Evolution of AI in Radiological Detection of Lumbar Disc Hernias: Emphasising Trustworthiness and Explainability

Jolanta Miliauskaitė[1], Asta Slotkienė[1], Susana Moleirinho[2], António Fernandes[2,3], Luís Mendes Gomes[3,4], José Machado[3]

[1] Institute of Data Science and Digital Technologies, Vilnius University, jolanta.miliauskaite@mif.vu.lt, asta.slotkiene@mif.vu.lt
[2] SliceD Group Research Center, Lisbon, Portugal, susana.moleirinho@slicedgroup.com, antonio.fernandes@slicedgroup.com
[3] ALGORITMI, LASI, Universidade do Minho, Portugal, jmac@di.uminho.pt
[4] Faculdade de Ciências e Tecnologia, Universidade dos Açores, ALGORITMI, Universidade do Minho, Portugal, luis.mp.gomes@uac.pt

INTRODUCTION

It is widely recognised that artificial intelligence (AI) is profoundly transforming medical imaging, particularly in the radiological detection of lumbar disc hernias. This study presents a comprehensive bibliometric analysis based on global research articles extracted from the Web of Science database, aiming to map out the advances made in radiology concerning lumbar disc hernia detection, with an emphasis on trustworthiness and explainability. The main contributions and findings have been identified, systematised, and visualised through keyword mapping of relevant AI techniques applied to this domain. These methods primarily facilitate the enhancement of diagnostic accuracy, automated segmentation, and classification of lumbar spine structures, thereby addressing clinical challenges such as subjective image interpretation and inter-observer variability. A critical focus is placed on the evolution of frameworks ensuring AI trustworthiness, including robustness, fairness, privacy compliance, and clinical reliability, alongside approaches to explainable AI (XAI) that promote transparency by visualising model decision-making processes, such as heatmaps highlighting key anatomical regions on MRI scans. These features are crucial for fostering clinician confidence and ensuring the ethical and safe deployment of AI in clinical workflows. The present study reveals main trends indicating progressive integration of multimodal data, including clinical, imaging, and genomic information, to enhance diagnostic precision and patient stratification. Additionally, it underscores the challenges faced, such as heterogeneous imaging protocols, limited availability of high-quality annotated datasets, and the need for standardised validation practices. The results support researchers and clinicians by providing valuable insights into AI applications in lumbar disc hernia radiology, guiding future investigations focused on developing robust, interpretable, and clinically relevant AI systems. This work underlines the indispensable role of explainability and trustworthiness as complementary pillars underpinning the responsible adoption of AI technologies, ultimately advancing patient care and resource efficiency in modern radiology.

RESULTS

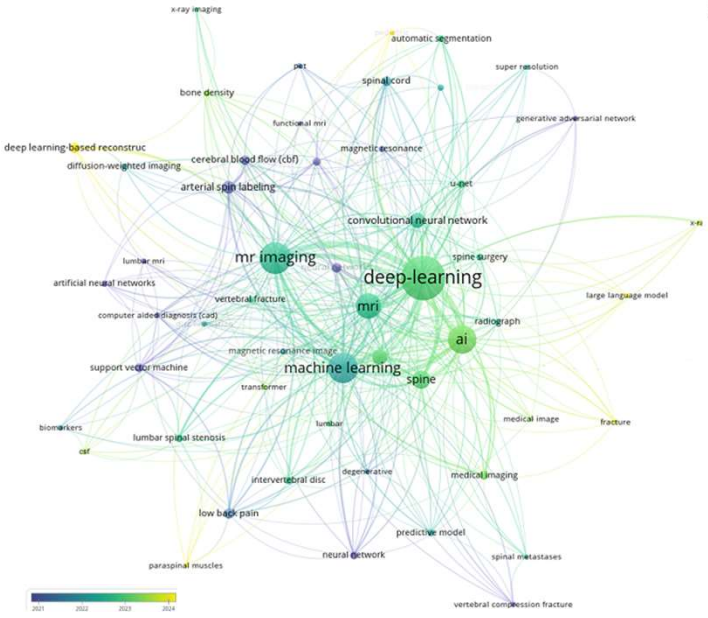

Figure 1 The most occurring keywords map.

