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Diagnostic value of MRI in the evaluation of breast cancer: A systematic review

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Abstract
Background: Breast cancer is a wide spread dreaded disease. Various non-invasive imaging methods, i.e. computed tomography, ultrasonography, magnetic resonance imaging, bone scans, and positron emission tomography are being used for its diagnostic purpose.
Objectives: The present study was planned with the objectives to evaluate the diagnostic accuracy and effectiveness of magnetic resonance imaging (MRI) in detecting and characterizing breast malignancies, to compare the sensitivity and specificity of MRI with other imaging modalities such as mammography and ultrasound in breast cancer detection and to identify the limitations and challenges of MRI, including false-positive findings, and explore strategies to improve its reliability and clinical application in breast cancer screening.
Methods: A total of 33 references were reviewed upto September, 2025 which were closely related to the studies on diagnostic value of MRI in the evaluation of breast cancer. These articles were consulted from databases such as PubMed, MEDLINE, EMBASE, Google Scholar, Cochrane databases. Of those, 11 articles were screed for meta-analysis considering their complete information.
Results: It was reported about the use of MRI in breast cancer detection, screening, and management Several studies demonstrated the role of MRI in detecting, diagnosing, and managing breast cancer. Another study investigated the imaging features of benign and malignant breast lesions using contrast-enhanced MRI.
Conclusion: MRI has proven to be a highly useful and sensitive method for detecting, evaluating, and managing breast cancers.

Keywords: Magnetic resonance imaging, Diagnosis, Breast cancer

Introduction
Nowadays cancer is a global threat. 20 million of new cancer cases were found in the year of 2022 and 9.7 million people already passed away [1]. Breast cancer is a one of the leading cause of deaths in women. worldwide 23.8% cases were related to breast cancer and 15.4% deaths were occurred in women [2]. However timely diagnosis improves patient survival and allows for less invasive breast surgery [3].

The current strategies for cancer diagnosis in clinical practice typically involve a combination of physical examination to detect abnormal changes in different anatomical regions, alongside a wide range of laboratory tests using blood and urine samples. These are complemented by non-invasive imaging methods such as computed tomography (CT), ultrasonography (US), magnetic resonance imaging (MRI), bone scans, and positron emission tomography (PET). To confirm the presence and stage of cancer, tissue sampling is performed through minimally invasive techniques such as fine needle aspiration or through surgical biopsy, followed by histopathological evaluation. In addition, immunological assays and flow cytometry play a vital role in diagnosing and monitoring haematological malignancies such as leukaemia's [4-6].

Mammography has limited accuracy in identifying breast cancer among patients with dense breast tissue [7]. The utility of ultrasound for diagnosing multifocal, multicentric, or in situ carcinoma is still uncertain [8]. Magnetic resonance mammography can detect multifocal and multicentric tumors. It also helps to predict tumor size and spread, which improves staging and treatment planning. This method is more sensitive than standard mammography, especially in women with a genetic risk of breast cancer [9].

In this study, we reviewed the efficiency of MRI to detect the breast carcinoma. To evaluate the diagnostic accuracy and effectiveness of Magnetic Resonance Imaging (MRI) in detecting and characterizing breast malignancies, to compare the sensitivity and specificity of MRI with other imaging modalities such as mammography and ultrasound in breast cancer detection and to identify the limitations and challenges of MRI, including false-positive findings, and explore strategies to improve its reliability and clinical application in breast cancer screening.

Material & Methods

A total of 33 references were reviewed upto September, 2025 which were closely related to the studies on diagnostic value of MRI in the evaluation of breast cancer (Fig. 1). These articles were consulted from databases such as PubMed, MEDLINE, EMBASE, Google Scholar, Cochrane databases. The inclusion criteria were as followed: (1) articles containing the diagnostic techniques of MRI (2) references upto to the year 2025 were included. Of those, 11 articles were screed for meta-analysis considering their complete information.

