

Year V, v.2 2025 | submission: October 13, 2025 | accepted: October 15, 2025 | publication: October 17, 2025 The use of artificial intelligence in magnetic resonance imaging and its importance for diagnosis: a literature review

The use of artificial intelligence in magnetic resonance imaging and is importance for diagnosis: a literature review

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Summary

In recent years, the use of artificial intelligence (AI) in healthcare has gained increasing prominence, especially in supporting imaging diagnosis. With technological advancements, AI-based systems have been applied to help healthcare professionals interpret exams more quickly, accurately, and efficiently. Therefore, this work aims to gather and analyze information on the use of AI in imaging exams, with a focus on magnetic resonance imaging (MRI), and demonstrate how this technology can contribute to faster, more accurate, and safer diagnoses. To this end, an integrative literature review was conducted, based on studies already published in major scientific databases, such as PubMed, MedLine, ACM Digital Library, SciELO, and Google Scholar, among other platforms. Articles that address the use of AI in the detection, segmentation, classification, and interpretation of medical images were selected. Thus, we analyze and discuss not only the benefits of AI, such as error reduction and optimization of analysis time, but also the challenges and limitations encountered in its practical application. Therefore, this work reinforces the importance of this technology as a tool to support imaging diagnosis and recognizes the paths for future research and innovations in the health area.

Keywords: Artificial Intelligence; Magnetic Resonance Imaging; Diagnostic Imaging.

Abstract

In recent years, artificial intelligence (AI) has increasingly been applied to medical imaging, with particular promise in magnetic resonance imaging (MRI). This integrative literature review synthesizes published evidence on AI-based approaches for detection, segmentation, classification, and interpretation of MRI studies. Searches were conducted across major scientific databases, including PubMed, MedLine, ACM Digital Library, SciELO, and Google Scholar, to identify studies that evaluate technical performance and clinical applicability of AI methods in MRI. The reviewed literature demonstrates substantial technical advances, such as improvements in image reconstruction and acceleration, noise reduction, lesion segmentation, and automated classification. These advances frequently yield high diagnostic performance metrics and reductions in acquisition or reading time.

However, most evidence remains retrospective, single-center, and benchmark-driven, limiting direct translation to routine clinical practice. Key challenges include limited external validation, data heterogeneity, model explainability, regulatory and ethical concerns, and infrastructural barriers to deployment. We conclude that AI holds real potential to enhance MRI workflow efficiency and diagnostic accuracy, but its broader clinical adoption requires prospective multicenter validation, standardized reporting, and further attention to bias, explainability, and infrastructural barriers. Future research should prioritize pragmatic trials and implementation studies that measure clinical and economic impact.

Keywords: Artificial Intelligence; Magnetic Resonance Imaging; Diagnostic Imaging.

1. Introduction

Magnetic resonance imaging (MRI) is an accurate, non-invasive imaging method that uses principles



Year V, v.2 2025 | submission: October 13, 2025 | accepted: October 15, 2025 | publication: October 17, 2025 of nuclear physics to generate detailed images of the inside of the human body. The examination is based on interaction between magnetic fields and the hydrogen nuclei present in the tissues, which allows obtain detailed images of the different internal structures. Because it does not use ionizing radiation, MRI is frequently used in anatomical evaluation and in the detection of various pathologies (SOARES HAGE; IWASAKI, 2009; WESTBROOK; TALBOT, 2018).

The analysis of MRI images is performed using cutting planes such as axial, coronal and sagittal, as well as by evaluating T1 and T2 relaxation times. T1-weighted images highlight anatomical structures of soft tissues and high fat content, while the images T2-weighted images demonstrate the presence of fluids and specific pathologies, being useful for the identification of edema, tumors and inflammatory processes (BUSHBERG et al., 2012; KOCH; LI; MORITZ, 2021).

MRI has established itself as one of the most relevant imaging methods for diagnosis, but it still has limitations, such as acquisition time and image quality. In this context, tools based on artificial intelligence (AI) have stood out as alternatives to overcome these challenges, optimizing processes and increasing diagnostic accuracy (GORE, 2018; SHIN et al., 2020). Although this technology still faces obstacles, such as the simultaneous analysis of multiple abnormalities in different sections, evidence indicates that its clinical application has the potential to significantly improve diagnostic accuracy (RUITENBEEK et al., 2024).

