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The Clinical Utility Of AI Models In Diagnostic And Endovascular Radiology

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Abstract

Background: Artificial intelligence (AI) has emerged as a powerful tool in radiology, offering enhanced diagnostic accuracy, improved workflow efficiency, and support for complex interventional procedures. Despite rapid technological advancement, evidence comparing AI-assisted interpretation and procedural guidance with conventional radiology remains limited. This study evaluated the clinical utility of AI models in diagnostic and endovascular radiology using real clinical data.

Methods: An analytical cross-sectional study was conducted on 240 patients, including 160 diagnostic radiology cases and 80 endovascular radiology cases. Diagnostic images (CT, MRI, and radiography) were interpreted by both radiologists and an AI model, with performance compared against a consensus reference standard. Endovascular data were analyzed to assess AI-generated vessel segmentation, catheter pathway prediction, and procedure optimization. Primary outcomes included sensitivity, specificity, accuracy, interpretation time, fluoroscopy time, contrast use, and total procedure duration. Statistical analyses were performed using SPSS version 27.

Results: AI-assisted diagnostic interpretation demonstrated higher sensitivity (90.6%), specificity (86.3%), and overall accuracy (88.8%) compared with conventional interpretation. AI also reduced interpretation time, with 81.3% of cases completed in under five minutes versus 42.5% conventionally. In endovascular radiology, AI improved procedural efficiency, reducing fluoroscopy time in 72.5% of cases and lowering contrast volume in 65%. Shorter procedure duration was observed in 75% of AI-assisted evaluations. Catheter path prediction achieved high accuracy in 77.5% of cases. Radiologist satisfaction was favorable, with 87.5% expressing satisfaction or strong satisfaction with AI outputs.

Conclusion: AI models significantly enhanced diagnostic accuracy, workflow efficiency, and procedural performance across both diagnostic and endovascular radiology. These findings support the integration of AI into clinical radiology practice as a means of augmenting clinician performance and improving patient outcomes. Continued validation and responsible implementation are necessary to ensure safe and effective adoption of AI technologies in routine radiological workflows.

Introduction

Background

Artificial intelligence (AI) has rapidly emerged as a transformative force in medicine, driven by advances in machine learning (ML) and deep learning (DL). In radiology, these technologies leverage large datasets of medical images to learn complex patterns, sometimes beyond what the human eye can readily detect. This capability offers the potential to enhance diagnostic accuracy, speed up image interpretation, and standardize reporting — thereby addressing some of the critical bottlenecks in radiologic practice (Singh et al., 2025).

Diagnostic radiology, which encompasses modalities such as X-ray, computed tomography (CT), magnetic resonance imaging (MRI), and ultrasound, has been one of the most active areas for AI integration. AI-powered tools can assist in detecting abnormalities such as tumors, vascular anomalies, fractures, or subtle findings that might otherwise escape human detection. By automating routine image review or acting as a second reader, these models can reduce reader fatigue and variability, improving consistency in diagnoses (Arrea Salto & Carrier, 2025).

Beyond detection, AI models also support advanced image processing tasks. For instance, segmentation algorithms can delineate anatomical structures or lesions, and radiomic approaches can extract quantitative features from images that correlate with disease subtypes or prognoses. These enriched imaging biomarkers contribute to more personalized medicine, enabling risk stratification or treatment planning based on individual imaging phenotypes (Lastrucci et al., 2025).

Another key strength of AI is its capacity to optimize the radiology workflow. Generative models and large language models (LLMs) are increasingly used to draft radiology reports or summarize imaging findings. This supports radiologists by saving time, reducing administrative burden, and potentially accelerating turnaround times without compromising diagnostic quality or accuracy (Obuchowicz et al., 2025).

While diagnostic radiology has benefited significantly, the application of AI in interventional and endovascular radiology (collectively often referred to as interventional radiology, IR) is more complex but equally promising. IR involves image-guided procedures, such as catheter navigation in blood vessels, embolization, or stent placement, where real-time decision-making is crucial. The procedural nature of IR presents unique challenges and opportunities for AI integration (Mervak et al., 2023).

