Original Article

Interacting Factors of Strain Ratio Values in Fibroadenomas and the Contribution of Color Scale

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Abstract

Background: The purpose of this retrospective study is to investigate the association of qualitative and semiquantitative strain elastography (SE) features with factors such as lesion size, skin-to-lesion distance, and patient's age in fibroadenomas and to discuss false-positive results. **Methods:** A total of 120 lesions that were performed SE with histopathologically confirmed fibroadenoma were included in the study. All images were reviewed from the archiving system with a consensus of two radiologists. Tsukuba elasticity score was used for color scoring (from 1 to 5). Lesions with strain ratio (SR) ≥2.27 and color scale score of 4 or 5 were considered as false positive. The patients were divided into two groups according to the age: <50 and ≥50 years old. Regard of the size, lesions were divided into two groups: <15 mm and ≥15 mm. The distances of the lesions to the skin were also divided into two groups: <5 mm and ≥5 mm. Statistical analysis to identify associations between these groups and SR was carried out with Pearson Chi-square test and Fisher's exact test. The false-positive rates were calculated. **Results:** There was no statistically significant difference between patients' age, lesion size, skin-to-lesion distance, and SR values. The false-positive rate was 21.66% for SR, while it was 3.33% for color scale. **Conclusion:** SR values of the fibroadenomas were not affected by factors such as age, lesion size, and depth. In addition, false-positive rates significantly decrease when color scale scores are evaluated for fibroadenomas.

Keywords: Color scale, fibroadenoma, strain elastography, strain ratio

Introduction

Fibroadenomas are the most common benign solid breast lesions and seen in one-quarter of women under 35.[1,2]

Ultrasonography (US) is the most appropriate imaging method for this age group because of its practical usage and lack of radiation, although mammography is used when it is necessary. However, the low specificity of the US may necessitate the use of additional techniques such as elastography.[3] Two methods are defined in strain elastography (SE): one qualitative-color score and one semiquantitative strain ratio (SR). Several studies reported that SE contributed to the grayscale US had a benefit to distinguish benign and malignant breast lesions.[4-8]

Fibroadenomas tend to be soft lesions, but some could be as stiff as malignant lesions.[9,10] In the literature, it was stated that large fibroadenomas were stiffer than smaller ones. Similarly, as patients' age increases, it has been reported that hyaline degeneration resulted in stiffness in fibroadenomas. It was also known that lesions close to the skin were evaluated as stiffer due to difficulty in compressing.

The purpose of this study is to investigate factors associated with SE findings in fibroadenomas and to discuss false-positive findings at SE. In previous studies, these factors were analyzed by shear wave elastography (SWE) technique.[7,8] SE is inexpensive, common, and easily accessible for evaluating tissue elasticity than SWE.[3]

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Patients and Methods

Breast lesions that were examined with SE and histopathologically confirmed fibroadenoma were re-evaluated. This retrospective study was approved by our Institutional's Ethics Committee (23.01.2019/752). Due to the retrospective nature of the study, informed consent was not required.

All images were reviewed with picture archiving computer systems by two radiologists who specialized in breast imaging and have 3 to 10 years of experience. The core biopsies were performed by the same radiologists using full-automatic 16 G biopsy needles (Bard Magnum, Covington, Georgia, USA) following US and SE examinations.

Grayscale US and SE examinations were performed (Hitachi Ezu-MT28-S1 model, Hitachi Inc., Japan) with a 13 MHz superficial probe by the same radiologists. On grayscale images, the long axis and the distance to the skin were measured and recorded. After that, SE was done with two consecutive compressions in 1 sec while the probe axis was perpendicular to the lesion. Three elastography images were obtained for each lesion and the images with the highest SR values were recorded. Two separate regions of interest with a diameter of 2–3 mm^2 were placed both over the hard part of the lesion and to the tissue adjacent at the equal depth from the skin. SR value was calculated automatically. Tsukuba elasticity score (TES) created by Itoh *et al*. was used for color scoring from 1 to 5 [Table 1].[10] According to the TES system, scores of 1, 2, and 3 were considered as benign and scores of 4 and 5 were considered as malignant. The color scoring was assessed from the recorded images with a consensus of two radiologists.

Lesions with SR ≥2.27 and TES of 4 or 5 were considered as false positive.[11]

The patients were divided into two groups according to the age: <50 years old and ≥50 years old. Regard of the size, lesions were divided into two groups: small (<15 mm) and large (≥15 mm). On the other hand, the distances of the lesions to the skin were also divided into two groups of <5 mm and ≥5 mm. In determining these parameters, Elseedawy *et al*.'s study was taken into consideration.[12]

Statistical analysis to identify associations between these groups and SR and color scale was carried out with the Pearson Chi-square test and Fisher's exact test.

