Al-Kindy College Medical Journal (KCMJ)

Research Article

Efficacy of Shear-Wave Elastography for Evaluation of Solid Breast Masses

Niranjan Sahu[1*], Ashish Kumar Agrahari[1], Bikash Parida[1], Somadatta Das[1]

[1] Department of Radiodiagnosis, Institute of Medical Sciences and Sum Hospital, Siksha O Anusandhan deemed to be University, Bhubaneswar-751003, Odisha, India

* Corresponding author's email: niranjanradiologist@gmail.com

Article history:
Received 21 August 2023
Accepted 7 November 2023
Available online 30 December 2023

https://doi.org/10.47723/kcmj.v19i3.1218–

Keywords: Elastography, histopathological correlation, breast masses

ABSTRACT

Background: Although various imaging modalities are available for evaluating suspicious breast lesions, ultrasound-based Shear-Wave Elastography is an advanced, non-invasive technique complementary to grayscale sonography. This technique evaluates the elasticity of a specific tissue by applying sonic pressure to that tissue.

Objective: The aim is to assess the role of Short-Wave Elastography's in evaluating solid breast masses in correlation to histopathological study results.

Subjects and Methods: This prospective study was done in a tertiary care teaching hospital from September 2019 to August 2020. A study population of 50 women aged 18 years or above with an ultrasonographic diagnosis of solid breast masses was included.

Results: A significantly higher value of Short-Wave Elastography's elasticity ratio (E-mean) was observed in malignant tumors than in benign tumors ($p < 0.0001$). The area-under-curve for the BI-RADS 4 lesions was 0.522 (95% CI, 0.343-0.701) with an E-ratio cut-off score of 85.25, the sensitivity and specificity were 50% for diagnosing malignant tumors, whereas area-under-curve for the histopathological examination study was 1.000 (95% CI, 1.000-1.000) with an E-ratio cut-off score of 134.25; both the sensitivity and specificity were 100% for diagnosing malignant tumors.

Conclusions: A well-defined Shear-Wave Elastography elasticity ratio range might help differentiating malignant from benign breast tumors and predict its aggressiveness. Furthermore, Short-Wave Elastography's correlation with BI-RADS in suspicious lesions adds to histopathology's advantage in distinguishing malignant tumors from benign ones.

Introduction

Breast Carcinoma is one of the most common malignancies globally, especially in patients aged 50-55 (1). Approximately 22% of all cancers in women worldwide are breast carcinomas. However, a broad spectrum of diseases is covered under breast masses; the most frequent benign breast tumor is a fibroadenoma. In contrast, Invasive Ductal Carcinoma is the most common malignant breast mass (2). Although various imaging modalities are available to image breast pathologies, Ultrasound-based elastography is an advanced, non-invasive technique to evaluate a suspicious breast lesion complementary to grayscale ultrasonography (USG). Shear-wave elastography (SWE) is a non-invasive method for determining the elasticity of a specific tissue (3). The transducer was applied lightly to the skin above the lesion with a generous amount of transducer jelly. The elasticity of the lesion is measured using the ultrasound elastography colour scale. Though numerous different scoring techniques are available, the Tsukuba elasticity score is a widely acknowledged and regularly used scoring system for breast lesion assessment (4). Once the breast lesion's elasticity is measured, a biopsy is done to confirm the breast lesion. A breast biopsy is a gold standard in diagnosing breast pathologies.

