Effectiveness of sonoelastography in differentiation of malignant and benign breast lesions

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Aims and objectives

Breast cancer, in both developed and developing countries, is the most common type of cancer in women. (1) Detecting and treating it at an early stage is very important for the prognosis of the disease. The routine tests such breast carcinoma as mammography and ultrasonography (US) can help detecting a lot of the lesions related to at an early stage but still more methods are needed for early diagnosis. Sonoelastography (SE) is a recently developed technology which may reveal the histological characteristics of lesions by evaluating the elasticity of tissues. The compression induces a smaller strain in harder tissues when compared with softer tissues; because the response of the tissues to an external compression is influentially associated with the distribution of tissue elasticity and gives a value of the underlying tissue stiffness. Therefore, the measurement of the compression induced strain can estimate the tissue hardness, which may be useful in the diagnosis of breast cancer. (2) In this study, we aimed to determine the efficacy of SE in the differentiation of benign and malignant breast lesions.
Methods and materials

Patients who were admitted to our department for percutaneous biopsy or stereotactic breast marking, for the lesions identified in the breast were included in this prospective study. Between February 2013 and August 2013 thirty four patients with a diagnosis of breast lesions were evaluated. These lesions were evaluated by using B-mode US and sonoelastography with Siemens S2000 device. B-mode US and ultrasonic elastography were performed before biopsy or stereotactic breast marking.

The examination was performed in the supine position with the arm placed behind the head. US probe was placed on the breast in a radial position. Quantitative analyses were obtained by strain ratio measurements. After gray scale and Doppler ultrasound imaging, SE was performed for the lesions. The strain ratio value was calculated by comparing the average strain measurement in the lesion with the adjacent adipose tissue in the breast. A representative ROI from the center of the lesion and a corresponding ROI of adjacent adipose tissue was selected to determine the average strain of the lesion.

The pathological analysis were performed at the Pathology department of the participant center. The correlation between histopathological findings and quantitative elasticity values were made by using paired T test. For statistical analyses, sensitivity, specificity and receiver operating characteristic (ROC) curve analysis was performed.
Results

Thirty four patients with breast lesions based on US were included in this study. The mean age of the patients was 50.2 years. Following the procedure of tru-cut or stereotactic biopsy, out of the 34 patients, 17 (50%) were diagnosed as malignant and 17 (50%) were benign histopathologically. The vast majority of the benign lesions were consisted of fibroadenoma and fibrocystic changes whereas; infiltrative ductal carcinoma was the most common lesion among the malign masses. (Table 1)

Average elasticity value in malignant breast lesions was 5.03±1.32 and in benign breast lesions was 1.64 ± 0.49 and statistically significant difference was found between the two groups (p <0.05).

In this study, we also compared BI-RADS classification and SE strain ratio value of the lesions. (Table 2)

Fifteen lesions in BIRADS 3 and 4A categories had a SR below the cut off value. Histopathologic findings of these lesions were reported as benign. (Figure 1)

One of the two lesions in BIRADS 4B category had a SR above the cut off value whereas the other had SR below the cut off value. Histopathologic findings of these lesions, one benign and other malign were reported to be correlated with the strain ratio values. (Figure 2)

Three lesions in BIRADS 4C category, one lesion had a SR below the cut off value whereas the other two lesions had SR above the cut off value. Histopathologic findings of these lesions, one benign and other two malign were reported to be correlated with the strain ratio values.

Fifteen lesions in BIRADS 5 category, fourteen lesions had a SR above the cut off value whereas the other one lesion had SR below the cut off value. Histopathologic results were reported as malignant for all of these lesions. (Figure 3)

The lesions of the breast tissue classified as BIRADS 5 category in the evaluation of Ultrasound, but SE evaluation of the measured values was benign with edematous appearance. Therefore, the surrounding tissue around the lesion was thought not to be an adequate response to compression. (Figure 4)

Benign lesions were found to have either softer than or had the same elasticity as adjacent glandular tissue.

