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Original Research Article

Evaluation of Focal Breast Lesions on Ultrasound, Color Doppler and Real Time Elastography: A Prospective Study

Dr. Jyoti Reddy[1], Dr. Sanjay M. Khaladkar[2]

[1]Postgraduate Resident, [2]Professor,
Department of Radiodiagnosis, Dr. D. Y. Patil Medical College and research centre,
Dr. D. Y. Patil Vidyapeeth, Pimpri, Pune.

Corresponding Author: Dr. Sanjay M. Khaladkar

ABSTRACT

Background: Carcinoma breast most commonly diagnosed malignancy amongst women. Ultrasound in combination with Doppler, elastography appears to be reliable in differentiation of focal malignant and benign breast lesions. This differentiation helps young females in whom it is undesirable to go for FNAC and excision biopsy

Materials and Methods: A total of 50 patients with focal breast lesions confirmed on USG were enrolled on the basis of inclusion and exclusion criteria. Patients underwent ultrasound followed by Doppler and elastography. The RI,PI, FLR ratio and elasticity scores were determined in all cases and their correlation with the lesion was studied. FNAC was used for histopathological confirmation of the lesions.

Results: Total of 50 women who fulfilled inclusion criteria and gave consent was included in study. The most common age group was 41-50 years (30%) followed by 21-30 years (20%). The mean age of the studied cases was 40.74 +/- 14.56. The histopathology of biopsied specimen showed that out of 50 patients 13 had malignant lesion (26%), 37 (74%) had benign lesions. Mean RI and PI of Benign lesions was 0.60 +/- 0.06 and 0.82 +/- 0.10 and Mean RI and PI of Malignant lesions was 0.81 +/- 0.07 and 1.62 +/- 0.38. Mean FLR of benign lesions was 2.15 +/- 0.86 and malignant lesions were 4.18 +/- 0.47. Statistical difference in FLR of benign and malignant lesions was ($P<0.0001$).

Conclusion: Ultrasound, Doppler and elastography can reliably differentiate focal benign and malignant breast lesions. This obviates need for invasive investigations in patients.

Keywords: Focal Breast Lesions, Ultrasound, Doppler, Elastography, Carcinoma.

INTRODUCTION

Breast cancer is among the most common causes of cancer deaths today, coming fifth after lung, stomach, liver and colon cancers. It is the most common cause of cancer related deaths in women. [1] In 2005 alone, 519000 deaths were recorded due to breast cancer. The first known clinical use of breast ultrasound was reported in 1951 by Wild and Neal, who used A-mode sonography to describe the features of one benign and one malignant breast mass. Several attempts were subsequently made to develop automated or multi-transducer scanners to evaluate the whole breast, both to detect subclinical disease (screening) as well as for lesion characterization. [2] The 1970s saw a declining interest in breast ultrasound, and, for more than a decade thereafter, ultrasound was relegated to differentiating solid from cystic masses. However, with increasing resolution and quality of US image, interest in its use for evaluation of

the breast has resurged. Refinement of high-frequency technology, particularly with 7.5-13 MHz probes, has brought out a totally new facet in USG breast imaging. Harmonic imaging and real time compounding has been shown to improve image resolution and lesion characterization. [3] More recently, ultrasound elastography seems to be quiet promising. Initial results indicate that it can prove the specificity and positive predictive value of USG in the characterization of breast masses.

Continuous-wave Doppler sonography was the first development of its kind to investigate the vascularity of breast tumors. In 1977, Wells et al. published the first study demonstrating continuous-wave Doppler blood-flow signals associated with malignant tumor neovascularization. [4] This technique could be used to record vascular signals from a palpable breast mass, but this signal was difficulty to observe in non-palpable lesions. Color Doppler sonography serves as a useful tool to differentiate cystic lesions from their solid counterparts, to distinguish benign nodules from malignant ones, to determine the aggressiveness of a suspicion lesion, to evaluate inflammatory conditions of the breast, to identify vascular abnormalities and to evaluate response to tumor therapy. [5] Although Doppler sonography is currently considered as a useful adjunct to gray scale ultrasound to differentiate benign from malignant lesions, the definite role of Doppler sonography in this respect remains to be established. [6] There are many new studies performed using various models to identify neo-vascularity that have demonstrated its promising role. However, further work is required to establish its efficacy to differentiate benign from malignant tumors. [7]

