

A Study on Elastic Ultrasound Waves Needed to Evaluate Tumors in the Breast

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Abstract

Background/Objectives: This study aims to determine the usefulness of the shear wave elastography during breast ultrasound for reducing unnecessary biopsy.

Methods/Statistical analysis

From patients who underwent breast ultrasound from September to December 2019, 69 patients with breast nodules were identified and their biopsies were retrospectively analyzed.

The average age of the patients was 47.75 years. Using shear wave elastography, we found the sensitivity, specificity, accuracy, positive predictive value, and negative predictive value to be 86.67%, 76.92%, 81.16%, 74.29%, and 88.24%, respectively.

Findings: In the comparative analysis of shear wave elastography and the biopsy method, the kappa value was high found to be 0.624 ($p < 0.05$), implying a good agreement between the two methods. During breast ultrasound examination, shear wave elastography ultrasound aided the differential diagnosis of malignant and benign breast masses.

Improvements/Applications: This study was conducted on a small patient group. In the future, additional testing will need to be done on a larger scale.

Keywords: breast ultrasonography, breast biopsy, breast mass, shear wave elastography, nodule

1. Introduction

In Korea, the incidence of breast cancer is increasing while the average age group with breast cancer is decreasing. Therefore, early screenings are performed to prevent breast cancer. Currently, Korean medicine is developing diagnostic and preventive medicines and identifying the survival rate of the patients who have undergone breast cancer surgery. Patients in stages 1 or 2—classified as early breast cancer phase—show an overall survival rate of more than 90%. However, stage 4 patients have a low survival rate of 34%; this highlights the importance of early breast cancer detection. Active screening has been conducted for early detection and treatment of female breast cancer [1-3]. This is why Korea's breast cancer mortality rate is the lowest in the world despite the rising incidence. The goal is to detect cancer early and increase the survival rate. However, the frequency of unnecessary biopsy has increased due to the discovery of nodules [4]. There is a limitation in distinguishing benign and malignant tumors solely by breast ultrasound findings. Hence, an accurate diagnosis can be reached using biopsy. However, for a few patients who have undergone biopsy, it is impossible to diagnose breast nodules as malignant. Imaging techniques that can reduce the frequency of biopsies and aid in diagnosis have been developed and applied in clinical practices. A test method is required to reduce side effects of biopsy, such as infection and bleeding. The study aims to determine the usefulness of the shear wave elastography during breast ultrasound and find a way to reduce unnecessary biopsy [5,6].

2. Materials and Methods

2.1. Subjects

Shear wave elastography was performed after obtaining ultrasound images of 69 patients. They were selected from the group of patients that underwent breast ultrasound between September

and December 2019; hence, they had their biopsy planned due to the detection of a triggered nodule. All 69 patients were female and were diagnosed cytologically through biopsy, even if they were not above category 4. The results of the ultrasound elasticity were analyzed.

2.2. Research method

Images were obtained after performing breast ultrasound using a 2–9 MHz linear transducer with RS85 (Samsung Medison, Korea) an ultrasound diagnostic device. Shear wave elastography was performed on patients with detected nodules, planned biopsy, evaluated stiffness, and classified breast nodules as benign or malignant.

2.3. Statistical analysis

Descriptive statistics and frequency analysis were performed to determine the usefulness of shear wave elastography and Kappa analysis to determine the consistency of diagnosis. Statistical significance was evaluated based on a less than 0.05 p-value. Moreover, all the statistical distances were used with SPSS Ver.18 (Chicago, IL, USA).

Ultrasound image was obtained using a Samsung Medison ultrasound diagnostic device. The scan was stopped at the nodule. Moreover, the stiffness was measured by applying shear wave elastography [Figure 1, Figure 2].

