ORIGINAL ARTICLE

Role of sonoelastography and MR spectroscopy in diagnosis of solid breast lesions with histopathological correlation

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Abstract  Objective: To demonstrate the role of ultrasound elastography and magnetic resonance spectroscopy in diagnosis of solid breast lesions with histopathological correlation.

Patients and methods: This study included 40 female patients, and their ages ranged from 17 to 73 years with mean age of 43.18 years. Patients were referred on the basis of suspected breast lesion and/or nipple discharge. All patients underwent elastography in addition to conventional ultrasoundography and MR spectroscopy and the radiological results were correlated with histopathological examination for achieving confirmed final diagnosis.

Results: All benign lesions were 17 on the basis of elastography, while the malignant lesions were 18. Fifteen malignant lesions (93.7%, 15/21) had an elastography score 5, while Thirteen benign lesions (86.7%, 13/19) had an elastography score 3. On the basis of DCE-MRI, benign lesions were 16, while the malignant lesions were 21. Sixteen malignant lesions (94.1%) were diagnosed as BI-RADS 5, while fourteen benign lesions (93.3%) were diagnosed as BI-RADS 3. On the basis of MR spectroscopy, benign lesions were 17, while the malignant lesions were 21. Nineteen malignant lesions (90.5) had positive choline peak while seventeen benign lesions (89.5%) had negative choline peak. The study showed that sonoelastography sensitivity, specificity, PPV, NPV and accuracy as 90%, 85%, 85.7%, 89.4% and 87.5% respectively.

Dynamic contrast enhanced MRI sensitivity, specificity, PPV, NPV and accuracy were 85.7%, 84.2%, 85.7%, 84.2% and 85% respectively, while MR spectroscopy sensitivity, specificity, PPV, NPV and accuracy were 90.4%, 89.4%, 90.4%, 89.5% and 80.5% respectively.

Conclusion: The study showed that sonoelastography and MR spectroscopy are valuable noninvasive diagnostic imaging techniques in diagnosis of early breast malignancy and other diagnostic tools, consequently help to avoid undesirable invasive surgical biopsy of the breast lesions.

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1. Introduction

In the past, ultrasound was only considered useful for the diagnosis of cysts, meanwhile, diagnosis of breast cancer has been widely improved since the development of high resolution ultrasound equipments. It improves the differential diagnosis of benign and malignant lesions, local preoperative staging and guided interventional diagnosis (1). Ultrasound has long been used to distinguish between cysts and solid masses. However, solid masses are not always malignant; for example, both fibroadenomas and scirrhous carcinomas are solid and stiff, but only the latter are malignant (2). Breast elastography is a new sonographic imaging technique which provides information on breast masses in addition to conventional ultrasonography (US) and mammography as it provides a noninvasive evaluation of the stiffness of a lesion (3). Elastography has integrated the diagnostic ability of palpation into an ultrasound instrument with a compressive probe and reflects the tissue stiffness (hardness) and elasticity in response to pressure, even in lesions that are not palpable by hand (4). Magnetic resonance imaging has shown promise in characterizing breast lesions and evaluating local extent of disease (5). Magnetic resonance spectroscopy shows excellent specificity in the detection of breast lesions. Choline is generally undetectable in normal breast tissue, and increased levels of choline compounds in a tumor are thought to be an indicator of the activity of that tumor, suggesting that it is malignant. This eliminates the need for biopsy, reduces patient morbidity, and saves unnecessary cost and time for both the patient and the medical staff (6).

The aim of the work was to demonstrate the role of ultrasound elastography and magnetic resonance spectroscopy in diagnosis of solid breast lesions with histopathological correlation.

2. Patients and methods

This prospective study was performed during the period from September 2012 to January 2014 at Radiodiagnosis Department, Al-Azhar University Hospital (New Damietta) and included 40 female patients, and their ages ranged from 17 to 73 years with mean age of 43.18 years. The patients were referred from General Surgery Department, Damietta Oncology Center and also from outpatient clinics on the basis of suspected breast lesion and/or nipple discharge. Inclusion criteria were as follows: patients with solid breast lesions, and exclusion criteria were as follows: 1. Patients with non-solid breast lesions and 2. Neoadjuvant chemotherapy or biopsy before MR examination. This study was approved by the local Ethics Committee, informed consent was taken from all patients, and then they were subjected to the following.

