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Original Research

Accuracy of breast MRI for cancer diagnosis: correlation with BI-RADS and biopsy findings

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Abstract

Background: Breast cancer remains a major global health concern, and early detection is essential for improving treatment outcomes. Breast magnetic resonance imaging (MRI), incorporating advanced multiparametric techniques, offers detailed morphological and functional assessment that enhances lesion characterization. Evaluating the diagnostic performance of MRI in comparison with histopathology is important for understanding its clinical utility.

Objectives: This study aims to evaluate the diagnostic performance of breast MRI at Al-Ahli Hospital and assess the agreement between MRI-based BI-RADS categories and biopsy results.

Methodology: A retrospective analysis was conducted on female patients who underwent breast MRI between October 2022 and October 2025. Among 394 MRI examinations, 109 patients also underwent mammography and subsequent biopsy, enabling direct correlation between imaging findings and histopathology. MRI interpretations utilized standardized BI-RADS criteria. Statistical analyses included chi-square testing, Spearman correlation, and calculation of sensitivity, specificity, PPV, and NPV.

Results: Of the 109 patients included, MRI demonstrated excellent sensitivity for malignancy detection at 100% (95% CI: 83.2–100%) and a negative predictive value (NPV) of 100% (95% CI: 90.5–100%). Specificity was lower at 41.6% (95% CI: 31.3–52.5%), reflecting overlap between benign and malignant enhancement patterns, while the positive predictive value (PPV) was 27.8% (95% CI: 18.0–39.6%). Overall diagnostic accuracy was 52.3% (95% CI: 42.5–62.0%). Tumor size showed a significant positive correlation with malignant MRI assessment. BI-RADS categorization demonstrated significant association with biopsy outcomes.

Discussion: Breast MRI showed outstanding sensitivity, in line with international literature, reaffirming its strength in ruling out malignancy when results are negative. However, the comparatively lower specificity reflects common interpretive challenges, particularly with benign enhancing lesions. These findings emphasize the importance of integrating MRI with mammography, ultrasound, clinical data, and histopathology rather than using MRI as an isolated diagnostic tool. BI-RADS scoring remains a valuable framework, but interobserver variability and overlapping enhancement patterns warrant careful multidisciplinary review.

Conclusion: Breast MRI provides exceptional diagnostic sensitivity and NPV within the studied population and serves as a powerful component of multimodal breast imaging. Nonetheless, due to reduced specificity, MRI findings should be interpreted in conjunction with other imaging and pathological assessments to optimize diagnostic accuracy and patient management.

Keywords: Breast MRI, BI-RADS, Breast cancer, Diagnostic performance, Histopathology, Multiparametric MRI

Introduction

Breast cancer remains the most frequently diagnosed malignancy among women worldwide and continues to be a major contributor to cancer-related mortality [1]. Achieving early detection and accurate characterization of breast lesions is essential for guiding treatment decisions and improving clinical outcomes. Magnetic resonance imaging (MRI) has become an advanced diagnostic tool

due to its superior soft-tissue contrast, dynamic contrast-enhanced capabilities, and ability to capture vascular and physiological tumor characteristics that are not easily visualized using mammography or ultrasound [2,3].

Modern multiparametric MRI utilizes a combination of high-resolution anatomical imaging, dynamic contrast enhancement (DCE), and diffusion-weighted imaging (DWI), providing complementary structural and functional data that enhance lesion assessment [2,4]. Numerous systematic reviews and meta-analyses have reported consistently high sensitivity for MRI in detecting invasive carcinoma and ductal carcinoma in situ, frequently exceeding 90% in different clinical environments [5–7]. This high sensitivity is particularly valuable for patients with dense breast tissue, those at increased risk, and individuals with inconclusive findings on conventional imaging [5,6].

However, MRI specificity is known to vary considerably, largely because benign conditions—such as fibroadenomas, papilloma, inflammatory changes, and background parenchymal enhancement—may exhibit enhancement features similar to malignancy [7–9]. To reduce interpretive variability, the American College of Radiology introduced the MRI BI-RADS lexicon to standardize lesion descriptors, kinetic patterns, and reporting terminology [10]. Correlating BI-RADS categories with histopathologic outcomes remains the gold standard for evaluating diagnostic accuracy and understanding the sources of false positive and false-negative results [11,12].

