Journal of Taibah University Medical Sciences (2025) 20(3), 272–279

Taibah University

Journal of Taibah University Medical Sciences

www.sciencedirect.com

Original Article

Dental practitioners versus artificial intelligence software in assessing alveolar bone loss using intraoral radiographs

Ammar Almarghlani, MSc [a], Jumana Fakhri, BDS [b], Abeer Almarhoon, BDS [b], Ghazzal Ghonaim, BDS [b], Hassan Abed, PhD [c] and Rayan Sharka, PhD [d,*]

[a] *Department of Periodontics, Faculty of Dentistry, King Abdulaziz University, Jeddah, KSA*
[b] *Teaching Dental Hospital, Faculty of Dentistry, King Abdulaziz University, Jeddah, KSA*
[c] *Department of Basic and Clinical Oral Sciences, Faculty of Dental Medicine, Umm Al-Qura University, Makkah, KSA*
[d] *Department of Oral and Maxillofacial Surgery, Faculty of Dental Medicine, Umm Al-Qura University, Makkah, KSA*

Received 9 November 2024; revised 7 February 2025; accepted 11 April 2025; Available online 9 May 2025

الملخص

أهداف البحث: إن دمج الذكاء الاصطناعي في مجال طب الأسنان له القدرة على تعزيز كفاءة الرعاية السنية. ومع ذلك، أظهرت دراسات قليلة أهمية برمجيات الذكاء الاصطناعي في تحقيق نتائج مماثلة لأطباء الأسنان (الممارسين العامين والمتخصصين) في تقييم فقدان العظم السنخي وتحديد الطريقة الأكثر موثوقية لتشخيص أمراض اللثة في البيئة السريرية. تهدف هذه الدراسة إلى مقارنة أداء الذكاء الاصطناعي في تقييم فقدان العظم السنخي مع أداء الممارسين العامين والمتخصصين.

طريقة البحث: كانت هذه الدراسة تقييما مقطعيا مقارنا لأداء أطباء الأسنان وبرمجيات الذكاء الاصطناعي في تقييم فقدان العظم السنخي. تم اختيار الصور الشعاعية عشوائيا لضمان عينة تمثيلية. قام أطباء الأسنان بتقييم الصور الشعاعية بشكل مستقل، بينما تم اختبار برنامج الذكاء الاصطناعي "برنامج الرأي الثاني" باستخدام نفس مجموعة الصور الشعاعية التي قيمها أطباء الأسنان. ثم تمت مقارنة النتائج من برنامج الذكاء الاصطناعي بالقيم الأساسية لقياس الدقة وتقديم مقارنة مباشرة مع أداء المتخصصين البشريين.

النتائج: تلقى الاستطلاع ١٤٩ استجابة، كل منها يجيب على ١٠ أسئلة لمقارنة قياسات الذكاء الاصطناعي وأطباء الأسنان في تقييم مقدار فقدان العظم بالأشعة. أظهرت تقديرات المشاركين ارتباطا إيجابيا متوسطا مع القياسات الشعاعية (معامل الارتباط = ٠,٥٤٧، قيمة الاحتمالية < ٠,٠٠١) وارتباطا أضعف ولكنه لا يزال مهما مع قياسات الذكاء الاصطناعي (معامل الارتباط = ٠,٣٦٥، قيمة الاحتمالية < ٠,٠٠١). أظهرت قياسات الذكاء الاصطناعي ارتباطا إيجابيا أقوى مع القياسات الشعاعية (معامل الارتباط = ٠,٧١٢، قيمة الاحتمالية < ٠,٠٠١) مقارنة بارتباطها بتقديرات أطباء الأسنان.

الاستنتاجات: أكدت هذه الدراسة على قدرة برمجيات الذكاء الاصطناعي على تعزيز دقة وكفاءة التقييمات المعتمدة على الصور الشعاعية لفقدان العظم السنخي. على الرغم من أن أطباء الأسنان أساسيون للتجربة السريرية، إلا أن تقنية الذكاء الاصطناعي توفر منهجية متسقة وقابلة للتكرار. التعاون المستقبلي بين خبراء الذكاء الاصطناعي والباحثين والممارسين واعد لتحسين رعاية المرضى.

الكلمات المفتاحية: فقدان العظم السنخي؛ الذكاء الاصطناعي؛ التصوير الشعاعي السني؛ التعلم العميق؛ علم اللثة

Abstract

Objectives: Integrating artificial intelligence (AI) in the dental field can potentially enhance the efficiency of dental care. However, few studies have investigated whether AI software can achieve results comparable to those obtained by dental practitioners (general practitioners (GPs) and specialists) when assessing alveolar bone loss in a clinical setting. Thus, this study compared the performance of AI in assessing periodontal bone loss with those of GPs and specialists.