2.1. History taking and clinical examination

2.1.1. Radiological examinations

2.1.1.1. Sonoelastography examination of the breast. Using Ultrasonix, SP, Canada with a convex probe 2–5 MHz and linear probe 5–10 MHz.

The lesions were characterized using BI-RADS ultrasound descriptors of mass margin (circumscribed, obscured, microlobulated, ill-defined/indistinct or spiculated), shape (oval, round, lobular or irregular), orientation (parallel or not parallel to the skin), matrix echogenicity and homogeneity (anechoic, hypoechoic or hyperechoic; homogeneous or heterogeneous) and attenuation (indifferent, shadowing or enhancement). Additionally, any associated findings (e.g. architectural distortion) or axillary lymphadenopathy was noted.

Elastographic diagnostic criteria were as follows: hardness of tissue is displayed in color tone, with increasing hardness presented in ascending order of red, yellow, green and blue. The hardness is scored on a scale of 1–5. Score 1 is defined as an overall green tone, whereas score 2 consists of a mosaic of green, blue and red and score 3 is presented by a blue center and green periphery. Scores 1–3 represent benign findings. Score 4 is defined as an almost blue color consistent with a hypoechoic region and score 5 as a definite blue color beyond that of a hypoechoic region. Malignant findings are represented by score 4 and score 5.

2.1.2. Dynamic MRI and MRS of breast. Using MRI machine (Philips, Achieva 1.5 Tesla-XR-Netherlands 2010).

Technical considerations of dynamic MRI for the breast scanning protocol:

1. Patient preparation and position

- The patients were instructed not to have any metallic objects such as cardiac pace makers and ocular implants.
- Patients were instructed to avoid motions.
- Patients were imaged in prone position with breasts hanging dependently within phased array breast coil.
- The ideal time for examination was 4–17 days from first day of menstrual cycle “less dense stroma and lower breast water content” and the average scan time was 30–45 min.

2. MRI imaging protocol

A. Initial scout views in axial, coronal and sagittal planes of both breasts to verify the precise position of the lesion.

B. T1-weighted pulse sequence: Nonfat saturated T1 WI was obtained by turbo spin echo (TSE) with the following parameters: Repetition time (TR): 450 ms, Echo time (TE): 14 ms, Number of signal averages (NSA): 1, slice thickness/inter slice gap: 3 mm/0.0, field of view (FOV): 300–360 mm, flip angle: 90°, matrix was 307×512 and acquisition time: 1.43 min.

C. T2-weighted pulse sequence: Nonfat saturated T2 WI was obtained by TSE with the following parameters: TR: 4 ms, TE: 120 ms, NSA: 1, slice thickness/inter slice gap: 3 mm/0.0, FOV: 300–360 mm, flip angle: 90°, matrix was 307×512 and acquisition time: 1.17 min.

D. Spectral attenuated inversion recovery (SPAIR) (Fat Sat.): SPAIR was obtained with the following parameters: TR: 13 ms, TE: 70 ms, inversion delay: 80 ms, NSA: 2, slice thickness/inter slice gap: 3 mm/0.0, FOV: 300–360 mm, flip angle: 90°, matrix was 307×512 and acquisition time: 2.32 min.

E. Dynamic study: This study was obtained using a T1 weighted sequence with fat suppression dynamic. The dynamic imaging consisted of 6 individual dynamic series each lasting for 1:25–1:27 min, one was obtained before and five after rapid bolus intravenous injection of gadopentetate dimeglumine at a
dose of 0.1 mmol per kilogram of body weight, followed by a 20 mL sterile saline solution flush. After the dynamic series, image subtraction was done to suppress the signal from fat. The used MRI pulse sequence parameters are detailed in Table 1 (see Tables 2–5).

