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Original Research Article

TO COMPARE SONOELASTOGRAPHY AND B-MODE ULTRASOUND IN THE DIAGNOSIS OF SOLID BREAST LESIONS WITH HISTOPATHOLOGICAL CO-RELATION

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ABSTRACT

Background: Breast cancer is the most common malignancy among women worldwide, with early detection being crucial to reduce mortality. While B-mode ultrasonography (USG) is highly sensitive, its specificity is limited, leading to unnecessary biopsies. Sonoelastography, a non-invasive imaging technique, assesses tissue elasticity and stiffness, offering improved differentiation between benign and malignant breast lesions.

Material and Methods: A prospective study involving 50 patients with solid breast lesions was conducted at a tertiary care center. B-mode USG and real-time sonoelastography were performed, with histopathology serving as the gold standard. Elastographic scoring and strain ratios were evaluated, with defined cut-offs used to differentiate between benign and malignant lesions. Statistical analyses were performed to assess sensitivity, specificity, and predictive values.

Results: Among the 50 lesions, 52% were malignant, and 48% were benign. Malignant lesions had higher mean elastographic scores (4.3 ± 0.88) and strain ratios (6.6 ± 1.4) compared to benign lesions (2.79 ± 0.65 and 2.9 ± 1.3, respectively). Strain ratio >3.67 predicted malignancy with a sensitivity of 92.31% and specificity of 91.67%, while elastographic score >3 achieved a sensitivity of 80.77% and specificity of 87.5%. B-mode USG demonstrated sensitivity of 96.15% and specificity of 79.17%. Sonoelastography significantly improved specificity and reduced false positives, although some overlap in scores occurred due to lesion heterogeneity.

Conclusion: Sonoelastography is a rapid, non-invasive method that enhances the specificity and positive predictive value of B-mode USG in the evaluation of solid breast lesions. It reduces unnecessary biopsies by improving the differentiation of benign and malignant lesions, making it a valuable adjunct in breast imaging.

Key Words: Breast cancer, sonoelastography, B-mode ultrasonography, tissue elasticity, strain ratio, elastographic scoring, diagnostic imaging.

INTRODUCTION

Breast cancer is the most common malignancy among women worldwide the second most common cause of cancer-related mortality.[1] Breast cancer (uncontrolled proliferation of cells) begins in breast tissue, which is made up of fatty, connective and lymphatic tissue and glands (arranged in ducts and lobules). Most masses are benign, they are not cancerous, do not grow uncontrollably or spread, and are not life threatening. Some breast cancers are called in situ because they are confined within ducts

(ductal carcinoma in situ or DCIS) or lobules (lobular carcinoma in situ or LCIS) where they originated. Most breast cancers are invasive, or infiltrating. These cancers started in the lobules or ducts of breast but have broken through the duct or glandular walls to invade the surrounding tissue of breast.[2]

Mammography and ultrasonography (US) are the diagnostic methods which have shown the highest sensitivity in the detection of breast cancer. However, both methods present some limitations. Mammography performed in dense breasts may often yield false-negative results.[3] USG is sensitive in the detection of lesions, but specificity is poor as most solid lesions are benign. In order to obtain an acceptable specificity, various characteristics of the lesions must be evaluated according to the BI-RADS criteria defined by the American College of Radiology (ACR).[4] Unfortunately, the BI-RADS criteria generate a significant number of false positive results.[5] This limitation leads to an increase in biopsies with a cancer "detection rate" of only 10%-30%.[6,7] Many biopsies are performed in benign lesions causing discomfort to the patients and increased costs. To overcome these limitations and obtain a more accurate characterization of breast lesions, US elastography was introduced. This technique combines US technology with the basic physical principles of elastography. US elastography is noninvasive and assesses tissue deformability by providing information on the elasticity.[8,9] It is based on the premise that there are significant differences in the mechanical properties of tissues that can be detected by applying an external mechanical force.[10,11] Elastography has proven to be highly specific in the evaluation of lesions situated in various organs: breast, prostate, thyroid, lymph nodes and testes.[12] However, this technique is still new, and considering that there are several technological solutions, its role in clinical practice is still to be defined.

