Evaluation of Focal Breast Lesions Using Ultrasound Elastography with FNAC and / or Histopathological Correlation - A Prospective Observational Study in the Region of Katihar, Bihar

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ABSTRACT

BACKGROUND

We wanted to evaluate the sensitivity and specificity of ultrasound elastography in the detection and characterization of various breast masses and study its role in differentiating benign vs malignant breast masses with fine needle aspirarion cytology (FNAC) and/or histopathological correlation of its findings.

METHODS

A total of 120 patients with breast lesions were prospectively evaluated using ultrasonography (USG) in the Department of Radiodiagnosis at Katihar Medical College, Katihar, Bihar. After procuring consent from the patients, B-mode and elastography examination of all the patients was carried out simultaneously, using the Philips EPIQ 5G ultrasound machine. The findings were noted in a proforma for observation and further comparisons. The usefulness of elastography, regarding prediction of the nature of the mass (benign/malignant), delineation of its exact extent, and correlation with clinical/cytological diagnosis was studied.

RESULTS

A sensitivity of 97.0% and specificity of 86.7% was observed when a cut off value of 3 was used for elasticity score. A specificity of 95.5% and a sensitivity of 93.3% was observed when a cut off of 3.8 was used for strain ratio (SR). In all cases, the extent of the pathology, the local or contiguous spread and vascular involvement, predicted by ultrasound elastography examination corroborated well with the cytological findings. The results of this study are in concordance with results of studies that have been conducted previously.

CONCLUSIONS

Ultrasound elastography is a simple and rapid method that can improve the sensitivity and specificity of ultrasonography of focal breast lesions and can decrease the rate of unnecessary biopsies. The diagnostic accuracy of combined ultrasound and elastography is quite high and thus improves the diagnostic confidence of the cases under evaluation.

KEYWORDS

Elastography, Ultrasound, Focal Breast Lesions

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DOI: 10.18410/jebmh/2021/402

How to Cite This Article:
Sinha R, Ali Z, Jaiswal M, et al. Evaluation of focal breast lesions using ultrasound elastography with FNAC and/or histopathological correlation - a prospective observational study in the region of Katihar, Bihar. J Evid Based Med Healthc 2021;8(25):2143-2148. DOI: 10.18410/jebmh/2021/402

Submission 23-10-2020,
Peer Review 03-11-2020,
Acceptance 04-05-2021,
Published 21-06-2021.

BACKGROUND

Breast cancer is the most frequently diagnosed cancer and a leading cause of cancer death in women worldwide.[1] It is progressively affecting more women in reproductive age group, and of utmost importance to help diagnose the disease at the earliest. Currently, palpation, mammography and USG are the common diagnostic tests performed to detect breast cancer, with varying degree of accuracy and predictive value.[2] Clinical palpation is the easiest examination method but has poor sensitivity and limited accuracy. Mammography helps in early detection through indirect signs, such as microcalcifications. But researchers have reported its limitations when trying to detect lobular cancer, intra-ductal cancer without characteristic micro calcifications, multifocal cancer, locally invasive cancer and recurrent cancer after hormone replacement therapy.[3] USG is more suited as a screening method with increased simplicity, real time dynamic imaging and non-invasive nature of the procedure but the specificity is poor as most solid tumours are benign. In the recent years, introduction of elastography has increased the specificity of ultrasound and facilitated earlier diagnosis of breast cancer. The use of quantitative elastography with strain ratio improves diagnostic accuracy in cases with equivocal criteria (stages 3 and 4 BIRADS).[4] It is on the basis of breast tissue elasticity that ultrasound elastography (SE) differentiates between benign and malignant lesions. In benign lesions the elasticity of the lesions will be similar to surrounding tissues while the malignant lesions will have decreased elasticity and therefore will be harder than surrounding tissues. They also display larger dimensions on elastography due to accompanying adjacent desmoplastic reaction whereas the benign lesions will have a smaller diameter on elastography than on B mode ultrasonography.[4]

We wanted to determine the sensitivity and specificity of ultrasound elastography in the detection and characterization of various breast masses and study its role in differentiating benign vs malignant breast masses with FNAC and/or histopathological correlation of its findings.

