Comparison and Combination of Strain and Shear Wave Elastography of Breast Masses for Differentiation of Benign and Malignant Lesions by Quantitative Assessment

Preliminary Study

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Objectives—To compare the diagnostic performance of strain and shear wave elastography of breast masses for quantitative assessment in differentiating benign and malignant lesions and to evaluate the diagnostic accuracy of combined strain and shear wave elastography.

Methods—Between January and February 2016, 37 women with 45 breast masses underwent both strain and shear wave ultrasound (US) elastographic examinations. The American College of Radiology Breast Imaging Reporting and Data System (BI-RADS) final assessment on B-mode US imaging was assessed. We calculated strain ratios for strain elastography and the mean elasticity value and elasticity ratio of the lesion to fat for shear wave elastography. Diagnostic performances were compared by using the area under the receiver operating characteristic curve (AUC).

Results—The 37 women had a mean age of 47.4 years (range, 20–79 years). Of the 45 lesions, 20 were malignant, and 25 were benign. The AUCs for elasticity values on strain and shear wave elastography showed no significant differences (strain ratio, 0.929; mean elasticity, 0.898; and elasticity ratio, 0.868; $P > .05$). After selectively downgrading BI-RADS category 4a lesions based on strain and shear wave elastographic cutoffs, the AUCs for the combined sets of B-mode US and elastography were improved (B-mode + strain, 0.940; B-mode + shear wave; 0.964; and B-mode, 0.724; $P < .001$). Combined strain and shear wave elastography showed significantly higher diagnostic accuracy than each individual elastographic modality ($P = .031$).

Conclusions—These preliminary results showed that strain and shear wave elastography had similar diagnostic performance. The addition of strain and shear wave elastography to B-mode US improved diagnostic performance. The combination of strain and shear wave elastography results in a higher diagnostic yield than each individual elastographic modality.

Key Words—breast; diagnostic performance; elastography; shear wave elastography; strain elastography

Ultrasound (US) elastography is a noninvasive technique that measures tissue stiffness.[1] It is useful for differentiating benign from malignant tumors in the breast.[1–6] For breasts,

the 2 most frequently used elastographic techniques are strain and shear wave elastography. These techniques differ in their measured physical quantities (strain or displacement versus shear wave speed).[7] On strain elastography, images are produced by displacement of the tissue from manual compression (by hand or using breathing motion or cardiovascular pulsation) or a low-frequency US pulse (ie, acoustic radiation force impulse).[7] Strain elastography determines the relative strain between a lesion and the surrounding tissue. In practice, the elasticity score (Tsukuba score) is widely used for differentiating benign lesions from breast cancer.[1] In addition, pseudoquantitative methods such as the strain ratio (the ratio of the lesion stiffness to fat) and the ratio of the lesion length on elastography to the lesion length on B-mode imaging have been used in routine clinical settings because of their feasibility during real-time US elastography, even though true quantitative elasticity imaging already has been available.[3,8,9] Shear wave imaging methods measure the propagation speed of a shear wave in tissue. The speed of the shear wave is linked to the Young modulus in kilopascals under specific simplifying assumptions.[10]

The American College of Radiology introduced elasticity assessment as an associated feature in the recently released Breast Imaging Reporting and Data System (BI-RADS) atlas.[11] Hence, an increased application of elasticity values in routine clinical practice for breast lesion evaluation is expected. Since US elastography was introduced in the late 1980s and early 1990s, its technology has improved, and some forms of elastography are available on most commercially available US systems.[12–15] Axial strain images created from predeformation and postdeformation radiofrequency US data acquired from quasistatic tissue deformation have been used to aid in distinguishing benign from malignant breast masses.[8,15–17] In addition to axial strain images, shear strain elastography provides supplementary information on bonding between the tumor and the surrounding tissue. As there are observed differences between benign and malignant tumors of the breast on their attachment to background tissue, axial shear strain imaging for breast cancer diagnosis has been investigated.[18–20] Research on dynamic methods, such as the quasistatic method, was started in the early 1990s.[21,22] In addition to the point shear wave measurement, a multiple–focal zone approach, which is termed "SuperSonic shear imaging" (SuperSonic Imagine, Aix-en-Provence, France), was introduced and led to a cylindrically shaped