The method which is currently the most widely used in clinical settings is real-time elastography (RTE) which generates "strain imaging" by compression. RTE can be performed using conventional US equipment with dedicated software, and this method assesses the relative elasticity of the tissues in a specific area of interest (the RTE-box) creating an elastogram that is superimposed to the US image and updated in real-time at a frequency of 10-15 Hz.[12,13] Real-time display allows a quick assessment of the strain distribution. The spatial resolution of RTE, which is currently about 1 mm, depends on a number of factors, such as US beam frequency, pulse length and particularly the length of the correlation window.[14]

In RTE evaluation of breast lesions the two most important characteristics are size and stiffness. Stiff nodules appear larger at elastography than at US resulting in a dimensional difference.[15] This phenomenon has been attributed to a desmoplastic reaction occurring in many breast tumors.[16] The dimensional difference can be expressed as the ratio between the diameter of the lesion on the elastogram as compared to the US image; a ratio of >1 is suggestive of malignancy.[17,18]

As regards the stiffness criteria, various scoring systems have been proposed which compare the presence, distribution and extent of areas of abnormal elasticity. The elastographic score can help the physician choose the most appropriate management of lesions which appear uncertain or benign at US examination.[12]

The scoring system suggested by Itoh et al,[12] assigns a score from 1 to 5: score 1 indicates deformability of the entire lesion; score 2, deformability of most of the lesion with some small stiff areas; score 3, deformability of the peripheral portion of the lesion with stiff tissue in the center; score 4, the entire lesion is stiff; score 5, the entire lesion and surrounding tissue are stiff. If a lesion is classified between 1 and 3 it is considered benign; if classified 4 or 5 it is considered to be malignant.

A multicenter Italian study proposed a different classification system which takes both solid and cystic lesions into account. Also this system has 5 levels: score 1 indicates a tri-stratified pattern (blue, green and red) typical of cysts; score 2, a mainly elastic lesion; score 3, a mainly elastic lesion, but with some stiff areas; score 4, most of the lesion is not deformable; score 5, a no deformable lesion surrounded by stiff tissue expressed by a blue margin around the lesion. Both score systems were insensitive to the volume of the breast as well as the depth and the diameter of the lesions. Elastography improves ultrasound's specificity by utilizing conventional ultrasound imaging to measure the compressibility and mechanical properties of a lesion. It uses pressure from breathing, heartbeat, or direct compressing on the skin to examine the compressibility of a lesion. Since cancerous tumors tend to be stiffer than surrounding healthy tissue or cysts, a more compressible lesion on elastography is less likely to be malignant. Elastography and B-mode ultrasound can be performed simultaneously and viewed on the split screen with the two-dimensional ultrasound image on one side and the elastography image on the other side.[19]

The present study evaluates the sonoelastographic features of breast in form of elasticity score and strain ratio and there differentiation into benign and malignant with defined cutoffs and its co-relation and comparison with B-mode ultrasonography in differentiation of lesions into benign and malignant taking histopathology as gold standard in patient with clinical suspicion of breast lump referred to radiology department in Apollo Hospital.

MATERIALS AND METHODS

This prospective, hospital-based study was conducted at Apollo Hospital, Jubilee Hills, Hyderabad, a tertiary referral center with a high

patient load and numerous referrals for breast ultrasounds. The study was carried out over 15 months, from November 1, 2013, to June 30, 2015. The study population comprised all female patients aged 18 years and above who were referred to the Department of Radiology due to clinical suspicion of breast lumps. A total of 69 patients initially underwent B-Mode ultrasound and sonoelastography, but 19 patients were excluded based on the study's inclusion and exclusion criteria. Reasons for exclusion included detection of cysts on B-Mode ultrasound, loss to follow-up, or lack of histopathological evaluation. Consequently, 50 patients formed the final sample size for analysis. Patients were included if they met the following criteria: female patients aged 18 years or older with clinical suspicion of breast lumps. Exclusion criteria involved women with a history of breast surgery, breast implants, superficial lesions located within 5mm of the skin surface, pregnancy or breastfeeding, and those with cystic breast lesions detected by B-Mode ultrasound.