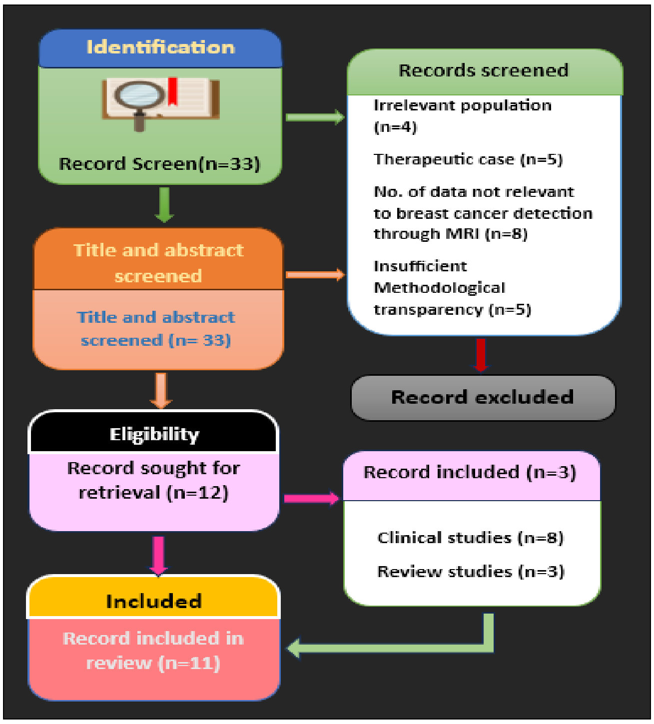

Fig 1: (Flow chart of recruited references)

Results & Discussion

MRI is a widely used diagnostic tool for the detection of breast cancer. In the present study, an attempt has been made to conduct a systematic review and meta-analysis in 11 recent related references to add some knowledge in this clinical and research fields (Table 1). It was reported about the use of MRI in breast cancer detection, screening, and management (SL No. 2, 6, 7, 8, 9, and 11). Several studies demonstrated the role of MRI in detecting, diagnosing, and managing breast cancer. SL No. 2 investigated the imaging features of benign and malignant breast lesions using contrast-enhanced MRI. The study achieved an area under the curve (AUC) of 0.925 for mass lesions, indicating excellent diagnostic accuracy. The high specificity (0.922) and positive predictive value (0.848) confirm MRI's reliability in identifying malignant lesions. It also showed that factors such as patient age, lesion site, and background parenchymal enhancement significantly influenced malignancy prediction. SL No. 6 conducted a large multicentre trial on women with extremely dense breast tissue and reported a substantial reduction in interval cancers among participants who underwent MRI screening compared to mammography alone. The cancer detection rate in the MRI group was 16.5 per 1000 screenings, demonstrating MRI's superiority in detecting early-stage and node-negative cancers that mammography often misses. SL No. 7 compared MRI and clinical breast examination (CBE) for high-risk women. MRI detected 1.6% of cancers, whereas CBE failed to detect any. Although MRI had a higher recall (11.2%) and biopsy rate (6.2%), its effectiveness in early diagnosis outweighed these drawbacks, suggesting that CBE adds minimal value when MRI screening is available. SL No. 8 analysed MRI-guided biopsies and found that while 18% of biopsied lesions were malignant, most were benign. The study demonstrated MRI's capability to locate subtle lesions and assess disease extent, but also revealed its tendency toward false positives, stressing the importance of histopathologic confirmation. SL No. 9 compared MRI performance in women with personal versus family history of breast cancer. Detection rates were nearly identical (1.7% vs. 1.8%), but false-positive rates were lower in those with a personal history (12.3%), suggesting MRI performs more accurately in previously diagnosed individuals. SL No. 11 reviewed MRI's broader role in breast cancer management, establishing it as a valuable imaging tool for staging, problem-solving, and post-treatment surveillance. The study emphasized MRI's unmatched sensitivity for detecting multifocal and multicentric disease, supporting its ongoing use in clinical oncology. Taken together, these six studies consistently highlight MRI's high sensitivity and effectiveness in breast cancer detection and follow-up. However, they also reveal common challenges, such as increased recall rates and false-positive findings. Despite these limitations, MRI remains indispensable, particularly for high-risk populations and dense breast tissue cases.

