# Role of Ultrasound Strain Ratio Elastography in Diagnostic Breast Imaging

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**Abstract:** ***Aim and Objectives**: 1) To establish and assess the diagnostic accuracy of the role of strain ratio elastography in characterization of breast masses, compared to conventional B mode ultrasonography. 2) To establish strain ratio cut off in differentiating between benign and malignant breast lesions. **Materials and Methods**: The study was conducted in our institute for a period of 6 months and included 101 female patients using inclusion and exclusion criteria. **Protocol**: Patients with breast mass were subjected to conventional B-mode breast ultrasonography by radial scanning pattern using very high frequency transducer (7.5-12MHz) of Hitachi Aloka arietta 70 and categorization was done according to BIRADS categories, then elastography mode was appliedto calculate the strain ratio (SR). Histopathological assessments were done. **Results**: Based on the ROC curve, the strain ratio cut off of 2.69 was established in differentiating benign and malignant breast lesions. The area under the curve of B mode USG based on BIRADS was 0.891, p value of 0.0005 (Statistically significant) under 95% CI. The area under the curve for strain ratio was 0.925. p value of 0.005 (statistically significant) under 95 % CI. The characterization based on BIRADS showed sensitivity of 78.1%, specificity of 100%, PPV of 100 %, NPV of 90.8% and accuracy of 93.1 %. The characterisation using strain ratio showed sensitivity of 93.8%, specificity of 91.3%, PPV 83.3%, NPV 96.9% and accuracy of 92.1%. **Conclusion**: Strain ratio elastography can be used as non-invasive tool to help in characterisation of benign and malignant breast lesions. Strain ratio elastography plays a significant role in complementing the conventional B mode ultrasonography for differentiation of benign and malignant lesions, thus preventing unnecessary intervention.***

**Keywords:** Ultrasound elastography, Strain ratio, breast lesions, B mode ultrasound

## 1. Introduction

Breast cancer is the leading cause of cancer deaths among female population worldwide.Based on world health organisation statistics, in 2020, about 2.3 million women were diagnosed with breast cancer and there were 685 000 deaths globally. As of the end of 2020, in the past 5 years, there were 7.8 million women alive who were diagnosed with breast cancer, making it the world's most prevalent cancer. Breast ultrasound elastography is a unique sonographic imaging technique that, in addition to standard ultrasonography (US) and mammography, gives information on breast lesions. Ultrasound elastography is a non-invasive method of determining a lesion's "stiffness" [(1)]. Recent studies indicate that ultrasonographic elastography (USE) offers higher diagnostic accuracy during breast cancer detection than standard B-mode ultrasonography, which helps to reduce falsepositive results and hence important in avoiding breast biopsy.

### Aim and Objectives

- To establish and assess the diagnostic accuracy of the role of strain ratio elastography in characterization of breast masses, compared to conventional B mode ultrasonography.
- To establish strain ratio cut off in differentiating between benign and malignant breast lesions.

## 2. Materials and Methods

The study was conducted in our institute for a period of 6 months and included 101female patients.

**Inclusion criteria:**

- Patients attending to OP ultrasound with breast mass.
- IP patients with breast mass.

**Exclusion criteria:**

- Unwilling patients.
- Breast implants.
- Superficial lesions (<5 mm deep to skin surface)

### Protocol

Patients with breast mass were subjected to conventional B-mode breast ultrasonography by radial scanning pattern using very high frequency transducer (7.5-12MHz) of Hitachi Aloka arietta 70 and categorization was done according to BIRADS categories, then elastography mode was applied, to calculate the strain ratio (SR). Histopathological assessments were done.

