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Artificial Intelligence in Dentistry: Advancements in Periodontology and Other Specialties, Diagnosis, Treatment Planning, and Ethical Considerations"

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ABSTRACT

This narrative review aims to highlight how periodontology is transformed by applying artificial intelligence (AI). AI impacts periodontology in diagnosis, treatment planning, and ethical considerations. AI uses deep learning, genetic algorithms, and different logic systems to offer improved solutions for dental practices, such as in dental restoration, plaque detection, endodontic therapy, dental radiography, detection of malignant tumors, and diagnosis of periodontal diseases. In periodontology, AI has improved diagnoses and treatment plans. This discussion focuses on the advancements of using AI in healthcare and dentistry to identify and manage issues by utilizing different technologies such as convolutional neural networks (CNNs) segmentation models such as U Net and Mask R CNN and classification systems, such as VGG 16.

This research discusses how AI is utilized to analyze radiography images and salivary biomarkers and classify diseases. It explores the influence of AI on treatment planning and outcome prediction. The ethical implications of AI in periodontology are also discussed, underscoring the significance of data confidentiality and protection. Periodontology can be revolutionized as AI may improve the diagnostic capability and facilintate highly individualized treatment methods to enhance the general quality of the treatment process.

Introduction

Artificial intelligence refers to the simulation of human intelligence processes by machines, particularly computer systems. These processes include learning, reasoning, and self-correction. In the field of periodontology, AI has the potential to revolutionize diagnosis, treatment planning, and patient management by providing more accurate and efficient solutions. Experts in periodontology admit the advantages of AI methods, such as expert systems, classifiers, and intelligent imagery[1]. AI techniques such as deep learning, genetic algorithms, learning machines, and fuzzy logic could enhance dental solutions such as dental prosthetics, plaque identification, endodontic therapy, radiography, and periodontal disease diagnosis[2].

Periodontology has seen significant advancements in the last few decades. Novel technologies have been introduced to enhance diagnostics, patient management, and periodontal therapy. with growing interest in AI applications within the field[3].

Artificial intelligence is primarily used in the field of dentistry to improve the accuracy and efficiency of diagnosis, which is the keystone in delivering effective treatment. Dentists mainly depend on their expertise to diagnose dental diseases and select the best treatment, while also predicting the possible outcomes[4]. But they may lack enough information to make quick decisions[4]. AI tools can assist by guiding them toward better clinical choices and improving their performance.

A comprehensive literature search was conducted following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines to ensure transparency and reproducibility in the review process[5]. The literature search was conducted using several relevant databases, including [Google scholar, PubMed, Scopus, and Web of Science]. The search was carried out for literature published between January 2019 to June 2024, and a systematic approach was used to identify studies that are relevant to the application of AI in periodontology.

The primary search keywords included combinations of terms such as "artificial intelligence," "AI," "machine learning," "deep learning," "periodontology," "periodontal disease," "diagnosis," "treatment

Abbreviations: AI, Artificial Intelligence; CNN, Convolutional Neural Network; ML, machine learning model; RBL, radiographic bone loss; CDSS, clinical decision support system; Dl, deep learning; YOLO-V4, You Only Look Once V4.

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planning," "prediction," and other related terms. Boolean operators (AND, OR) were used to combine the keywords appropriately to ensure a comprehensive search.

Inclusion and Exclusion Criteria

Inclusion Criteria

- Study investigates the application of AI in:
  - General dentistry and its different branches
  - Diagnosis of periodontal conditions
  - Prognosis of periodontal disease
  - Treatment planning or interventions for periodontal conditions
- Study is published in a peer-reviewed journal
- Study is related to dentistry (periodontal focus)

Exclusion Criteria

- Study does not involve AI technologies
- Study focuses on fields outside dentistry (e.g., general medicine, non-dental AI applications)
- Study is not peer-reviewed (e.g., conference abstracts, editorials, non-peer-reviewed reports) |

Historical background of AI

AI is the field of science and engineering that tries to make machines smart by giving them formulas or rules that make them think and act like humans[6]. For example, machines can learn and solve problems[7]. AI is concerned with developing computers that engage in human-like thought processes such as learning, reasoning, and self-correction[8].