In addition to detecting primary tumors, MRI often reveals multifocal, multicentric, or contralateral disease that may alter surgical planning, with prior studies reporting additional lesion detection rates ranging from 16% to 30% [5,13,14]. Conversely, MRI may occasionally downgrade lesions initially considered suspicious on mammography or ultrasound, potentially reducing unnecessary biopsies when interpreted in the proper clinical context [15,16].

Adjunctive techniques, such as DWI with apparent diffusion coefficient (ADC) measurements, have been investigated as tools to improve specificity, although variability in ADC thresholds limits their universal application [17–19]. Abbreviated MRI (AB-MRI) protocols have also gained interest in providing efficient cancer detection without significantly compromising diagnostic performance [18,19].

Given the central role of breast MRI in diagnostic evaluation, preoperative planning, and supplemental screening, evaluating its accuracy within a given clinical setting is essential. Accordingly, this study aims to assess the diagnostic performance of breast MRI at Al-Ahli Hospital, examine BI-RADS–pathology concordance, and identify factors influencing MRI interpretation in our patient population.

Methodology

Study design

This retrospective study was conducted at Ahli Hospital and included all female patients who underwent breast magnetic resonance imaging (MRI) between October 2022 and October 2025. A total of 394 breast MRI examinations were reviewed. Among these, 109 patients also underwent breast biopsy and mammography, allowing for correlation between MRI findings, BI-RADS classification, and histopathological results.

MRI protocol

All MRI examinations were performed using a 3-Tesla system. Standard breast MRI protocols were applied, including T1-weighted, T2-weighted, fat-suppressed, and dynamic contrast-enhanced sequences, following internationally accepted recommendations for breast MRI performance [20]. Images were interpreted independently by two consultant radiologists with expertise in breast imaging at the same institution.

BI-RADS assessment

All lesions were categorized using the Breast Imaging Reporting and Data System (BI-RADS) MRI lexicon established by the American College of Radiology (ACR) [21]. BI-RADS categories were subsequently correlated with histopathology and mammographic findings.

Biopsy correlation

Histopathological confirmation was available for 110 patients who underwent either ultrasound-guided core needle biopsy, or ultrasound-guided vacuum-assisted biopsy. All biopsy procedures were performed according to standard breast interventional guidelines [22].

Data analysis

Data was tabulated using Microsoft Excel and analyzed using IBM SPSS v25. Continuous data was reported as mean and standard deviation; categorical variables were reported as frequency and percentage. Chi-square test was used to find any association between the results of MRI, BI-RADS, and the biopsy. Correlation between MRI results and tumor size was tested using Spearman rho. MRI sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) for detection of malignancy were calculated using biopsy results as the gold standard. BI-RADS categories 4 and 5 were considered positive for malignancy, whereas BI-RADS 1–3 was considered negative.

Ethical considerations

The study was conducted in accordance with institutional ethical policies and adhered to the Declaration of Helsinki for research involving human subjects.

Results

A total of 394 patient records has been reviewed. From those records, 109 patients had both MRI and biopsy performed and these were included in the analysis. The age ranged from 16–74 years (mean = 43.33, SD = 9.70). The three diagnostic modalities studied in this research were MRI, BI-RADS, and biopsy (**Table 1**).

Using chi-square test to compare MRI results to those of the biopsy showed a significant association (χ^2 (1) = 12.587, p<0.001). Confusion matrix of these tests is shown in **Table 2.** Cohen's kappa analysis showed a significant agreement between the results of MRI and biopsy (kappa = 0.207, p<0.001). Considering biopsy as the gold standard for the diagnosis of breast tumors, the sensitivity of MRI was found to be 100%, that means all cases classified as 'malignant' by biopsy were classified as 'malignant' by MRI (**Table 2**), the specificity was 41.6%, positive predictive value 27.8%, and negative predictive value was 100%. The accuracy of MRI was 52.3%.

Table 1. Tumor classification according to diagnostic method.