METHODS

This was a hospital based prospective observational study conducted at Katihar Medical College and Hospital, Bihar (a tertiary care teaching hospital). The study was conducted over a period of one year (January 2019 – January 2021). The patients presenting with breast swelling/lumps in the (OPD) were referred to the Radiodiagnosis Department to be evaluated by USG and this formed the study population.

For ultrasonography, the patient was positioned in a supine position with the arms placed behind and over the pillow. Both breasts were scanned. Scanning was done in transverse and longitudinal planes and also in the radial (parallel to the ducts) and anti-radial (perpendicular to ducts) planes to exhibit ductal abnormalities if any. The specific location, including laterality (left or right breast), the clock-face location, and the distance from the nipple, were accurately annotated on the images and documented in the reports.

In all, a total of 120 patients were studied. To obtain acceptable specificity, various characteristics of the tumours were evaluated according to the breast imaging reporting and data system (BIRADS) criteria defined by the American College of Radiology (ACR).[5] Unfortunately, reporting even according to these criteria may not help in differentiation of some tumours, which leads to undue increase in the number of breast lesion biopsies.[6,7] A non-invasive method of determining mechanical properties of tissue, USG elastography technically compensates for the deficiencies of conventional USG since we can clearly identify and locate breast tumours in the elasticity mode.

After recognition of the target lesion on B mode ultrasonography, images of the target lesions were attained. The US features of the identified breast masses were classified according to the ACR BIRADS US lexicon, based on the analysis of US descriptors of six morphologic features including the shape, orientation, margin, lesion boundary, internal echo pattern and posterior acoustic features.[5] Lesions with BIRADS categories 1 and 2 were considered as benign, BIRADS category 3 as indeterminate, and those with BIRADS 4 and 5 as malignant. After acquiring the B mode US images, ultrasound elastography was performed on these lesions. No additional pressure in the form of freehand compressions was used during scanning of US elastographic images. Although elastographic machine uses "strain" technology, physiological stimuli, such as patient respiration, causes the required strain in tissue deformation. The elasticity images were acquired with the elasticity color map, superimposed on the B-mode images, and displayed on the left side of a dual-display image while the corresponding B-mode image was on the right in order to maintain continuous real-time visualization. The region of interest (ROI) was set within a box highlighted manually. Each ROI included the breast mass and sufficient surrounding adjacent tissue up to 0.5 cm with inclusion of the subcutaneous layers and pectoralis muscle but without involvement of the costal cartilages.

On the basis of the overall pattern, each image was assigned an elasticity color score on the basis of a five-point colour scale. Lesions with a score of 0 with a unique layered red-green-blue signature indicated simple cystic lesions, score of 1 indicated even strain for the entire hypoechoic lesion (i.e. the entire lesion was evenly shaded in green) which was deduced as benign, score of 2 signified strain in most of the hypoechoic lesion, with some areas of no strain (i.e. the hypoechoic lesion had a mosaic pattern of green and red) which was interpreted as benign, score of 3 signified strain at the periphery of the hypoechoic lesion, with sparing of the center of the lesion (i.e. the peripheral part of lesion was blue/green, and the central part was red) which was deduced as probably benign, score of 4 indicated no strain in the entire hypoechoic lesion (i.e. the entire lesion was red, but its surrounding area was not included) which was deduced as malignant, score of 5 indicated no strain in the entire hypoechoic lesion or in the surrounding area (i.e. both the entire hypoechoic lesion and its surrounding area were red) which was deduced as malignant.

Statstical Analysis

Data was entered in MS Excel Sheet and was analysed using MedCalc stastistical software 197.2.2. Analysis was done for age, sex, laterality of the lesion. The frequencies of the various variables were derived and presented using percentages and frequencies for nominal data while mean and standard deviation were derived for continuous/discrete variables. All statistical analysis was undertaken with calculation of sensitivity and specificity for strain ratio values and elasticity score was calculated. A P - value of < 0.05 was considered statistically significant. Statistical tests used were chi square test and other non-parametric tests. ROC curve was plotted for both benign and malignant lesions and area under the curve was evaluated. The co-efficient correlation between the methods was also evaluated. The results are presented in tables and charts. Representative diagnostic images with demonstrable pathology were sampled and presented.

Observations

Benign Lesions

Case 1: A 21-year-old woman presented with a painless mobile palpable breast lump (HPE: Fibroadenoma). Findings: Strain Ratio : 2.2 Elasticity score: 2.