Methods: This comparative cross-sectional study evaluated the performance of dental practitioners and AI software in assessing alveolar bone loss. Radiographs were randomly selected to ensure representative samples. Dental practitioners independently evaluated the radiographs, and the AI software "Second Opinion Software" was tested using the same set of radiographs evaluated by the dental practitioners. The results produced by the AI software were then compared with the baseline values to

* Corresponding address: Department of Oral and Maxillofacial Surgery, Faculty of Dental Medicine, Umm Al-Qura University, Makkah 22254, KSA.

E-mail: rmsharka@uqu.edu.sa (R. Sharka)

Peer review under responsibility of Taibah University.

ELSEVIER Production and hosting by Elsevier

 https://doi.org/10.1016/j.jtumed.2025.04.001

measure their accuracy and allow direct comparison with the performance of human specialists.

Results: The survey received 149 responses, where each answered 10 questions to compare the measurements made by AI and dental practitioners when assessing the amount of bone loss radiographically. The mean estimates of the participants had a moderate positive correlation with the radiographic measurements (rho = 0.547, $p < 0.001$) and a weaker but still significant correlation with AI measurements (rho = 0.365, $p < 0.001$). AI measurements had a stronger positive correlation with the radiographic measurements (rho = 0.712, $p < 0.001$) compared with their correlation with the estimates of dental practitioners.

Conclusion: This study highlights the capacity of AI software to enhance the accuracy and efficiency of radiograph-based evaluations of alveolar bone loss. Dental practitioners are vital for the clinical experience but AI technology provides a consistent and replicable methodology. Future collaborations between AI experts, researchers, and practitioners could potentially optimize patient care.

Keywords: Alveolar bone loss; Artificial intelligence; Deep learning; Dental radiography; Periodontics

Introduction

The term "artificial intelligence" (AI) was introduced in 1956 during a conference where researchers explored the creation of machines that can emulate human intelligence.[1] This field focuses on developing systems that replicate human cognitive processes and decision making. AI is revolutionizing many industries, including healthcare, where it has significantly advanced medical specialties. As AI integrates further into society, its ethical, social, and economic implications continue to be subjects of scholarly discussion.[2,3] In dentistry, AI can enhance the diagnosis and treatment of oral health conditions by providing objective insights through patient data analysis to improve accuracy and efficiency.[4,5]

AI has provided a wide array of insights, equipping clinicians with invaluable tools to enhance the accuracy of radiological assessments.[6,7] AI technologies facilitate precise analysis and interpretation of radiographic images, enabling healthcare professionals to make more informed decisions.[8,9] Recent studies indicate that AI models, particularly those built using deep learning methods such as convolutional neural networks (CNNs), can accurately recognize and evaluate alveolar bone loss.[10−12] These AI systems use CNNs to examine intraoral radiographs, identifying small changes in bone density and structure that may escape human observation.

Previous studies have shown that CNN-based models may attain diagnostic performance equivalent to that of experienced dental professionals, thereby providing a viable instrument for improving diagnostic precision and uniformity in clinical environments.[13,14] For instance, Kim et al. introduced a deep learning-based approach by utilizing algorithms that are a subset of machine learning. These algorithms employ neural networks with multiple layers to model complex patterns in data. The aim of their method known as the Deep Neural Transfer Network (DeNTNet) is to develop an automated diagnostic support system for detecting periodontal bone loss (PBL) in panoramic dental radiographs. DeNTNet leverages pre-trained networks and adapts them to the specific task of dental radiograph analysis in order to identify lesions and also provide the corresponding tooth numbers based on the dental federation notation. DeNTNet uses deep CNNs with transfer learning and incorporates clinical expertise to address morphological variations in lesions.[13]

Similarly, Lee et al. designed a computer-assisted detection system by using a CNN algorithm to diagnose and predict periodontally compromised teeth.[14] They integrated a pre-trained deep CNN with a self-trained network and used periapical radiographic images to identify the best CNN algorithms and weights. Their results demonstrated the effectiveness of the deep CNN algorithm at diagnosing and predicting periodontally compromised teeth.[14]

The main advantage of using an AI-based model is that it provides a standardized approach to radiographic analysis, which reduces the variability of human interpretation. Thus, standardization ensures that consistent and reproducible results are obtained, which is essential for maintaining high-quality patient care.[13] However, the performance of DeNTNet depends greatly on the quality and quantity of the training data. In addition, training and deploying deep learning models like DeNTNet require significant computational resources, which may not be readily available in all clinical settings.[13]

