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Value of MRI in Differentiation between Benign and Malignant Breast Mass

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Abstract
Objectives: This study aimed to evaluate the role of MRI in differentiation between benign and malignant well-circumscribed breast masses.
Methods: A prospective cross-sectional study conducted on selected female patients with Breast mass who their age older than 35 years. All patients underwent examination using 1.5 Tesla magnetic resonance unit (MAGNETOM AERA, SIMENS).
Results: 30 female patients were selected (mean age of 44.2 ± 9.2 years, range between 35–69). Final findings of MRI revealed that 6 (20%) women had malignant breast mass while 24 (80%) women had benign breast mass. The histopathology revealed that 4 (13.3%) women were having malignancy while 26 (86.6%) were having benign breast tumor. There was a highly significant association between malignancy and hyperdense mammography findings of women ($P < 0.001$), multiple lymph nodes for women ($P < 0.001$), increased size of mass by MRI ($P < 0.001$), circumscribed macrolabular lesion on MRI, rapid early kinetic phase of enhanced MRI ($P < 0.001$), washout late kinetic phase enhanced MRI ($P < 0.001$), and MRI kinetic curve type 3 ($P < 0.001$). There was a highly significant association between homogenous enhanced MRI findings of women and benign lesions ($P < 0.001$).
Conclusion: The validity results of MRI in differentiation between benign and malignant circumscribed breast masses are high, except for positive predictive value, and application of kinetic curve dynamic contrast enhancement increases magnetic resonance in differentiation between benign and malignant circumscribed breast masses.
Keywords: Magnetic resonance imaging, circumscribed breast mass, Iraq

Introduction

Although a vast majority of all well-circumscribed breast masses are benign lesions, 10–20% of breast malignancies are also well-circumscribed masses, and these malignant masses include papillary, mucinous, medullary, and metaplastic carcinomas, as well as malignant phyllodes tumors.[1] Generally, such lesions may be difficult to recognize as malignant if they possess a benign appearance such as a well-circumscribed margin or oval shape. There are limitations in differentiating benign-looking malignant breast lesions from truly benign breast lesions, especially when using conventional imaging modalities such as mammography and ultrasound (US).[2] Recently, Magnetic Resonance imaging (MRI) has been widely used for detecting and assessing breast lesions. MR imaging is sensitive in detecting breast cancers, with a sensitivity as high as 100% for invasive breast cancers,[3] and therefore has emerged as an adjunctive breast imaging modality to mammography and US. However, in a previous report, investigators had suggested that MR imaging allows detection of breast lesions but has limitations in lesion characterization.[1] Nevertheless, it is still anticipated that MR imaging may have potential advantages in differentiating between benign breast lesions and benign-looking breast cancers.[4] Breast MRI is a second-line technique performed in combination with mammography and breast ultrasonography. The indications for breast MRI are multiple and include screening of women with a high risk of breast and ovarian cancer and the locoregional extension profile of breast cancer in certain specific situations (under 40 years old, neo-adjuvant chemotherapy, radio-clinical discordance, oncoplastic decision-making, and invasive lobular cancer). The breast MRI report should include the clinical context, technique, and results.[5,6] The aim of study is to evaluate the role of MRI in differentiation between benign and malignant well-circumscribed breast masses.