shear wave extending over a larger depth.[23,24] Subsequently the dynamic method has been referred to as "shear wave imaging" and the quasistatic method as "strain imaging" based on the measured quantity. The measured physical quantity in strain imaging is strain or displacement, and that in shear wave imaging is shear wave speed. According to the methods for inducing displacement, strain imaging is categorized into strain elastography (manual compression) and acoustic radiation force impulse imaging (acoustic radiation force impulse excitation). Likewise, shear wave imaging is classified into shear wave speed measurement, or imaging using acoustic radiation force impulse excitation, and transient elastography using a controlled external vibration.[7] Multiple studies have been reported the possible role of strain elastography and shear wave elastography in improving the accuracy of breast US and breast elastography for differentiating benign from malignant lesions and could potentially reduce unnecessary biopsies.[10,25–29] Several studies that compared strain and shear wave elastography in breast imaging demonstrated similar overall diagnostic performance for differentiation of benign from malignant masses.[28,29] Chang et al[28] compared the elasticity value on shear wave elastography and elasticity score on strain elastography in 150 breast lesions. The diagnostic performance of shear wave and strain elastography was similar, but the sensitivity and specificity of the methods were different according to the histologic profile, tumor grade, and breast thickness of the lesions. Youk et al[29] compared the qualitative (strain score, visual color score of maximum elasticity [kilopascals], and homogeneity of elasticity) and quantitative (strain ratio, mean and maximum elasticity values, and the ratio of the mean elasticity value in the lesion to that in fat) assessment of shear wave and strain elastography in 79 breast lesions. These elastographic techniques were comparable in terms of diagnostic performance, both when used in dependently and when combined with B-mode US. In both studies, strain imaging on a Hitachi Aloka Medical (Tokyo, Japan) system and shear wave imaging on a SuperSonic Imagine system were compared. However, Barr and Zhang[30] reported an area under the receiver operating characteristic curve (AUC) of 0.990 for the elastographic-to-B-mode lesion length ratio in 140 breast lesions on strain elastography (acoustic radiation force impulse imaging) and an AUC of 0.789 for the shear wave velocity in 122 breast lesions using a Siemens Medical Solutions

(Mountain View, CA) system. The authors emphasized that precompression should be strictly controlled for accurate evaluation of the results, in that the addition of a quality measure of shear wave velocity estimation improved sensitivity without a significant change in specificity. More research is required because elastographic protocols are vendor specific for US systems. In practice, images obtained by current elastographic systems include information other than the elastic modulus and might induce several artifacts. In strain elastography, the stress distribution is not uniform within the body, and the stress tends to concentrate on curved boundaries. In shear wave elastography, the assumption of tissue homogeneity within the shear wave estimation region is violated, and incorrect shear wave speed estimates can occur. Tissue nonlinearity is associated with decreased elastographic contrast on strain imaging and increased shear wave speeds.[7] As a result, results from strain and shear wave imaging do not always correlate.

Recently, there has been a trend for systems to offer both strain and shear wave elastography, and some authors suggested that both are complementary in breast imaging.[31,32] However, to our knowledge, there has been no study about combined strain and shear wave elastography. Therefore, this study was performed to compare the diagnostic performance of strain and shear wave elastography of breast masses for differentiation of benign and malignant lesions by quantitative assessment and to evaluate the accuracy of combined strain and shear wave elastography.

Materials and Methods

Patients and Lesions
This prospective study was conducted with approval from our Institutional Review Board. Informed consent was provided by all patients. Between January and February 2016, 42 consecutive women scheduled to undergo US-guided core needle biopsy or surgical excision were examined with B-mode US and both strain and shear wave elastography. Among these patients, 5 who had elastographic images that were inadequate for analysis were excluded (target lesions were located too superficially adjacent to skin in 2 cases; target lesions were nonmass lesions or calcifications without masses in which acquisition of an exact elasticity value was impossible in 2 cases; and a target was cyst in 1 case). Thus, 37 women with a total of 45 breast lesions were

included. The number of lesions assigned to BI-RADS categories on B-mode US were 2 BI-RADS 3 (4.4%), 20 BI-RADS 4A (44.4%), 7 BI-RADS 4B (15.6%), 8 BI-RADS 4C (17.8%), and 8 BI-RADS 5 (17.8%), respectively. Two BI-RADS 3 lesions were biopsied at the patient's or surgeon's request.

Ultrasound Examinations and Biopsy
Breast US examinations were performed by 1 of 3 radiologists with 5 to 10 years of experience in breast US. After B-mode US examinations, which were performed only for patients who had been scheduled to undergo US-guided core needle biopsy or surgical excision, US elastography was performed by a single radiologist with 5 years of experience in breast imaging. Images were acquired by high-resolution US with a 14-MHz transducer and US elastography (Aplio 500; Toshiba Medical Systems, Otawara, Japan) before biopsy. Strain elastographic images were obtained first. Shear wave elastographic images were acquired in the same plane without changing the patient's position. The investigator was aware of clinical and mammographic findings at the time of the US examination.