Malignant Lesions

Case: A 55-year-old woman with a left breast lump since 2 months and puckering of the nipple. (HPE: DCIS)
Findings: Strain Ratio : 5.0 Elasticity score: 3; El/B mode ratio > 1

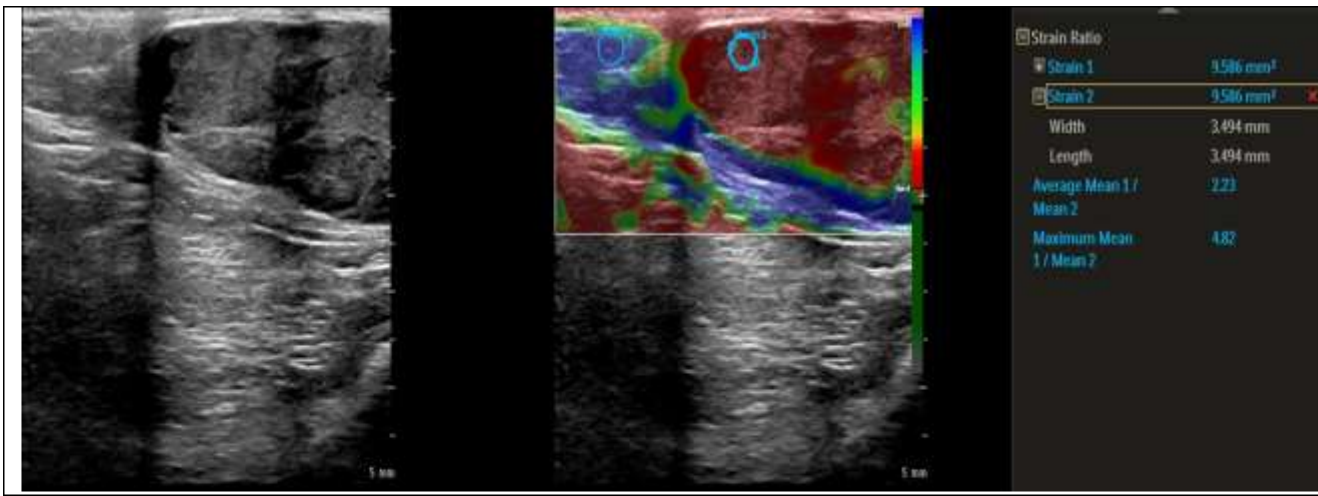


Figure 1. B Mode and Elastography of Case 1. Histopathology Confirmed Fibroadenoma with Pericanalicular Pattern

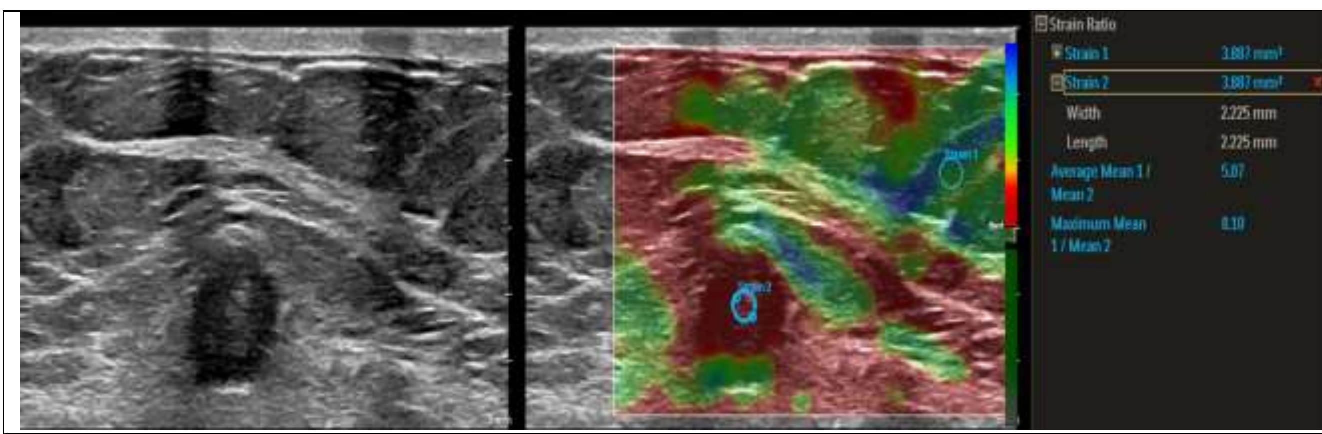


Figure 2. B Mode and Elastography of Case 2. Histopathology Confirmed Ductal Carcinoma In-Situ