Methods

This study is a prospective follow up study carried out in MRI unit of Radiology Department in Al-Imamein Al-Kadhimein Medical city in Baghdad during the period from 1st of October, 2017 to 30th of July, 2018. All women with selected criteria of breast mass referred to Radiology Department of Al-Imamein Al-Kadhimein Medical city were the study population. **Inclusion criteria:** Adults (age >35 years), breast circumscribed mass findings detected by ultrasonography and/or mammography. **Exclusion criteria:** Speculated and irregular masses, Contraindication for MRI, Contraindication to contrast media, Pregnancy, Patient could not lie prone position. The data was collected by researcher from the patients directly and filled in a prepared questionnaire. The questionnaire was designed by the researcher and supervisor. After taking history and information from selected women with breast mass, the researcher examined carefully the patients. First, some patients were examined with mammography and all patients were examined with ultrasonography. Patients with US-BIRADS 2, 3, and 4 were referred to MRI for evaluation. All patients underwent MRI examination using 1.5 Tesla MR unit (MAGNETUM AERA, SIMENS). Coro-T1 weighted spin echo sequence was carried out for localization purpose, Axial T1 weighted fast spin echo sequence CTR = 307 ms, TR = 307 ms, TE 4.60 ms, slice thickness 3 mm, FoV read = 350 mm, FoV phase 100.0%. Fov T1 with dynamic contrast TR 5.08 ms, TE 2.39 ms, slice thickness T 1-5 mm, Fov 360 mm, in addition to T2 weighted first spin echo sequence (TR = 3750.0 ms, TE 75.0, slice, thickness 4.0 mm,

Fov 340.0 mm. For dynamic MR study, Gd-DTPA was injected intravenously in dose of (0.1 mmol/Kg) using automatic power injector with low saline infusion. The patient lied prone with breast positioned onto the breast coil and checked to be as center and deep in coil and nipples faced straight down with no movement of patients, the examination take about 45 minute. The MRI study recorded according to lexicon BI-RADS-MRI. Because of each lexicon in this study was detected as mass, interpretation of breast MR imaging finding based on 5 points; shape of mass (oval, rounded, irregular or lobular), margin of mass (smooth, irregular or speculated), internal mass enhancement (homogenous, heterogenous, rim enhancement, internal septation, central enhancement or no enhancement), early phase of time signal intensity curve (TIC) on dynamic study (slow, medium rapid), delay phase of TIC (persistent, platue, washout). MRI-BIRADS classification was applied for each lesion combination of morphology and kinetic criteria, there were any patient with category I. The histopathology was conducted in the laboratory of Al-Imamein Al-Kadhimein Medical city and some of them were done in private laboratory. The samples were collected by excisional biopsy (4 patients) or core biopsy (2 patients) or fine needle aspiration (24 patients). All breast mass patients' data entered using computerized statistical software; Statistical Package for Social Sciences (SPSS) version 20 was used. Descriptive statistics presented as (mean ± standard deviation) and frequencies as percentages. Multiple contingency tables conducted and appropriate statistical tests performed, Chi-square used for categorical variables (Fishers exact test was used when total of expected variables was less than 20% of total). In all statistical analysis, level of significance (*P* value) set at ≤0.05.

Results

The mammography was carried out for 10 women and showed hyperdensity (13.3%), isodense (10%), hypodensity (6.7%) and isodense lesion contain calcification (3.3%). The ultrasonography of women with breast mass revealed commonly oval isoechoic lesion (36.7%), oval hypoechoic lesion (30%) rounded isoechoic lesion (13.4%), rounded hypoechoic (10%), etc. The associated radiological findings were absent in 90% of women with breast mass, multiple lymph nodes involvement in 6.7% and increase skin thickness in 3.3%. All these findings were shown in Table 1.

The MRI revealed the followings; shape round (66.7%) and oval (33.3%). Mean size was 10.9 ± 4 mm; 46.7% of women had size of more than 10 mm. Smooth margins were predominates (93.3%), while circumscribed macrolabular in 6.7%. Findings of MRI-TI were 40% hypo, 46.7% iso, 10% hyper and 3.3% hypo with central hyper. Findings of MRI-T2 were 30% hypo, 63.3% hyper and 3.3% iso & hyper with fat sat. All these findings were shown in Table 2.

MRI enhancement showed commonly homogenous 70.0%, heterogenous (16.6%), homogenous with non-septal enhancement (6.7%) and rim enhancement (6.7%). Early phase of kinetic was slow (66.7%), Medium (20%), and rapid (13.3%). Late phase of kinetic was persistent (70.0%), Plateau (20%) and washout (10%). Types of curve were type 1 (70.0%), type 2 (20%) and type 3 (10%). All these findings were shown in Table 3.