Breast elastography is a new sonographic imaging technique which provides information on breast lesions in addition to conventional ultrasonography and mammography. Elastography provides non-invasive evaluation of the stiffness of a lesion. [8] Today, two technical solutions are available for clinical use: strain elastography and shear wave elastography. Initial evaluations of these techniques in clinical trials suggest that they may substantially improve the possibility of differentiating benign from malignant breast lesions thereby limiting recourse to biopsy and considerably reducing the number of benign breast biopsy diagnosis [9] Although elastography is easy to perform, training and technical knowledge are required in order to obtain images permitting a correct interpretation. [10]

We conducted this study to analyse the role of ultrasound, color doppler and real time elastography for evaluation of focal breast lesions and their differentiation into benign and malignant lesion.

MATERIALS AND METHODS

This was a prospective cohort study conducted in the department of radiology of a tertiary care medical college situated in an urban area. In this study 50 women of more than 18 years and having focal breast lesion were included on the basis of a predefined inclusion and exclusion criteria. The study was approved by institutional ethical committee. Informed consent was obtained from all the patients before including them in the study. A detailed history and through clinical examination was done in all the cases.

Scanning Method:

Scanning was done in supine position. If needed patient was rolled patient slightly to spread the breast evenly. The side being scanned was elevated using a wedge under the shoulder. The scanning technique used was grid scanning pattern followed by a radial (clock face) technique for the hard copy imaging. High-frequency technology, particularly 7.5-13 MHz (linear probe) was used.

Grid Scanning Pattern:

1. Begin in the upper outer quadrant, scanning in transverse. Slide inferiorly from top to bottom.
2. Move across and repeat the sweep inferior to superior.

3. Repeat this across the breast.
4. Rotate into a sagittal plane and repeat the pattern. A variation, particularly in larger or mobile breasts, is to apply the grid pattern quadrant by quadrant.

Radial scanning pattern (clock-face)

1. The breast is scanned and described as a clock-face.
2. Begin at 12o'clock in a sagittal plane with the toe of the probe at the nipple.
3. Scan by rotating the probe around the nipple.
4. Depending on breast size, a second pass further from the nipple may be required.
5. If pathology is identified, the probe was rotated 90degrees in the 'anti-radial' plane.

   Ultrasound examination was followed by Doppler and elastography in all the cases. Final diagnosis was made on the basis of histopathology on the basis of fine needle aspiration cytology (FNAC). If FNAC was inconclusive then excision biopsy was done in selected cases. Microsoft office was used for preparation of charts and graphs. The data was analysed using SSPE 16 software and p value less than 0.05 was taken as statistically significant.

Inclusion Criteria:

1. Women of age more than 18 yrs.
2. Patients with clinically suspected focal breast lesions
3. Patients with prior history of focal breast lesions.

Exclusion Criteria:

1. Post-operative patients
2. Patients with previous history of radiotherapy and chemotherapy.
3. Those who refused informed consent.

RESULTS

The study consisted of 50 women with clinically suspected focal breast lesions. The age of the patients varied from 18 years to 73 years. The most common age group affected was found to be between 41-50 years (30%) followed by 21-30 years (20%). The mean age of the studied cases was found to be 40.74 +/- 14.56.

Table 1: Age Distribution of the studied cases.

