RADIOMICS RESEARCH IN ORAL AND MAXILLOFACIAL RADIOLOGY: A BIBLIOMETRIC ANALYSIS.

Abstract:

Radiomics analysis is a method that provides quantitative results by evaluating pixel-based differences in images that cannot be detected by the human eye. This study aimed to examine the scientific production, conceptual structure, and thematic evolution of radiomics-related literature in oral and maxillofacial radiology using bibliometric analysis. Data were obtained from articles indexed in the Web of Science Core Collection database between 2017 and 2025. A total of 210 publications were analyzed using bibliometrix through R, RStudio, and Biblioshiny. The findings demonstrated increasing scientific production and growing integration of radiomics with artificial intelligence-based applications.

Key words: Artificial Intelligence, Bibliometric Analysis, Deep Learning, Machine Learning, Radiomics.

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Introduction: The development of technology and the increase in digitalization have led to significant changes in the field of dentistry, as in many other fields. The evolution of information technology has also introduced human–machine interaction into the field of dentistry (1, 2). As a result, the terms artificial intelligence, machine learning, and deep learning have become routinely used concepts in the field of dentistry (1-3). Radiomics is a decision-support tool used to identify quantitative features from medical images through artificial intelligence-based methods (4, 5). With the development of imaging systems in the medical field, more complex images containing larger amounts of data have begun to be produced (6). This increase in the imaging data pool has led to the identification of certain mathematical features that cannot normally be detected by the human eye through the use of various software tools. In this respect, radiomic analysis is useful for extracting quantitative parameters and features from images. Thus, quantitative information can be obtained regarding characteristics such as the borders, gradients, signal intensities, and shapes of the structures within the relevant image (2, 7-9). The literature in this field has expanded considerably, especially in recent years, making it increasingly difficult to evaluate the main research themes and the evolution of the field. Therefore, it is necessary to assess the conceptual structure and research trends of the related literature. Bibliometric analysis is a quantitative method used to perform such evaluations. Through this method, analyses such as Annual Scientific Production, Keyword Co-occurrence Analysis, Trend Topics Analysis, Thematic Map Analysis, and Thematic Evolution Analysis can be examined within the relevant field (10-12). Although bibliometric analyses related to artificial intelligence in dentistry have been reported in the literature, there is limited information regarding bibliometric studies specifically focused on radiomics in the field of oral and maxillofacial radiology (13-16). Therefore, the aim of this study was to evaluate the scientific production structure, conceptual organization, and thematic evolution of the radiomics-related literature in the field of dentistry using bibliometric methods.The development of technology and the increase in digitalization have led to significant changes in the field of dentistry, as in many

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Materials and Methods: The present study was designed as a bibliometric analysis investigating the use of radiomics analysis methods in the field of oral and maxillofacial radiology. Since no human or animal subjects were involved during the conduct of the study, ethical approval was not required.

The data required for this study were obtained from the Web of Science Core Collection (WoSCC) database by entering the following query into the advanced search section: (("radiomics" OR "radiomic features") AND ("oral" OR "maxillofacial") AND ("radiology" OR "radiography" OR "imaging" OR CBCT OR "computed tomography" OR MRI)). Scientific publications published between 2017 and 2025 were screened, and only articles were included in the analysis. Conference proceedings, editorial papers, and articles unrelated to the topic were excluded to ensure the homogeneity of the dataset.

In the present study, the bibliometrix package (version 5.3.0) was used through R (version 4.6.0), RStudio, and Biblioshiny for bibliometric analysis. Within the scope of descriptive analyses, Annual Scientific Production was performed; within the scope of

conceptual structure analysis, Keyword Co-occurrence Analysis was conducted; and within the scope of thematic analyses, Trend Topics Analysis, Thematic Map Analysis, and Thematic Evolution Analysis were carried out. A network-based clustering method was used to examine the conceptual structure and dominant themes related to the subject. In this respect, the conceptual structure, keyword relationships, and thematic clusters within the relevant literature were evaluated using Keyword Co-occurrence Analysis. In the generated networks, edge thickness represented co-occurrence strength, colors represented different thematic clusters, and node size represented keyword frequency. From a thematic perspective, emerging/declining themes, niche themes, basic themes, and motor themes were examined.

