Original Article

MRI Evaluation of Mass-Like and None-Mass-Like-Proven Breast Cancer from Moderate-to-High Background Enhancement

Maryam Farghadani, Parinaz Sanei

Department of Radiology, School of Medicine, Isfahan University of Medical Sciences, Isfahan, Iran

Abstract

Background: Breast cancer is considered one of the most prevalent cancers among females worldwide. The aim of this study was to assess the magnetic resonance imaging (MRI) patterns of female breast cancer, and also the prevalence of mass-like and nonmass-like lesions among these patients.

Materials and Methods: 32 patients with proven breast cancer (based on their pathologic findings and background parenchymal enhancement [BPE] of their magnetic resonance [MR] images) were included in this cross-sectional study which was performed from 2017 to 2019 in Isfahan, Iran, using a1.5 Tesla (Achieva Philips, Netherland) MRI scanner system. The MR sequences (noncontrast image and at least two contrast-enhanced images) were done in the prone position for studied patients.

Results: It was found that 68.8% (n = 44) and 31.2% (n = 20) of breast cancers were suffered from moderate and severe BPE, respectively. Furthermore, the prevalence of mass-like nonmass-like and both tumors were 43.8%, 43.8%, and 12.4%, respectively. Pathological studies indicated that 50%, 37.5%, and 12.5% of cancers were ductal carcinoma *in situ* (DCIS), invasive ductal carcinoma (IDC), and DCIS, respectively. In addition, a significant relationship between MRI characteristics and pathologic findings was found for IDC and DCIS (P = 0.03).

Conclusion: Based on the results of this study, the relationship between BPE level and MRI finding including mass-like or nonmass-like lesions in biopsy-proven breast cancers was not significant.

Keywords: Background parenchymal enhancement, breast cancer, magnetic resonance imaging

Address for correspondence: Dr. Maryam Farghadani, Department of Radiology, School of Medicine, Isfahan University of Medical Sciences, Isfahan, Iran.
E-mail: dr.m.farghadani@med.mui.ac.ir
Submitted: 24-Jul-2021; **Revised:** 29-Jan-2022; **Accepted:** 05-Feb-2022; **Published:** 27-Apr-2024

Introduction

Breast cancer is considered one of the most common cancers among females with a high prevalence rate worldwide.[1-4] The prevalence of breast cancer is high in both developed and developing countries.[4] Previous studies indicated that in every eight women in the United States, one will be diagnosed with breast cancer, and also a large number of females may suffer from breast lesions.[5] Incidence rates increased for estrogen receptor-positive breast cancers in the youngest white women, Hispanic women aged 60 years to 69 years, and all but the oldest African American women. In contrast, estrogen receptor-negative breast cancers declined among most age and racial/ethnic groups. These divergent trends may reflect etiologic heterogeneity and the differing effects of some factors, such as obesity and parity, on risk by tumor subtype.[6] Several studies also showed that breast cancer may cause many mortalities among women around the world. Based on the results of many studies, 250000 breast cancer females per year are diagnosed, and 180000 of them (72%) are suffered from invasive and

Access this article online

Quick Response Code:

Website: www.advbiores.net

DOI: 10.4103/abr.abr_221_21

How to cite this article: Farghadani M, Sanei P. MRI evaluation of mass-like and none-mass-like-proven breast cancer from moderate-to-high background enhancement. Adv Biomed Res 2024;13:36.

metastatic mentioned cancer.[7-11] Breast cancer subtypes are associated with distinct patterns of metastatic spread with notable differences in survival after relapse.[10] Metastatic cancers require some extreme treatment methods such as surgery, chemotherapy, and radiotherapy.[9] Therefore, it would seem that early screening, diagnosing, and treating of breast cancer females are pretty crucial.[12,13] Based on the evidence, the most important factor in the prognosis of breast cancer is the stage at the time of diagnosis. It is considered that about 80% of breast cancer females who are diagnosed in stage I, have 5 years survival rates, while this rate is decreased to 50% for higher stages. Screening programs are nowadays widely used mostly by mammography, ultrasonography, and biopsy (for any suspicious lesions which are detected on their mammography).[14] Diagnostic mammography is also administered when a suspicious mass or lesion is detected in the patient's physical examinations. SWE has better diagnostic value in terms of determining the nature of the breast masses. SWE can increase the diagnostic function of differentiating benign masses from malignant ones.[8]