## 3. Representative Cases

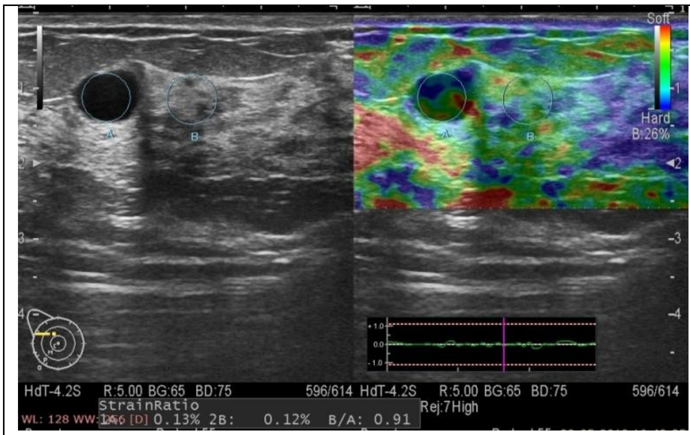


**Figure 1. Breast cyst**

**B MODE USG**-A well circumscribed oval anechoic lesion in the right breast with posterior acoustic enhancement -
**Breast cyst**- BIRADS-2

**ASPIRATE CYTOLOGY**- negative for malignant cells

**STRAIN RATIO-0.91**

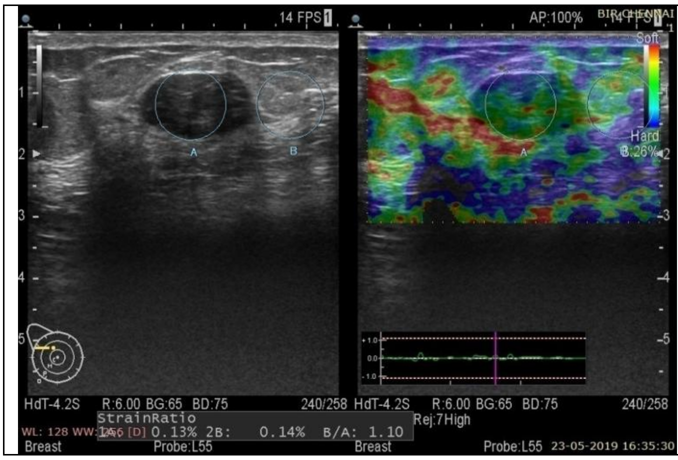


**Figure 2. Fibroadenoma**

**B MODE USG**-A well circumscribed oval hypoechoic lesion noted in 6 o clock position of left breast, BIRADS-2.

**STRAIN RATIO1.10**

**HPE -Fibroadenoma**

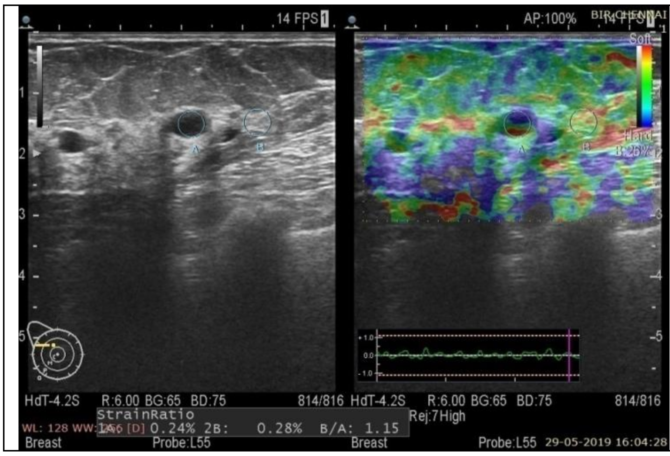


**Figure 3 -Fibrocystic disease**

**B MODE USG**-prominent fibro glandular tissue with multiple diffuse small cysts, - Fibrocystic disease - BIRADS-2.

**STRAIN RATIO: 1.15**

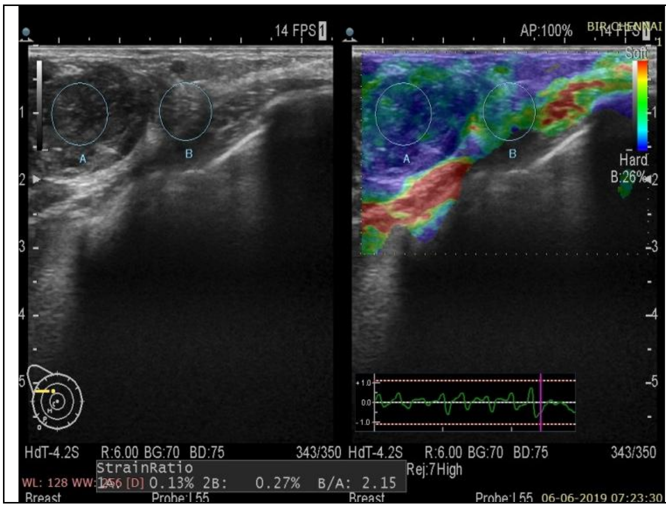


**Figure 4 – Phyllodes tumour**

**B MODE USG** shows heteroechoic solid appearing mass containing multiple clefts like spaces in zone 1-2 at 9 o clock to 12 o clock position of left breast -BIRADS-3