Results: Considering the exclusion criteria, a total of 210 scientific publications were identified. Evaluation of the Annual Scientific Production analysis demonstrated an overall increasing trend in scientific production over the years. This increase became particularly more pronounced after 2020. The highest Annual Scientific Production value was reached in 2025 (Figure 1).

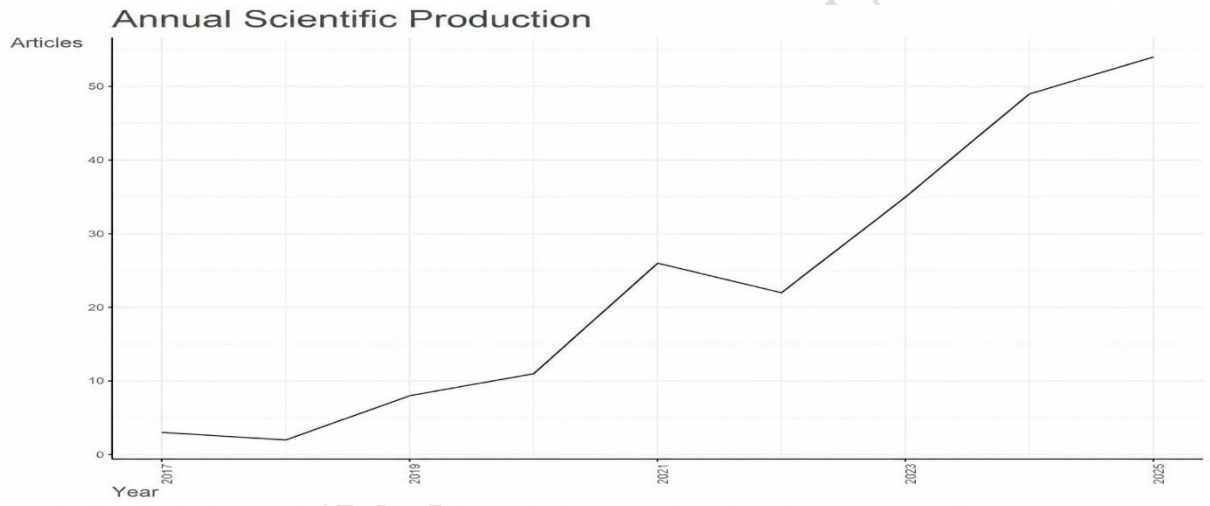

Figure 1. Annual scientific production in radiomics research in oral and maxillofacial radiology.

Evaluation of the co-occurrence network of authors' keywords revealed that the term "radiomics" had the highest connection density and was located at the center of the network. Terms such as "machine learning," "deep learning," "artificial intelligence," "cone-beam computed tomography," and "magnetic resonance imaging" were observed to form relationships with the term "radiomics" (Figure 2).

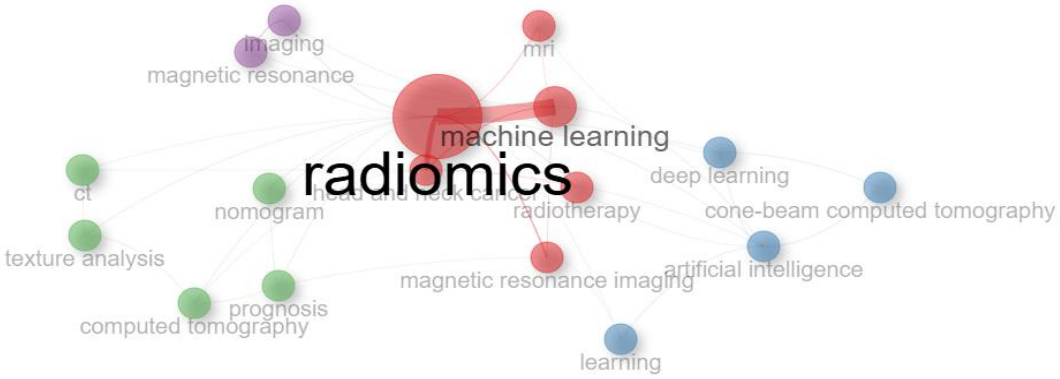

Figure 2. Co-occurrence network of authors' keywords in radiomics research in oral and maxillofacial radiology.