For all included patients, imaging was performed using the PHILIPS IU 22 machine equipped with an L12-5 MHz linear probe. Both B-Mode ultrasound and sonoelastography were performed during a single session, which lasted approximately 10-20 minutes, with an additional 3-5 minutes for acquiring elastographic images. During imaging, the morphological features of the breast lesions were recorded, including lesion size, location, and characteristics indicative of malignancy or benignity. Sonoelastography was conducted by applying light pressure with the transducer to capture strain elastography images, which were classified using the Tsukuba Elasticity Score.

Each patient underwent further diagnostic procedures, including fine needle aspiration cytology (FNAC) or core biopsy, to obtain tissue samples for histopathological analysis. The findings from both imaging modalities were compared with histopathology results to determine the sensitivity and specificity of sonoelastography and B-Mode ultrasound in differentiating benign from malignant breast lesions. The level of statistical significance was set at 0.05 and a p value < 0.05 was considered statistically significant.

RESULTS

A total of 69 patients underwent B-MODE ultrasound and sonoelastography, who have been referred to breast ultrasound because of clinical suspicion of breast lesion. Patients were selected in accordance with the pre-decided case inclusion and exclusion criteria of the study. After exclusion, ultrasonography was performed on 50 patients who presented with history, signs and symptoms.

Maximum numbers of cases are in the age group of 51-60 yrs (26%) followed by 41-50 yrs (22%). Minimum numbers of cases are in the age group of 81-90 yrs (2%). The mean age is 50.28±14.09 yrs.

In the age group 21 to 30, all (100%) lesions were benign(4 out of 4), In the age group 71 to 80 and 81 to 90, there is no(0%) benign lesion (0 out of 4 and 0 out of 1), Incidence of benign lesions is more in younger age group and decreases with age. Mean age for benign lesion is 40.7± 8.9.

In the age group 21 to 30, there is no (0%) malignant lesion (0 out of 4). In the age group 71 to 80 and 81 to 90, all (100%) lesions are malignant (4 out of 4 and 1 out of 1). Incidence of malignant lesions is more in elder age group and increases with age. Mean age for malignant lesion is 59.1± 11.

48% of the cases are in between 20-50 yrs i.e. reproductive age group and 52% of the cases are in the menopausal age group. In reproductive age group, 62.5% cases are benign and 33.3% cases are malignant. In menopausal age group, 34.6% cases are benign and 65.4% cases are malignant. So, benign lesions are more common in reproductive age group and malignant lesions are more common in postmenopausal age group.

Lesions in left breast (62%) are more common than right breast (38%).

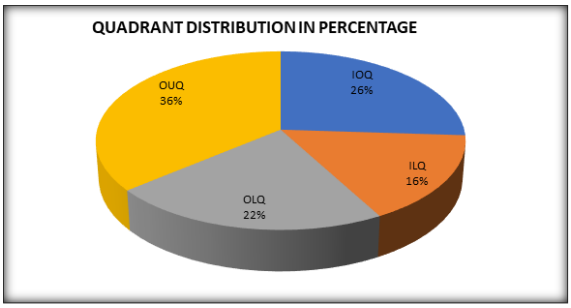

Figure 1: Distribution of Cases According to Quadrants

Breast lesions are most common in outer upper quadrant (36%) followed by inner upper quadrant (26%). Breast lesions are least common in inner lower quadrant (16%).

Minimum size of the lesion is 0.6×0.5 mm & Maximum size of the lesion is 9.7×9.5mm. 26 (52%) lesions were >2 cms in size; 1(2%) lesion was <1cm in size & 23 (52%) were 1-2 cm in size. [Table 1]

The lesion having size less than 1 cm is benign (100%). Lesions between 1-2cms sizes,11(22%) are benign and 12(24%) are malignant. Lesions with size >2cms, 12(24%) are benign and 14(28%) are malignant. [Table 2]

Among 20 lesions showing benign findings, 19 (95%) are benign and 1 (5%) turned out to be malignant. Among 30 lesions which show malignant findings, 25 (83.3%) are malignant and 5(16.7%) turned out to be benign. [Table 3]

So there is an overlapping in benign and malignant lesions mainly in sore 3 and 4. All lesions with elasticity score 5, turned out to be malignant. Average score for benign lesions is 2.79±0.65.