**STRAIN RATIO: 2.15**

**HPE – Phyllodes tumour**

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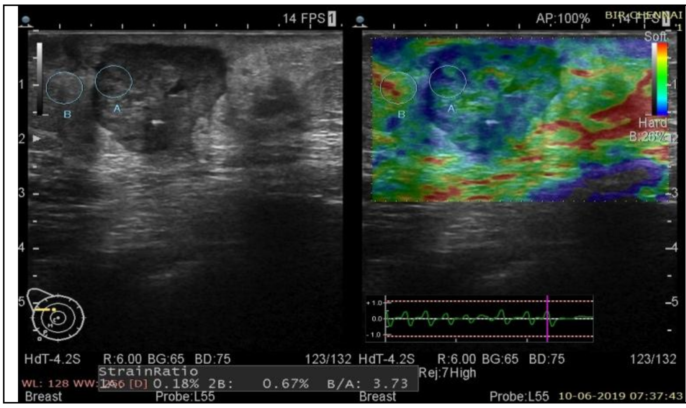



**Figure 5 -Ductal carcinoma**

**B MODE USG** shows ill-defined heteroechoic lesion with cystic spaces and specks of calcification in Zone 2 at 7 o clock position of right breast, BIRADS-4

**STRAIN RATIO – 3.73**

**HPE – Ductal carcinoma**

## 4. Results

In our study, out of 101 patients, benign lesions were 69 (68%) and malignant lesions were 32(32%) as shown in figure 6. Fibroadenoma was the most common benign lesion [2] (35%) and ductal carcinoma was the most common malignant lesion [3] (19%), corresponding to the literature. The percentage distribution of histopathology results of cases in our study are shown in figure 7.

