DIAGNOSTIC VALUES OF SONOGRAPHIC ELASTOGRAPHY PARAMETERS IN BREAST LESIONS

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ABSTRACT: Ultrasound is one of the imaging techniques used to screen and evaluate breast lesions. In particular, when combined with strain elastography, it has been shown to improve the diagnostic effectiveness of breast lesions in many studies. However, few studies have directly compared all three strain elastography methods to determine whether one is more accurate than the others. We aimed to evaluate and compare the sensitivity, specificity, and diagnostic accuracy of the five-point elastography score (Tsukuba score), strain ratio (SR), and length ratio (E/B ratio) in suspected breast lesions correlate with pathology results as the gold standards. Materials and methods: This is a cross-sectional descriptive study, 59 patients with 61 lesions were classified BIRADS from 3 to 5 after obtaining Strain elastography and B-mode ultrasound that have got histopathologic results at Can Tho Oncology Hospital from November 2022 to May 2024. In this study, there was a total of 61 lesions of 59 female patients aged 47.2◎1.9 years, 26 were benign, and 35 were malignant, they mainly located in the upper outer quadrant. Sensitivity, specificity and accuracy rate of 86%, 81%, and 84% for the Tsukuba score. These of 97%, 79%, and 92% for E/B ratio (cutoff value 1.05, AUC 0.91), 60%, 89%, and 72% for SR (cutoff value 3.09, AUC 0.74) were obtained, respectively. This study has shown that all three methods are valuable in evaluating breast lesions. Among them, the E/B ratio had the highest sensitivity and diagnostic accuracy, while the specificity of the strain ratio was superior to the others.

KEYWORDS: *elastography score, strain ratio, E/B ratio, breast lesions*

1.0 INTRODUCTION

According to 2022 statistics, breast cancer was the most common cancer in women and mortality rate with an estimated more than 10000 deaths in Vietnam [1]. Ultrasound is one of the most commonly used modalities for screening breast lesions, which are classified according to the standard American Institute of Radiology (ACR) Breast Imaging Reporting and Data System (BIRADS) lexicon. Some lesions are categorised into BIRADS 3 or 4a, leading to dilemmas for the treating clinician and the reporting radiologist in case the biopsy is considered, elastography may be helpful to increase diagnostic confidence. There are two main elastographic techniques to evaluate breast lesions: strain elastography (SE) and shear wave elastography (SWE) [2].

For strain elastography, imaging is generated by compression with the transducer or with physiological patient motion (breathing or heartbeat). Each vendor's system has an optimal amount of displacement to generate a strain image. Malignant masses are stiffer than the normal tissues, so measuring the tissue strain by compressing the sonography transducer provides information with three methods, including the five-point elastography score (Tsukuba score) displayed by using a color map, the strain of breast lesions about the surrounding fatty tissue (strain ratio) and breast lesion elasticity in strain elastography compared to its length in B mode sonography (E/B ratio).

As the WFUMB guideline, there is insufficient data to prove that one method is superior to another [2]. Previous studies have also had varied results. In 2018, a systematic review and meta-analysis of the three methods, the E/B had the highest sensitivity, and the E/B ratio and five-point score had the highest specificity [3]. Whilst in 2020, another study recorded that among the three different methods of strain elastography, the five-point score was superior to E/B ratio and strain ratio [4]. With those background, this article was to focus on the values of three methods of strain elastography in characterising breast lesions.

2.0 METHODOLOGY

2.1 Research subjects

All female patients having breast masses underwent strain elastography and obtained pathology results from ultrasound-guided core needle biopsy at Can Tho Oncology Hospital from 11/2022 to 5/2024.

- Selection criteria: The patients were determined to have breast lesions by conventional ultrasound, with or without mammography, and had strain elastography reports and pathology results from core needle biopsy under ultrasound guidance.

- Exclusion criteria: having a history of breast cancer, under treatment for other cancers, having cosmetic breast augmentation.

2.2. Research methods

- Study design: a cross-sectional descriptive study.

- Sample size:

$$n_{sp} = \frac{FP + TN}{1 - p_{dis}} \quad \text{với} \quad FP + TN = \frac{Z^2_{1-\frac{\alpha}{2}} \times p_{sp} \times \left(1 - p_{sp}\right)}{w^2}$$

In which: n is the smallest sample size, Z = 95%, $Z^2_{1-\frac{\alpha}{2}}$ = 1,96; w = 0,06, is the margin of error; p_{sp} =94% in research of Sinha Dimpi et al. [5]; p_{dis} =0,125%, is 5-year breast cancer prevalence rate in Vietnam (GLOBOCAN 2020 [6]).