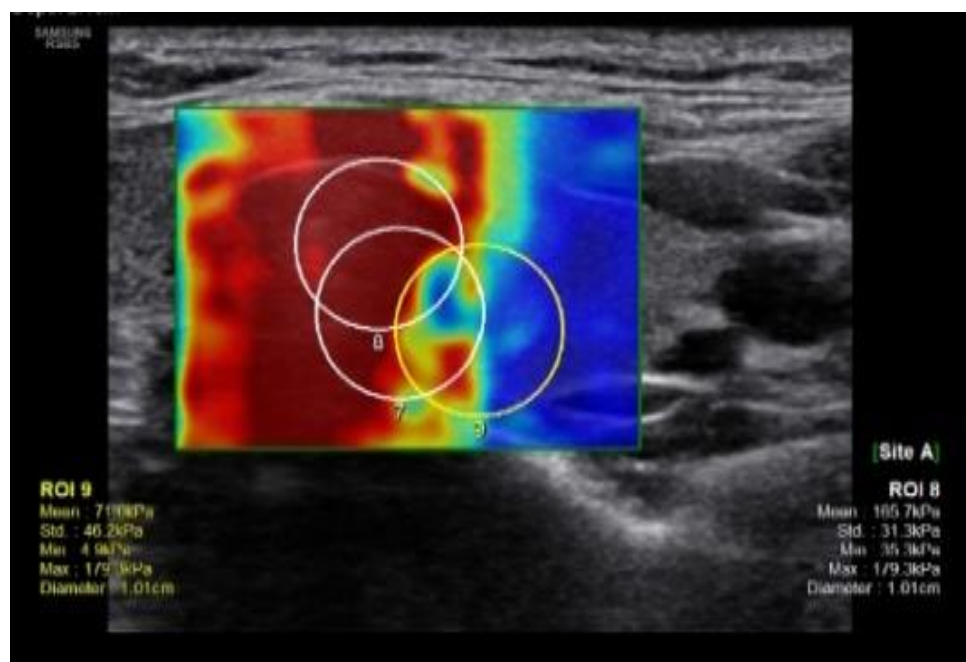


Figure 1. Shear wave elastography method



Figure 2. Samsung Medison ultrasound device (RS85, Korea)

3. Results and Discussion

3.1 General characteristics of the subjects

The age of the subjects ranged from 32 to 78 years, with an average age of 47.75 ± 9.75 years. The minimum, maximum, and mean values of the shear wave max of 69 subjects were 10, 179, and 98.42, respectively, with the standard deviation of 51.258 kPa. The results of the shear wave and biopsy analyses showed 34 (49.3%) shear wave positive and 35 (50.7%) malignant patients. A total of 39 biopsy-positive (56.5%) and 30 (43.5%) malignant patients were found [Table 1, Table 2].

Table 1. Shearwave elastography minimum, maximum, mean and deviation(Unit. KPa)

Variable	N	Min	Max	Mean	sd
Shear wave Elastography	69	10	179	98.42	51.258

Table 2. Shear wave elastography and biopsy analyses results

Variable	Benign	Malignant
Shear wave Elastography	34(49.3%)	35(50.7%)
Biopsy	39(56.5%)	30(43.5%)

3.2 Receiver-Operating characteristic curve analysis

ROC analysis was conducted to find out useful factors in discriminating malignancies. In discriminating malignancy, the AUC was high at 0.818. It can be seen as a good test in the

detection of malignancies[Figure 3].

