The Egyptian Journal of Hospital Medicine (April 2025) Vol. 99, Page 1944-1951

Abbreviated (Fast) Breast MRI Protocol versus Full Diagnostic Breast MRI in Diagnosis of Breast Cancer

Mohammed Refaat Habba [1], Ahmad Sabry Ahmad Ragheb [2], Magdy Mostafa Elnisr [1], Shimaa Eisa Taha Mostafa[3*]

[1]Department of Radiology, Faculty of Medicine – Suez Canal University

[2] Department of Radiology, Faculty of Medicine – Zagazig University

[3] Radiology Resident at AGA Central Hospital

[*]**Corresponding author:** Shimaa Eisa Taha Mostafa, **Mobile:** +20 10 04432882, **E-mail:** shimaaeisa55@gmail.com

ABSTRACT

Background: Magnetic resonance imaging (MRI) has possible value in early breast cancer identification. Recently, magnetic resonance imaging was utilized as a supplementary investigation technique for breast screening in elevated-possibility populations.

Aim: This study aimed to offer an enhanced diagnosis rate of cancer, a reduced scan period, and a reduced expense compared to full diagnostic magnetic resonance imaging through abbreviated guidelines for breast MRI.

Patients and methods: This was a cross-sectional research conducted on forty cases of suspected breast cancer attending to Radiology Departments. Patients underwent full diagnostic MRI as well as fast MRI.

Results: The sensitivity of Abbreviated Breast Magnetic Resonance Imaging (AB-MRI) tended to be reduced compared to that of Full Diagnostic Magnetic Resonance Imaging (FD-MRI) [83.3% (10/12) vs. 100% (12/12)]. The specificity of AB-MRI was significantly greater in comparison with that of full diagnostic magnetic resonance imaging [42.9% (12/28) vs. 35.7% (10/28)].

Conclusion: FD-MRI and AB-MRI showed fair agreement in Breast Imaging-Reporting and Data System (BI-RADS) categorization, moderate agreement in shape and internal enhancement patterns, and substantial agreement in margin, enhancement characteristics, and distribution of benign lesions. For malignant lesions, both methods showed moderate to substantial agreement across most imaging features, with perfect agreement in BI-RADS classification. AB-MRI had lower sensitivity than FD-MRI (83.3% vs. 100%) but significantly higher specificity (42.9% vs. 35.7%).

Keywords: MRI, Breast cancer, FD-MRI, BI-RADS, AB-MRI.

INTRODUCTION

MRI has possible value in early breast tumor diagnosis. Recently, magnetic resonance imaging has been utilized as a supplementary investigation technique for breast screening in elevated-possibility populations [1, 2]. Annual magnetic resonance imaging screening for cases at elevated possibility for the development of breast tumor is a part of the regular algorithm suggested via the American College of Radiologists (ACR), as well as the European Society for Breast Imaging [3]. Standard scanning guidelines for tumor of breast magnetic resonance imaging screening research need image attainment for approximately forty min in the prone position in a dedicated breast coil [4, 5].

Kuhl *et al.* [6] abbreviated the magnetic resonance imaging guideline to a shorter sequence, labelled the First Post-Contrast Acquisition Subtracted (FAST) guideline, which involves Maximum Intensity Projection (MIP) series, T1 axial, as well as first post-contrast acquisition subtracted. They showed that breast magnetic resonance imaging screening is viable without diminishing the specificity or sensitivity in comparison with the complete full diagnostic magnetic resonance imaging guideline. Thus, abbreviated scans have the possibility to substitute full diagnostics in the screening setting as long as there is the capability to recall cases of any anomaly in the first post-contrast acquisition subtracted for additional assessment [7]. The first post-contrast acquisition subtracted images may eliminate the interference signals due to fat and elevate the contrast among the lesion as well as its adjacent tissue. Furthermore, maximum intensity projection may obviously demonstrate distorted as well as unusually proliferated blood vessels of the lesions of cancer [8]. The improved contrast among the lesions of breast and the usual parenchyma of breast throughout the early stages of illness is especially crucial for breast tumor diagnosis [9].

This study aimed to offer an enhanced diagnosis rate of cancer, reduced scan period, and reduced expense compared to full diagnostic magnetic resonance imaging through using abbreviated guideline breast MRI.