Several studies on MRI in early cancer detection beyond breast malignancy (SL No. 1, 3, and 10). SL No. 1 conducted a comparative analysis of MRI and clinical palpation for detecting lymph node metastasis in oral and maxillofacial malignancies. The study found MRI sensitivity at 69.39% compared to 46.51% for palpation. When both techniques were combined, sensitivity increased to 74.42% and specificity to 75.93%, indicating that MRI complements clinical examination, enhancing diagnostic accuracy. SL No. 3 compared magnetic resonance imaging and X-ray in early cancer detection across multiple cancer types. The paper concluded that MRI is particularly vital for identifying brain cancers at an early stage, while X-ray remains more practical for lung cancer screening. It also emphasized that early detection using imaging significantly improves patient survival outcomes. SL No. 10 evaluated MRI for lung cancer detection in over 11,000 healthy individuals. The study achieved an overall detection rate of 0.4%, mostly identifying small adenocarcinomas under 3 cm. Although MRI proved capable of detecting early-stage lung cancers, several false positives were also noted, highlighting the need for confirmatory diagnostic tools. These studies collectively confirm MRI's expanding role beyond breast imaging, showing its utility in detecting various early malignancies. While sensitivity is consistently high, specificity issues persist, suggesting that MRI should be integrated with other diagnostic methods for optimal accuracy.

Limitations, false positives, and screening challenges (SL No. 4, 5, and 8). SL No. 4 focused on false-positive incidental lesions in contrast-enhanced breast MRI. The study reported an 82.2% false-positive rate, with irregular lesion shape being a major factor influencing true positive outcomes. T2-hyperintense lesions were often misclassified as malignant. These findings underline the limitations of MRI interpretation and the need for radiologic-pathologic correlation. SL No. 5 reviewed the application of whole-body MRI for general cancer screening and concluded that, despite its ability to detect lesions throughout the body, it frequently identifies indeterminate or benign findings. This high rate of incidental discoveries restricts WB-MRI's clinical usefulness in population-based screening programs. SL No. 8 similarly observed that most MRI-guided biopsies yielded benign results. This again demonstrates MRI's tendency toward false-positive findings when used for screening rather than targeted diagnosis. Collectively, these studies emphasize that while MRI is a powerful diagnostic tool, its application in population screening must be approached with caution. High false-positive rates not only increase patient anxiety but also lead to unnecessary biopsies and healthcare costs.

Table 1: (Meta-analysis of related references on MRI as a diagnostic tool of breast cancer)