Age	No of patients	Percentage
< 20 years	5	10%
21-30 years	10	20%
31-40 years	8	16%
41-50 years	15	30%
51-60 years	8	16%
>60 years	4	8%
Total	50	100%

The characteristics of breast lesions showed that amongst the studied cases majority of the patients had single focal lesion (86%) while 7 (14%) patients had multiple lesions either in single breast or in both the breasts. Majority of the lesions were oval in shape (46%) followed by irregular in shape (36%). Only 9 (18%) patients had a round shape. The orientation of lesion was non-parallel in 27 (54%) cases where as lesion was parallel in 23 (36%) of the cases. The analysis of size of the lesions showed that majority of the patients had lesion measuring 2-3 cms in its largest dimension (34%) followed by lesion of less than 2 cm (28%) and lesions between 3-5 cms (16%). Only 4 (8%) patients had lesion of more than 5 cms in greatest dimension. The most common side involved was right breast (52%) followed by left breast (36%). In 6 (12%) patients lesions were present bilaterally. Upper Outer quadrant was involved in 21 (42%) cases followed by lower outer quadrant (18%), lower inner quadrant (16%) and in 7 (14%) patients lesions were present in multiple quadrants. The analysis of margins showed that 30 (60%) patients had well circumscribed margins whereas remaining 20 (40%) patients had non-circumscribed margins. Architectural distortion and skin retraction was seen in 15 (30%) and 1 (2%) patients respectively. Axillary lymphadenopathy was seen in 4 (8%) patients.

Table 2: Characteristics of the breast lesions in the studied cases.

	Characteristics of lesion		
		No Of Patients	Percentage
Number Of Lesions	Single	43	86 %
	Multiple	7	14 %
Shape	Oval	23	46%
	Round	9	18%
	Irregular	18	36%
Orientation	Parellel	23	46%
	Not-Parallel	27	54%
Size	< 2 cms	14	28%
	2-3 cms	17	34%
	3.1-5 cms	8	16%
	>5cms	4	8%
Side	Left	18	36%
	Right	26	52%
	Bilateral	6	12%
Quadrant	Multiple	7	14%
	Lower Inner	8	16%
	Lower Outer	9	18%
	Upper Inner	5	10%
	Upper Outer	21	42%
Margins	Circumscribed	30	60%
	Non-Circumscribed	20	40%
Associated features	Architectural Distortion	15	30%
	Skin Retraction	1	2%
	Normal	34	68%
Lymphadenopathy	Right Axillary	2	4%
	Left Axillary	2	4%
	No Lymphadenopathy	46	92%

The analysis of characteristic ultrasound features showed that the most common ultrasound feature in studied cases was homogenously hypoechoic mass which was seen in 14 (28%) patients. The other common features included heterogeneously hypoechoic lesion (16%), and mixed echoic lesions (16%).