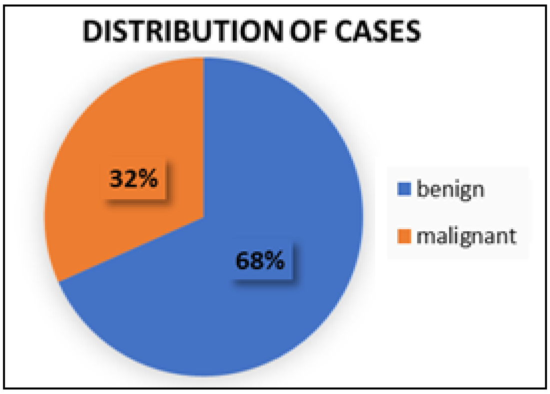



**Figure 6:** Distribution of cases

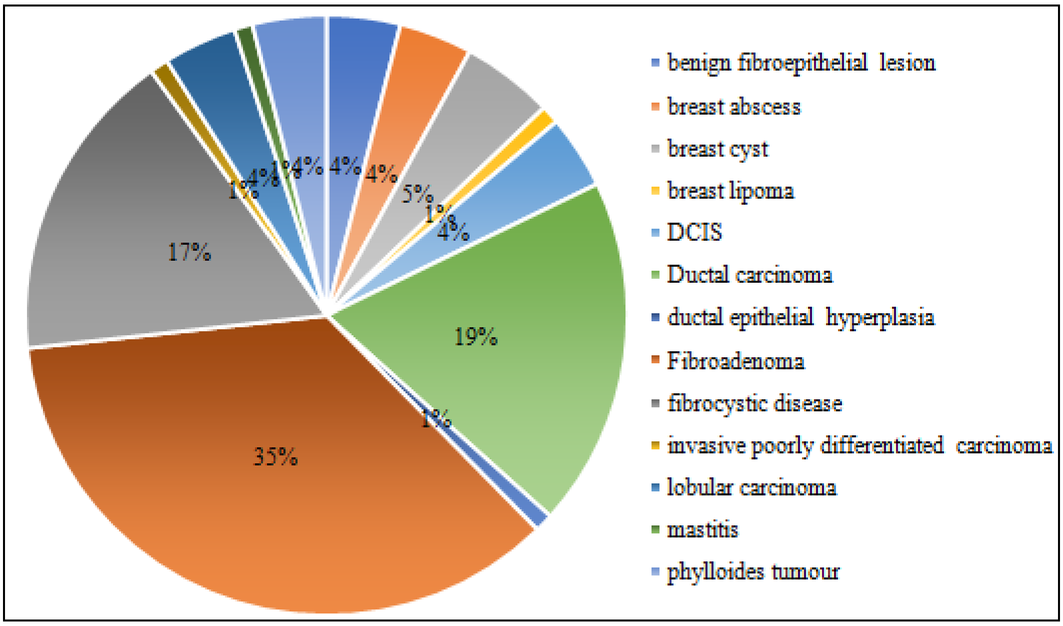
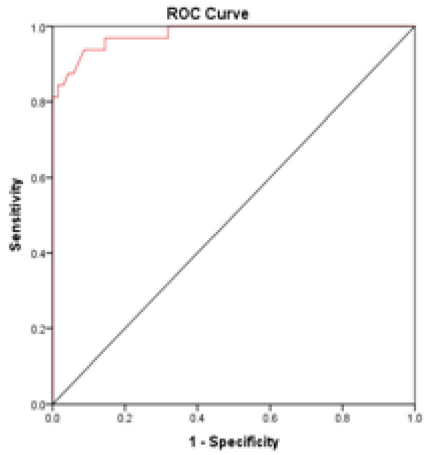



**Figure 7:** The percentage distribution of histopathology results

## 5. Statistical Analysis

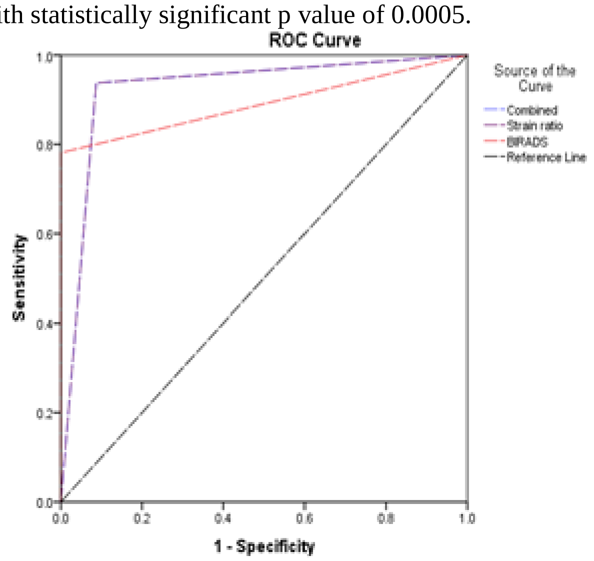
The collected data were analysed with IBM SPSS Statistics for Windows, Version 23.0.(Armonk, NY: IBM Corp).To describe about the data descriptive statistics frequency analysis, percentage analysis was used for categorical variables and the mean & S.D were used for continuous variables. To find the efficacy of the tools to predict the malignancy the Receiver Operating Characteristics curve (ROC) was used with sensitivity,specificity, NPV& accuracy. In the above statistical tool, the probability value .05 is considered as significant level.

The receiver operator curve analysis with strain ratio as variable was done.The area under the curve was 0.979 with ***p value of 0.0005 which is statistically significant***, under 95% confidence interval limits from 0.956 to 1.000. Based on the ROC curve, **the strain ratio cut off of 2.69** was established in differentiating benign and malignant breast lesions



Diagonal segments are produced by ties.

Based on the ROC curve, the area under the curve of B mode USG based on BIRADS was 0.891, ***p value of 0.0005 (Statistically significant)***under 95% confidence interval limits from 0.803 to 0.978. The area under the curve for strain ratio was 0.925. ***p value of 0.005 (statistically significant)***under 95 % confidence interval limits from 0.863 to 0.987. The area under the curve of combined BIRADS and strain ratio was similar to that to strain ratio with statistically significant p value of 0.0005.



Diagonal segments are produced by ties.