As per the National Cancer Registry Program of Indian Council of Medical Research (ICMR), the incidence of breast carcinoma in Indian women is five per one lakh women per year in rural regions and thirty per one lakh women per year in urban areas. A unified report is produced based on the hospital registries. The absence of population screening among Indians and the resulting overdiagnosis in the Western population contributes significantly to statistical discrepancies. Breast carcinoma is most prevalent in Breast Cancer gene (BRCA) BRCA1 and BRCA2 genes. The three studies described below are crucial, among many others. The study assesses risk factors for triple-negative breast carcinoma (TNBC) versus estrogen receptor-positive breast carcinoma (5). Focal breast lesions are classified as either benign or malignant. We have many modalities to detect these changes, including USG, mammography, Magnetic resonance imaging (MRI), and histopathological procedures such as : Fine-needle aspiration cytology (FNAC) and biopsy. Though the histopathological test is the gold standard, it has some disadvantages, such as being invasive, infection-prone, painful procedures, and expensive. Change in the elasticity of affected breast tissue in focal breast lesions is one of the earliest signs indicating a pathological alteration of the tissue.

Shear wave elastography is sensitive to identifying such subtle changes in tissue architecture. Hence, stiffness measurement could also accurately predict the presence of benign or malignant changes. Breast cancer has a high incidence, and its delayed progression before diagnosis has prompted research into new diagnostic tools. The addition of elastography to USG has boosted its specificity and allowed for earlier detection of breast cancer (6,7). The word elastography has been used in USG to refer to various techniques for visualizing tissue strain since the early 1990s (8-10). Intrinsic elasticity is a characteristic of tissue that may alter due to tumors, aging, inflammation, and many such pathophysiological events. The needed stress (pressure) ratio to the accomplished relative change in length is called elasticity in this circumstance (strain, distortion). As a result, it expresses the force required to induce tissue to deform elastically due to its intrinsic elasticity modulus (Young's modulus). Clinical investigations have demonstrated the advantage of using tissue elasticity as extra information for various organ systems for years (11).

The value of utilizing tissue elasticity as extra information in clinical investigations for various organ systems and elasticity studies of organs like the parotid gland has been shown for years, thyroid gland, liver, prostate gland, and cervix (12,13). In breast sonography, verifying the absence of strain in a focused finding is an indicative criterion that enhances diagnostic reliability.

Furthermore, better discrimination between benign and malignant lesions and between Breast Imaging Reporting & Data System (BI-RADS) 3 and BI-RADS 4 was obtained with the help of SWE. As a result, adopting SWE as an additional criterion in breast diagnostics lowered the number of false-positive findings. Additional method validation is needed using unselected screening populations, but it has yet to be found thus far (14,15). This research aims to determine how effectively SWE identifies the malignant nature of solid breast lesions. The aim is to correlate the histopathological diagnosis of a solid breast mass with the mean stiffness determined by SWE.

Subjects and methods

This prospective study was conducted in a tertiary care teaching hospital from 2019 to 2020 at IMS and SUM Hospital, Bhubaneswar, Odisha. Before enrolling in the study, the Institutional Ethics Committee approved the study with Ref. No/DMR/IMS.SH/SOA/180223, dated 24 May 2019, and informed consent was sought. The study population comprised 50 women aged 18 years or above, presenting with breast masses demonstrating solid consistency on USG and a size larger than 5mm (An elastogram can be beneficial only in lesions more than 5mm) and consenting to a thorough work-up were included. Exclusion criteria are pregnant or nursing women, women having breast implants, under radiation or chemotherapy for any carcinoma, ipsilateral breast surgery, skin lesions that had been biopsied previously, and patients who disagreed with giving consent. A standard questionnaire/proforma was used to collect data in the included study group. The primary patient information on the proforma comprises the patient's name, gender, age, address, educational qualification, occupation, dietary habits, and smoking/alcohol habits. The proforma also included a general check-up and a local assessment of the breast lump of the patient by inspection and palpation. USG and SWE images were obtained using the Samsung HS70A and GE LOGIQ S8 fitted with a 4-15 MHz linear-array transducer.