Early developments

Alan Mathison Turing, born on June 23, 1912, in London, was a British mathematician and computer scientist who laid the groundwork for modern computer science and artificial intelligence[9]. During World War II, he famously broke the Germans' Enigma code, significantly aiding the Allies. Turing also conceptualized the universal machine, now known as the Turing Machine, and in 1950, he introduced the Turing Test to evaluate a machine's ability to exhibit human-like intelligence. His visionary ideas continue to influence researchers and scientists worldwide, cementing his legacy as a pioneering genius in his field[10].

AI in medicine and dentistry

- **Overview**

Improvements in AI could change many parts of Medicine and Dentistry, improve the quality of services accessibility, and increase efficiency. AI techniques such as machine learning, deep learning, and natural language processing are employed to analyze medical and dental data[11]. The objective of AI in Medicine and Dentistry is to enhance patient outcomes by facilitating the early identification of chronic diseases such as Alzheimer's[12], diabetes[13], different types of malignancies[14,15], and some oral diseases such as dental caries and periodontitis. This, in turn, helps to alleviate the financial burdens and severity of illnesses[16,17].

AI applications in the medical field encompass the analysis of patient data to identify diseases at an early stage, the use of natural language processing to interpret data efficiently, the automation of routine tasks, the assistance in image analysis to make accurate diagnoses, and the prediction of patient outcomes to make informed decisions[18]. Furthermore, AI has made significant progress in diagnosing diseases, predicting disease outcomes, providing treatment, enhancing medical education, and utilizing surgical robots[19]. These improvements were made possible by continuous ongoing research and better technology, which successfully overcame several problems [20].

- **Milestones**

The history of AI in medical and dental fields is fascinating and characterized by continuous advancements from the 1950s to the present. The initial advancement was based on rule-based systems and expert systems for diagnosis[21]. In the 2000s, electronic health records and machine learning made it possible to process large amounts of data in the interest of patient care[22]. In the 2010s, deep learning revolutionized medical imaging, whereas individualized treatment and task offloading emerged[23]. Nonetheless, concerns regarding data privacy, security, and ethical implications arise from recent advancements in AI [24] (Table 1).

AI in periodontology

AI has made remarkable steps in periodontology, mainly in diagnosing and managing periodontal diseases (gingivitis and periodontitis) [26]. This cutting-edge technology has proven to be a power, providing many benefits, such as increasing clinical efficiency, ensuring diagnostic consistency, and ultimately promoting treatment acceptance among patients and practitioners. By employing the power of AI, dental professionals can raise their practice and deliver superior patient care. From a population analysis standpoint, it leverages extensive datasets and detects various trends [19]. AI has significantly changed the approaches to diagnosing and treating periodontal diseases. They cannot doubt its influence on the field, and the prospects for dentistry, undoubtedly, are connected with the achievements of artificial intelligence[27].

Advancements in diagnosis, treatment, and management of periodontal diseases

Artificial intelligence technologies have revolutionized periodontal therapy by providing superior data fusion to help clinicians diagnose the disease and plan treatment effectively[28]. New AI models can diagnose the development of periodontitis and thus provide timely treatment and work out individualized treatment plans[29]. The different fundamental AI models applied in periodontal care are described in Table 2 and are developed to achieve unique functionalities for diagnosis, classification, and prognosis. For instance, the Deep CNN model[30] effectively detects damaged teeth, whereas U-Net and Mask R-CNN[31] give fine contours of periodontal tissue components, including periodontal ligament and alveolar bone. The VGG-16 model predicts periodontal disease severity from clinical and radiographic features, and Faster R-CNN accurately determines the degree of bone loss in radiographs[32,33]. Other models include deep learning algorithms[34], which predict the outcomes of treatments and classify periodontal defects in radiographic images as per

Table 1
History and key developments of AI in medical and dental fields.

