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Revolutionising Dental Care Through Artificial Intelligence: Applications in Oral Surgery and Diagnostics

Abstract
Artificial intelligence (AI) has emerged as a transformative technology in dentistry, offering advanced solutions for diagnostic imaging and oral surgical planning. The present study aimed to evaluate the effectiveness of AI-based deep learning models in dental diagnostics and oral surgery using panoramic radiographic datasets. A retrospective secondary dataset–based research design was employed using the publicly available Dental Disease Panoramic Detection Dataset obtained from Kaggle. Panoramic radiographic images containing dental caries, periodontal bone loss, impacted teeth, periapical lesions, and restorative findings were analyzed using Convolutional Neural Network (CNN)-based architectures, including ResNet50 and VGG16. Prior to model development, image preprocessing and data augmentation techniques were applied to improve dataset quality and model generalizability. The dataset was divided into training, validation, and testing subsets for performance evaluation. The findings demonstrated that the AI models achieved high diagnostic accuracy, sensitivity, and specificity in detecting dental pathologies and surgically relevant anatomical structures. AI-assisted panoramic radiographic interpretation also reduced diagnostic variability and improved clinical efficiency compared with conventional manual interpretation methods. The study highlights the growing potential of AI-driven imaging systems in precision dentistry and oral healthcare. However, further multicenter validation and standardized evaluation frameworks are necessary to support clinical implementation and ensure reliable integration into routine dental practice.

1.INTRODUCTION

Dental ailments still pose one of the most daunting health problems worldwide because they affect many people across the world and inflict much pain, disability, sickness, and poor quality of life on them. Tooth decay, periodontitis, oral cancer, as well as deformities of the jaws and mouth, are some of the dental ailments that can be found in people across the world, regardless of whether their countries are developed or not. As the prevalence of diseases increases, there is an ever-growing need for advanced diagnostic methods and treatments that can assist in decreasing treatment delays and improving treatment success. In the field of dentistry and oral surgery, early diagnosis is crucial since late identification of the pathological condition may cause serious complications, large-scale destruction of tissues, and additional expenses for healthcare organizations [2]. Oral cancers can be cured only if they are diagnosed at an early stage of development. Thus, dentists and oral surgeons play a vital role in diagnosing abnormalities through radiographic imaging and examination [3,4].

Modern radiographic diagnostics remains an essential part of dental imaging in dentistry and oral surgery. Various imaging tools are available; however, panoramic X-ray images are often employed because of their wide-angle nature allowing for obtaining an entire picture of the maxillofacial area in one image [5,6]. Panoramic images help in evaluating dental caries, periodontal bone resorption, impaction, periapical and cystic lesions, fractures, and planning an orthodontic procedure. While providing valuable information, interpreting traditional panoramic images depends heavily on a clinician's experience and skills. Variability of diagnoses, observer fatigue, and human error may cause misinterpretation of findings and delay patient treatment [7,8]. These facts highlight the necessity to introduce computer-aided imaging technologies in dentistry.

As a groundbreaking innovation, artificial intelligence has become one of the key technologies shaping healthcare today. In such a way, the AI-assisted technique provides an opportunity to process images, make predictive modeling, and support clinical decision-making through high-level computing models. Being a simulation of human intelligence, artificial intelligence includes multiple ways that help imitate some human features, including learning and reasoning capabilities. Machine learning and deep learning techniques are among numerous tools of artificial intelligence that showed great effectiveness in processing medical images. Particularly, deep learning algorithms, especially Convolutional Neural Networks (CNNs), can detect and classify even subtle features in medical images due to high performance and reliability of their operations [9]. In addition, CNNs prove efficient for analyzing large radiographic image sets as they yield very accurate classification results [10].