Breast sonography and SWE of each patient were carried out by two senior radiologists, each with 5 to 10 years of expertise. The transducer was applied lightly to the skin above the lesion with a generous amount of transducer jelly. And it was held still for 5 to 10 seconds to let the SWE image stabilize, and an elastography image displaying abnormal stiffness clearly without pressure artifacts was frozen and saved. The built-in-region-of-interest (ROI) of the system was set to include the mass, and the surrounding breast parenchyma tissue, which demonstrated a semi-transparent colour map of tissue stiffness overlaid on the B-mode image with a range of dark blue, indicating the lowest stiffness, to red, indicating the highest stiffness (0–180 kPa). Quantitative elasticity values were measured using two 2mm-diameter circular quantification ROIs in all cases. One was placed by an investigator on the stiffest part of the mass and included some tissue adjacent to the stiffest part. And the other ROI was placed on the normal fatty tissue. The system automatically calculated and visualized the Emax, mean elasticity (E-mean), standard deviation, and elasticity ratio (E-ratio), which is the ratio of the E-mean value in the stiffest portion of the mass to the E-mean value of normal fatty tissue.

Statistical Package for Social Sciences SPSS 20.0 was used for statistical analyses (SPSS, Chicago, IL). To compare continuous variables between the benign and malignant groups, an independent two-sample t-test was performed. In addition, receiver operating characteristic (ROC) curve studies have been prepared to evaluate the diagnostic performance of quantitative SWE parameters versus histopathological examination (HPE) and BI-RADS results separately. A p-value less than 0.05 is considered statistically significant

Results

The mean age was 41 years for benign lesions and 57.5 years for malignant lesions. Thirty-four percent of the patients were between 40 and 49 years old, followed by 26% of those below 40 and between ages 50 and 59. Totals of 30 (60%) BI-RADS 3, 18 (36%) BI-RADS 4, and 2 (4%) BI-RADS 5 lesions were undergone histopathological evaluation. Among all lesions, 32 (64 %) were benign, and 18 (36 %) were malignant. The most common benign lesion was fibroadenoma (n=27), whereas invasive ductal carcinoma (n=12) was the most common malignant lesion (Table 1). The mean age of patients with benign histopathological findings was 41.0 years, and that of those with malignant lesions was 57.5 years (p = <0.0001). The upper outer quadrant location is most common for benign (14/32) and malignant (13/18) lesions. The malignant lesion had shown relatively more prevalence on the left side, whereas benign lesions showed almost equal prevalence on either side. The elastography parameters for malignant lesions were significantly higher than those for benign lesions (Fig. 1).

Furthermore, no significant difference was observed between the groups of patients in terms of characteristics such as laterality (p = 0.178), tumor location (p = 0.162), and vascularity (p = 0.741). A significantly higher value of the SWE E-ratio cut-off score had been observed in malignant tumors in comparison to benign tumors (p <0.0001) (Table 1). At the E-ratio cut-off score of 134.25 kPa, based on HPE findings, the sensitivity and specificity were 100% for diagnosing malignant tumors. At the E-ratio cut-off score of 85.25 kPa, based on BI-RADS grading, the sensitivity, and specificity for diagnosing malignant tumors was 50% (Fig. 2).

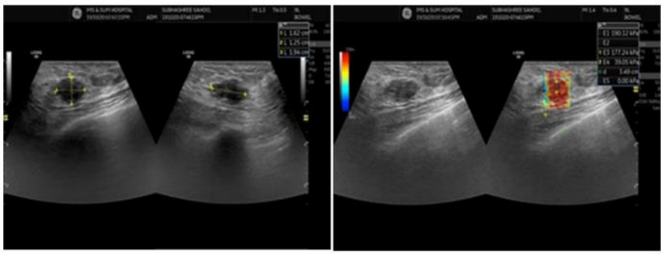

Figure1: Shear-wave elastography shows Emax 177.2 kPa (the whole lesion appears red)