RESULTS

A total of 120 patients with breast lesions confirmed on USG were enrolled for the study, out of which 8 had to be excluded as they had lost to follow-up. So, 112 participants were considered for subsequent analysis. Majority (29, 25.89%) of the participants were in the age group 31 - 40 years, followed by 21 - 30 years age group (27, 24.10%), with 20 (17.85%) patients in the 41- 50 years age group, 8 (7.14%) patients 20 years or younger and 10 (8.92%) in the 61 - 70 age group. Mean age of participants was 40.25 years. There were 54 (48.3 %) malignant and 58 (51.7 %) benign lesions. Most of the malignant lesions were observed between 30 - 60 years of age while most of the benign lesions were noted in the 20 - 50 years age group.

- Among the benign nodules, fibroadenoma (22, 19 %), fibrocystic disease (21, 18.1 %) and benign cystic lesions (15, 12.9 %) were the commonest ones.
- Among the malignant lesions, ductal carcinoma (invasive) (34, 29.3 %) was by far the commonest entity

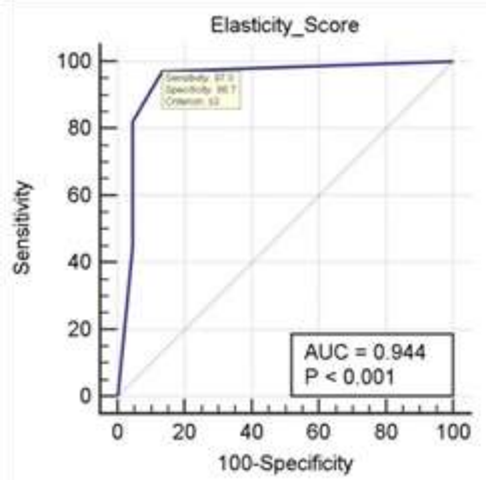
followed by the ductal carcinoma in situ (18, 15.5 %) (Table 2).

Amongst seventy benign lesions, thirty-two cases had fibroadenoma, twenty-one had fibrocystic disease, while fifteen had benign cystic lesions. Amongst forty-two malignant lesions, twenty cases of invasive ductal carcinoma while eighteen cases of ductal carcinoma in situ were the most common pathologies encountered.

Malignant nature of the lesions could be predicted accurately on B-mode ultrasound by radiological findings of ill-defined speculated margins, hypoechoic appearance, taller than wider dimensions, micro calcifications and infiltration of surrounding structures or combination of above features, while elastography provided additional information, by measuring and analysing strain ratio and Elasticity: B - mode ratio.

Type		Elasticity Score 1	2	3	4	5	Total
Benign	N	30	25	10	3	2	70
	%	42.8	35.7	14.2	4.2	2.8	100
Malignant	N	2	0	4	16	20	52
	%	3.8	0	7.6	30.7	38.4	100
Total	**N**	**32**	**25**	**14**	**19**	**22**	**112**
	%	**28.5**	**22.3**	**12.5**	**16.9**	**19.6**	**100**

Table 1. Elasticity Scores for Benign and Malignant Lesions (N = 112)

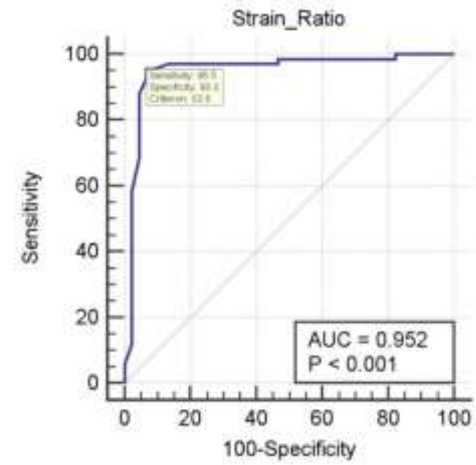


Graph 1. ROC Plot and Elasticity Score for Benign and Malignant Lesions When Cut Off Value of 3 was Used

Fibroadenoma appeared either softer than or had the same elasticity score as adjacent glandular tissue. While breast cysts had a characteristic three-layered appearance: blue-green-red (BGR), blue being the superficial colour and red the deep one, even in large dimension sections, and an elasticity score of fibrocystic nodules had elasticity similar to surrounding parenchyma.