Average score for malignant lesion is 4.3 ±0.88. So, average elasticity score for malignant lesions was significantly higher than that for benign lesion. [Table 4]

In my study, sensitivity and specificity of B-MODE USG are 96.15% and 79.17% respectively. P value is 0.0001, which is considered extremely significant. [Table 7]

Table 1: Distribution of Cases according to Size of the Lesion

SIZE (cms)	No. of cases	% of cases
0-1	1	2%
1-2	23	46%
>2	26	52%

Table 2: Illustration of size of the lesion with Histopathological Nature of Lesion

SIZE (cms)	NO. OF BENIGN CASES	NO. OF MALIGNANT CASES
0-1 (n=1)	1/1 (100%)	0(0%)
1-2 (n=23)	11/23 (47.8%)	12/23 (52.2%)
>2 (n=26)	12/26 (46.2%)	14/26 (53.8%)

Table 3: Illustration of b-mode USG findings of benign and malignant lesions

	HPE FINDINGS	
B-MODE FINDINGS	BENIGN (n=24)	MALIGNANT (n=30)
BENIGN (n=20)	19/20 (95%)	1/20(5%)
MALIGNANT(n=30)	5/30 (16.7%)	25/30 (83.3%)

Table 4: Illustration elasticity scores of benign and malignant lesions

HPE FINDINGS	ELASTICITY SCORES				
	1 (n=0)	2 (n=9)	3 (n=17)	4 (n=10)	5 (n=14)
BENIGN (n=24)	0 (0%)	8/9 (88.9%)	13/17 (76.5%)	3/10 (30%)	0 (0%)
MALIGNANT (n=26)	0 (0%)	1/9 (11.1%)	4/17 (23.5%)	7/10 (70%)	14/14 (100%)

Table 5: Illustration of strain ratio of benign and malignant lesions

	HPE FINDINGS	
STRAIN RATIO	**BENIGN (n=24)**	**MALIGNANT (n=26)**
<3.67 (n=24)	22/24 (91.7%)	2 (7.7%)
>3.67 (n=26)	2/24 (8.3%)	24 (92.3%)

Table 6: Illustration of histopathological diagnosis of all lesions

	PATHOLOGICAL DIAGNOSIS	n (%)
BENIGN (n=24)	FIBROADENOMA	22 (44%)
	EPITHELIAL HYPERPLASIA	1 (2%)
	BENIGN PHYLLODE	1 (2%)
MALIGNANT (n=26)	EPITHELIAL HYPERPLASIA WITH NUCLEAR ATYPIA	2 (4%)
	MALIGNANT PHYLLODE	1 (2%)
	DUCTAL CARCINOMA IN SITU (DCIS)	5 (10%)
	INVASIVE DUCTAL CARCINOMA (IDC)	18 (36%)

Table 7: Sensitivity and specificity calculations

(A) Sensitivity and specificity calculations for B mode USG

	HPE FINDINGS	
B-MODE FINDINGS	**BENIGN**	**MALIGNANT**
BENIGN	**19**	**1**
MALIGNANT	**5**	**25**

Sensitivity = 96.15%; Specificity= 79.17%; PPV= 87.50%; NPV= 95.00%; P value-0.0001

(B) Sensitivity and specificity calculations for elasticity score

	HPE FINDINGS	
ELASTICITY SCORE	**BENIGN**	**MALIGNANT**
BENIGN (1-3)	**21**	**3**
MALIGNANT (4-5)	**5**	**21**

(B) Sensitivity and specificity calculations for strain ratio

	HPE FINDINGS	
STRAIN RATIO	**BENIGN**	**MALIGNANT**
BENIGN (< 3.67)	**24**	**2**
MALIGNANT(>3.67)	**2**	**22**

(D) Summary table

	B-MODE USG	ELASTICITY SCORE	STRAIN RATIO
SENSITIVITY	**96.15%**	**80.76%**	**92.31%**
SPECIFICITY	**79.17%**	**87.50%**	**91.67%**
PPV	**87.50%**	**87.50%**	**92.31%**
NPV	**95.00%**	**80.76%**	**91.67%**

