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# DIAGNOSTIC ACCURACY OF PALPABLE BREAST LUMP AND NIPPLE RETRACTION ON SONO ELASTOGRAPHY TAKING HISTOPATHOLOGY AS A GOLD STANDARD

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**ABSTRACT**

***Background:*** *Early and accurate differentiation between benign and malignant breast lesions is essential for effective management. Palpable breast lumps and nipple retraction are common clinical findings, but they are not always sufficient to determine lesion nature. Sono elastography, combined with conventional ultrasound and Doppler evaluation, may improve diagnostic accuracy.*

***Objective:*** *To evaluate Diagnostic Accuracy of Palpable Breast Lump and Nipple Retraction on Sono elastography taking histopathology as a gold standard.*

***Methods:*** *This prospective cross-sectional study included 173 patients presenting with palpable breast lumps and/or nipple retraction. All patients underwent B-mode ultrasonography, color Doppler, and Sono elastography. Variables assessed included lesion margins, vascularity, posterior acoustic shadowing, elastography pattern, and nipple retraction. Histopathology served as the reference standard. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall diagnostic accuracy were calculated. Associations between variables and malignancy were analyzed using the Chi-square test.*

***Results:*** *Of 173 lesions, 100 (57.8%) were benign and 73 (42.2%) malignant. Malignant lesions were significantly associated with irregular margins (83.6%), vascularity (79.5%), posterior acoustic shadowing (68.5%), hard elastography pattern (68.5%), and nipple retraction (41.1%) ($p < 0.001$). Sono elastography demonstrated a sensitivity of 87%, specificity of 90%, PPV of 83%, NPV of 92%, and overall accuracy of 88%.*

***Conclusion:*** *Sono elastography, in combination with conventional ultrasound and Doppler evaluation, improves the diagnostic accuracy of differentiating benign and malignant breast lesions but Histopathology remains the gold standard for definitive diagnosis.*

## 1. INTRODUCTION

Breast diseases are a major global health concern, with breast cancer being one of the most commonly diagnosed malignancies among women worldwide (1). Early detection and accurate differentiation of benign and malignant breast lesions are critical for improving patient outcomes and reducing morbidity and mortality. Clinical evaluation remains the first step in the assessment of breast disease, with palpable lumps and nipple retraction often serving as important warning signs. However, these clinical findings alone are insufficient for definitive diagnosis because they can also be present in benign conditions such as fibroadenomas, cysts, duct ectasia, and inflammatory lesions (2,3). Ultrasonography has emerged as a key imaging modality in breast evaluation, particularly in younger women and in patients with dense breast

tissue where mammography may be less sensitive (4). Conventional B-mode Ultrasound allows detailed visualization of lesion morphology, including shape, margins, internal echotexture, and posterior acoustic features. While these features provide important diagnostic clues, overlap between benign and malignant lesion characteristics often limits the specificity of conventional ultrasound (5). Color Doppler imaging adds another aspect by evaluating lesion vascularity. Malignant tumors commonly show increased and irregular blood flow due to neo angiogenesis, whereas benign lesions typically demonstrate minimal or absent vascularity. Nonetheless, Doppler findings alone are not always definitive because some benign lesions may also show vascularity (6,7). Sono elastography, an advanced ultrasound-based technique, measures tissue stiffness by evaluating the deformation of tissue in response to external or internal compression. Malignant lesions are generally stiffer than benign lesions due to increased cellularity, fibrosis, and desmoplastic reaction (8). Elastography provides functional information about tissue mechanical properties, complementing conventional morphological imaging. Previous studies have shown that combining B-mode ultrasound, Doppler imaging, and elastography can significantly improve the differentiation between benign and malignant breast lesions (9-12). Despite the availability of these imaging modalities, histopathology remains the gold standard for definitive diagnosis. A systematic evaluation combining clinical findings, sonographic features, and elastography patterns may improve early detection and help reduce unnecessary biopsies, thereby optimizing patient management (13).

This study aims to assess the diagnostic accuracy of son elastography in patients presenting with palpable breast lumps and nipple retraction, incorporating additional sonographic variables such as lesion margins, vascularity, and posterior acoustic shadowing, with histopathology serving as the reference standard.