Time period	Critical Developments in AI in Healthcare
1950s-1970s	The emergence of intelligent machines helping doctors, the dominance of rule-based systems, and systems acting like human experts
1980s	Use of expert systems to make diagnoses based on data[25]
2000s	Electronic health records, which enable computers to analyze vast amounts of data for better diagnoses, fuel the growth of machine learning[20].
2010s-present	Advances in deep learning transforming image analysis, particularly in medical imaging; AI in personalized medicine examining genetic data for specific treatments; automation of tasks and natural language processing Issues of data privacy, security, and ethical considerations in healthcare due to new AI developments

Table 2
AI models and their applications in periodontology.

AI Model	Application	Description	Performance Metrics
Deep CNN	Diagnosis and prediction of periodontally compromised teeth	Utilizes deep convolutional neural networks for detecting compromised teeth conditions	High accuracy in prediction and diagnosis[29]
U-Net & Mask R-CNN	Segmentation of periodontal structures	Provides detailed segmentation of periodontal ligament and alveolar bone	High accuracy in segmentation[30]
VGG-16	Classification of periodontal disease severity	Classifies the severity of periodontal disease based on clinical and radiographic features	High classification accuracy[31]
Faster R-CNN	Detection of periodontal bone loss	Detects bone loss in dental radiographs with high precision	Precision and recall metrics were reported as high [32]
Deep Learning (CNN)	Predicting periodontal treatment outcomes	Predicts treatment outcomes based on patient data and clinical indicators	High accuracy in prediction[33]
Sequence-to-Sequence model	Detection and classification of periodontal defects	Classifies defect morphology and severity in radiographic images	High classification accuracy[34]

CNN: Convolutional Neural Network.

the model's objective with commendable efficacy[35]. Cumulatively, all these AI applications enrich the periodontal assessment and planning for treatment significantly and prove AI's role in advancing periodontal care.

The application of AI in periodontology encompasses various levels, including diagnostics, therapy planning, and outcomes control. AI technologies, particularly machine learning and convolutional neural networks, are transforming traditional practices by enhancing accuracy and efficiency in periodontal care[36].

Diagnostics

AI models analyze clinical parameters, dental X-rays, and patient records to identify disease progression and risk factors[37]. This aids in individualized treatment planning and early intervention; algorithms can evaluate the degree of gingivitis and periodontitis and track the positive or negative dynamics of the disease process[38].

Juan et al., in 202,2[39], conducted a study whose objective was focused on the improvement of knowledge of oral hygiene and the development of new technologies to further encourage better oral hygiene habits. To accomplish the above objective, they designed convolutional neural networks for diagnosing oral diseases. This technology helps patients maintain the correct and proper approach towards plaque control, thus improving their general health and well-being especially those with periodontal disease[39].

- **Radiographic Analysis**

Research highlights the potential of AI in diagnosing periodontal disease through radiographic analysis. Studies reveal that CNN models can automate the detection of radiographic bone loss (RBL) with accuracy rates between 63 % and 99 %, depending on the type of radiograph analyzed[40,41]. AI, particularly CNN algorithms, accurately detect and categorizes the severity of alveolar bone loss in periapical radiographs, offering an efficient approach to periodontal disease detection and staging[42].

Machine learning (ML) models also enhance clinical diagnostics by identifying periodontal defects on 2D periapical images, potentially replacing manual assessments and supporting practitioners with improved precision[43]. Additionally, clinical decision support systems (CDSS) use advanced machine learning to personalize periodontal disease predictions, creating data-driven, individualized models[44]. AI models such as YOLO-v4 further facilitate early periodontitis diagnosis by reliably detecting alveolar bone loss in panoramic radiographs, showing that regional detection within radiographs can be more accurate than general detection. Together, these AI advancements signal a promising future in automated and precise periodontal disease diagnosis, supporting early intervention and effective patient management [45].

