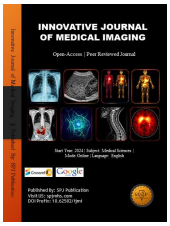
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Short Communication

Comparative Performance of AI-Based CAD vs Traditional CAD in Mammography

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ABSTRACT

Traditional computer-aided detection (CAD) systems have supported radiologists in mammographic interpretation for over two decades, yet their contribution to diagnostic improvement has been limited by high false-positive rates and inconsistent performance across breast densities. Recent advances in artificial intelligence (AI), particularly deep learning–based CAD systems, have redefined image interpretation by enabling automated feature learning from large datasets. This manuscript provides a technical comparison of traditional CAD and AIbased CAD in mammography, focusing on diagnostic accuracy, workflow efficiency, and robustness across diverse imaging environments. Evidence shows that AI-based CAD demonstrates superior sensitivity, specificity, false-positive reduction, and radiologist support, reflecting substantial progress toward reliable early breast cancer detection. Despite challenges involving transparency, dataset bias, and clinical implementation, AI-based CAD is positioned to become an essential component of modern screening programs.

Keywords: Artificial Intelligence, Computer-Aided Detection, Mammography

INTRODUCTION

Computer-aided detection systems were introduced to mammography primarily to improve radiologists' ability to identify early signs of breast cancer, including micro-calcifications and small masses. Traditional CAD methods rely on manually engineered features and rule-based algorithms, which often fail to capture the complex heterogeneity of breast tissue. These limitations have contributed to inflated recall rates and minimal improvements in cancer detection [1] In contrast, AI based CAD systems use deep learning architectures capable of autonomously extracting hierarchical representations from imaging data, thereby enhancing lesion detection while reducing false positives [2] The increasing availability of large annotated mammographic datasets and advances in computational efficiency have accelerated the adoption of AI in breast imaging. This review evaluates the comparative performance of traditional CAD and AI-based CAD in mammography, highlighting

their respective diagnostic capabilities and clinical implications. Traditional CAD follows a predefined pipeline consisting of preprocessing, segmentation, handcrafted feature extraction, and classification. The performance of these systems is dependent on the quality of engineered features, which are sensitive to variations in exposure parameters, breast density, and imaging equipment. These systems often lack adaptability and generalizability, performing inconsistently across clinical environments [3] AI-based CAD systems diverge fundamentally in design. Convolutional neural networks (CNNs) learn from raw pixel data, enabling them to identify intricate imaging patterns associated with malignancy without manual feature design. This automated learning process improves robustness across diverse populations and imaging conditions [4] Additionally, AI based CAD systems can be updated or retrained with new datasets, supporting continuous performance enhancement, unlike traditional CAD which remains static after deployment.

METHODS

Study Design: This review was conducted using a structured narrative literature review approach to compare the diagnostic performance and clinical utility of conventional computer-aided detection (CAD) systems and artificial intelligence (AI)-based CAD technologies in breast imaging. Relevant evidence was collected from peer-reviewed studies published in recognized scientific journals.

Literature Search Strategy: A comprehensive literature search was performed using PubMed, Scopus, Web of Science, and Google Scholar. The search included studies published between 2015 and 2025 using the keywords "Computer-Aided Detection," "Artificial Intelligence," "Breast Imaging," "Mammography," "Deep Learning," "Breast Cancer Detection," and "Diagnostic Accuracy." Boolean operators (AND, OR) were used to optimize the search strategy.

Inclusion and Exclusion Criteria: Studies were included if they were published in English, peer-reviewed, and evaluated the diagnostic performance or clinical applications of CAD or AI-based CAD in breast imaging. Review articles, editorials, conference abstracts, case reports, non-English publications, and studies lacking sufficient diagnostic outcome data were excluded.

