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Original Research Article

Role of Contrast MRI in the Evaluation of Breast Lesions with Histopathological Correlation

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Abstract:

Background: Breast cancer is still the most general cancer among women globally, and effective treatment depends on early detection and precise diagnosis. High sensitivity and specificity in the assessment of breast lesions make contrast-enhanced magnetic resonance imaging (CE-MRI) an indispensable diagnostic tool, especially in cases when results from traditional imaging techniques are unclear. The purpose of this study was to analyse the diagnostic accuracy and clinical utility of CE-MRI in assessing breast lesions, along with a later histological correlation.

Methods: A total of 120 females with breast lesions identified through mammography or ultrasound underwent contrast-enhanced MRI followed by biopsy for histopathological examination. MRI findings were categorized using BI-RADS criteria and correlated with histopathological results. Statistical analysis was done using SPSS version 21.0.

Results: The study included patients aged 18 to 75 years (mean age 45.3 years). MRI findings were categorized as BI-RADS 2 (20.8%), BI-RADS 3 (25.0%), BI-RADS 4 (33.3%), and BI-RADS 5 (20.8%). Histopathological examination revealed 54.2% benign and 45.8% malignant lesions. MRI demonstrated a sensitivity of 90.9%, specificity of 83.1%, PPV of 83.6%, and NPV of 90.6% in detecting malignancy. A significant association between MRI findings and histopathological outcomes was observed ($\chi^2 = 61.34$, $p < 0.001$).

Conclusion: Contrast-enhanced MRI is a highly effective diagnostic tool for evaluating breast lesions, providing valuable information for clinical decision-making. Its high sensitivity and specificity support its use in distinguishing between benign and malignant lesions, potentially reducing unnecessary biopsies and facilitating early cancer detection.

Recommendations: Incorporating contrast-enhanced MRI into routine diagnostic protocols for breast cancer, especially in cases with dense breast tissue or inconclusive conventional imaging, is recommended. Further studies should explore cost-effective strategies and training programs to enhance the accessibility and interpretation of MRI findings.

Keywords: Breast cancer, Contrast-enhanced MRI, Diagnostic accuracy, BI-RADS, Histopathological correlation.

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Introduction

In the world, breast cancer is the most frequent cancer among females and the primary cause of cancer-related mortality. Effective treatment and a better prognosis depend on early detection and precise diagnosis. Although mammography and ultrasonography are commonly used screening methods, additional imaging modalities are required due to their limitations, especially in dense breast tissue [1]. When it comes to evaluating breast lesions, contrast-enhanced magnetic resonance imaging (CE-MRI) has become a potent diagnostic technique with excellent sensitivity and specificity for identifying cancer.

Gadolinium-based contrast agents are used in CE-MRI to improve tissue differentiation and facilitate precise visualisation of breast anatomy and disease. Its well-documented capacity to identify benign and malignant tumours as well as detect tiny lesions [2]. When examining ambiguous results from mammography or ultrasound, MRI is especially helpful in determining the degree of disease in cases of newly diagnosed breast cancer and tracking the patient's reaction to neoadjuvant treatment.

Studies have shown that MRI performs better in terms of diagnosis than other imaging modalities.

For example, a meta-analysis found that MRI had a 90% pooled sensitivity, which is far greater than mammography and ultrasound combined [3]. According to a different study, MRI can identify up to 18 more tumours for every 1,000 women tested, especially in those with dense breast tissue [4]. These results highlight how crucial it is to use MRI in breast cancer diagnosis procedures.

Despite its advantages, the use of MRI in breast imaging is not without challenges. The high cost, limited availability, and need for contrast administration pose significant barriers to widespread implementation. Additionally, the interpretation of MRI results requires specialized training and expertise. False-positive findings, leading to unnecessary biopsies and anxiety, are also a concern.

This study evaluated the role of CE-MRI in the assessment of breast lesions, with subsequent histopathological correlation.

Methdology

Study Design: A prospective observational study.

