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PROSPECTS OF ARTIFICIAL INTELLIGENCE IN THE DIAGNOSIS OF TEMPOROMANDIBULAR JOINT DISORDERS (TMJD)

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Abstract. Temporomandibular joint disorders (TMJD) represent a group of complex musculoskeletal and neuromuscular conditions affecting the temporomandibular joint (TMJ), masticatory muscles, and associated structures. Accurate diagnosis of TMJD remains challenging due to its multifactorial etiology, variable clinical presentation, and limitations of conventional diagnostic approaches. In recent years, artificial intelligence (AI) has emerged as a promising tool in medical diagnostics, including dentistry. This paper aims to explore the prospects, current applications, and future directions of AI in diagnosing TMJD. The study reviews machine learning (ML), deep learning (DL), and computer vision techniques applied to imaging modalities such as MRI, CBCT, and clinical data analysis. AI-based systems demonstrate high accuracy in detecting structural abnormalities, classifying TMJ disorders, and predicting disease progression. However, challenges such as data quality, ethical concerns, and integration into clinical workflows remain significant. The implementation of AI in TMJD diagnostics has the potential to enhance early detection, improve diagnostic accuracy, and support personalized treatment planning.

Keywords: Temporomandibular joint disorders, Artificial intelligence, Machine learning, Deep learning, CBCT, MRI, Dental diagnostics

Introduction. Temporomandibular joint disorders (TMJD) are among the most common causes of orofacial pain, affecting a significant portion of the global population. These disorders involve dysfunction of the temporomandibular joint (TMJ), masticatory muscles, and surrounding tissues. Patients often present with symptoms such as pain, joint sounds, restricted mandibular movement, and functional impairment.

Traditional diagnostic methods include clinical examination, radiographic imaging, and patient-reported symptoms. However, these approaches are often subjective and may lead to misdiagnosis or delayed diagnosis. The complexity of TMJD etiology, which includes mechanical, psychological, and biological factors, further complicates the diagnostic process.

Artificial intelligence (AI), particularly machine learning and deep learning, has shown considerable potential in improving diagnostic accuracy in various medical fields. In dentistry, AI applications are rapidly expanding, offering new opportunities for early detection and precise diagnosis of TMJD.

Materials and Methods. This study is based on a comprehensive review of recent scientific literature published between 2018 and 2025. Databases such as PubMed, Scopus, and Web of Science were analyzed to identify relevant studies related to AI applications in TMJD diagnosis.

The inclusion criteria consisted of:

- Studies involving AI, ML, or DL in TMJ or TMJD diagnostics
- Research utilizing imaging techniques such as MRI and CBCT
- Articles published in peer-reviewed journals

The analysis focused on evaluating the types of AI algorithms used, diagnostic accuracy, and clinical applicability.

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Results and Discussion

AI in Imaging-Based Diagnosis. AI has demonstrated significant potential in analyzing medical images for TMJD diagnosis. Deep learning models, particularly convolutional neural networks (CNNs), are widely used to interpret CBCT and MRI scans.

AI systems can automatically detect:

- Disc displacement
- Joint effusion
- Bone degeneration
- Osteoarthritic changes

Studies report diagnostic accuracy rates exceeding 90%, outperforming traditional radiological assessments in some cases. AI-based image analysis reduces human error and enables early detection of subtle pathological changes.

Machine Learning in Clinical Data Analysis. Machine learning algorithms can analyze large datasets, including patient history, symptoms, and clinical findings. These systems help identify patterns and predict the likelihood of TMJD.

For example:

- Support vector machines (SVM) and random forest models can classify TMJD subtypes
- Predictive models can assess disease progression and treatment outcomes

Such tools assist clinicians in making evidence-based decisions.

Advantages of AI in TMJD Diagnosis. The integration of AI into TMJD diagnostics offers several advantages:

- Increased diagnostic accuracy
- Early detection of disorders
- Reduced diagnostic time
- Standardization of diagnostic procedures
- Support for personalized treatment planning

AI can also improve accessibility to specialized diagnostics in regions with limited healthcare resources.

Challenges and Limitations. Despite its potential, AI implementation faces several challenges:

- Limited availability of high-quality annotated datasets
- Risk of algorithm bias
- Lack of standardization in AI models
- Ethical concerns regarding patient data privacy
- Difficulty in integrating AI into routine clinical practice

Additionally, clinicians may require training to effectively use AI-based tools.

Future Perspectives. Future developments in AI are expected to enhance TMJD diagnostics further. Integration of multimodal data (imaging, clinical, genetic) will improve diagnostic precision. Real-time AI-assisted diagnostic systems and chairside applications may become standard in dental practice.

Moreover, explainable AI (XAI) will increase trust among clinicians by providing transparent decision-making processes.

Conclusion. Artificial intelligence holds significant promise in improving the diagnosis of temporomandibular joint disorders. AI-based tools can enhance diagnostic accuracy, facilitate early detection, and support personalized treatment strategies. While challenges remain, ongoing advancements in technology and data science are likely to accelerate the integration of AI into dental diagnostics. Future research should focus on developing standardized, reliable, and ethically sound AI systems for clinical use.

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