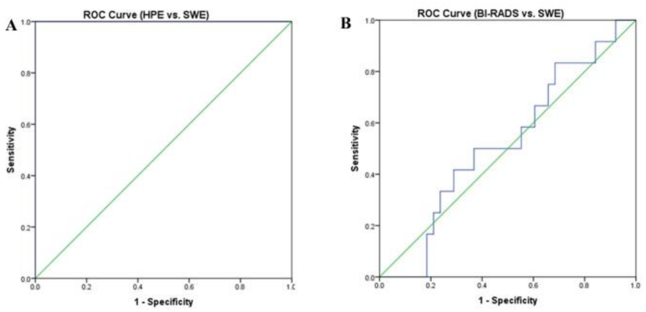

Figure 2: A; ROC Curve (HPE vs. SWE), B; ROC Curve (BI-RADS vs. SWE)

Table1: Comparison between benign and malignant tumor cases

	Benign (n=32)	**Malignant (n=18)**	***p*-value**
Mean Age (years)	41.0	57.5	<0.0001
Location of tumors UIQ	5	3	
UOQ	14	13	0.162
LIQ	8	1	
LOQ	5	1	
Vascularity	30	18	0.741
Affected breast side (Laterality)	17/15 (Right /Left)	6/12 (Right /Left)	0.178
SWE	58.75 [38.72, 2.57]	181.55 [167.02, 190.15]	<0.0001
HPE findings			
Fibroadenoma	27	0	
Invasive ductal carcinoma	0	12	
Invasive lobular carcinoma	0	3	
Lipoma	2	0	
Medullary carcinoma	0	2	<0.0001
Granuloma	2	0	
Mixed ductal and lobular-Carcinoma	0	1	
Phyllode tumour	1	0	

Discussion

Breast cancer is more prevalent in younger women in India, with fifty-two percent of all breast cancer diagnosed in women between 40 and 49 (16). A large majority of patients were under 30 years old. Most of the women in our study (34%) were between 40 and 49 years old. The present study is consistent with the previous research; according to Murthy et al. an incidence of 0.5-2% each year has been observed in all age categories and all regions of India, particularly in the younger age group 45 years (17). Of Indian patients, more than 80% are under 60 years; the average age of patients varied from 44.2 years to 49.6 years, as reported (18). According to several nationwide population-based studies, 50-53 years was the average age for breast cancer. Many breast cancer patients are under 35 years old, ranging between 11% at Tata Memorial Hospital in Mumbai and 26% at SGPGIMS in Lucknow (19).

Breast cancer asymmetry is thought to be caused by differences in mammary gland sensitivity to hormone stimulation, resulting in varying amounts of tissue at risk of developing carcinoma. In the present study, 54% of the women had tumors on the left side. A potential reason has been suggested: the left breast is more prominent than the right (20). Breastfeeding on the right breast, rather than the left, protects against cancer (21). Although there is a slight excess of tumors on the left side, it does not appear to have any clinical significance (22). Irradiation of the breast or chest wall causes larger radiation doses to the heart, as left-sided cancers are more prevalent than right-sided lesions (23). Premenopausal patients had statistically significant left-sided lateralization of breast tumors compared to post-menopausal patients (24). The mammograms of healthy women were used to calculate relative breast volumes, and 55% of the women were found to have bigger left breasts. In a recent multicentric study, 51% of breast cancers occurred on the left side, as reported (25). Fibroadenomas account for over half of all breast biopsies, reaching

75% among women under 20 years (26). Based on BI-RADS classification, in the present study, the majority of women belonged to BI-RADS-3 (60%), followed by BI-RADS-4 (36%) and BI-RADS-5 (4%). Based on another study, 58.6% of the women belonged to BI-RADS-1 (34.6%), BI-RADS-2 (7%), BI-RADS 3, and none of BI-RADS 4 (27). In our study, Fibroadenoma was the most common type of breast tumor (54%) prevalent in women from higher socio-economic strata.