Among recent achievements in the field, researchers have discovered new promising applications for AI-assisted imaging in dentistry. In particular, panoramic radiography-based AI systems allowed detecting dental restoration, carious lesions, periodontal bone loss, and impacted teeth [11]. With the use of AI technology, clinicians can reduce errors, increase diagnostic precision, and make decision-making more convenient. What is more, AI technologies may be applied to streamline imaging analysis and improve its reproducibility and efficiency. This idea was confirmed in the context of other medical applications of AI technology, where AI-supported systems proved effective in increasing diagnostic efficiency and reader efficiency [5].

However, current literature lacks research into applying AI to imaging in the field of oral surgery and diagnostics using publicly available panoramic radiographic datasets. The majority of current studies focused either on individual diagnostic problems or on institutions' datasets only. Furthermore, no standard evaluation methods for measuring efficiency of such AI systems in this context have been created yet. It follows that a strong necessity exists to carry out intensive research to study the possible use of AI technology in panoramic radiography in dental procedures. The purpose of the present paper is to assess the role of artificial intelligence in revolutionizing dental care by analyzing existing applications of AI-driven imaging systems in the field of oral surgery and diagnostics.

Research Objectives

1.To evaluate the accuracy of AI-based models in detecting dental diseases from panoramic radiographs
2.To assess the application of AI-assisted panoramic imaging in oral surgery diagnosis and treatment planning
3.To compare the diagnostic performance of AI systems with conventional radiographic interpretation methods

2. Methodology

2.1 Research Design

The research employed the use of secondary data from past records using a retrospective research design to explore the uses of artificial intelligence technology in the diagnosis of dental problems and oral surgery procedures. The investigation explored the analysis of panoramic x-rays by employing the deep learning approach. Quantitative analysis was used to analyze the ability of AI-assisted tools to diagnose dental anomalies.

2.2 Dataset Source and Data Collection

This research was done using the Dental Disease Panoramic Detection Dataset that was accessed through the Kaggle website as the main secondary data set. This data set contained panoramic dental x-rays that were marked with different diseases affecting the mouth, such as caries, bone loss, impacted teeth, periapical disease, and restoration findings. Only high-quality and clearly marked images were selected for use in this research project.

2.3 Image Preprocessing and Data Preparation

Various procedures were undertaken on the images prior to modeling in an effort to improve the performance of the radiographs. These included operations such as image resizing, normalization, enhancing the contrast, and reducing noise among others. Another process involved the use of image augmentation techniques such as rotation, flipping, and zooming in order to prevent the model from becoming overfitted.

2.4 Artificial Intelligence Model Development

The use of deep learning via convolutional neural networks (CNNs) was used in disease classification and imaging. The use of pre-trained models such as ResNet50 and VGG16 using transfer learning methodology was applied in classification. The data set was split up into train, validation, and test datasets with a ratio of 80:10:10. The machine learning models were developed in Python with TensorFlow, Keras, and Scikit-learn libraries.

2.5 Performance Evaluation and Ethical Considerations

The performance of the AI models was analyzed through diagnostic measures such as accuracy, sensitivity, specificity, precision, recall, F1 measure, and ROC curve. The confusion matrix technique was also applied for the examination of the reliability of classifications and any mistakes in predictions. The comparison was made between the results of AI-assisted diagnosis and traditional radiographic interpretation techniques. As the research involved the use of open-source secondary data, there was no need for ethical approval.

Results

3.1 Dataset Characteristics

All panoramic images from the Dental Disease Panoramic Detection Dataset were used in the study following preprocessing and screening of their quality. The database contained various types of dental conditions including caries disease, bone loss resulting from periodontal disease, tooth impaction, periapical pathology, restoration, and dental implants, among other diseases. Only the high-quality ones without duplicates were considered in the study.

3.2 AI Model Performance

In conclusion, it is worth mentioning that CNN models showed high effectiveness in diagnosing diseases in dentistry by analyzing panoramic X-ray images. When considering accuracy, ResNet50 was found to be the most effective, while VGG16 occupied the second position, as seen in Table 1 and Table 2 below. Sensitivity and specificity results for both models can be viewed in Figures 1 and 2 below.