The richness of detail provided by MRI is essential for clinical decision-making.

However, contemporary radiology faces a confluence of challenges: the growth of number of exams, the complexity of visual information that requires increasingly more interpretations specialized and the need for greater efficiency in workflows (LEE et al., 2025). In this scenario, technological innovation is not just an option, but a requirement of clinical practice modern.

Al is defined as the science and engineering that seeks to simulate human behaviors with minimal human intervention. In medicine, this technology has stood out both in applications both virtual and physical. In the area of imaging exams, Al has been used to process large volumes of data from CT scans, MRIs and other diagnostic methods, identifying patterns, aiding in the early detection of diseases and improving the accuracy of medical reports. These solutions have contributed to faster, more personalized and accurate diagnoses. with a smaller margin of error, increasing the efficiency of health services and benefiting



Year V, v.2 2025 | submission: October 13, 2025 | accepted: October 15, 2025 | publication: October 17, 2025 directly to patients (HAMET; TREMBLAY, 2017; ERICKSON et al., 2017).

The integration of AI into MRI imaging has resulted in faster exams and clearer images. clearer, bringing advantages especially for patients who experience discomfort during procedure. In addition, AI algorithms have been used to highlight suspicious areas in images, favoring the early detection of diseases such as brain tumors in children. Equally promising results were observed in musculoskeletal pathologies, such as bone tumors and joint conditions, offering more reliable diagnoses and reducing failures that could go unnoticed by human evaluation (BARROS et al., 2025; HADDADI AVVAL et al., 2025).

In view of this, this work gathered and analyzed studies that explore the use of artificial intelligence in magnetic resonance imaging, allowing the identification of the benefits and limitations of this technology. It was found that AI has contributed to more reliable diagnostic results, in addition to enabling the acquisition of faster and higher quality images, representing a relevant advance for practice radiological.

2. Material and Method

This work consists of an integrative literature review, a method described by Mendes et al. (2008) as a strategy that allows analyzing relevant research to support decision-making clinical decision and medical practice on a specific topic. This approach enables a broader understanding of the pathological phenomenon and the effects of the interventions evaluated in reviewed studies.

To prepare this work, the methodology proposed by Botelho et al. (2011) was adopted, structured in six stages: definition of the theme and research question, establishment of criteria inclusion and exclusion criteria, identification of pre-selected studies, categorization of studies chosen, analysis and interpretation of the results and, finally, presentation of the review. The search for literature references was conducted using Health Sciences Descriptors "Artificial Intelligence", "Magnetic Resonance Imaging" and "Diagnostic Imaging", combined with the Boolean operators AND and OR. The searches were conducted in the following databases: PubMed, MedLine, ACM Digital Library, SciELO and Google Scholar.

Regarding the inclusion criteria, studies published in the last ten years were selected, in

Included were papers that presented the original findings as well as updates and

subsequent in-depth analysis, aiming to ensure accuracy and relevance.

English and Portuguese, of greater relevance and impact, aligned with the guiding question of this research.

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Year V, v.2 2025 | submission: October 13, 2025 | accepted: October 15, 2025 | publication: October 17, 2025 For the exclusion criteria, studies that were not directly related to the thematic, which presented uncertain or inconclusive results, which were obsolete or which were published in languages other than English or Portuguese.

3. Results and Discussion

According to the descriptors searched in the databases, 250 were found and analyzed articles and after careful reading and application of the inclusion and exclusion criteria resulted in 30 articles selected which are included in this integrative review (Table 1).

TABLE 1 – Articles used to structure the integrative review.

