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Original Research Article

# Assessment of Breast Lesions by Sonoelastography with Histopatho / Cytological Correlation

**Maitry R. Talavia[1], Kavita U. Vaishnav[2], Harshil K. Patel[3], (Maj.) Deepak K. Rajput[4], Rutvik G. Patel[5], Jay M. Chaudhary[6], Harsh Jagetiya[7]**

[1]Third Year Postgraduate, Department of Radio-Diagnosis, Narendra Modi Medical College, LG Hospital, Ahmedabad, Gujarat, India

[2]Professor (Higher Grade), Department of Radio-Diagnosis, Narendra Modi Medical College, LG Hospital, Ahmedabad, Gujarat, India

[3]Assistant Professor, Department of Radio-Diagnosis, Narendra Modi Medical College, LG Hospital, Ahmedabad, Gujarat, India

[4]Professor and Head of Department, Department of Radio-Diagnosis, Narendra Modi Medical College, LG Hospital, Ahmedabad, Gujarat, India

[5]Third Year Postgraduate, Department of Radio-Diagnosis, Narendra Modi Medical College, LG Hospital, Ahmedabad, Gujarat, India

[6]Third Year Postgraduate, Department of Radio-Diagnosis, Narendra Modi Medical College, LG Hospital, Ahmedabad, Gujarat, India

[7]Second Year Postgraduate, Department of Radio-Diagnosis, Narendra Modi Medical College, LG Hospital, Ahmedabad, Gujarat, India

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**Corresponding Author: Dr. Harshil K. Patel**

**Conflict of interest: Nil**

**Abstract**

**Introduction:** Breast lesions encompass wide spectrum of pathologies, ranging from benign conditions such as fibroadenomas to malignant neoplasms like invasive ductal carcinoma. Early and accurate characterization of these lesions is critical for appropriate clinical management, timely intervention, and avoidance of unnecessary invasive procedures. Conventional B-mode ultrasonography is widely used, non-invasive imaging tool for initial evaluation of breast abnormalities. However, it has limitations, particularly in differentiating benign from malignant lesions, which can lead to false positives and unnecessary biopsies. Sonoelastography, an advanced ultrasound technique that assesses tissue stiffness, has emerged as valuable adjunct in breast imaging. Malignant lesions tend to be stiffer compared to benign ones, and elastography leverages this difference to improve diagnostic specificity.

**Aims and objectives:** (1). To evaluate the role of sonoelastography in the characterisation of breast lesions. (2). To study added benefit of sonoelastography in differentiation of benign and malignant breast lesions with histopatho/cytological correlation.

**Materials and Methods:** Females with complaints of pain / lump in breast referred to Department of Radio-diagnosis who have positive ultrasonography findings from period of July 2024 to July 2025 were taken. A prospective analytical study of all patients was subjected to B-mode ultrasound and sonoelastography. Histopatho/cytological results were taken as gold standard. 80 patients of age groups 20 to 70 years were evaluated. Ultrasound machine equipped with real time elastography software and Linear probe with bandwidth of 3-12 MHz for B mode ultrasound and elastography was used for US and elastography.

**Results**: Overall breast lesions are most common in age group 31 to 40 years. Number of benign lesions decreases as age increases, highest in age groups 31- 40 years. Number of malignant lesions increases as age increases, is highest in age groups 41- 50 years.

The results indicate that elastography could be as effective as conventional ultrasound in characterizing breast lesions, as it enhances diagnostic specificity and thereby reduces the false positive rate.

**Conclusion**: Sonoelastography is a useful adjunct to conventional ultrasound, improving differentiation of benign and malignant breast lesions. Its correlation with histopathology/cytology supports its role in enhancing diagnostic accuracy and potentially reducing unnecessary biopsies.

**Keywords:** Breast lesions, B- mode Ultrasonography, Strain elastography.

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## Introduction

**Purpose of the Article:** The purpose of the article is to evaluate the effectiveness of sonoelastography in characterizing breast lesions, and to determine its additional value in differentiating benign from malignant lesions, using histopathological or cytological findings as the gold standard.

**Rationale for the Study:** Breast lesions can be benign or malignant, and accurate diagnosis is essential to guide treatment and avoid unnecessary procedures. While conventional ultrasound is widely used, it has limitations—especially in distinguishing benign from malignant lesions, leading to false positives and unnecessary biopsies. Sonoelastography, which measures tissue stiffness, may improve diagnostic accuracy. This study was conducted to assess whether adding sonoelastography to standard ultrasound can better differentiate between benign and malignant breast lesions and improve overall diagnostic reliability.

