DOI: 10.21088/ijde.0974.6099.19226.3

Indian Journal of Dental Education
Volume 19, Number 2, May-August 2026

Review Article

Artificial Intelligence in Periodontology: Current Applications, Challenges, and Future Perspectives: A Narrative Review

Zubair Ahmad Janbaz[1], Suhail Majid Jan[2], Roobal Behal[3]

How to cite this article:

Zubair Ahmad Janbaz, Suhail Majid Jan, Roobal Behal. Artificial Intelligence in Periodontology: Current Applications, Challenges, and Future Perspectives: A Narrative Review. Ind J Dent Educ. 2026; 19(2): 70-74.

ABSTRACT

Artificial intelligence (AI) has emerged as a transformative technology in healthcare, offering unprecedented opportunities for improving diagnosis, treatment planning, prognosis, and personalized patient care. In periodontology, AI applications have expanded rapidly owing to advances in machine learning (ML), deep learning (DL), computer vision, and natural language processing. These technologies facilitate the analysis of complex clinical, radiographic, microbiological, and genetic datasets, thereby supporting clinicians in making evidence-based decisions. AI-driven systems have demonstrated promising accuracy in detecting periodontal bone loss, classifying periodontitis, predicting disease progression, and evaluating treatment outcomes. Furthermore, integration of AI with digital dentistry and precision medicine may enhance individualized periodontal care. Despite these advantages, challenges such as limited dataset diversity, lack of external validation, ethical concerns, algorithmic bias, and regulatory issues continue to impede widespread clinical adoption. This narrative review discusses the fundamental concepts of AI, current applications in periodontology, limitations of existing evidence, and future directions for research and clinical implementation.

KEYWORDS

• Artificial Intelligence • Machine Learning • Deep Learning • Periodontology • Periodontitis • Precision Dentistry

Author's Affiliation:

[1] Registrar, Department of Periodontics, Govt Dental College and Hospital, Srinagar, Jammu and Kashmir, India.

[2] Professor and Head, Department of Periodontics, Govt Dental College and Hospital, Srinagar, Jammu and Kashmir, India.

[3] Associate Professor, Department of Periodontics, Govt Dental College and Hopsital, Srinagar, Jammu and Kashmir, India.

Corresponding Author:

Zubair Ahmad Janbaz, Registrar, Department of Periodontics, Govt Dental College and Hospital, Srinagar, Jammu and Kashmir, India.

E-mail: zubairjanbaz11@gmail.com

➢ **Received:** 13-06-2026 ➢ **Accepted:** 15-07-2026

INTRODUCTION

Periodontal diseases remain among the most prevalent chronic inflammatory conditions worldwide and constitute a major cause of tooth loss in adults.[1] Traditional periodontal diagnosis relies on clinical examination, radiographic assessment, and clinician interpretation. However, variability in disease presentation and progression often complicates diagnosis and treatment planning.[2]

Artificial intelligence (AI) refers to computational systems capable of performing tasks that typically require human intelligence. Machine learning (ML), a subset of AI, enables systems to learn from data and improve performance without explicit programming. Deep learning (DL), an advanced branch of ML, employs multilayer neural networks for pattern recognition and image analysis.[3]

Recent developments in digital dentistry have generated large volumes of clinical and imaging data, creating opportunities for AI-assisted decision-making. AI applications in periodontology include automated diagnosis, radiographic interpretation, risk assessment, treatment prediction, and personalized periodontal care.[4]

FUNDAMENTALS OF ARTIFICIAL INTELLIGENCE IN PERIODONTOLOGY

AI encompasses several technologies relevant to periodontal practice:

Machine Learning

Machine learning algorithms identify patterns within datasets and generate predictive models. Common algorithms include decision trees, support vector machines, random forests, and artificial neural networks.[5]

Deep Learning

Deep learning utilizes multilayer neural networks capable of extracting complex features from radiographic and photographic images. Convolutional neural networks (CNNs) are particularly useful in periodontal imaging applications.[6]

Natural Language Processing

Natural language processing (NLP) allows AI systems to extract information from electronic health records and unstructured clinical notes, improving disease classification and clinical documentation.[7]

AI IN PERIODONTAL DIAGNOSIS

Radiographic Detection of Periodontal Bone Loss

Radiographic assessment remains fundamental in periodontal diagnosis. AI-based systems have demonstrated high accuracy in detecting alveolar bone loss from panoramic, periapical, and bitewing radiographs.[8] Deep learning models can automatically identify anatomical landmarks, calculate bone levels, and classify disease severity. Lee *et al.* reported that deep learning systems achieved diagnostic performance comparable to experienced clinicians in assessing radiographic bone loss.[9]