Study Setting: The study took place at the Radiology Department, from August 2023 to February 2024.

Participants: A total of 120 female patients presenting with breast lesions identified through mammography or ultrasound and referred for MRI evaluation were included in the study.

Inclusion Criteria

1. Female patients aged 18 years and above.

2. Patients with detected breast lesions on mammography or ultrasound.

3. Patients willing to undergo MRI and provide informed consent for participation.

4. Patients willing to undergo biopsy for histopathological examination.

Exclusion Criteria

1. Patients with contraindications to MRI.

2. Pregnant or lactating women.

3. Patients who had received prior treatment for breast cancer.

Bias: To minimize bias, random sampling was used to select participants from the eligible patient pool. MRI and histopathological examinations were performed and interpreted by radiologists and pathologists blinded to each other's findings.

Variables: Variables included contrast-enhanced MRI findings, and histopathological diagnosis.

Data Collection: Data were gathered through patient interviews, medical records, MRI reports, and histopathological reports. Each participant's demographic information, clinical history, MRI findings, and histopathological results were recorded.

Procedure

1. MRI Procedure:

- All patients underwent CE-MRI using a 1.5 Tesla scanner.

- Standard MRI protocol for breast imaging, including T1-weighted, T2-weighted, and dynamic contrast-enhanced sequences, was followed.

- MRI findings were documented and categorized based on BI-RADS (Breast Imaging Reporting and Data System) criteria.

2. Histopathological Examination:

- Following MRI, all patients underwent a biopsy of the breast lesion.

- Histopathological examination was performed by a pathologist to determine the nature of the lesion.

- Histopathological results were categorized as benign or malignant.

Statistical Analysis: SPSS version 21.0 was used to analyse the data. The MRI results, histopathological findings, and patient demographics were compiled using descriptive statistics. For the purpose of identifying cancer, the contrast-enhanced MRI's sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated. To estimate the correlation between MRI results and histological consequences, the Chi-square test was employed. P-values < 0.05 were deemed statistically significant.

Ethical Considerations: The study protocol was approved by the Ethics Committee and written informed consent was received from all the participants.

Result

The study comprised 120 female patients, aged between 18 and 75 years, with a mean age of 45.3 years. The patients presented with breast lesions identified through mammography or ultrasound and underwent contrast-enhanced MRI followed by histopathological examination.

Table 1: Age distribution

Age Group (years)	Number of Patients	Percentage (%)
18 – 30	20	16.7
31 – 45	40	33.3
46 – 60	40	33.3
61 – 75	20	16.7

Table 2: MRI Findings

BI-RADS Category	Number of Patients	Percentage (%)
BI-RADS 2	25	20.8
BI-RADS 3	30	25.0
BI-RADS 4	40	33.3
BI-RADS 5	25	20.8

Table 3: Histopathological Results

Histopathological Diagnosis	Number of Patients	Percentage (%)
Benign Lesions	65	54.2
- Fibroadenoma	25	20.8
- Fibrocystic Changes	20	16.7
- Other Benign Lesions	20	16.7
Malignant Lesions	55	45.8
- Invasive Ductal Carcinoma	35	29.2
- Invasive Lobular Carcinoma	10	8.3
- Other Malignant Lesions	10	8.3

The statistical analysis for MRI in detecting malignancy was as follows:

Table 4: Statistical Analysis of MRI

Statistical Measure	Value
Sensitivity	90.9%
Specificity	83.1%
PPV	83.6%
NPV	90.6%

The Chi-square test was used to assess the association between MRI findings (BI-RADS categories) and histopathological results (benign vs. malignant).

Table 5: Association between MRI and Histopathological Results

BI-RADS Category	Benign Lesions (n)	Malignant Lesions (n)	Total (n)
BI-RADS 2	23	2	25
BI-RADS 3	25	5	30
BI-RADS 4	15	25	40
BI-RADS 5	2	23	25

The Chi-square test indicated a significant association between MRI findings and histopathological outcomes ($\chi^2 = 61.34$, $p < 0.001$).