## Methods

**Inclusion Criteria:** Females with complaints of pain / lump in the breast referred to Department of Radio-diagnosis who have positive ultrasonography findings.

**Exclusion criteria**

- Patient who don't give consent for the study.
- Patient is not willing for FNAC.
- Patient with bleeding diathesis.

**Source of Data:** Females with complaints of pain / lump in the breast referred to department of Radio-diagnosis who have positive ultrasonography findings from period of July 2024 to July 2025 were taken.

**Study Design:** A prospective analytical study of all patients were subjected to B-mode ultrasound and sonoelastography. Histopatho/cytological results were taken as gold standard. 80 patients of age groups 20 to 70 years were evaluated.

**Equipment and procedure:** Mindray Resona I 9 Ultrasound Machine equipped with real time elastography software and Linear probe with bandwidth of 3 – 14 MHz for B mode ultrasound and elastography was used for US and elastography.

**Measurements**

1. The radiological findings on ultrasonography were recorded and accordingly BIRADS category were given using BIRADS classification by the American College of Radiology (2013)
2. Strain elastography was performed with slight probe pressure over the region of interest and lesions were graded according to the elastography scoring system (Tsukuba score) and elastography Strain ratio. The elastogram, is created as a colour coded map (the areas of great stiffness are coded in RED, those which are more deformable in BLUE, and GREEN indicates intermediate levels of elasticity.)
3. Cut off of >3 was decided to distinguish between benign and malignant lesions

## Results

**Table 1: Distribution of patients according to age**

| Age (Years) | Benign | Malignant | Total |
|---|---|---|---|
| 21-30 | 7 | 0 | 7 |
| 31-40 | 30 | 5 | 35 |
| 41-50 | 5 | 14 | 19 |
| 51-60 | 5 | 9 | 14 |
| >60 | 0 | 5 | 5 |
| Total | 47 | 33 | 80 |

Overall breast lesions are most common in age group of 31 to 40 years.
Number of benign lesions decreases as age increases, highest in the age group of 31 - 40 years.
Number of malignant lesions increases as age increases, is highest in age group of 41-50 years.

**Table 2: BIRADS category wise distribution**

| | |
|---|---|
| BIRADS 0: Assessment incomplete | 0 |
| BIRADS I: Negative | 0 |
| BIRADS II: Benign | 14 |
| BIRADS III: Probably benign | 16 |
| BIRADS IV: Suspicious of malignancy | 18 |
| BIRADS V: Highly suggestive of malignancy | 30 |
| BIRADS VI: Known biopsy proven case | 2 |
| Total | 80 |

**Table 3: BIRADS category-wise diagnostic performance**

| | COUNT | PERCENTAGE |
|---|---|---|
| TRUE POSITIVE | 32 | 40% |
| TRUE NEGATIVE | 34 | 42.5% |
| FALSE POSITIVE | 6 | 7.5% |
| FALSE NEGATIVE | 8 | 10% |

Sensitivity: 80%
Specificity: 85%
PPV: 84%
NPV: 81%

**Table 4: Elastography score wise distribution**

| **Tsukuba Score** | **Number of Patients** |
|---|---|
| SCORE 1 High strain throughout lesion (solid green) BGR pattern : cystic lesions | 10 |
| SCORE 2 (Mixed high and low strain - green and red) | 22 |
| SCORE 3 High strain at periphery (green) with low strain at centre(red) | 12 |
| SCORE 4 Low strain throughout lesion(red) | 18 |
| SCORE 5 Low strain throughout lesion and extend beyond lesion boundary (red) | 18 |
| Total | 80 |

**Table 5: Elastographycategory-wise diagnostic performance**

| | **Count** | **Percentage** |
|---|---|---|
| True Positive | 37 | 46% |
| True Negative | 36 | 45% |
| False Positive | 4 | 5% |
| False Negative | 3 | 3.8% |

