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Original Article

Comparison of diagnostic values of two magnetic resonance imaging (MRI) protocols for diagnosis of breast lesions

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Abstract: Background: Magnetic resonance imaging (MRI) has a pivotal role in diagnosing breast lesions. Here we aimed to compare the diagnostic values of Abbreviated and Full Breast MRI for breast lesions. Methods: This is a cross-sectional study performed in 2017-2021 on 80 women with breast lesions. Using the available MRI analysis software, the necessary sequences for the Abbreviated MRI were extracted from standard breast MRI protocol. First, a Full Breast MRI was examined by a radiologist giving Breast imaging-reporting and data system (BI-RADS). Then, from this Full Breast MRI, the necessary sequences for Abbreviated Breast MRI were prepared. The second expert radiologist read them in this field and BIRADS was reported. The data relating to each patient were recorded in the patient-specific profile and then the pathology results were followed for each patient. Results: Modified breast MRI had 84% sensitivity and 58.18% specificity, while full Breast MRI had 100% sensitivity and 38.18% specificity. Comparing the results of pathology (benign or malignant) for breast tumors and BIRADS reported by modified breast MRI indicated that these results were similar in 53 cases (66.3%) and different in 27 patients (33.8%). On the other hand, similar assessments for Full Breast MRI and pathology reports showed that the results were the same in 46 patients (57.5%) and different in 34 patients (42.5%). Conclusion: Abbreviated breast MRI has lower sensitivity and higher specificity than full breast MRI.

Keywords: Breast MRI, lesion, malignancy, diagnosis

Introduction

Breast cancer is the most common leading cause of death due to cancers in women with a higher prevalence in 20-59 years of age [1]. Epidemiologic studies have reported that breast cancer is the second cause of death in the United States [2]. Although the prevalence of breast cancer is lower in Asian countries than in Western populations, the prevalence is increasing [3]. Recent studies in Iran have reported that the prevalence of this cancer among Iranian women has reached 22% and unfortunately, the age of onset of this disease in Iranian women is 10 to 15 years less than the age of onset in Western countries [4].

Thus, given the high prevalence of breast cancer and its incidence and mortality worldwide, preventive strategies are the most critical controlling methods [5]. As a result, screening methods are conducted worldwide [6, 7]. These methods include self-examinations, physical examinations, mammography, breast ultrasound, and magnetic resonance imaging (MRI) [8].

MRI is more suitable for diagnosing cancers that are not visible on mammography. Full Breast MRI is more sensitive than mammography and can provide additional information than other methods, especially mammography [9]. Perspective studies suggest that this option should be used as a screening tool in high-risk women, i.e., patients with dense breast tissue, family history of breast cancer, BRCA1 and BRCA2 mutations, or specific genetic syndrome [10-12]. Full Breast MRI can diagnose malignant lesions [13, 14]. Negative magnetic resonance imaging can reliably rule out cancer. It is an excellent screening tool for patients at high risk for genetically engineered breast cancer or those with dense breasts. Full Breast MRI can detect benign epithelial lesions (proliferative or non-proliferative) and other benign findings at a glance, thus eliminating the need for costly and unnecessary biopsies [15]. Despite the great help of Full Breast MRI imaging, this method also has some negative points.

These disadvantages include unwanted financial burden to the patient, long imaging time, fear of the MRI environment in patients, and, more importantly, the large number of images produced for each person, which require a longer time for assessments [16]. Therefore, physicians and researchers have always considered the use of alternative methods in this field.

One of these new methods is using the Abbreviated Breast MRI protocol compared to Full Breast MRI. Abbreviated Breast MRI is a shortened version of breast MRI designed to screen for additional breast cancers not seen on mammography. This method reduces the time for performing the imaging and the number of images [17, 18]. Due to the reduction in the number of images obtained in Abbreviated Breast MRI compared to the Full Breast MRI method, the sensitivity and accuracy of this method in diagnosing breast lesions have always been discussed by researchers [19, 20]. The results of previous studies in this field have been different. Researchers have explained that Abbreviated Breast MRI could have similar specificity to Full Breast MRI. Therefore, it is a better screening and diagnostic tool due to the reduced requirement of time and resources. Some researchers believe that this method could miss the diagnosis of some lesions and has a lower diagnostic value [21, 22].

Due to the differences in the method and results of studies on Abbreviated Breast MRI and the lack of a similar survey in the Iranian population, and the increasing prevalence of breast cancer in the country, this study aims to compare the diagnostic values of Full Breast MRI and Abbreviated Breast MRI in patients with suspected breast lesions.