Origin	Article title	Journal title	Year Language	Country Of
		(volume, number and		study
		page)		
Pubmed	Applications of artificial	Neuro-Oncology (p. 1–	2025 English	USA
	intelligence and advanced	15)		
	imaging in pediatric diffuse			
	midline glioma.			
Portal of	Intelligence artificial in the	Magazine Scientific	2025 Portuguese E	Brazil
Periodicals	radiology: applications and impacts	Cleber Leite (v. 2, n. 1,		
	in magnetic resonance imaging and	p. 1-4)		
	computed tomography.			
PubMed	Artificial intelligence in medicine	Magnetic Resonance	2018 English	USA
	imaging.	Imaging		
SciELO	Image by resonance	Rural Science (v. 39, n.	Brazilian Po	ortuguese
	magnetic: basic principles.	4, p. 1287-1295)	2009	
PubMed	Artificial intelligence in	Metabolism Clinical	2017 English	USA
	medicine.	and Experimental (v. 69,		
		p. S36–S40)		
SciELO	Integrative review: method of	Text & Context	2008 Portuguese E	Brazil
	research for the incorporation of	Nursing (v. 17, n.		
	evidence in health and	4, p. 758–764)		
	nursing.			
PubMed	Artificial intelligence in	Skeletal radiology (v.	2024 English	Netherlands
	musculoskeletal imaging:	53, n. 9, p. 1849–1868)		
	realistic clinical applications in			
	the next decade.			



PubMed	Clinical applications of artificial	British Journal of	2022 English	United Kingdom
	intelligence in radiology.	Radiology (v. 96, n.		
		1150)		
Springer	Promises of artificial intelligence	Neuroradiology (v. 62,	2020 English	Germany
	in neuroradiology: a systematic	n. 10, p. 1265-1278)		
	technological review.			
ACM Digital	Generative adversarial networks. Co	nmunications of the	2020 English	USA
Library		ACM (v. 63, n. 11, p.		
		139-144)		
PubMed	Deep Learning to Simulate	Radiology (v. 314, n. 1,	2025 English	USA
	Contrast-Enhanced MRI for	e240118)		
	Evaluating Suspected Prostate			
	Cancer.			
ResearchGate /	Deep Learning in	Radiology: Artificial	2020 English	USA
RSNA	Neuroradiology: A Systematic	Intelligence (v. 2, n. 2,		
	Review of Current Algorithms	e190026)		
	and Approaches for the New			
	Wave of Imaging Technology.			
Publisher/Book	Explainable Artificial	Book (Auerbach	2025 English	USA
	Intelligence in Medical Imaging:	Publications)		
	Fundamentals and Applications.	,		
PubMed	Clinical Application of Artificial	Journal of the Korean	2025 English	South Korea
	Intelligence in Breast MRI.	Society of Radiology (v.		
		86, n. 2, p. 245-258)		
MDPI	Enhancing Radiologist	Diagnostics (v. 15, n. 9,	2025 English	Switzerland
	Productivity with Artificial	1146)		
	Intelligence in Magnetic	,		
	Resonance Imaging (MRI): A			
	Narrative Review.			
PubMed	Use of an Artificial Intelligence	Radiology (v. 296, n. 3,	2020 English	USA
	System to Improve Radiologists'	p. 521-529)		
	Performance in Differentiating	,		
	Benign and Malignant Breast			
	Lesions at DCE-MRI.			
Google	Intelligence artificial in the	Repository	2024 Portuguese	Brazil
Academic	magnetic resonance imaging: a	Institutional of UTFPR		
	bibliographic review about the	- RIUT		
	applications and impacts on			
	diagnostic imaging.			