Magnetic resonance imaging (MRI) is considered a more suitable method for diagnosing high dense breast cancer females compared to other radiological modalities.[15] The most important factor for breast cancer images is differentiating benign and malignant tumors which are performed by the means of tissue biopsy and histological studies. Furthermore, MRI is also widely used for breast size measurements and also vascularization conditions of tumors, especially before surgical clinical procedures.[16,17] Background parenchymal enhancement (BPE) is defined as primary enhancements of normal breast tissues in contrast enhancement MRI studies, and is divided into minimal, mild, moderate, and marked based on breast imaging and reporting and data system (BI-RADS) scores.[18] Mass-like tumors are also defined based on MRI findings and radiological patterns when a mass or a space-occupying lesion is detected. Moreover, nonmass-like tumors are defined when no mass or space-occupying lesions are seen in breast MRI.[19] In Figure 1, axial T_1 weighted fat suppressed contrast-enhanced MRI for different degrees of BPE including minimal (<25% enhancement glandular tissue), mild (26%–50% enhancement of glandular tissue), moderate (51%–75% enhancement of glandular tissue), and marked (>75% enhancement of glandular tissue) are shown. In some studies, marked background enhancement is considered a risk factor for breast cancer patients. For the patients, magnetic resonance (MR) images are assessed in mass and nonmass lesions types. However, it seems that there are some correlations between radiological patterns of a breast lesion and its pathological features. Thus, the purpose of this study is to evaluate the MRI patterns of background enhancement in patient with biopsy-proved breast cancer, and the prevalence of mass-like and nonmass like lesions among these patients.

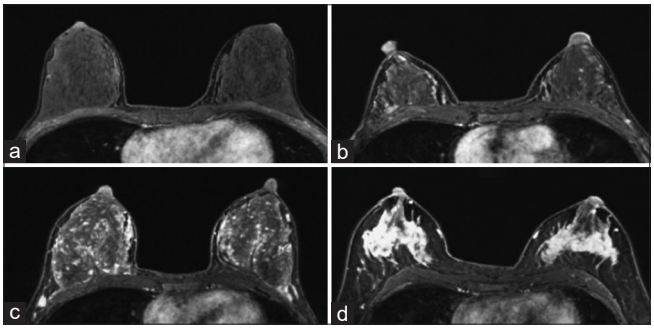

Figure 1: The axial T1-weighted fat suppressed contrast-enhanced Magnetic resonance imaging. Minimal (<25% enhancement glandular tissue) (a), mild (26%–50% enhancement of glandular tissue) (b), moderate (51%–75% enhancement of glandular tissue) (c), and marked (>75% enhancement of glandular tissue) (d) (Akiko Kawamura *et al*)

Materials and Methods

This cross-sectional study was performed on 32 patients (who were diagnosed with breast cancer based on their pathological findings) who referred to Al-Zahra hospital and Sepahan medical imaging center, Isfahan, Iran from 2017 to 2019. The study design was verified by the ethical board of Isfahan University of Medical Sciences, Isfahan, Iran.

Patient selection

The mentioned patients were recruited based on inclusion and exclusion criteria and by census method. The inclusion criteria were: documented breast cancer based on pathological studies, 4th and 5th BI-RADS scores based on the BI-RADS system of screening mammography, and BPE levels of moderate or marked in former MRI of the nonaffected breast. In addition, patients who suffered from refusal and any other lesions in their nonaffected breasts were excluded from this study.