Methods and material

Study design

This is a cross-sectional study performed in 2017-2021 in all MRI imaging centers affiliated to Isfahan University of Medical Sciences. The current study was conducted on patients with breast lesions. The study protocol was approved by the Research Committee of Isfahan University of Medical Sciences and the Ethics committee has confirmed it (Ethics code: IR. MUI.MED.REC.1399.855).

Inclusion and exclusion criteria

The inclusion criteria were women aged 20 to 70 years, suspicious of breast lesions based on clinical examinations, candidates of MRI due to breast lesions, and signing the written informed consent to participate in this study. The exclusion criteria were inaccessibility to the patient documents, patient's will to exit the study, inappropriate quality of images, previously diagnosed breast cancer or lesions, consumption of medications containing estrogen or progesterone and lack of patient's consent.

Study population

In the present study, we evaluated data of 80 eligible patients who met the mentioned criteria. All of the study patients were women. The mean age of patients was 41.33±9.37 years (ranging from 32 to 51 years) and the mean size of the tumors was 19.08±8.74 mm. Based on primary data analysis, fibroadenoma was the most common detected mass (32.8%), followed by invasive ductal carcinoma (28.1%). These data are shown in **Table 1**.

Data collection

Patients were recruited based on the mentioned criteria. The demographic data of patients, including age, were collected. Then, the necessary sequences for the Abbreviated MRI were extracted from standard breast MRI protocol. First, a Full Breast MRI was examined by a radiologist giving Breast imaging-reporting and data system (BI-RADS) scores. Then, from this Full Breast MRI, the necessary sequences for Abbreviated Breast MRI were prepared. The second expert radiologist read them in this field, and BIRADS was reported.

Full breast MRI

Full Breast MRI was performed as follows: The patient was in the prone position, with the breast hanging into a dedicated breast coil and imaging was conducted using a Philips-Ingenia 1/5T MRI machine. Imaging of patients was

Table 1. Tumor characteristics based on imaging and pathology findings

		Number	%
Pathology type	Fat necrosis	1	1.6%
	Invasive ductal	18	28.1%
	Fibroadenoma	21	32.8%
	Cyst	6	9.4%
	FCC	7	10.9%
	Lobular carcinoma	1	1.6%
	Atypical hyperplasia	3	4.7%
	Adenosis	2	3.1%
	Epithelial hyperplasia	3	4.7%
	High grade DCIS	1	1.6%
	Fibrosis	1	1.6%
Pathology	Benign	21	26.3%
	Malignant	59	73.8%
Enhancement	Minimal	39	48.8%
	Mild	19	23.8%
	Moderate	9	11.3%
	Marked	9	11.3%
	Severe	4	5.0%
Dynamic MRI	No mass	12	15.0%
	Mass	66	82.5%
	Distorti	2	2.5%
ADC	Negative	47	64.4%
	Positive	26	35.6%
DWIBS	Negative	16	21.9%
	Positive	57	78.1%

performed in T2-weighted imaging (T2WI), STIR and Dynamic T1-weighted post-contrast sequences.

For dynamic T1 weighted contrast-enhanced sequences, first Pre contrast images and then 90 seconds after injection of contrast material imaging were done and in total, four post-contrast phases were prepared. There are three kinetic curves defined in the BI-RADS atlas. They are classified based on the degree of early enhancement and the delayed change in enhancement after the peak. First, we examined the initial upslope of the curve during the first two minutes. It is either slow, medium, or rapid. For the delayed phase, three patterns are observed: progressive or persistent, plateau and washout. The kinetic analysis can lead to three types of the curve: Type 1: a slow rise and continuous increase in signal intensity through time. Type 2: a slow or rapid initial rise followed by a plateau in the delayed phase. Type 3: shows a rapid rise, flowed by a drop off with time (washout). The chance of malignancy in the type 3 curve is up to 70%, in the type 1 curve is 6% and in the type 2 curve lies somewhere between the two mentioned curves. The dynamic contrast agent used in the imaging was Omniscan, with a maximum dose of 0.1 mmol/kg. The total time required for imaging in the Full Breast MRI Protocol was 40 minutes.

Abbreviated breast MRI

Sequences used for Abbreviated Breast MRI Protocol included STIR, pre-contrast T1 fat sat (e THRIVE), 90 seconds post-contrast T1 fat sat, subtraction and MIP images. The acquisition time will be about 10 minutes.

Finally, the two reports obtained from Full Breast MRI and Abbreviated Breast MRI were compared in terms of the following criteria: MRI lesions were examined for size, location, types of lesions for contrast enhancement, duration of MRI imaging in both methods, histopathological findings, presence of lymph node involvement, and lesions for BIRADS criteria.

Further assessments

In evaluating benign and malignant lesions and differentiation, first, the size of breasts, symmetry, fibroglandular tissue categories, and background parenchymal enhancement were examined.

