Research Article

The Role of Elastogram in Evaluation of Breast Lesions

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Abstract
Introduction: Breast ultrasound elastography (USE) is a new technique of ultrasonic imaging that has shown effectiveness of characterization of breast lesions by Elastography. **Aim Of The Work:** Is to focus on the application of USE for further characterization of lesions especially if initially categorized as BI-RADS-US 3 or 4 as these categories can imply both malignant and benign lesions and a more precise prediction of a lesion's malignancy status in these categories would be valuable. **Patients and Methods:** This study will include 20 Patients of different age groups that are referred to the department of Radiology at El-Minia University Hospital for Elastogram assessment of breast lesions. **Results:** This study included 20 patients presenting with different breast lesions.
Keywords: ACR: American College of Radiologists **DCE:** Dynamic contrast enhancement **MR:** Magnetic resonance

Introduction
Breast ultrasound elastography (USE) is a new technique of ultrasonic imaging that has shown effectiveness of characterization of breast lesions by elastography, USE provides information about the mechanical properties of tissue such as elasticity and strain and maps it into color images.(1-4)

Elasticity is the tendency of a tissue to resume the original size and shape; while strain is the level of change in size or shape in response to external compression (stress).(4)

Each pixel of the image is assigned one of 256 specific colors and demonstrates the magnitude of tissue strain depending on physiological and pathological changes in breast structure.(3,5)

Harder tissues such as malignancy may result in decreased strain and are shown in blue, while softer tissues will reflect increased strain and are shown in red. Normal breast tissue which reflects average strain is shown in green.(3)

The color image is superimposed on B-mode ultrasound (US) image for a better recognition of the relationship between the strain distribution and the anatomical borders of the lesion.(3,4,6) This information is further interpreted by evaluating the color pattern in a hypoechoic lesion (e.g., within lesion borders on US image), and in the surrounding breast tissue.(3)

A 1–5 scale elasticity score (ES) is assigned to each image based on its overall pattern, with the harder tissues (e.g. breast cancer) showing higher elasticity scores.(3) Although characterization of solid breast masses by sonography has improved greatly since the early 1990s, specificity remains low, and to date a large number of breast biopsies result in benign diagnoses. Therefore, any additional sonographic information to improve lesion characterization would help increase specificity.(7)

Aim of the Work:
Is to focus on the application of USE for further characterization of lesions especially if initially categorized as BI-RADS-US 3 or 4 as these categories can imply both malignant and benign lesions and a more precise prediction of a lesion's malignancy status in these categories would be valuable.

Patients and Methods
This study will include 20 Patients of different age groups that are referred to the

department of Radiology at El-Minia University Hospital for Elastogram assessment of breast lesions

Patients were subjected to:
I. Full history taking:
II. Imaging Examination:
I. Full history taking:

- Personal history including name, age, marital status and parity.
- Complaint and present history that the major clinical presentation of the patients is palpable mass.
- Past history of breast diseases and other organ malignancy.
- Family history including history of similar conditions or any other breast disease.
- Operative history emphasizing previous breast operations.

II. Imaging Examination:
A- US Examination:
All patients were subjected to breast US using 7.5 MHz linear probe. Examinations were performed using a high-end ultrasound system (Toshiba Aplio XG Medical Systems, Japan). The transducers were directly applied to the skin surface to examine the inner quadrants of the breasts, and the supine oblique position, to evaluate the outer quadrants. Scanning was performed in the radial and antiradial planes in relation to the nipple, and/or sagittal and transverse planes were used, where it begins in the upper inner quadrant of the breast and proceeds slowly to the outer quadrant to obtain sagittal images. The transducer is then moved lower on the breast and the scanning action is repeated until the whole breast has been examined. At that point the transducer is rotated 90° and transverse scan is taken proceeding from inner to outer. Both axillary regions are then examined by longitudinal scanning. All nodes were examined in the longitudinal and transverse nodal planes that demonstrated the largest and smallest diameters of the node. The comment on the US included description of the breast parenchymal pattern, skin thickening and evaluating ducts for duct ectasia, intraductal soft tissue lesions, or inspissated secretions. Evaluation of any focal lesion for site, size, shape, echogenicity, borders, posterior acoustic phenomena (shadowing, enhancement or none), architect-tural distortion or tissue edema, vascularity of the lesion on Doppler US, effect of compression on the lesion, whether it is flattened, compressed or not and if the lesion is mobile or fixed under the probe.