Magnetic resonance imaging acquisition

MRI studies were performed using a1.5 Tesla (Achieva Philips, Netherland) MRI scanner system. It should also be noted that to prevent the effects of menstrual cycles on the studied breast tissues, the imaging studies were performed between 7th and 10th days of the menstrual cycle in nonmenopausal patients. The patients were placed in the prone position,[13] and MR sequences including noncontrast image and at least two contrast-enhanced (Gadolinium) images were done as follows; T_1-weighted fat-saturated (short-time inversion recovery or [STIR]), three dimensional fast spoiled gradient-recalled and T_2W fat-suppressed STIR. Then, postprocessing images of subtraction and maximum intensity projection were performed for the patients. Images were taken in axial sections with the following parameter: 5.5 ms/2.7 ms repetition time/echo time, 10° file angle, 32–38 field of view, 1.6 mm of slice thickness, and the matrix size of 420 × 420. Images with contrast were taken within 90 s after contrast injection. The data and also BPE of nonaffected breasts and also types of tumors such as mass-like or nonmass-like tumors were diagnosed by an expert radiologist.

Statistical analysis

Patients were chosen according to the easy sampling available method. All these data were collected and analyzed using the

SPSS program (Version 20, Chicago, USA) for evaluating the prevalence of mass-like or nonmass-like tumors. Furthermore, the statistical analysis was done using Independent *t*-test, One-way Analysis of variance, Chi-square and Logistic regression.[20]

Results

Table 1 illustrates the background disease of the studied patients at the beginning of this study. None of our patients had breast cancer background, and also were not undergo radiotherapy as well as chemotherapy before the beginning of this study. In this work, some of the MRI modalities including T_1-weighted fat-saturated three-dimensional fast spoiled gradient-recalled and T_2W fat-suppressed were used, and it would seem that the first subtraction contrast enhancement T_1W with fat suppression sequence provided better results in comparison with others [Figure 1]. Table 2 demonstrates the used MR sequences parameters as well as the number of slices for the stated females. As can be seen in this table, all employed parameters were similar for all of our cases, which may lead to generating some valid evidence about the patients. Table 3 indicates the relationship between MR findings for the mass and nonmass-like patients. Table 4, shows the regression analysis of pathology for nonmass-like tumors. Figure 1 shows the contrast enhancement T_1w images of one of the studied patients. Figure 2, illustrates the T_1W contrast enhancement, and the colored image of T_1W contrast enhancement MR images for a 39 years old female with dense breast tissue and strong family history of breast cancer. The mean age of these patients was 38.43 ± 10.33 years, and there were not any significant differences between the age range of them ($P > 0.05$). In addition, 68.8% ($n = 44$) of patients had moderate BPE based on their breast MRI and 31.2% ($n = 20$) of them were suffered severe BPE. Our data also indicated that the prevalence of mass like, nonmass like and both tumors were 43.8%, 43.8%, and 12.4%, respectively. Pathological studies also indicated that 50% of cancers were ductal carcinoma *in situ* (DCIS). Furthermore, 37.5% of them were found to be invasive ductal carcinoma (IDC) and 12.5% were DCIS and IDC. Furthermore, it was found that there was a significant relationship among MRI and pathologic findings for IDC and DCIS ($P = 0.03$). The 42.9%, 50%, and 7.1% of mass-like lesions was DCIS, IDC and DCIS and IDC, respectively. Furthermore, 71.4%, 21.4%, and 7.1% of

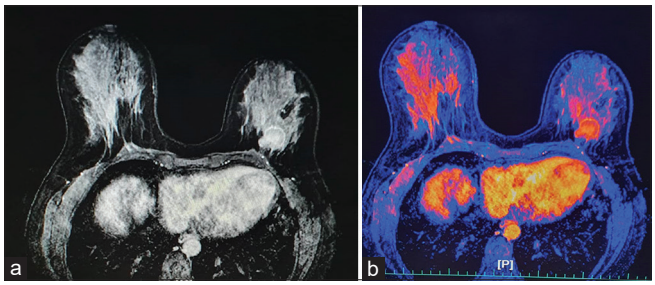

Figure 2: The T_1W contrast enhancement (a), and the colored image of T_1W contrast enhancement (b) Magnetic resonance image for a 39-year-old female with dense breast tissue and strong family history of breast cancer

