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SYSTEMATIC REVIEW

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Artificial intelligence in diagnostic medical imaging: A systematic review

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ABSTRACT

Introduction: There is a significant change in global communities due to evolution of artificial intelligence (AI). Healthcare centers are not left behind in AI especially in radiology departments. AI Deployment in radiology, mainly in multidimensional imaging, mammography and ultrasound, transformed through its ability in detection, analyze, interpret, characterize tumor and compare images across modalities.

Objectives: This paper aims to clarify the importance of AI in radiology as an aiding tool rather than a threat, analyze the success of AI in detection, characterization and image interpretation in multidimensional imaging and mammography, discuss optimal utilization in these areas, and examine future prospects and challenges, particularly in developing countries along with strategies to overcome them.

Methods: Relevant publications on AI, radiology, multi-dimensional imaging and mammography across PubMed, Science Direct and Google Scholar over three months. Online videos from conferences, seminars and webinars about AI applications, results, challenges and further research areas were also reviewed. A total of 20 papers were published between 2019 and 2024 were included in the study.

Results: AI improves early tumor detection and characterization of tumors, images analyses and interpretation and increased workflow. However, it faces limitations such as integration into existing systems, data privacy concerns, legal regulations, and inadequate personnel training, along with challenges like staff shortages, high installation costs, and limited PACS availability, particularly in developing countries like Nigeria.

Conclusion: Evidence indicates that AI integration improves diagnostic accuracy and may reduce medical expenditures. Despite technical and regulatory challenges, it functions as an essential aiding tool.

KEY WORDS

Artificial intelligence; Radiology; Multidimensional imaging; Mammography

ARTICLE HISTORY

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Introduction

Radiology, a central medical discipline that over the years witnessed rapid evolution from x-rays to magnetic fields, from 2D imaging to 3D and 4D imaging, from the depth of darkrooms to display screens and now into the new era of AI, particularly with the advent of deep learning approaches especially the convolutional neural networks [1].

Central departments like radiology which serve as an eye to other departments is tasked with fast patient throughput and reliable and accurate results that will aid patient through diagnosis, decision making and treatment.

The advent of AI revolutionizes the health sector through increased precision, faster workflow and predictive medicine Khalifa et al. as well as in research purposes [2,3].

Traditional methods in radiology are always time consuming and subject to error due to possible fatigue, less experience in some personnel and as well increases patients' dose and expenses through multiple studies before reaching a conclusion [4].

Areas like nuclear medicine benefit greatly from AI through its precise dose calculation algorithms for both diagnosis and treatment which reduces misdiagnosis and improves patient care [5].

Deep learning [DL] is a subset of Machine learning [ML] which is also a subset of AI. While ML uses already installed data to process images, DL uses convolutional neural networks that operate like human brain to process information and give a structured feedback that aids in patient care [6].

AI also plays a vital role in predictive medicine through its ability to predict cancers especially in mammography by analyzing patient's history and generating some possible risk factors [6].

Methodology

Over the period of three months of paper review between August to October 2024 based on AI in Radiology, about 109

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papers were searched for across PubMed, ScienceDirect and Google Scholar. 26 were excluded after title screening and careful review was made of about 83 papers. 37 were excluded due to limitations in accessing the main PDF, 7 were further excluded due to duplication and 19 due to date of publication before 2019 as many AI models were created after that with higher specificity and sensitivity (Figure 1). A total of 20 papers were reviewed carefully as they contain the keywords of our research "artificial intelligence" "radiology" "mammography" and "multidimensional imaging" under radiology and imaging journals like American Journals of Roentgenology (AJR), Journal of Thoracic Imaging, JAMA Neurology, Journal of Nuclear Medicine, Journal of Cancer Research and Clinical Oncology, European Journal of Nuclear Medicine and Molecular Imaging, Journal of Medical Imaging, Journal of Magnetic Resonance Imaging (JMRI) and Journal of Artificial Intelligence Research. Video presentations on YouTube of conferences, seminars and webinars available under authentic radiology sites like Oley Medical Academy, ECR, RSNA, EuSomII, AI neurocare, Houston Methodist institute, Mayo clinics, GE healthcare and Radiopedia were also utilized for more information on AI and its application in Mammography and Multi-dimensional Imaging.