Diagnostic Method	Benign	Malignant
MRI	37 (33.9%)	72 (66.1%)
BI-RADS	73 (67.0%)	36 (33.0%)
Biopsy	89 (81.6%)	20 (18.4%)

Data are presented as number (%)
BI-RADS: Breast Imaging Reporting and Data System

The size of the tumors in the records reviewed ranged from 4–70 mm (mean = 19.18, SD = 12.16). The tumor size variable was non-normally distributed (both Kolmogorov-Smirnov and Shapiro-Wilk tests had p<0.001). Spearman's rho was used to find any correlation between tumor size and MRI diagnosis, and a significant correlation was found (rho = 0.211, p = 0.028), this means that the larger the size of the tumor was, the more likely that it will be diagnosed as 'malignant' by MRI (**Table 2**).

Comparing biopsy with BI-RADs showed a significant association (χ^2 (1) = 8.056, p = 0.005). The association between the results of MRI and BI-RADS was also significant (χ^2 (1) = 12.499, p<0.001). The confusion matrices of these two comparisons are shown respectively in **Tables 3** and **4**.

Discussion

Breast cancer continues to be the most commonly diagnosed cancer among women globally, posing a major health challenge [1]. MRI is widely regarded as the most sensitive imaging modality for breast cancer detection, particularly in high-risk patients and in situations where mammography or ultrasound yield ambiguous findings [23,24]. The results of our study closely reflect this established performance profile.

Among the 109 patients included, MRI demonstrated excellent sensitivity (100%), identifying all biopsy-confirmed malignant lesions. This finding is consistent with previously reported sensitivity ranges of 93–100% in large imaging studies [24]. The high negative

Table 2. Correlation between breast MRI findings and histopathological diagnosis.

Biopsy Classification	MRI Classification		Total
	Benign	Malignant	
Benign	37	52	89
Malignant	0	20	20
Total	37	72	109

Data are presented as number of cases

Table 3. Association between BI-RADS classification and histopathological diagnosis.

Biopsy Classification	BIRADS		Total
	Benign	Malignant	
Benign	65	24	89
Malignant	8	12	20
Total	73	36	109

Data are presented as number of cases

Table 4. Correlation between breast MRI interpretation and BI-RADS classification.

BI-RADS Classification	MRI		Total
	Benign	Malignant	
Benign	33	40	73
Malignant	4	32	36
Total	37	72	109

Data are presented as number of cases

predictive value (NPV) observed further reinforces MRI's value as a reliable tool for excluding malignancy when imaging findings appear benign.

Despite strong sensitivity, MRI specificity in our cohort was relatively low (41.6%), aligning with earlier research documenting substantial variability in MRI specificity due to overlapping enhancement characteristics between benign and malignant processes [25,26]. Fibroadenomas, cystic changes, and inflammatory enhancement frequently exhibit kinetics or morphology resembling malignant lesions, contributing to false-positive interpretations. This limitation underscores the need for supplementary MRI techniques, such as diffusion-weighted imaging, which has been shown to improve overall specificity in several studies [25].

The study also demonstrated a significant positive correlation between tumor size and MRI-based malignancy classification. This observation supports prior findings that larger or more biologically aggressive lesions tend to demonstrate more prominent enhancement characteristics, while smaller or low-grade ductal carcinoma in situ (DCIS) lesions may be less conspicuous on MRI [27].

Although BI-RADS scoring exhibited a significant association with biopsy outcomes, variability in lesion appearance—particularly for non-mass enhancement—and radiologist interpretation may account for residual discrepancies. Such variations align with previous studies evaluating BI-RADS diagnostic performance [26].

Despite the clear strengths identified, several limitations should be acknowledged. These include the retrospective design, reliance on a single-center patient population, and potential variability in MRI interpretation despite adherence to established reporting standards. Nonetheless, the findings of this study reinforce the established role of breast MRI as a highly sensitive diagnostic tool.

In conclusion, MRI in our patient population demonstrated excellent sensitivity and NPV for detecting malignant lesions but exhibited limited specificity, a pattern consistent with international literature. These results support the use of MRI as part of a multimodal diagnostic strategy rather than a standalone test, integrating BI-RADS assessment, clinical evaluation, and histopathology for optimal diagnostic accuracy and patient management [4].

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