DISCUSSION

Breast cancer is the most common malignancy among women worldwide. In the absence of a known preventable cause of breast cancer, the single most important factor in reducing death from breast cancer and the extent of treatment required is early detection through screening. As ultrasound has the potential to result in more biopsies because of its relatively low specificity, or inability to accurately distinguish cancerous lesions from benign ones. Approximately 80 percent of breast lesions biopsied turn out to be benign, according to the American Cancer Society. But adding elastography -- which is simply a matter of adding or activating software during an ultrasound -- may improve diagnostic accuracy and therefore reduce the number of unnecessary biopsies. Ultrasound elastography is a new screening modality in addition to sonography for detecting and identifying lesions in the breast. It can provide the investigator with another characteristic, stiffness, of the lesion. Through lightly compressing of the target lesion, UE can noninvasively determine strain and elasticity distributions inside objects scanned and map the elasticity of the lesion by using a standardized color scale, with blue indicating regions with low elasticity (harder tissue areas) and red indicating high elasticity (soft tissue areas).[20]

Advantages of elastography are

- short examination time required
- real-time display
- immediate interpretation
- limited cost

So, Elastography may be a means of reducing pain and anxiety from biopsies after suspicious findings on mammograms and B-mode USG.

The study population therefore consisted of 50 patients with solid breast lesions. This study sample size is comparable to study conducted by Gheonea et al,[21] on 58 patients. Maximum numbers of cases were in the age group of 51-60 yrs (26%) followed by 41-50 yrs (22%). Minimum numbers of cases were in the age group of 81-90 yrs(2%). The youngest patient in our study was 21 years old and the oldest 81 years old. The mean age was 50.28±14.09 yrs. In a study conducted by Zhi et al22 (n=296), mean age of patient was 42 years, with a range of 17 to 87 years. In the age group 21 to 30, all lesions (100%) were benign (4 out of 4). In the age group 71 to 80 and 81 to 90, all lesions (100%) were malignant (4 out of 4 and 1 out of 1). So, in the younger age group, benign lesions are more common and in the older age group, malignant lesions are more common. As the age increases, incidence of benign lesions decrease and malignant lesions increases. Mean age for benign lesion was 40.7± 8.9 and mean age for malignant lesion was 59.1± 11. Among these 50 patients, 24 (48%) of the patients are in between 20-50 yrs i.e. reproductive age group. 26(52%) of the patients are in the menopausal age group. In reproductive age group, 62.5% cases are benign and 33.3% cases are malignant. In menopausal age group, 34.6% cases are benign and 65.4% cases are malignant .So, benign lesions are more common in reproductive age group and malignant lesions are more common in postmenopausal age group.

Breast lesions were most common in outer upper quadrant (36%) followed by inner upper quadrant (26%) and least common in inner lower quadrant (16%). In this study, lesions in left breast (62%) were more common than right breast (38%).

Among the 50 lesions, 26 (52%) lesions were >2 cms in size, 1(2%) lesion was <1cm in size and 23 (52%) were 1-2 cm in size. Only lesion having size less than 1 cm is benign. Lesions between 1-2cms sizes,11 (22%) are benign and 12(24%) are malignant. Lesions with size >2cms, 12(24%) are benign and 14(28%) are malignant.

Histopathological examination revealed that there were 26 (52%) malignancies out of 50 lesions. The remaining 24 (48%) lesions were benign. Gheonea et al,[21] conducted a study on 58 patients having breast lesions found 28 lesions as benign and 30 lesions as malignant. There study included both solid and cystic lesions in there study. My study was comparable to this study in the fact that fibroadenoma was the most common benign lesion. However, most common malignant lesion in my study was invasive ductal carcinoma and in there study it was ductal carcinoma in situ.