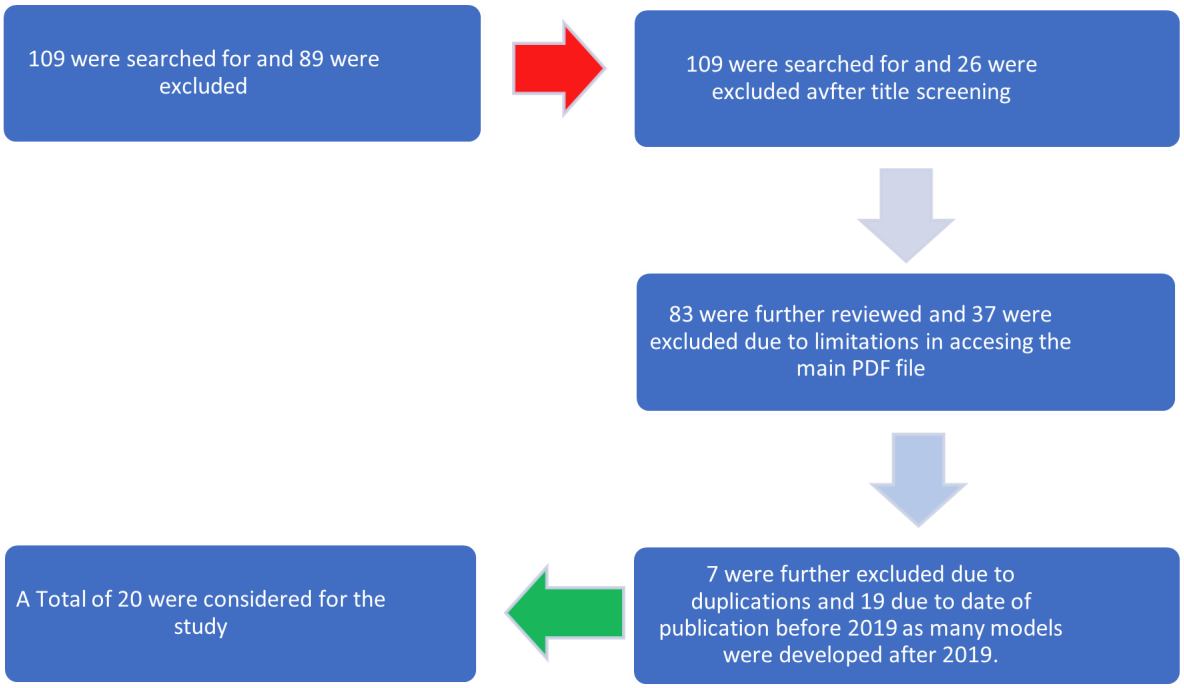

Figure 1. Flow chart for inclusion and exclusion criteria.

Results

After careful review process, it was found that AI is a great tool in imaging as it aids in different functions. The most successful functions include improved accuracy, reduced interpretation time for radiologists, increased workflow, improved patient care and broaden research (Table 1).

Table 1. 20 literatures with title, objectives, study design, modality and key findings.

S/N	Title	Objective	Design	Modality	Key findings	Authors
1	AI in mammography; a systematic review of external validation	To conduct a systematic review of external validation studies on the use of different AI algorithms in breast cancer screening with mammography.	Prospective study	Mammography	Ai is a great tool when compared with average radiologists but shows no significant contribution when compared to radiologists with more than 20+ years' experience.	Brancho PE et al, 2024 [3]