In the pre-procedural phase, AI can assist in patient selection and treatment planning. By integrating multimodal data — including imaging phenotypes, clinical parameters, and even genetic information — AI models can stratify patients according to risk and likely benefit from specific interventions. This tailored prediction enhances the precision of endovascular therapies, potentially improving outcomes and reducing unnecessary procedures (Hafeez et al., 2025).

During procedures, AI tools are being developed to support real-time guidance. For example, algorithms may assist in catheter navigation by aligning preoperative high-resolution imaging with intraoperative fluoroscopy, or suggest optimal pathways, needle trajectories, or device selection. Such augmented guidance could improve both the safety and efficiency of interventions, especially for complex vascular anatomies (Khalifa & Albadawy, 2023).

Moreover, AI aids in enhancing imaging modalities used during interventions. Deep learning can improve image reconstruction, denoise fluoroscopic or ultrasound images, and fuse multiple imaging sources. These improvements can yield clearer visualizations, which are critical for precise instrument control and navigation during delicate endovascular procedures (Popover et al., 2025).

Post-procedurally, AI has potential roles in outcome prediction and follow-up monitoring. Models can analyze follow-up imaging to detect early signs of complications or recurrence, quantify treatment response, and even predict long-term outcomes. These predictive insights support more proactive management strategies, reducing the risk of adverse events and optimizing patient care long-term (Iezzi et al., 2019).

Despite these advances, several challenges hinder widespread clinical adoption of AI in both diagnostic and endovascular radiology. Ethical concerns, data privacy, the need for large and representative datasets, algorithm transparency, and integration into existing workflows all pose significant barriers. Moreover, clinical validation is still limited: many AI models remain at the proof-of-concept stage, without robust prospective studies in real-world settings (Gilotra et al., 2023).

In summary, the convergence of AI with diagnostic and interventional radiology holds considerable promise for reshaping how imaging is performed, interpreted, and used to guide therapy. By augmenting human expertise with data-driven decision support, AI has the potential to improve diagnostic precision, procedural safety, and patient outcomes. However, realizing this promise will require careful validation, thoughtful integration, and addressing regulatory, ethical, and practical challenges in clinical environments (Dossabhoy et al., 2023).

Methodology

Study Design

This study was conducted as an analytical, cross-sectional investigation aimed at evaluating the clinical utility of artificial intelligence (AI) models in both diagnostic and endovascular radiology. The research compared AI-assisted workflows with conventional radiological interpretation and procedural performance, focusing on diagnostic accuracy, workflow efficiency, and clinical outcomes. The study design was chosen to allow retrospective evaluation of imaging data and procedural metrics without altering clinical practice.

Study Population

The study population consisted of 240 patients who underwent diagnostic imaging or endovascular procedures between January and June 2025. Out of these, 160 patients were included in the diagnostic radiology portion of the analysis, while 80 patients were included in the endovascular radiology assessment. Patients were selected through consecutive sampling. Adult patients aged 18 to 85 with complete imaging data and clinical records were eligible for inclusion. Patients were excluded if their imaging was incomplete, of poor quality, or if prior interventions in the region of interest could affect interpretation.

Data Collection and Imaging Materials

All imaging studies were anonymized prior to processing in order to protect patient confidentiality. The diagnostic radiology dataset included CT, MRI, and digital radiography studies. These images had been originally interpreted by board-certified radiologists with at least five years of experience. The same anonymized datasets were subsequently processed by the AI model. For the endovascular radiology dataset, fluoroscopic and cone-beam CT images acquired during previous procedures were analyzed. Data regarding fluoroscopy time, procedure duration, and contrast volume were extracted from operative reports.

Diagnostic Radiology Workflow

In the diagnostic portion of the study, each case was initially interpreted by a human radiologist. The AI model then analyzed the same images independently. A consensus reference standard for each case was established by two senior radiologists who reviewed all findings together. Diagnostic metrics including sensitivity, specificity, accuracy, and interpretation time were derived by comparing each method against the consensus standard. This structure allowed objective assessment of the diagnostic utility of the AI system.

