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Diagnostic Performance of Sonoelastography in Addition to Ultrasound in Investigating Breast Lesions: Can Concomitant Use of These Techniques Lead to Improvement of Differentiation?

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ABSTRACT

Background: Sonoelastography (SE) is introduced as a complementary technique for ultrasoungraohy (US) to evaluate breast lesions. This method isased on tissue strain in response to compression and decompression. The current study was designed to investigate the diagnostic performance of SE for differentiating between benign and malignant breast lesions.

Methods: A total of 35 women with 45 breast lesions who were referred to a university affiliated hospital in Tehran were enrolled. All patients were visited and examined by a same radiologist. A five-point scale was applied for categorizing lesions in SE as malignant or benign. The results of US and SE were compared with histopathological results to calculate sensitivity and specificity of each mentioned techniques.

Results: Histopathological evaluations in 12 cases were in favor of malignancy, and the rest were classified as benign. The sensitivity and specificity for US were 100% and 69.7%, respectively. On the other hand, SE obtained a lower sensitivity (58.3%) and higher specificity (90.9%) in comparison with US.

Conclusions: simultaneous evaluation of suspicious breast lesions with both US and SE can have high sensitivity and specificity and prevent unnecessary invasive interventions.

Introduction

Early diagnosis of breast cancer has a major role in disease prognosis and can significantly reduce cancer mortality. This is partly achieved by technical innovations in breast cancer imaging. Several approaches such as dynamic contrast-enhanced MRI and 18-fluorodeoxyglucose- PET have enabled physicians to detect and characterize breast cancer lesions more accurately and at earlier stages.[1-3]

Nevertheless, still large number of misdiagnosis exists, such as late detection with worse clinical

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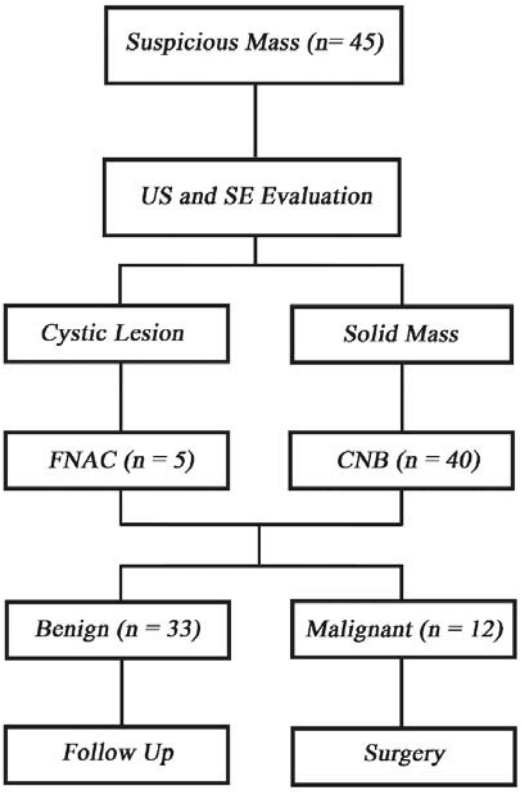


Figure 1. Study protocol and the number of patients evaluated in each step.

outcomes in false negative group. On the other hand, false positive findings lead to unnecessary interventions.[4] In an attempt to reduce unnecessary invasive procedures, sonoelastography (SE) has been introduced as a complementary imaging modality to improve the ultrasonic characterization of breast lesions.[5-7] SE is an extended imaging technique based on tissue strain images in response to compression and de-compression of target tissue.[8] Elasticity of breast tissue reduces under several circumstances, e.g. malignant transformation.[9] Malignant tissue rarely deforms in response to pressure and thus, can help us to make a distinction between normal and abnormal breast tissues.[9]

Although several studies have shown the diagnostic role of SE in breast cancer, the results were not consistent enough to consider this method as routine diagnostic tool. The aim of the current study was to investigate the performance of SE for differentiating between benign and malignant breast lesions.

Methods

Patients

The study was carried out at the imaging center of a university affiliated hospital in Tehran, Iran between July and December 2011. Study group consisted of 35 patients who were recently diagnosed with breast mass through either clinical examination or mammography. A total of 45 breast lesions were examined using ultrasound (US) and SE techniques by a single radiologist. After radiologic evaluation of all patients, the subjects underwent Usguided core needle biopsy (CNB) or fine needle aspiration cytology (FNAC). If the results were in favor of malignancy, then the participants were referred for excision, and the pathologic results of excised mass was considered as the final diagnosis (The pathologist was blinded to imaging results). Patients with benign lesions in CNB were all visited after 6 months and no significant changes in the size and morphology of lesions were noted. Among 45 lesions, only in 5 cases the final diagnosis was made by FNAC (all were benign cysts). Study protocol is presented in Figure 1. All patients were asked to fill informed consent prior to enrolment.

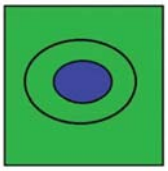
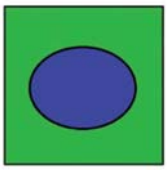
Radiologic evaluation

Images were recorded by means of B-mode US examination (MYLAB 70 XVG, Esaote Company, Jenoa, Italy) and characteristics of lesions such as size, location, echogenicity, axis, calcification, concurrent axillary lymphadenopathy and halo echogenicity were recorded. Images were characterized according to BIRADS classification provided with American College of Radiology (ACR).

During sonoelastographic examination the B-mode US images were shown in the left side of the monitor, while the color coded SE images were shown in the right side. The elasotgraphic images were obtained by up-and-down movements of the probe (transducer stress) with light constant pressure and were compared with adjacent tissues. Elastography was considered proper when the value of the reference LEDs on the monitor were constant (3 or 4), with the values being indicative of balance between pressure and tissue strain.