Results

One-hundred twenty patients with fibroadenomas were evaluated. Patient ages were ranged between 17 and 83 years, with a mean age of 36.39 ± 13.09 years and a median of 34 years. The mean lesion size was 16.58 ± 6.13 mm (median: 16 [6–38]). The mean skin-to-lesion distance was 4.58 ± 4.1 mm (median: 3 [0–20]]. The SR mean and median were 1.76 ± 1.17 and 1.48, respectively (ranged between 0.14 and 7.52). Association between lesion and SR and patient characteristics at SE are shown in Table 2. The false-positive rate for SR was 21.66%.

Table 1: Tsukuba elasticity scoring system (10)

Score	Description
1	Entirely in green: The lesion is soft
2	Blue and green mosaic: The heterogeneous distribution of soft-hard internal structure
3	The center surrounded by green color: The central lesion is hard while has a softer outer structure
4	Completely blue: The lesion is completely rigid
5	Blue on the lesion and surrounding adjacent tissue: Larger than the size of the lesion due to the desmoplastic reaction

Table 2: The descriptive findings of all of patients

	n (%)	B/A, median (minimum-maximum)		*P*
Age <50	103 (85.8)	1.76±1.08	1.48 (0.14-5.14)	1.000
Age ≥50	17 (14.2)	1.82±1.68	1.47 (0.24-7.52)	
Diameter <15 mm	58 (48.3)	1.73±1.05	1.57 (0.14-4.98)	0.664
Diameter ≥15 mm	62 (51.7)	1.8±1.29	1.39 (0.36-7.52)	
Distance to skin <5 mm	72 (60.0)	1.8±1.14	1.51 (0.14-5.14)	0.831
Distance to skin ≥5 mm	48 (40.0)	1.71±1.23	1.46 (0.38-7.52)	

B/A: Strain ratio, B: Externally applied compression, A: The tissue's response

According to the TES 11, 94, 11, 4, and 0, cases were seen in the scale from 1 to 5, respectively. Four patients were false positive in color scale and false-positive rate was 3.33% for color scale. Three of four hard lesions belongs to the patients < 50 years of age (3/103, 2.9%) and the last one was belong to the patient above 50 years of age (1/17, 5.9%). The distance from the lesion to the skin was <5 mm in two cases, while ≥5 mm in other two cases. The mean lesion size was 18.54 ± 5.12 mm and the diameter of two lesions was <15 mm, while the diameter of the other two lesions was ≥15 mm. SR values were between 3.55 and 4.57. Since the number of these cases was very small, no analysis was performed.

There was no statistically significant difference between patients' age, lesion size, skin-to-lesion distance, and SR, and their *P* values were 1.000, 0.664, and 0.831, respectively.

Discussion

In this study, we showed that qualitative color scale and semiquantitative SR scale SE findings of fibroadenomas were not affected by factors such as patients' age, lesion size, and depth. We also found that the false-positive rates were quite low on the color scale, and TES is a reliable method for fibroadenoma diagnosis than SR.

Sonographical findings are often adequate in the diagnosis of fibroadenomas, while the addition of sonoelastographic findings contributes to more correct diagnosis. There are some differences in the elastographic findings of malignant and benign masses. In color scale, the size of the benign lesion was

the same or less than the gray scale, whereas in malign ones, the lesion seemed larger than gray scale because of secondary to the possible desmoplastic reaction.[13] In addition, the absence of score 5, suggesting malignancy, showed that color scale could be sensitive in the differentiation of benign-malignant lesions.

There is not certain cut off value for SR distinguishing benign-malign lesions.[14] SR is ranging between 2.27 and 3.8 for benign breast lesions.[11] We accepted the lowest value of these as the cutoff value. In some reports, the evaluation of SR is superior to the color scale[9,15] because the interpretation of the color scale is subjective, qualitative, and operator dependent. Furthermore, these studies have performed between benign and malignant solid masses. In our study, we evaluated only benign masses and false positives were very low in color scale (3.33%). Among these cases, the ratio of patients over the age of 50 (5.9%) was higher than the other group in accordance with the literature.[9,10] False-positive results were significantly higher in SR analysis than those obtained with the color scale. The high false positivity of SR may be secondary to the adoption of the lowest cutoff value that is given in the literature. Furthermore, consensus evaluation may increase sensitivity in color scale [Figure 1].

In the study of Elseedawy *et al*. also, no statistically significant difference was found between the patient's age and lesion stiffness, as in our study.[12] In this study, the patient's age has examined as <50 years old (84 patients) and ≥50 years old (28 patients) in two groups too, and the distributions of their groups are more homogeneous than our study (respectively, 103 and 17).