With the above data, we calculated n=60, in fact, our study selected 61 samples that met the standards.

- Study contents:

+ General characteristics of research subjects: age, distribution of lesions, pathology results.

+ Assessment of the values of three methods of strain elastography: Tsukuba score, E/B ratio, and strain ratio.

- Data collection method:

+ Bilateral whole breast imaging was performed by using Siemens Acuson Juniper machine with a 3-12 MHz linear transducer.

+ After the B-mode ultrasound images were obtained, strain elastography was used for breast lesions that got BIRADS from 3 to 5 in B-mode ultrasound. Lesion images in strain elastography were displayed, including Tsukuba score, length ratio, and strain ratio. Final BIRADS were categorised according to the combination of B-mode and strain elastography ultrasound results.

+ Finally, samples were taken by 16G core needle biopsy under ultrasound guidance. The histopathological results of lesions were compared with the ultrasound findings.

- Statistical analysis: the data was analysed using SPSS 26.0 software.

- Ethics in research: The study was approved by the Ethics Council in Biomedical Research of Can Tho University of Medicine and Pharmacy No. 22.127.HV/PCT-HĐĐĐ.

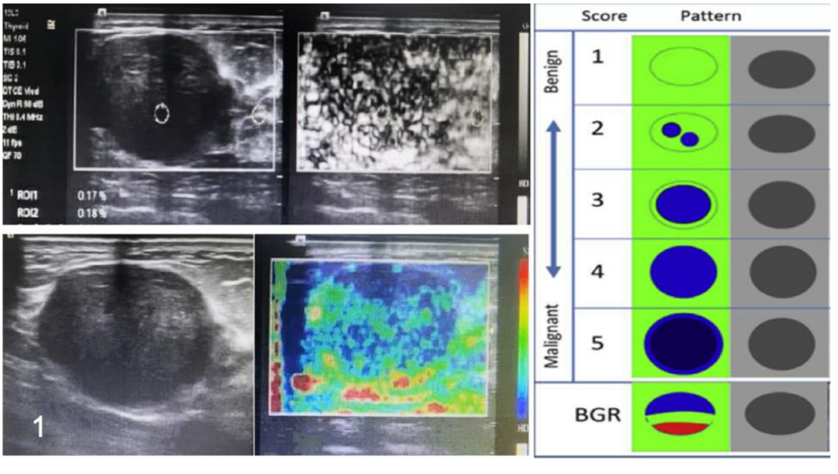

Figure 1: 16 year old. Strain ratio was 0.92. Tsukuba score was 2. Histopathalogy: fibroadenoma

3.0 RESULTS AND DISCUSSION

3.1 General characteristics of research subjects

There were 59 patients recruited in our study with a total of 61 breast lesions. Among the participants, the mean age was 47.2±1.9 years old, raging from 16 to 81 years old. The youngest patient is 16 years old, and the oldest is 81 years old. The lesions were mainly found in the upper half of the breast, about 80%, and the upper outer quadrant occupied approximately 49% of all. In the study, the benign tumor involved 18 cases, which mostly were fibroadenoma [Fig3]. Besides, non-tumor benign lesions accounted for 8 cases, and they were recorded to be fibrocystic change and mastitis. There were 35 malignacies, most of which were invasive ductal carcinoma [Figure 4 and 5].

Most of the studies showed that the breast carcinoma rise steeply in the patients over 35 years of age [7]. The age groups also has been showed the same demographic data with our country population [8]. The pathophysiology is due to the perimenopause status causing abnormal endocrine changes which affects the breast parechyma endocrinologically . In our study, the youngest age to have breast lesions was 16 year old but the age of sustained carcinoma was 37 years old.

Our results showed that the most common distribution of breast lesions was in the upper outer quadrant, with a rate of 49%. Similarly, it was about 55% in Yu Ding's study of 247 cases [9]. It could be concluded that the upper outer quadrant is the most common location of breast lesions, which can be explained by the fact that this area has a high density of glandular tissue due to anatomical characteristics. The results noted that there were 35 lesions of malignancies and 26 benign lesions. In the group with malignant lesions, the majority was invasive ductal carcinoma (97%). Meanwhile in the benign group, the most common were mostly fibroadenomas (83%). Sinha Dimpi et al. researched 113 lesions, including 73 benign and 40 malignant ones, fibroadenoma accounted for 79.5% of the benign group and invasive ductal carcinoma accounted for 67.5% of the malignant lesions [5]. In general, our study and other studies are related to the conclusion that fibroadenoma is the most common type of benign tumors. Meanwhile, invasive ductal carcinoma is the most common cancer among malignant lesions.