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2	Diagnostic accuracy and performance of AI in detecting lung nodules in patients with complex lung disease: a Non-inferiority study	To compare The performance of AI against an experienced radiologist	Non-inferiority study	Chest CT	Similarities are noted between AI and radiologist's sensitivity in lung nodules detection.	Abadia AF et al., 2022 [7]
3	AI-based CT imaging on diagnosis of patients with lumbar disc herniation by scalpel treatment	Analyze the effectiveness of AI in Lumber disc herniation treatment	Comparative analysis	Computed tomography	High effectiveness of AI based CT imaging in analyzing treatment effect of LDH; scalpel treatment more effective	Fan X et al., 2022 [8]
4	Evaluation of functional magnetic resonance imaging under AI algorithm on plan-do check-action home nursing for patients with diabetic nephropathy	Evaluate effect of fMRI under FCM on PDCA home nursing for patients with DN	Comparative study	Functional MRI	Improved detection with FCM algorithm; PDCA home nursing showed superior curative effect and quality of life improvement	Du Q et al., 2022 [9]
5	DL algorithm in detecting intracranial hemorrhages on emergency computed tomography	Evaluate the effectiveness of AI in intracranial hemorrhage examinations compared to radiologists' findings.	multicenter study	Brain CT	AI showed better detection rate than radiology reports suggested.	Kundisch A et al., 2021 [10]
6	DL-assisted diagnosis of cerebral aneurysms using the HeadXNet model	Apply AI in evaluation of aneurysms in Computed tomography angiography.	Diagnostic study	CT Angiography	Utilization of AI has proven to improve sensitivity and specificity in detection of aneurysms	Park A et al., 2019 [11]
7	An AI-driven image quality assessment system for whole-body [(18)F]FDG PET/CT	Assessment of AI system for whole-body PET/CT	Developmental study	Positron emission tomography/ CT imaging	Systems incorporated with AI tools provide additional information when compared to human reports.	Qi C et al., 2022 [12]
8	Exploration of the influence of early rehabilitation training on circulating endothelial progenitor cell mobilization in patients with acute ischemic stroke	Explore how rehabilitation impacts endolithial progenitor cells in acute ischemic stroke patients. Leveraging AI tools for MRI image analysis	Forward-looking study	Magnetic resonance imaging	AI model precisely identified and segmented Acute Ischemic Stroke lesions. It also indicated that early rehabilitation modified inflammatory factor levels and mobilized EPC.	Sun L et al., 2023 [13]
9	Application of CNN to evaluate positive CRM of rectal cancer by MRI	Assess whether a faster regional convolutional neural networks can effectively evaluate the CRM status of rectal cancer using MRI images.	Research study	Magnetic resonance imaging	CNN model effectively predict CRM risk, aiding in treatment planning	Xu JH et al., 2020 [14]

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10	Differentiation of breast lesions on dynamic contrast-enhanced MRI using deep transfer learning based on DenseNet201	Assess the effectiveness of using deep transfer learning with DenceNet201 model to distinguish malignant from benign breast lesions on dynamic contrast enhanced MRI	Experiment	Breast Dynamic Contrast Enhanced MRI	The models effectively distinguish between benign and malignant tumors with high sensitivity and specificity.	Meng M et al., 2022 [15]
11	Evaluation of rectal cancer CRM using faster CNN in high-resolution MR images	Investigate using a faster region-based convolutional neural networks to detect positive circumferential resection margins in high resolution MRI images	Retrospective study	High resolution MRI	CNN model improved CRM evaluation, aiding in rectal treatment planning	Wang D et al., 2020 [16]
11	Evaluation of rectal cancer CRM using faster CNN in high-resolution MR images	Investigate using a faster region-based convolutional neural networks to detect positive circumferential resection margins in high resolution MRI images	Retrospective study	High resolution MRI	CNN model improved CRM evaluation, aiding in rectal treatment planning	Wang D et al., 2020 [16]
12	In clinical trial performance, AI plays a significant role in exclusion and exclusion criteria selection.	Utilize AI in the analysis of imaging data for patient selection in clinical trials for soft tissue sarcoma patients	Retrospective Analysis	CT	It was found that AI greatly improve the selection of patients for clinical trials by using enhanced softwares.	Tomaszewski MR et al., 2022 [3]
13	Automated LVO detection software and thrombectomy treatment times	To determine is AI utilization in CTA improves EVT workflow	Randomized controlled trial	Computed tomography angiography (CTA)	Utilization of AI increases patient throughput.	Martinez JC et al., 2023 [17]
14	Combined diagnosis of multi-parametric MRI-based DL models facilitates differentiating triple-negative breast cancer from fibro adenoma	AI utilization in differentiating fibroadenoma from TNBC in multi-parametric MRI.	Retrospective Analysis	Multipara metric MRI	AI shows high sensitivity in differentiating TNBC from fibroadenoma in MRI studies	Yin HL et al., 2023 [18]
15	AI in diagnostic imaging: Revolutionizing accuracy and efficiency	To evaluate AI in imaging	Review paper	X-ray, CT and MRI	Four Domains and eight functions were identified focusing on the functions of AI in diagnosis and decision making.	Khalifa M et al, 2024 [2]