Among 20 lesions showing benign findings, 19 (95%) are benign and (5%) turned out to be malignant. Among 30 lesions which show malignant findings, 25 (83.3%) are malignant and 5(16.7%) turned out to be benign. In my study, sensitivity and specificity of B-MODE USG are 96.15% and 79.17% respectively. P value is 0.0001, which is

considered extremely significant. A sensitivity of 71.2% and specificity of 73.2% for B-MODE USG were reported by Zhi et al,[22] in a study where 296 breast lesions were examined. A study by Houssami et al,[23] reported a sensitivity of 81.7% and specificity of 87.6% for B-MODE USG where 240 breast lesions were examined. A study by Stavros et al,[24] reported a sensitivity of 98.4% and specificity of 67.8% for B-MODE USG where 750 breast lesions were examined. A study by Yoon JH et al,[25] reported a sensitivity of 100% and specificity of 19%, PPV of 52.6% and NPV of 100% for B-MODE USG where 150 breast lesions were examined. [Table 8]

In our study, the elasticity of tissues (strain) was visualized on both gray scale and colour-coded mode. On the basis of the overall pattern of the degree and distribution of strain, we assigned each elastographic image an elasticity score on a four-point colour coded scale similar to the one described by Itoh et al.[12] The average elasticity score for benign lesions was 2.79±0.65 and average elasticity score for malignant lesions was 4.3 ±0.88. So, average elasticity score for malignant lesions was significantly higher than that for benign lesion. [Table 9]

In my study, sensitivity and specificity of elasticity score are 80.76% and 87.50% respectively. P value is 0.0001, which is considered extremely significant. A sensitivity of 86.5% and specificity of 89.8% for elasticity score were reported by Itoh et al,[12] in a study where 111 breast lesions were examined taking cutoff point of between 3 and 4. Another study by Gheonea et al,[21] reported a sensitivity of 86.7% and specificity of 92.9% for elasticity score where 296 breast lesions were examined taking cutoff point of between 3 and 4. [Table 10]

The average SR for benign lesions was 2.9±1.3 and average SR for malignant lesions was 6.6 ±1.4. So, average strain ratio for malignant lesions was significantly higher than that for benign lesion. In this study when a cutoff point of 3.67 was used, we found sensitivity and specificity of strain ratio are 92.31% and 91.67% respectively. P value is 0.0001, which is considered extremely significant. A sensitivity of 92.4% and specificity of 91.1% of strain ratio were reported by Hui Zhi et al,[22] in a study where 58 breast lesions were examined with cutoff point being 3.05. Another study by Gheonea et al,[21] reported a sensitivity of 93.3% and specificity of 92.9% of strain ratio where 296 breast lesions were examined with cutoff point being 3.67. [Table 11]

In our study, most malignant lesions showed higher strain ratios (>3.67) and high elasticity scores (a score of 4 or 5) on strain elastography, and most benign lesions showed lower strain ratios (<3.67) and low elasticity scores (a score of 1-3). However, in this study few fibroadenomas showed high elasticity values and few malignant lesions showed lower elasticity values. In study by Yoon JH et al,[25] there were some malignant lesions, including grade 3 IDC and DCIS, which showed low elasticity values or elasticity scores in one of the elastography techniques and benign lesions, such as fibroadenomas or papillomas, which showed high elasticity values or elasticity scores in one of the elastography technique. In a study by Zhi et al,[22,26] out of 87 lesions were false negative by elastography. Most false negative findings on UE were found in early stages of invasive ductal carcinoma, which were all in stages 1 and 2, and noninvasive carcinoma. Six of the false-negative invasive ductal carcinomas had somewhat large central necrosis. Study by Zhi et al,[22] also had 5 of the 6 cystosarcoma phyllodes false-negative findings on UE .This is in concordance with my study where one malignant phyllode had lower elasticity score and strain ratio giving false negative results. [Table 12]

Table 8: Comparison of published studies with present study on pathological diagnosis