In SWE, instead of the operator manipulating the probe physically, an acoustic impulse produced electronically by the device causes the deformation of the breast tissue. As a result, we anticipated that quantitative SWE parameters would be more relevant in clinical practice for identifying breast cancer based on diverse histological findings. We found a significant positive correlation of SWE with histopathology grading ($r = 0.83$ $p < 0.0001$). In malignant tumors, the mean SWE was significantly higher (181.55) than in benign tumors (58.75). We concord with Youk et al. 2013, who reported similar findings (28). Similarly, Zhu et al. said a higher HP grade was closely correlated with a higher mean, minimum, and maximum shear-wave velocity value ($p < 0.05$) (29). In our study, the AUC for the BI-RADS was 0.522 (95% CI, 0.343-0.701) at a SWE cut-off score of 85.25, and the sensitivity and specificity in diagnosing malignant tumors was 50%. The AUC for the HPE study was 1.000 (95% CI, 1.000-1.000) at a SWE cut-off of 134.25, and the sensitivity and specificity for diagnosing malignant tumors were 100%. In a study by Youk et al. the AUC of the E-ratio (0.952) was the greatest of the elasticity values (mean, maximum, and lowest elasticity, 0.949, 0.939, and 0.928, respectively; p 0.04), while the AUC of the colour pattern was 0.947 (30).

SWE is recognized to assess local tissue elasticity mostly independent of neighbouring tissues and, in principle, is unaffected by target size (31). However, tumor size has been shown to affect elasticity values. The elasticity value was still considerably higher for malignant lesions (invasive tumors with an ultrasonic size of 0.001) than for benign lesions (32). The SWE is better at discriminating the ability to identify malignant tumors (33).

Limitations

However, more research with large sample sizes would be required in the near future to emphasize the SWE findings more accurately.

Conclusion

SWE is utilized for differentiating malignant from benign breast tumors. A well-defined range of SWE may help predict the malignancy of breast tumors. The association of SWE with BI-RADS in suspicious lesions furthers an advantage close to histopathology in differentiating malignant tumors from benign lesions. Although the findings cannot be generalized because of the small sample size, further research with a large population would be required to validate the results. In addition, we can differentiate malignancy with mean SWE values; the role of minimum and maximum SWE values must be considered.

Conflict of interest

The authors declare no conflict of interest.

Funding

This research did not receive any specific funding.

ORCID

Niranjan Sahu 0000-0002-4712-5033
Bikash Parida 0000-0002-9805-7982

References

[1] Dawson AE, Mulford DK. Benign versus malignant papillary neoplasms of the breast. Diagnostic clues in fine-needle aspiration cytology. Acta Cytol. 2016;80:23-8. PMID: 8291351.

[2] Jung I, Han K, Kim MJ, Moon HJ, Yoon JH, Park VY, Kim EK. Annual Trends in Ultrasonography-Guided 14-Gauge Core Needle Biopsy for Breast Lesions. Korean J Radiol. 2020;21(3):259-267. https://doi.org/10.3348/kjr.2019.0695

[3] Yildirim D, Akıncı Ö, Tekcan D. Quantitative Ultrasound Elastography of Breast: A Review and Update with Emphasis on Shear Wave Imaging (ARFI). Open Journal of Medical Imaging. 2021;11:58-72. https://doi.org/10.4236/ojmi.2021.112006

[4] Itoh A, Ueno E, Tohno E, Kamma H, Takahashi H, Shiina T, et al. Breast disease: clinical application of US elastography for diagnosis. Radiology. 2006;239(2):341- 50. https://doi.org/10.1148/radiol.2391041676

[5] Ghosh J, Gupta S, Desai S, Shet T, Radhakrishnan S, Suryavanshi P, et al. Estrogen, progesterone and HER2 receptor expression in breast tumors of patients, and their usage of HER2-targeted therapy, in a tertiary care center in India. Indian Journal of Cancer. 2011;48(4):391. https://doi.org/10.4103/0019-509x.92245

[6] Gheonea IA, Stoica Z, Bondari S. Differential diagnosis of breast lesions using ultrasound elastography. Indian J Radiol Imaging. 2011;21(4):301-5. https://doi.org/10.4103/0971-3026.90697

