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Original Research Article

Artificial Intelligence–Assisted Evaluation of Periodontal Treatment Planning: A Pilot Clinical Investigation

Article History:

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Abstract: ***Background***: Precise assessment of periodontal disease severity is critical for selecting appropriate treatment strategies and determining prognosis. Conventional evaluation relies on clinician- based interpretation of clinical findings and radiographs, which may introduce subjective variability. Artificial intelligence (AI) has the potential to enhance diagnostic consistency by analyzing complex clinical patterns through data-driven algorithms. ***Objective***: To evaluate the feasibility and diagnostic performance of an AI-based deep learning model in assessing periodontal treatment parameters using combined clinical and photographic data. ***Materials and Methods:*** A pilot cross-sectional study was conducted among 15 patients aged 25–65 years presenting with varying severities of periodontal disease. Clinical parameters recorded included gingival recession, tooth mobility (Miller's classification), Russell's Periodontal Index, and clinical attachment level (CAL). Standardized intraoral photographs were obtained under uniform conditions. A convolutional neural network (CNN) utilizing transfer learning with a MobileNet backbone was developed. The dataset was divided into 80% training and 20% validation subsets. Model performance was assessed using accuracy, sensitivity, specificity, and confusion matrix evaluation. ***Results***: The AI model demonstrated an overall classification accuracy of 90.8%. Sensitivity for identifying moderate to severe periodontal involvement was 98%. Misclassification primarily occurred between adjacent disease severity categories. Data augmentation techniques improved validation stability and reduced overfitting. ***Conclusion***: AI-assisted evaluation showed promising diagnostic reliability in periodontal assessment. Although encouraging, these findings require validation through larger, multi-center studies before routine clinical implementation.

Keywords: Artificial intelligence, Periodontal disease, Deep learning, Clinical decision support, Treatment planning.

INTRODUCTION

Accurate evaluation of periodontal disease is essential for determining appropriate treatment strategies and predicting prognosis. Clinicians traditionally rely on clinical measurements such as attachment loss, gingival recession, probing depth, mobility, and

radiographic findings. While these methods are well established, they depend largely on examiner expertise and clinical experience. As a result, some degree of inter-examiner variability is inevitable.

With advancements in computational sciences, artificial intelligence has emerged as a supportive tool in various medical and dental fields. Machine learning and deep learning algorithms are increasingly being applied for pattern recognition, image interpretation, and disease classification. In dentistry, AI applications have expanded into radiographic diagnostics, orthodontic planning, and detection of periodontal bone loss.

Considering the multifactorial nature of periodontal disease, integrating AI into treatment planning may help analyze multiple parameters simultaneously and provide consistent evaluations. The present study was undertaken to explore whether an AI-based model could assist in the assessment of periodontal treatment parameters in a clinical setting.

MATERIALS AND METHODS

Study Design and Ethical Approval

This pilot cross-sectional study was conducted after obtaining approval from the Institutional Ethical Committee. Written informed consent was obtained from all participants prior to data collection.

STUDY POPULATION

Fifteen patients between 25 and 65 years of age diagnosed with localized or generalized periodontal disease were included using purposive sampling. All participants underwent comprehensive clinical examination.

INCLUSION CRITERIA

Age 18 years and above Clinical evidence of periodontal disease Availability of clear intraoral photographic records Willingness to participate

EXCLUSION CRITERIA

Patients undergoing orthodontic treatment Individuals with systemic conditions known to significantly influence periodontal health History of periodontal surgery within the last six months More than eight missing teeth (excluding third molars)

CLINICAL ASSESSMENT

A full-mouth periodontal examination was performed for each participant. The following parameters were recorded:

Gingival recession: Measured from the cementoenamel junction to the free gingival margin using a UNC-15 periodontal probe

Tooth mobility: Graded according to Miller's Mobility Index

Clinical attachment level: Determined from the cementoenamel junction to the base of the periodontal pocket

Russell's Periodontal Index score

Standardized intraoral photographs were captured under consistent clinical conditions to ensure uniformity for AI analysis.

DEVELOPMENT OF THE AI MODEL

Clinical data and corresponding images were organized based on severity categories. The dataset was divided into training (80%) and validation (20%) groups.

A convolutional neural network (CNN) architecture incorporating transfer learning with a MobileNet backbone was utilized. To enhance the robustness of the model and reduce overfitting, data augmentation techniques such as rotation and scaling were applied.