Breast carcinoma appeared larger on the elastography image because of better visualisation of the surrounding desmoplastic reaction. The mean elasticity score for benign lesions was 1.88. Breast carcinomas showed an average elasticity score of 3.42. The mean strain ratio for benign lesions was 2.63. Breast carcinomas showed an average strain ratio of 6.05.

For sensitivity and specificity of ultrasound elastography, lesions with elasticity score of 1 - 3 were classified benign, while 4 or 5 were classified as malignant. When a cut off value of 3 was used, with area under the curve – 0.944, 95% CI – 0.896 to 0.996, P – 0.0001. A sensitivity of 97.0% and specificity of 86.7% was observed.



Graph 2. ROC Plot and Strain Ratio for Benign and Malignant Lesions When Cut Off Value of 3.8 was Used

The average strain ratio for benign lesions was 2.63 and malignant lesions was 6.05. When a cut off of 3.8 was used, area under the curve – 0.952, 95% CI – 0.875-0.991, P – 0.0001. A specificity of 95.5 % and a sensitivity of 93.3 % was observed. The correlation co-efficient for elasticity scores and SR values was 0.7989, indicating very good agreement (correlation) between the two methods.

DISCUSSION

With the steady rise in incidence of breast cancer, early detection of breast cancer is the only practical and possible way to reduce the mortality and morbidity associated with breast cancer as it is highly unlikely to be able to prevent the occurrence of the disease. A palpable breast mass is the most common clinical presentation of various breast pathologies. The breast masses may range from benign cystic lesions to malignant mass lesions. A large number of lesions are concluded to be benign among the lesions undergoing biopsy or FNACs. Thus, radiologists play an impecable role to avoid gratuitous biopsies or FNACs when it comes to the differentiation of benign and malignant masses by using non-invasive techniques. Due to the advancements in computed tomography (CT) and magnetic resonance imaging (MRI) in the recent years, diagnostic ultrasound is under scrutiny to stay competent. Ultrasonography is a key examination tool in young women. It is considered as a sensitive modality for recognition of breast cancers, which is one of the varieties of elements leading to false-negative outcomes on mammography.

Tissue biopsy is obligatory for confirmation of malignancy. However, increasing number of biopsies are being performed, which in case of benign lesions, predispose to an additional setback involving the risk of infection, resultant patient anxiety, patient uneasiness, operator reliance and increased expenses. Continuous progression and recent advances in sonographic opinion and its related software, including doppler techniques and elastography have strengthened the diagnostic capability of the B-mode US in breast pathology with consequent reduction in the overall number of tissue biopsies for benign lesions. In this prospective study, the lesions were studied for their location, number, size, shape, margins, internal contents, echogenicity, posterior acoustic shadowing, and posterior acoustic enhancement with associated secondary changes.

USG elastography was done in focal breast lesions. The interpretation of breast nodule detected on B-mode USG relies mainly on morphological criteria. To improve the accuracy of USG, additional techniques can be used, including Doppler and harmonic imaging.[8,9] Strain elastography (SE) is known to help differentiate between benign and malignant breast lesions. Results of the clinical use of SE were initially published in 1990-91, but it was only in 2003-2004 that USG equipment was developed that had incorporated software for real-time processing of elastography images and routine USG examinations.[10,11]

In this study, when a cut-off point of 3 was used, a sensitivity of 97.0% and a specificity of 86.7% was obtained for elasticity score. An observation that is consistent with available literature on the use of real-time USG elastography.[12-15] Although SR of > 4 is generally considered suspicious for malignancy, there is considerable ongoing research for establishing the correct values for differentiation of benign and malignant lesions.[16] In the present study, the mean SR for benign lesions was 2.63 and for malignant lesions it was 6.05, with the cut-off point being 3.8. The sensitivity of 95.5% and specificity of 93.3% was obtained, results that are consistent with other published data from previous similar studies.[15,17-19] This is in close obedience with results reported by Gheoneae et al.[20] who reported a sensitivity of 93.3% and specificity of 92.9% for SR (cut off point of 3.67 was used). Bojanic et al.[21] reported a sensitivity of 87.5% and specificity of 87.6% for the SR (cut off point = 3.5).