F. MRS acquisition: A single-voxel 1H MRS was performed using a point-resolved spectroscopy sequence (PRSS), and the proton signals are converted into frequency information on the spectrum. According to the American College of Radiology BI-RADS-MRI lexicon, suspicious malignant lesions were diagnosed on the basis of the morphological features of the mass such as spiculated borders, microlobulated margins, irregular masses and breast stroma architectural distortion. Benign breast lesions were diagnosed based on their morphological feature (smooth masses of well defined borders and absence of surrounding breast stroma architectural distortion). Time–signal intensity plots of dynamic images were generated using console software. A small region of interest (ROI > 3 pixels) was placed selectively over the most intensely enhancing area of the lesion. The evaluation of enhancement kinetic curve was based on initial phase (within the first 2 min or when the curve starts to change), and late phase (after 2 min or after the change). The initial enhancement phase was categorized into fast, medium, and slow. The late enhancement phase was described as persistent, plateau, and washout. A spectrum was considered “positive” for choline if there was a well-defined peak at 3.2 ppm. The MRS result was considered “negative” if there was no peak at 3.2 ppm with appearance of adequate lipid suppression and shimming.

2.2. Histopathological study

The definitive diagnosis was provided by histopathological examination of the biopsied tissue using fine needle, core or surgical biopsies or surgical excision. All radiological examination results were compared with histopathological results, and the latter was regarded as the standard reference.

2.3. Statistical analysis

The collected data were organized, tabulated and statistically analyzed, using statistical package for social science (SPSS) version 19 (SPSS Inc, Chicago, USA), running on IBM compatible computer with Microsoft Windows 7 operating System. Mean, standard deviation, frequency and percentage were used as descriptive; Chi square test (χ²) was used for testing significance of observed differences between studied patients. The level of significance was adopted at p < 0.05%.

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Dynamic breast MRI pulse sequence parameters.</th>
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</thead>
<tbody>
<tr>
<td>Parameters</td>
<td>Sequences</td>
</tr>
<tr>
<td>Repetition time (TR)</td>
<td>450 ms</td>
</tr>
<tr>
<td>Echo time (TE)</td>
<td>14 ms</td>
</tr>
<tr>
<td>Field of view (FOV)</td>
<td>320 × 320</td>
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<tr>
<td>Slice thickness</td>
<td>3 mm</td>
</tr>
<tr>
<td>Interslices gap</td>
<td>0 mm</td>
</tr>
<tr>
<td>Matrix</td>
<td>307 × 512</td>
</tr>
<tr>
<td>Flip angle</td>
<td>90°</td>
</tr>
<tr>
<td>NSA</td>
<td>1</td>
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<tr>
<td>Acquisition time</td>
<td>1.43 min</td>
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<table>
<thead>
<tr>
<th>Table 2</th>
<th>Distribution of patients regarding lactation.</th>
</tr>
</thead>
<tbody>
<tr>
<td>State of patient</td>
<td>Count</td>
</tr>
<tr>
<td>Nonlactating cases</td>
<td>37</td>
</tr>
<tr>
<td>Lactating cases</td>
<td>3</td>
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<tr>
<td>Total</td>
<td>40</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 3</th>
<th>Distribution of patients regarding menopausal state.</th>
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</thead>
<tbody>
<tr>
<td>Count</td>
<td>Percent (%)</td>
</tr>
<tr>
<td>Perimenopausal</td>
<td>6</td>
</tr>
<tr>
<td>Postmenopausal</td>
<td>21</td>
</tr>
<tr>
<td>Childbearing</td>
<td>13</td>
</tr>
<tr>
<td>Total</td>
<td>40</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Table 4</th>
<th>Distribution of patients regarding hormonal replacement therapy (HRT) intake.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Count</td>
<td>Percent (%)</td>
</tr>
<tr>
<td>Without HRT</td>
<td>30</td>
</tr>
<tr>
<td>With HRT</td>
<td>10</td>
</tr>
<tr>
<td>Total</td>
<td>40</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 5</th>
<th>Distribution of patients regarding complaint and clinical signs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient complaint</td>
<td>Count</td>
</tr>
<tr>
<td>Painless breast lump</td>
<td>28</td>
</tr>
<tr>
<td>Painful breast lump</td>
<td>6</td>
</tr>
<tr>
<td>Nipple discharge</td>
<td>4</td>
</tr>
<tr>
<td>Palpable axillary lymph node</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>40</td>
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</table>
predictive value and accuracy were used as measurements of validity for MRI regarding histopathological results.

