancer being the most common cancer among women causing significant mortality and morbidity requires proper screening to detect early lesions for early intervention. Grey-scale ultrasonography and mammography along with breast-self-examination and clinical examination have been the prime modalities for screening of these lesions till date; however due to their low specificity, most of the patients having benign lesions need to undergo biopsy for confirmation of the nature of lesion. This affects the patient mentally, physically and financially even if the lesion is not malignant. Being in an era of advanced medical facilities, we need techniques which are most beneficial and least harmful to the patient.

Strain ratio elastography is a novel technique with limited data about its diagnostic performance. The sensitivity, specificity, positive predictive value, negative predictive value and accuracy of strain elastography was good in our study but is a semi-quantitative and partly operator dependent method. Concurrent grey scale ultrasonography helps in a better and more confident diagnosis and when combined, they have the potential to non-invasively diagnose breast malignancies, significantly decreasing the need for biopsies and resultant morbidity to the patient.

However, regular follow-up and more studies about the diagnostic performance with standardization of cut-off ratios is advised

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