Table 1: The studied breast cancer females background based on their evidences

Variable	Disease background		
	Breast cancer	Chemotherapy	Radiotherapy
Abnormalities			
DCIS	None	None	None
IDC	None	None	None
DCIS and IDC	None	None	None

DCIS: Ductal carcinoma *in situ*, IDC: Invasive ductal carcinoma

Table 2: The magnetic resonance imaging sequences which were used for studied breast cancer patients

	T_1W fat-saturated three dimensional fast spoiled GRE	T_2W fat suppressed	Patient position
DCIS	Performed	Performed	Prone
IDC	Performed	Performed	Prone
DCIS and IDC	Performed	Performed	Prone
TR (ms)	5.5	5.5	-
TE (ms)	2.7	2.7	-
Number of slices	2	2	-
FOV (cm)	32-38	32-38	-
Slice thickness (mm)	1.6	1.6	-
Image matrix size	420×420	420×420	-

DCIS: Ductal carcinoma in situ, IDC: Invasive ductal carcinoma, TR: Repetition time, TE: Echo time, FOV: Field of view, T_1W: T1 weighted, T_2W: T2 weighted

Table 3: Relation between magnetic resonance findings for the studied patients

Variable	MRI findings			*P*
	Mass like	Nonmass like	Both	
Age (years)	35.35±6.05	40.21±7.99	43.01±24.12	0.52
Pathology (%)				
DCIS	6 (42.9)	10 (71.4)	0	0.03
IDC	7 (50)	3 (21.4)	2 (50)	
DCIS and IDC	1 (7.1)	1 (7.1)	2 (50)	

DCIS: Ductal carcinoma *in situ*, IDC: Invasive ductal carcinoma, MRI: Magnetic resonance imaging

Table 4: Regression analysis of pathology for nonmass-like tumors

Variable	*P*	OR	95% CI	
			Lower	Upper
Pathology				
DCIS	0.54	2.84	0.09	85.02
IDC	0.74	0.56	0.01	18.32

Nonmass-like tumors were assessed as reference value. DCIS: Ductal carcinoma in situ, IDC: Invasive ductal carcinoma, OR: Odds ratio, CI: Confidence interval

nonmass-like lesions were DCIS, IDC, and DCIS and IDC, respectively [Table 2]. Moreover, Table 2 indicates for both cases (mass and nonmass like) 50% and 50% of them were IDC and DCIS and IDC, respectively, and none of them suffered from DCIS. Based on regression analysis, there was not any significant relationship between pathologic results and risk of nonmass-like tumors ($P > 0.05$) [Table 2].

Discussion

Breast MRI is considered one of the most suitable choices for evaluating breast tumors, in terms of their location and size. However, it would seem that there is little knowledge about the mass and nonmass-like breast lesions for females. Therefore, in this study, we focused on breast cancer females who had severe or moderate BPE in their breast MRI, and it was found that there was not any significant relationship between BPE level, mass-like or nonmass-like tumors prevalency, and pathological features of tumors. In this work, it is considered that the T_1 postcontrast images with fat suppression are a good choice for MR investigation of our discussed patients. In our studied patients, who had breast cancer background, and also underwent chemo or radiation therapy were excluded. Tables 1 and 2 give a comparison of MRI and pathological findings among the studied patients. For the mass-like lesions, DCIS was lower (up to 40%) than nonmass-like lesions. However, the IDC for the mass like was higher (up to 60%) than nonmass patients. The DCIS and IDC for the mass and nonmass like patients were similar, but for both cases (mass and nonmass) was higher than others. Furthermore, our study, indicates that the prevalence rate for the mass and nonmass-like lesions were similar, while the prevalence of both lesions was lower than others. On the other hand, the results of this study indicated that there was not any significant association between tumor MRI and pathologic findings. Besides, this study has introduced a more useful MR diagnostic sequence for the mass and nonmass patients. Similar results were reported in some other studies. Telegrafo *et al*. have focused on the effect of BPE on breast cancer detection using MRI and concluded that there was not any significant relationship between BPE levels of nonaffected breast and tumor sizes,[19] which is in line with our findings. In another study,[21] Telegrafo *et al*. have studied about breast MRI BPE correlates with the risk of breast cancer, and it has been also reported that BPE levels are not a trusted method for evaluating cancer risk or cancer types such as mass-like or nonmass-like tumors.[20] Baek *et al*. had also studied on 399 breast cancer patients and found moderate and marked BPE are related to the inaccurate estimation of tumor size based on MRI.[22] Furthermore, they concluded that the specificity and accuracy of MRI in diagnosing or size measurement of mass like tumors was higher than nonmass-like tumors, and their findings are also in line with the results of our study. Quan-Xin *et al*. have also evaluated important diagnostic characteristics for nonmass-like tumors in MRI and concluded that segmental dissemination, clustered ring enhancement, and a short time to make the peak with contrast enhancement materials could be accounted as diagnostic characteristics of nonmass like tumors.[23]