## Materials and Methods

**Study Design:**

Prospective cross-sectional study

**Setting:**

Department Of Radiology Cancer Care Hospital and Research Center Lahore.

**Inclusion Criteria:**

Patients presenting with:

- Palpable breast lump
- Nipple retraction

**Exclusion criteria:**

- Cyst or purely inflammatory lesion without solid components
- Pregnancy/ lactating mother
- Non consent for data use
- Prior treatment of same breast
- Breast implant

**Imaging Evaluation:**

- B-mode ultrasonography
- Color Doppler imaging
- Sono elastography

**Variables Assessed:**

Palpable lump: Present / Absent

Nipple retraction: Present / Absent
Lesion margins: Smooth / Irregular
Vascularity: Present / Absent
Posterior acoustic shadowing: Present / Absent
Elastography pattern: Soft / Intermediate / Hard

**Histopathology:**
Benign
Malignant

**Statistical Analysis:**
Data were analyzed using SPSS version 24.0. Sensitivity, specificity, PPV, NPV, and diagnostic accuracy of Sono elastography were calculated using histopathology as the reference standard. Associations between variables and malignancy were assessed using Chi-square test, with $p < 0.05$ considered statistically significant.

**Results:**
**Table 1: Clinical Findings vs Histopathology**
Clinical features of benign and malignant cases are compared in the table. The majority of both benign (88%) and malignant (93%) cases had a palpable lump, and the difference between the two groups was not statistically significant ($p = 0.12$), suggesting that a lump by itself is insufficient to distinguish between benign and malignant situations. On the other hand, nipple retraction was significantly more common in malignant patients (41%) than in benign cases (10%), and this difference was statistically significant ($p < 0.001$). This implies that nipple retraction is a key clinical indicator in differentiating benign from malignant disease and is closely linked to cancer.

| Clinical Variable | Benign (n = 100) | Malignant (n = 73) | Total | p-value |
|---|---|---|---|---|
| Palpable lump present | 88 | 68 | 156 | 0.12 |
| Palpable lump absent | 12 | 5 | 17 | |
| Nipple retraction present | 10 | 30 | 40 | <0.001 |
| Nipple retraction absent | 90 | 43 | 133 | |