Moreover, Uzun Saylan et al. evaluated AI models for detecting alveolar bone loss using the PyTorch-based YOLO-v5 model in CranioCatch software based on 685 panoramic radiographs. They found that regional detection was more successful than general detection, especially in the maxillary incisor region, thereby highlighting the potential of applying AI as a clinical decision support tool in dentistry, and suggesting that a more comprehensive data set could enhance the effectiveness of AI in regional PBL detection.[15]

Despite the growing interest in AI within the field of dental radiography, few studies have directly compared the diagnostic performance of AI systems and human practitioners. Previous studies primarily focused on the development and validation of AI models, whereas few involved head-to-head comparisons between AI and dental professionals. This gap highlights the need for comprehensive research to evaluate the relative accuracy, efficiency, and clinical utility of AI-assisted diagnostic tools versus traditional human assessments. Comparative studies are crucial for understanding the potential benefits and limitations of integrating AI in dental practice to ultimately guide its adoption and implementation in clinical settings. Moreover, the integration of AI in dental radiography could potentially revolutionize the field by enhancing the diagnostic precision and reducing the workload of dental professionals. AI systems can rapidly and accurately analyze vast amounts of data, which could assist in the early detection of dental anomalies, leading to more timely and effective treatments. However, successful integration depends on rigorous validation through comparative studies to ensure that AI tools can match or surpass the diagnostic capabilities of experienced practitioners.

Therefore, the aim of the present study was to compare the diagnostic accuracy and efficiency of dental practitioners, including general practitioners (GPs) and specialists, with that of AI software when assessing alveolar bone loss using intraoral radiographs. The question addressed in this study is: does AI software provide more accurate measurements of alveolar bone loss space compared with dental practitioners? The null hypothesis is: there is no significant difference in diagnostic accuracy between AI software and dental practitioners when assessing alveolar bone loss in dental radiographs. The alternative hypothesis is: AI software provides significantly more accurate measurements of alveolar bone loss compared with dental practitioners based on dental radiographs.

Materials and Methods

Study design and participants

This comparative cross-sectional study evaluated the performance of dental practitioners and AI software in assessing alveolar bone loss. The cross-sectional design of the study means that data were collected at a single point in time, providing a snapshot comparison of the two diagnostic methods. This study design is particularly useful for identifying differences in performance between groups. A randomized sampling technique was employed to select the dental radiographs, ensuring that the selected radiographs were representative of the population and that bias was minimized. The study was approved by the Research Ethics Committee, Faculty of Dentistry at King Abdulaziz University (Approval Number: 235-11-23, dated January 31, 2024).

The inclusion criteria required that the participants were dental practitioners and specialists with a minimum of two years professional experience and who understood English. The participants could include periodontists, endodontists, prosthodontists, restorative dentists, advanced general dentists, and GPs. Undergraduate students were excluded from the study to ensure that all participants possessed advanced expertise and practical experience in dental radiology disciplines. This criterion was essential for obtaining reliable and relevant data from professionals who were highly experienced in the complexities and nuances of the field.

A priori power analysis was conducted using G*Power version 3.1.9.7 to determine the sample size required for the study. The aim of the analysis was to achieve a power of 0.8 at a significance level of 0.05. The effect size was set based on the expected difference in sensitivity between the null hypothesis (0.7) and alternative hypothesis (0.8), with a condition prevalence of 0.5. G*Power calculated that a minimum sample size of 310 evaluations was necessary to detect a significant difference in sensitivity with the specified power and significance level.

Data sources and image augmentation

To compile the study data set, digital bitewing and periapical dental radiographs were obtained from a single source; the dental teaching hospital. The inclusion criteria required that the selected radiographs were intraoral radiographs, either bitewings or periapical, of adult patients. The images had to contain clear cementoenamel junctions (CEJs), visible alveolar bone, and minimal angulation to ensure accurate readings. In addition, they had to conform to the standard dose and duration protocols for dental radiography procedures at the hospital. The exclusion criteria comprised images with substantial metal artifacts, incorrect patient positioning, poor quality, and atypical bone morphologies. The selected radiograph images included in the study were cropped and resized from the original 1440 × 1920 pixels to 224 × 224 pixels, and then converted into PNG format to ensure standardized evaluation.

Data labeling and prediction of PBL

The images were labeled by two board-certified investigators who were both consultants with over 5 years of experience. The evaluators established a consensus regarding the method for determining bone loss. First, reference points were identified by locating the CEJ and alveolar crest in the radiograph. The CEJ is the junction where the enamel of the tooth meets the cementum, and the alveolar crest represents the highest point of the alveolar bone surrounding the tooth. Next, the vertical distance was measured between the CEJ and alveolar crest. The calculations were used as baseline values for comparison with those made by AI and the participants. Examples of radiographs used in the study are shown in Figure 1.