For strain elastography, a rectangular region of interest (ROI) box was focused on the target lesion and adjusted to include the subcutaneous fat layer to the superficial portion of the pectoralis muscle layer. The target lesion was vertically compressed by the transducer under light manual compression.[1] After adjustment of the pressure and speed of the manual compression to reveal the subcutaneous fat as a mix of red and green for the reference area, representative strain elastographic images were obtained. Two additional ROIs were placed: a 3- to 5-mm circle ROI was positioned at the stiffest part of the target lesion, and another ROI of the same size was placed in subcutaneous fat. The ROI size was based on the lesion size. Depth placement of the ROIs was as similar as possible to avoid stress decay.[33] The mean strain ratio (fat strain to target strain) within ROIs was calculated automatically.

Shear wave elastographic images were generated with no pressure from the transducer, as recommended.[2] After a few seconds of immobilization to allow the shear wave image to stabilize, the shear wave image was frozen and saved. The built-in ROI of the system was set to include the lesion and surrounding normal tissue. Quantitative elasticity values were displayed as colors ranging from dark blue, representing the lowest stiffness, to red,

representing the highest stiffness (0–180 kPa). Fixed 1 × 1-mm ROIs were placed by the investigator over the stiff portion of the target, including the adjacent stiff halo tissue. Another ROI of the same size was placed in dark blue subcutaneous fat. The system calculated the mean elasticity of ROIs and the target-to-fat ratio of mean elasticity values.

Ultrasound-guided core needle biopsies were performed by a freehand technique with high-resolution US. A 14-gauge dual-action, spring-activated needle (2.2-cm excursion; TSK Acecut; Create Medic, Yokohama, Japan) was used.

Data and Statistical Analyses

Strain ratio values for lesions on strain elastography and mean elasticity and elasticity ratio values for lesions on shear wave elastography were compared for benign and malignant lesions by a 2-sample t test. To evaluate the diagnostic performance of each data set for distinguishing benign from malignant lesions, the AUC was obtained and compared among data sets. The cutoff points yielding the maximal sum of sensitivity and specificity for strain and shear wave elastography were calculated. Sensitivity and specificity using the cutoffs were calculated and compared by the McNemar test. For combined sets of B-mode US and elastography, the AUC was obtained after reevaluation of category 4a lesions for downgrading to category 3 according to cutoffs for elasticity values from receiver operating characteristic curves. For the comparison of multivariable receiver operating characteristic curves to compare the AUCs for strain elastography, shear wave elastography, and combined elastography, the method of DeLong et al[34] was used. Statistical analyses were performed with SPSS version 23.0.0 (IBM Corporation, Armonk, NY) and Stata version 12.0 (StataCorp, College Station, TX) software. Differences were considered statistically significant at $P < .05$.

Results

The 37 women included had a mean age of 47.4 years (range, 20–79 years). Of the 45 lesions, 25 were benign, and 20 were malignant. The lesion diameter on B-mode US imaging ranged from 0.4 to 5.1 cm (mean ± SD, 1.6 ± 1.1 cm). Malignant lesions comprised invasive ductal carcinomas (n = 15), invasive lobular carcinomas (n = 2), and ductal carcinomas in situ (n = 3). Benign

lesions comprised fibroadenomas (n = 22), acute mastitis (n = 1), adenosis (n = 1), and fibrosis (n = 1).

Strain ratio, mean elasticity, and elasticity ratio values for lesions on strain and shear wave elastography are shown in Table 1. Elasticity values for malignant lesions were significantly higher than for benign lesions. For diagnosis of breast lesions, AUCs for the strain ratio were not significantly different from elasticity values for shear wave elastography (mean elasticity and elasticity ratio). The analysis of elasticity values for shear wave elastography showed that the AUCs were higher for mean elasticity than the elasticity ratio, but these differences were not significant ($P = .436$). When we used a strain ratio of 2.63 and elasticity value of 67.8 kPa as cutoffs for strain and shear wave elastography, the strain ratio had sensitivity that was higher than that for mean elasticity, and specificity was higher for mean elasticity than the strain ratio. However, the sensitivity and specificity were not significantly different for strain and shear wave elastography ($P > .05$). Of the 20 malignant and 25 benign lesions, 4 benign lesions had false-positive results and 1 malignancy had a false-negative result on strain elastography, and 1 benign lesion had a false-positive result and 3 malignancies had false-negative results on shear wave elastography. Figure 1 shows a plot of the strain ratio values versus the mean elasticity and elasticity ratio values for the 45 lesions differentiated into malignant and benign masses.