Statistical analysis of the data
Data were fed to the computer and analyzed using IBM SPSS software package version 20.0. Qualitative data were described using number and percent. Quantitative data were described using range (minimum and maximum) mean and standard deviation for normally distributed data while abnormally distributed data was expressed using median. Significance of the obtained results was judged at the 5% level.

Results

This study included 20 patients presenting with different breast lesions. Their ages ranged from 24 years to 67 years with a mean age of 46 years.

Table (VI): Relation between the elastography score and the diagnosis of breast lesions

	Total (n = 36)		Benign lesion (n = 21)		Malignant lesion (n = 15)		χ^2	^{MC}p
	No.	%	No.	%	No.	%		
Elastography score								
1	4	11.1	4	19.0	0	0.0	19.964*	<0.001*
2	11	30.6	11	52.4	0	0.0		
3	5	13.9	2	9.5	3	20.0		
4	13	36.1	4	19.0	9	60.0		
5	3	8.3	0	0.0	3	20.0		

χ^2: Chi square test MC: Monte Carlo test *: Statistically significant at $p \leq 0.05$

Ultrasound elastography: **(Table VI)** Elastoraphy was performed on 20 cases with a total number of 36 lesions being classified according to modified Ueno and Ito elasticity score system as follow:
Benign lesions had elastography score 1, 2, 3 and 4: 4 lesions (19%) had elastography score 1, 11 lesions (52.4%) had elastography score 2, 2 lesions (9.5%) had elastography score 3 and 4 lesions (19%) had elastography score 4.
Malignant breast lesions had elastography score 3, 4 and 5: 3 lesions (20%) had elstography score 3, 9 lesions (60%) had elstography score 4 and 3 lesions (20%) had elastography score 5.
None of the malignant lesions had score 1or 2, while none of the benign lesions had score 5.

Table (VII): Relation between the BIRADS and the diagnosis of breast lesions

BIRADS	Total (n = 36)		Benign lesion (n = 21)		Malignant lesion (n = 15)		χ^2	^{MC}p
	No.	%	No.	%	No.	%		
0	0	0.0	0	0.0	0	0.0	32.502*	<0.001*
1	0	0.0	0	0.0	0	0.0		
2	16	44.2	16	76.1	0	0.0		
3	8	22.2	5	23.8	3	20		
4	2	5.5	0	0.0	2	13.3		
5	8	22.2	0	0.0	8	53.3		
6	2	5.5	0	0.0	2	13.3		

χ^2: Chi square test MC: Monte Carlo test *: Statistically significant at $p \le 0.05$

According to the BIRADS classification: (**Table VII)** 16 breast lesions (44.2%) had BIRADS 2 and were all benign, 8 lesions (22.2%) had BIRADS 3 and 5 of them were benign. Among the malignant lesions, 3 lesions (20%) had BIRADS 3, 2 lesions (13.3%) had BIRADS 4, 8 lesions (53.3%) had BIRADS 5 and 2 lesions (13.3%) had BIRADS 6.

Discussion

Breast cancer is the most common invasive cancer in women. World wide, it accounts for 22.9% of all cancers in women. More than one million women are newly diagnosed with breast cancer each year. A recent decline in cancer mortality is now observed due to improvement in the imaging technologies in addition to a higher degree of health awareness and educational programs.

The widespread mammography screening for the early detection of breast cancer gave rise to a tremendous number of biopsies taken in order to determine the nature of sono-or mammographically diagnosed breast abnormalities. The role of gray-scale ultrasound (US) has considerably expanded in characterizing focal breast lesions. This is a result of continuous technological advances that have greatly improved both its spatial and contrast resolution. Doppler US is a non-invasive technique capable of aiding evaluation of tumor neo vascularization in vivo.