Data collection process

A questionnaire with two sections was formulated using Google Forms. The first section captured data regarding consent, specialty, and years of expertise. The second section contained 10 radiographs and participants were asked to estimate the distance from the CEJ to the alveolar bone in millimeters for each radiograph.

The initial draft of the online questionnaire was piloted with ten dental residents enrolled in postgraduate programs to evaluate the clarity of the questions and the quality of the images. This pilot testing phase was crucial for identifying any ambiguities or misunderstandings in the questionnaire items and for ensuring that the images were appropriately interpreted.

Between February and July 2024, the online questionnaire was distributed among dental practitioners working in dental clinics in three major cities in KSA: Jeddah, Dammam, and Riyadh. Questionnaires were distributed via a link and QR code, as well as through social media platforms, particularly WhatsApp and Instagram, to disseminate our survey and engage with participants. These platforms were selected based on their widespread use and accessibility, which allowed us to reach a diverse group of participants.

AI software evaluation

Second Opinion® software (available at https://www.hellopearl.com/products/second-opinion) was selected for evaluation. The software was provided by My Clinic dental center. The radiographs used in this study were uploaded to the software in PNG format, which was used to preserve superior image quality and provide uniformity across all assessments. After importing the images, the program used AI algorithms for analysis. The data were then presented in an intuitive manner using distinct visual markers that emphasized areas of concern. This interface enabled dental practitioners to efficiently evaluate and understand the data (see Figure 1).

Statistical analysis

Descriptive statistics were calculated to summarize the central tendencies and variability of the data. Spearman's rho correlation coefficients were used to assess the strength and direction of the monotonic relationships between variables. All statistical analyses were conducted using SPSS version 29 (IBM Corp., Armonk, NY, USA).

Results

The survey received a total of 149 responses, resulting in a response rate of 48 %. Among the respondents, 58.3 % were GPs, 16.7 % were periodontist specialists, 8.3 % were prosthodontics specialists, and the remaining participants represented other dental specialties. The majority of participants (73.6 %) had more than 4 years of experience, and approximately 20 % had over 10 years of experience.

The mean estimates provided by the participants had a moderate positive correlation with the radiographic measurements (rho = 0.547, $p < 0.001$) and a weaker but still significant correlation with the AI measurements (rho = 0.365, $p < 0.001$). It was notable that the AI measurements had a stronger positive correlation with the radiographic measurements (rho = 0.712, $p < 0.001$) compared with the estimates of the dental practitioners (Table 1).

In Figure 2, the x-axis shows the relative frequency of radiographic measurements and the y-axis shows the relative frequency of measurements. Both axis labels are marked as "relative frequency" but the axes are not scaled. Overall, the scatter plot shows that there was a positive correlation between the relative frequency of

Figure 1: (A) Plain radiographs without any measurements for annotation by dental practitioners in the questionnaire. (B) Radiographs including measurements generated by AI software. (C) Radiographs calibrated and labeled by consultants, which were used to detect labels for alveolar bone loss and applied as the reference standard for comparison.

Table 1: Correlations between radiographic measurements, mean estimates of dental practitioners, and AI measurements.

Spearman's rho correlation coefficients	Radiographic measurements	Mean estimates of dental practitioners	AI measurements
Radiographic measurements	1.00		
Mean estimates of dental practitioners	0.547[a]	1.00	
AI measurements	0.712[a]	0.365[a]	1.00

[a] p-value <0.001.

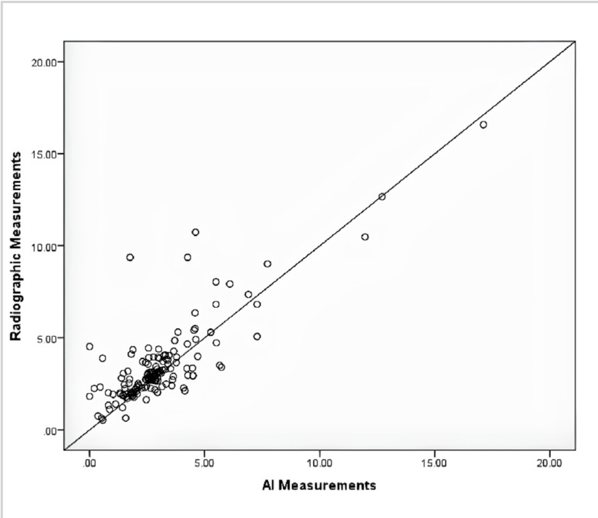

Figure 2: Relationship between relative frequency of AI measurements and relative frequency of radiographic measurements.