3. Results

Forty female patients were included in this study, their ages ranged from 17 to 73 years (mean age 43.18 y), three patients were lactating and 37 patients were non-lactating. Twenty-eight cases presented clinically by painless breast lump (70%), six cases with painful breast lump (15%), four cases with nipple discharge (10%) and two cases with palpable axillary lymph nodes (5%).

In this study, there were 30 cases with no history of hormonal intake but 10 cases received oral HRT. Among them, 8 patients postmenopausal received oral HRT in the form of estradiol and 2 cases received oral contraceptive pills.

Twenty-eight cases presented clinically by painless breast lump (70%), six cases with painful breast lump (15%), four cases with nipple discharge (10%) and two cases with palpable axillary lymph nodes (5%).

On the basis of sonographic BI-RADS categorization, our cases were classified as follows: (20 cases) class 3, (5 cases) class 4 and (15 cases) class 5. No case was assigned to class 0, 1, 2 or 6 (Table 6).

All benign lesions diagnosed by ultrasound were 16, while the malignant lesions were 17. Fourteen malignant lesions (14/21, 93.3%) were diagnosed BI-RADS 5, and sixteen benign lesions (16/19, 80%) were diagnosed BI-RADS 3.

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Twenty-eight cases presented clinically by painless breast lump (70%), six cases with painful breast lump (15%), four cases with nipple discharge (10%) and two cases with palpable axillary lymph nodes (5%).

On the basis of elastographic color scoring categorization, our cases were classified as follows: 5 cases (score 2), 15 cases (score 3), 4 cases (score 4) and 16 cases (score 5) (Table 7) (see Figs. 1–3).

All benign lesions diagnosed by ultrasound were 16, while the malignant lesions were 17. Fourteen malignant lesions (14/21, 93.3%) were diagnosed BI-RADS 5, and sixteen benign lesions (16/19, 80%) were diagnosed BI-RADS 3.

On the basis of elastographic color scoring categorization, our cases were classified as follows: 5 cases (score 2), 15 cases (score 3), 4 cases (score 4) and 16 cases (score 5) (Table 7) (see Tables 8–10).

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On the basis of elastographic color scoring categorization, our cases were classified as follows: 5 cases (score 2), 15 cases (score 3), 4 cases (score 4) and 16 cases (score 5) (Table 7) (see Tables 8–10).

All benign lesions diagnosed by elastography were 17, while the malignant lesions were 18. Fifteen malignant lesions (15/21, 93.7%) had an elastography score 5. Thirteen benign lesions (13/19, 86.7%) had an elastography score 3 (see Figs. 1–3).

On the basis of MRI BI-RADS categorization, our cases were classified as follows: (3 cases) class 2, (15 cases) class 3,
Table 10  Conventional ultrasound, ultrasound elastography, DCE-MRI and MRS sensitivity, specificity, PPV, NPV and accuracy in diagnosis of solid breast lesions.

<table>
<thead>
<tr>
<th>Examination</th>
<th>Sensitivity (%)</th>
<th>Specificity (%)</th>
<th>PPV (%)</th>
<th>NPV (%)</th>
<th>Accuracy (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional ultrasound</td>
<td>85</td>
<td>80</td>
<td>80.9</td>
<td>84.2</td>
<td>82.5</td>
</tr>
<tr>
<td>Ultrasound elastography</td>
<td>90</td>
<td>85</td>
<td>85.7</td>
<td>89.4</td>
<td>87.5</td>
</tr>
<tr>
<td>Dynamic contrast enhanced MRI (DCE-MRI)</td>
<td>85.7</td>
<td>84.2</td>
<td>85.7</td>
<td>84.2</td>
<td>85</td>
</tr>
<tr>
<td>MRI spectroscopy</td>
<td>90.4</td>
<td>89.4</td>
<td>90.4</td>
<td>89.5</td>
<td>80.8</td>
</tr>
</tbody>
</table>

In this study the conventional ultrasound sensitivity, specificity, PPV, NPV and accuracy were 85%, 80%, 80.9%, 84.2% and 82.5% respectively. Ultrasound elastography sensitivity, specificity, PPV, NPV and accuracy were 90%, 85%, 85.7%, 89.4% and 87.5% respectively. Dynamic contrast enhanced MRI sensitivity, specificity, PPV, NPV and accuracy were 85.7%, 84.2%, 85.7%, 84.2% and 85% respectively. MRS sensitivity, specificity, PPV, NPV and accuracy were 90.4%, 89.4%, 90.4%, 89.5% and 80.5% respectively.