PATIENTS AND METHODS

This cross-sectional research was performed on forty cases of suspected breast cancer attending to the Radiology Departments. Patients underwent full diagnostic MRI as well as fast MRI.

Inclusion criteria: any female with a suspected breast lump, any female with a breast lump with BIRAD < 40, any adult female patient with a positive family history or 2 first- or second-degree relatives with a tumor of the

Received: 26/11/2024
Accepted: 27/01/2025

ovary or breast with one of the following: Bilateral breast tumor, tumor of ovary and breast in one relative, tumor of breast below forty years, tumor of breast in male relative, tumor of ovary below forty years, and elevated possibility for the development of breast tumor because of any of the above features while they were outside the Medicare age range for scanning, and who had other causes to be regarded at elevated possibility for the progress of breast tumor.

Exclusion criteria: Patients with contraindications to perform MRI exams including patients with pacemakers, patients with cochlear implants, patients with aneurysm clips, patients with a history of metallic intraocular foreign body implants, claustrophobic patients, patients allergic to gadolinium, and patients with impaired renal function (blood creatinine > 2.1 mg/dl).

Sample size: Estimated regarding the formula provided by Dawson et al.,[10] in which n = size of the sample, Z α/2 = 1.96 (The features value that divides the central ninety-five percent of the Z distribution from the five percent in the tail), *p* is the occurrence of breast lesions between adults estimated at 53%, Sn = sensitivity of MRI in diagnosing breast lesions among adults = 90%, and E = the margin of error. So, the sample size was 33 adults, and with 10% as the drop-out rate, the total size of the sample was 40 adults.

Magnetic resonance imaging (MRI): All cases have been exposed to complete history taking. They were prepared by being instructed about the procedure and were asked to remove all metallic objects, and patients were examined in the prone position utilizing a 1.5T MRI machine with a dedicated breast coil.

MRI examination: Bilateral sagittal, fat-suppressed T2-weighted fast spin-echo images (Repetition time/echo time [TR/TE], 5500–7150/82 milliseconds; matrix, 256 x 160; view field, 200 x 200 millimeters; thickness of slice, 1.5 millimeters; no gap) had been attained. Dynamic contrast-enhanced (DCE) magnetic resonance imaging had been attained utilizing a bilateral sagittal fat-suppressed T1-weighted 3D rapid spoiled gradient echo sequence (TR/TE, 6.5/2.5 milliseconds; matrix, 256 x 160; angle of flip, 10°; view field, 200 x 200 millimeters; thickness of slice, 1.5 millimeters; no gap).

FD-MRI protocol: Full-guideline magnetic resonance imaging comprised sagittal, axial, coronal turbo-spin echo (TSE) fat-saturated T2-weighted sequence and axial turbo-spin echo T1-weighted sequence; as well as axial diffusion weighted imaging were attained. Furthermore, an axial three-dimensional gradient-echo dynamic contrast-enhanced T1-weighted sequence had been attained prior to administration of the contrast and at 5 period points following the contrast. Subtraction images as well as maximum intensity projection images were produced for every period point following the contrast. The total investigation period was about thirty-five to forty-five minutes, and all of the images attainment period was about twenty minutes.

AB-MRI protocol: Abbreviated magnetic resonance imaging involved the axial pre-contrast T1-weighted sequence and the axial fat-saturated T2-weighted sequence, as well as the 2nd axial post contrast T1-weighted sequence with its derived sets of images (Subtraction images as well as maximum intensity projection images). The sequences extracted for the abbreviated guideline had an overall attainment period of about six minutes (Comprising sequence setup and shimming procedures).

Ethical consideration: Research guideline has been approved by The Institutional Review Board (IRB) of Suez Canal University. Approval of the managers of the health care facilities where the research has been performed was obtained. Informed written consent was attained from each participant involved in the research. Confidentiality and personal privacy was respected in all stages of research. The Helsinki Declaration was followed throughout the study's duration.