Table 1. **Mammography and ultrasonography findings of women with breast mass**

Variables	No.	%
Mammography		
None	20	66.7
Hyperdensity	4	13.3
Isodense	3	10
Hypodensity	2	6.7
Isodense lesion contain calcification	1	3.3
Total	30	100.0
Ultrasonography		
Rounded hypoechoic	3	10.0
Complex cystic & solid thick wall	1	3.3
Rounded isoechoic	4	13.4
Oval echogenic with dilated duct	1	3.3
Rounded echogenic	1	3.3
Oval isoechoic	11	36.7
Oval hypoechoic	9	30.0
Total	30	100.0
Associated radiological findings		
Negative	27	90.0
Multiple lymph nodes	2	6.7
Increase skin thickness	1	3.3
Total	30	100.0

Table 2. **MRI findings of women with breast mass**

Variables	No.	%
Shape		
Round	20	66.7
Oval	10	33.3
Total	30	100.0
Size Mean ± SD (10.9 ± 4 mm)		
≤10 mm	16	53.3
>10 mm	14	46.7
Total	30	100.0
Margins		
Circumscribed macrolabular	2	6.7
Smooth	28	93.3
Total	30	100.0
MRI-T1		
Hypo	12	40.0
Iso	14	46.7
Hyper	3	10.0
Hypo with central hyper	1	3.3
Total	30	100.0
MRI-T2		
Hypo	9	30.0
Hyper	19	63.3
Iso & hyper with fat sat	2	6.7
Total	30	100.0

The MRI showed that BIRADS of breast mass were distributed as followings; BIRADS II (66.7%), BIRADS III (13.3%), BIRADS IV (13.3%) and BIRADS V (6.7%). Final findings of MRI revealed that 6 (20%) women had malignant breast mass while 24 (80%) women had benign breast mass. All these findings were shown in Table 4.

The histopathology examination showed mainly fibroadenoma (66.7%), intraductal papilloma (10%), fat necrosis (6.7%), invasive ductal carcinoma (6.7%), phyloid carcinoma (3.3%), mucinous carcinoma (3.3%) and lipoma (3.3%). Finally, the histopathology revealed that 4 (13.3%) women were having malignancy while 26 (86.7%) were having benign breast tumor. All these findings were shown in Table 5.

Table 3. **MRI findings of women with breast mass**

Variables	No.	%
Enhancement		
Heterogenous	5	16.6
Homogenous with non-septal	2	6.7
Rim enhancement	2	6.7
Homogenous	21	70.0
Total	30	100.0
Early phase kinetic		
Rapid	4	13.3
Medium	6	20
Slow	20	66.7
Total	30	100.0
Late phase kinetic		
Washout	3	10
Plateau	6	20
Persistent	21	70.0
Total	30	100.0
Type of curve		
Type 1	21	70.0
Type 2	6	20
Type 3	3	10
Total	30	100.0

Table 4. **MRI findings of women with breast mass**

Variables	No.	%
MRI-BIRADS		
II	20	66.7
III	4	13.3
IV	4	13.3
V	2	6.7
Total	30	100.0
Final MRI findings		
Malignant	6	20.0
Benign	24	80.0
Total	30	100.0

There was a highly significant association between hyperdense mammography findings of women and malignancy ($P < 0.001$). Women with rounded hypoechoic lesion on ultrasonography findings were significantly associated with malignancy while women with oval isoechoic lesion on lesion ultrasonography findings were associated with benign lesions ($P < 0.001$). There was a highly significant association between associated findings of multiple lymph nodes for women and malignancy ($P < 0.001$). All these findings were shown in Table 6.

