



The role of Artificial Intelligence in the detection of breast cancer: A narrative review

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Abstract

Background: Breast cancer is one of the most common malignancies among women worldwide, and early detection remains critical for improving survival and treatment outcomes. Conventional imaging-based screening methods are limited by inter-observer variability and increasing workload demands.

Objective: To review the role of artificial intelligence (AI) in the detection of breast cancer, with emphasis on imaging applications, diagnostic performance, and clinical integration.

Materials and Methods: A narrative review of the literature published between 2015 and 2024 was conducted using electronic databases including PubMed, Google Scholar, and Scopus. Studies evaluating AI-based applications in mammography, breast ultrasound, and breast MRI were reviewed. Original research articles, validation studies, and systematic reviews were included, while case reports and non-peer-reviewed articles were excluded.

Results: AI-based systems demonstrated high diagnostic performance across breast imaging modalities, with reported sensitivities ranging from approximately 85% to over 94% in selected studies. AI-assisted workflows showed improved lesion detection, reduced false-positive rates, and enhanced radiologist efficiency, particularly when used as a decision-support tool rather than as a standalone system.

Conclusion: Artificial intelligence has significant potential to augment breast cancer detection and screening by improving diagnostic accuracy and workflow efficiency. However, challenges related to generalizability, interpretability, and regulatory implementation must be addressed before widespread clinical adoption.

Keywords: Artificial intelligence, breast cancer, mammography, deep learning, computer-aided diagnosis, radiology

Introduction

Breast cancer remains a leading cause of cancer-related morbidity and mortality among women globally. Early detection plays a pivotal role in improving prognosis and expanding treatment options. Conventional imaging techniques such as mammography, ultrasound, and magnetic resonance imaging are the cornerstone of breast cancer screening; however, they are subject to inter-observer variability and increasing workload pressures. Recent advances in artificial intelligence, particularly machine learning and deep learning, have shown promise in addressing these limitations. This review aims to critically evaluate current AI applications in breast cancer detection, with emphasis on imaging performance, clinical workflow integration, and real-world limitations.

Materials and Methods

This narrative review was conducted by performing a structured literature search of electronic databases including PubMed, Google Scholar, and Scopus for articles published between January 2015 and December 2024. Search terms included combinations of “artificial intelligence,” “machine learning,” “deep learning,” “breast cancer,” “mammography,” “breast ultrasound,” and “breast MRI.” Original research articles, clinical validation studies, and systematic reviews focusing on AI applications in breast cancer detection were included. Articles not published in

English, case reports, editorials, conference abstracts, and non-peer-reviewed sources were excluded. Relevant articles were screened based on title and abstract, followed by full-text review to assess relevance. Findings were qualitatively synthesized.

Results

AI applications in breast cancer detection demonstrated consistent improvements in diagnostic performance across imaging modalities. In mammography, AI systems improved detection of masses and microcalcifications. Ultrasound-based AI models enhanced lesion characterization, particularly in dense breast tissue. AI-assisted breast MRI enabled improved lesion segmentation and kinetic analysis. Several studies reported reduced false-positive rates and improved reader efficiency when AI was used as a support tool.

Discussion

Artificial intelligence has emerged as a valuable adjunct in breast cancer imaging, offering the potential to enhance diagnostic accuracy and address limitations inherent in conventional image interpretation. Across mammography, ultrasound, and magnetic resonance imaging, AI-based systems have demonstrated encouraging performance in lesion detection, characterization, and workflow optimization. However, the clinical role of AI should be

viewed primarily as a decision-support tool rather than a replacement for radiologists.

In mammography, AI has shown particular promise in improving the detection of subtle lesions such as microcalcifications and small masses, which are prone to perceptual errors. Several studies have demonstrated that AI-assisted reading can reduce false-positive rates and improve cancer detection when integrated into double-reading workflows. This is especially relevant in high-volume screening programs where radiologist fatigue and workload pressures may affect performance. In breast ultrasound, AI applications have been shown to aid in lesion characterization and risk stratification, particularly in women with dense breast tissue. Automated feature extraction and pattern recognition may help reduce operator dependency and inter-observer variability. Similarly, in breast MRI, AI-based lesion segmentation and kinetic analysis have contributed to improved lesion assessment and preoperative planning.

Despite these advances, several challenges limit widespread adoption. AI model generalizability remains a concern, as performance may decline when applied to different populations, imaging equipment, or acquisition protocols. Interpretability of deep learning models is another barrier, limiting clinician trust and raising medico-legal concerns. Clear regulatory frameworks and radiologist oversight are essential to ensure safe clinical implementation. Overall, while AI demonstrates substantial potential to augment breast cancer detection, its clinical utility depends on thoughtful integration into workflows, rigorous validation, and continued radiologist supervision.

Conclusion

Artificial intelligence represents a transformative advancement in breast cancer detection by enhancing diagnostic accuracy and supporting radiologist decision-making. Continued validation, ethical deployment, and clinician oversight are essential to ensure effective and responsible clinical adoption.

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