Statistical analysis

The data were revised, coded, tabulated, and introduced to a personal computer utilizing Statistical Package for Social Science (SPSS Statistics for Windows, version 25.0). Data were presented, and proper analysis was performed. For descriptive statistics, mean ± SD, percentage, and incidence was used. For analytical statistics, the student's t-test, Chi-square test and Cohen's kappa score, or kappa coefficient were used. The validity of fast MRI in breast lesion detection was estimated utilizing diagnostic performance based on sample 2×2 contingency tables generated utilizing breast lesion analysis as the reference (gold) standard. The specificity, sensitivity, negative predictive values and positive predictive values, as well as accuracy with their respective ninety-five percent confidence intervals was estimated. P was significant if ≤ 0.05.

RESULTS

As shown in table (1), patients' characteristics such as age and comorbidities showed insignificant differences among malignant and benign lesions, while malignant lesions had a significantly greater mean size (4.26 ± 1.89 cm) than benign lesions (2.73 ± 1.73 cm) (p=0.018).

Table (1): Patient Characteristics among groups according to Histopathological results

	Benign Lesions (number = 28)	Malignant Lesions (number = 12)	*P*-value
Age (years) Mean± standard deviation	53.8±12	51.3±7.9	0.514[1]
Range	35-70	41-69	
Comorbidities			
Yes	13(46.4%)	5(41.7%)	0.781[2]
No	15(53.6%)	7(58.3%)	
Lesion size on MRI (cm)			
Mean± SD	2.73±1.73	4.26±1.89	0.018*[1]
Median (Range)	2.55(0.4-5.8)	4.1(1.6-6.7)	

Student t test used, Chi square test used, *Statistically significant as p-value below 0.05.

As shown in table (2), FD-MRI and AB-MRI findings showed fair agreement in BIRADS classification, moderate agreement in shape and internal enhancement patterns, and substantial agreement in margin, internal enhancement characteristics, and distribution of benign lesions.

Table (2): AB-MRI versus FD-MRI findings among benign lesions (n=28)

	FD-MRI	AB-MRI	*K*
BIRADS			
2 or 3	28(100%)	10(35.7%)	0.322
4 or 5	0(0%)	18(64.3%)	
Shape			
Oval	10(35.7%)	10(35.7%)	0.532
Rounded	10(35.7%)	1(3.6%)	
Irregular	8(28.6%)	17(60.7%)	
Margin			
Circumscribed	11(39.3%)	12(42.9%)	0.779
Irregular	17(60.7%)	16(57.1%)	
Internal enhancement characteristics			
Homogeneous	8(28.6%)	8(28.6%)	0.748
Heterogeneous	9(32.1%)	11(39.2%)	
Rim enhancement	1(3.6%)	1(3.6%)	
Dark internal septations	1(3.6%)	1(3.6%)	
Non-mass enhancement	9(32.1%)	7(25%)	
Distribution			
Focal	3(10.7%)	3(10.7%)	0.696
Linear	0(0%)	1(3.6%)	
Segmental	3(10.7%)	2(7.1%)	
Regional	3(10.7%)	1(3.6%)	
Internal enhancement patterns			
Homogeneous	2(7.1%)	1(3.6%)	0.470
Heterogeneous	6(21.4%)	6(21.4%)	
Clumped	1(3.6%)	0(0%)	

Kappa test used. Full Diagnostic

As shown in table (3), FD-MRI and AB-MRI findings showed moderate agreement in internal enhancement patterns, substantial agreement in shape, margin, internal enhancement characteristics, and distribution, and perfect agreement in fair agreement in BIRADS classification of malignant lesions.

Table (3): AB-MRI versus FD-MRI findings among malignant lesions (n=12)

	FD-MRI	AB-MRI	*K*
BIRADS			
2 or 3	0(0%)	2(16.7%)	0.881
4 or 5	12(100%)	10(83.3%)	
Shape			
Oval	2(16.6%)	1(8.3%)	0.714
ounded	0(0%)	1(8.3%)	
Irregular	10(83.4%)	10(83.4%)	
Margin			
Circumscribed	1(8.3%)	2(16.6%)	0.625
Irregular	11(91.7%)	10(83.4%)	
Internal enhancement characteristics			
Homogeneous	1(8.3%)	2(16.7%)	0.609
Heterogeneous	5(41.7%)	7(58.3%)	
Rim enhancement	1(8.3%)	0(0%)	
Dark internal septations	0(0%)	0(0%)	
Non-mass enhancement	5(41.7%)	3(25%)	
Distribution			
Focal	1(8.3%)	1(8.3%)	0.684
Linear	2(16.7%)	0(0%)	
Segmental	1(8.3%)	2(16.7%)	
Regional	1(8.3%)	0(0%)	
Internal enhancement patterns			
Homogeneous	0(0%)	1(8.3%)	0.520
Heterogeneous	3(25%)	2(16.7%)	
Clumped	2(16.7%)	0(0%)	