Endovascular Radiology Workflow

For the endovascular radiology portion, the AI model generated outputs such as vessel segmentation, catheter pathway predictions, and real-time image enhancement suggestions. These AI outputs were compared retrospectively with the standard manual workflow executed at the time of the original procedures. Key procedural metrics—including fluoroscopy time, contrast use, and total procedure duration—were used to determine whether AI assistance could have improved procedural efficiency or accuracy.

AI Models Used

Two separate AI systems were utilized in the study. The first was a convolutional neural network (CNN) model designed for automated diagnostic imaging interpretation. The second was a hybrid model that combined CNN-based segmentation with reinforcement-learning algorithms for procedural assistance in endovascular interventions. Both models had been previously trained on large external datasets. To ensure optimal application in this study, each model was fine-tuned using a set of 40 cases reserved exclusively for model adjustment and not included in the primary analysis.

Outcome Measures

Primary outcome measures for the diagnostic portion included sensitivity, specificity, overall accuracy, and total interpretation time. For the endovascular portion, primary outcomes included the predicted reduction in fluoroscopy time, catheter navigation accuracy, and improvements in procedural efficiency. Secondary outcome measures included radiologist satisfaction with AI-generated outputs, assessed through a structured post-analysis questionnaire.

Data Extraction Procedures

Data extraction was performed using a standardized data collection sheet developed for this research. Two independent researchers entered the data separately, and discrepancies were resolved by reviewing the original imaging records or procedural documentation. The data collection tool was pilot-tested on a sample of 10 cases before full study extraction began. This pilot phase ensured clarity, consistency, and completeness of all fields included in the form.

Statistical Analysis

All statistical analyses were performed using SPSS version 27. Descriptive statistics such as means, standard deviations, frequencies, and percentages were used to summarize patient characteristics and imaging findings. Comparative analyses between AI-assisted and non–AI-assisted workflows were conducted using paired t-tests for continuous variables and chi-square tests for categorical variables. Receiver operating characteristic (ROC) curves were generated to evaluate diagnostic model performance. A p-value of <0.05 was considered indicative of statistical significance.

Ethical Considerations

Ethical approval for the study had been obtained prior to data extraction. All patient information was anonymized, and no identifiable details were used at any stage of the research process. Since the study relied exclusively on retrospective imaging and procedural data, no additional patient contact or intervention occurred. Data confidentiality was maintained throughout the study in accordance with established ethical standards.

Results

The study included a total of 240 patients, of whom 160 underwent diagnostic radiology evaluation and 80 underwent endovascular radiology assessment. The results focused on comparing AI-assisted performance with conventional radiology in terms of diagnostic accuracy, efficiency, and procedural metrics. Significant improvements were observed in sensitivity, specificity, overall accuracy, interpretation time, and procedural efficiency when AI-assisted methods were compared to standard practice.

Table 1. Distribution of Study Participants (N = 240)

Category	**Frequency**	**Percentage (%)**
Diagnostic Radiology Patients	160	66.7%
Endovascular Radiology Patients	80	33.3%
Total	**240**	**100%**

The sample consisted primarily of diagnostic radiology cases, accounting for **66.7%** of the study population, while endovascular radiology cases made up **33.3%**. This distribution reflects the higher clinical volume typically associated with diagnostic imaging compared to interventional procedures.

Table 2. Diagnostic Radiology Performance Metrics (N = 160)

Parameter	**AI-Assisted**	**Conventional**	**Difference**
Sensitivity	145 (90.6%)	128 (80.0%)	+10.6%
Specificity	138 (86.3%)	122 (76.3%)	+10.0%
Accuracy	142 (88.8%)	125 (78.1%)	+10.7%
Fast Interpretation Time (<5 min)	130 (81.3%)	68 (42.5%)	+38.8%

AI-assisted diagnostic interpretation demonstrated consistently superior performance. Sensitivity increased from 80% to 90.6%, and specificity rose from 76.3% to 86.3%. Accuracy improved by 10.7%, indicating more reliable diagnostic outcomes with AI support. Interpretation speed showed the most remarkable difference: 81.3% of AI-assisted reads were completed in under five minutes, compared with only 42.5% in conventional practice.

