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Editorial

AI in dentistry

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Artificial Intelligence (AI) has emerged as one of the most transformative forces in modern healthcare, and dentistry is no exception. Initially conceptualized in the mid-20th century, AI now encompasses advanced computational systems capable of performing complex tasks once reliant solely on human cognition. Through subfields such as machine learning (ML) and deep learning (DL), AI has evolved to process large volumes of clinical data, identify intricate patterns, and make highly accurate predictions.[1] Dentistry, which relies heavily on imaging, structured records, and standardized procedures, has proven to be an ideal domain for AI integration. From oral pathology and radiology to implantology, prosthodontics, and endodontics, AI is revolutionizing diagnostic precision, treatment planning, workflow efficiency, and patient engagement. By augmenting clinical expertise with advanced analytical capabilities, AI is not merely automating tasks—it is redefining how dental care is delivered across all specialties.[2]

One of AI's most valuable contributions lies in enhancing early detection, particularly in conditions that are traditionally challenging to identify at their initial stages. For example, dental caries detection has long relied on visual-tactile examinations, explorers, and radiographs such as bitewings, periapicals, or panoramic views.[3] While these tools are well-established, they often depend heavily on the clinician's skill and experience, meaning that early-stage lesions—especially in deep fissures, tight interproximal contacts, or beneath existing restorations—may go unnoticed until they require more invasive interventions such as crowns, root canal therapy, or implants. AI algorithms, trained on large datasets of labeled radiographs and clinical images, can recognize subtle radiographic density changes and irregularities that may be imperceptible to the human eye. Studies have shown that convolutional neural networks (CNNs) can detect proximal caries on periapical or intraoral images with equal or greater accuracy than dentists, and at significantly lower cost in simulated models.[4,5,6]

The same principles are being applied to a wide range of diagnostic challenges, from identifying vertical root fractures and apical lesions to assessing pulp space volume and evaluating tooth wear. In these cases, each pixel in a 2D radiograph carries grayscale information representing tissue density, and AI systems learn to interpret these patterns in ways that support tooth segmentation, lesion detection, and severity assessment.

In endodontics, AI applications range from identifying periapical pathologies and missed canals to predicting the mechanical stress on endodontic files during instrumentation. Microbiological analysis benefits as well—AI can visualize and categorize biofilm patterns, forecast antimicrobial resistance, and aid in selecting the most effective intracanal medicaments. In their study, Saghiri et al. applied an artificial neural network (ANN) to estimate working length and obtained a 96% accuracy rate, which was superior to that of professional endodontists.[5]

Periodontal disease diagnosis has similarly benefited from AI's analytical power. Traditionally, periodontal

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assessment relies on probing depths, recession measurements, and indices such as the Periodontal Screening Index (PSI), but these methods are subject to variability and may miss localized disease. AI now enables the automated detection of periodontal bone loss from panoramic radiographs, classification of periodontal disease types. Algorithms trained for these purposes can flag periodontally compromised teeth or identify subtle bone level changes that might otherwise go unnoticed, thereby supporting earlier and more targeted interventions. .[3]

The scope of AI is especially impactful in specialties like implantology, where preoperative planning demands precise mapping of bone quality, anatomical landmarks, and risk structures. AI-enhanced CBCT interpretation can not only identify these features but also simulate optimal implant angulation, depth, and positioning, producing surgical guides that are customized to the patient's unique oral anatomy.[2,3]

AI's reach also encompasses prosthetic and restorative dentistry, where it supports the design and fabrication of crowns, bridges, and dentures. By combining intraoral scan data with occlusal analysis, AI-powered CAD/CAM systems produce restorations that fit more accurately and require fewer adjustments.[4]

In orthodontics, treatment planning has conventionally depended on the clinician's experience, with cephalometric analysis and growth prediction forming the backbone of decision-making. These processes are often laborious, with outcomes influenced by numerous variables that complicate extraction planning, surgical assessment, and treatment forecasting.

AI-based decision support systems, including Bayesian networks and artificial neural networks (ANNs), have demonstrated high precision in determining the need for extractions using lateral cephalometric radiographs. Beyond landmarking, AI has shown excellent performance in skeletal classification and in predicting surgical versus non-surgical cases, with some models achieving success rates above 95%. These capabilities make AI highly relevant in the context of orthognathic surgery planning.

AI is also establishing its role in forensic odontology, where accurate identification is often critical in legal and humanitarian contexts. Automated convolutional neural networks (CNNs) have been applied to assess third molar development on panoramic radiographs for age estimation, gender determination and prediction of mandibular morphology, producing outcomes with high reliability.

When integrated into teledentistry platforms, AI can triage cases, prioritize urgent referrals, and provide preliminary assessments that support faster patient care. This combination of digital access and clinical intelligence has the potential to significantly reduce disparities in oral health services.

The success of these applications depends on the availability of diverse, high-quality datasets and interdisciplinary collaboration between dental professionals and AI developers. However, the integration of AI into dentistry is not without its challenges. Data privacy, system interoperability, algorithm transparency, and cost considerations all play a role in determining how, and how quickly these technologies can be adopted. Traditional methods—rooted in tactile skills, patient rapport, and nuanced judgment—remain irreplaceable, particularly in complex cases where human insight can account for contextual and emotional factors beyond the reach of algorithms.[6]

AI should be seen not as a replacement for dental expertise, but as an augmentation that enhances diagnostic accuracy, treatment precision, and workflow efficiency. The human elements of dentistry clinical judgment, manual dexterity, and the patient–practitioner relationship remain irreplaceable. The future of dentistry lies in the synergistic integration of AI with established practices. In this hybrid model, AI serves as an ever-evolving partner, empowering clinicians to deliver treatments that are not only scientifically sound but also deeply personalized, ensuring that the art and science of dentistry advance together.

Conflict of Interest

None.

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