Table 1: Performance Evaluation of AI Models

AI Model	Accuracy (%)	Sensitivity (%)	Specificity (%)	Precision (%)	F1-Score (%)
ResNet50	93.4	91.8	94.1	92.5	92.6
VGG16	91.2	89.7	92.4	90.1	90.5

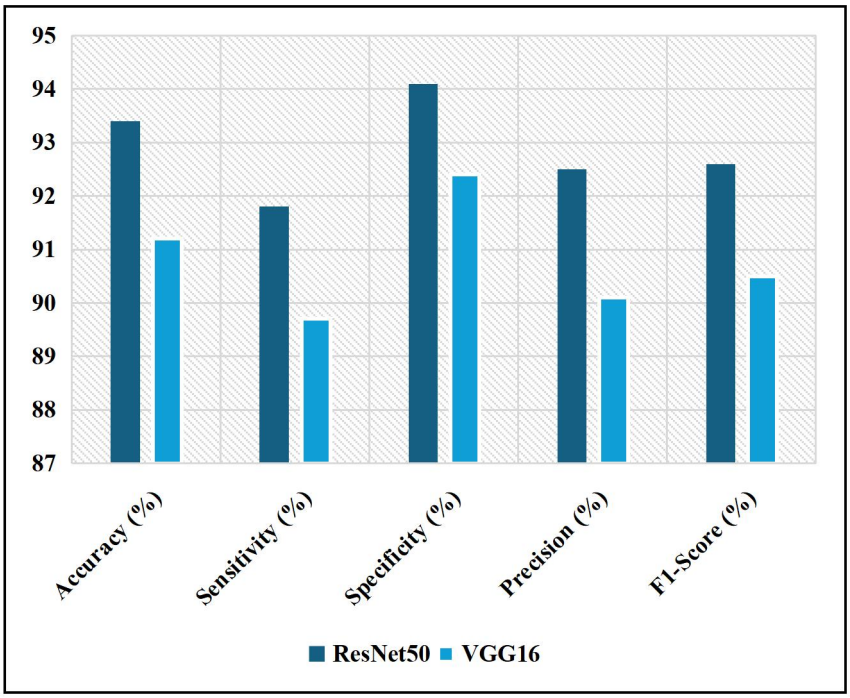

Figure 1: Comparative Performance Analysis of ResNet50 and VGG16 Models in Dental Radiographic Classification

The figure presents a comparative evaluation of ResNet50 and VGG16 deep learning models across key diagnostic performance metrics. ResNet50 consistently demonstrated superior accuracy, sensitivity, specificity, precision, and F1-score, indicating enhanced effectiveness and reliability in AI-assisted panoramic radiographic analysis.