In contrast, in a study by Yamada *et al*. which was discussed the radiologic-pathologic correlation of DCIS for their patients, it has been mentioned that there might be a relationship between tumoral pathologic and MRI findings. They also indicated that nonmass-like tumors are mostly observed in patients with diagnosed DCIS based on their pathologic studies.[24] The different results might be due to the variety of study populations. In another study by Uematsu *et al*. an association between pathological and MRI findings have shown, but it was mentioned that MRI findings could also be inaccurate in some cases.[25]

Based on our results, the relationship between BPE level and MRI finding including mass-like or nonmass-like lesions was not significant. As a result of the importance of differentiating mass and also nonmass-like lesions for breast cancer patients, further research about the mentioned abnormality is suggested.

Limitations

Lack of enough participants is the major limitation of this study.

Conclusion

In this work, the MR prevalency of mass-like and nonemass-like lesions for high levels of background enhancement breast cancer patients was evaluated.

In the current study, there was not any significant relationship between mass-like and nonmass-like tumors in patients with high levels of BPE. The results of this study also showed that tumor pathologies and MRI findings are not associated with the all of mentioned patients.

Acknowledgments

The authors would like to thank Sepahan medical imaging center and Radiology department of Al-Zahra Hospital, Isfahan University of Medical Sciences, Isfahan, Iran.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Stephens PJ, Tarpey PS, Davies H, Van Loo P, Greenman C, Wedge DC, *et al.* The landscape of cancer genes and mutational processes in breast cancer. Nature 2012;486:400-4.
2. Tavakoli MB, Taheri H, Akhavan A. Measurement of ipsilateral lung and heart dose in radiotherapy of left sided mastectomy patients in common different clinical techniques: A phantom study. Int J Radiat Res 2018;16:389-94.
3. Taheri H, Tavakoli MB, Akhavan A. Radiobiological evaluation of three common clinical radiotherapy techniques including combined photon-electron, tangential beams and electron therapy in left-sided mastectomy patients. Adv Biomed Res 2018;7:99.
4. Taheri H, Akhavan A, Moghareabed R, Tavakoli MB, Kianinia M. Dosimetric comparison and TCP-NTCP modelling for lung, heart, left