In our study, the false-positive rate was 21.66% (26/120) for SR, while this ratio 26% (39/151) were reported in Elseedawy *et al*.'s study.[12] In Yoon *et al*.'s study performed with the SWE technique, the false-positive rates of benign solid lesions were 6.45–36.6%.[16] Lesion's size and depth were related false-positive results in these studies. In our study, false-positive rates were similar with these studies, but there were no factors (size and depth) interacting false-positive rates.

Score 4 which was highly suggestive for malignant masses in Tsukuba classification was defined in four cases in this study [Figure 2a and b]. The SR values of these cases were above the cutoff value of 2.27. However, the color scale of 116 patients was compatible with a benign lesion (96.66%) and false-positive rate was only 3.33%. We consider this classification more reliable than SR in fibroadenomas. In other words, when SR was high, it would be more accurate to define the lesion as a fibroadenoma if color scores were 1, 2, and 3. This score system was first classification system and the majority of patients were examined with the TES in the literature.[7,10]

Some grading systems include cyst or postcompression findings; however, in all scoring systems, low scores are soft, while high scores represented hard lesions.[17,18] In Tsukuba scoring, benign lesions are defined as scores 1, 2, and 3, while malignant ones are 4 and 5. Itoh *et al*. reached 86.5% sensitivity and 89.8% specificity with this scoring, but in the same study, it has been shown that elastography has the same diagnostic performance with the grayscale US of Breast Imagıng Reported and Data System.[10]

It is known that breast parenchyma is affected by age, hormonal therapy, menstrual cycles, pregnancy, and lactation. Kılıç *et al*. have shown that the period of the menstrual cycle is an important factor for SE as in magnetic resonance imaging (MRI) and mammography. They recommend performing the elastography examination in the 2nd week of the menstrual cycle, as in MRI.[19] Since we did not take into consideration of hormonal therapy, menstrual cycles, pregnancy, and lactation processes when performing elastographic examinations, we could not evaluate the interaction of the tumor with the surrounding parenchyma.

One of the limitations of this study is a small number of cases and single-center design. Furthermore, there was no equal distribution of age groups among patients because most of the cases were under 50 years of age and the breast parenchyma was not evaluated as a factor influencing SR. Another limitation is that we did not evaluate the interobserver agreement. In

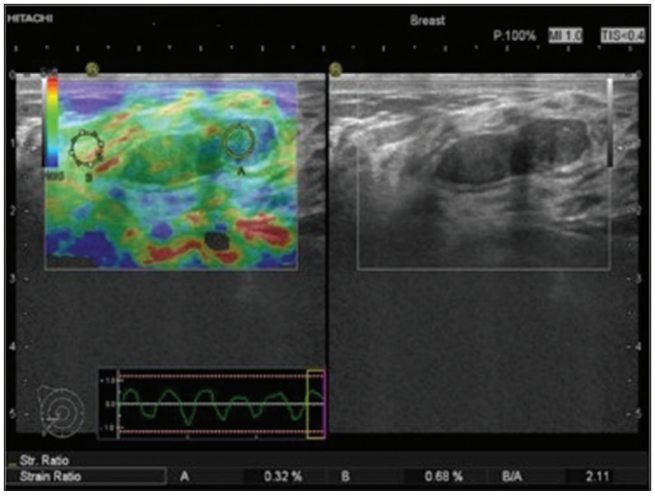

Figure 1: A 32-year-old with fibroadenoma female patient. Strain elastography and gray scale ultrasound images are seen side by side. The color scale image shows 2 according to Tsukuba elasticity scoring. The strain ratio value is shown as b/a in the left lower corner of images

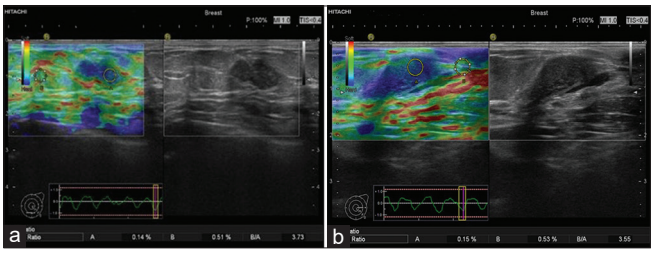

Figure 2: A 45-year-old (a) and a 72-year-old (b) with fibroadenoma female patients. The color scale findings of two false positive fibroadenomas (Score 4). It's seen the strain ratios also are high

addition, although we used the SE technique SWE technical parameters are also taken as reference.

Conclusion

In conclusion, SE findings of the fibroadenomas have not be affected by factors such as patients' age, lesion size, and depth, in this study. In addition, false-positive rates decrease with the utilization of color scale, and TES can contribute more accuracy to the diagnosis of fibroadenoma than SR. If these results are supported by large series, unnecessary biopsies, short follow-ups, additional examinations, and patient anxiety can be reduced.

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Conflicts of interest

There are no conflicts of interest.

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