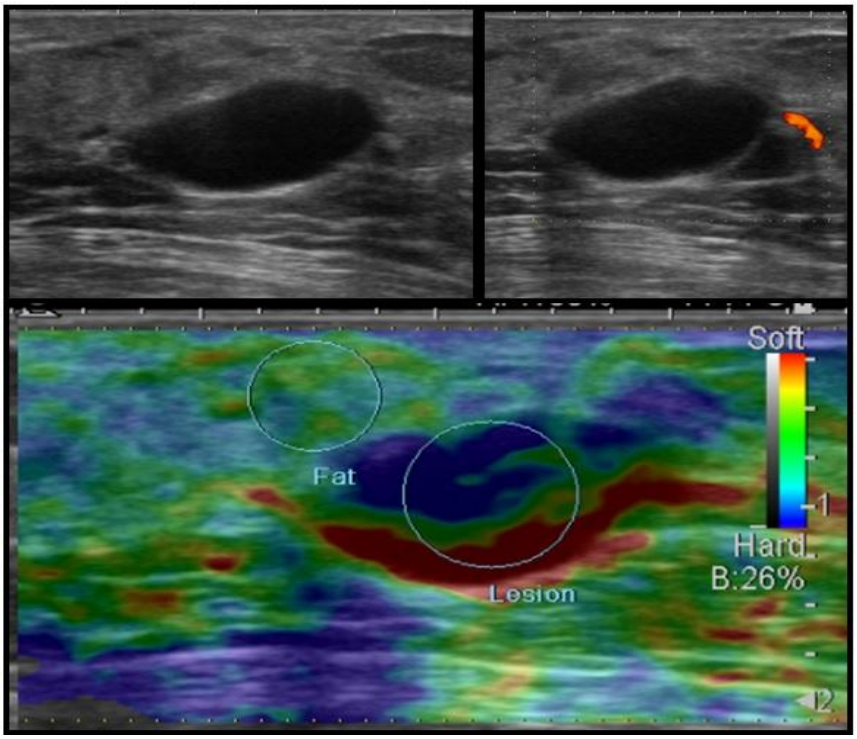

Figure 1: Simple Breast Cyst. On B-Mode a well defined anechoic lesion suggestive of cystic lesion (Left Upper corner). Doppler ultrasound showed no vascularity within the lesion (Right Upper Corner). Elastography showed BGR pattern i.e. blue, green and red according to Tsukuba scoring method (Lower Image).

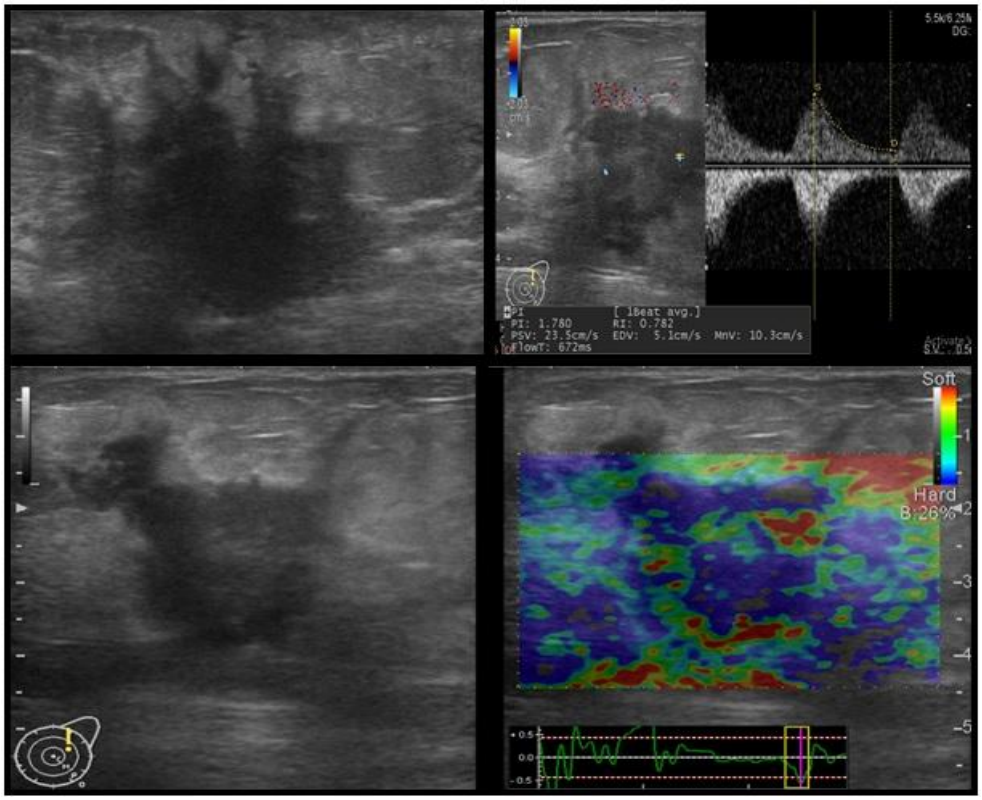

Figure 2: Carcinoma Breast. On B-Mode showed an ill-defined lesion heterogeneously hypoechoic lesion with spiculated margins and posterior acoustic shadowing(Left Upper corner), Doppler images showed both central and peripheral vascularity with peak systolic velocity (right upper corner), Elastography showed the hypoechoic lesion and surrounding area to be hard suggestive of malignant etiology (Right Lower Corner).