anterior descending and right coronary artery in left sided breast cancer conventional and hypofractionated radiotherapy. Int J Cancer Manag. 2021;14:e117987.
5. Bray F, Ren JS, Masuyer E, Ferlay J. Global estimates of cancer prevalence for 27 sites in the adult population in 2008. Int J Cancer 2013;132:1133-45.
6. DeSantis C, Ma J, Bryan L, Jemal A. Breast cancer statistics, 2013. CA Cancer J Clin 2014;64:52-62.
7. Farghadani M, Hekmatnia A, Sharif H, Riahinezhad M. Assessment of background parenchymal enhancement in dynamic contrast material-enhanced magnetic resonance imaging for breast cancer screening. Med Sci 2020;24:632-8.
8. Farghadani M, Barikbin R, Rezaei MH, Hekmatnia A, Aalinezhad M, Zare H. Differentiating solid breast masses: Comparison of the diagnostic efficacy of shear wave elastography and magnetic resonance imaging. Diagnosis (Berl) 2021;8:382-7.
9. Farghadani M, Soofi GJ, Sarrami AH. Is there any correlation between magnetic resonance imaging features of breast lesions of BIRADS category 4 with histopathologic results? Adv Biomed Res 2017;6:7.
10. Kennecke H, Yerushalmi R, Woods R, Cheang MC, Voduc D, Speers CH, *et al.* Metastatic behavior of breast cancer subtypes. J Clin Oncol 2010;28:3271-7.
11. Quispe D, Shi R, Burton G. Osteonecrosis of the jaw in patients with metastatic breast cancer: Ethnic and socio-economic aspects. Breast J 2011;17:510-3.
12. Gøtzsche PC, Jørgensen KJ. Screening for breast cancer with mammography. Cochrane Database Syst Rev 2013;2013:CD001877.
13. Wang J, Azziz A, Fan B, Malkov S, Klifa C, Newitt D, *et al.* Agreement of mammographic measures of volumetric breast density to MRI. PLoS One 2013;8:e81653.
14. Rakha EA, Reis-Filho JS, Baehner F, Dabbs DJ, Decker T, Eusebi V, *et al.* Breast cancer prognostic classification in the molecular era: The role of histological grade. Breast Cancer Res 2010;12:207.
15. Turnbull L, Brown S, Harvey I, Olivier C, Drew P, Napp V, *et al.* Comparative effectiveness of MRI in breast cancer (COMICE) trial: A randomised controlled trial. Lancet 2010;375:563-71.
16. King V, Brooks JD, Bernstein JL, Reiner AS, Pike MC, Morris EA. Background parenchymal enhancement at breast MR imaging and breast cancer risk. Radiology 2011;260:50-60.
17. Huang YH, Chang YC, Huang CS, Wu TJ, Chen JH, Chang RF. Computer-aided diagnosis of mass-like lesion in breast MRI: Differential analysis of the 3-D morphology between benign and malignant tumors. Comput Methods Programs Biomed 2013;112:508-17.
18. Morrow M, Waters J, Morris E. MRI for breast cancer screening, diagnosis, and treatment. Lancet 2011;378:1804-11.
19. Telegrafo M, Rella L, Stabile Ianora AA, Angelelli G, Moschetta M. Effect of background parenchymal enhancement on breast cancer detection with magnetic resonance imaging. Diagn Interv Imaging 2016;97:315-20.
20. Telegrafo M, Rella L, Stabile Ianora AA, Angelelli G, Moschetta M. Breast MRI background parenchymal enhancement (BPE) correlates with the risk of breast cancer. Magn Reson Imaging 2016;34:173-6.
21. Taheri H, Tavakoli MB. Measurement of apparent diffusion coefficient (ADC) values of ependymoma and medulloblastoma tumors: A patient-based study. J Biomed Phys Eng 2021;11:39-46.
22. Baek JE, Kim SH, Lee AW. Background parenchymal enhancement in breast MRIs of breast cancer patients: Impact on tumor size estimation. Eur J Radiol 2014;83:1356-62.
23. Yang QX, Ji X, Feng LL, Zheng L, Zhou XQ, Wu Q, *et al.* Significant MRI indicators of malignancy for breast non-mass enhancement. J Xray Sci Technol 2017;25:1033-44.
24. Yamada T, Mori N, Watanabe M, Kimijima I, Okumoto T, Seiji K, *et al.* Radiologic-pathologic correlation of ductal carcinoma *in situ*. Radiographics 2010;30:1183-98.
25. Uematsu T, Kasami M, Yuen S. Triple-negative breast cancer: Correlation between MR imaging and pathologic findings. Radiology 2009;250:638-47.