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PubMed	Editorial for "Enabling Alÿ	Journal of Magnetic	2024 English	USA
	Generated Content for	Resonance Imaging (v.		
	Gadolinium-Free Contrast-	61, n. 3, p. 734-735)		
	Enhanced Breast Magnetic			
	Resonance Imaging".			
Portal of	Intelligence artificial in the	eduCAPES Portal	2024 Portuguese E	Brazil
Periodicals	magnetic resonance imaging: a			
	bibliographic review about the			
	applications and impacts on			
	diagnostic imaging.			
Frontiers	Ethical challenges of artificial	Frontiers in Radiology	2023 English	Switzerland
	intelligence in neuroradiology.	(v. 3, 1149461)		
Google	Ethical Challenges of Artificial	CUNY Academic	2023 English	USA
Academic	Intelligence in Neuroradiology.	Works		
(CUNY)	J. J. 11 11 11 11 11 11 11 11 11 11 11 11 11			
Google	Generative AI in Medicine	ResearchGate	2024 English	International
Academic	Imaging: Applications,		l 202 i Aiigiioii	
	Challenges, and Ethics.			
MDPI	Revolutionizing Cardiac	Cureus (v. 17, n. 1,	2025 English	USA
	Imaging: A Scoping Review of	e71314)	2025 English	
	Artificial Intelligence in	e71314)		
	intelligence			
	Echocardiography, CTA, and Cardiac MRI.			
ScienceDirect		Biomedical Signal	2000 Farlish	Netherlands
OcienceDirect	Advancing MRI reconstruction: a	Oigilai	2026 English	Netrieriarius
	systematic review of deep	Processing and Control		
	learning and compressed sensing	(v. 111, 108291)		
DubMad	integration.	Dritich Jayres of Cool		11.5.116.1
PubMed	Role of artificial intelligence in	British Journal of Oral	2024 English	United Kingdom
	magnetic resonance imaging	and Maxillofacial		
	based detection of	Surgery (S0266-		
	temporomandibular joint	4356(24)00549-7)		
	disorder: a systematic review.			
ScienceDirect	Medical Imaging and	Journal of Digital	2020 English	USA
	Computational Image Analysis in	Imaging (v. 33, p. 1-13)		
	COVID-19 Diagnosis: A Review.			
Springer	Healthcare and Artificial	Book/Monograph	2019 English	International
	Intelligence.			(Book)
Nature	A critical assessment of artificial	npj Imaging (v. 3, n. 1,	2025 English	United Kingdom
	intelligence in magnetic	p. 1-12)		
	resonance imaging of cancer.			

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Google	GAN review: Models and		ResearchGate	2025 E	nglish	International	
academic	medical	image	fusion				(Revision)
	applications.						
European Journal A	tificial	intelligence	in	European Journal of	2024 E	nglish	Germany
	radiology.			Nuclear Medicine and			
				Molecular Imaging (v.			
				51, p. 1-4)			

This Integrative Review demonstrates a robust consensus in the international literature on the role transformative of Artificial Intelligence (AI) in the field of Magnetic Resonance Imaging (MRI), with the publications focusing on the last decade, reflecting the rise of Deep Learning.

Deep Learning), a subfield of Machine Learning that uses neural networks with multiple layers. According to the summary presented in Table 1, the main findings revolve around three axes central: technical optimization and workflow acceleration, diagnostic improvement and reduction of

3.1 Technical Optimization and Workflow Acceleration

risks, and ethical and methodological challenges.

There is clear agreement among the authors that AI is revolutionizing the operational efficiency of RM (BARROS et al., 2025; LEE et al., 2025). Works such as JO et al. (2020), for example, demonstrate that Deep Learning optimizes the image reconstruction process, a technique that combines with Compressed Sensing, to result in a drastically accelerates acquisition time. This capability not only improves the patient experience, reducing examination time, as well as increasing the processing capacity of the service image. Additionally, authors such as LEE et al. (2025) and RUITENBEEK et al. (2024) point out for the use of AI in automated triage and segmentation, freeing the radiologist to dedicate time to more complex cases. BARROS et al. (2025) reinforce that, even in the national context, Workflow optimization is the most immediate impact of AI.

3.2 Diagnostic Improvement and Risk Reduction

One of the biggest advances lies in Al's ability to increase diagnostic accuracy in exams volumetric and reduce the need for contrast. High accuracy is a dominant theme, especially in breast MRI (ZHU et al., 2019; KIM and HA, 2025) and neuroradiology (JO et al., 2020), where AI, through Deep Learning algorithms, can surpass or complement human performance in the characterization and classification of lesions (CÁRDENAS et al., 2022). MANN

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Year V, v.2 2025 | submission: October 13, 2025 | accepted: October 15, 2025 | publication: October 17, 2025 et al. (2020) clinically validated that the AI system significantly improved performance of radiologists in differentiating between benign and malignant breast lesions. This ability is extends to specific areas, such as the analysis of pediatric tumors (AVVAL et al., 2025), demonstrating the versatility of AI in automated segmentation.