Sensitivity: 92%
Specificity: 90%
PPV: 90%
NPV: 92.3%

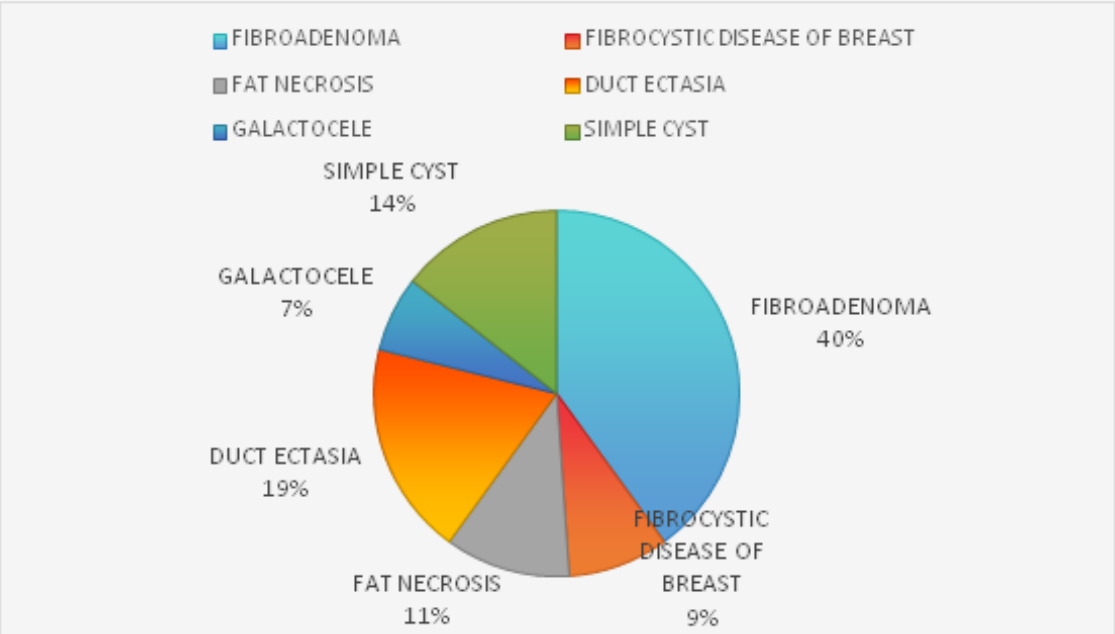


**Figure 1: Histopathological / Cytological Examination of Breastlesions**

## Discussion

This prospective analytical study evaluated the diagnostic utility of sonoelastography in differentiating benign from malignant breast lesions, with histopathology or cytology serving as the reference standard. The findings affirm the potential of sonoelastography as a complementary imaging modality to conventional B-mode ultrasonography, particularly in improving diagnostic accuracy and reducing unnecessary biopsies [8,9].

The age-wise distribution of lesions aligns with established epidemiological patterns. Benign lesions were more common in younger women (particularly between 31–40 years), while malignant lesions showed a rising trend with increasing age, peaking in the 41–50 year age group. This reinforces the age-dependent prevalence and malignant potential of breast lesions, underscoring the need for vigilant imaging-based screening in older age groups [10]. In our study, conventional ultrasonography showed a sensitivity of 80% and specificity of 85%, consistent with prior reports that indicate reasonable diagnostic performance but also highlight the risk of false positives—often leading to avoidable biopsies and patient anxiety [11]. In contrast, sonoelastography demonstrated markedly improved performance metrics, with a sensitivity of 92%, specificity of 90%, positive predictive value (PPV) of 90%, and negative predictive value (NPV) of 92.3%. These findings are in line with several previous studies. For instance, Itoh et al. introduced the Tsukuba scoring system and reported similarly high sensitivity and specificity in differentiating benign from malignant lesions using strain elastography [5]. The improved specificity observed in our study suggests that elastography can effectively reduce false positives by distinguishing firm malignant tissue from softer benign tissue based on elasticity differences [6,8,9]. The elastographic scoring in our study further strengthens these findings. Lesions with Tsukuba scores 1 and 2 were predominantly benign, whereas scores 4 and 5 were largely associated with malignancy. Notably, score 3, which represents intermediate strain patterns, had mixed histological outcomes and may warrant close radiologic-pathologic correlation or short-term follow-up imaging [12,13].

Our illustrative cases further highlight the diagnostic versatility of sonoelastography. For example, benign entities such as fibroadenomas and simple cysts consistently demonstrated low Tsukuba scores (1–2), whereas malignant lesions like invasive ductal carcinoma and liposarcoma showed higher scores (4–5). Importantly, even rare or histologically borderline lesions like phyllodes tumours and intraductal papillomas were evaluated with reasonable accuracy, suggesting a broader applicability of elastography [14]. Of the breast malignancies, ductal carcinoma is most common. Primary breast sarcomas are rare, accounting only 1 % of all breast malignancies, in our study we have included one case of liposarcoma - accounts for 0.3% of the breast sarcomas [16].