The other ultrasound features included hypoechoic lesion with moving internal echoes (10%), inhomogeneous mass with cleft like cystic spaces (10%) and anechoic lesions (6%). The analysis of post-acoustic features showed that post-acoustic shadowing and enhancement was seen in 15 patients (30%) each and there was no post-acoustic enhancement or shadowing in 20 (40%) patients. A solid mass was seen in 39 (78%) patients whereas cystic lesion was seen in 13 (26%) patients. A combination of solid and cystic mass was seen in 8 patients (16%). Calcification and was vascularity within the lesion was seen in 9 (18%) and 22 (44%) respectively.

Table 3: Ultrasound characteristics of the lesion

	Ultrasound characteristics of the lesion	No of patients	Percentage
Tissue Characterization On Ultrasound	Anechoic	3	6%
	Mixed echoic	8	16%
	Hyperechoic	2	4%
	Homogeneously hypoechoic	14	28%
	Heterogeneously Hypoechoic	8	16%
	Hypoechoic with moving internal echoes	5	10%
	Thick wall thick septae with moving echos	1	2%
	An inhomogeneous mass with cleft like cystic spaces	5	10%
	Cystic mass with mural nodule	2	4%
	Prominent fibroglandular tissue with small cysts in the mammary zone	2	4%
Post Acoustic Features	Enhancement	15	30 %
	Shadowing	15	30 %
	No feature	20	40 %
Cystic Areas/Mass	Mass	39	78%
	Cystic Area	13	26%
	Mass and Cystic Areas	8	16%
Calcification	present	9	18%
	Absent	41	82%
Vascularity	present	22	46%
	Absent	28	54%

The analysis of histopathological examination of biopsied specimen showed that out of 50 patients 13 patients had malignant lesion (26%) whereas 37 (74%) patients had benign lesions. The most common malignant lesion was found to be ductal carcinoma (22%) whereas the most common benign lesion was fibroadenoma which was seen in 12 (24%) patients. The other common benign pathologies included abscess (10%), hamartoma (10%) and phyllodes tumor (10%).

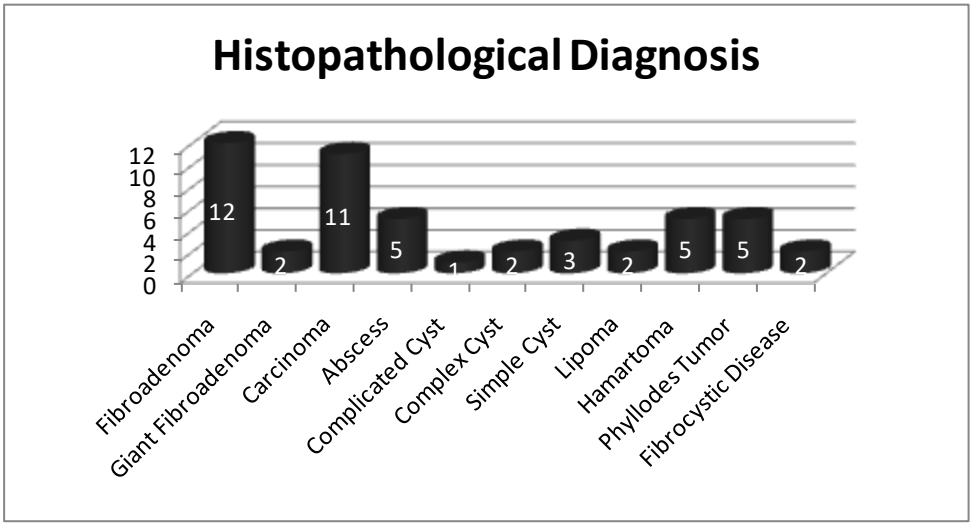

Figure 3: Histopathology in studied cases.