Table 5. **Histopathology findings of women with breast mass**

Variables	No.	%
Histopathology		
Invasive ductal carcinoma	2	6.7
Phyloid carcinoma	1	3.3
Mucinous carcinoma	1	3.3
Fat necrosis	2	6.7
Lipoma	1	3.3
Intraductal papilloma	3	10.0
Fibroadenoma	20	66.7
Total	30	100.0
Final histopathology		
Malignant	4	13.3
Benign	26	86.7
Total	30	100.0

Table 6. **Distribution of women's mammography and ultrasonography findings according to histopathology**

Variables	Malignant		Benign		*P*
	No.	%	No.	%	
Mammography					
None	0	–	20	76.9	
Hyperdensity	4	100.0	0	0	
Isodense	0	–	3	11.5	**0.001***S
Hypodensity	0	–	2	7.7	
Isodense lesion contain calcification	0	–	1	3.9	
Ultrasonography findings					
Rounded hypoechoic	3	75.0	0	–	
Complex cystic & solid thick wall	1	25.0	0	–	
Rounded isoechoic	0	–	4	15.4	
Oval echogenic with dilated duct	0	–	1	3.8	**<0.001***S
Rounded echogenic	0	–	1	3.8	
Oval isoechoic	0	–	11	42.3	
Oval hypoechoic	0	–	9	34.6	
Associated radiological findings					
Negative	1	25.0	26	100.0	**<0.001***S
Multiple lymph nodes	2	50.0	0	–	
Skin thickness	1	25.0	0	–	

*Fishers exact test. S, Significant.

There was a highly significant association between homogenous enhanced MRI findings of women and benign lesions ($P < 0.001$). A highly significant association was observed between rapid early kinetic phase of enhanced MRI and malignancy ($P < 0.001$). Women with washout late kinetic phase enhanced MRI findings were significantly associated with malignancy ($P < 0.001$). There was a highly significant association between MRI kinetic curve type 3 for women and malignancy ($P < 0.001$). All these findings were shown in Table 7.

There was a highly significant association between increased MRI- BIRADS (BIRADS IV & V) of women and malignant breast lesions ($P < 0.001$) as shown in Table 9C. The histopathology revealed that 4 (13.3%) women were having malignancy while 26 (86.6%) were having benign breast tumor as shown in Table 8.

Table 7. **Distribution of women's MRI findings according to histopathology**

Variables	Malignant		Benign		*P*
	No.	%	No.	%	
Enhancement					
Heterogenous	2	50.0	3	11.5	
Homogenous with non-septal enhancement	2	50.0	0	–	<0.001*S
Rim enhancement	0	–	2	7.6	
Homogenous	0	–	21	80.9	
Early phase kinetic					
Rapid	3	75.0	1	3.7	<0.001*S
Medium	1	25.0	5	19.3	
Slow	0	–	20	76.0	
Late phase kinetic					
Washout	3	75.0	0	–	<0.001*S
Plateau	1	25.0	5	19.3	
Persistent	0	–	21	80.7	
Type of curve					
Type 1	0	–	21	80.7	<0.001*S
Type 2	1	25.0	5	19.3	
Type 3	3	75.0	0	–	

*Fishers exact test. S, Significant.

Table 8. **Distribution of women's MRI findings according to BIRADS**

Variables	Malignant		Benign		*P*
	No.	%	No.	%	
MRI-BIRADS					
II	0	–	20	83.3	
III	0	–	4	16.7	
IV	4	66.7	0	–	**<0.001***S
V	2	33.3	0	–	
Total	6	100%	24	100%	

*Fishers exact test. S, Significant.

The validity results of MRI regarding malignant breast mass were sensitivity (100%), specificity (92.3%), PPV (66.6%), negative predictive value (NPV) (100%) and accuracy (86.7%). All these findings were shown in Table 9.