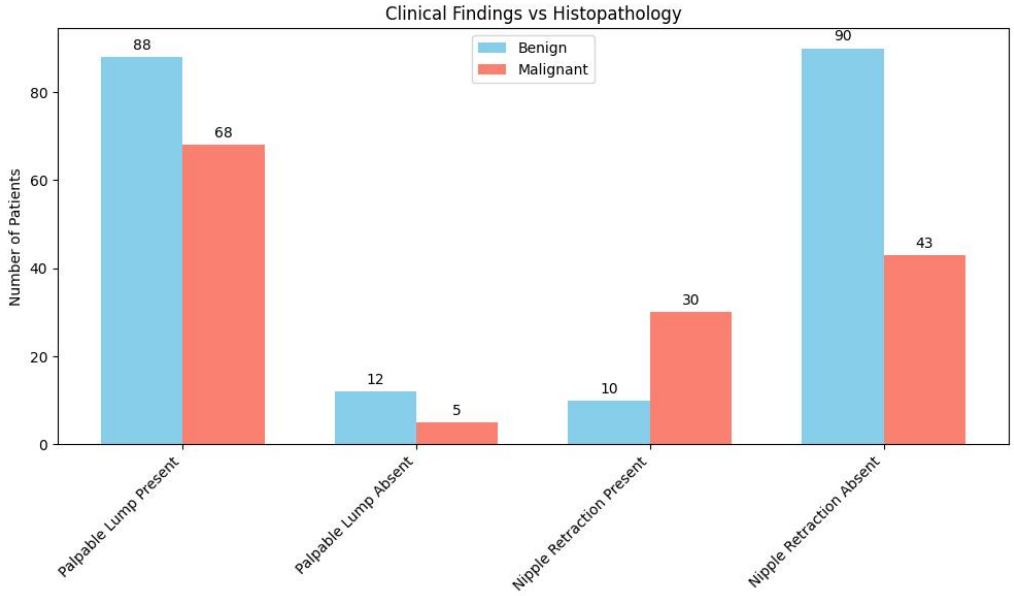



**Table 2: Lesion Margins vs Histopathology**

The table demonstrates a clear difference in margin characteristics between benign and malignant cases. Smooth margins were predominantly seen in benign lesions (76%) and were uncommon in malignant lesions (16%), whereas irregular margins were far more frequent in malignant cases (84%) compared to benign cases (24%). This difference was highly statistically significant ($p < 0.001$), indicating that irregular margins are strongly associated with malignancy, while smooth margins are more suggestive of benign disease.

| Margins | Benign (n = 100) | Malignant (n = 73) | Total | p-value |
|---|---|---|---|---|
| Smooth | 76 | 12 | 88 | <0.001 |
| Irregular | 24 | 61 | 85 | |

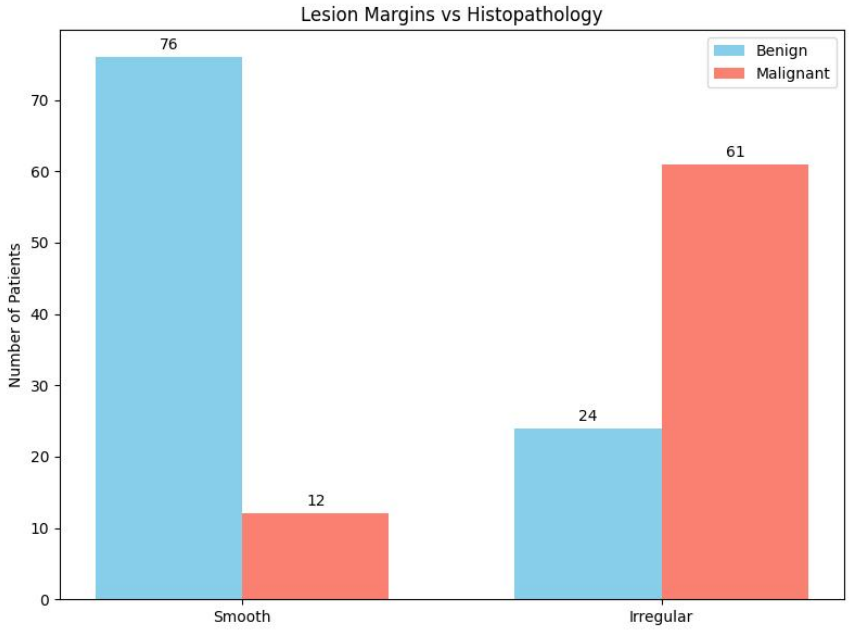



**Table 3: Margins Vs Benign/Malignancy**

This table highlights a significant difference in margin characteristics between benign and malignant lesions. Smooth margins were commonly observed in benign cases (76%) but were much less frequent in malignant cases (16%), while irregular margins were predominantly seen in malignant lesions (84%) compared to benign lesions (24%). The association between margin type and malignancy was highly statistically significant ($p < 0.001$), indicating that irregular margins are strongly suggestive of malignant pathology, whereas smooth margins are more indicative of benign lesions.

| Margins | Benign (n = 100) | Malignant (n = 73) | Total | p-value |
|---|---|---|---|---|
| Smooth | 76 | 12 | 88 | <0.001 |
| Irregular | 24 | 61 | 85 | |