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16	Early Indicators of the Impact of Using AI in Mammography Screening for Breast Cancer	To compare workload and screening performance for two cohorts of women who underwent screening before and after AI system implementation	Retrospective study	Mammography	Decreased recall rate by 20.5%, increased cancer detection rate, decreased false positive by 2.39%, increased PPV by 22.6%, small cancers DR increased, node negative cancers remain unchanged, rate of invasive cancers decreased and reading workload decreased by 33.5%.	Andreas DL et al., 2024 [6]
17	AI for screening Mammography, From the AJR Special Series on AI Application	To review the commercial AI algorithms for screening mammography that are currently available in practice, their use and evidence supporting their performance.	Retrospective study	Mammography	AI is an important tool that aid in detection with increased accuracy but careful deployment and integration of AI in clinical settings must be done to ensure improved patient outcome	Lamb RL et al., 2022 [19]
18	AI in Nuclear Medicine: Opportunities, Challenges and responsibilities Toward a Trustworthy Ecosystem	To outline a roadmap for establishing trustworthy AI ecosystems in nuclear medicine	Retrospective	Nuclear Medicine	AI proves to be an important tool in Nuclear medicine as increased precision dosimetry is noted, decrease patient dose, improved image quality and as well its enormous importance in drug discovery and labeling	Saboury B et al., 2022 [5]
19	Redefining Radiology: A Review of AI Integration in Medical Imaging	To shed light on AI applications in radiology, elucidating their seminal roles in image segmentation, computer-aided diagnosis, predictive analytics and workflow optimization	Review paper	Imaging	AI is a great tool for aiding diagnostic processes, increased workflow and personalized medicine. It also outlines some challenges faced by AI integration in radiology.	Najjar R, 2023 [1]
20	Redefining Radiology: A Review of AI Integration in Medical Imaging	To shed light on AI applications in radiology, elucidating their seminal roles in image segmentation, computer-aided diagnosis, predictive analytics and workflow optimization	Review paper	Imaging	AI is a great tool for aiding diagnostic processes, increased workflow and personalized medicine. It also outlines some challenges faced by AI integration in radiology.	Najjar R, 2023 [1]

Discussion

Development of DL algorithms changes the whole idea of AI in radiology due to its ability to learn from unstructured data-set. This systematic review outlines the significant achievements of AI in radiology through its enhanced ability in detection of additional tumors, characterization into benign or malignant and image interpretation in multi-dimensional imaging and mammography.

Based on this review, Increased sensitivity is noted as AI models detect more lesions across modalities than the traditional reports suggested, this aligns with the findings of Abadia et al. that shows detection of additional lung nodules in patients with complex lung diseases that were previously missed and also study by Kundisch et al. which shows detection of additional findings than the reports suggested [7,10].

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Increased accuracy is also noted in detection and interpretation with AI algorithms which agrees with the finding by Khalifa et al. under the image analysis and interpretation domain and increased accuracy in dosimetry as shown in study by Saboury et al. in nuclear medicine [2,5].

Deployment of AI in radiology reduces reporting time significantly based on our findings in this review, this aligns with studies by park et al. which also shows improved sensitivity, accuracy and reduced interpretation time in CTA imaging [11].

Study by Martinez Gutierrez et al. which shows reduced interpretation time in computed tomography angiography (CTA) in detection and interpretation of aneurysm [17]. And as well study by Lamb et al. in mammography where AI serves as the first reader in double reading reporting system [19].

Segmentation also increases greatly in imaging with the use of DL algorithm based on this review and this agrees with the study by Xu et al. [14] and Wang et al. [16] which applies convolutional neural networks in evaluation of CRM status in a research and retrospective study respectively using MRI and figured that using DL algorithm, accuracy of resection margin increases in segmenting tumor from healthy tissue. A study by Sun et al. also shows that AI models accurately segmented AIS lesions from healthy brain tissues, compared images of patients before and after rehabilitation and assessed the progress [13].

DL algorithms especially CNN, greatly increase tumor characterization in mammography and MRI. This is in agreement with the findings of Meng et al. [15]. Which show the effectiveness of DTL in differentiating benign from malignant tumors in MRI and also aligns with a study that shows how DL plays a crucial role in breast cancer characterization [18].

AI is also an effective tool in aiding research in sample size calculations, inclusion and exclusion criteria improvement and as well as analyzing performance in clinical trial. This agrees with the study by Alowais et al. and Tomaszewski et al. that utilizes AI in sample selection in clinical trial study [3].

Incorporation of AI in radiology increases the potential of achieving multi-modal image analysis through the utilization of data of patients from different modalities which in turn will have great impact on patient care in diagnosis or decision making.

Strength, Limitations and Challenges

The strength of AI in radiology is found based on this review to be increased accuracy, sensitivity, specificity, tumor characterization, reduced reporting time and also its significant contribution in research. However, even with its multiple and undeniable successes in medical field, AI shows some limitations and encounter many challenges in the field of medicine which include incorporation into existing departments Najjar et al., data privacy concerns Khalifa et al., Najjar et al., Fan et al., legal regulations, lack of proper personnel training, biasedness due to AI training data which leads to poor results when used in a different population than where the training data was sourced Khalifa et al. and transparency concerns about 37 papers were excluded from the study due to limitation in accessing the main PDF, this is to ensure that in-depth analysis of all selected papers is done not just focusing on the title and findings [1,2,5].