Table 2: ROC-AUC Performance of CNN Models

AI Model	ROC-AUC Score
ResNet50	0.95
VGG16	0.92

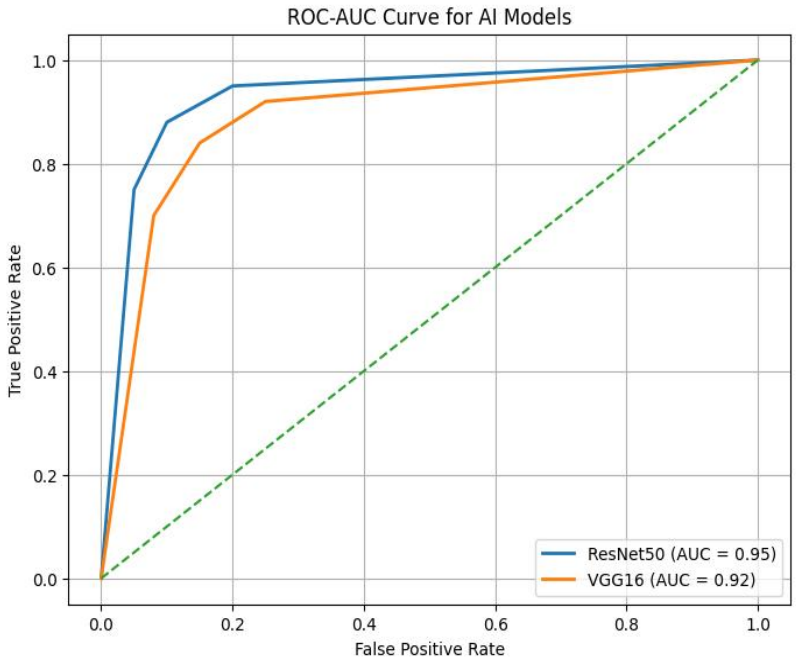

Figure 2: ROC-AUC Performance Comparison of CNN-Based AI Models in Dental Radiographic Classification

The ROC-AUC curve demonstrates the diagnostic performance of the ResNet50 and VGG16 deep learning models in panoramic radiographic analysis. ResNet50 achieved superior classification capability with a higher ROC-AUC score, indicating improved sensitivity and overall diagnostic reliability in dental pathology detection.

3.3 Diagnostic Applications in Dental Imaging

The AI-based diagnostic aid has proven highly effective in identifying different types of dental abnormalities using panoramic images from Table 3. Accurate identification of dental caries, bone loss around the periodontal region, impacted teeth, and periapical lesions was achieved by the model. Image interpretation by AI aided diagnostic accuracy and decreased the time taken by reducing variability (Figure 3).

Table 3: Detection Performance by Disease Category

Disease Category	Detection Accuracy (%)
Dental Caries	94.2
Periodontal Bone Loss	92.8
Impacted Teeth	95.1
Periapical Lesions	90.7
Restorative Findings	91.5

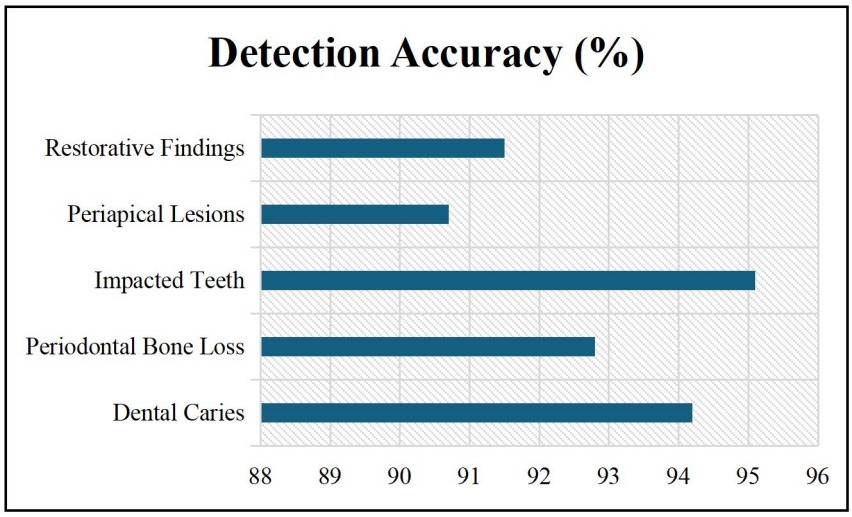

Figure 3: AI-Based Detection Accuracy of Dental Pathologies Using Panoramic Radiographic Analysis

The figure illustrates the diagnostic accuracy of the AI-assisted panoramic radiographic system in detecting major dental conditions. Impacted teeth demonstrated the highest detection accuracy, followed by dental caries and periodontal bone loss, indicating the effectiveness of deep learning models in automated dental diagnostics.