Table 1. Breast lesions in age groups

	Mean ± standard deviation	Minimum	Maximum
Age	47,2±1,9	16	81

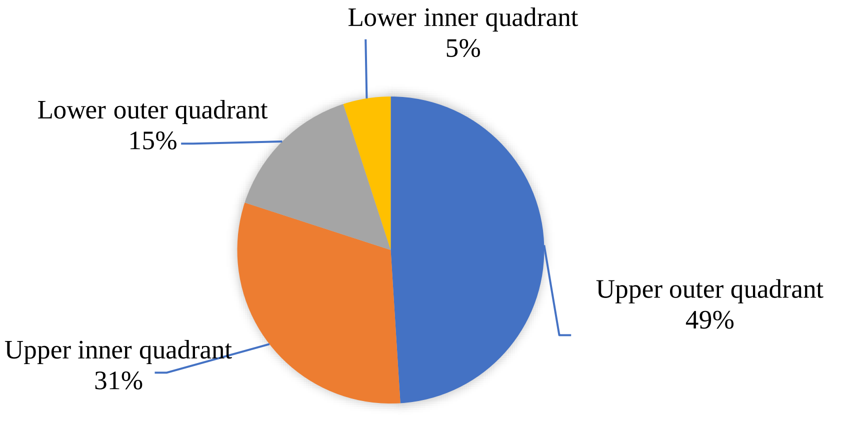

Figure 2: Lesion distribution

Table 2: Lesion pathologies

		Frequency (n)	Rate (%)
Benign	Fibroadenoma	15	24,6%
	Phyllodes tumor	1	1,6%
	Papilloma	2	3,3%
	Others (Fibrocystic change, mastitis)	8	13,1%
Malignant	Invasive ductal carcinoma	34	55,7%
	Ductal carcinoma in situ	1	1,6%

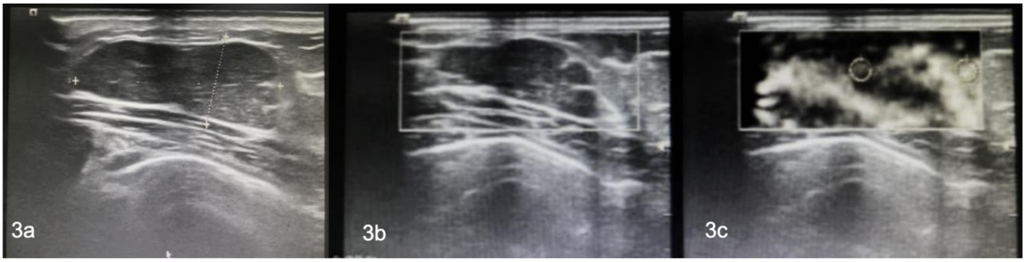

Figure 3: 27 year old. a) well defined, hypoechoic lesion at 2 o' clock in the left breast, 4cm from the areola, measuring 33x11mm, transverse axis, smooth border, no increase in doppler signal. BI-RADS 2/ACR 2013. B) Combined with strain elastography, c) Tsukuba score 2; E/B ratio 0,9; SR 1,8. BI-RADS 2. Histopathology: fibroadenoma

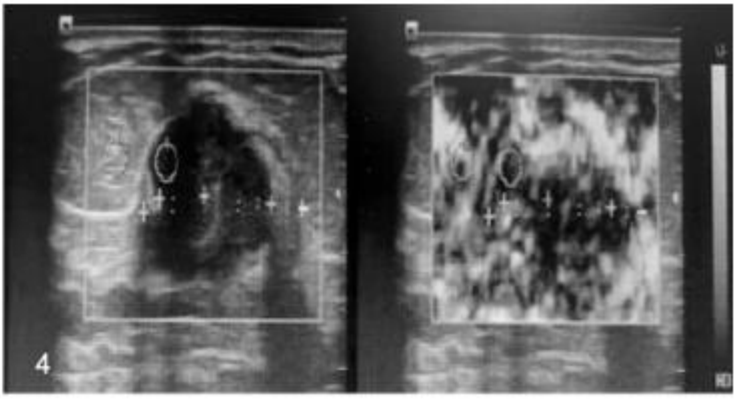

Figure 4: Strain elastogram of invasive ductal carcinoma from a 62 year old woman. Image showed that E/B ratio was 1.4 and SR ratio was 4

