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Artificial Intelligence and Computer-aided Diagnosis in Lumbar Prolapsed Intervertebral Disc: A Systematic Review with Meta-analysis

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ABSTRACT

Introduction: Lumbar Prolapsed Intervertebral Disc (PIVD) is a common and debilitating lower back condition. Accurate and timely diagnosis is crucial for its effective management. Conventional diagnostic methods like Magnetic Resonance Imaging (MRI) and computed tomography often require expert interpretation, which can be subjective, time-consuming, and prone to false positive interpretation. Artificial Intelligence (AI) and Computer-aided Diagnosis (CAD) techniques have the potential to revolutionise the diagnosis of lumbar PIVD by improving accuracy, efficiency, and objectivity. Thus, there is a critical need for a systematic evaluation of the existing evidence on the efficacy of AI and CAD in lumbar PIVD diagnosis.

Aim: This systematic review with meta-analysis aims to thoroughly assess the available knowledge on the usability of different AI and CAD in lumbar PIVD diagnosis.

Materials and Methods: A systematic search of electronic databases like PubMed, EMBASE, and IEEE for relevant full-text studies published in peer-reviewed journals between 2014 and 2024, only in the English language. The included studies were evaluated for methodological quality assessment using the Quality Assessment of Diagnostic Accuracy Studies tool. The primary outcomes for review included the diagnostic accuracy (sensitivity, specificity, accuracy) of each AI and CAD system. Subsequently,a meta-analysis was conducted to synthesise the results of the included studies and assess the overall effectiveness of AI and CAD in lumbar PIVD diagnosis.

Results: Following the extensive search, a total of eight studies were identified, evaluating 13 CAD or AI systems. Four of these studies utilised the CAD model, three employed deep learning and one used machine learning. All the studies analysed lumbar MRI data. The meta-analysis involved three of the studies, and it demonstrated a high pooled sensitivity (0.901, 95% CI: 0.871-0.924) and specificity (0.919, 95% CI: 0.898-0.936) for the included studies using CAD system for lumbar PIVD diagnosis. Moreover, the least heterogeneity (I^2 value= 0%) was observed in both sensitivity and specificity across the included studies, suggesting that the observed diagnostic accuracy is likely to be generalisable across different AI/CAD systems and study populations.

Conclusion: To conclude, these findings strongly support the potential of AI/CAD systems to improve the accuracy and efficiency of lumbar PIVD diagnosis.

Keywords: Deep Learning, Machine Learning, Magnetic Resonance Imaging