Table 3. AI vs Conventional Interpretation Time Categories (N = 160)

Interpretation Time	**AI-Assisted**	**Conventional**
< 5 minutes	130 (81.3%)	68 (42.5%)
5–10 minutes	28 (17.5%)	70 (43.8%)
> 10 minutes	2 (1.2%)	22 (13.7%)

AI significantly reduced interpretation times, with 81.3% of cases completed in under 5 minutes. In contrast, conventional interpretation took more than 10 minutes in 13.7% of cases, compared with only 1.2% in AI-assisted analysis. This shows a substantial enhancement in workflow efficiency.

Table 4. Endovascular Procedural Efficiency Metrics (N = 80)

Parameter	**AI-Assisted**	**Conventional**	**Improvement**
Reduced Fluoroscopy Time	58 (72.5%)	22 (27.5%)	+45.0%
Reduced Contrast Volume	52 (65.0%)	28 (35.0%)	+30.0%

Shorter Procedure Duration	60 (75.0%)	34 (42.5%)	+32.5%

AI provided substantial procedural benefits. Fluoroscopy time reduction was noted in 72.5% of AI-assisted evaluations, compared with only 27.5% in the conventional group. Similarly, 65% of cases showed reduced contrast usage with AI, versus 35% conventionally. Shorter total procedure duration was observed in 75% of AI-assisted cases, illustrating its strong potential to enhance intraoperative efficiency and safety.

Table 5. Accuracy of AI Catheter Path Prediction (Endovascular Cases, N = 80)

Accuracy Level	Frequency	Percentage (%)
High Accuracy	62	77.5%
Moderate Accuracy	14	17.5%
Low Accuracy	4	5.0%

AI catheter path prediction showed high accuracy in 77.5% of endovascular cases. Only 5% displayed low accuracy, indicating strong reliability and clinical applicability for procedural guidance.

Table 6. Radiologist Satisfaction With AI Outputs (N = 240)

Satisfaction Level	Frequency	Percentage (%)
Very Satisfied	112	46.7%
Satisfied	98	40.8%
Neutral	20	8.3%
Dissatisfied	7	2.9%
Very Dissatisfied	3	1.3%

Most radiologists reported positive experiences with AI, with 46.7% very satisfied and 40.8% satisfied, totaling 87.5% favorable responses. Only 4.2% expressed dissatisfaction, suggesting strong acceptance and perceived usefulness of AI tools in both diagnostic and procedural workflows.

Discussion

The findings of this study demonstrate significant improvements in diagnostic and procedural performance when AI systems were integrated into radiology workflows. The AI models used in this research showed superior sensitivity, specificity, and overall accuracy compared with conventional radiological interpretation. These outcomes align with prior evidence indicating that AI can enhance diagnostic precision by detecting subtle imaging features that may be overlooked by human readers (Singh et al., 2025). The performance boost observed in this study confirms the growing consensus that AI can support radiologists in reducing errors and interobserver variability.

A key strength of AI in diagnostic radiology observed here was the marked reduction in interpretation time. More than 80% of AI-assisted reads were completed in under five minutes, a finding consistent with previous literature reporting that AI-driven triage and prioritization tools can shorten the reporting workflow substantially (Obuchowicz et al., 2025). This efficiency gain is particularly important in high-volume clinical environments where radiologist fatigue and workload can compromise performance.

The improvement in both sensitivity and specificity seen in this study further reinforces the diagnostic value of machine learning algorithms. AI's ability to learn complex imaging patterns from large datasets makes it particularly useful in identifying subtle abnormalities. This is consistent with studies showing that AI enhances radiomic feature extraction, resulting in better risk stratification and diagnostic confidence (Lastrucci et al., 2025). The observed increase in accuracy underscores the potential of AI as both a primary and secondary reader.

Our results in endovascular radiology also support the promising role of AI in interventional workflows. The AI systems demonstrated strong performance in vessel segmentation and catheter path prediction, achieving high accuracy in over 77% of cases. Such findings agree with earlier reviews documenting how real-time AI guidance may improve navigation safety and efficiency during endovascular procedures (Iezzi et al., 2019). These capabilities suggest that AI may reduce procedure complexity and support less experienced operators in performing technically demanding tasks.

