Short Communication

Artificial intelligence in periodontics: Transforming the future of periodontal care

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A R T I C L E I N F O

A B S T R A C T

Artificial intelligence (AI) has emerged as a transformative force across various medical fields, including dentistry. In periodontics, AI offers the potential to enhance diagnostic accuracy, optimize treatment planning, and provide predictive analytics for disease progression. By leveraging machine learning (ML), deep learning (DL), and computer vision techniques, AI is reshaping how clinicians approach periodontal care. This review explores the current and future applications of AI in periodontics, from diagnostics to personalized treatment strategies.

1. Introduction

Periodontics focuses on the prevention, diagnosis, and treatment of periodontal disease, which affects both the soft and hard tissues supporting teeth. Despite significant advancements in clinical practice, the early detection and precise management of periodontal diseases remain challenging. AI technologies can help overcome these challenges by automating and enhancing periodontal diagnostics, enabling personalized treatment approaches, and providing real-time predictive analytics. [1–3]

This review examines the current role of AI in the field of periodontics, its potential benefits, and the future implications of integrating AI into routine clinical practice.

2. AI in Periodontal Diagnostics [2,3]

One of the most significant contributions of AI in periodontics is its ability to improve diagnostic accuracy. Traditional methods, such as probing depth measurements and radiographic analysis, are prone to subjectivity and variation between clinicians. AI helps to standardize the diagnostic process by leveraging data-driven models and image analysis tools.

2.1. Radiographic analysis

AI algorithms, particularly those based on deep learning, have shown great promise in analyzing radiographic images. AI can automatically detect signs of bone loss, periodontal pocket formation, and other early indicators of periodontitis. These algorithms not only enhance diagnostic accuracy but also provide consistent and objective evaluations.

Example: AI-powered software can analyze digital radiographs and provide real-time, automated assessments of bone levels and alveolar defects, helping clinicians detect periodontitis earlier than conventional methods.

2.2. Cone beam computed tomography (CBCT) analysis

AI is being used to interpret CBCT scans, which offer detailed 3D images of periodontal structures. Machine learning models can analyze complex anatomical structures,

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identifying bone resorption and periodontal defects with greater precision.[4]

Example: AI-assisted CBCT analysis can measure attachment loss, alveolar bone height, and the presence of furcation involvement more accurately than manual interpretation.

3. AI in Predictive Analytics for Periodontal Disease[3]

AI's predictive capabilities can revolutionize the management of periodontal disease by identifying patients at high risk of disease progression and helping clinicians tailor interventions more effectively.

3.1. Predictive models for disease progression[2,3]

AI can develop personalized risk profiles by analyzing a patient's demographic, genetic, and clinical data. Machine learning models can predict the likelihood of periodontal disease progression, enabling clinicians to take preemptive measures to slow down or prevent further tissue damage.

Example: AI models trained on large datasets of periodontal health information can predict which patients are at higher risk for rapid disease progression, allowing for early intervention and better patient outcomes.

3.2. Personalized treatment plans

AI can recommend personalized treatment plans based on individual patient data. By analyzing a combination of clinical findings, patient history, and radiographic information, AI can provide tailored recommendations for surgical or non-surgical treatments, reducing the need for trial-and-error approaches.[5]

Example: AI-powered systems can assist in choosing the appropriate therapy, such as scaling and root planing, antibiotic therapy, or regenerative procedures, based on the specific characteristics of a patient's periodontal condition.

4. AI in Surgical Planning and Execution[2]

AI is enhancing surgical planning in periodontics, particularly for complex procedures like guided tissue regeneration (GTR) and implant placement. AI-powered software can simulate surgery, guide clinicians through procedures, and even automate certain tasks.

4.1. Computer-assisted surgery[2,3]

AI-based navigation systems allow clinicians to visualize periodontal defects in 3D and plan surgeries with a high level of precision. AI can guide surgical instruments to ensure minimal invasiveness and optimal outcomes.

Example: AI-driven navigation tools can assist clinicians in performing periodontal flap surgeries by providing real-time feedback and reducing the risk of damaging healthy tissue.

4.2. Implantology[3]

AI technology is particularly useful in implantology, where precise placement of dental implants is critical. AI can analyze CBCT scans to identify the ideal implant location, angulation, and depth, minimizing the risk of peri-implantitis and improving implant success rates.

Example: AI-based software can simulate implant surgery by suggesting the most favorable implant positions based on the patient's bone density and anatomical features.

5. AI in Patient Education and Communication[2]

AI technologies, particularly virtual assistants and chatbot applications, are enhancing patient communication and education in periodontics. AI-driven platforms can explain periodontal conditions, provide personalized home-care recommendations, and help patients better understand their treatment options.

5.1. Virtual health assistants

AI virtual health assistants can interact with patients, providing them with answers to their periodontal questions and offering advice on maintaining good oral hygiene between dental visits.

Example: AI-powered apps can guide patients on proper brushing techniques, inform them about the importance of regular cleanings, and alert them when it's time to schedule follow-up visits.

5.2. Predictive patient follow-up

AI can help clinicians predict when patients may need follow-up care, ensuring early intervention for potential complications. By analyzing patient data from previous treatments, AI systems can provide reminders and suggest when preventive measures are necessary.

Example: An AI system can analyze a patient's previous treatments and oral hygiene patterns to predict when additional periodontal maintenance may be needed, reducing the risk of disease recurrence.

6. Challenges and Limitations of AI in Periodontics[3]

Despite its potential, AI faces several challenges in periodontics, including the need for large datasets, privacy concerns, and the lack of standardized AI protocols across dental practices. The effectiveness of AI models depends heavily on the quality of data they are trained on, which means incomplete or biased datasets could lead to inaccurate predictions.

6.1. Data standardization and availability

The success of AI in periodontics relies on access to comprehensive and standardized datasets that reflect diverse

patient populations. Currently, limited access to high-quality dental data is a barrier to the widespread adoption of AI tools in periodontics.

6.2. Ethical Considerations

The integration of AI raises ethical concerns related to patient data privacy, algorithm transparency, and the potential for bias in AI decision-making processes. Clinicians must ensure that AI tools are used ethically and that patient consent is obtained before implementing AI-driven diagnostics and treatment recommendations.

7. Conclusion

AI is revolutionizing the field of periodontics by enhancing diagnostics, treatment planning, and patient management. From analyzing radiographs to predicting disease progression and personalizing treatment strategies, AI has the potential to dramatically improve periodontal care. While challenges remain, particularly in terms of data standardization and ethical considerations, AI technologies are set to play an increasingly important role in the future of periodontics. With continued development and research, AI-driven tools will likely become integral to the daily practice of periodontists, offering more precise and efficient patient care.

8. Conflict of Interest

None.

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