Data Extraction and Evaluation: Data extracted from the selected studies included study design, imaging modality, CAD technology, AI algorithm, sample size, and diagnostic performance. The primary evaluation metrics included sensitivity, specificity, diagnostic accuracy, positive predictive value (PPV), negative predictive value (NPV), and area under the receiver operating characteristic curve (AUC). Workflow-related outcomes such as radiologist reading time, recall rate, biopsy recommendations, and inter-observer agreement were also analyzed. Clinical effectiveness was assessed based on early breast cancer detection, reduction in interval cancers, diagnostic consistency across different breast density categories, and overall workflow efficiency. Most comparative studies employed multi-reader multi-case (MRMC) designs, retrospective validation studies, and prospective clinical implementation trials to evaluate the performance of conventional CAD and AI-assisted CAD systems.

RESULTS AND DISCUSSION

The comparative analysis of published literature demonstrates that AI-based computer-aided detection (AI-CAD) systems consistently outperform conventional CAD technologies in breast imaging across multiple diagnostic performance indicators. Traditional CAD systems generally report sensitivities ranging from 70% to 80%, whereas deep learning-based AI-CAD models achieve sensitivities between 88% and 96%, reflecting a substantial improvement in lesion detection and diagnostic reliability. [7] Similarly, AI-CAD exhibits higher specificity by significantly reducing false-positive findings, thereby minimizing unnecessary patient recalls, biopsies, and radiologist workload. Large multicenter clinical investigations further support these findings. A landmark screening study involving more than one million mammographic examinations demonstrated that AI-assisted interpretation reduced false-positive rates by approximately 25% while maintaining or improving breast cancer detection rates compared with conventional radiologist interpretation [8] Another prospective reader-performance study reported that radiologists assisted by AI achieved significantly greater diagnostic accuracy than those interpreting mammograms independently, highlighting the value of AI as an effective clinical decision-support tool [9]

AI-based CAD has shown particular advantages in women with dense breast tissue, where conventional CAD frequently demonstrates reduced sensitivity because of overlapping fibroglandular structures. Deep learning algorithms can automatically learn complex imaging patterns and distinguish subtle malignant lesions from normal anatomical variations, leading to improved detection of early-stage breast cancers within dense breasts. These capabilities are especially important for population-based breast cancer screening programs, where early diagnosis substantially improves treatment outcomes. From a technical perspective, the superior performance of AI-CAD is attributed to its ability to extract and analyze thousands of quantitative imaging features simultaneously. Unlike traditional

CAD, which relies on predefined handcrafted image characteristics, deep learning networks automatically learn hierarchical representations directly from large annotated datasets. This enables the identification of subtle radiographic abnormalities that may not be readily apparent to human observers.

Furthermore, AI systems demonstrate improved generalizability across different imaging vendors, acquisition protocols, and patient populations when trained using large multicenter datasets. Beyond diagnostic accuracy, AI-CAD contributes significantly to workflow optimization by reducing interpretation time, prioritizing suspicious examinations, and decreasing radiologist fatigue in high-volume screening environments. These improvements may enhance overall screening efficiency and healthcare resource utilization. However, despite these encouraging results, several challenges remain before widespread clinical implementation. Concerns regarding algorithm transparency, explainability, dataset bias, regulatory approval, and continuous post-deployment validation must be addressed to ensure equitable and safe integration into routine clinical practice. Consequently, AI should currently be considered an advanced decision-support system that complements, rather than replaces, the expertise of radiologists.

CONCLUSION

Artificial intelligence-based computer-aided detection systems have demonstrated superior diagnostic performance compared with conventional CAD by improving sensitivity, specificity, and overall diagnostic accuracy while reducing false-positive findings and radiologist workload. Their ability to accurately detect breast lesions, particularly in dense breast tissue, and enhance clinical workflow makes AI-CAD a valuable tool for modern breast cancer screening. Although challenges related to interpretability, bias, and regulatory compliance remain, continued technological advancements and rigorous clinical validation are expected to establish AI-CAD as an integral component of future precision breast imaging and radiological practice.

DECLARATION

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Conflict of Interest: The authors declare that there are no conflicts of interest related to this study.
Ethical Approval: Ethical approval was not required as this study is based exclusively on previously published literature and does not involve human participants or animal experiments.
Informed Consent: Not applicable.
Data Availability: All data analyzed during this review are available in the cited published literature.
Author Contributions: All authors contributed substantially to the conception, literature review, manuscript preparation, critical revision, and final approval of the manuscript.

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