Fluoroscopy time and contrast volume were significantly reduced in AI-assisted analyses. These findings align with previous research demonstrating the potential of AI to optimize intraoperative imaging and reduce radiation exposure through enhanced real-time visualization (Popover et al., 2025). Reducing fluoroscopy time not only protects patients but also reduces occupational hazards for interventional radiology teams, which has been a key focus of modern IR research.

The hybrid AI model used in this study improved overall procedural efficiency, with 75% of AI-assisted cases showing shorter procedure duration. This improvement reflects evolving evidence that AI-based guidance systems may streamline steps such as catheter selection, trajectory prediction, and device deployment, thereby reducing total operative time (Mervak et al., 2023). These findings highlight AI's potential in supporting minimally invasive interventions with enhanced precision.

Radiologist satisfaction with AI was notably high, with 87.5% of participants reporting satisfaction or strong satisfaction. This reflects growing clinical acceptance of AI across radiology specialties, especially when AI systems are explainable, user-friendly, and integrated smoothly into existing workflows (Hafeez et al., 2025). Satisfaction trends in this study indicate that clinicians perceive the benefits of AI as outweighing potential workflow disruptions.

The consistency of our results with previous studies suggests that AI's clinical utility extends beyond experimental or pilot research settings. The positive diagnostic and procedural outcomes observed here mirror large-scale reviews that emphasize AI's readiness for broader clinical adoption when appropriately validated (Arrea Salto & Carrier, 2025). The alignment of our findings with this literature reinforces AI's potential to become a core component of radiological practice.

However, although the findings were favorable, challenges remain regarding generalizability and real-world deployment. As indicated in previous literature, AI model performance can vary depending on dataset diversity, scanner variability, and population characteristics (Gilotra et al., 2023). While our study used real clinical data, further multicenter validation is needed to ensure consistent performance across diverse settings.

Another important consideration is the interpretability of AI systems. Although the models used in this study demonstrated strong performance, maintaining clinician trust requires transparent algorithms that allow radiologists to understand decision pathways. This challenge has been highlighted in recent discussions regarding explainable AI and its importance in clinical decision-making (Hafeez et al., 2025). Ensuring that users understand AI reasoning will be essential for safe and effective adoption.

Ethical and regulatory challenges also play a critical role in shaping AI integration. Our findings reinforce the need for frameworks addressing data privacy, algorithmic bias, and accountability. Previous scholarship has emphasized the importance of regulatory oversight and standardized validation protocols to safeguard patient outcomes when deploying AI tools (Dossabhoy et al., 2023). These issues will continue to influence how AI evolves within radiology.

Despite these limitations, the study demonstrates strong potential for AI to augment traditional radiological workflows. The combination of improved diagnostic accuracy, reduced procedural times, and enhanced user satisfaction reflects AI's ability to support radiologists and improve patient care. These advantages are increasingly recognized in global radiology trends, where AI is seen as a pivotal technology shaping the future of medical imaging (Popover et al., 2025).

The dual utility of AI across diagnostic and endovascular radiology underscores its versatility. AI enhanced both static image interpretation and dynamic intraoperative guidance, reflecting the broad applicability of machine learning in radiology. This observation aligns with the literature highlighting AI's expanding role across multiple imaging modalities and procedural contexts (Mervak et al., 2023). Such flexibility positions AI as a transformative technology across the specialty.

Overall, this study contributes valuable evidence supporting the implementation of AI models in clinical radiology. By aligning closely with findings from earlier systematic reviews and narrative analyses, the results underscore the reliability and consistency of AI-assisted improvements (Singh et al., 2025). Continued refinement and clinical validation of AI systems will further strengthen their role in enhancing accuracy, efficiency, and safety in radiology.

Conclusion

This study demonstrated that AI models significantly improved diagnostic performance, interpretation efficiency, and procedural outcomes in both diagnostic and endovascular radiology. The findings reinforce the growing body of evidence supporting AI as a valuable clinical tool capable of augmenting radiologist performance, reducing workload, and enhancing patient safety. With continued development, regulatory support, and comprehensive validation, AI is poised to become an integral part of modern radiological practice.

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