Discrepant results were obtained for 5 breast lesions (Table 2). Two invasive ductal carcinomas showed

Table 1. Quantitative Analysis of Breast Masses for Differentiating Between Benign and Malignant Lesions

Variable	Strain Ratio[a]	Mean Elasticity, kPa[b]	Elasticity Ratio, kPa[c]
Benign	2.06 ± 0.97	39.13 ± 25.56	5.26 ± 3.74
Malignant	5.26 ± 2.73	105.51 ± 34.58	16.81 ± 12.95
P	<.001	<.001	.001
Sensitivity, % (n)	95 (19/20)	85 (17/20)	90 (18/20)
Specificity, % (n)	84.0 (21/25)	96.0 (24/25)	72.0 (18/25)
AUC	0.929	0.898	0.868
P[d]		.490	.235

Data are presented as mean ± SD where applicable.
[a]Cutoff value, 2.63.
[b]Cutoff value, 67.8 kPa.
[c]Cutoff value, 6.43.
[d]Comparison of AUC with strain ratio.

correct results only on strain elastography (Figure 2), and 3 fibroadenomas showed correct results only on shear wave elastography. Of the 20 malignancies, 1 invasive lobular carcinoma showed false-negative findings on both strain and shear wave elastography. Both the strain ratio and mean elasticity of the lesion were lower than the cutoff values (2.03 and 13.5 kPa, respectively; Figure 3). One fibroadenoma showed a high elasticity value, leading to false-positive results: specifically, a strain ratio of 8.61 on strain elastography and mean elasticity of 127.2 kPa on shear wave elastography (Figure 4).

After selective downgrading of BI-RADS category 4a lesions based on the strain and shear wave elastographic cutoffs (using the strain ratio and mean elasticity), the AUCs for the combined sets were improved (Table 3). When strain was combined with B-mode US, 18 (90%) benign BI-RADS 4a lesions were downgraded without false-negative results; combining shear wave elastography with B-mode US led to 20 (100%) downgrades without false-negative results. In the comparison of receiver operating characteristic curves for strain elastography, shear wave elastography, and combined modalities, combined strain and shear wave elastography showed significantly higher diagnostic accuracy than each individual modality (Figure 5).

Discussion

In our study, strain and shear wave elastographic values showed significant differences for benign and malignant lesions. Strain and shear wave elastography showed similar diagnostic performance for differentiation of benign and malignant lesions. This result was concordant with previous studies.[28,29] These results were expected, considering that strain obtained by static deformation should correlate with the elastic modulus obtained by shear wave velocity. Although no significant differences were observed in the sensitivity and specificity of strain and shear wave elastography in our study, Chang et al[28] reported higher sensitivity for shear wave elastography than strain elastography and higher specificity for strain elastography than shear wave elastography. Barr and Zhang[30] reported superior diagnostic performance of strain elastography than shear wave velocity imaging. More research is required in this area because each study was performed with different US systems, and elastographic protocols are vendor specific for US systems.

Figure 1. Strain ratio values versus mean elasticity and elasticity ratio values for the 45 lesions differentiated into malignant and benign.
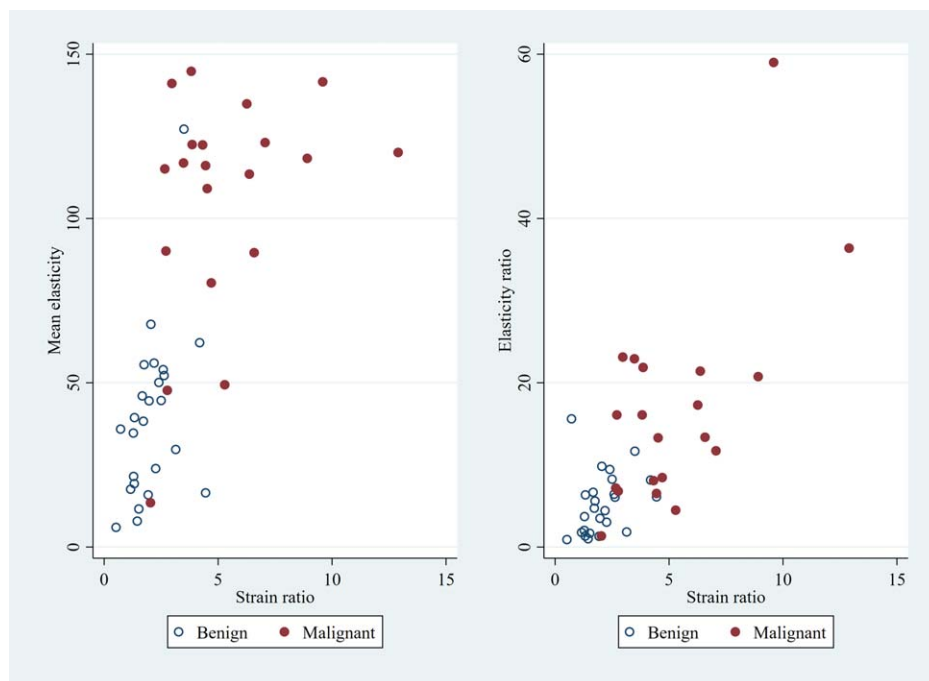
Even though we have increased confidence in the results if both types of elastographic findings are concordant, 5 breast lesions in our study showed discrepant results with the two elastographic systems. Among these 5 cases, 2 cancers were classified as false-negative by using the cutoff value for shear wave elastography but were classified as true-positive on strain elastography. Barr et al[32] reported similar results and explained that poor shear wave generation in invasive cancers led to false-negative findings. We thought that the way to solve