4. Discussion

Regarding the patients demography, there were 40 patients included in our study. The mean age of the patients was 43.18 years (range of age, 17–73 years).

Many studies showed that the age at diagnosis of breast cancer in Arab countries is a decade younger than that in Western countries. In the United States, the median age at presentation for breast cancer is 61 years, compared to 50–54 years in Egypt. Boivin et al. (8) stated that sonography remains efficient in the diagnosis of masses. In addition to their diagnosis and characterization, it allows indispensable guided biopsies or monitoring of their evolution during neoadjuvant chemotherapy. The sonographic semiology of the masses does not seem to change during lactation. The MRI has its own semiology during lactation, related to the physiological changes. Even so, it remains efficient, allowing satisfactory detection according to the BI-RADS classification of tumors by the American College of Radiology (ACR). Also Iman et al. (9) mentioned that MRI breast should be used for
undetermined cases and for staging of malignancy. Among the patients in this study, 3 cases (7.5%) were lactating.

Age at menopause has long been identified as a risk factor for breast cancer (10). Early menarche and late menopause are known to increase women’s risk of developing breast cancer (11). The menopausal state is an important differentiating factor in the classification of patients with breast cancer. Instead of classifying by age, women with breast cancer are separated into either pre- or postmenopause (12). Among the patients of this study, 21 cases (52.5%) were postmenopausal.

In our study, ten patients received hormonal therapy (HT). Several studies have shown that the prognosis of HRT associated breast cancers is more favorable than that without HRT. This may be due to their greater hormone dependency, earlier diagnosis, lower tumor grades, better cooperation and surveillance of the patients or other yet unidentified factors. Although the studies showed an increased risk of breast cancer among women taking HRT, the same patients survived longer than women with breast cancer who did not take HRT (13).

The risk of breast cancer depends on duration of hormonal therapy (HT) use, and is reduced after cessation of use, leveling off after 5 years since quitting HT (14). The most presenting complaint was painless breast lump which represented 28 cases (70%) as breast mass was the most commonly reported first symptom. Furthermore, the development or increase in breast mass size was the main cause for seeking medical care in three-quarters of the patients (15).

Introduction of BI-RADS has provided a standardized ultrasound categorization system for lesion morphology. It has been successfully established in the interpretation of ultrasonography. Because the sonographic features of benign and malignant lesions have been shown to over-ride largely with each other, there are many false-negative and false-positive findings. These limitations of BI-RADS, and great desire not to miss a malignant lesion in the early stage of disease lead to an aggressive biopsy. The biopsy rate for cancer is only 10–30%. This means that 70–90% of breast biopsies are performed with benign diseases, which induce unnecessary patient discomfort and anxiety besides increasing financial cost of the patient. Clearly, there is a great need for the development of additional reliable methods to complement the existing diagnostic procedures to avoid unnecessary biopsy. Elastography is a new modality in addition to US to detect and identify the breast lesions. It can show another characteristic stiffness of the lesion to the investigator and give some help in diagnosis of breast lesions by US (16).

On the basis of sonographic BI-RADS categorization, our cases were classified as follows: (20 cases) class 3, (5 cases) class 4 and (15 cases) class 5. The conventional ultrasound sensitivity in diagnosis of solid breast lesions was 85% and it was lower than results of the literature by Leong et al. (17) in which the sensitivity was 88.5%, while the specificity and accuracy were 80% and 82.5% respectively and they were higher than the results of the literature by Leong et al. (17) in which specificity and accuracy were 42.5% and 53.6% respectively. The histopathological results revealed 19 benign lesions and 21 malignant lesions.