[7] Youk JH, Gweon HM, Son EJ. Shear-wave elastography in breast ultrasonography: the state of the art. Ultrasonography. 2017;36(4):300-309. https://doi.org/10.14366/usg.17024

[8] Sigrist RMS, Liau J, Kaffas AE, Chammas MC, Willmann JK. Ultrasound Elastography: Review of Techniques and Clinical Applications. Theranostics. 2017;7;7(5):1303-1329. https://doi.org/10.7150/thno.18650

[9] Drakonaki EE, Allen GM, Wilson DJ. Ultrasound elastography for musculoskeletal applications. Br J Radiol. 2012;85(1019):1435-45. https://doi.org/10.1259/bjr/93042867

[10] Gennisson JL, Deffieux T, Fink M, Tanter M. Ultrasound elastography: principles and techniques. Diagnostic and interventional imaging. 2013;1;94(5):487-95. https://doi.org/10.1016/j.diii.2013.01.022

[11] Trębacz H, Barzycka A. Mechanical Properties and Functions of Elastin: An Overview. Biomolecules. 2023;22;13(3):574. https://doi.org/10.3390/biom13030574

[12] Klintworth N, Mantsopoulos K, Zenk J, Psychogios G, Iro H, Bozzato A. Sonoelastography of parotis gland tumours:

initial experience and identification of characteristics patterns. Eur Radiol. 2012;22:947-956. https://doi.org/10.1007/s00330-011-2344-7

[13] Friedrich-Rust M, Nierhoff J, Lupsor M, Sporea I, Fierbinteanu-Braticevici C, Strobel D, et al. performance of acoustic radiation force impulse imaging for the staging of liver fibrosis: a pooled meta-analysis. J of Viral Hepatitis. 2012;19:e212-e219. https://doi.org/10.1111/j.1365-2893.2011.01537.x

[14] Schmachtenberg C, Engelken F, Fischer T, Bick U, Poellinger A, Fallenberg EM. Intraoperative Specimen Radiography in Patients with Nonpalpable Malignant Breast Lesions. Fortschr Röntgenstr. 2012; 184:635-642. https://doi.org/10.1055/s-0032-1312730

[15] Waldmann A, Adrich S, Eisemann N, Fauteck H, Grande-Nagel I, Schaefer FK, et al. Struktur- und Prozessqualität in der qualitätsgesicherten Mammadiagnostik in Schleswig-Holstein. Fortschr Röntgenstr. 2012;184:113-121. https://doi.org/10.1055/s-0031-1281983

[16] Khokhar A. Breast cancer in India: where do we stand and where do we go? Asian Pac J Cancer Prev. 2012;13(10):4861-6. https://doi.org/10.7314/apjcp.2012.13.10.4861

[17] Murthy NS, Agarwal UK, Chaudhry K, Saxena S. A study on time trends in incidence of breast cancer-Indian scenario. Eur J Cancer Care. 2007;16:185-6. https://doi.org/10.1111/j.1365-2354.2006.00761.x

[18] National Cancer Registry Programme: Consolidated report of the population-based cancer registries 1990-1996. Indian Council of Medical Research, New Delhi, 2001

[19] Agarwal G, Pradeep PV, Aggarwal V, Yip CH, Cheung PS. Spectrum of breast cancer in Asian women. World J Surg. 2007;31:1031-40. https://doi.org/10.1007/s00268-005-0585-9

[20] Hudson SM, Wilkinson LS, Denholm R, De Stavola BL, Dos-Santos-Silva I. Ethnic and age differences in right-left breast asymmetry in a large population-based screening population. Br J Radiol. 2020;93(1105):20190328. https://doi.org/10.1259/bjr.20190328

[21] Anstey EH, Shoemaker ML, Barrera CM, O'Neil ME, Verma AB, Holman DM. Breastfeeding and Breast Cancer Risk Reduction: Implications for Black Mothers. Am J Prev Med. 2017;53(3S1):S40-S46. https://doi.org/10.1016/j.amepre.2017.04.024