Similarly, good sensitivity and specificity was also seen in our study with a cut off of 3.5. According to Kamis et al.[22] the sensitivity, specificity, positive predictive value, negative predictive value and accuracy of the strain ratio in the diagnosis of solid breast masses were 93.3%, 97.3%, 95.5%, 96.1% and 95.8% respectively (when cut off value 3.77 was used), the values being comparable to our study. This study is in close compliance with Qing - Li Zhu et al.[23] who also concluded that addition of US elastography imaging to conventional US could be helpful in the detection and characterization of breast masses. This study is also in agreement with results by Itoh et al.[24] who found that when a cut-off point between 3 and 4 was used, elastography had 86.5% sensitivity, 89.8% specificity and 88.3% accuracy. Bojanic et al.[21] reported a sensitivity of 90.5% and specificity of 93.2% for the ES (cut off point = 3.8). According to Kamis et al.[22] the sensitivity, specificity, positive predictive value, negative predictive value and accuracy of the elasticity score in the diagnosis of solid breast masses were 100%, 88%, 83.3%, 100% and 92.5% respectively. Gheonea et al.[20] obtained a sensitivity of 86.7% and specificity of 92.9 for elasticity score which is similar to our study. The results obtained in this study are also consistent with studies by Thomas A et al.[25] who obtained a sensitivity of 81% and specificity of 89% for elastography.

The slight differences may be attributed to the varying prevalence of breast cancer in different areas, interobserver variability, different patient selection criteria, the different number of studied lesions and differences in equipment used Routine USG examination is not very specific for screening cases.[26] Quantitative elastography with SR shows increased specificity of USG and enabled early diagnoses of sub-centimetre breast cancer and decreased need for biopsies.[27] In clinical setting, strain elastography is useful for deciding whether to follow-up patients with imaging or to intervene.[27] This study showed good correlation between qualitative and quantitative elastography methods (Elasticity score and SR) and by performing both the techniques a more confident diagnosis can be made. Some limitations of SE are worth mentioning; non-focal anomalies: less sensitive than standard USG not indicated for the evaluation of postoperative changes, diffuse lesions, or large ones that exceed the probe length or field of view limited usefulness in very dense fibrous parenchyma in cases of hematomas or breast implants.[28]

CONCLUSIONS

Imaging plays an important role in the management of palpable masses of the breast. Combined use of grey scale ultrasound and elastography is useful in most instances to better characterize palpable lesions and arrive at a diagnosis. These imaging modalities help to reduce the patient anxiety and avoid unnecessary interventions in those cases in which imaging findings are unequivocally benign. Diagnostic accuracy of combined elastography and sonographic imaging is very high and is reassuring to the patient.

Limitations

There may be intra observer and inter observer variability for the acquisition of the strain index. Comparing all the techniques of grey USG, elastography score and strain ratio, the sensitivity of USG was the highest with elastography score and strain ratio showing similar sensitivities. Elastography evaluation had the highest specificity when compared with grey scale ultrasound evaluation and strain ratio.

Data sharing statement provided by the authors is available with the full text of this article at jebmh.com.
Financial or other competing interests: None.
Disclosure forms provided by the authors are available with the full text of this article at jebmh.com.

REFERENCES

[1] Bray F, Ferlay J, Soerjomataram I, et al. Global cancer statistics 2018: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA: A Cancer Journal for Clinicians 2018.

[2] Saarenmaa I, Salminem T, Geiger U, et al. The effect of age and density of the breast on the sensitivity of breast cancer diagnostic by mammography and ultrasonography. Breast Cancer Res Treat 2001;67(2):117-123.

[3] Olsen O, Gotzsche PC. Cochrane review on screening for breast cancer with mammography. Lancet 2001;358(9290):1340-1342.

[4] Gheonea IA, Stoica Z, Bondari S, et al. Differential diagnosis of breast lesions using ultrasound elastography. Indian J Radiol Imaging 2011;21(4):301-305.

[5] Breast Imaging Reporting and Data System (BIRADS). ACR BI-RADS Atlas®. 5th edn. Accessed on 04 Oct 2018. https://www.acr.org/ClinicalResources/Reporting-and-Data-Systems/Bi-Rads.