Discussion

In 120 female patients between the ages of 18 and 75, this study evaluated the effectiveness of CE-MRI in evaluating breast abnormalities with histological correlate. 20.8% of lesions were benign (BI-RADS 2), 25.0% were probably benign (BI-RADS 3), 33.3% were suspicious (BI-RADS 4), and 20.8% were highly suggestive of malignancy (BI-RADS 5), according to the MRI findings.

54.2% of the lesions were verified by histopathological investigation to be benign and 45.8% to be malignant. Invasive ductal carcinoma (29.2%) and invasive lobular carcinoma (8.3%) were the most common diagnoses among the malignant cases. Higher BI-RADS categories are substantially connected with malignancy, according to statistical analysis utilising the Chi-square test, which showed a considerable connection between MRI findings and histopathological outcomes ($\chi^2 = 61.34$, $p < 0.001$). The excellent sensitivity and specificity results support the validity of MRI in differnetiating between benign and malignant breast lesions.

Overall, the results suggest that CE-MRI is a highly effective diagnostic tool for evaluating breast lesions. It provides valuable information that can guide clinical decision-making and improve patient management. The significant correlation between MRI findings and histopathological results highlights the potential of MRI to reduce unnecessary biopsies and enhance early detection of breast cancer.

Since CE-MRI has a high sensitivity and can distinguish between benign and malignant tissues, it is frequently employed in the evaluation of breast lesions. When contrast-enhanced spectral mammography (CESM) and MRI were compared, the results showed that CESM had marginally greater specificity (89.5% vs. 71.7%) and accuracy (81% vs. 80.2%) for the identification of breast cancer. Similar results were seen for both modalities' negative predictive value (82.1%) and sensitivity (91.5%) [5].

A study investigated early kinetic parameters from ultrafast dynamic CE-MRI and found significant associations with prognostic factors like tumor size and estrogen receptor status. The study highlighted the utility of early enhancement parameters in predicting aggressive breast cancer features [6]. A study correlated DCE-MRI parameters with histopathological prognostic factors, finding significant correlations between initial peak enhancement, slope increase, and Ki-67 expression. Time-signal intensity curve types were also associated with higher Ki-67 expression, indicating more aggressive tumor behavior [7].

A study compared CESM and MRI in a multiethnic cohort and found CESM to be as effective as MRI in evaluating breast cancer, with higher specificity and positive predictive value. CESM showed good agreement with MRI and histopathology in measuring tumor size [8]. Research explored the relationship between DCE-MRI features and breast cancer prognostic factors, finding significant correlations between enhancement patterns and markers like ER, PR, and Ki-67. These findings suggest that DCE-MRI can provide valuable prognostic information [9].

Conclusion

According to the study, high sensitivity and specificity CE-MRI is a useful method for evaluating breast lesions. The reliability of MRI in differentiating between benign and malignant breast lesions is highlighted by the strong correlation observed between MRI findings and histological results.

Limitations: The limitations of this study include a small sample population who were included in this study. Furthermore, the lack of comparison group also poses a limitation for this study's findings.

Recommendations: Incorporating contrast-enhanced MRI into routine diagnostic protocols for breast cancer, especially in cases with dense breast tissue or inconclusive conventional imaging, is recommended. Further studies should explore cost-effective strategies and training programs to enhance the accessibility and interpretation of MRI findings.

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List of abbreviations:

BI-RADS - Breast Imaging Reporting and Data System

CE-MRI - Contrast-Enhanced Magnetic Resonance Imaging

MRI - Magnetic Resonance Imaging

SPSS - Statistical Package for the Social Sciences

PPV - Positive Predictive Value

NPV - Negative Predictive Value

ER - Estrogen Receptor

PR - Progesterone Receptor

CESM - Contrast-Enhanced Spectral Mammography

DCE-MRI - Dynamic Contrast-Enhanced Magnetic Resonance Imaging

Ki-67 - A marker used to determine the proliferation rate of cells

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