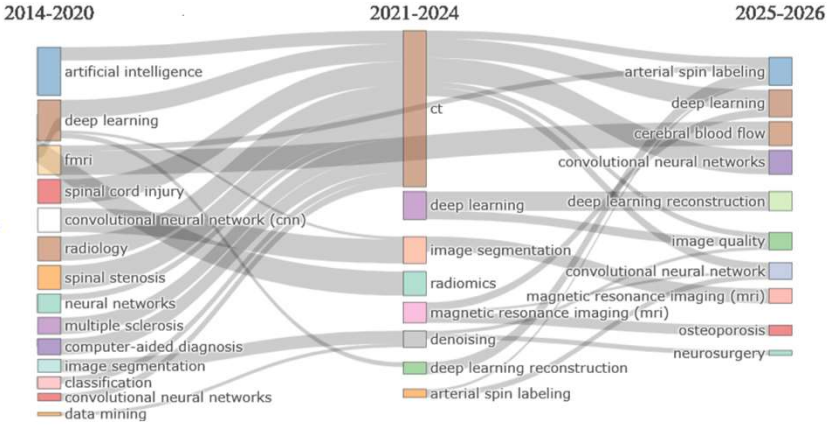

Figure 2. Thematic evolution of AI in rradiological ddetection of Lumbar Disc Hernias.

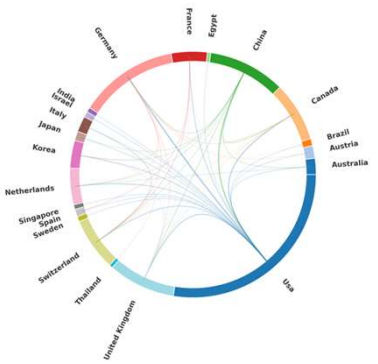

Figure 3. Countries collaboration network in analyzed topic.

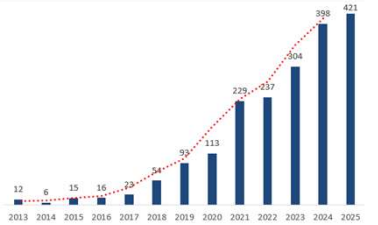

Figure 4. Chronological distribution of AI in radiological detection of lumbar disc hernias.

METHODOLOGY

Table 1. Search strings in Web of Science (WoS) during period 2013-2025+.

Context	Parts of Search String (connected with AND)
Medical context (medical diagnostic's area)	(lumbar* OR spin* OR *vertebra* OR hernia* OR disc?)
AI technologies	(XAI OR "explain*AI" OR AI OR "artificial intelligence" OR "machine learning" OR "deep learning" OR "*neural network*" OR "natural language *")
Methodological solutions	(method* OR model* OR "framework*" OR algorithm*)
Diagnostic imaging methods	(radiol* or MRI OR "magnetic resonan*")

Table 2. The search limitations in the WoS database.

Language	Categories	Document Type	Result
English	*Radiology Nuclear Medicine Medical Imaging* OR *Neurosciences OR Clinical Neurology* OR *Engineering Biomedical* OR *Engineering Multidisciplinary* OR *Computer Science Artificial Intelligence* OR *Computer Science Theory Methods* OR *Computer Science Information Systems* OR *Computer Science Interdisciplinary Applications* OR *Computer Science Software Engineering* OR *Orthopaedics* OR *Surgery OR Imaging Science Photographic Technology* OR *Medical Informatics OR Rheumatology* OR *Medicine Research Experimental* OR *Neuroimaging OR Medicine General Internal OR Multidisciplinary Sciences*	*Article* OR *Proceeding Paper* OR *Review Article* OR *Early Access*	1972

CONCLUSIONS

- The performed bibliometric analysis confirms that AI and medical technologies have significantly matured, from theoretical research to practical solutions for automating segmentation and classification.
- The emerging bibliometric clusters highlight four key areas: super-resolution, DL-based reconstruction, LLM, and quantitative imaging biomarkers, which are used for more reliable physiological assessment of the lumbar spine.

REFERENCES

[1] Wang, H., Jin, Q., Li, S., Liu, S., Wang, M., & Song, Z. (2024). A comprehensive survey on deep active learning in medical image analysis. Medical Image Analysis, 95, 103201.
[2] Lundervold, A. S., & Lundervold, A. (2019). An overview of deep learning in medical imaging focusing on MRI. Zeitschrift fuer Medizinische Physik, 29(2), 102-127.
[3] Donthu N, et al. How to conduct a bibliometric analysis: an overview and guidelines. *J Bus Res*. 2021;133:285–296.
[4] Aria, M., & Cuccurullo, C. (2017). bibliometrix: An R-tool for comprehensive science mapping analysis. Journal of informetrics, 11(4), 959-975.