We used the color range in the SE images to predict the tissue characteristics, in which blue suggests a hard tissue with no strain, red indicates soft tissue with highest strain (commonly seen for liquid) and green represents average strain. A five-point scale was applied for categorizing lesions as malignant or benign. In the mentioned scale, score 1 is applied to a lesion which demonstrates three different layers (blue, green and red) in SE, score 2 corresponds to a high strain lesion (green) accompanied with some low strain segments (blue), score 3 indicates a high strain peripheral part (green) and low strain central segment (blue), score 4 represents a low strain lesion (blue) and finally score 5 is used to determine a hard lesion with low strain peripheral part (blue) (Figure 2).

Figure 2. Sonoelastograhic appearance, score and possible diagnosis of different lesions.

Appearance	Score	Possible diagnosis
	**Score 1:** Three different layer (blue, green, red)	Most probably liquid
	**Score 2:** Most parts of the lesion show high strain	Benign
	**Score 3:** High peripheral strain with low strain central part	Benign
	**Score 4:** Low strain lesion	Malignant
	**Score 5:** Low strain lesion with low peripheral parts	Malignant

Statistical analysis

SPSS software version 18.0 was used to conduct statistical analyses. The results of US and SE were compared with gold standard (histopathology) and the values of true negative, false negative, true positive and false positive were calculated for each technique. After all, the values were employed to etermine sensitivity, specificity, positive predictive value and negative predictive value.

Results

A total of 35 women with mean age of 44.5 ± 12.9 years were recruited. Among them, 11 (31.4%) had no history of pregnancy, 19 (54.3%) had never used oral contraceptive pills (OCP) and neither of them had previous history of breast cancer. Mean age at menarche was 13.4 ± 1.6 years and mean age of menopause in 9 postmenopausal participants were 50.1 ± 4.4 years. The results of final histopathological evaluation of all lesions are presented in Table1.

Table 1. Histopathological diagnosis of evaluated lesions

Benign (n = 33)	n (%)	Malignant (n = 12)	n (%)
Fibrocystic mastopathy	11 (33.3%)	Invasive ductal carcinoma	7 (58.3%)
Fibroadenoma	10 (30.3%)	Invasive carcinoma	3 (25.0%)
Fibrosis	3 (9.1%)	Invasive lobular carcinoma	2 (16.7%)
Papilloma	2 (6.1%)		
Cyst	5 (15.2%)		
Atypical hyperplasia	1 (3.0%)		
Tubular adenoma	1 (3.0%)		

Table 2. Diagnostic accuracy of US and SE in evaluating suspicious breast lesions

	Ultrasound	Sonoelastography
Sensitivity	100%	58.3%
Specificity	69.7%	90.9%
Negative predictive value (NPV)	100%	85.7%
Positive predictive value (PPV)	54.5%	70%

Using US, all 12 malignant lesions were correctly identified leading to the sensitivity of 100%. Although among 33 benign lesions, 23 cases were correctly classified (Specificity = 69.7%). The remaining 10 lesions were classified as indeterminate nature (BIRADS 4) (Table 2).

SE was able to correctly identify 7 out of 12 malignant cases (Sensitivity = 58.3%). The remaining cases had strain index of 2 to 3. In contrast to US, the ES resulted in appropriately distinguishing 30 lesions out of 33 benign lesions (Specificity = 90.9%). All the other 3 cases were assigned to class 4 of tissue strain pattern (Table 2).

Discussion

The main objective of this study was to delineate the diagnostic role of SE in evaluating suspicious breast lesions. The accuracies of SE and US were compared with histopathological results as the gold standard. Based on radiologic findings, patients were referred for FNAC, CNB and surgical removal of lesions. The results denoted that SE has higher specificity and lower sensitivity compared to the US.

Ultrasound is a useful non-invasive method to evaluate breast lesions and gives valuable information about the structure of suspected lesions with high sensitivity.[10] However, this technique is operator-dependent and its low specificity leads to high false-positive results and unnecessary biopsies and invasive interventions.[10,11] In order to overcome the disadvantages of this method, sonoleastography was introduced as a complementary evaluating tool. 6 Idea of differentiating between malignant and benign breast lesions based on elasticity of tissue was first proposed in 1997.[12] During up-and-down movements of probe in SE, the software helps the radiologist to assess the accuracy of techniques by a scale. If the shown number is 3 or 4, the procedure is performed correctly.[13] First reports on diagnostic performance of SE, suggested the specificity of 21% to 56%, but development of five point scale lead to dramatic increase in specificity of SE to even 95%.[12-14] The scoring system was first developed by Ueno and his colleagues, but further adjustment and modification was made by Italian Multi-Centric Team of Study for Sonoelastography Evaluation.[15,16]

Our observation was consistent with the literature reporting US high sensitivity and low specificity.[17] A large prospective study conducted in the United States has shown that among 1208 evaluated cases, sensitivity and specificity of ultrasound were 95.7% and 89.2%, respectively. 18 Our findings supported the results of several studies published on efficacy of SE in improving the diagnostic role of routine US.[13,16,19] Thomas *et al*. demonstrated that SE has a relatively lower sensitivity compared to US (82% vs. 94%, respectively) and higher specificity (87% vs. 83%).[19]

Relatively small number of patients enrolled in the study was the most important limitation that might affect the final results. Nevertheless, based on the consistency of obtained results with previous reports on accuracy of SE it seems that the results are valid and can be taken into account.

In conclusion, simultaneous evaluation of suspicious breast lesions with both US and SE can have high sensitivity and specificity and prevent the unnecessary invasive interventions.

Conflicts of interests

The authors declare no conflict of interest.

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