SL No	Author & Sources	Year of Publication	Place of the study	Title of the study	Types of study	No of Patients	Finding
1.	Chen J et al [10]	2025	Chaina	Comparative analysis of preoperative MRI detection and clinical palpation examination in patients with oral and maxillofacial malignant tumor.	Comparative analysis	97	MRI showed 69.39% sensitivity and 65.12% specificity, while palpation had 46.51% sensitivity and 74.07% specificity; combining both improved accuracy to 74.42% sensitivity and 75.93% specificity, though MRI was less specific for tongue cancer.
2.	Kubota K et al. [11]	2024	Japan	Investigation of imaging features in contrast-enhanced magnetic resonance imaging of benign and malignant breast lesions	Retrospective	200	Among 100 malignant cases, 66 were invasive ductal carcinoma and 24 were ductal carcinoma in situ. The logistic regression model showed high accuracy (AUC = 0.925) for mass lesions, while decision tree analysis achieved 0.770 sensitivity, 0.922 specificity, and 0.848 PPV. For non-mass enhancement, the model had an AUC of 0.829 with 0.538 sensitivity and 0.913 specificity. Age, lesion location, and BPE level were key predictors of malignancy.
3.	Zhang CY et al. [12]	2023	Not Applicable	Effectiveness of early cancer detection method: magnetic resonance imaging and X-ray technique	comparative review	Not Applicable	The paper stresses that advancements in nano-drug delivery and non-surgical treatments can control early cancers, highlights MRI and X-ray roles in early detection, and notes limited options for advanced cancer, emphasizing the need for better early diagnosis.
4.	Alikhassi A et al. [13]	2023	Multi-institutional study	False-positive incidental lesions detected on contrast-enhanced breast MRI: Clinical and Imaging Features	Retrospective	219	Among 219 MRI-guided biopsies, 62.5% were benign, 18% malignant, and 19.6% high-risk, with a false-positive rate of 82.2%. Age and irregular mass shape were linked to higher true-positive rates, while T2-hyperintense lesions were associated with false positives.
5.	Petralia G et al. [14]	2021	Not Applicable	Whole-body magnetic resonance imaging (WB-MRI) for cancer screening: recommendations for use	systematic review	Not Applicable	The clinical utility of WB-MRI for cancer screening in the general population remains debated due to high rates of indeterminate incidental and false-positive findings.
6.	Mihalco SP et al. [15]	2020	UK	Comparison of the utility of clinical breast examination and MRI in the surveillance of women with a high risk of breast cancer	Retrospective	561	MRI screening detected cancer in 1.6% of cases with an 11.2% recall rate, while CBE found no cancers and had a 6.2% ultrasound referral rate. Biopsy rates were 6.2% for MRI versus 0.2% for CBE, suggesting CBE is not essential for high-risk surveillance.
7.	Bakker MF et al. [16]	2019	Dutch population	Supplemental MRI Screening for Women with Extremely Dense Breast Tissue	Multicentre	40373	MRI screening reduced interval cancers to 2.5 per 1000 compared to 5.0 per 1000 with mammography alone. It showed a higher cancer detection rate (16.5 per 1000), with more node-negative, early-stage, and invasive cancers identified, and a slightly lower rate of late-stage cases.
8.	Jabbar SB et al. [17]	2017	UK	Pathologic Findings of Breast Lesions Detected on Magnetic Resonance Imaging	Retrospective	177	In 177 MRI-guided biopsies on 152 patients, 18% were malignant, mostly invasive carcinoma (61%) or DCIS (39%). Most biopsies (82%) were BI-RADS 4, with disease extent assessment (43%) and high-risk screening (39%) as common indications.
9.	Lehman CD et al. [18]	2016	Washington	Screening MRI in Women with a Personal History of Breast Cancer	Retrospective	1521	Among 1521 women screened by MRI, cancer detection rates were similar for those with personal (1.7%) and genetic/family history (1.8%). The PH group had higher PPV (25% vs. 14.7%), lower false positives (12.3% vs. 21.6%), and higher specificity (94% vs. 86%) than the GFH group.
10.	Wu NY et al. [19]	2011	Taiwan	Magnetic resonance imaging for lung cancer detection: Experience in a population of more than 10,000 healthy	Retrospective	11,766	Among 11,766 individuals, 49 primary lung cancers were diagnosed (0.4% detection rate), mostly adenocarcinomas (77.6%). Detection was 0.9% in smokers and 0.4% in never-smokers, with eight false positives due to infections.

				individuals			
11.	Enriquez L et al. [2]	2009	Not Applicable	Role of MRI in breast cancer management	Review	Not Applicable	The authors conclude that MRI is highly effective for breast cancer staging, detection, and post-treatment monitoring, with ongoing advancements expected to further enhance its role in management.

Conclusion
Magnetic Resonance Imaging (MRI) has proven to be a highly useful and sensitive method for detecting, evaluating, and managing breast cancers. The studies reviewed show that MRI performs better than traditional imaging methods like mammography and ultrasound, especially for women with dense breast tissue or those at high risk of breast cancer. Its strong ability to detect multiple or early-stage tumors helps improve diagnostic accuracy and supports more effective treatment planning.

Despite its high sensitivity, MRI also has some drawbacks. It can produce a number of false-positive results, which may cause unnecessary biopsies, patient stress, and added medical costs. Accurate interpretation of MRI images requires skilled professionals, and results should always be confirmed with other imaging tests or tissue analysis for better reliability.

Furthermore, although MRI shows potential in detecting other types of cancers early, its lower specificity limits its use as a single screening tool for everyone. Continued improvements in imaging technology, artificial intelligence, and contrast materials are expected to make MRI more precise and reduce false positives.

Overall, MRI remains an important tool in the early detection and treatment of breast cancer. When used correctly, it supports other diagnostic methods, improves patient outcomes, and continues to play a key role in cancer imaging.

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Conflicts of interest
There are no conflicts of interest.

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