EVALUATION OF MODEL PERFORMANCE

The predictions generated by the AI system were compared with clinical assessments made by experienced periodontists. Performance indicators included overall accuracy, sensitivity, specificity, and confusion matrix analysis

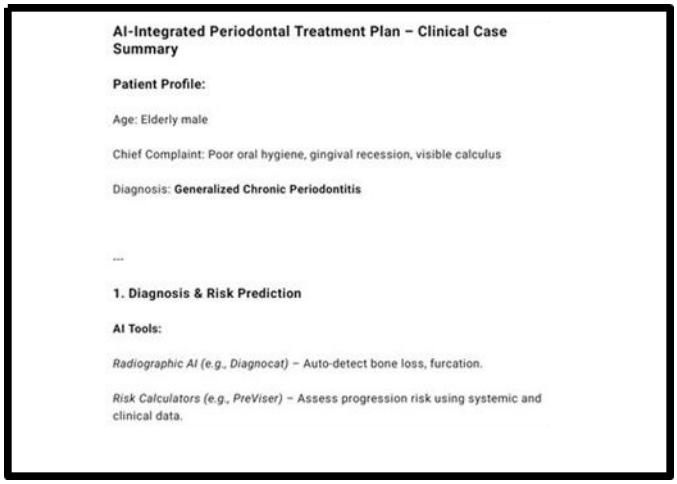
RESULTS

DEMOGRAPHIC DETAILS

A total of 15 patients were evaluated, with ages ranging from 25 to 65 years. Clinical parameters including gingival recession, mobility, CAL, and Russell's Index were documented for all participants.

AI MODEL OUTCOMES

The AI model achieved an overall classification accuracy of 90.8%. Sensitivity in detecting moderate to severe periodontal involvement was 98%. Misclassification was limited and occurred mainly between closely related disease stages. The application of data augmentation improved validation performance and reduced variability in predictions



AI-Integrated Periodontal Treatment Plan – Clinical Case Summary

Patient Profile:

Age: Elderly male

Chief Complaint: Poor oral hygiene, gingival recession, visible calculus

Diagnosis: **Generalized Chronic Periodontitis**

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1. Diagnosis & Risk Prediction

AI Tools:

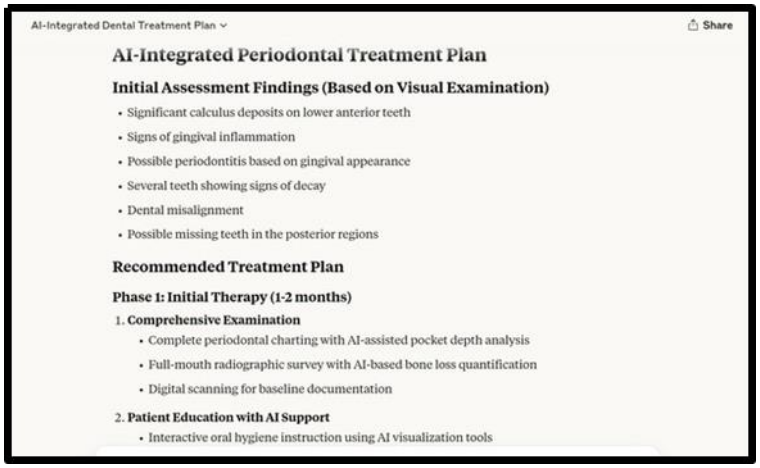
Radiographic AI (e.g., Diagnocat) – Auto-detect bone loss, furcation.

Risk Calculators (e.g., PreViser) – Assess progression risk using systemic and clinical data.

DISCUSSION

This pilot investigation evaluated the feasibility of implementing an AI-based deep learning model in periodontal treatment assessment. The results indicate that the proposed system achieved high diagnostic performance, particularly in identifying moderate to severe periodontal involvement, where timely intervention is critical.

The observed accuracy aligns with previously reported outcomes in AI- assisted periodontal diagnostics. Deep learning architectures have demonstrated substantial capability in analyzing dental images and predicting disease patterns.



By minimizing examiner-dependent variability, AI-driven tools may provide structured and reproducible support during clinical decision-making. However, several limitations must be acknowledged. The sample size was small, and only internal validation was performed. Therefore, extrapolation of these findings to broader populations should be approached with caution. Additionally, the present model did not incorporate advanced imaging modalities such as CBCT or longitudinal treatment response data, which could further refine predictive performance.

Future research should focus on multi- center datasets, external validation protocols, and integration of radiographic as well as microbiological parameters. Such advancements may enable development of robust clinical decision support systems tailored to periodontal therapy.

CONCLUSION

Within the limitations of this pilot study, AI-assisted evaluation showed encouraging accuracy in assessing periodontal treatment parameters. Although the results are promising, larger-scale investigations are required before such systems can be routinely integrated into clinical practice. AI should be viewed as an adjunctive support tool that complements, rather than replaces, professional clinical judgment.

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