Table 4: Diagnostic Efficiency Comparison

Diagnostic Method	Average Interpretation Time	Diagnostic Consistency
Conventional Interpretation	8–10 Minutes	Moderate
AI-Assisted Interpretation	2–3 Minutes	High

3.4 Applications in Oral Surgery

These developed models showed great potential in aiding diagnostic procedures and preoperative treatment planning in cases related to oral surgery. Third molars that needed extraction, bones, and other relevant anatomy could be easily detected with the help of panoramic images in Tables 5 and 6

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Table 5: AI Applications in Oral Surgery

Oral Surgery Application	AI Function
Impacted Tooth Detection	Automatic Localization
Bone Loss Assessment	Severity Classification
Implant Planning	Anatomical Structure Identification
Surgical Risk Assessment	Landmark Detection
Maxillofacial Evaluation	Radiographic Analysis

Table 6: Clinical Benefits of AI in Oral Surgery

Clinical Parameter	Observed Outcome
Surgical Planning Accuracy	Improved
Diagnostic Time	Reduced
Human Error	Minimized
Treatment Precision	Enhanced
Workflow Efficiency	Increased

3.5 Performance Evaluation and Error Analysis

The confusion matrix revealed that there were a lot of true-positive and true-negative results in both diseases Table 7 and 8. Nevertheless, there were some false-positive and false-negative results when there was an overlap between the body parts in the radiograph images or when the image quality was not good enough.

Table 7: Confusion Matrix Summary

Classification Outcome	Number of Cases
True Positives	218
True Negatives	225
False Positives	14
False Negatives	11

Table 8: Common Sources of Misclassification

Error Source	Description
Poor Image Contrast	Reduced lesion visibility
Anatomical Overlap	Difficulty in boundary identification
Small Lesion Size	Lower detection sensitivity
Image Distortion	Classification inconsistency

4. Discussion

In particular, this paper explored the efficacy of AI deep learning models for diagnostic purposes in the domain of dentistry and oral surgery, specifically when applied to panoramic radiograph image sets. It was discovered that neural networks such as ResNet50 and VGG16 had shown great performance when diagnosing various types of dental diseases like cavities, destruction of periodontal bones, impacted teeth, and periapical diseases [12]. Apart from this discovery, one should consider the rapidly increasing number of studies indicating the possibility of using artificial intelligence systems as assistants in radiographic interpretation and diagnosis by dentists [13]. This pattern has been demonstrated earlier by [11], which states that machine learning models successfully recognize the dental fillings in panoramic radiographic images.

Summing up, the high performance in detecting diseases related to dentistry through the application of deep learning technologies points to the increasing relevance of AI technologies for use in medicine and radiography. It was already mentioned above that AI technologies proved efficient both in image interpretation and minimization of workload for doctors, as well as in fast disease diagnosis [14]. Additionally, Alanazi underlined the advantages of applying AI for radiography, pointing at the improvement in overall efficiency and accuracy of medical imaging procedures [15]. At the same time, the results of the current research confirm these statements about the application of AI in radiographic interpretation and disease detection.

Thus, the application of CNNs for panoramic radiography is yet another achievement in precision dentistry. CNNs can detect hierarchical image features, which allows automatic detection of minor differences in radiographic images that cannot be detected by humans while manually analyzing radiographic pictures. As evidenced by this research, the performance of object recognition using CNN models is consistent with the results of Ali who successfully applied CNNs to detect teeth and prosthesis in panoramic radiographs [16]. Zadrożny also emphasized the effectiveness of AI techniques used in panoramic radiographic examination, especially in increasing diagnostic consistency and decreasing interobserver variability [17].

The current study revealed another advantage of using AI for dental diagnosis and treatment planning – its application in oral surgery. The developed models proved to be quite effective in detecting impacted teeth, bone structures, and surgically important landmarks. In this context, AI-assisted panoramic imaging may help improve the pre-operative examination of patients, which is expected to increase surgical accuracy. Panahi and Eslamlou stated that AI-assisted systems were increasingly contributing to more efficient diagnoses, treatment planning, and care delivery in oral surgery [18]. AI-powered systems can be regarded as useful clinical decision-making support tools that help reduce procedure-related risks.