Then a search was made for masses and non-mass like enhancements. In case of masses, shape, margin and internal enhancement characteristics were analyzed. Malignant lesions tend to have irregular shape, irregular spiculated border and rim or internal septal enhancement. On the other hand, round, oval or lobulated lesions with smooth margin and homogenous contrast enhancement are mostly considered benign and scored as BIRADS 2 or 3. In STIR sequence, high signal lesions were considered benign and low signal lesions were considered malignant. Non-mass enhancement (NME) were described based on distribution and internal enhancement pattern. Segmental, ductal or linear distribution with clumped or clustered ring enhancement have a high positive predictive value for malignancy.

Accompanying findings were considered, such as skin or nipple retraction, skin thickening

Table 2. Evaluation of different BIRADS based on Full Breast MRI (A) and Abbreviated Breast MRI (B)

		Count	%
BIRADS A	2	9	11.3%
	3	12	15.0%
	4	52	65.0%
	5	4	5.0%
	6	3	3.8%
BIRADS B	2	13	16.3%
	3	23	28.7%
	4	43	53.8%
	5	1	1.3%
	6	0	0%

that could be focal or diffuse, trabecular thickening, muscle invasion, architectural distortion and axillary adenopathy. The lesion was also identified as the inner or outer or upper or lower part of the breast and was central or retroareolar.

Finally, the data related to each patient were recorded in the patient-specific profile and then the pathology results were followed for each patient.

Data analysis

The obtained data were entered into the Statistical Package for Social Sciences (SPSS) version 24. Quantitative data were reported as mean ± standard deviation and qualitative data as frequency distribution (percentage). Receiver operating characteristic (ROC) curve and area under the curve (AUC) were used to analyze the data. *P*-value <0.05 was considered as the significance threshold.

Results

Primary data assessments

Evaluation of lesion characteristics indicated that 21 lesions (26.3%) were benign and 59 lesions (73.8%) were malignant. The most common pathology type was fibroadenoma (32.8%) followed by invasive ductal lesions (28.1%). Evaluation of imaging characteristics showed that 39 lesions (48.8%) had minimal enhancements and 19 lesions (23.8%) had mild enhancements and 4 cases (5%) had severe enhancements in background fibroglandular tissue. The apparent diffusion coefficient (ADC) was negative in 47 patients (64.4%) and positive in 26 patients (35.6%). Other data are also presented in **Table 1**.

The link between BIRADS and breast MRI

The frequencies of different BIRADS based on Full Breast MRI (A) and Abbreviated Breast MRI (B) were evaluated. Data evaluation of Full Breast MRI showed that the most common BIRADS was 4 (65%), followed by 3 (15%), while Abbreviated Breast MRI showed that 53.8% of cases had BIRADS 4 and 28.7% had BIRADS 3 (**Table 2**).

Sensitivity and specificity of MRIs

Based on the ROC curve, by comparing the results of modified breast MRI and the pathology results, modified breast MRI had 84% sensitivity, 58.18% specificity, 47.73% positive predictive value and 88.89% negative predictive value for detection of malignant or benign tumors. These data are shown in **Table 3**.

Similar assessments were conducted by ROC curve for Full Breast MRI. These data demonstrated that Full Breast MRI had 100% sensitivity, 38.18% specificity, 42.37% positive predictive value and 100% negative predictive value (**Table 4**).

Further findings

A comparison of the results of pathology (benign or malignant) for breast tumors and BIRADS reported by modified breast MRI indicated that these results were similar in 53 cases (66.3%) and different in 27 cases (33.8%). On the other hand, similar assessments for Full Breast MRI and pathology reports showed that the results were same in 46 patients (57.5%) and different in 34 patients (42.5%) (**Table 5**).

Among the 27 patients that had a discordant diagnosis based on modified breast MRI, 7 patients (25.9%) were diagnosed correctly by Full Breast MRI, and 20 patients (74.1%) were also diagnosed wrong by Full Breast MRI. We should note that from the 27 cases, fibroadenoma was the most common pathology 12 cases (44.4%) followed by fibrocystic change 5 cases (18.5%) and atypical ductal hyperplasia 2 cases (7.4%). These pathologies were scored by four based on BIRADS but had different pathology reports.

Table 3. Evaluation of different BIRADS by modified breast MRI

BIRADS	Sensitivity	Specificity	PPV	NPV	Accuracy	AUC
2.000	0.960	0.218	0.358	0.923	0.450	
3.000	0.840	0.582	0.477	0.889	0.663	0.725
4.000	0.040	1.000	1.000	0.696	0.700	
5.000	0.000	1.000		0.688	0.688	

PPV: positive predictive value, NPV: negative predictive value, AUC: area under curve.