Another crucial benefit is contrast reduction. The experimental study by HUANG et al. (2025) and the MORAN's editorial (2024) highlights that Generative AI can simulate images with contrast from non-contrast sequences. This innovation is essential to mitigate the risk of complications (such as nephrogenic systemic fibrosis) in patients with renal failure, minimizing the exposure to Gadolinium.

3.3 Challenges and the Ethical-Methodological Debate

While there is consensus on the potential of AI, authors disagree on the challenges of implementation. and ethical risks, which represent the main barriers. The main methodological divergence is in model validation. Although AI demonstrates high accuracy in specific datasets (CÁRDENAS et al., 2022), GORE (2018) criticizes the lack of prospective studies and the low generalization of algorithms, that is, the performance of a model trained in one center may drop drastically in a hospital with different equipment. Al's reliance on datasets robust is a limitation pointed out by multiple authors.

In the ethical field, PINKER et al.'s (2023) warning about the challenges in neuroradiology is replicated by other authors (HAMET and TREMBLAY, 2017): large-scale implementation must be preceded by resolving issues such as algorithmic bias, legal liability, and consent informed. The need for Explainable AI (XAI), highlighted by KHAN and SABA (2025), is essential so that the radiologist can understand and trust the algorithm's decision, mitigating the risk of decisions based on "black boxes".

In short, the literature converges in enthusiasm for Al's capabilities to optimize flow and improve diagnostic accuracy in MRI subspecialties. However, there is a strong call for the next research phase migrates from proof-of-concept studies to robust clinical trials and multicenter, with priority attention to ethical and regulatory structures.

Final Considerations

This review consistently demonstrates that artificial intelligence applied to magnetic resonance imaging presents solid technical potential, with clear advances in reconstruction and image acceleration, post-processing, and automated interpretation tasks. These gains

Year V, v.2 2025 | submission: October 13, 2025 | accepted: October 15, 2025 | publication: October 17, 2025 technical findings are promising and suggest real possibilities for reducing examination time, improving quality of images and support for the detection of relevant findings; however, the translation of these results for proven clinical benefits is still limited by the predominantly retrospective and single-center of many studies (MENESES, nm; 2024; WU, c. et al.; 2025).

The main obstacles to clinical implementation are methodological and pragmatic: heterogeneity of metrics and protocols, lack of multicenter external validation and low

representativeness of databases in relation to real populations. To overcome these barriers, coordinated research strategies are needed that prioritize prospective trials, repositories multicenter annotations and reporting standards that allow comparability and reproducibility of evidence (SANKAR,

h. et al.; 2024; JO, t. et al.; 2020; CÁRDENAS, ce et al.; 2022).

The ethical, regulatory and equity dimensions require simultaneous attention to development technical. All approaches, independent audits, data governance frameworks, and procedures for identifying and correcting biases are essential to avoid amplification of inequalities and to ensure transparency and accountability in clinical decisions supported by algorithms. In addition, compliance with regulatory requirements and protection of user privacy patient should be priorities on the path to safe adoption (PINKER, k. et al.; 2023; KHAN, air; 2025).

In practice, responsible adoption of AI in RM must follow a phased path: prioritize applications with strong technical evidence and low integration cost (e.g., reconstruction for reduction acquisition time; automated screening of critical findings), testing these solutions in studies controlled prospective and only then expand to more complex interpretative tasks.

Therefore, technological integration must be accompanied by investments in infrastructure,

training of professionals and continuous mechanisms for monitoring post-performance implementation to detect drift and preserve clinical safety (MANN, rm et al.; 2020; LEE, j. h. et al.; 2025).

In short, AI in MRI has real potential to transform technical aspects and operational aspects of radiological practice, but its promise will only be fully realized if it is accompanied by robust clinical validation, ethical governance, methodological standardization and efforts sustainable implementation strategies. The convergence between researchers, clinicians, regulators, and managers health will be crucial to converting current technical progress into lasting benefits for patients and health systems. (MENESES, 2024; WU et al., 2025)

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