In conclusion, sonoelastography, when used together with B-mode ultrasound, significantly enhances the characterization of breast lesions. Its high specificity and NPV support its role in reducing unnecessary biopsies for benign lesions. The correlation with histopathology validates its diagnostic relevance, encouraging broader clinical adoption, particularly in resource-constrained settings where biopsy access may be limited [6,9,11].

Ultrasonography plays a vital role in the radiological evaluation of breast lesions, particularly as an adjunct to mammography. It can assess the morphology, orientation, internal structure, vascularity and margins of lesions from multiple planes with high resolution[15].

Ultrasonography offers significant advantages:

- Easy availability
- Absence of ionizing radiation
- Real time imaging
- Affordability
- Tool for guiding interventional procedures such as fine-needle aspiration or core needle biopsy.

**Table 6: Characteristics of sonogram evaluation of breast lesions[15]**

| Lexicon | Benign Tumor | Malignant Tumor |
|---|---|---|
| Shape | Oval, round | Irregular |
| Orientation | Parallel, wider than taller | Vertical, taller than wider. |
| Margin | Well defined, smooth | Iil defined, spiculated |
| Echogenicity | Hyperechoic, isoechoic, mildly hypoechoic | Markely hypoechoic |
| Posterior features | Enhancement, no change | Shadowing |
| Calcification | Absent | Micro calcification |
| Surrounding tissue | Compression, no alteration | Architectural distorsion |
| Retraction phenomena | Absent | Present |

Breast elastography is particularly useful in differentiating benign from malignant lesions: stiffer lesions are more likely to be malignant, guiding biopsy procedures: identifying the most suspicious areas of sampling, monitoring treatment response: assessing changes in tissue stiffness over time. It has certain limitations like operator dependency, technical factors and interpretation challenges.

1. **Case of Fibroadenoma**

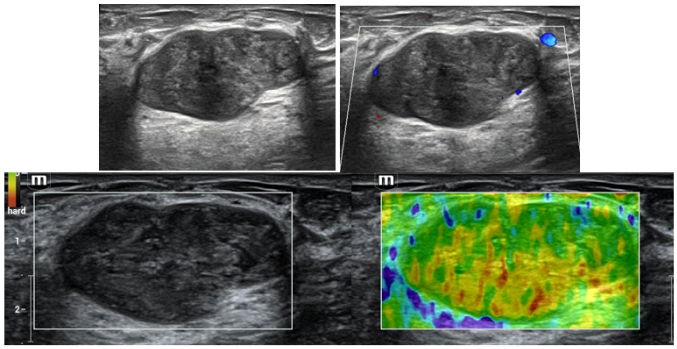

**Figure 2: 20 years old female patient presented with C/o lump in right breast since 2 months; USG - Single well defined oval hypoechoic lesion without internal vascularity; BIRADS - 3; TSUKUBA SCORE – 2; HPE - Benign proliferative lesion s/o Fibroadenoma**

2. **Case of simple cyst**

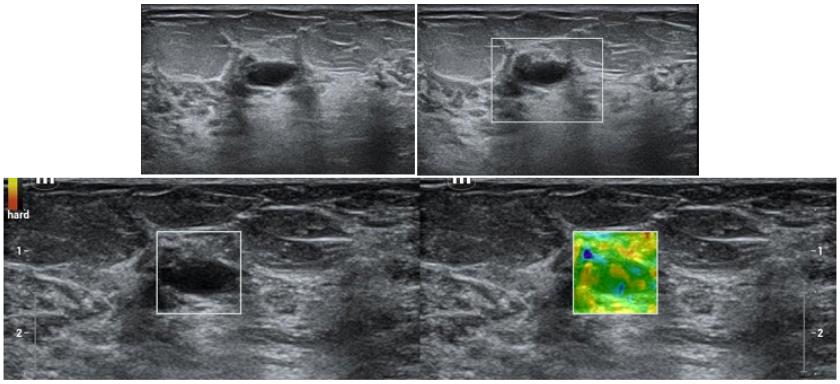

**Figure 3: 28 years old female patient with C/o right breast pain since 2 months; USG - Single well defined anechoic cystic lesion without internal vascularity; BIRADS – 1; TSUKUBA SCORE – 1; HPE - Benign cystic lesion**