Automated Classification of Periodontitis

The 2018 Classification of Periodontal Diseases introduced staging and grading systems that require integration of multiple clinical variables. AI models can process these variables simultaneously and generate accurate classifications.[10] Several studies have reported diagnostic accuracies exceeding 80% for AI-assisted classification of periodontitis stages.[11]

Detection of Furcation Involvement

Furcation involvement significantly affects prognosis. CNN-based models have demonstrated encouraging results in detecting furcation defects from radiographic images, potentially reducing observer variability.[12]

RISK ASSESSMENT AND DISEASE PREDICTION

One of the most promising applications of AI is prediction of disease susceptibility and progression. Traditional risk assessment tools rely on a limited number of variables. AI systems can incorporate demographic factors, smoking status, systemic diseases, microbial profiles, genetic markers, and previous periodontal history.[13] Machine learning algorithms have demonstrated strong predictive performance for identifying patients at high risk of disease progression. Such predictive capabilities may facilitate early intervention and preventive care.[14]

Prediction of Tooth Loss

Tooth loss is a critical outcome measure in periodontology. AI models have been developed to predict tooth survival using clinical and radiographic variables. These systems can support clinicians in prognosis determination and treatment planning.[15]

AI in Periodontal Imaging

Panoramic radiographs are widely available and commonly used for periodontal screening. Deep learning models have achieved diagnostic accuracies ranging from approximately 81% to 99% for detecting periodontitis-related changes.[16] Likewise, Periapical radiographs provide superior resolution for evaluating periodontal structures. AI algorithms can automatically identify cementoenamel junctions, alveolar crests, and root surfaces, enabling objective measurements of bone loss.[9] Similarly, Cone-Beam Computed Tomography (CBCT) imaging offers three-dimensional assessment of periodontal defects. AI-assisted analysis can improve detection of infrabony defects, furcation involvement, and anatomical variations.[17]

Intraoral Photography

Recent studies have demonstrated the feasibility of using AI to identify gingival inflammation and periodontal disease from intraoral photographs, opening possibilities for teledentistry and remote screening.[18]

AI and Precision Periodontology

Precision medicine aims to tailor treatment according to individual patient characteristics. AI supports this approach by integrating data from multiple sources including Clinical parameters, Radiographic findings, Microbiological profiles, Genetic information, Lifestyle factors and Systemic health conditions.Through advanced data analysis, AI can generate personalized diagnostic and therapeutic recommendations.[19]

MICROBIOME-BASED ANALYSIS

Periodontitis is associated with dysbiotic microbial communities. Machine learning approaches have been used to identify microbial signatures associated with disease severity and treatment response.[20]

Biomarker Discovery

AI facilitates identification of salivary, gingival crevicular fluid, and serum biomarkers associated with periodontal disease activity. These biomarkers may contribute to personalized diagnostics and monitoring.[21]

AI IN TREATMENT PLANNING

AI can assist clinicians by evaluating large datasets and recommending evidence-based treatment strategies. Potential applications include selection of nonsurgical versus surgical therapy, prediction of regenerative outcomes, implant treatment planning, maintenance interval determination and prognosis assessment. Such systems may improve consistency and reduce subjective variation among clinicians.[22]

Natural Language Processing and Electronic Health Records

Electronic health records contain substantial amounts of unstructured data. NLP techniques can automatically extract periodontal diagnoses, treatment histories, and clinical findings from textual records.[23] Recent studies have demonstrated near-perfect accuracy in extracting periodontal classifications from clinical documentation. This capability may enhance research, quality assurance, and clinical workflow efficiency.[23]

Integration with Teledentistry

The integration of AI and teledentistry may significantly expand access to periodontal care. Smartphone-based image analysis and cloud-based diagnostic platforms can facilitate remote screening, early disease detection, monitoring of treatment outcomes and patient education. These applications may be particularly beneficial in underserved populations.[24]

CHALLENGES AND LIMITATIONS

Despite promising results, several barriers remain.

Limited Generalizability

Most AI models are trained using single-center datasets, limiting external validity. Differences in imaging systems, patient demographics, and disease prevalence may affect performance.[25]

Data Quality

AI performance depends heavily on data quality. Incomplete records, inconsistent labeling, and imaging artifacts may reduce accuracy.[26]

Ethical and Legal Concerns

Implementation of AI raises concerns regarding patient privacy, data security, algorithmic bias, transparency and accountability for clinical decisions. Appropriate regulatory frameworks are essential for safe implementation.[27]

Lack of Clinical Validation

Although numerous studies report high accuracy, prospective clinical trials evaluating patient-centered outcomes remain scarce.[28]

FUTURE PERSPECTIVES

Future developments are likely to focus on:

1. Multicenter datasets and external validation.
2. Explainable AI systems.
3. Integration with wearable and mobile technologies.
4. Real-time clinical decision support.
5. Precision periodontal medicine.
6. AI-assisted robotic periodontal procedures.
7. Digital twins and predictive simulation models.