Figure 2. Discordant strain and shear wave elastographic results in a 58-year-old woman with multifocal breast cancer. B-mode US showed a 2.0-cm irregular spiculated hypoechoic mass in the right breast at the 12-o'clock position (**A**) and a 0.4-cm hypoechoic mass in the right breast at the 9-o'clock position (**B**). Strain (**C**) and shear wave (**D**) elastography accurately predicted malignancy for the 12-o'clock mass. The strain ratio was 6.37, and the mean elasticity was 113.5 kPa. For the 9-o'clock mass, the strain ratio was 5.29 and accurately predicted malignancy (**E**). Shear wave elastography coded the mass with a mean elasticity of 49.4 kPa, suggestive of a benign lesion (**F**).
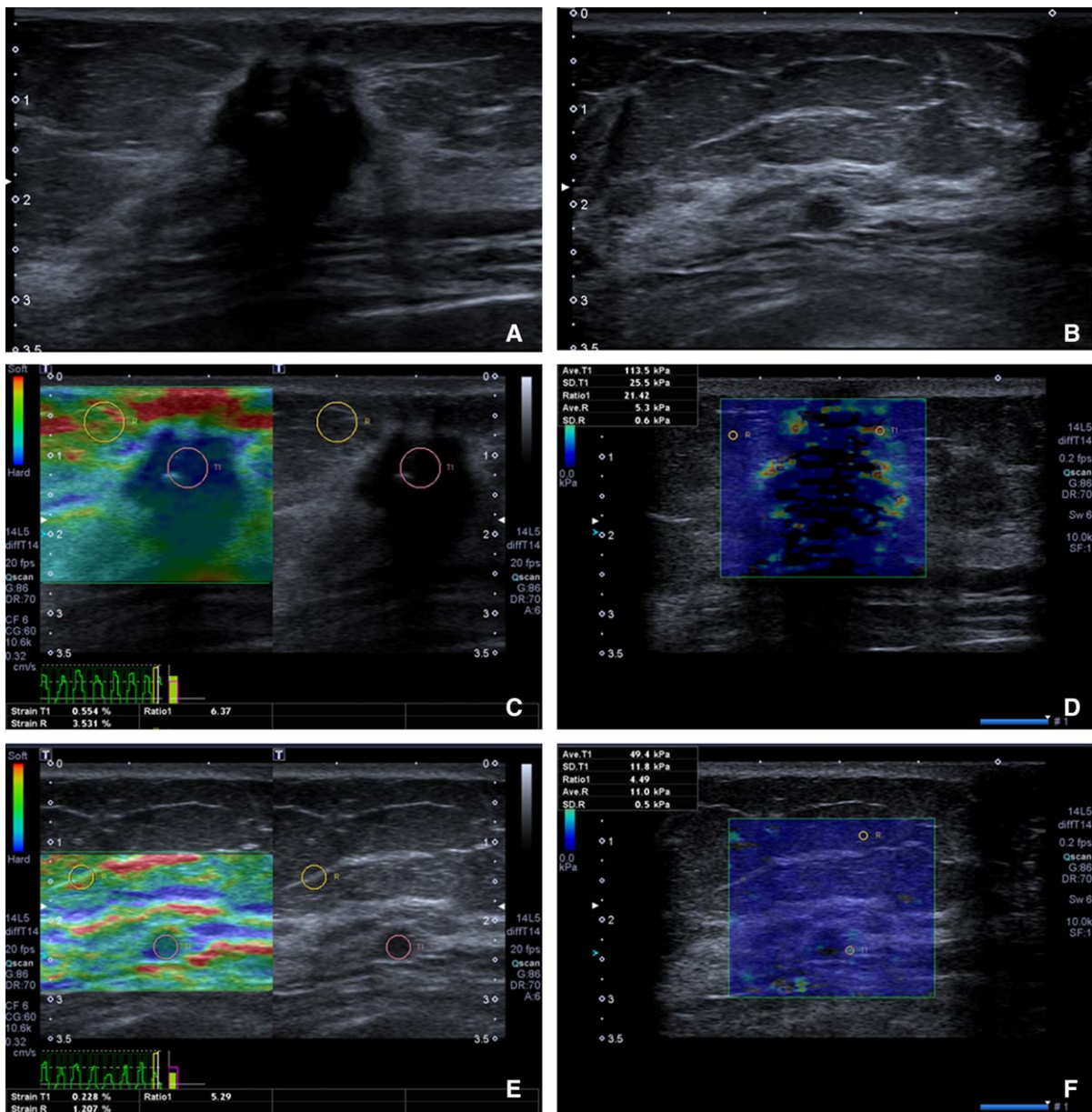
the problem of poor shear wave generation would be to combine strain elastographic values. Bai et al[35] reported inadequate shear waves for measurement in a large