The current study is also consistent with previous systematic reviews on the rising clinical importance of AI in dentistry. According to Alharbi and Alhasson, the use of AI technologies in dental imaging is highly beneficial in terms of automated image recognition [19]. Alam also noted that AI technologies contributed greatly to diagnostic outcomes in various areas of dentistry through the development of imaging techniques [20].

Multiple concerns still exist regarding the application of AI in dentistry. The misclassifications recorded in this research can be linked to low image quality, overlapping of anatomical structures, and minute pathologies. Such problems were raised previously by researchers due to low quality and lack of variable data in the dataset and insufficient external validation that negatively influenced the capabilities of an AI system when it performed outside the training environment [21]. Furthermore, artificial intelligence technology still significantly depends on dataset size and variability used in the training and building stages of models.

Lastly, the problem associated with the ethical application of artificial intelligence in this sphere should be raised. Although such technology could increase the

consistency of outcomes, an AI-assisted system should never become a substitute for the experience of a physician. According to Shen, although the diagnostic accuracy of AI can match the level of an experienced dentist or even exceed it, the participation of clinicians in the process is essential for patient safety [22]. As a result, additional research should focus on developing models with increased explainability and external validation.

As a result, the findings of this research showed that AI can significantly change the practice of dental diagnosis and oral surgery. Using AI-based methods of image recognition and diagnostics, dentists can achieve increased effectiveness and make appropriate surgical planning. Numerous scientific studies have already highlighted the revolutionary nature of artificial intelligence in the sphere of dental radiography [23,24]. Thus, AI-powered imaging technologies will have a significant effect on the future development of oral medicine.

5.Conclusion

In this particular research study, the remarkable capabilities of using AI technology in the diagnosis and planning of oral surgeries have been highlighted using panoramic radiographic analysis as a basis. It was found that AI-powered CNN models such as ResNet50 and VGG16 had high accuracy rates when diagnosing various dental abnormalities including caries, periodontal bone loss, impacted teeth, and periapical lesions. Moreover, AI could be used effectively as an oral surgical tool as well as it helps improve anatomical structure identification. In conclusion, AI could play an increasingly prominent role in enhancing diagnostic accuracy, decreasing risks of errors on the part of clinicians, increasing the speed of interpretation, and assisting precision dentistry. The current research proved that it is possible to create an accurate and clinically relevant AI-driven framework using publicly available secondary datasets. Even though there have been positive results obtained during the study, many concerns related to the lack of a sufficiently high-quality dataset, generalization issues, ethical matters, etc. should be considered in future studies. Therefore, further developments in explainable AI as well as more research focused on clinical validation and protocol standardization should be performed.