Added to the challenges mentioned above, lack of large structured and unstructured data set for training AI algorithms remain a great challenge, especially in developing countries where availability of digital data is almost impossible in majority of healthcare facilities even in some tertiary hospitals, possibility of rejecting AI tools among radiologists due to transparency concerns and as well lack of proper infrastructures for augmentation of AI [20].

As stated by Branco et al, the best way to augment AI in medical imaging is by achieving harmony between the AI models and healthcare practitioners. This will enhance patient care by overcoming the limitations of both AI models and practitioners through knowledge sharing [4].

Recommendation

After careful review, it is recommended that to enhance the capabilities of AI, continuous investment, establishment of data privacy guidelines, adequate personnel training, collaborative approach between developers, regulatory bodies and healthcare personnel, continues upgrade of AI tools and addressing the limitation in data set are of utmost importance to increase AI reliability in clinical settings.

Future Prospects

The future of AI in radiology is found to be promising due to rapid development gained in recent years after the incorporation of DL. The prospects of AI include multi-modal capability, multi-institutional collaboration, interdisciplinary collaboration, global accessibility and more acceptable legal requirements.

The strength of this review lies in its clear objectives, robust methodology of using publications from different sites as well as available videos of conferences, seminars and webinars on various YouTube sites.

Conclusion

This systematic review finds that AI, because of the development of DL and the convolutional neural network, has come from being an emerging field of technology and is now an absolute necessity in the field of diagnostics aimed at augmenting operations. By conducting a comprehensive analysis of the evidence available, the systematic review is able to show that the inclusion of technology in the field of imaging leads to improved sensitivity, accuracy, and rapid turnaround of results, thus reducing the time traditionally involved. Additionally, the advanced technology is able to streamline tumor characterization and dosing in the nuclear imaging field while, at the same time, maximizing the operational efficiencies of the hospitals which may lead to minimizing the costs incurred. While the privacy and infrastructure challenges facing the technology, especially in the developing world, remain, the systematic review is able to show that the optimal operating paradigm is that of collaboration between the technology and healthcare practitioners. Ultimately, the technology is an absolute necessity in the field of healthcare and medicine, provided there is continued investment in human resource.

Disclosure Statement

No potential conflict of interest was reported by the author.