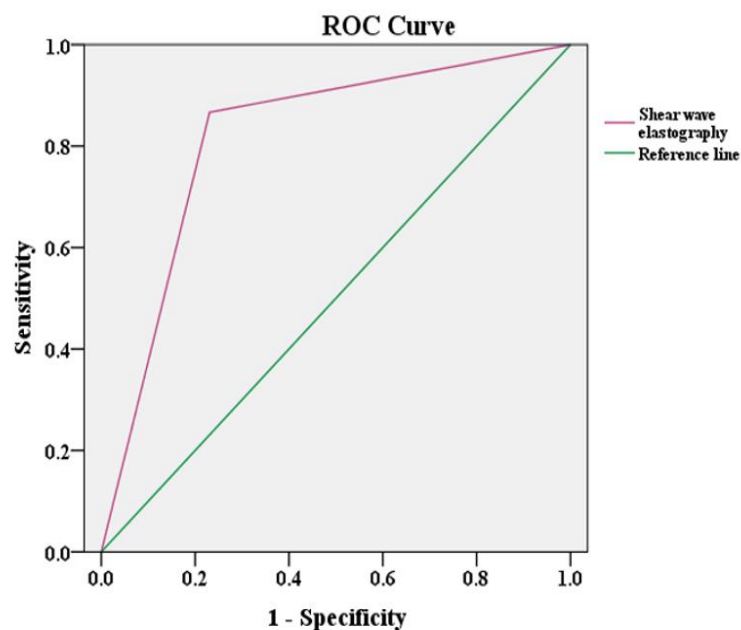


Figure 3. Receiver-Operating characteristic curve analysis

3.3 Analysis of sensitivity, specificity, and validity between shear wave elasticity and biopsy methods

Sensitivity, specificity, accuracy, positive prediction, and sound prediction were analyzed using the shear wave and biopsy methods [Table 3].

Table 3. Analysis of sensitivity, specificity, and validity between shear wave elasticity method and biopsy

Variable	(%)
Sensitivity	86.67
Specificity	76.92
Accuracy	86.66
Positive predictive value	74.29
Negative predictive value	88.24

3.4 Agreement analysis between shear wave elastography and biopsy methods

The agreement analysis between the shear wave elastography and biopsy methods resulted in the kappa value of 0.624 ($p < 0.05$), implying a good agreement between the two methods [Table 4].

Therefore, it was confirmed that shear wave elastography is as useful as the biopsy method for diagnosing malignant tumors.

Table 4. Analysis of correspondence between shear wave elastography and biopsy

method	Kappa value	p-value
Shear wave Elastography	0.624	0.000

4. Discussion

The survival rate of stage 1 and 2 patients who underwent breast cancer surgery is more than 90%. Thus, it is important to detect breast cancer early. However, additional tests are required owing to the detection of many benign nodules, increasing the burden on patients [7].

Breast image reporting and system (BI-RADS) recommends a biopsy for category 4 or higher. With novel tests that can help distinguish between malignant and benign nodules, the side effects of infection and the patient's pain and burden can be reduced.

This study aimed to determine whether unnecessary breast biopsy can be reduced by applying shear wave elastography to grayscale ultrasound for diagnosing breast cancer [8-10]. Shear wave elastography measures the stiffness of malignant tissue that hardens while forming connective tissue with its surrounding. the Shear wave elastography technique is a method in which a push pulse is generated in an ultrasonic probe and the wave of the transverse wave passes the mass and the velocity due to the tissue stiffness is expressed in kPa or m / s [2].

Through this study, I think it is meaningful to find out the results through comparative analysis between shear wave elastography and biopsy.

Using shear wave elastography, we found sensitivity, specificity, accuracy, positive predictive, and negative predictive value to be 86.67%, 76.92%, 86.66%, 74.29%, and 88.24%, respectively.

Kappa analysis was performed to determine the degree of agreement between shear wave elastography and biopsy methods. The kappa value was 0.624 ($p < 0.05$), implying that the two methods are consistent.

Hence, we verified that the shear-wave elastography method is as useful as conducting biopsy in breast cancer diagnosis.

However, our study is limited to a small number of subjects. We believe that the results can be improved and better insights can be gleaned by including more patients in future studies [11,12].

5. Conclusion

Through this study, it was confirmed that the shear wave elasticity test is as useful as the biopsy test for the diagnosis of malignant tumors.

It will be helpful in diagnosing malignancies and benignity if shearwave elastography is applied during breast ultrasound examination. If used before performing breast biopsy, it is thought that unnecessary biopsy can be reduced and used as basic data for clinical application.

In this study, the experiment was conducted on fewer patients, but it is thought that the utilization can be improved if additional research is conducted on more patients.

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