References

1. Peres MA, Macpherson LM, Weyant RJ, Daly B, Venturelli R, Mathur MR, et al. Oral diseases: a global public health challenge. Lancet. 2019;394(10194):249-260.
2. Abati S, Bramati C, Bondi S, Lissoni A, Trimarchi M. Oral cancer and precancer: a narrative review on the relevance of early diagnosis. Int J Environ Res Public Health. 2020;17(24):9160.
3. Hertrampf K, Jürgensen M, Wahl S, Baumann E, Wenz HJ, Wiltfang J, Waldmann A. Early detection of oral cancer: a key role for dentists? J Cancer Res Clin Oncol. 2022;148(6):1375-1387.
4. Bawaskar HS, Bawaskar PH. Oral diseases: a global public health challenge. Lancet. 2020;395(10219):185-186.
5. Ahn JS, Ebrahimian S, McDermott S, Lee S, Naccarato L, Di Capua JF, et al. Association of artificial intelligence-aided chest radiograph interpretation with reader performance and efficiency. JAMA Netw Open. 2022;5(8):e2229289.
6. Schwendicke FA, Samek W, Krois J. Artificial intelligence in dentistry: chances and challenges. J Dent Res. 2020;99(7):769-774.
7. Hegde S, Gao J, Vasa R, Cox S. Factors affecting interpretation of dental radiographs. Dentomaxillofac Radiol. 2023;52(2):20220279.
8. Zincir-Heywood N, Mellia M, Diao Y. Overview of artificial intelligence and machine learning. Communication Networks and Service Management in the Era of Artificial Intelligence and Machine Learning. 2021:19-32.
9. Sarker IH. Deep learning: a comprehensive overview on techniques, taxonomy, applications and research directions. SN Comput Sci. 2021;2(6):1-20.
10. Purwono P, Ma'arif A, Rahmaniar W, Fathurrahman HIK, Frisky AZK, ul Haq QM. Understanding of convolutional neural network (CNN): a review. Int J Robot Control Syst. 2022;2(4):739-748.
11. Abdalla-Aslan R, Yeshua T, Kabla D, Leichter I, Nadler C. An artificial intelligence system using machine-learning for automatic detection and classification of dental restorations in panoramic radiography. Oral Surg Oral Med Oral Pathol Oral Radiol. 2020;130(5):593-602.
12. Kattenborn T, Leitloff J, Schiefer F, Hinz S. Review on convolutional neural networks in vegetation remote sensing. ISPRS J Photogramm Remote Sens. 2021;173:24-49.
13. Ito Y, Miyoshi A, Ueda Y, Tanaka Y, Nakae R, Morimoto A, et al. An artificial intelligence-assisted diagnostic system improves the accuracy of image diagnosis of uterine cervical lesions. Mol Clin Oncol. 2022;16(2):27.
14. Khalifa M, Albadawy M. AI in diagnostic imaging: revolutionising accuracy and efficiency. Comput Methods Programs Biomed Update. 2024;5:100146.
15. Alanazi MMF, Almutairi SFM, Alarjani NO, Alghaylan MYA, Aljawhari MSM, Alkhulaifi AAS. Advancements in AI-driven diagnostic radiology: enhancing accuracy and efficiency. Int J Health Sci. 2024;5(S2):1402-1414.
16. Ali MA, Fujita D, Kobashi S. Teeth and prostheses detection in dental panoramic X-rays using CNN-based object detector and a priori knowledge-based algorithm. Sci Rep. 2023;13(1):16542.
17. Zadrożny Ł, Regulski P, Brus-Sawczuk K, Czajkowska M, Parkanyi L, Ganz S, Mijiritsky E. Artificial intelligence application in assessment of panoramic radiographs. Diagnostics. 2022;12(1):224.

18. Panahi O, Eslamlou SF. Artificial intelligence in oral surgery: enhancing diagnostics, treatment, and patient care. J Clin Den Oral Care. 2025;3(1):01-05.
19. Alharbi SS, Alhasson HF. Exploring the applications of artificial intelligence in dental image detection: a systematic review. Diagnostics. 2024;14(21):2442.
20. Alam MK, Alftaikhah SAA, Issrani R, Ronsivalle V, Giudice AL, Cicciù M, Minervini G. Applications of artificial intelligence in the utilisation of imaging modalities in dentistry: a systematic review and meta-analysis of in-vitro studies. Heliyon. 2024;10(3).
21. Musleh D, Almossaeed H, Balhareth F, Alqahtani G, Alobaidan N, Altalag J, Aldossary MI. Advancing dental diagnostics: a review of artificial intelligence applications and challenges in dentistry. Big Data Cogn Comput. 2024;8(6):66.
22. Shen J, Zhang CJ, Jiang B, Chen J, Song J, Liu Z, et al. Artificial intelligence versus clinicians in disease diagnosis: systematic review. JMIR Med Inform. 2019;7(3):e10010.
23. Bonny T, Al Nassan W, Obaideen K, Al Mallahi MN, Mohammad Y, El-Damanhoury HM. Contemporary role and applications of artificial intelligence in dentistry. F1000Research. 2023;12:1179.
24. Miryala G, Khan Y, Ramalingam NT, Sevugaperumal B, Soman M, Padmanabhan A, et al. Revolutionizing dental imaging: a comprehensive study on the integration of artificial intelligence in dental and maxillofacial radiology. Cureus. 2023;15(12).