The analysis of elasticity score on the basis of elastography showed that majority of the benign lesions had a elasticity score of either 1 or 3. There was no benign lesion having an elasticity score of 4 or above. Whereas no malignant lesion had a elasticity score of less than 3 and majority of the malignant lesions had a elasticity score of 5 (12%).

Table 4: Elasticity score of Benign Vs Malignant Lesions.

Type	Elasticity Score						Total
		1	2	3	4	5	
Benign	No Of Patients	17	5	15	0	0	37
	Percentage	34%	10%	30%	0	0	74%
Malignant	No Of Patients	0	0	3	4	6	13
	Percentage	0	0	6%	8%	12%	26%
Total	No Of Patients	17	5	18	4	6	50
	Percentage	34%	10%	36%	8%	12%	100%

The elasticity score of the benign lesions was found to be 1 to 3, whereas the elasticity score of a malignant lesion was found to be 3 to 5(predominantly 4 and 5). Similarly Mean RI and PI of Benign lesions were found to be 0.60 +/- 0.06 and 0.82 +/- 0.10. Whereas mean RI and PI of Malignant lesions was found to be 0.81 +/- 0.07and 1.62 +/- 0.38. There was a statistically significant difference in mean RI and PI of benign and malignant breast lesions. Finally FLR ratios of benign and malignant lesions were compared. In cases of benign breast lesions the mean FLR was Found to be 2.15 +/- 0.86 whereas in cases of malignant lesions mean FLR was found to be 4.18 +/- 0.47. There was a statistically significant difference in FLR of benign and malignant lesions (P<0.0001).

Table 5: Mean RI, Mean PI and Mean FLR Ratio in Benign Vs Malignant Lesions.

Characteristic	Benign	Malignant	95% CI	P value
Mean RI	0.60 +/- 0.06	0.81 +/- 0.07	-0.2699 to -0.1501	P <0.0001 (Significant)
Mean PI	0.82 +/- 0.10	1.62 +/- 0.38	-1.0723 to -0.5277	P < 0.0001 (Significant)
FLR Ratio	2.15 +/- 0.86	4.18 +/- 0.47	-2.5416 to -1.5184	P < 0.0001 (Significant)

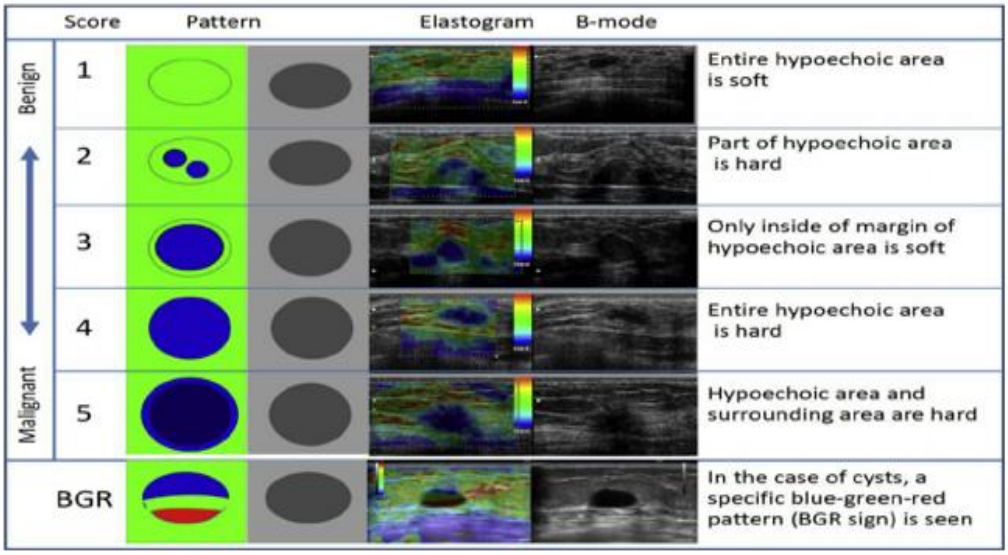

Figure 3 : Elasticity Score- score of 1 indicates even strain throughout the entire hypoechoic lesion, score 2 indicates strain in most of the hypoechoic lesion with some areas of no strain; a score of 3 indicates strain at the periphery of the entire hypoechoic lesion, score 4 indicates no strain throughout the surrounding area. Score 5 is characterized by hypoechoic area surrounded by hard area.