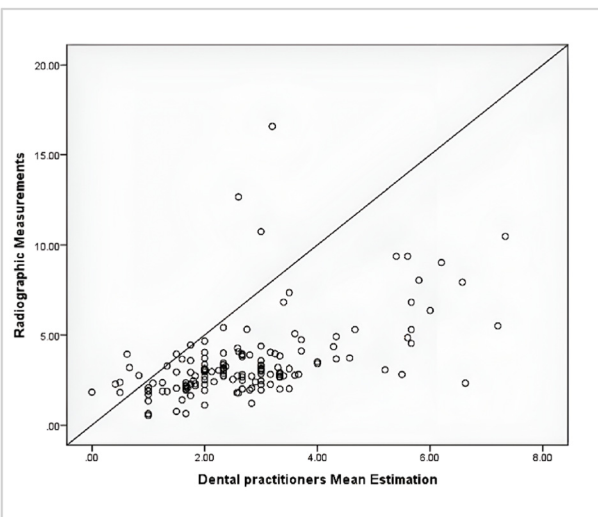

Figure 3: Relationship between mean estimates of dental practitioners and radiographic measurements.

measurements and the relative frequency of radiographic measurements.

According to Figure 3, the residual measurements appeared to be the difference between the mean estimates of the dental practitioners and some unknown reference values.

Figure 4 shows that there was a positive correlation between the number of measurements and the mean estimates of dental practitioners. Thus, the mean estimates of the dental practitioners tended to increase as the number of measurements increased.

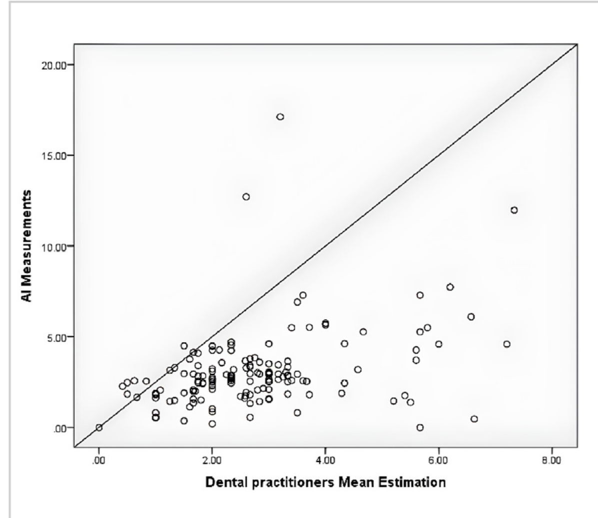

Figure 4: Correlation between number of measurements and mean estimates of dental practitioners.

Discussion

The topic of the present study "dental practitioners versus AI software when assessing alveolar bone loss using intraoral radiographs was chosen due to the growing interest and advancements in AI within dentistry. As AI is increasingly applied for analyzing dental X-rays, it is crucial to evaluate its effectiveness compared with human expertise. Thus, we explored how AI can enhance the diagnostic accuracy and efficiency when assessing alveolar bone loss. By comparing assessments made by dental practitioners and AI software, this study aimed to increase our understanding of the role of technology in improving traditional diagnostic processes.

Significant associations were found between the radiographic measurements, estimates of dental practitioners, and AI measurements. The mean estimates of dental practitioners had a moderate positive correlation with radiographic measurements and a weaker but still significant correlation with AI measurements. The correlation coefficients suggest that the estimates of dental practitioners agreed moderately well with the radiographic measurements, indicating a certain level of proficiency at visually assessing alveolar bone loss.

However, the weaker correlation with AI measurements highlights the potential limitations of human judgment in accurately quantifying subtle changes in radiographic images compared with AI algorithms, which may be due to the subjective nature of human interpretations of radiographs because of various factors, such as experience, fatigue, and cognitive biases. Previous studies have shown that AI algorithms, particularly those based on deep learning, can process and interpret medical images with a level of precision that surpasses human capabilities.[11–13] AI has the ability to analyze large data sets and detect minute changes that may be overlooked by human eyes, highlighting its potential to enhance diagnostic accuracy. For instance, Kim et al. discovered that a completely automated approach for PBL detection in panoramic dental radiographs performed better than detection by dental professionals.[13] Moreover, a review of AI integration in radiology showed that AI algorithms can significantly improve image analysis and mitigate diagnostic errors by providing standardized and reproducible assessments.[16] These findings suggest that human expertise remains invaluable but the incorporation of AI tools can complement and enhance the diagnostic process.