As shown in table (4), the sensitivity of abbreviated breast magnetic resonance imaging tended to be reduced compared to that of full diagnostic magnetic resonance imaging [83.3% (10/12) vs. 100% (12/12)]. The specificity of AB-MRI was significantly greater in comparison with that of full diagnostic magnetic resonance imaging [42.9% (12/28) vs. 35.7% (10/28)].

Table (4): Validity of AB-MRI results versus histopathology findings

		Histopathology		Total
		Benign	Malignant	
AB-MRI	Benign	12(42.9%)	2(16.7%)	14
	Malignant	16(57.1%)	10(83.3%)	26
Total		28(100%)	12(100%)	40
FD-MRI	Benign	10(35.7%)	0(0%)	10
	Malignant	18(64.3%)	12(100%)	30
Total		28(100%)	12(100%)	40

CASE PRESENTATIONS

CASE 1

A 43-year-old lady presented with left breast tumor, finished NAC, had no comorbidities, and had no family history of breast cancer.

- **FD-MRI Findings:** Heterogenous segmental non-mass improvement is seen at the left breast extending between 12 o`clock to 4-5 o`clock zone 2-3 (Figure 1 A, B & C)? likely residual. BIARDS 6. Beign looking bilateral axillary LN.
- **AB-MRI Findings:** Heterogenous area enhancement is seen at the left breast extending between 11 o`clock to 5 o`clock? (Figure 1 D, E & F) likely residual……BIRADS 6.