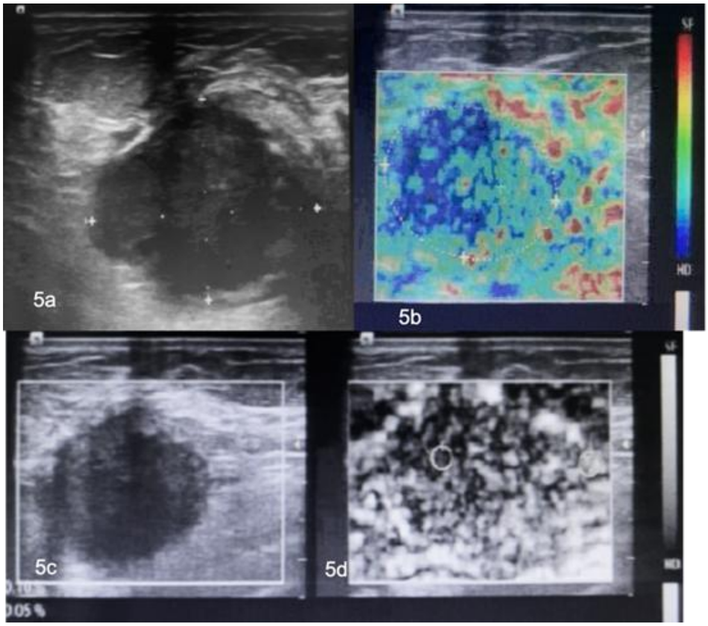

Figure 5: 59 year old, a) Ill defined, hypoechoic lesion at 9 o'clock of the right breast, 4cm from the nipple, measuring 32x21mm with multimicrolobulation, no increase in doppler signal. Bl-RADS 4a/ACR 2013. b) and c) combined elastography. d) Tsukuba score 3; E/B ratio 1.25; SR 2,09. BI-RADS 4b. Histopathology: invasive ductal adenocarcinoma

3.2 Assessment of the values of three methods of strain elastography

Our study found that the Tsukuba score had a sensitivity of 86%, a specificity of 81%, an accuracy of 84%, PPV of 86%, and NPV of 81% in diagnosis. The difference was statistically significant ($p<0.001$). After analysis, results were recorded that the E/B ratio (cutoff value of 1) had a sensitivity of 94%, a specificity of 58%, an accuracy of 79%, a PPV of 75%, and a NPV of 88% in diagnosis. The difference was statistically significant ($p<0.001$). Using receiver operating characteristic (ROC) analysis, E/B ratio with a cutoff value of 1.05 had a sensitivity of 97%, a specificity of 79%, and diagnostic accuracy of 92%, AUC of 0.91 ($p<0,001$). The strain ratio with a cutoff value of 3.09 had a sensitivity of 60%, a specificity of 89%, and diagnostic accuracy of 72%, AUC of

0.74 (p=0,001). The Tsukuba score in our study had a sensitivity of 86%, a specificity of 81%, and an accuracy of 84%. There were five malignant cases diagnosed as benign Tsukuba, they were mucinous cancer and tumour necrosis that often present with cystic components, which may result in false negative results. The study also recorded five benign lesions with Tsukuba score suspicious for malignancy, seen in cases of fibrocystic changes or fibroadenomas that harden breast tissue, causing false positives. Several other research about the value of the Tsukuba score obtained high sensitivity, specificity, and accuracy of about 90-94%, 87-88%, and 89% in diagnosing breast lesions [3,10]. Overall, our results obtained a relatively high value of the Tsukuba elasticity score compared to other studies. When analysing the ROC curve of the E/B ratio, the cutoff was chosen to be 1.05 (AUC 0.91) with a sensitivity of 97%, specificity of 79%, and accuracy of 92%. The E/B ratio in our study had high sensitivity and quite high specificity, and this result was consistent with the study of 110 cases with the cutoff value of 1.05 (AUC 0,77), the sensitivity of 73% and the specificity of 78% [4, 12, 13, 14]. High sensitivity can be explained because malignant lesions often tend to invade the surrounding tissue, making the surrounding tissue stiffer, so the lesion diameter on elastography will be larger than it will be on conventional ultrasound. There was a significant difference in specificity and accuracy between the E/B ratio cutoff value of 1 and 1.05, due to the higher number of false positives at the E/B ratio cutoff value of 1. A major interpretation problem leading to possible false positives is fibroadenoma and fibrocystic change due to stiffness properties similar to normal fibroglandular tissue, therefore, these benign lesions are often difficult to identify in glandular tissue, making it hard to perform accurate E/B measurements.