As computational technologies evolve, AI may become an integral component of routine periodontal practice.[29]

CONCLUSION

Artificial intelligence is reshaping modern periodontology by enhancing diagnostic accuracy, improving risk assessment, supporting treatment planning, and facilitating personalized patient care. Applications involving radiographic interpretation, disease classification, prognostic prediction, and electronic health record analysis have demonstrated considerable promise. Nevertheless, challenges related to data quality, generalizability, ethics, and regulatory oversight must be addressed before widespread clinical implementation. Future research should emphasize multicenter validation studies, explainable AI frameworks, and prospective clinical trials. With continued technological advancement, AI has the potential to become a valuable adjunct that complements rather than replaces clinical expertise in periodontology.

Conflict of Interest: Nil

REFERENCES

1. Tonetti MS, Greenwell H, Kornman KS. Staging and grading of periodontitis. J Periodontol. 2018;89:S159-S172.
2. Papapanou PN, Sanz M, Buduneli N, et al. Periodontitis: Consensus report. J Clin Periodontol. 2018;45:S162-S170.
3. Russell SJ, Norvig P. Artificial Intelligence: A Modern Approach. 4th ed. Pearson; 2021.
4. Pitchika V, Büttner M, Schwendicke F. Artificial intelligence and personalized diagnostics in periodontology: A narrative review. Periodontol 2000. 2024;95:220-231.
5. Deo RC. Machine learning in medicine. Circulation. 2015;132:1920-1930.
6. LeCun Y, Bengio Y, Hinton G. Deep learning. Nature. 2015;521:436-444.
7. Nadkarni PM, Ohno-Machado L, Chapman WW. Natural language processing. J Am Med Inform Assoc. 2011;18:544-551.
8. Scott J, Biancardi AM, Jones O, Andrew D. Artificial Intelligence in Periodontology: A Scoping Review. Dent J. 2023;11:43.
9. Lee CT, Kabir T, Nelson J, *et al.* Use of deep learning approach to measure alveolar bone level. J Clin Periodontol. 2022;49:110-119.
10. Tonetti MS, Sanz M. Implementation of the new classification. J Clin Periodontol. 2019;46:398-405.
11. Tichy A, et al. Artificial Intelligence in Periodontology: A Systematic Review. J Periodontal Res. 2025.
12. Krois J, et al. Deep learning for dental radiographic diagnostics. Sci Rep. 2019;9:8495.
13. Lang NP, Tonetti MS. Periodontal risk assessment. Oral Health Prev Dent. 2003; 1:7-16.
14. Shirmohammadi A, et al. Machine learning models in periodontal risk prediction. Clin Oral Investig. 2022;26:5231-5241.
15. Avila-Ortiz G, et al. Prognosis determination in periodontology. Periodontol 2000. 2021; 87:45-62

16. Pitchika V, et al. AI-assisted diagnosis in periodontology. Periodontol 2000. 2024; 95:220-231.

17. Kim J, et al. Deep learning in CBCT analysis. Dentomaxillofac Radiol. 2021;50:20200385.

18. Tichy A, et al. AI diagnosis from intraoral photographs. J Periodontal Res. 2025.

19. Schwendicke F, Samek W, Krois J. Artificial intelligence in dentistry. J Dent Res. 2020;99:769-774.

20. Huang S, et al. Machine learning and periodontal microbiome analysis. Front Cell Infect Microbiol. 2022;12:850321.

21. Giannobile WV. Salivary diagnostics. J Am Dent Assoc. 2012;143:6S-11S.

22. Schwendicke F, Golla T, Dreher M, Krois J. AI in clinical decision support. J Dent. 2019;92:103260.

23. Chuang YS, et al. Artificial intelligence in extracting diagnostic data from dental records. 2024.

24. Chuang YS, *et al.* NLP for periodontal diagnosis extraction. J Dent Inform. 2024.

25. Estai M, et al. Teledentistry and AI. Int Dent J. 2022;72:331-337.

26. Beam AL, Kohane IS. Big data and machine learning in healthcare. JAMA. 2018;319: 1317-1318.

27. Topol EJ. High-performance medicine. Nat Med. 2019;25:44-56.

28. Yu KH, Beam AL, Kohane IS. Artificial intelligence in healthcare. Nat Biomed Eng. 2018;2:719-731.

29. Azhari AA. Accuracy of artificial intelligence applications in periodontics: A thematic narrative review. Front Dent Med. 2026;7:1729825.