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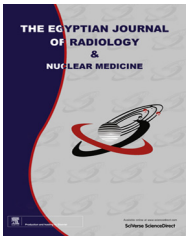

ORIGINAL ARTICLE

Incremental value of real-time ultrasound elastography in differentiating breast masses

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KEYWORDS

Ultrasound;
Elastography;
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Abstract *Aim of the work:* To evaluate the value of real-time ultrasound elastography (RTE) in differentiating benign from malignant breast masses.
Materials and methods: This study included, whether palpable or non-palpable, 145 sonographically proven breast masses in 121 patients, imaged by conventional B-mode US, color-flow Doppler US and RTE with histopathological analysis considered as the golden standard reference.
Results: Lesions were differentiated into benign and malignant by conventional B-mode US (79; 45.5% and 66; 54.5%, respectively), RTE (80; 55.2% and 65; 44.8% respectively), and histopathology (82; 56.6% and 63; 43.4%, respectively). The mean difference in the mass size was significant between B-mode US and RTE in malignant masses ($P = 0.002$), while not significant among benign masses ($P = 0.153$). The B-mode US depicted sensitivity of 92.06%, specificity of 90.24%, PPV of 87.88%, NPV of 93.67% and accuracy of 91.03%, while the RTE showed sensitivity of 98.41%, specificity of 96.34%, PPV of 95.38%, NPV of 98.75% and accuracy of 97.24%.
Conclusion: Combined use of RTE can complement conventional B-mode US with improving its diagnostic performance in differentiating breast lesions with subsequent reduction in the rate of unnecessary biopsies in benign lesions.

Abbreviations: US, ultrasonography; RTE, real-time ultrasound elastography; ACR, American College of Radiology; BI-RADS, Breast Imaging Reporting and Data System; ES, elasticity score; PPV, positive predictive value; NPV, negative predictive value; DCIS, ductal carcinoma in situ; IDC, invasive ductal carcinoma; SR, strain ratio

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1. Introduction

Breast cancer is the most common invasive cancer in women. Worldwide, it accounts for 22.9% of all cancers in women (1). More than one million women are newly diagnosed with breast cancer each year (2). 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 (3).

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

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both its spatial and contrast resolution (4). Doppler US is a non-invasive technique capable of aiding evaluation of tumor neovascularization in vivo (5).

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 (6). 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 (7). It can differentiate between benign and malignant lesions based on their elasticity. Benign lesions have elasticity similar to the surrounding tissue, while malignant lesions are harder than the adjacent tissue (8). A 5-score system was described by Itoh et al. (8) to classify elastographic findings that can be easily correlated to the American College of Radiology (ACR) Breast Imaging Reporting and Data System (BI-RADS) 5-score classification for B-mode images (9).

The aim of this study was to evaluate the value of RTE in differentiating benign from malignant breast masses.

2. Materials and methods

This study was carried out in the period from February 2012 to May 2013 and included 139 consecutive patients with sonographically evident breast masses. Eighteen patients were excluded from the study due to unavailable or indefinite histopathological results. The remaining 121 patients showed 145 sonographically and pathologically proved breast masses either palpable (n = 89) or non-palpable (n = 56). Three of them had 3 mass lesions, 18 had 2 mass lesions and 100 had one mass lesion in each patient. All patients were women except one male patient who was presented with localized disfigurement and palpable retroareolar eccentric mass in his left breast. An official permission to carry out the study was obtained from the local medical research ethics committee. Patient consent to participate in the study was obtained.

The indications of the initial ultrasound examination were abnormalities detected on mammography (n = 92), palpable breast mass (n = 89), localized disfigurement (n = 5), pain (n = 56), abnormal nipple discharge (n = 40), palpable axillary lymph node (n = 87) and asymptomatic screening due to a first or second degree relative with cancer breast

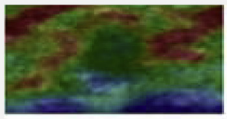
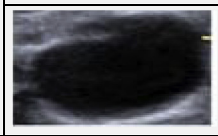
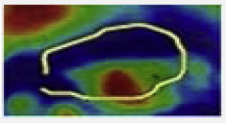
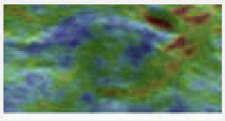
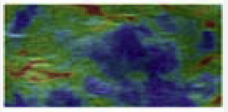
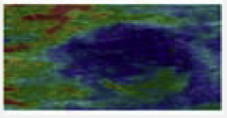
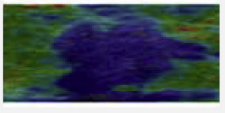
Elastosonographic Score	Typical B-mode image	Chromatic code	Typical elastosonographic image	Classification standard
Elasticity Score 1: Prevalently in benign lesions as well as in the simple cysts.				Strain is seen in the entire hypoechoic area (the entire lesion is shown in green similar to the surrounding tissue).
				A tri-stratified pattern of blue, green and red (BGR sign) which is a typical artifact seen in a cystic lesion.
Elasticity Score 2: Prevalently in benign forms				Strain is seen within most of the hypoechoic area but some areas show no strain (the lesion is a mixture of green and blue).
Elasticity Score 3: Probably benign.				Strain appears only in the periphery with no strain in the center of the lesion (the centre of the lesion is shown as blue with the periphery in green).
Elasticity Score 4: Probably malignant.				No strain is measured within the lesion (the entire lesion is shown in blue).
Elasticity Score 5: Prevalently in malignant forms.				No strain is measured within the lesion nor in the surrounding tissues (the entire lesion and the surrounding tissue are blue).

Fig. 1 Categories of breast lesions on the B-mode US and RTE according to the modified classification introduced by Italian Multi Center Team of Study [Quoted from Smajlovic et al. (17)].