Interestingly, AI measurements had a stronger positive correlation with radiographic measurements compared with the correlation with the estimates of dental practitioners. This finding highlights the great potential for using AI technologies to accurately assess radiographic measurements. The stronger correlation between AI measurements and radiographic measurements suggests that AI technologies possess the capability to provide objective and consistent assessments of alveolar bone loss in radiographs. This finding agrees with previous research, which demonstrates the efficacy of AI in dental radiograph analysis and its potential to enhance diagnostic accuracy in clinical practice.[17,18] A systematic review also highlighted the high accuracy of AI models in detecting various dental conditions, such as caries, osteoporosis, and PBL, with sensitivity and specificity rates often exceeding 90 %. This high level of accuracy shows the great potential of AI for enhancing diagnostic precision and reducing the likelihood of diagnostic errors.[19] Furthermore, Turosz et al. demonstrated that AI-driven software achieved high performance metrics in analyzing dental panoramic radiographs, with greater than 90 % accuracy at detecting missing teeth, root canal fillings, and implants.[20] These findings suggest that AI can effectively complement clinical expertise by providing practitioners with reliable diagnostic insights, thereby improving the overall quality of patient care. Moreover, Junhua et al. developed an AI framework for diagnosing multiple dental diseases using panoramic radiographs and conducted an initial performance evaluation. The AI system obtained promising results in accurately diagnosing various dental conditions, further supporting the potential of AI for enhancing diagnostic precision and reducing errors.[21]

However, Patil and Joda conducted a systematic review to evaluate the effectiveness of AI models at detecting PBL and lesion classification.[22] Using various AI algorithms and radiographic modalities, six studies met the inclusion criteria. The results indicated mixed outcomes, where some studies found that AI was comparable to dental clinicians and others showed the superiority of AI.[22] AI is promising for PBL detection but further research is needed to standardize algorithms and confirm clinical utility. Thus, caution is advised due to the availability of limited evidence and variations in AI performance.[22]

Moreover, Krois et al. investigated the use of deep CNNs to detect PBL based on panoramic dental radiographs by utilizing a data set of 2001 image segments.[8] The CNN comprising a seven-layer deep neural network with over 4.2 million weights achieved a mean classification accuracy of 0.81, which was comparable to the mean accuracy of 0.76 obtained by six participating dentists. Sensitivity analyses indicated minimal changes in the performance metrics with varying PBL cut-off values.[8] The findings obtained in the present study highlight the potential use of CNNs in dental diagnostics, as well as suggesting that additional data and assessments of PBL morphology could enhance performance. Although the CNN performed in a similar manner to experienced dentists, future research should consider factors that might influence its performance.

Limitations

Despite the initial plan for a sample size of 310, logistical constraints reduced the sample to 149. This reduction could limit the generalizability and statistical power of the results, particularly in small-group analyses or different patient populations. Thus, further research with larger sample sizes is necessary to corroborate and expand the findings.

Efforts were made to standardize the evaluation process, but there could still have been variations in how dental practitioners and specialists interpreted the radiographic images of alveolar bone loss. Differences in expertise, training background, and diagnostic criteria could have affected the accuracy and consistency of their assessments, thereby impacting the reliability of the study outcomes.

Furthermore, radiographs calibrated by consultants were used as the reference standard for evaluating AI software. The reliability and consistency of these reference measurements could have been affected by interpretation bias or intra-observer variability. Inconsistencies in the reference standard could have introduced uncertainty into the comparative analysis of human and AI assessments. To mitigate these potential biases, it is essential to implement rigorous calibration protocols and ensure that multiple consultants independently verify the reference measurements. This approach can help enhance the reliability of the reference standard and provide a more robust basis for comparing the diagnostic performance of AI and human practitioners.

Given these limitations, future research should address these challenges and build upon the findings obtained in this study to further enhance the integration of AI technology in dental diagnostics, ultimately improving patient care and outcomes.

Future directions

Future research should aim to further validate the efficacy of AI technologies in dental radiograph analysis through large-scale clinical trials and real-world implementation studies. One strategy involves collaborating with additional institutions and dental centers to recruit a larger and more diverse participant pool. In addition, conducting longitudinal studies will facilitate the observation of trends and changes over time, providing more robust data. Moreover, offering incentives and shortening the questionnaire can help increase participant response rates by motivating participants to engage more actively and reducing the burden on respondents, leading to higher completion rates.[23] In addition, incorporating various AI technologies in future research would enhance the relevance of the results obtained across different healthcare environments. Collaborative efforts between dental practitioners, researchers, and AI developers are also essential to fully harness the potential of AI in advancing periodontal diagnosis and treatment. Moreover, further research should consider the effects of using AI and its practical implications, such as how it affects workflow, how much it costs, and how much training is required.[16–18] These issues are important for implementing AI technologies in beneficial applications in clinical practice. Understanding workflow implications will aid the potential integration of AI into current clinical practices, potentially boosting efficiency and reducing the workload of dental practitioners.[18] A thorough cost study is crucial for assessing the financial viability of using AI technology, including the initial expenditure on AI technologies and the ongoing expenses related to maintenance and upgrades, as well as potential savings derived from enhanced diagnostic precision and efficiency.[24] Training requirements constitute a significant area that warrants further examination. Comprehensive training programs are essential to guarantee that dental practitioners can proficiently and comfortably use AI technologies,[22] including understanding the capabilities and constraints of AI, analyzing AI-generated outcomes, and incorporating these insights into clinical decision making. Further investigations should examine the ethical implications of AI in dental diagnostics, including data privacy, algorithmic bias, and the involvement of practitioners in decision making. It is essential to address these ethical problems to guarantee the responsible and equitable deployment of AI technology.[22–24]

