World Journal of Advanced Research and Reviews
eISSN: 2581-9615 CODEN (USA): WJARAI
Cross Ref DOI: 10.30574/wjarr
Journal homepage: https://wjarr.com/

(REVIEW ARTICLE)

AI in neurodegenerative disorders: A neurosurgical perspective

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World Journal of Advanced Research and Reviews, 2024, 24(01), 1453–1455

Publication history: Received on 08 September 2024; revised on 15 October 2024; accepted on 17 October 2024

Article DOI: https://doi.org/10.30574/wjarr.2024.24.1.3173

Abstract

This paper investigates the application of artificial intelligence (AI) in diagnosing and managing neurodegenerative disorders that require neurosurgical intervention, such as Parkinson's disease (PD) and Alzheimer's disease (AD). A systematic review of the literature was conducted to identify studies that utilized AI techniques for diagnosis, treatment planning, or post-operative monitoring of these conditions. The results demonstrate the potential of AI to improve early detection, treatment outcomes, and patient care. However, challenges such as data quality, explainability, and ethical considerations must be addressed to ensure the responsible and effective integration of AI into clinical practice.

Keywords: Artificial Intelligence; Neurodegenerative Disorders; Parkinson's Disease; Alzheimer's Disease; Neurosurgery; Diagnosis; Treatment Planning; Post-Operative Monitoring

1. Introduction

Neurodegenerative disorders, characterized by the progressive loss of brain cells, pose a significant global health challenge. Conditions like PD and AD have a profound impact on patients' quality of life and impose a substantial burden on healthcare systems. Traditional diagnostic and treatment methods often have limitations, especially in the early stages of disease. The advent of AI offers promising advancements in the diagnosis and management of neurodegenerative disorders.

AI algorithms can analyze large datasets of medical images, genetic information, and clinical data to identify patterns and biomarkers that may be indicative of disease progression. Additionally, AI-powered tools can assist in treatment planning, surgical simulation, and post-operative monitoring, potentially improving patient outcomes and reducing the overall cost of care.

2. Literature Review

A systematic review of the literature was conducted to identify studies that utilized AI techniques for the diagnosis, treatment planning, or post-operative monitoring of neurodegenerative disorders. Several electronic databases, including PubMed, Scopus, and Web of Science, were searched using relevant keywords. The inclusion criteria were limited to studies published in English between 2010 and 2023 that focused on the use of AI for neurodegenerative

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disorders requiring neurosurgical intervention. Exclusion criteria included studies that did not involve AI techniques or did not address the specific conditions of interest.

The results of the review revealed a growing body of research exploring the application of AI in neurodegenerative disorders. AI algorithms have been successfully used to analyze MRI scans to detect subtle changes in brain structure associated with AD and PD (Wang et al., 2020). These algorithms have demonstrated high accuracy in differentiating between patients with and without these conditions. Additionally, AI-powered tools have been developed to analyze speech patterns and identify early signs of cognitive decline in patients with AD (Li et al., 2019).

In the realm of treatment planning, AI has shown promise in predicting surgical outcomes and identifying optimal treatment strategies. For instance, machine learning algorithms have been employed to predict the risk of complications following DBS surgery for PD (Lee et al., 2021). Furthermore, AI-powered surgical simulation tools can provide surgeons with a virtual environment to practice complex procedures and improve their skills.

3. Methodology

This study conducted a systematic review of the literature to investigate the application of AI in diagnosing and managing neurodegenerative disorders requiring neurosurgical intervention. Several electronic databases, including PubMed, Scopus, and Web of Science, were searched using relevant keywords (e.g., "AI," "neurodegenerative disorders," "neurosurgery"). Inclusion criteria were limited to studies published in English between 2010 and 2023 that focused on the use of AI for diagnosis, treatment planning, or post-operative monitoring of neurodegenerative disorders. Exclusion criteria included studies that did not involve neurosurgical intervention or did not utilize AI techniques.

Two reviewers independently screened the identified studies for eligibility and extracted relevant data, including study design, sample size, AI techniques used, and key findings. Disagreements were resolved through discussion or consultation with a third reviewer. The quality of the included studies was assessed using the QUADAS-2 tool.

4. Results

The systematic review identified a total of 14 studies that met the inclusion criteria. The majority of studies focused on the use of AI for diagnosis, followed by treatment planning and post-operative monitoring. The most commonly used AI techniques were deep learning and machine learning algorithms.

The results demonstrated the potential of AI to improve early detection and diagnosis of neurodegenerative disorders. AI algorithms were able to accurately identify subtle changes in brain structure and detect early signs of cognitive decline. In terms of treatment planning, AI-powered tools were shown to predict surgical outcomes and identify optimal treatment strategies. Additionally, AI-assisted surgical simulation was found to enhance surgical skills and reduce the risk of complications.

5. Discussion

The findings of this review highlight the significant potential of AI to revolutionize the diagnosis and management of neurodegenerative disorders. AI algorithms can improve early detection, leading to earlier intervention and potentially delaying disease progression. Furthermore, AI-powered tools can optimize treatment planning and enhance surgical outcomes, improving the overall quality of care for patients with neurodegenerative disorders.

However, several challenges must be addressed to ensure the responsible and effective integration of AI into clinical practice. One of the key challenges is the quality and quantity of data required for AI training. High-quality, annotated datasets are essential for developing accurate and reliable AI models. Additionally, ensuring data privacy and ethical considerations is crucial.

Another challenge is the explainability of AI models. Many AI algorithms are complex and difficult to understand, making it challenging to interpret their decisions. Developing interpretable models is essential for building trust and ensuring transparency in decision-making.

6. Conclusion

This review highlights the significant potential of AI to improve the diagnosis and management of neurodegenerative disorders. AI algorithms can enhance early detection, optimize treatment planning, and improve surgical outcomes. However, challenges such as data quality, explainability, and ethical considerations must be addressed to ensure the responsible and effective integration of AI into clinical practice. Future research should focus on developing robust AI models, addressing ethical concerns, and evaluating the long-term impact of AI on patient outcomes.

Compliance with ethical standards

Disclosure of conflict of interest

The authors declare that they have no competing interest to declare.

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