Discussion

In present study, hyperdensity of mammography was associated significantly with malignancy detected by histopathology ($P = 0.001$). This is similar to reports of Giess et al.[7] study in USA which stated that density of mammographic picture is helpful in interpreting mammography when compared with surrounding tissues. Additionally, the present study showed that rounded hypoechoic lesion by ultrasonography was associated significantly with malignancy detected by histopathology ($P < 0.001$). This finding is consistent with results of Kim et al.[8] study in South Korea. Multiple lymph nodes involvement with breast mass in this study was associated significantly with malignancy ($P < 0.001$). Pinherio et al.[9] found that lymph nodes involvement in women with breast mass is predictive for malignancy and poor prognosis. Our study showed a significant association between benign breast mass and each of MRI findings of small size, smooth margins, homogenous enhancement, slow early kinetic phase, persistent late phase and type 1 enhancement curve. These findings agree with Cheng et al.[10] study in China and Agrawal et al.[11] study in USA. A highly significant association was observed between rapid early kinetic phase, washout late kinetic phase of enhanced MRI and malignancy. This is similar to results of Leong et al.[12] study in USA. These findings of MRI in general revealed that 66.7% of beast masses were BIRADS II, 13.3% BIRADS III, 13.3% BIRADS IV and 6.7% BIRADS V. Women with breast mass of MRI-BIRADS IV and V were significantly associated with malignancy ($P < 0.001$). Fujiwara et al.[13] study in Japan reported that women with MRI-BIRADS 4 are definitely malignant and the problem is in MRI-BIRADS 3 that could be solved with use of MRI-ADC value. In our study, 4 women with BIRADS III were diagnosed by histopathology as benign, while 2 women with classified by MRI as BIRADS IV were diagnosed as benign by histopathology. Many versions and updated technologies of MRI were provided to acquire more accurate imaging and precise BIRADS classification

Table 9. **Validity test results of MRI findings in comparison to histopathology regarding breast mass**

Validity test			Histopathology		
			Malignant	Benign	Total
			No. (%)	No. (%)	No. (%)
MRI	**Malignant**	**No.**	4 (66.6)	2 (33.3)	6 (100.0)
	Benign	**No.**	0 (–)	24 (100.0)	24 (100.0)
	Total	**No.**	4 (13.3)	26 (86.7)	30 (100.0)
Sensitivity			100%		
Specificity			92.3%		
PPV			66.6%		
NPV			100%		
Accuracy			86.7%		

like multiparametric fluorodeoxyglucose positron emission tomography magnetic resonance imaging.[14] Final MRI diagnosis clarified that 20% of breast masses were malignant and 80% were benign. A highly significant association was observed between malignant breast mass detected by MRI and malignancy detected by histopathology ($P < 0.001$). These findings are consistent with results of An et al.[15] study in South Korea and Min et al.[16] study in China which documented higher accuracy of MRI in detection of breast mass malignancy. Our study findings regarding role of MRI in differentiation between benign and malignant breast mass is similar to results of Yamaguchi et al.[17] study in Japan which stated that in addition to role of MRI as a significant diagnostic tool in early detection and characterizing of breast mass, it has a great advantage in aiding the management of breast masses by MRI findings and MRI indication findings. Current study revealed validity results of MRI in differentiation between malignant and benign breast mass as sensitivity (100%), specificity (84.6%), positive predictive value (50%), negative predictive value (100%) and accuracy (86.7%). Current Iraqi study conducted by Al-Maammory et al.[18] found that validity findings of MRI in differentiation between benign and malignant breast masses in comparison to histopathology using kinetic curve of dynamic contrast enhancement were sensitivity (90.3%), specificity (88.8%) and accuracy (96.5%), while when using MRI-BIRADS were sensitivity (93.3%), specificity (55.5%) and accuracy (85%). Teama et al.[19] study in Egypt found that dynamic contrast enhancement MRI has a higher sensitivity and specificity results than conventional MRI in diagnosis of malignant breast mass. High false positive rate detected in present study is similar to results of Mahoney et al.[20] study in USA which reported that MRI diagnostic imaging of breast masses is highly accompanied by low positive predictive value that is related to high sensitivity of MRI and relatively low specificity.

Conclusion

The validity results of MRI in differentiation between benign and malignant circumscribed breast masses are high, except for positive predictive value, and application of kinetic curve dynamic contrast enhancement increases magnetic resonance in differentiation between benign and malignant circumscribed breast masses.

Conflicts of Interest

None.

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