Trend Topics Analysis demonstrated that in the early and middle periods of radiomic analysis studies in the field of oral and maxillofacial radiology, the terms "features," "head and neck cancer," "cancer," and "head" were more frequently used in research, whereas in later periods the terms "machine learning," "radiomics," and "deep learning" were used more frequently (Figure 3).

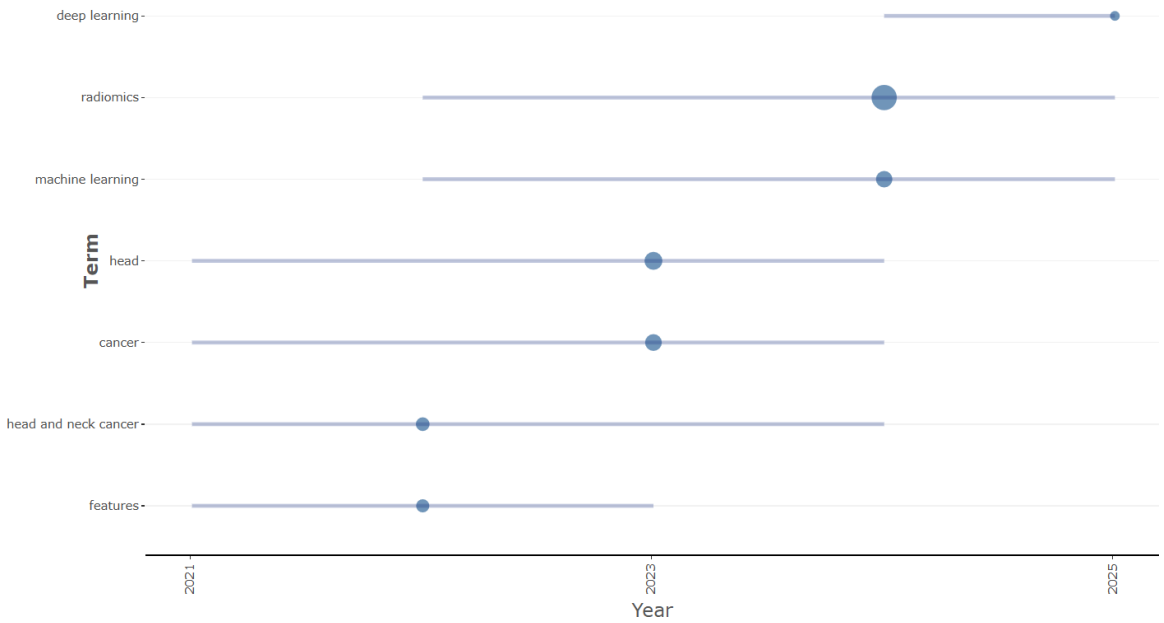

Figure 3. Trend topics in radiomics research in oral and maxillofacial radiology

Thematic Map Analysis revealed that the terms “artificial intelligence” and “magnetic resonance imaging” were located in the motor themes area, the term “radiomics” was located in the basic themes area, the term “texture analysis” was located in the niche themes area, and the terms “imaging” and “learning” were located in the emerging/declining themes area (Figure 4).