- **Biomarker Identification**

Biomarker identification in salivary diagnostics is another avenue where AI can improve efficiency and precision of periodontal disease detection. Research demonstrates that machine learning models, such as random forest classifiers, accurately identify periodontal health status based on salivary biomarkers and non-clinical parameters, effectively distinguishing health, gingivitis, and various stages of periodontitis[46]. AI further analyzes large datasets of salivary bacterial profiles to predict chronic periodontitis severity, achieving average accuracies as high as 93 % in distinguishing between healthy and moderate/severe cases[47]. These AI-driven methods identify and select key biomarkers and enhance model performance through feature selection and data balancing, ultimately optimizing diagnostic accuracy and predictive capability before clinical applications[48]. Such advancements in AI-driven biomarker identification show promise for improving periodontal diagnostics and individualizing treatment strategies, presenting a significant step forward in personalized oral healthcare[49].

- **Staging**

The application of AI can improve accuracy of periodontitis staging. AI improves clinical data extraction and radiographic image interpretation by using machine learning algorithms and natural language processing, resulting in more accurate periodontal disease stage assessments[50]. A thorough analysis found that deep learning methods improve periodontitis staging with good pooled sensitivity (0.88) and specificity (0.82)[51]. This technology helps dental professionals classify consistently, saving workload and enhancing diagnostic reliability [51].

Treatment planning

AI can improve treatment planning for periodontitis by enhancing diagnostic accuracy, personalizing treatment options, and supporting clinical decision-making. AI technologies, including deep learning and Bayesian networks[52], aid in the identification and management of periodontal disease, ultimately leading to improved patient outcomes [53].

By analyzing diverse datasets—such as clinical records and molecular information—AI enables personalized treatment approaches that address individual patient differences. Predictive analytics also allows clinicians to forecast disease progression and patient responses to treatment, facilitating the creation of customized care plans[54].

AI enhances medical education by facilitating patient understanding and acceptance of treatment alternatives, enhancing periodontitis management[55]. Advanced AI algorithms may evaluate dental X-rays, clinical parameters, and patient records to discern each patient's risk factors and disease susceptibility, enabling dentists to tailor treatment regimens. By employing these individualized strategies, periodontists can choose the most suitable therapeutic interventions, such as scaling and root planing, periodontal surgery, or antimicrobial therapy, and meticulously observe patient responses to attain optimal results in periodontal treatment[56].

AI in other dental specialties

General applications

Artificial intelligence is gradually integrating into several dental specialities (orthodontics, endodontics, oral and maxillofacial radiography, oral pathology, periodontology, pediatric dentistry, and general dental health) to enhance diagnostics, treatment planning, and patient care. It is utilized in image analysis, disease diagnosis and prognosis, and treatment recommendation via artificial intelligence and advancements such as machine learning and deep learning[57]. (Table 3)

Table 3 details AI models used in dentistry across several domains, including their applications, techniques, and performance indicators.

Orthodontics uses the YOLO-V4 (You Only Look Once V4) model to detect and classify teeth in dental radiographs. YOLO-V4, a real-time object identification model, accurately identifies and classifies teeth [58]. Endodontics' VGGNet (Visual Geometry Group Network) detects periapical lesions from dental radiographs. This model is sensitive and specific, especially with CBCT images, but slightly lower with OPG images[59]. Oral and Maxillofacial Radiology uses the Faster R-CNN (Region-Based Convolutional Neural Network) model to detect mandibular fractures in panoramic radiographs with good precision and recall[60]. Inception V3 in Oral Pathology distinguishes benign from malignant oral lesions with approximately 90 % accuracy[61]. In periodontology, the Faster R-CNN object detection approach uses panoramic radiographs to diagnose periodontal disease, particularly bone loss, with high accuracy[62].