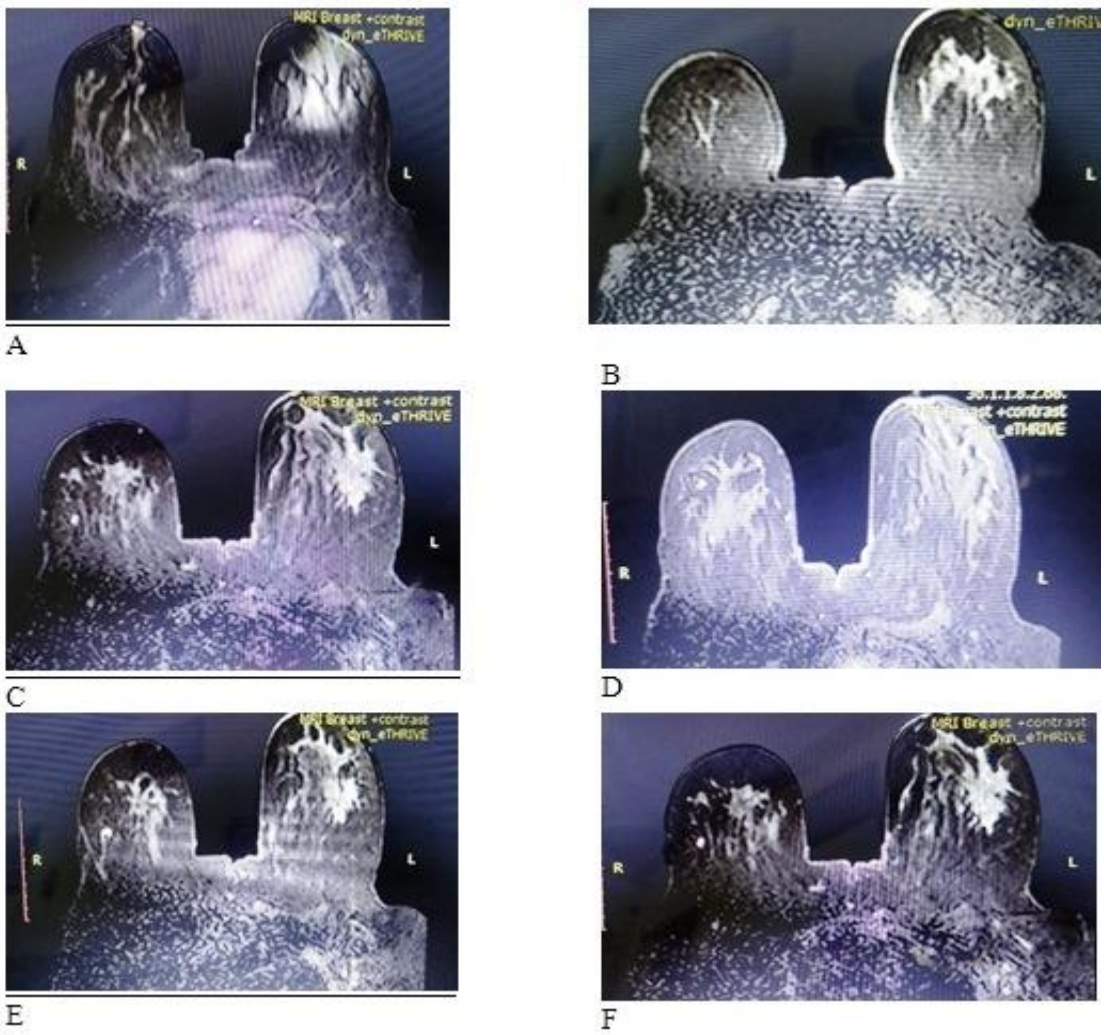

Figure (1): (A, B, C): represent FD MRI showing residual of breast cancer at LT breast.
(D, E, F): represent AB MRI showing non mass enhancement at LT breast.

CASE 2

A 66-year-old lady presented with left breast cancer, finished NAC, had history of DM, and had no family history of breast cancer.

- **FD-MRI Findings:** Left breast UOQ metallic artifact (Figure 2 B) with anterior related segmental non-mass enhancement measuring about 54 x 34 mm occupying from 1 to 3 o`clock zone 2 (Figure 2 A, C & D) …...BIRADS 6. Being looking bilateral axillary LN.
- **AB-MRI Findings:** Left breast UOQ metallic artifact (Figure 2 F) with anterior related area enhancement measuring about 62 x 36 mm occupying from 12 to 3 o`clock (Figure 2 E, G & H) ……. BIRADS 6.