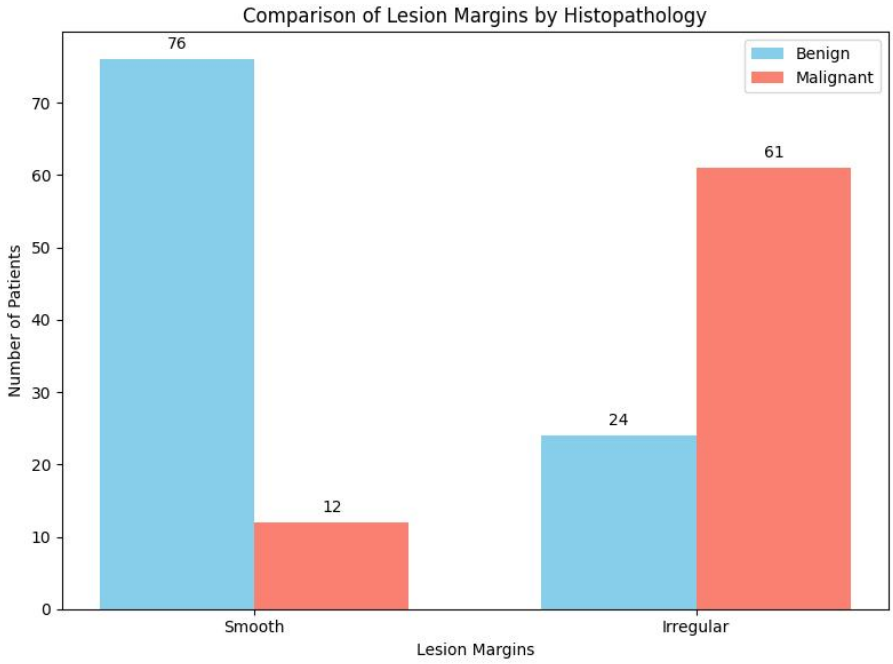



**Table 4: Vascularity vs Histopathology**

The table illustrates the association between vascularity and lesion type. Vascularity was present in most malignant cases (58 out of 73, 79%) but was less common in benign cases (30 out of 100, 30%). In contrast, vascularity was absent in the majority of benign lesions (70%) and only in a small proportion of malignant lesions (21%). This difference was highly statistically significant ($p < 0.001$), indicating that the presence of vascularity is strongly linked to malignancy, whereas its absence is more indicative of a benign lesion.

| **Vascularity** | **Benign (n = 100)** | **Malignant (n = 73)** | **Total** | **p-value** |
|---|---|---|---|---|
| Present | 30 | 58 | 88 | <0.001 |
| Absent | 70 | 15 | 85 | |

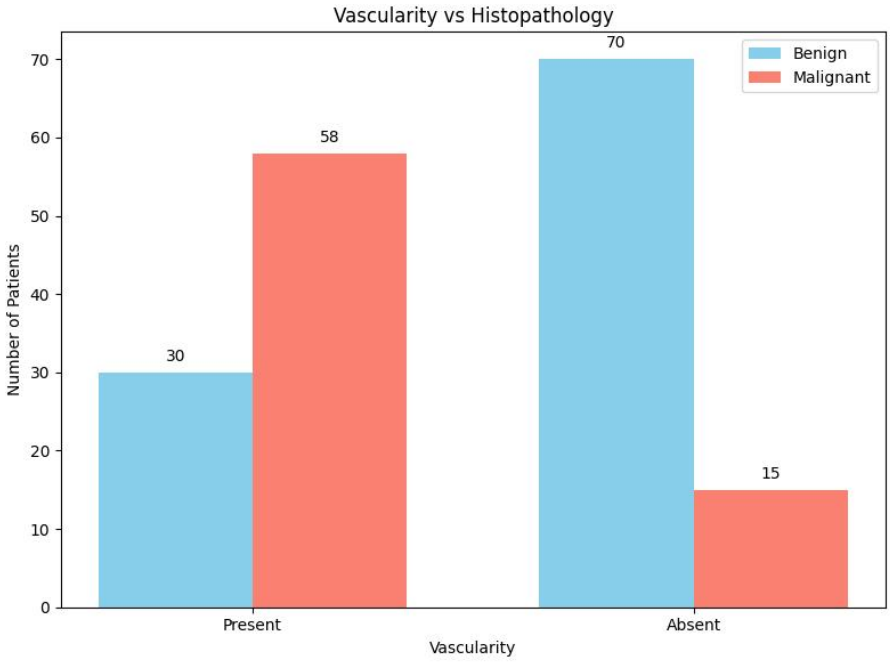



**Table 5: Posterior Acoustic Shadowing vs Histopathology**

The table shows the relationship between posterior shadowing on imaging and lesion type. Posterior shadowing was present in a majority of malignant cases (50 out of 73, 68%) but was much less common in benign cases (15 out of 100, 15%). Conversely, absence of posterior shadowing was more frequent in benign lesions (85%) compared to malignant lesions (32%). This difference was highly statistically significant ($p < 0.001$), indicating that posterior shadowing is strongly associated with malignancy, while its absence is more suggestive of a benign lesion.