The U-Net mode accurately segments dental structures in CBCT scans for prosthetic planning and implant location in prosthodontics and implantology[63]. U-Net can accurately recognize and classify primary tooth carious lesions in pediatric dentistry pictures[64]. Finally, in Dental Public Health, Partial Least Squares Structural Equation Modeling (PLS-SEM) accurately predicts dental service utilization trends by examining time-series data and patient visit patterns[65].

These AI models have been applied across various dental specialties, demonstrating substantial accuracy and reliability in detection, classification, and segmentation tasks.

Specific applications

- **Orthodontics**

Artificial intelligence markedly improves orthodontics by improving diagnostic and treatment planning through predictive modeling, virtual treatment simulations, and tele-orthodontics for remote monitoring. These innovations result in enhanced efficiency, accuracy, and increased patient satisfaction[66]. AI enhances patient management through the automation of scheduling and the facilitation of virtual consultations, fostering a more efficient and patient-centered methodology in orthodontic clinics[67]. Moreover, deep learning applications boost cephalometric analysis and 3D imaging, reducing human errors and improving patient care quality[68]. AI facilitates clinical decision-making in orthodontics by aiding in the estimation of growth and development, assessing face proportions, anticipating cephalometric landmarks, guiding force systems, and analyzing soft tissue treatment outcomes. AI is transforming orthodontic care by enhancing the precision, efficacy, and customization of treatments for individual patients through various applications[69].

- **Oral medicine and maxillofacial radiology**

Artificial Intelligence has shown significant benefits in oral and maxillofacial radiology by improving the diagnostic precision and efficiency[70]. Research has demonstrated the efficacy of AI in different clinical applications. For example, a 2019 systematic review by Hung et al. evaluated AI's ability to localize cephalometric landmarks, differentiate between maxillofacial cysts and tumors, and diagnose conditions such as osteoporosis. These findings underscore AI's applicability across diverse clinical functions, highlighting its potential to enhance diagnostic accuracy and efficiency in oral and maxillofacial radiology[71].

Advanced imaging methodologies such as Cone Beam Computed Tomography (CBCT) and Magnetic Resonance Imaging (MRI), in conjunction with artificial intelligence, can identify tiny alterations in the oral cavity structures that were before challenging to detect[72]. AI enhances the analysis of routine dental radiographs, improving the visibility of fractures and other anomalies and enabling dentists to devote more time to patient evaluations and complicated cases[73]. Furthermore, AI facilitates individualized therapy by assisting dentists in identifying active lesions and other critical information, enabling the formulation of unique strategies for each patient. AI can revolutionize dental radiology by delivering high-precision diagnostic instruments that improve patient care and clinical efficiency[74].

Table 3
of AI models and their applications in different fields of dentistry.

AI Model	Field of Dentistry	Application	Description	Performance Metrics
YOLO-V4 (You Only Look Once V4)	Orthodontics	Detection and classification of teeth in dental radiographs	Real-time object detection model to identify and classify teeth	High accuracy in detection and classification tasks[57]
VGGNet (Visual Geometry Group Network)	Endodontics	Identification of periapical lesions	Analyzes dental radiographs to detect periapical lesions	The AI exhibited a notable level of sensitivity and specificity when identifying PLs in CBCT images, but its sensitivity was comparatively lower when applied to OPG images[58]
Faster R-CNN (Region-Based Convolutional Neural Network)	Oral and Maxillofacial Radiology	Detection of mandibular fractures in panoramic radiographs	Identifies fractures with high precision and recall rates	Precision and recall metrics were reported as high[59]
Inception V3	Oral Pathology	Classification of oral lesions	Distinguishes between benign and malignant oral lesions	Accuracy of over 90 % in lesion classification[60]
Faster R-CNN object detection method	Periodontology	Detection of periodontal disease from panoramic radiographs	Assesses bone loss and other periodontal indicators	High accuracy in bone loss detection[61]
U-Net	Prosthodontics and implantology	Segmentation of dental structures in CBCT scans	Provides detailed segmentation of dental anatomy for prosthetic planning and implant positioning	High segmentation accuracy was reported[62].
U-Net model	Pediatric Dentistry	Caries detection in children's dental images	Identifies and classifies carious lesions in primary teeth	High detection accuracy and reliability[63]
Partial Least Squares Structural Equation Modeling (PLS-SEM) technique	Dental Public Health	Predicting dental service utilization trends	Analyzes time-series data to predict patient visit patterns	High accuracy in trend prediction[64]