3. **Case of Galactocele**

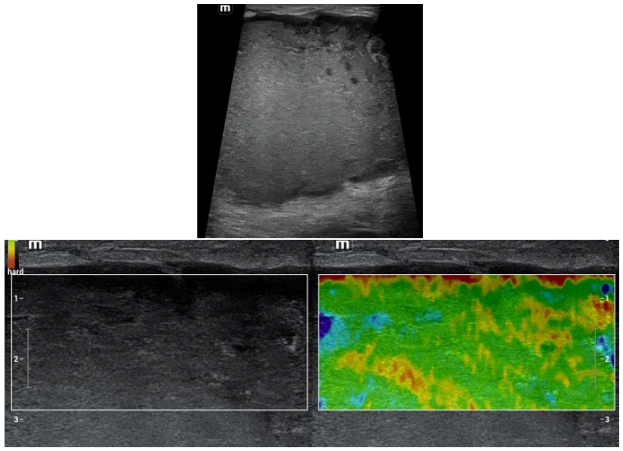

**Figure 4: 25 years old lactating female with complain of right breast pain since 1 week; USG - Well defined hypoechoic lesion with internal moving echoes without internal vascularity; BIRADS – 1; TSUKUBA SCORE – 1; HPE – Galactocele**

4. **Case of Invasive Ductal carcinoma**

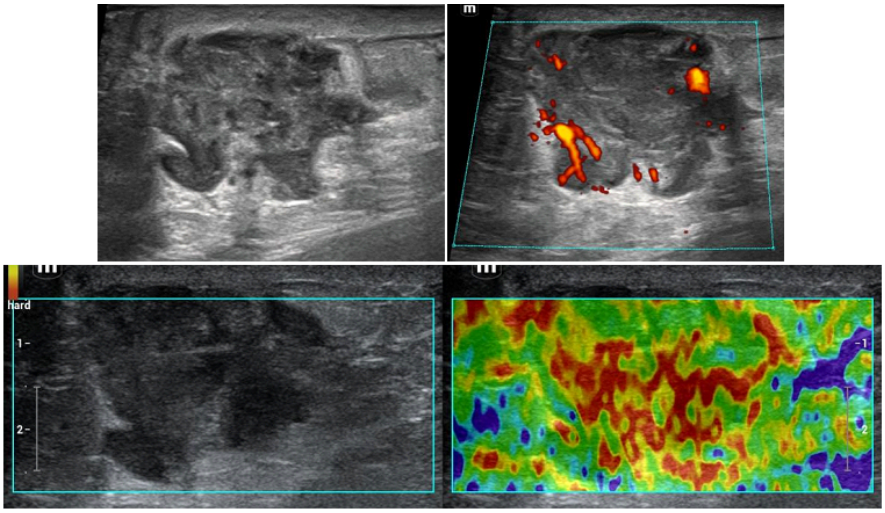

**Figure 5: 60 years old female with complain of left breast lump since 5-6 months associated with significant weight loss; USG - Well defined irregular marginated hypoechoic lesion with internal vascularity; BIRADS – Iva; TSUKUBA SCORE – 4; HPE - Invasive ductal carcinoma**

**5. Case of intraductal papilloma**

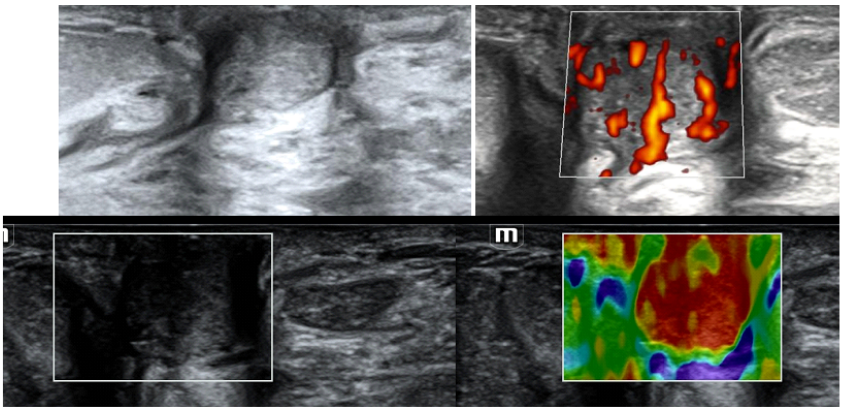

**Figure 6: 31years old female with complain of bloody discharge from nipple of right breast since 15-20 days; USG - Well circumscribed smooth marginated oval hypoechoic intraductal mass with significant internal vascularity; BIRADS – III; TSUKUBA SCORE – 3; HPE - intraductal papilloma**