Figure 3. False-negative results strain and shear wave elastographic results in a 45-year-old woman with invasive lobular carcinoma. B-mode US showed a 0.7-cm irregular spiculated hypoechoic mass, which was classified as BI-RADS category 4b (**A**). The strain ratio (2.03) and mean elasticity (13.5 kPa) were lower than the cutoff values (**B** and **C**).
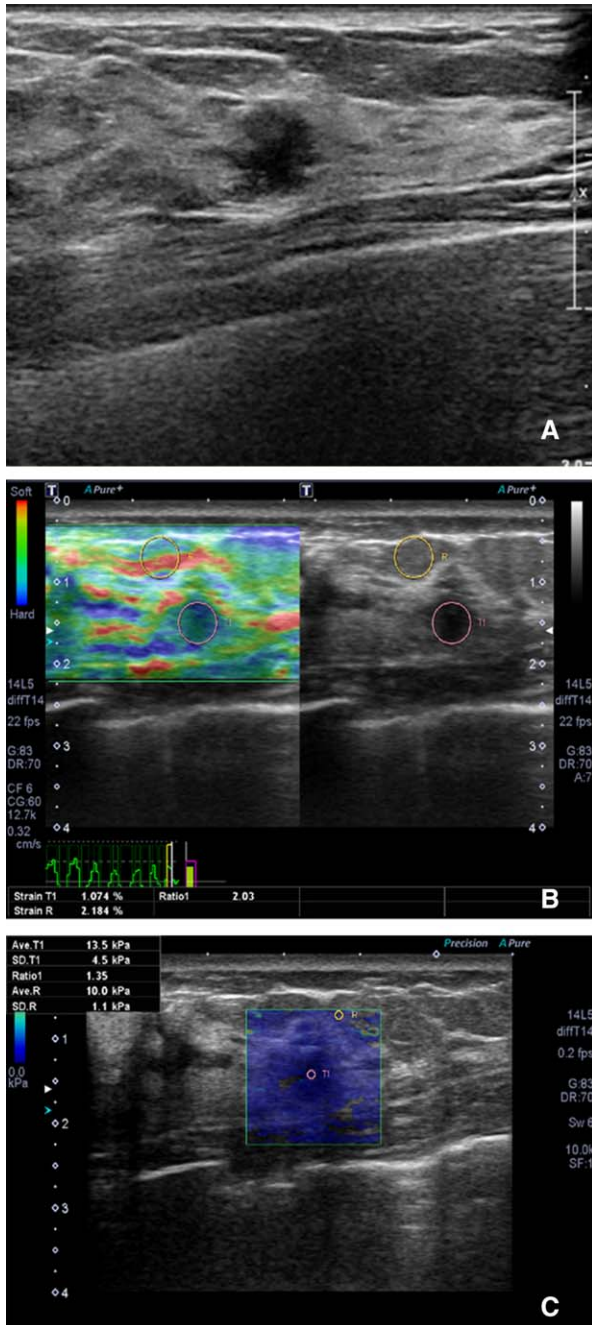
number of breast cancers. Barr et al[1,31,32] suggested the possibility of false-negative results on shear wave elastography due to incorrect coding of a low shear wave velocity and the superiority of combined strain and shear