- **Prosthodontics**

Artificial Intelligence is transforming prosthodontics by optimizing processes and enhancing patient care[75]. AI systems utilize patient data to deliver personalized solutions, from accurate diagnosis and treatment planning to sophisticated image analysis and custom prosthetic design[76]. AI algorithms can analyze X-rays to identify specific implant systems, verify the accuracy of prosthetic fit, and support clinical decision-making in treatment. Additionally, AI assists in maintaining proper jaw alignment, selecting aesthetically appropriate tooth colors, and designing maxillofacial prosthetics according to individual needs[77]. The manufacturing process for dentures also benefits from AI's automated design capabilities, which enable faster and more precise production. Overall, AI integration in prosthodontics prepares the stage for a future of highly precise, efficient, and patient-centered care[78].

- **Preventive dentistry**

AI is emerging as a powerful tool in preventive dentistry, capable of predicting oral health conditions and enhancing treatment outcomes, particularly in the prevention of periodontal disease[79]. AI technology enhances preventive measures by enhancing infection control methods and hygiene standards, hence improving dental health care[80]. Despite being in its early phase, artificial intelligence in preventative dentistry has experienced significant advancement over the last twenty years, prompting dentists and researchers to accurately use these technologies [80].

AI applications in preventive dentistry enable early diagnosis by identifying conditions like carious lesions and periodontal diseases in their initial stages. This facilitates prompt treatment, improving patient outcomes[81]. Predictive analytics enables AI to evaluate patient data and identify risks for future dental issues, therefore aiding in the development of personalized preventative treatment strategies[82]. In pediatric dentistry, AI aids in formulating preventative methods customized to the specific dental health requirements of children, facilitating early diagnosis and intervention for this population[83]. AI has a lot of promise to improve proactive and individualized dental care, which will lead to better oral health in the future[84].

- **Detection of oral cancer**

Artificial Intelligence is helping diagnose oral cancer in ways unimagined before by applying several systems that enhance its diagnosis[85]. Advanced image analysis technologies and diagnostics of biopsy samples provide detailed identification of early-stage oral cancer with high accuracy[86]. Furthermore, the specific deep learning models for the oral squamous cell carcinoma (OSCC) diagnosis increase the diagnostic probabilities by distinguishing between malignancies in image-centric data[87]. It also plays the role of screening the patients to draw attention to whatever might be strange and also make a precise diagnosis that helps in customizing diagnostic methods depending on the specific patients involved[88]. In other words, artificial intelligence helps prevent diagnostic delays while intensifying its accuracy, eventually opening new opportunities for diagnosing oral cancer. With these advancements, the future of AI in the diagnosis of oral cancer seems to be most effective[89].

Ethical considerations and uses of AI in dentistry

There are various ethical concerns about the integration of artificial intelligence (AI) in the field of dentistry[90,29]. Despite its impressive capabilities, AI in the dental field has limitations [91,92]. Critics persistently raise concerns about patient privacy rights, algorithm design, and various legal issues surrounding the implementation of AI in healthcare[93]. AI algorithms facilitate and objectify dental diseases diagnosis, enhance treatment compliance, and optimize clinical productivity[94]. The proposals emphasize the importance of identifying guidelines and measures for implementing AI and protecting the privacy and rights of patients in the context of dental practice[95]. The collective actions of dentists, AI scientists, healthcare authorities, and policymakers[96] play an essential role in handling these ethical concerns and harnessing the opportunities for AI interventions in dentistry without compromising their negative impacts[97].