ROC curve analyses revealed a sensitivity of 94.3% and a specificity of 96.2% for strain ratio, when cutoff point of 3.15 was used.
**Table 1:** The pathologic diagnosis in all 34 lesions

<table>
<thead>
<tr>
<th>Pathology</th>
<th>Number of lesions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malignant lesions</td>
<td>17</td>
</tr>
<tr>
<td>Invasive ductal carcinoma</td>
<td>14</td>
</tr>
<tr>
<td>Ductal carcinoma in situ</td>
<td>2</td>
</tr>
<tr>
<td>Invasive micropapillary carcinoma</td>
<td>1</td>
</tr>
<tr>
<td>Benign lesions</td>
<td>17</td>
</tr>
<tr>
<td>Fibroadenomas</td>
<td>8</td>
</tr>
<tr>
<td>Fibrocystic disease</td>
<td>4</td>
</tr>
<tr>
<td>Adenosis</td>
<td>3</td>
</tr>
<tr>
<td>Fat Necrosis</td>
<td>1</td>
</tr>
<tr>
<td>Lobular Hyperplasia</td>
<td>1</td>
</tr>
</tbody>
</table>
Table 2: Distribution of benign and malignant lesions for each BI-RADS class.

<table>
<thead>
<tr>
<th></th>
<th>Class 3</th>
<th>Class 4A</th>
<th>Class 4B</th>
<th>Class 4C</th>
<th>Class 5</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benign SE Measurements</td>
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<td>1</td>
<td>1</td>
<td>1</td>
<td>18</td>
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<tr>
<td>Malign SE Measurements</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>13</td>
<td>16</td>
</tr>
<tr>
<td>Total</td>
<td>4</td>
<td>11</td>
<td>2</td>
<td>3</td>
<td>14</td>
<td>34</td>
</tr>
</tbody>
</table>

Fig. 1: 34 year-old woman. B-mode US examination evaluated in the BIRADS 4A category, sonoelastograf evaluation of the measured values was benign. Pathology: Fibroadenoma

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**Fig. 2:** 47 year-old woman. B-mode US examination evaluated in the BIRADS 4B category, sonoelastograf evaluation of the measured values was benign. Pathology: Adenosis

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**Fig. 3:** 74 year-old woman. B-mode US examination evaluated in the BIRADS 5 category, sonoelastograf evaluation of the measured values was malign. Pathology: Invasive ductal carcinoma

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Fig. 4: 55 year-old woman. B-mode US examination evaluated in the BIRADS 5 category, sonoelastograf evaluation of the measured values was benign. Pathology: Invasive ductal carcinoma

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Conclusion

In clinical practice conventional US, palpation and mammography are the major three steps routinely performed for to diagnosis of the breast lesions suspicious for the malignancy. However, none of them alone or in combination with each other is able to differentiate malignancy and there is always the need to obtain biopsy or fine needle aspiration to confirm the diagnosis. A high percentage of these biopsies are benign. (3)

SE helps us not only understanding the morphological information achieved by routine gray scale imaging but also enables us to have an idea about the elasticity of the lesions. The evaluation of tissue elasticity and hardness is remarkably useful for differentiating the benign and malignant lesions. (4) The SR represents the relative compliance stiffness of lesions compared with surrounding tissues, therefore SR has certain advantages in the evaluation of benign and malignant breast lesions. In the current study, we correctly diagnosed the benign (17 cases) and malign (16 cases) lesions by using the SE. Only one case was found to be false-negative with SR assessment.

This method with high specificity and sensitivity is the ideal goal in imaging medicine. In this study, quantitative measurements of elasticity achieved by SE were found out to be valuable in the differentiation of malignant and benign lesions. We found that, 3.15 was the best cut-off value, and the sensitivity and specificity were calculated 94.3% and 96.2%, respectively.

The diagnosis may be false-negative if the hardness of malignant lesions will reduce due to bleeding or cystic degeneration whereas, it may be false-positive when benign lesions are accompanied with calcification, organization, rich stromal cells or increasing degree of the fibrosis in lesions. (5)

In conclusion, breast SE is a very practical and rapid method to improve the sensitivity and specificity of US, in particular to evaluate the lesions of BI-RADS 3 or 4. Additionally, we suggest that SE is of good clinical tool in diagnosis and differentiation of benign and malignant breast lesions. We believe that SE is a noninvasive and accessible imaging method to decrease the rate of unnecessary biopsies.
References


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