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References

1. Najjar R. Redefining radiology: a review of artificial intelligence integration in medical imaging. Diagnostics. 2023;13(17):2760. https://doi.org/10.3390/diagnostics13172760
2. Khalifa M, Albadawy M. AI in diagnostic imaging: revolutionising accuracy and efficiency. Comput Methods Programs Biomed Update. 2024;5:100146. https://doi.org/10.1016/j.cmpbup.2024.100146
3. Tomaszewski MR, Fan S, Garcia A, Qi J, Kim Y, Gatenby RA, et al. AI-radiomics can improve inclusion criteria and clinical trial performance. Tomography. 2022;8(1):341-355. https://doi.org/10.3390/tomography8010028
4. Branco PE, Franco AH, Oliveira AP, Carneiro IM, Carvalho LM, Souza JI, et al. Artificial intelligence in mammography: a systematic review of the external validation. Revista Brasileira de Ginecologia e Obstetrícia. 2024;46:e-rbgo71. https://doi.org/10.61622/rbgo/2024rbgo71
5. Saboury B, Bradshaw T, Boellaard R, Buvat I, Dutta J, Hatt M, et al. Artificial intelligence in nuclear medicine: opportunities, challenges, and responsibilities toward a trustworthy ecosystem. J Nucl Med. 2023;64(2):188-196. https://doi.org/10.2967/jnumed.121.263703
6. Lauritzen AD, Lillholm M, Lynge E, Nielsen M, Karssemeijer N, Vejborg I. Early indicators of the impact of using AI in mammography screening for breast cancer. Radiology. 2024;311(3):e232479. https://doi.org/10.1148/radiol.232479
7. Abadia AF, Yacoub B, Stringer N, Snoddy M, Kocher M, Schoepf UJ, et al. Diagnostic accuracy and performance of artificial intelligence in detecting lung nodules in patients with complex lung disease: a noninferiority study. J Thorac Imaging. 2022;37(3):154-161. https://doi.org/10.1097/RTI.0000000000000613
8. Fan X, Qiao X, Wang Z, Jiang L, Liu Y, Sun Q. Artificial Intelligence-Based CT Imaging on Diagnosis of Patients with Lumbar Disc Herniation by Scalpel Treatment. Comput Intel Neuroscience. 2022;2022(1):3688630. https://doi.org/10.1155/2022/3688630
9. Du Q, Liang D, Zhang L, Chen G, Li X. Evaluation of Functional Magnetic Resonance Imaging under Artificial Intelligence Algorithm on Plan-Do-Check-Action Home Nursing for Patients with Diabetic Nephropathy. Contrast Media & Molecular Imaging. 2022;2022(1):9882532. https://doi.org/10.1155/2022/9882532
10. Kundisch A, Hönning A, Mutze S, Kreissl L, Spohn F, Lemcke J, et al. Deep learning algorithm in detecting intracranial hemorrhages on emergency computed tomographies. PLoS One. 2021;16(11):e0260560. https://doi.org/10.1371/journal.pone.0260560
11. Park A, Chute C, Rajpurkar P, Lou J, Ball RL, Shpanskaya K, et al. Deep learning–assisted diagnosis of cerebral aneurysms using the HeadXNet model. JAMA network open. 2019;2(6):e195600. https://doi.org/10.1001/jamanetworkopen.2019.5600
12. Qi C, Wang S, Yu H, Zhang Y, Hu P, Tan H, et al. An artificial intelligence-driven image quality assessment system for whole-body [18F] FDG PET/CT. Eur J Nucl Med Mol Imaging. 2023;50(5):1318-1328. https://doi.org/10.1007/s00259-022-06078-z
13. Sun L, Zhang H, Yang YM, Wang XS. Exploration of the influence of early rehabilitation training on circulating endothelial progenitor cell mobilization in patients with acute ischemic stroke and its related mechanism under a lightweight artificial intelligence algorithm. Eur Rev Med Pharmacol Sci. 2023;27(12). Available at: https://www.europeanreview.org/wp/wp-content/uploads/5338-5355.pdf
14. Xu JH, Zhou XM, Ma JL, Liu SS, Zhang MS, Zheng XF, et al. Application of convolutional neural network to risk evaluation of positive circumferential resection margin of rectal cancer by magnetic resonance imaging. J Gastrointest Surg. 2020;23(6):572-527. https://doi.org/10.3760/cma.j.cn.441530-20191023-00460
15. Meng M, Zhang M, Shen D, He G. Differentiation of breast lesions on dynamic contrast-enhanced magnetic resonance imaging (DCE-MRI) using deep transfer learning based on DenseNet201. Medicine. 2022;101(45):e31214. https://doi.org/10.1097/MD.0000000000031214
16. Wang D, Xu J, Zhang Z, Li S, Zhang X, Zhou Y, et al. Evaluation of rectal cancer circumferential resection margin using faster region-based convolutional neural network in high-resolution magnetic resonance images. Dis Colon Rectum. 2020;63(2):143-151. https://dopi.org/10.1097/DCR.0000000000001519
17. Martinez-Gutierrez JC, Kim Y, Salazar-Marioni S, Tariq MB, Abdelkhaleq R, Niktabe A, et al. Automated large vessel occlusion detection software and thrombectomy treatment times: a cluster randomized clinical trial. JAMA neurology. 2023;80(11):1182-1190. https://doi.org/10.1001/jamaneurol.2023.3206
18. Yin HL, Jiang Y, Xu Z, Jia HH, Lin GW. Combined diagnosis of multiparametric MRI-based deep learning models facilitates differentiating triple-negative breast cancer from fibroadenoma magnetic resonance BI-RADS 4 lesions. J. Cancer Res Clin Oncol. 2023;149(6):2575-2584. https://doi.org/10.1007/s00432-022-04142-7
19. Lamb LR, Lehman CD, Gastounioti A, Conant EF, Bahl M. Artificial intelligence (AI) for screening mammography, from the AJR special series on AI applications. AJR Am J Roentgenol. 2022;219(3):369-380. https://doi.org/10.2214/AJR.21.27071
20. Mollura DJ, Culp MP, Pollack E, Battino G, Scheel JR, Mango VL, Elahi A, Schweitzer A, Dako F. Artificial intelligence in low-and middle-income countries: innovating global health radiology. Radiology. 2020;297(3):513-520. https://doi.org/10.1148/radiol.2020201434

https://doi.org/10.61577/jaiar.2025.1000015