Dental practitioners are increasingly using AI software due to its ability to enhance patient care, increase diagnostic precision, and streamline dental office administration. Practitioners must address logistical, ethical, and regulatory factors to facilitate smooth adoption without compromising patient care. Research indicates that while some dental practitioners acknowledge the advantages of AI, there is a need for extensive training and education to mitigate resistance and facilitate successful deployment.[5] The integration of AI software in dental settings is highly promising for saving time and enhancing efficiency. Studies have demonstrated that AI may enhance several aspects of dental practice, including diagnostic procedures and administrative functions.[5,6] AI-driven diagnostic systems can swiftly evaluate radiographic images to accurately detect conditions such as dental caries or periodontal disease, and thus minimize the time dentists dedicate to manual analysis. However, further research is needed to comprehensively understand the long-term effects of AI integration on healthcare results and patient satisfaction.

In this study, Second Opinion® software was selected for evaluation, which is among the first real-time dental AI software platforms to feature a computer vision segmentation model that is capable of distinguishing tooth parts and supporting structures, as well as detecting various conditions and pathologies in dental X-rays to provide dental practitioners with a second opinion. This software was approved by the Food and Drug Administration (FDA). It was tested using the same set of radiographs evaluated by the participants and compared to the baseline to measure accuracy, allowing direct comparison with the performance of human specialists. Future studies should explore the long-term clinical outcomes obtained from integrating AI tools like Second Opinion® into routine dental practice. In addition, researchers should investigate the performance of the software across diverse patient populations and various clinical settings to ensure its generalizability and robustness.

Conclusions

The findings obtained in this study highlight the potential of using AI software to enhance the precision and efficiency of alveolar bone loss assessment. Human specialists remain indispensable but AI technologies may provide a standardized and reproducible method for radiographic analysis. More studies are needed to further validate these findings across diverse populations and clinical settings.

Source of funding

This research was not supported by any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflict of interest

The authors declare no conflicts of interest.

Ethical approval

This study was approved by the Research Ethics Committee, Faculty of Dentistry at King Abdulaziz University (Approval Number: 235-11-23) on 21/1/2024.

Authors contributions

AMA: Conceptualization, Data curation, Supervision, Writing—review and editing. JF: Investigation, Formal analysis, Writing—original draft. ABA: Investigation, Formal analysis, Validation, Writing—original draft. GG: Investigation, Formal analysis, Validation, Writing—original draft. HA: Conceptualization, Methodology, Project administration, Writing—review and editing. RS: Data curation, Validation, Supervision, Writing—review and editing. All authors have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jtumed.2025.04.001.

References

1. Artificial Intelligence (AI) Coined at Dartmouth. https://home.dartmouth.edu/about/artificial-intelligence-ai-coined-dartmouth. [Accessed 1 October 2024].
2. Sharka R, San Diego J, Nasseripour M, Banerjee A. Factor analysis of risk perceptions of using digital and social media in dental education and profession. **J Dent Educ 2023**; 87(1): 118–129.
3. Sharka R, San Diego JP, Nasseripour M, Banerjee A. Identifying risk factors affecting the usage of digital and social media:

a preliminary qualitative study in the dental profession and dental education. **Dent J 2021**; 9(5): 53.
4. Ding H, Wu J, Zhao W, Matinlinna JP, Burrow MF, Tsoi JKH. Artificial intelligence in dentistry—a review. **Front Dent Med 2023**; 4:1085251.
5. Al-Dabbagh N, Alnowailaty Y, Abed H, Sharka R, Alhilou A, Almarghlani A. Patients' perception of using robotics and artificial intelligence in dentistry: a cross-sectional study. **Open Dent J 2024**:e18742106339605.
6. Hung K, Montalvao C, Tanaka R, Kawai T, Bornstein MM. The use and performance of artificial intelligence applications in dental and maxillofacial radiology: a systematic review. **Dentomaxillofacial Radiol 2020**; 49(1):20190107.
7. Ryu J, Lee DM, Jung YH, Kwon O, Park S, Hwang J, et al. Automated detection of periodontal bone loss using deep learning and panoramic radiographs: a convolutional neural network approach. **Appl Sci 2023**; 13(9): 5261.
8. Krois J, Ekert T, Meinhold L, Golla T, Kharbot B, Wittemeier A, et al. Deep learning for the radiographic detection of periodontal bone loss. **Sci Rep 2019**; 9(1): 8495.
9. Alotaibi G, Awawdeh M, Farook FF, Aljohani M, Aldhafiri RM, Aldhoayan M. Artificial intelligence (AI) diagnostic tools: utilizing a convolutional neural network (CNN) to assess periodontal bone level radiographically—a retrospective study. **BMC Oral Health 2022**; 22(1): 399.
10. Shiri F, Perumal T, Mustapha N, Mohamed R. A comprehensive overview and comparative analysis on deep learning models: CNN, RNN, LSTM, GRU. **ArXiv 2023**; 6(1): 17473.
11. Chen IH, Lin CH, Lee MK, Chen TE, Lan TH, Chang CM, Tseng TY, Wang T, Du JK. Convolutional-neural-network-based radiographs evaluation assisting in early diagnosis of the periodontal bone loss via periapical radiograph. **J Dent Sci 2024**; 19(1): 550−559.
12. Lin PL, Huang PY, Huang PW. Automatic methods for alveolar bone loss degree measurement in periodontitis periapical radiographs. **Comput Methods Progr Biomed 2017**; 148: 1−11.
13. Kim J, Lee HS, Song IS, Jung KH. DeNTNet: deep Neural Transfer Network for the detection of periodontal bone loss using panoramic dental radiographs. **Sci Rep 2019**; 9(1):17615.
14. Lee JH, Kim D Hyung, Jeong SN, Choi SH. Diagnosis and prediction of periodontally compromised teeth using a deep learning-based convolutional neural network algorithm. **J Periodontal Implant Sci 2018**; 48(2): 114−123.
15. Uzun Saylan BC, Baydar O, Yeşilova E, Kurt Bayrakdar S, Bilgir E, Bayrakdar İS, et al. Assessing the effectiveness of artificial intelligence models for detecting alveolar bone loss in periodontal disease: a panoramic radiograph study. **Diagnostics 2023**; 13(10): 1800.
16. Najjar R. Redefining radiology: a review of artificial intelligence integration in medical imaging. **Diagnostics 2023**; 13(17): 2760.
17. Kurt-Bayrakdar S, Bayrakdar İS, Yavuz MB, Sali N, Çelik Ö, Köse O, et al. Detection of periodontal bone loss patterns and furcation defects from panoramic radiographs using deep learning algorithm: a retrospective study. **BMC Oral Health 2024**; 24(1): 155.
18. Putra RH, Doi C, Yoda N, Astuti ER, Sasaki K. Current applications and development of artificial intelligence for digital dental radiography. **Dentomaxillofacial Radiol 2022**; 51(1):20210197.
19. Turosz N, Chęcińska K, Chęciński M, Brzozowska A, Nowak Z, Sikora M. Applications of artificial intelligence in the analysis of dental panoramic radiographs: an overview of systematic reviews. **Dentomaxillofacial Radiol 2023**; 52(7):20230284.
20. Turosz N, Chęcińska K, Chęciński M, Sielski M, Sikora M. Evaluation of dental panoramic radiographs by artificial intelligence compared to human reference: a diagnostic accuracy study. **J Clin Med 2024**; 13(22): 6859.
21. Zhu J, Chen Z, Zhao J, Yu Y, Li X, Shi K, Zheng Y. Artificial intelligence in the diagnosis of dental diseases on panoramic radiographs: a preliminary study. **BMC Oral Health 2023**; 23(1): 358.
22. Patil S, Joda T, Soffe B, Awan KH, Fageeh HN, Tovani-Palone MR, et al. Efficacy of artificial intelligence in the detection of periodontal bone loss and classification of periodontal diseases: a systematic review. **J Am Dent Assoc 2023**; 154(9): 795−804.e1.
23. Singer E, Ye C. The use and effects of incentives in surveys. **Ann Am Acad Polit Soc Sci 2013**; 645(1): 112−141.
24. Rossi JG, Rojas-Perilla N, Krois J, Schwendicke F. Cost-effectiveness of artificial intelligence as a decision-support system applied to the detection and grading of melanoma, dental caries, and diabetic retinopathy. **JAMA Netw Open 2022**; 5(3): e220269.

How to cite this article: Almarghlani A, Fakhri J, Almarhoon A, Ghonaim G, Abed H, Sharka R. Dental practitioners versus artificial intelligence software in assessing alveolar bone loss using intraoral radiographs. J Taibah Univ Med Sc 2025;20(3):272−279.