In the last decade, different sonographic methods have been developed to determine the relationship between different structures and their tissue elasticity as well as the potential use of this relationship for diagnosing malignant tumors. Real-time ultrasound elastography (RTE) is a non-invasive dynamic imaging technique that assesses the strain of soft tissues and provides structural information other than the morphologic features shown by conventional B-mode US. Elastography is an easy way to eliminate needle biopsy for probably benign lesion. Elastography impr-oves ultrasound's specificity by utilizing conventional ultrasound imaging to measure the compressibility and mechanical properties of a lesion. Sonoelastography is a noninvasive technique that can depict relative tissue stiffness or displacement (strain) in response to an applied force. Stiff tissues deform less and exhibit less strain than compliant tissues in response to the same applied force. Since cancerous tumors tend to be stiffer than surrounding healthy tissue or cysts, a more compressible lesion on elastography is less likely to be malignant.

This study was conducted on 36 breast lesions from 20 patients aiming to study the role of US elastography in differentiating benign from malignant lesions. All patients did conventional ultrasonography on both breasts and 17 patients did mammography on both breasts, the three other patients were pregnant.

In this study ages of the studied cases ranged from 24 years to 67 years with mean age of 46 years. In our study 8 from 12 cases their age were above 40 years and had malignant lesions. In agreement with the various previous studies including Abeloff et al., who reported that risk of developing breast cancer increases as we get older. About 1 out of 8 invasive breast cancers are found in women younger than 45 years, while about 2 of 3 invasive breast cancers are found in women aged 55 years or older.

In our study 13 cases (65%) had no family history of pervious breast disease, and 7 cases (35%) had family history of pervious breast disease. Many studies including Azim et al.,[(100)] who mentioned that breast cancer risk is higher among women whose close blood relatives have this disease. Having one first-degree relative (mother, sister, or daughter) with breast cancer approximately doubles a woman's risk. Having 2 first-degree relatives increases her risk about 3-fold. The exact risk is not known, but women with a family history of breast cancer in a father or brother also have an increased risk of breast cancer. Altogether, less than 15% of women with breast cancer have a family member with this disease. This means that most (over 85%) women who get breast cancer do not have a family history of this disease.

In our study 14cases (70%) had no history of pervious breast disease, 3 cases (15%) had history of fibrocystic disease, 1 case (5%) had history of fibroadenoma and 2 cases(10%) had history of breast cancer with recurrence in the surgical bed or other breast, this was matching with most of the previous studies including Azim et al., who reported that woman with cancer in one breast has an increased risk of developing a new cancer in the other breast or in another part of the same breast. This risk is even higher if breast cancer was diagnosed at a younger age.

In our study 11 cases (55%) had history of breast feeding and 9 cases (9%) had no history of breast feeding. Corresponding studies including Ciatto et al., suggested that breast feeding may slightly lower breast cancer risk, especially if it is continued for 1½ to 2 years. But this has been a difficult area to study, especially in countries such as the United States, where breastfeeding for this long is uncommon. One explanation for this possible effect may be that breastfeeding reduces a woman's total number of lifetime menstrual cycles (similar to starting menstrual periods at a later age or going through early menopause).

Conclusion

Elastography is not used independently but as an additional role for conventional ultrasound examination assessed by the BIRADs scoring system and not as a separate examination. Elastography is performed in the same session of ultrasound taking about five minutes more than the conventional ultrasound examination.

SE is widely available and easy to use in a clinical setting. The fact that SE is real-time and can be done bedside along with the B-mode examination makes the use of SE feasible in a lot of different anatomic areas. In breast cancer, SE has shown great potential and a good diagnostic performance in several studies. The two most important elastographic characteristics in evaluating breast lesions are size and stiffness criteria.

One of the best applications is the characterization of solid breast nodules, categorized as BI-RADS 3 and BI-RADS 4a, in order to try to reduce unnecessary breast biopsies. In summary, real-time sonoelastography is a useful technique for the characterization of benign and malignant solid lesions as it increases the diagnostic specificity comparable to B-mode ultrasound.

Although not yet established for routine clinical use, US elastography is a promising adjunctive modality for evaluating breast lesions, on the basis of the results of the initial laboratory and clinical investigations.

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