On the basis of elastography score categorization, our cases were classified as follows: (5 cases) score 2, (15 cases) score 3, (4 cases) score 4 and (15 cases) score 5. In this study, the ultrasound elastography sensitivity, specificity, PPV, NPV and accuracy were 90%, 85%, 85.7%, 89.4% and 87.5% respectively. Sonoelastography was useful for differentiating between benign and malignant lesions by evaluation of tissue elasticity and hardness.

Generally, the elasticity of pathological tissue changes and most of malignant tumors are constituted with hard lesion,
adhered to adjacent structure, which decreases activity and elasticity and therefore increases hardness (18). Based on the results of this study, we can estimate the diagnostic value of elastography because a good correlation was found between the elastography scores and the histology results. In our study, the PPV of elastography was 85.7%, lower than results from the literature by Houelleu et al. (19) who showed PPV 91.9%, and higher than results from the literature by Sahar and Omar (20) who showed PPV 70.6%. The NPV of elastography was 89.4%, higher than results found in a study by Houelleu et al. (19) in which the NPV was 61.3%.

The sensitivity of elastography in diagnosis of solid breast lesions was 90%, lower than results from the literature by Leong et al. (17) in which sensitivity was 100%, and slightly lower than results from the literature by Sahar and Omar (20) in which the sensitivity was 92.3%. The sensitivity of

![Images of various imaging techniques](A) Conventional ultrasound (B) Ultrasound elastography (C) T1 WI without contrast (D) T2 WI (E) T2 SPAIR (F) Dynamic THRIVE (contrast) (G) Dynamic THRIVE (Subtraction) (H) Time Intensity Curve (I) MRI spectroscopy

**Fig. 5** 62 years-old female with right breast lumps. US showed multiple speculated lesions with heterogeneous hypoechoogenicity (A). Elastography showed the lesions and the surrounding area blue with elastography score 5 (B). MRI showed multicentric ill-defined speculated lesions, low signal in T1 and T2 WIs (C), (D) and (E). Asymmetrical enlargement of right pectoralis muscle with abnormal intrasubstance signal (C) and (D). Dynamic study showed heterogenous enhancement of all lesions with type III intensity curve pattern (rapid washout) (F), (G) and (H). Single voxel MRS revealed positive choline peak (I). MRI diagnosis: multicentric malignant lesions (BI-RADS V). Histopathological result: Multicentric Intraductal Carcinoma (IDC).
elastography was also higher than results from the literature by Houelleu et al. (19), Yerli et al. (21) and Qiao et al. (18) in which specificity were 73.9%, 80% and 84.2% respectively. The specificity of elastography was 85% and looks lower than results from the literature by Yerli et al. (21) in which specificity was 95%, and slightly lower than results from the literature by Houelleu et al. (19) in which the specificity was 86.4%. The specificity of elastography was also higher than results from the literature by Sahar and Omar (20), Leong et al. (17) and Qiao et al. (18) in which specificity was 74.1%, 73.8% and 84.6% respectively. The accuracy of elastography was 87.5%, higher than results from the literature by Leong et al. (17) in which accuracy was 80%.

Dynamic contrast enhanced (DCE) magnetic resonance imaging (MRI) is an established technique for detection, diagnosis and staging of breast cancer. However, it has an

Fig. 6 38 years-old female with right breast well defined oval shaped lesion. US showed homogeneous hypoechoic echo pattern with no calcification or cystic degeneration (A). Elastography showed the lesion has mosaic pattern of green, blue and red, giving an elastography score 2 (B). MRI showed low signals in T1 and intermediate signals in T2 WIs (C) and (D). Dynamic study showed homogeneous enhancement of the lesion with type I intensity curve pattern (persistent curve) (F), (G) and (H). Single voxel MRS showed no evidence of choline peak detected at the spectrum (I). MRI diagnosis: benign lesion (BI-RADS III). Histopathological result: Myxoid Fibroadenoma.
inherently high sensitivity but only moderate specificity for characterization of breast lesions. The standard breast imaging protocol enables the analysis of the morphological and kinetic patterns of benign and malignant breast lesions detected at MRI (Tan et al. (22)).