[22] Baran B, Mert Ozupek N, Yerli Tetik N, Acar E, Bekcioglu O, Baskin Y. Difference Between Left-Sided and Right-Sided Colorectal Cancer: A Focused Review of Literature. Gastroenterology Res. 2018;11(4):264-273. https://doi.org/10.14740/gr1062w

[23] Sardaro A, Petruzzelli MF, D'Errico M, Grimaldi PL, Pili G, Portaluri M. Radiation-induced cardiac damage in early left breast cancer patients: risk factors, biological mechanisms, radiobiology, and dosimetric constraints. Radiother Oncol. 2012;103(2):133-42. https://doi.org/10.1016/j.radonc.2012.02.008

[24] Kakkar V, Sharma R, Singh K, Randhawa A. Trends of breast tumour laterality and age-wise incidence rates in North Indian population. Int Surg J. 2020;7:2523-6. http://dx.doi.org/10.18203/2349-2902.isj20203229

[25] Doval DC, Radhakrishna S, Tripathi R, Kashinath RI, Talwar V, Batra U, et al. A multi-institutional real world data study from India of 3453 non-metastatic breast cancer patients undergoing upfront surgery. Sci Rep. 2020;3;10(1):5886. https://doi.org/10.1038/s41598-020-62618-3

[26] Salati SA. Breast fibroadenomas: a review in the light of current literature. Polish Journal of Surgery. 2021;93(1):40-8. https://doi.org/10.5604/01.3001.0014.5676

[27] Takkar N, Kochhar S, Garg P, Pandey AK, Dalal UR, Handa U. Screening methods (clinical breast examination and mammography) to detect breast cancer in women aged 40-49 years. J Mid-life Health. 2017;8:2-10. https://doi.org/10.4103/jmh.jmh_26_16

[28] Youk JH, Gweon HM, Son EJ, Kim JA, Jeong J. Shear-wave elastography of invasive breast cancer: correlation between quantitative mean elasticity value and immunohistochemical profile. Breast Cancer Res Treat. 2013;138(1):119-26. https://doi.org/10.1007/s10549-013-2407-3

[29] Zhu YC, Zhang Y, Deng SH, Jiang Q, Wang DS. Correlation between histopathological grading and shear-wave Elastography in evaluating invasive carcinoma of no special type. Exp Ther Med. 2018;16(6):4700-4706. https://doi.org/10.3892/etm.2018.6790

[30] Youk JH, Gweon HM, Son EJ, Han KH, Kim JA. Diagnostic value of commercially available shear-wave Elastography for breast cancers: integration into BI-RADS classification with subcategories of category 4. Eur Radiol. 2013;23(10):2695-704. https://doi.org/10.1007/s00330-013-2873-3

[31] Marcy PY, Thariat J, Lacout A. Should we catch the train of shear-wave Elastography? AJR Am J Roentgenol. 2012;198:W624-W625. https://doi.org/10.2214/ajr.11.8078

[32] Evans A, Whelehan P, Thomson K, McLean D, Brauer K, Purdie C, et al. Quantitative shear wave ultrasound elastography: initial experience in solid breast masses. Breast Cancer Res. 2010;12:R104. https://doi.org/10.1186/bcr2787

[33] Berg WA, Cosgrove DO, Dore CJ, Schafer FK, Svensson WE, Hooley RJ, et al. Shear- wave-elastography improves the specificity of breast US: the BE1 multinational study of 939 masses. Radiology. 2012;262:435-449. https://doi.org/10.1148/radiol.11110640

To cite this article: Sahu N, Agrahari AK, Parida B, Das S. Radiological Significance of Shear-Wave Elastography Technique for Evaluation of Solid Breast Masses with Histopathological Correlation. AL-Kindy College Medical Journal. 2023;19(3):26–30. https://doi.org/10.47723/kcmj.v19i3.1218.