Mörch et al. in 2021 summarized the main ethical concerns (Table 4) [98]

Prospects and challenges

Researchers in the field of dental artificial intelligence are becoming more aware of the significance of clinical data and the function it plays in the development of AI applications within the dental field[102]. Large datasets are required for effective artificial intelligence training, which in turn needs the collection, modeling, standardization, and sharing of data that has been published as well as data that has not been published[103]. In order to facilitate the incorporation of artificial intelligence into clinical practice, interdisciplinary teams consisting of physicians and data scientists will be required[104]. These teams will combine their knowledge in clinical care with advanced data analytics to make judgments that are precise and informed by data. to fully exploit the potential of artificial intelligence, data systems need to adopt standardized formats that are interoperable and ensure the quality and application of the data[105]. In addition, developments in dental imaging and registry systems necessitate a focus on protecting the privacy of patients and optimizing the preservation of data in order to facilitate the implementation of artificial intelligence models in real-world scenarios[106]. The development of precision periodontics will make it possible to create AI-driven treatment plans that are tailored to the specific data of each individual patient[107]. However, there are still ethical problems to be faced, particularly when it comes to managing the complexity of patient data[108]. A dynamic flow of knowledge will be made possible by increased collaboration between dentistry and related professions, which has the potential to reshape the roles of specialists and the ethical issues that are taken into account in clinical practice [109].

Conclusion

Artificial intelligence is transforming several dental specialties. In

Table 4
Ethical considerations in AI applications in dentistry.

Ethical Concern	**Description**
Prejudice and Equity	This issue relates to the possible biases in AI algorithms that may result in unfair treatment outcomes. AI systems trained on biased datasets may unintentionally favor specific demographics, leading to unequal patient care. Addressing these biases is essential to guarantee that AI technologies in dentistry are equitable and accessible to all patients[99].
Secrecy and Audibility	This topic includes the issues related to data privacy and transparency in artificial intelligence. Since AI models in dentistry frequently utilize sensitive patient information, safeguarding privacy is vital. Furthermore, the opaque nature of numerous AI systems can hinder dentists' comprehension of the decision-making processes, posing issues of openness and responsibility in patient care[100].
Epistemic Outcomes	Benefits of AI in knowledge creation versus ethical compromises: This worry is about finding a balance between the good things AI can do for creating information and the bad things it might do for ethics. AI has the potential to make diagnosis and treatment plans much more accurate, but it also brings up questions about the validity and morality of the information it creates. For responsible progress in dental AI applications, it is important to make sure that AI-driven findings are in line with ethical standards[101].

orthodontics, AI models have been tested to recognize and differentiate the teeth in dental radiographs for treatment purposes. AI improves the endodontic diagnosis by detecting periapical lesions in the radiographic images. In oral and maxillofacial radiology, AI-generated models come into play for mandibular fracture detection, which is quite famous for their accuracy and reliability. AI classifiers can distinguish between benign and malignant oral lesions with an accuracy of over 90 percent. in periodontology, AI identifies bone loss and predicts future treatment plans. In prosthodontics and implantology, segmentation models assist in planning prostheses and determining optimal implant positions. Furthermore, this narrative review highlights that AI can identify and categorize carious lesions in children's dental images with high accuracy.

These developments across several subfields of dentistry show how AI optimizes work procedures, optimizes diagnostic accuracy, and improves patients' well-being. Recent advancements in AI technologies are set to revolutionize dentistry and allow dentists to deliver more effective treatment with increased accuracy.

Declaration of generative AI in scientific writing

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Declaration of competing interest

The author declares that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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