

A Review on Artificial Intelligence and Dentistry

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Synopsis

Introduction

In recent years, the field of dentistry has undergone significant change due to the incorporation of Artificial Intelligence (AI). Dental practices are undergoing a radical change in workflows related to diagnosis, treatment planning, patient education, and administration as a result of the quick developments in machine learning (ML), deep learning (DL), and data-driven technologies. This overview goes into greater detail about the clinical uses, moral dilemmas, worldwide inequalities, and prospects for AI in dentistry as they are discussed in the compilation of papers written or reviewed by different authors.

Clinical Applications Across Dental Specialties

AI has demonstrated notable benefits across nearly all branches of dentistry:

- **Radiology & Diagnostics:** AI algorithms, particularly convolutional neural networks (CNNs), can interpret dental X-rays, CBCT scans, and panoramic images with accuracy comparable to expert radiologists. These models help detect caries, periapical lesions, bone loss, and oral tumors faster and more reliably.
- **Endodontics:** ML and DL models support root canal treatments by assisting in canal detection, predicting treatment outcomes, and identifying anatomical anomalies. Tools like YOLO and random forests outperform traditional diagnostic techniques in identifying caries and fractures.
- **Orthodontics:** AI assists in cephalometric landmark detection, growth prediction, and aligner design. ML tools help optimize treatment plans and monitor progress.
- **Restorative and Prosthodontic Dentistry:** AI aids in the diagnosis of decayed regions, guides material selection, and simulates restoration longevity. It also supports CAD/CAM design and prosthetic fit prediction.
- **Implant Dentistry:** AI contributes to precise implant planning, anatomical landmark detection, bone quality assessment, and outcome prediction. Integration with robotic systems allows real-time surgical navigation.
- **Oral Pathology and Pediatric Dentistry:** In pathology, AI helps detect TMJ disorders, oral cancer, and sinusitis. For children, AI tools analyze facial expressions and physiological signals to predict anxiety and aid in behavior management.
- **Administrative Automation:** AI chatbots manage scheduling, documentation, billing, and patient engagement, streamlining workflow and improving clinic efficiency.

Ethical Considerations and Frameworks

While AI presents undeniable clinical advantages, it also raises several ethical and professional concerns:

- **Consent and data privacy:** Because AI systems use massive patient datasets, there is a greater chance of data breaches and unapproved sharing.
- **Bias and Discrimination:** AI tools trained on non-representative datasets may yield biased outputs, leading to diagnostic disparities.
- **Accountability and Transparency:** Many AI algorithms are "black box" in nature, making it challenging to comprehend how conclusions are reached. This makes it more difficult to assign blame for mistakes and take legal responsibility.
- **Professional Responsibility:** Clinicians must maintain ultimate control over diagnoses and treatments, using AI as a support tool rather than a replacement.
- **Global Ethical Frameworks:** The synopsis highlights the need for adopting ethical guidelines such as the Montreal Declaration and the EU's Ethics Guidelines for Trustworthy AI. A structured ethical checklist is proposed to ensure responsible AI use in dentistry.

AI and Sustainability in Dentistry

AI can contribute to environmental sustainability:

- **Digital Workflows:** Reducing the need for paper, chemical-based imaging, and physical storage.
- **Optimized Resource Use:** Predictive analytics prevent overuse of materials and assist in inventory control.
- **Teledentistry:** AI-supported virtual consultations reduce patient travel and clinic resource burden.
- **Energy Management:** AI-enabled smart systems reduce water and electricity use in dental facilities.

Conclusion

By improving diagnostic accuracy, facilitating individualized care, increasing sustainability, and changing dental administration and education, artificial intelligence is completely changing the field of dentistry. To guarantee safe and fair access, its integration must be directed by strong ethical frameworks, interdisciplinary cooperation, and ongoing validation. AI has the potential to become a key component of patient-centered, future-ready dental care globally with the right funding and regulatory backing.