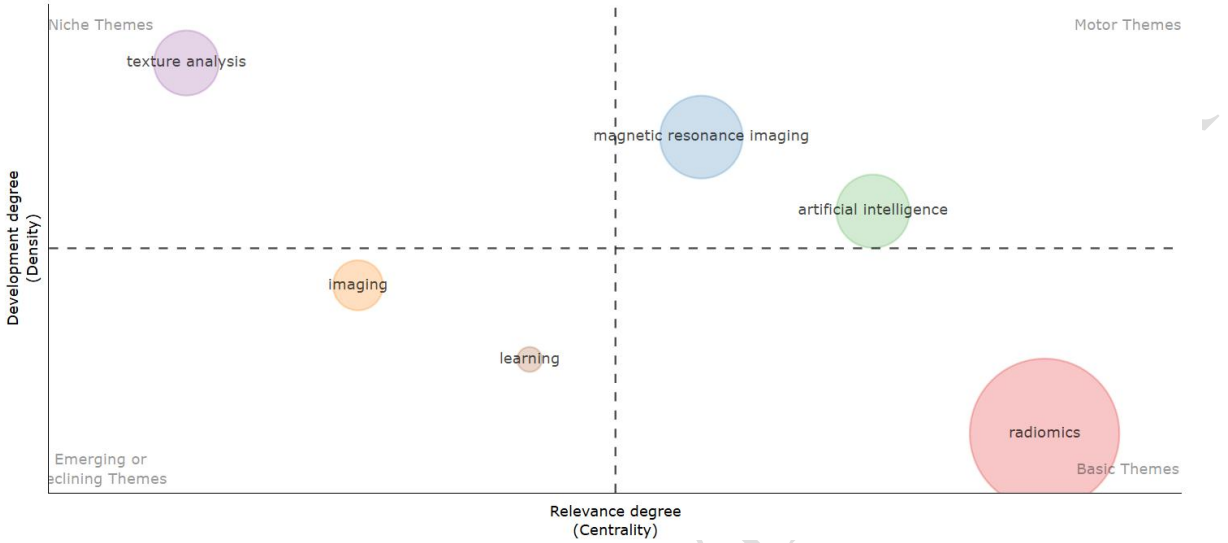

Figure 4. Thematic map of radiomics research in oral and maxillofacial radiology.

Thematic Evolution Analysis demonstrated that until 2021, the themes “hpv,” “cancer,” “radiomics,” “texture analysis,” “images,” “diagnosis,” “squamous-cell carcinoma,” and “nomogram” were prominent. After 2021, the terms “head,” “squamous-cell carcinoma,” “radiomics,” “artificial intelligence,” and “magnetic resonance imaging” became more prominent (Figure 5).

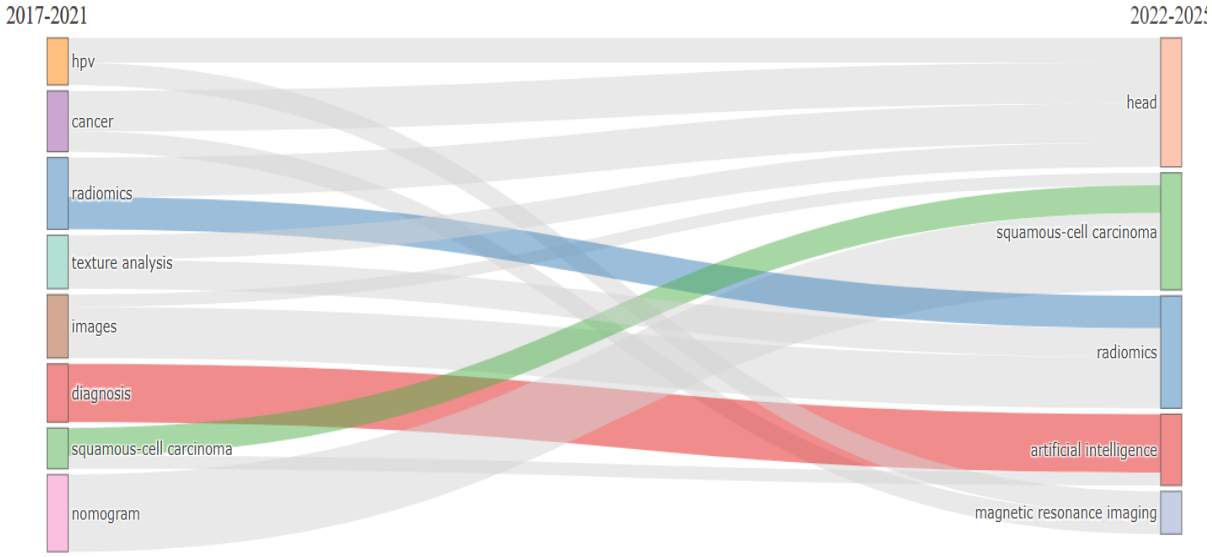

Figure 5. Thematic evolution of radiomics research in oral and maxillofacial radiology.