**6. Case of Phyllodes Tumour**

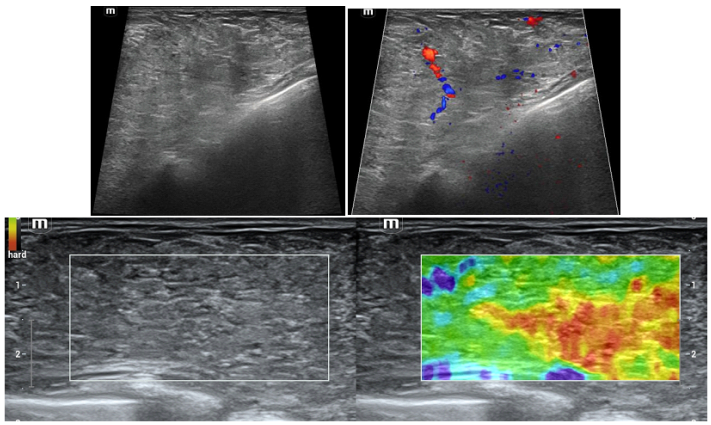

**Figure 7: 57years old female with complain of rapidly growing painless left breast mass since 1.5-2 months; USG - Well circumscribed smooth heterogeneous mass with internal vascularity; BIRADS – IV; TSUKUBA SCORE – 4; HPE - Phyllodes Tumour**

**7. Case of Invasive ductal carcinoma**

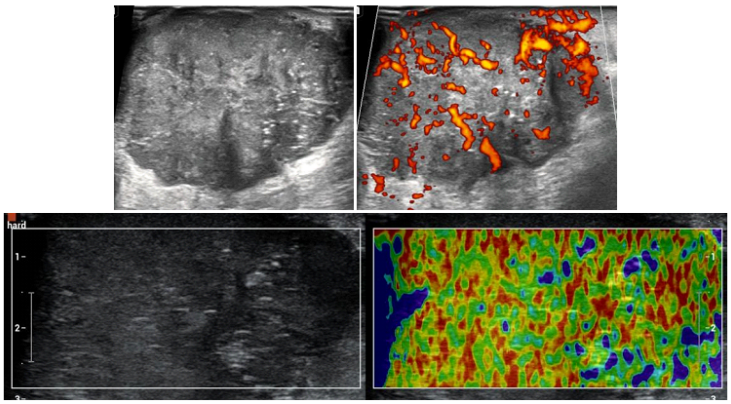

**Figure 8: 70 Years old female with complaint of lump in left breast for 8-9 months; USG - ill-defined hypoechoic lesion with multiple internal calcific foci and significant internal vascularity; BIRADS – V; TSUKUBA SCORE – 4; HPE - Invasive ductal carcinoma**

**8. Case of Liposarcoma**

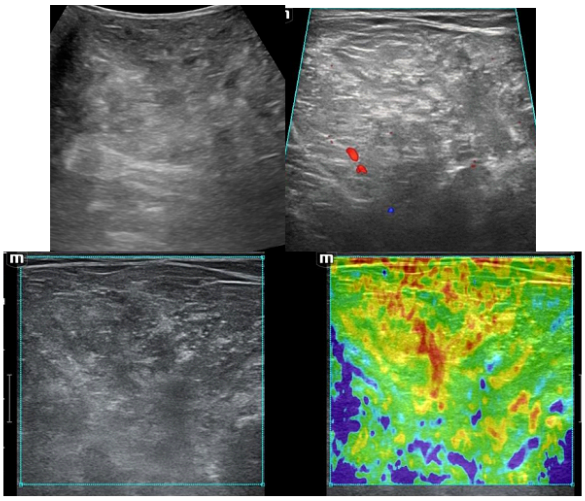

**Figure 9: 48 Years female with complain of right breast pain radiating to right shoulder region since 12-13 months; USG - Heterogeneous hypoechoic lesion with irregular margin with internal vascularity; BIRADS – IV; TSUKUBA SCORE – 3; HPE - lipomatous proliferation with occasional lipoblast and mild stromal atypia**

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