Our study also had choosen a SR cutoff value of 3.09 (AUC 0.74) for differentiating malignant breast lesions [Figure7] from benign lesions; with those, the sensitivity was 60%, specificity was 89%, and accuracy was 72%. The SR cutoff values for malignant lesions were 3.2 (AUC 0.97) [10], 1.9 (AUC 0.88) [3], and 3 (AUC 0.96) [5]. In this method, fat in the breast is used as a reference standard, since it is of relatively similar stiffness between patients and within a patient. Ultrasound systems use different methods to determine the relative strain of the tissues, and ratios obtained on one vendor's equipment may not be the same as those from another vendor's equipment [11, 16]. Besides the technical factors, the histological makeup of breast lesions, the effect of precompression, and the shape of the breast can also influence SR values. According to WFUMB guidelines, SR <2.8 suggests benign lesions, and SR>4.5 suggests malignancy, the range between the two values requires additional methods [1,15]. Many study show that combining B mode with sonoelastography will increase the efficiency in differentiating malignant breast lesions [17,18,19, 20].

Table 3: Value of Tsukuba score

		Pathology		Total	
		Benign	Malignant		p<0.001
Tsukuba score	Score 1, 2, 3	21	5	26	
	Score 4, 5	5	30	35	
Total		26	35	61	

Table 4: Value of E/B ratio

	Pathology		Total	
	Benign	Malignant		p<0.001
E/B <1	15	2	17	
E/B ≥1	11	33	44	
Total	26	35	61	

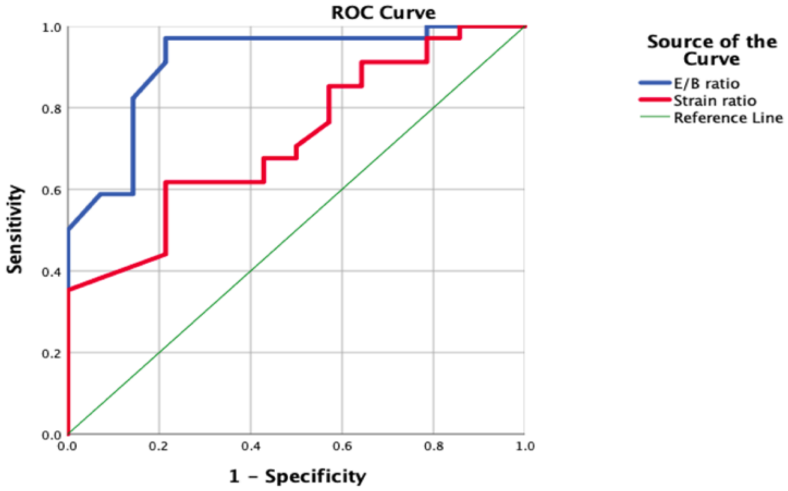

Figure 6: ROC curve for E/B ratio and strain ratio

Figure 7: 64 year old. A) Spiculated hypoechoic lesion at 6 o' clock of the right breast, 3cm from the nipple, measuring 33x20 with angular borders and course calcification within. There are demoplastic surrounding tissues. No increase in doppler signal. BI-RADS 4c/ ACR 2013. b) Combined with strain elastrography c) Tsukuba score 4; E/B ratio 1,3; SR 3,1. To become BI-RADS 5. Histopathology: infiltrating ducal adenocarcinoma

4.0 CONCLUSION

In our practice, the differentiation between malignant and benign breast lesions was more precise when combining routine ultrasonography with strain elastography. Of the three methods of interpreting breast strain elastography which are five-point elastography score (Tsukuba score), strain ratio (SR) and length ratio (E/B ratio), the E/B had the highest sensitivity and diagnostic accuracy and the strain ratio had the highest specificity.

CONFLICT OF INTEREST STATEMENT

The authors have no conflicts of interest to declare and are in agreement with the contents of the manuscript.

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