

Artificial Intelligence in Dentistry: Present Applications and Future Outlook

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Introduction

Dentistry has long relied on clinical skill, manual dexterity, and patient interaction. The emergence of digital dentistry has paved the way for AI-based solutions that support clinical decision-making and workflow optimization. AI, defined as the simulation of human intelligence by machines, utilizes large datasets to improve diagnostic precision and treatment outcomes, contributing to a more patient-centered approach to oral healthcare.^[1]

Evolution of AI in Dentistry

The digital transformation of dentistry began with the introduction of CAD/CAM systems in the 1980s, enabling accurate prosthetic fabrication. Subsequently, AI-assisted radiology enhanced the interpretation of intraoral radiographs and cone-beam computed tomography (CBCT), improving diagnostic consistency. Recent advancements in deep learning have significantly improved the detection of dental caries, periodontal disease, and oral cancers, representing a major shift in diagnostic capabilities.^[2]

Core AI Technologies

Machine learning enables predictive analytics for caries risk assessment, orthodontic treatment planning, and disease progression. Deep learning, particularly convolutional neural networks, is highly effective in image-based diagnostics, including lesion detection and oral cancer screening. Natural language processing supports automated clinical documentation, extraction of insights from electronic dental records, and patient communication tools.^[3]

Integration of AI with robotics has also shown promise in improving precision during implant placement and endodontic procedures.^[4]

Current Applications in Dentistry

AI has been widely adopted in diagnostic imaging for the detection of caries, periapical lesions, and alveolar bone loss. In restorative dentistry, AI-assisted design improves prosthetic accuracy and reduces chairside time. Orthodontics benefits from AI-driven treatment planning, aligner design, and monitoring of tooth movement. In periodontology, AI tools assist in disease monitoring and prediction of treatment outcomes. Additionally, AI contributes to dental biomaterials research and enhances administrative efficiency through automated scheduling, billing, and patient engagement systems.^[5]

Ethical and Practical Considerations

The adoption of AI in dentistry presents challenges related to data privacy, algorithmic bias, cost, and accessibility. Ensuring secure handling of patient data and the use of representative training datasets is essential to minimize diagnostic disparities. AI should serve as a supportive tool rather than a replacement for clinical expertise. Efforts are also required to improve access to AI technologies in resource-limited settings.^[6,7]

Future Directions

AI is expected to advance personalized dentistry by enabling precision treatment planning based on

individual clinical, behavioural, and biological profiles.^[8] Further integration with robotics may enhance surgical accuracy, while AI-powered smart clinics could automate operational workflows. AI-driven research platforms are anticipated to accelerate progress in biomaterials, regenerative dentistry, and dental education through simulation-based training.^[3]

Conclusion

Artificial intelligence is transforming dentistry by improving diagnostic accuracy, clinical efficiency, and patient outcomes. Although challenges remain, continued technological innovation and responsible implementation will ensure that AI becomes an integral component of future dental practice.

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