Figure 4. False-positive strain and shear wave elastographic results in a 41-year-old woman with fibroadenoma. B-mode US showed a 1.9-cm oval microlobulated hypoechoic mass, which was classified as BI-RADS category 4a (**A**). The strain ratio was 8.61, and the mean elasticity was 127.2 kPa (**B** and **C**).
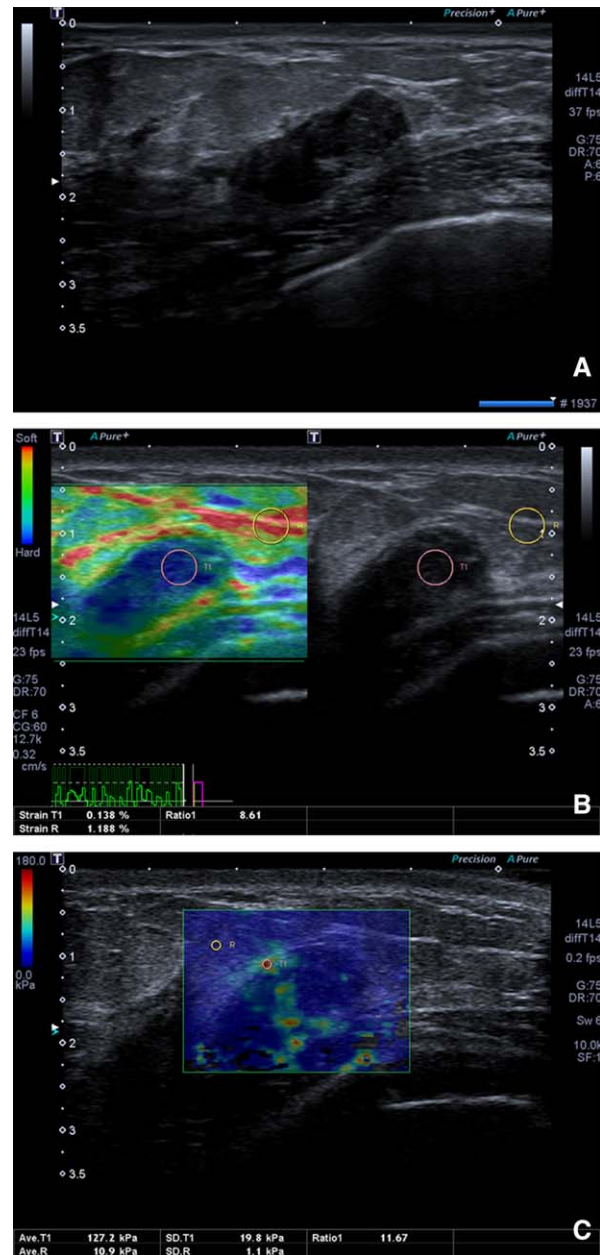
wave imaging over each individual method due to their complementary roles in breast imaging. The improved diagnostic ability of combined strain and shear wave elastography in our results supports that suggestion. In our study, 3 fibroadenomas showed high strain ratios, leading to false-positive results. These lesions showed correct results only on shear wave elastography. Strain elastographic, but not shear wave elastographic, images were produced by using US transducer compression. Intraobserver and interobserver variability is considered inevitable with strain elastography because of the repetitive compression on the skin.[36] To obtain optimal images from strain induced by manual compression, techniques are required according to the algorithm used by the manufacturer of the system, from no manual compression to minimal compression or moderate displacement.[1,32] On strain elastography, false-positive results in benign lesions may appear if only soft tissue is in the field of view. Therefore, a large field of view with multiple tissue type of varying stiffness (from fat to a portion of the pectoralis muscle) is helpful for obtaining adequate images and strain of tissue.[1,31,32] As a result, for discordant elastographic findings, efforts are needed to find reasons for discrepancies or to interpret results with standard B-mode US. In cases that were coded as malignant on strain elastography but coded as benign on shear wave elastography, the discrepancies may have been due to false-negative results on shear wave elastography because of poor shear wave generation or due to false-positive results on strain elastography in benign lesions.[31]

In our study, a 0.7-cm invasive lobular carcinoma categorized as BI-RADS category 4c on B-mode US imaging showed elasticity values on both strain and shear wave elastography suggesting that it was benign. Smaller malignant masses are known to lead to possible false-negative results on both strain and shear wave

elastography.[36–38] A 1.9-cm fibroadenoma showed elasticity values suggesting malignancy on both strain and shear wave elastography. Even though shear wave elastography is considered more objective and reproducible than strain elastography, precompression induces high

Figure 5. Receiver operating characteristic (ROC) curves for strain elastography, shear wave elastography, and the combination of both. The AUC for combined strain and shear wave elastography was significantly higher than that for strain or shear wave elastography ($P = .031$).
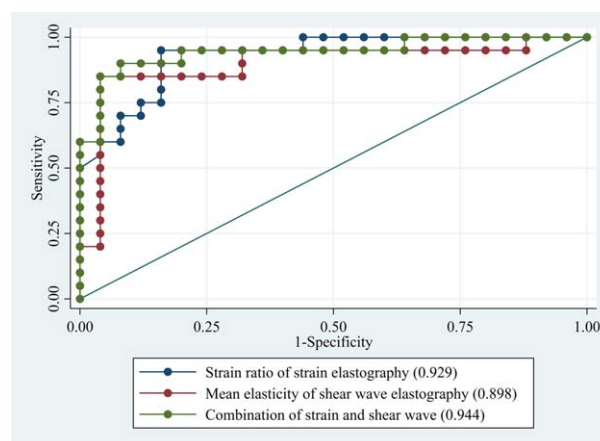