On the basis of MRI BI-RADS categorization, our cases were classified as follows: (3 cases) class 2, (15 cases) class 3, (5 cases) class 4 and (17 cases) class 5, and showed DCE-MRI sensitivity, accuracy, PPV and NPV of 85.7%, 85%, 85.7% and 84.2% respectively, which is lower than results of

Fig. 7  32 years-old female with right breast lesion. US showed heterogeneous hypoechoic pattern (A). Elastography showed the lesion in blue with score 4 (B). MRI showed ill-defined speculated lesion, low signals in T1 and intermediate signals in T2 WIs (C), (D) and (E). The lesion showed invasion of suspensory ligament with subsequent nipple retraction and subjacent focal skin thickening. Focal bulge in the pectoralis major muscle suspected infiltration. Dynamic study showed heterogeneous enhancement of the lesion with type III intensity curve pattern (F), (G) and (H). Single voxel MRS revealed positive choline peak (I). MRI diagnosis: malignant lesion with pectoralis muscle infiltration (BI-RADS V). Histopathological result: intraductal carcinoma (IDC) with muscle invasion.
the literature by Pinker et al. (23) in which the sensitivity, accuracy, PPV and NPV were 97.6%, 89.8%, 89.1% and 92.3% respectively. The specificity was 84.2% and it was higher than results of the literature by Pinker et al. (23) in which specificity was 70.6%. Regarding MRI spectroscopy, there were 19 malignant lesions with positive choline peak in contrast with 17 benign lesions with negative choline peak.

Suppiah et al. (24) stated that, in a study conducted using 1.5 T MR systems reported the presence of the resonance of total choline (tCho) containing compounds at 3.2 parts per million (ppm), which includes contributions from choline, phosphocholine, glycerophosphocholine and taurine as reliable biomarkers of breast cancer. This is because choline-containing metabolites detected in breast lesions are an indicator of the increased cellular metabolism noted in malignant breast tumors. In our study the sensitivity of MRI spectroscopy was 90.4%, which is lower than results from the literature by Suppiah et al. (24) and Naglaa et al. (25) in which sensitivity was 95.2% and 96.7% respectively. The sensitivity of MRI spectroscopy was also higher than results from the literature by Katerina et al. (26) and Pascal et al. (27) in which sensitivity was 80% and 62% respectively.

In this study the specificity of MRI spectroscopy was 89.4%, which is lower than results from the literature by Suppiah et al. (24) and Naglaa et al. (25) in which specificity was 93.3% and 95.5% respectively. The specificity of MRI spectroscopy was also higher than results from the literature by Katerina et al. (26) and Pascal et al. (27) in which specificity was 81.8% and 86% respectively. The PPV of MRI spectroscopy was 90.4%, so it is lower than results from the literature by Suppiah et al. (24) in which PPV was 97.6%, and slightly higher than results from the literature by Pascal et al. (27) in which the PPV was 90%. The NPV of MRI spectroscopy was 89.5.4% and looks slightly higher than results from the literature by Suppiah et al. (24) in which NPV was 87.2%. The accuracy of MRI spectroscopy was 80.8% and looks slightly higher than results from the literature by Katerina et al. (26) in which accuracy was 80.7%.

Regarding our study, there were a few limitations of elastography as follows:

First, this was a relatively small study where the number of malignant cases was small. A larger pool of malignancies is required to assess “soft” tumours, such as mucinous carcinomas, cancers that do not incite significant desmoplastic reaction (e.g. invasive lobular carcinoma), and tumors with central necrosis or solid-cystic complex appearance, all of which can elicit a benign appearance on elastographic scoring system because of their soft interiors.

Second, ultrasound elastography, as with most ultrasound applications, is user-dependent. The amount of pressure to be applied on the breast when performing elastography, the recognition of the various elastographic patterns and the measurement techniques were some of the areas that were subjective and these limitations were also mentioned by Leong et al. (17).

As regards MRS limitations, some lesions that had erratic spectra due to technical problems (i.e. patient breathing/movement artefacts, susceptibility artefacts due to field inhomogeneity, and inability to perform proper high-order shimming for certain lesions) were also excluded. It would have also been better to perform MRS for normal tissue on the non-lesion containing breast, as the peritumoral environment could influence the tCho measurements and this was in accordance with Suppiah et al. (24).

Conflict of interest

No conflict of interest.

References