DISCUSSION

Although it may be impossible to distinguish all benign from all malignant breast nodules using USG criteria, a reasonable goal for breast USG is to identify a subgroup of solid nodules that has such a low risk of being malignant that the option of short-interval follow-up can be offered as a viable alternative to biopsy. In a 4- year follow-up of palpable, circumscribed, non-calcified solid breast masses(similar to BI-RADS category 3), Graf et al [11] found that such cases can be adequately managed with short term follow-up at 6 month intervals for 2 years.

Combined studies, which included USG and mammography, have demonstrated a near 100% negative predictive value for palpable breast lesions, when both are used together. In a study based on characterization of breast masses according to BIRADS-US criteria, Kwak et al [12] found no statistical differences between fine –needle aspiration cytology and USG with regard to sensitivity and Negative Predictive value(P>0.05) Heinig et al [13] also found USG characterization of breast lesions using BIRADS-US criteria to be highly accurate. Fibroadenoma tends to occur in young women and adolescent girls, usually those who have never been pregnant. Breast Cancer risk for fibroadenoma has been estimated at 3.1 annual incidences per 1000, person –year rate, and the relative cancer risk estimated at 7.0.6. This lesion is firm, well circumscribed, and freely mobile, justifying the description of the "breast mouse". [13] This is a relatively large tumor with features highly resembling a giant fibroadenoma except that mitotic features may be present, suggesting a sarcomatous change. [14] This lesion is usually regarded as a giant fibroadenoma and usually excised as a benign breast lesion.

The quality of a procedure is highly dependent on the operator's knowledge of the equipment, the appropriate technique, the results interpretation, the patient's history, besides the malign at, benign and functional alterations of the breast. Notwithstanding all the students reviewed have utilized high-resolution equipment and trained professionals, the divergence observed in the literature are due to different methodologies applied, either utilizing different morphological characteristics or different criteria for distinguishing malignant from benign lesions. [15] This diversity reflects the fact that not always all the morphological characterization of an image with all their variables can be utilized. Some features are unique to ultrasound, such as orientation and

echogenicity, and some are fundamental to interpreting images, such as shape and margins. [16] Among the studies selected for the purpose of comparative analysis, all of them utilized the description of the contour or margin, followed by echo transmission, echogenicity, echo-texture, and orientation. The features less utilized were: limits, compressibility, branching and size of the lesion. [17]

Chhadi T et al [18] conducted a study to evaluate the sensitivity and specificity of ultrasound elastography in detection and characterization of various breast masses and study its role in differentiating benign and malignant breast masses with FNAC and/or histopathological correlation. In this study of 126 patients with breast lesions confirmed on USG were enrolled for the study. There were 56 (48.3%) malignant and 60 (51.7%) benign lesions. A sensitivity of 83.9% and a specificity of 91.7% were found for elasticity score when cut-off value of 3.5 was used. Sensitivity of 91.1% and specificity of 88.3% was obtained for SR scores, when a cut off of 2.94 was used. The authors concluded that elastography is a simple and rapid method that can improve the sensitivity and specificity of USG and can decrease the rate of unnecessary biopsies. The results of this study were similar to the study conducted by us. Similar utility of elastography in differentiating benign and malignant breast lesions were also reported by Giuseppetti GM et al [19] and Zhi H et al. [20]

CONCLUSION

Ultrasound examination of breast lesions in combination with Doppler and elastography can reliably differentiate between benign and malignant breast lesions. There was a statistically significant difference between elasticity scores, Mean PI, Mean RI and FLR ratios of benign and malignant breast lesions.

Conflict Of Interest: None

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