Table 3. Diagnostic Performance of Combined Sets After Selectively Downgrading BI-RADS Category 4a Masses Using Cutoffs for Elastographic Values From Receiver Operating Characteristic Curves

Modality	Sensitivity, %	Specificity, %	AUC	P
B-mode US			0.724	
+ Strain elastography	100	80.0	0.940	<.001
+ Shear wave elastography	100	88.0	0.964	<.001

Table 2. Breast Lesions With Discrepant Results on Strain and Shear Wave Elastography

No.	Correct Diagnosis	BI-RADS Category[a]	Strain Ratio	Mean Elasticity, kPa	US Size, cm	Pathologic Diagnosis
1	Strain	4B	5.29	49.4	0.4	Grade 2 IDC
2	Shear wave	4A	4.45	16.5	1.6	Fibroadenoma
3	Shear wave	4A	4.19	67.7	3.0	Fibroadenoma
4	Strain	4C	2.77	47.7	1.2	Grade 2 IDC
5	Shear wave	3	3.14	29.7	0.5	Fibroadenoma

IDC indicates invasive ductal carcinoma.
[a]BI-RADS category on B-mode US.

shear wave speeds throughout the images, regardless of whether the tissue is "soft" or "hard," and may result in false-positive results in benign lesions.[1,27,39] With strain elastography, the lesion size may interfere with adequate image acquisition because applying even compression forces to the skin around larger masses is difficult.[36] In addition to fibroadenomas, other stiff benign tumors such as papillomas and sclerosing adenosis have been reported.[40] Even with concordant shear wave and strain elastographic results, the use of B-mode US must be considered because slipping or movement of the US transducer during elastographic data acquisition can also lead to false-negative or false-positive results on shear wave and strain elastography.[28,39,41] Elastography is recommended as a complementary technique with B-mode US imaging, and it is important to remember that the US criteria of shape, margin, and echogenicity are predictive factors.[11,42]

In our study, the AUC for the strain ratio on strain elastography was 0.929, which was comparable to the AUC value of 0.926 from a similar system.[43] The previous study found that 4.01 was the best cutoff value for differentiating benign and malignant lesions, which was higher than the value in our study (2.63). This difference was probably due to the difference in the depth of the ROI in subcutaneous fat. In the previous study, the ROI in subcutaneous fat was placed superficially, adjacent to the skin layer. However, in our study, 2 ROIs for the target lesion and subcutaneous fat were placed as similarly as possible to avoid stress decay. In addition, the mean lesion size in the previous study was 2.6 cm, which was larger than the 1.6 cm in our study, and the difference in the mean lesion size could have affected the results. According to studies from other system, the best cutoff value was higher in the group with the higher mean lesion size (cutoff values of 2.00, 2.24, and 2.45 for groups with mean lesion sizes of 0.7, 0.9, and 1.6 cm, respectively).[44–46] A recent large multicenter study using shear wave elastography on a different system reported that any of the features analyzed by shear wave elastography could improve the diagnostic performance of the BI-RADS score, and the best-performing features was the quantified maximum stiffness of the lesions.[25] In our study, the maximum stiffness was not available in the system; thus, we obtained the mean elasticity and elasticity ratio. The AUCs for the mean elasticity and elasticity ratio were 0.898 and 0.868, which were comparable with 0.907 and 0.917 from Youk et al.[29] However, these results were obtained from different systems; thus, it is

difficult to accurately compare these results with our study. The results of our study are preliminary results because the numbers included in the study were very small. Even though this study failed to suggest a rule for the combination of the elastographic techniques, our results suggest that the combination of strain and shear wave elastography may improve diagnostic confidence and performance in breast lesions. Additional prospective work with larger numbers and further standardization for the combination of strain and shear wave elastography will be helpful to validate these results.

This study had some limitations. First, the sample size was too small to draw solid conclusions. Second, long-term follow-up data were not available for benign lesions for which imaging and pathologic findings were concordant after core needle biopsy. Third, elasticity values derived from histologic subtypes, histologic grades, lesion sizes, and lesion depths were not statistically analyzed because of the small sample size, even though these factors were expected to influence the results of elastography. Fourth, strain and shear wave elastography were performed after scanning B-mode US examinations, and B-mode US results can affect the performance of the radiologist. Fifth, this study was also limited in that the images were interpreted by the radiologist performing the breast US examinations, who was not blinded to the clinical information. Sixth, although our study compared and reviewed both elastographic techniques, it did not directly evaluate these modalities in different clinical settings and with different populations or physicians performing the examinations.

In conclusion, strain and shear wave elastography showed similar diagnostic performance for differentiating between benign and malignant breast lesions. When combined with B-mode US, the diagnostic performance was significantly improved compared with B-mode US alone. The combination of strain and shear wave elastography results in a higher diagnostic yield than each individual modality.

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