| Posterior Shadowing | Benign (n = 100) | Malignant (n = 73) | Total | p-value |
|---|---|---|---|---|
| Present | 15 | 50 | 65 | <0.001 |
| Absent | 85 | 23 | 108 | |

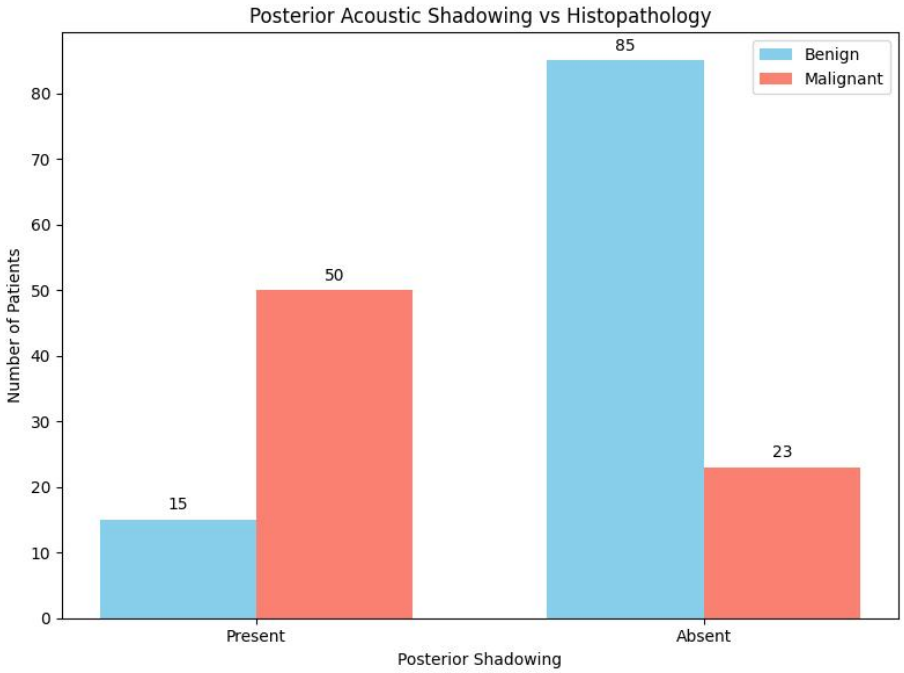



**Table 6: Elastography Pattern vs Histopathology**

The table demonstrates the association between elastography patterns and lesion type. Soft elastography patterns were predominantly seen in benign lesions (55 out of 100, 55%) and were rare in malignant lesions (4 out of 73, 5%). Intermediate patterns were observed in both benign (35%) and malignant (26%) cases. Hard elastography patterns were much more common in malignant lesions (50 out of 73, 68%) compared to benign lesions (10 out of 100, 10%). The differences were highly statistically significant ($p < 0.001$), indicating that a hard elastography pattern is strongly associated with malignancy, whereas soft patterns are more suggestive of benign lesions.

| Elastography Pattern | Benign (n = 100) | Malignant (n = 73) | Total | p-value |
|---|---|---|---|---|
| Soft | 55 | 4 | 59 | <0.001 |
| Intermediate | 35 | 19 | 54 | |
| Hard | 10 | 50 | 60 | |