Table 4. Evaluation of different BIRADS by Full Breast MRI

BIRADS	Sensitivity	Specificity	Cost	PPV	NPV	Accuracy	AUC
2.000	1.000	0.164	80	0.352	1.000	0.425	
3.000	1.000	0.382	80	0.424	1.000	0.575	0.777
4.000	0.280	1.000	80	1.000	0.753	0.775	
5.000	0.120	1.000	80	1.000	0.714	0.725	
6.000	0.000	1.000	80		0.688	0.688	

PPV: positive predictive value, NPV: negative predictive value, AUC: area under curve.

Table 5. Comparison of pathology reports based on modified breast MRI and Full Breast MRI

Type of MRI		Frequency	Percent
Modified breast MRI	Different pathology report	27	33.8
	Same pathology report	53	66.3
Full Breast MRI	Different pathology report	34	42.5
	Same pathology report	46	57.5

Discussion

In the current study, we compared the diagnostic values of modified breast MRI and full Breast MRI. Our data indicated that modified breast MRI had 84% sensitivity and 58.18% specificity, while full Breast MRI had 100% sensitivity and 38.18% specificity. By comparing the results of pathology (benign or malignant) for breast tumors and BIRADS reported by modified breast MRI indicated that these results were similar in 53 patients (66.3%) and different in 27 cases (33.8%). On the other hand, similar assessments for Full Breast MRI and pathology reports showed that the results were same in 46 patients (57.5%) and different in 34 patients (42.5%). These data indicate that both modified breast MRI and full Breast MRI are valuable in diagnosing the breast lesions.

Modified breast MRI requires less time and a reduced number of images. Therefore, this technique could decrease the financial burden and is easier to interpret. Our study showed that modified breast MRI had lower sensitivity but higher specificity for the diagnosis of benign or malignant breast lesions compared to full Breast MRI. In this regard, previous studies have evaluated these methods and reported different results. In 2018, a study was conducted by Kuhl that assessed the use of abbreviated breast MRI for screening women with dense breasts. Based on the findings of this study, abbreviated breast MRI could be a viable alternative for population-wide screening due to its high sensitivity and specificity in the diagnosis of breast lesions [23]. Another study was performed by Comstock and colleagues in 2020. In this study, data of 1444 cases were assessed and it was demonstrated that among women with dense breasts undergoing screening, abbreviated breast MRI was associated with significantly high rates of invasive cancer detection. The reported sensitivity rate was 95.7% and the specificity was 86.7% for abbreviated breast MRI [19]. These results were in line with the findings of our study.

Some other studies have reported different results compared to our data. In 2017, Machida and others assessed the feasibility and potential limitations of abbreviated breast MRI in 176 breasts. The results showed that the sensitivity of abbreviated breast MRI and full breast MRI were 87.1% for both techniques and the specificity was 91.7% and 90.3% respectively [24]. Another study by Harvey and colleagues in 2016 evaluated 568 cases that underwent both abbreviated and full breast MRI. Based on their findings, abbreviated MRI is as practical as full-protocol MRI for detecting cancers in the high-risk screening setting, with only 12 (2.1 %) cases recommended for additional MRI evaluation [25]. These differences could be justified by variations in the number and characteristics of the study populations.

Furthermore, in 2021, a systematic review and meta-analysis was performed by Geach and others. By assessing 2763 women and 3251 screening rounds, they showed that the sensitivity and specificity of abbreviated breast MRI compared to pathology results were 94.8% and 94.6%, respectively [26]. Our findings also showed that the abbreviated breast MRI had 84% sensitivity and 58.18% specificity. These data were somehow in line, but we reported significantly lower specificity rates. In the review article by Heacock and others in 2020, they reported that abbreviated breast MRI is a valuable method with acceptable sensitivity and specificity but further data might reveal various findings [27].

Our results cast doubt on the reported specificity of abbreviated breast MRI, and we believe more assessments on larger populations should be conducted. However, comparing our results to the previous reports, the sensitivity of abbreviated breast MRI was higher. This method had higher specificity than the full breast MRI in our study. Regarding our limited study population, these data seem acceptable. The main limitations of our study were restricted study population and performing this study in a single center. As a result, further multi-centric studies on larger populations could demonstrate different results.

Conclusion

Our data indicated that abbreviated breast MRI has lower sensitivity and higher specificity than full breast MRI. These results were somehow in line with previous studies, but some different results have been reported previously. It should be noted that the abbreviated breast MRI in our study had similar or higher sensitivity compared to previous studies and given attention to our restricted study population; these data highlight the importance of abbreviated breast MRI. It is suggested that further research on different populations should be conducted before updating recommendations.

Disclosure of conflict of interest

None.

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