**Area under the curve**

**Table 1:** Statistical analysis of Strain ratio and BIRADS

| Test Result Variable(s) | Area | p-value | 95% C.I | |
|---|---|---|---|---|
| | | | LB | UB |
| Strainratio | .925 | .0005 | .863 | .987 |
| BIRADS | .891 | .0005 | .803 | .978 |

** p value-Highly Significant at $p < 0.01$

The characterization based on BIRADS showed sensitivity of 78.1%, specificity of 100%, PPV of 100 %, NPV of 90.8% and accuracy of 93.1 %. The characterisation using strain ratio showed sensitivity of 93.8%, specificity of 91.3%, PPV 83.3%, NPV 96.9% and accuracy of 92.1%.

## 6. Discussion

J Ophir et al, 1991 first described Strain Elastography[4]. Elastography is a non-invasive technique which assess tissue elasticity. This technique is applicable to a variety of organs (Breast, Thyroid, Liver, Prostate, MSK, Gynaecology, …).

The novel imaging technique aims at imaging the tissue stiffness, which provides an additional relevant information for the clinicians. Even though tissue diagnosis by biopsy is the gold standard tool for characterisation of breast masses, it cannot be done in all patients as it is expensive and invasive. Hence, strain elastography acts as a complimentary paradigm for characterisation of benign andmalignant breast lesions.

In general, Malignant breast lesions have higher strain ratios than benign lesions. This might reflect that there exists different degree of stiffness between benign and malignant lesions [5].

The results of sensitivity and specificity of strain elastography of our study are better than few of other studies in literature such as Bojanic et al[6] ,kumm et al[7] ,Yilmaz et al[8] and almost similar results when compared to studies Gheonea et al [9] , Ahmed et al [10] and zhi et al[11] However, our study results showed higher specificity for conventional ultrasound imaging than strain elastography for unknown reasons, which is contrary to most of the studies in literature. Kumm et al[7] andYilmaz et al [8] also reported lower sensitivity and specificity for sono-elastography when compared with conventional B mode ultrasound.

Kumm et al[7] suggested that NPV of a diagnostic test should approach 0.98 to characterize a lesion as benign confidently. The NPV of strain elastography of our study was 96.9 %.

The accuracy of our study using strain elastography was 92.1% which is similar to study by Dimpisanha[12] (92%) and better than Bojanic et al[6] (86.9%), however, sample size was less when compared to these studies.

Strain ratio cut off in differentiating between benign and malignant lesions was established as 2.69 in our study. Deniz ozel et al[13]reported 3.1 as cut off, 3.0 was the cut off in Dimpi Sinha et al study [12] ,3.5 in Bojanic et al[6], 4.25 in Yilmaz et al[8], 3.67 in Gheonea et al[9], 2.57 in Ahmed et al[10], 3.01 in Zhi et al[11]and 2.45 in Thomas et al[14].The variation in strain ratio cut off values about different studies may be attributed to the inconsistent placement of ROI box and interoperator variability. The ROI box should be of equal size and should be placed at its cm depth at the lesion as well as at adjacent fat for optimal elastography study. The interoperator variability occurs because of the variation in magnitude of external compression.

In our study, out of 69 benign lesions, 4 benign lesions had higher strain ratio values more than cut off. Similarly, out of 32 malignant lesions, 2 had lower strain ratio values than the established cut off. Hence, any lesion can have the propensity to be malignant. Thus, combined use of grey scale and elastography are needed to avoid unnecessary biopsies.

The limitations of our study carry general limitations of strain elastography which include variation in external probe pressure and operatordependency [(15).] Our study was a single centre study and we did not use shear wave elastography technique to avoid the effect of operator dependency, which could be considered as limitations. Intraobserver variations were not analysed in our study.

## 7. Conclusion

Strain ratio elastography can be used as non-invasive tool to help in characterisation of benign and malignant breast lesions.Strain ratio elastography plays a significant role in complementing the conventional B mode ultrasonography for differentiation of benign and malignant lesions therefore preventing unnecessary intervention. However, all solid breast lesions still have the possibility to be malignant, even though B mode ultrasoundand strain ratio elastography findings contradict the same. Future studies using shear wave ultrasound elastography can be conducted to overcome the limitations of strain elastography.

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