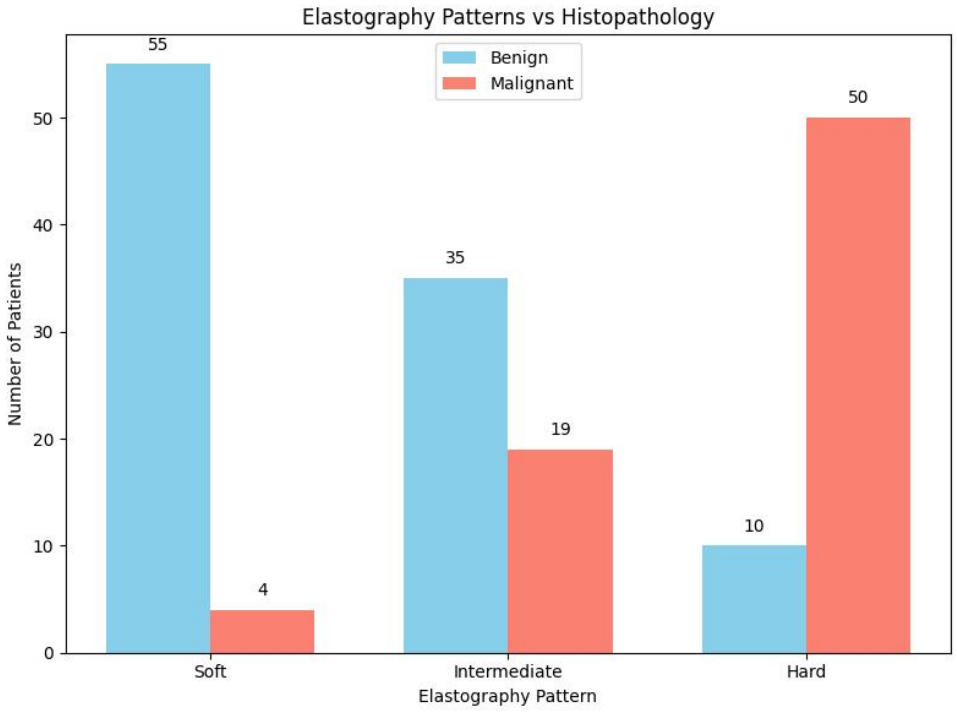
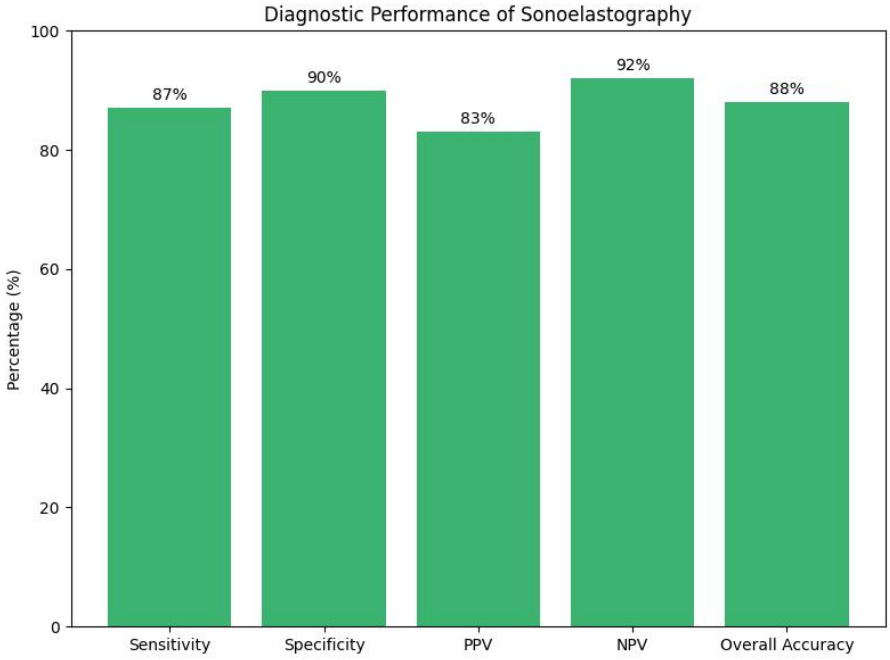