Pathological Diagnosis	Present Study	Gheonea et al[21]
BENIGN	**24 (48%)**	**28 (48.27%)**
FIBROADENOMA	22 (44%)	10 (17.3%)
EPITHELIAL HYPERPLASIA	1 (2%)	-
BENIGN PHYLLODE	1 (2%)	-
CYSTS	-	8 (13.8%)
FIBROCYSTIC DISEASE	-	10 (17.3%)
MALIGNANT	**26 (52%)**	**30 (51.72%)**
EPITHELIAL HYPERPLASIA WITH NUCLEAR ATYPIA	2 (4%)	-
MALIGNANT PHYLLODE	1 (2%)	-
DUCTAL CARCINOMA IN SITU	5 (10%)	20 (34.9%)
INVASIVE DUCTAL CARCINOMA	18 (36%)	10 (17.3%)

Table 9: Comparison of published studies with present study on B-mode USG in breast lesions

	SENSITIVITY	SPECIFICITY	PPV	NPV
PRESENT STUDY	**96.15%**	**79.17%**	**87.5%**	**95%**
Zhi et al[22]	71.2%	73.2%	52.5%	86%
Houssami et al[23]	81.7%	87.6%	-	-
Stavros et al[24]	98.4%	67.8%	-	-
Yoon JH et al[25]	100%	19%	52.6%	100%

Table 10: Elasticity score for each pathological diagnosis of solid breast lesions

PATHOLOGICAL DIAGNOSIS(n)	SCORE 1 n=0	SCORE 2 n=9	SCORE 3 n=17	SCORE 4 n=10	SCORE 5 n=14
BENIGN	**0**	**8**	**13**	**3**	**0**
FIBROADENOMA (22)	0	7	12	0	0
EPITHELIAL HYPERPLASIA (1)	0	0	1	0	0
BENIGN PHYLLODE (1)	0	0	0	0	0
MALIGNANT	**0**	**1**	**4**	**7**	**14**
EPITHELIAL HYPERPLASIA WITH NUCLEAR ATYPIA(2)	0	0	0	2	0
MALIGNANT PHYLLODE (1)	0	1	0	0	0
DUCTAL CARCINOMA IN SITU (5)	0	0	1	2	2
INVASIVE DUCTAL CARCINOMA (18)	0	0	3	3	12

Table 11: Comparison of published studies with present study on elasticity score by sonoelastography in breast lesions

	SENSITIVITY	SPECIFICITY	PPV	NPV
PRESENT STUDY	80.77%	87.50%	87.50%	80.77%
Zhi et al[22]	70.1%	95.7%	87.1%	88.5%
Gheonea et al[21]	86.7%	92.9%	-	-
Itoh et al[12]	86.5%	89.8%	-	-

Table 12: Comparison of published studies with present study on strain ratio by sonoelastography in breast lesions

	SENSITIVITY	SPECIFICITY	PPV	NPV
PRESENT STUDY (cut off-3.67)	92.31%	91.67%	92.31%	91.67%
Zhi et al[22] (cut off-3.05)	92.4%	91.1%	-	-
Gheonea et al[21] (cut off-3.67)	93.3%	92.9%	-	-

CONCLUSION

Breast sonoelastography is a simple, rapid, and non-invasive method that enhances the diagnostic accuracy of high-resolution ultrasonography in differentiating solid breast lesions. While conventional gray-scale ultrasonography alone showed high sensitivity (96.15%) but moderate specificity (79.17%), sonoelastography improved specificity (87.5%) and positive predictive value (PPV, 87.5%) using elastographic scoring, and further increased both sensitivity (92.31%) and specificity (91.67%) with strain ratio analysis. Malignant lesions demonstrated higher elastographic scores (mean: 4.3 ± 0.88) and strain ratios (mean: 6.6 ± 1.4) compared to benign lesions, although overlap occurred in some cases due to the fibrous components of fibroadenomas or necrotic areas in ductal carcinomas. By providing complementary information to ultrasonography, sonoelastography has the potential to reduce unnecessary biopsies in women with benign lesions, thereby improving the overall efficiency and patient experience in breast lesion evaluation.

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