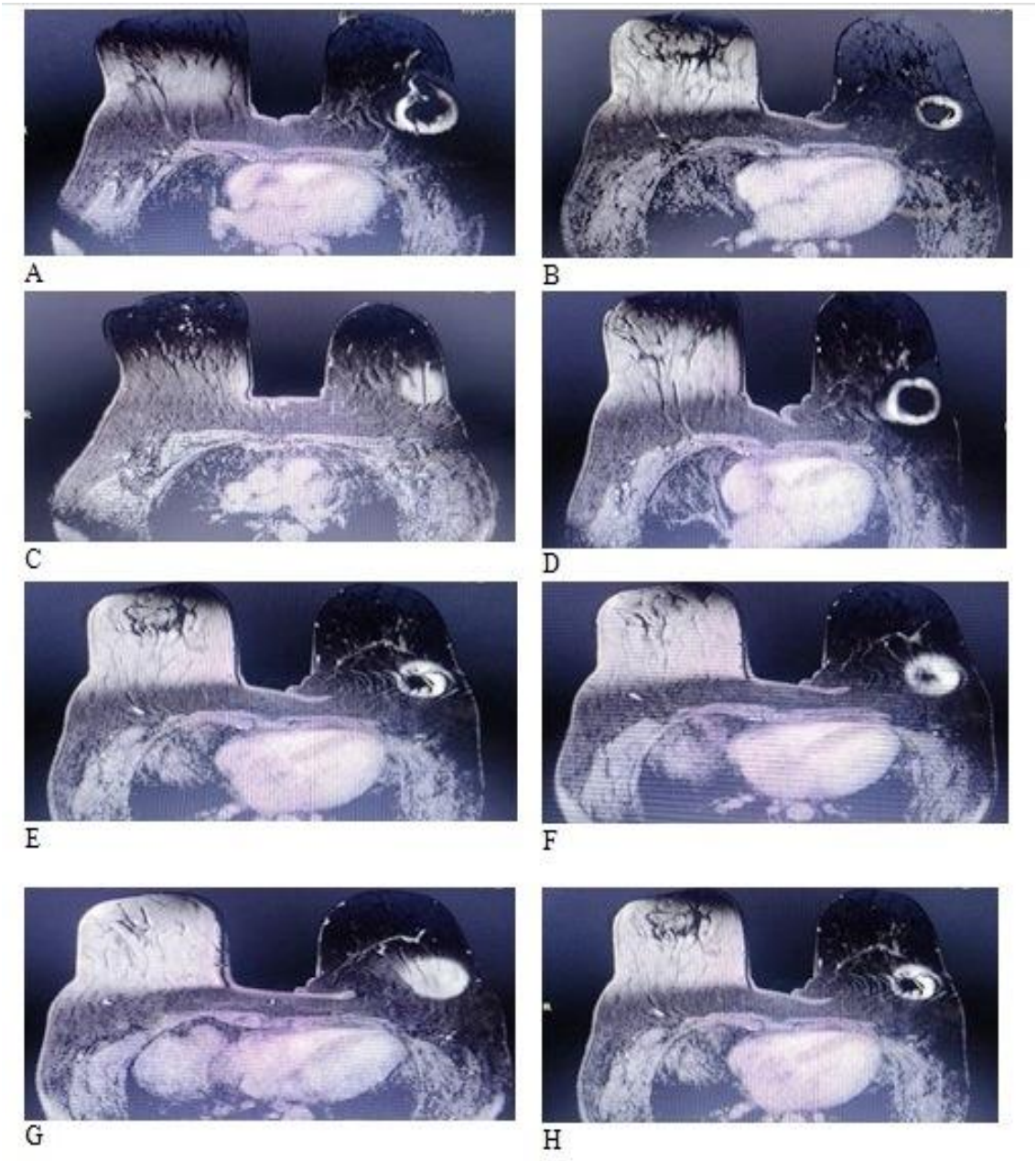

Figure (2): (A, B, C, D): represent FD MRI showing non mass enhancement at LT breast. (E, F, G, H): represent AB MRI showing LT breast cancer.

DISCUSSION

Our study showed that patient characteristics such as age and comorbidities showed insignificant differences among malignant and benign lesions, while malignant lesions had a significantly greater mean size (4.26 ± 1.89 cm) than benign lesions (2.73 ± 1.73 cm) (p=0.018).

Regarding FD-MRI and AB-MRI findings, our results showed fair agreement in BIRADS classification, moderate agreement in shape and internal enhancement patterns, and substantial agreement in margin, internal enhancement characteristics, and distribution of benign lesions.

Our results revealed that FD-MRI and AB-MRI findings showed moderate agreement in internal enhancement patterns, substantial agreement in shape, margin, internal enhancement characteristics, and distribution, and perfect agreement in fair agreement in BIRADS classification of malignant lesions.

In this research, **t**he sensitivity of AB-MRI tended to be reduced in comparison with that of FD-MRI (83.3% [10/12] vs. 100% [12/12]). The specificity of AB-MRI was significantly greater in comparison with that of FD-MRI (42.9% [12/28] vs. 35.7% [10/28]). Two false-negative lesions on AB-MRI were DCIS (0.8 cm) and IDC (1 cm) and showed irregular margin and heterogeneous internal enhancement characteristics and patterns.

In agreement with another multireader research, simulated AB-MRI with single 1st images following the contrast tended to exhibit a reduced sensitivity and greater specificity compared to FD-MRI in distinguishing among benign and malignant lesions observed through magnetic resonance imaging screening, though FD-MRI and AS-MRI had comparable AUCs. Among the thirty-four malignant lesions, five (fifteen percent) were categorized as BIRADS final evaluation category two or three on AB-MRI through 3 or higher of the 5 readers. Every 5 false-negative cancers on AB-MRI were low- or intermediate-grade ductal carcinoma in situ or low- or intermediate-grade invasive tumors of not higher than one centimeter. Not only the lack of kinetic data, however additionally the more suspicious internal or margins improvement observed in the delayed stage of full diagnostic magnetic resonance imaging compared to the first images following the contrast of AB-MRI have been associated with the differences among the 2 guidelines [(11)].