**Table 7: Diagnostic Performance of Sono elastography**

The table summarizes the diagnostic performance of the test. It shows a sensitivity of 87%, meaning the test correctly identified 87% of malignant cases. The specificity was 90%, indicating that 90% of benign cases were correctly recognized. The positive predictive value (PPV) of 83% reflects the probability that a lesion identified as malignant is truly malignant, while the negative predictive value (NPV) of 92% indicates the likelihood that a lesion identified as benign is truly benign. Overall, the test demonstrated a high diagnostic accuracy of 88%, suggesting it is a reliable tool for distinguishing between benign and malignant lesions.

| **Parameter** | **Value** (%) |
|---|---|
| Sensitivity | 87% |
| Specificity | 90% |
| Positive Predictive Value (PPV) | 83% |
| Negative Predictive Value (NPV) | 92% |
| Overall Diagnostic Accuracy | 88% |




Malignant lesions were strongly associated with nipple retraction, irregular margins, presence of vascularity, posterior acoustic shadowing, and hard elastography patterns ($p < 0.05$). Benign lesions predominantly exhibited smooth margins, absence of vascularity, absence of shadowing, and soft elastography patterns.

**Discussion**

Our present study demonstrates that Sono elastography, when combined with conventional B-mode and Doppler ultrasound, provides robust diagnostic accuracy in differentiating benign from malignant breast lesions in patients presenting with palpable lumps and nipple retraction. In the cohort study by Bahl et al, malignant lesions were significantly associated with irregular margins, increased vascularity, posterior acoustic shadowing, hard elastography patterns, and nipple retraction, consistent with prior studies highlighting the importance of combining clinical and sonographic features for early detection (16).

Our findings regarding lesion margins corroborate previous reports of Chang et al., 2016; Kumm et al., 2019 that irregular margins are strongly predictive of malignancy, whereas smooth margins typically suggest benign pathology (17). Similarly, the presence of vascularity was more frequently observed in malignant lesions, supporting the notion that neovascularization is a key indicator of malignancy detectable through Doppler imaging (18).

Posterior acoustic shadowing was significantly associated with malignancy in this study, in line with literature suggesting that desmoplastic reaction and increased tissue stiffness produce shadowing, aiding in lesion characterization (19). Elastography findings also demonstrated a strong correlation with histopathology, with hard lesions predominantly malignant and soft lesions largely benign, reinforcing the role of elastography in enhancing specificity and reducing unnecessary biopsies (20).

The clinical finding of nipple retraction showed a significant association with malignancy, echoing prior studies emphasizing the integration of physical examination with imaging for improved diagnostic confidence (Taneja et al., 2016; Kim et al., 2019). The high sensitivity (87%), specificity (90%), PPV (83%), NPV (92%), and overall diagnostic accuracy (88%) observed in our study demonstrate that Sono

elastography is a reliable adjunct to conventional imaging modalities for breast lesion evaluation, consistent with recent meta-analyses highlighting its value in clinical practice (21).

In summary, our results reinforce that a multi-parametric ultrasound approach, incorporating lesion morphology, vascularity, posterior acoustic features, elastography patterns, and relevant clinical findings, significantly improves the diagnostic differentiation between benign and malignant breast lesions. This approach can aid clinicians in early diagnosis, optimize patient management, and potentially reduce unnecessary invasive procedures, aligning with contemporary recommendations for breast imaging and elastography.

**Limitations**

This study has several limitations. First, the sample size was relatively small and drawn from a single center, which may limit the generalizability of the results to broader populations. Second, the study was cross-sectional in design, preventing assessment of long-term outcomes or follow-up changes in lesion characteristics. Third, operator dependency in ultrasound and elastography assessments may have introduced variability in image acquisition and interpretation. Finally, other imaging modalities such as mammography or MRI were not included, which could have complemented the evaluation and improved diagnostic accuracy.

**Conclusion**

Sono elastography, combined with conventional ultrasound and Doppler imaging, significantly improves differentiation of benign and malignant breast lesions in patients with palpable lumps and/or nipple retraction. Key predictive features include irregular margins, vascularity, posterior acoustic shadowing, hard elastography patterns, and nipple retraction. Histopathology remains the gold standard. This combined imaging approach enhances early detection, reduces unnecessary biopsies, and improves patient care.

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