[6] Duncan JL, Cederbom GJ, Champaign JL, et al. Benign diagnosis by image-guided core-needle breast biopsy. Ak Surg 2000;66(1):5-9.

[7] Chiou SY, Chou YH, Chiou HJ, et al. Sonographic features of non-palpable breast cancer: a study based on ultrasound guided wire-localized surgical biopsies. Ultrasound Med Biol 2006;32(9):1299-1306.

[8] Rizzatto G. Real-time elastography of the breast in clinical practice: The Italian experience. Medix Hitachi Suppl 2007;1:12-15.

[9] Itoh A. Review of the techniques and diagnostic criteria of breast ultrasound elastography. Medix Hitachi Suppl 2007;1:8-11.

[10] Ophir J, Cespedes I, Ponnekanti H, et al. Elastography: a quantitative method for imaging the elasticity of biological tissues. Ultrason Imaging 1991;13(2):111-134.

[11] Konofagou EE. Quo Vadis elasticity imaging? Ultrasonics 2004;42(1-9):331-336.

[12] Itoh A, Ueno E, Tohno E, et al. Breast disease: clinical application of US elastography for diagnosis. Radiology 2006;239(2):341-350.

[13] Zhi H, Ou B, Luo BM, et al. Comparison of ultrasound elastography, mammography and sonography in the diagnosis of solid breast lesions. J Ultrasound Med 2007;26(6):807-815.

[14] Barr RG, Destounis S, Lackey LB, et al. Evaluation of breast lesions using sonographic elasticity imaging: a multicenter trial. J Ultrasound Med 2012;31(2):281-287.

[15] Thomas A, Degenhardt F, Farrokh A. Significant differentiation of focal breast lesions: calculation of strain ratio in breast sonoelastography. Acad Radiol 2010;17(5):558-563.

[16] Wang Z, Yang T, Wu Z, et al. Correlation between elastography score and strain ratio in breast small tumour. Zhong Nan Da Xue Xue Bao Yi Xue Ban 2010;35(9):928-932.

[17] Kumm TR, Szabunio MM. Elastography for the characterization of breast lesions: initial clinical experience. Cancer Control 2010;17(3):156-161.

[18] Tan Sm, The HS, Mancer JFK, et al. Improving B-mode ultrasound evaluation of breast lesions with real-time ultrasound elastography: a clinical approach. Breast 2008;17(3):252-257.

[19] Zhi H, Xiao XY, Yang HY, et al. Semi-quantitative stiffness of breast solid lesions in ultrasound elastography. Acad Radiol 2008;15(11):1347-1353.

[20] Gheonea IA, Stoica Z, Bondari S, et al. Differential diagnosis of breast lesions using ultrasound elastography. Indian J Radiol Imaging 2011;21(4):301-305.

[21] Bojanic K, Katavic N, Smolic M, et al. Implementation of elastography score and strain ratio in combination with B-mode ultrasound avoids unnecessary biopsies of breast lesions. Ultrasound Med Biol 2017;43(4):804-816.

[22] Khamis ME, El-Deen AM, Ismail AA. The diagnostic value of sonoelastographic strain ratio in discriminating malignant from benign solid breast masses. The Egyptian Journal of Radiology and Nuclear Medicine 2017;48(4):1149-1157.

[23] Zhu QL, Jiang YX, Liu JB, et al. Real-time ultrasound elastography: its potential role in assessment of breast lesions. Ultrasound Med Biol 2008;34(8):1232-1238.

[24] Itoh A, Ueno E, Tohno E, et al. Breast disease: clinical application of US elastography for diagnosis. Radiology 2006;239(2):341-350.

[25] Thomas A, Degenhardt F, Fahrrokh A, et al. Significant differentiation of focal breast lesions. Acad Radiol 2010;17(5):558-563.

[26] Starvos AT, Thickman D, Rapp CL, et al. Solid breast nodules: use of sonography to distinguish benign and malignant lesions. Radiology 1995;196(1):123-134.

[27] Thomas A, Kummel S, Fritsche F, et al. Real-time sonoelastography performed in addition to B-mode ultrasound and mammography: improved differentiation of breast lesions? Acad Radiol 2006;13(12):1496-1504.

[28] Giuseppetti GM, Martegani A, Di Cioccio B, et al. Elastography in the diagnosis of the nodular breast lesions: preliminary report. Radiol Med 2005;110(1-2):69-76.