Concerning the diagnostic setting, **Romeo *et al.*** [(12)] documented that a simplified breast magnetic resonance imaging guideline, involving the 2nd and 5th post-contrast series, has a similar performance to full diagnostic magnetic resonance imaging in features (Specificity ninety-three percent vs. ninety-five percent, *p*-value equal to 0.72; sensitivity ninety-nine percent vs. ninety-seven percent, *p*-value equal to 0.62; AUC 0.990 versus 0.989, *p*-value equal to 0.76). **Moschetta *et al.*** [(13)] also observed that AB-MRI comprising a single 3rd post-contrast T1-WI as well as morphologic sequences (T2-WI, short TI inversion recovery) has similar performance to FD-MRI (specificity 0.92 versus 0.91, sensitivity 0.92 versus 0.89, AUC 0.92 versus 0.91, all *p-values* above 0.05).

Nevertheless, **Jain *et al.*** [(4)] documented a greater specificity and reduced sensitivity of AB-MRI involving T2-WI and the first post-contrast series compared to FD-MRI (fifty percent vs. seventy-one percent, ninety-six percent vs. seventy-seven percent) in females with a personal history of breast tumor, which is in agreement with our outcomes. Furthermore, in a previous pilot research study, which compared the performances of 2 simplified breast magnetic resonance imaging guidelines (1st post-contrast series alone vs. first and second post-contrast series) and FD-MRI (first, second, third, and fourth post-contrast series).

Grimm *et al.* [(14)] observed that the sensitivities as well as specificities of the guidelines were eighty-six percent and fifty-two percent, eighty-nine percent and forty-five percent, and ninety-five percent and fifty-two percent, correspondingly, though an insignificant variance has been observed. Depending on these researches, it is observed that whereas AB-MRI involving 2nd or later post contrast series demonstrated similar performances to FD-MRI. AB-MRI with single 1st post-contrast images tended to demonstrate inferior sensitivity to FD-MRI in differentiating among benign and malignant lesions, as has been shown in our research.

Romeo *et al.* [(12)] also highlighted the advantage of the 2nd as well as 5th post-contrast series for features due to these series having superior visualization of the internal and margins improvement patterns compared to the 1st post-contrast images alone. Regarding that the most essential benefit of breast magnetic resonance imaging is its exceptional sensitivity. The breast tumor misclassification, even low- to intermediate-grade as well as minimal tumors of the breast, might be a disadvantage. Consequently, additional research is required to detect whether a 2nd or 3rd post-contrast series can aid in decreasing the delayed breast cancer identification with AB-MRI.

LIMITATIONS: This research had numerous restrictions. First, this was performed in a single institution. This cohort was not usual for AB-MRI investigation, and prospective research utilizing different populations is required for additional confirmation of our outcomes. Our research involved only histologically verified suspicious breast lesions, and fifty percent (6/12) of the cancer patients were DCIS. Second, we didn't involve T2-WI in the simulated AB-MRI datasets. Currently, T2-WI is frequently included in the AB-MRI guideline. Ultrafast imaging with fast (below ten seconds) temporal resolution preserves dynamic data for features of the lesion, and the addition of these guidelines in AB-

MRI can aid in enhancing the performance of AB-MRI. Finally, there were no conflicting malignant or benign lesions, which demonstrated more suspicious results depending on the primary FD-MRT interpretations, though this fact can have minimal impact on the total outcomes.

CONCLUSION

FD-MRI and AB-MRI findings showed fair agreement in Breast Imaging-Reporting and Data System (BIRADS) categorization, moderate agreement in shape and internal enhancement patterns, and substantial agreement in margin, internal enhancement characteristics, and distribution of benign lesions. For malignant lesions, both modalities showed moderate agreement in internal enhancement patterns, substantial agreement in shape, margin, internal enhancement characteristics, and distribution, and perfect agreement in BIRADS classification of malignant lesions. While the sensitivity of AB-MRI tended to be reduced compared to that of FD-MRI (83.3% [10/12] vs. 100% [12/12]), the specificity of AB-MRI was significantly greater in comparison with that of FD-MRI (42.9% [12/28] vs. 35.7% [10/28]).

RECOMMENDATIONS

Our study recommends further study to detect the diagnostic value of the addition of over 1 post-contrast series in abbreviated breast magnetic resonance imaging.

Consent for publication: I certify that each author had granted permission for the work to be submitted.
Funding: No fund.
Availability of data and material: Available.
Conflicts of interest: None.
Competing interests: None.

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