Discussion: Imaging methods used in oral and maxillofacial radiology are mainly based on two-dimensional and three-dimensional imaging techniques (17, 18). The ability of the human eye to perceive differences within these images is limited. This limitation can be overcome through radiomic analysis methods. With this method, radiomic features are extracted from images and interpreted using a quantitative approach through mathematical models. In this process, regions of interest within the images are segmented, and quantitative data are obtained by applying statistical methods to the pixels (7, 19, 20). In this way, information beyond human perception can be integrated with artificial intelligence systems such as machine learning and deep learning, thereby increasing diagnostic efficiency (5, 21). In recent years, the use of artificial intelligence systems has become increasingly widespread, and bibliometric analysis studies investigating the scientific production, conceptual structure, and thematic organization of the field have been reported. However, there is limited information regarding the evaluation of scientific production, conceptual structure, and thematic organization specifically related to radiomics in the field of oral and maxillofacial radiology. (13-16). Therefore, this study is expected to contribute to the literature regarding the scientific production structure, conceptual organization, and thematic evolution of the relevant field. Evaluation of the Annual Scientific Production analysis demonstrated a progressively increasing trend in scientific production over the years. This finding indicates growing academic interest and the increasing popularity of the subject. This trend may be associated with technological advancements and the more frequent use of artificial intelligence-based analysis methods (22-24). The highest Annual Scientific Production value being reached in 2025 indicates that the relevant field is still developing. In addition, other possible reasons for this increase may include the growing number of journals indexed in the relevant database and the rise in multidisciplinary studies. Overall evaluation of the Annual Scientific Production analysis suggests that this research field may continue to grow in the future.

Evaluation of the co-occurrence network analysis demonstrated that the term “radiomics” was located at the center of the network with the highest connection density. The increasing interest in the quantitative interpretation of images in recent years may have contributed to this finding (22, 24, 25). In addition, the strong relationships between the terms “machine learning,” “deep learning,” and “artificial intelligence” with “radiomics” indicate that radiomic analysis methods are increasingly being integrated into artificial intelligence-based applications. This finding suggests that conventional image interpretation techniques are gradually becoming automated and transforming into decision-support systems. The ability of artificial intelligence-based applications to analyze large-scale datasets may have positively contributed to the success of radiomics analysis methods in image recognition (26, 27). The prominent connections of the terms “cone-beam computed tomography” and “magnetic resonance imaging” within the network structure indicate that radiomics analysis is used with advanced imaging techniques for both soft tissue and hard tissue imaging (28, 29).

Trend Topics Analysis demonstrated that while the terms “features,” “head and neck cancer,” “cancer,” and “head” were prominent in earlier studies, the terms “machine learning,”

"radiomics," and "deep learning" became more prominent in later research. This finding suggests that radiomics in the field of oral and maxillofacial radiology was initially used for the characterization of lesion features and was subsequently increasingly integrated with artificial intelligence-based applications (26, 27).

Thematic Map Analysis demonstrated that the terms "artificial intelligence" and "magnetic resonance imaging" were located within the motor themes cluster, indicating that these topics are both central to the research field and possess a high level of development. This finding suggests that artificial intelligence-based applications have become a major focus in radiomics analysis (30, 31). The term "texture analysis" was observed within the niche themes cluster, indicating that this topic represents a limited and specialized research area. The terms "imaging" and "learning" were located within the emerging/declining themes cluster, suggesting that these topics are undergoing transformation within current research trends or may gain greater importance in the future.

Thematic Evolution Analysis demonstrated that the prominence of the terms "hpv," "cancer," "texture analysis," "diagnosis," "nomogram," and "squamous-cell carcinoma" in the early period indicates that radiomics was initially used mainly for the evaluation of lesion characteristics, particularly in cancer diagnosis. In later periods, the increasing prominence of terms such as "artificial intelligence" and "magnetic resonance imaging" suggests growing interest in artificial intelligence and advanced imaging techniques within the field. In particular, the term "artificial intelligence" suggests that radiomics analysis methods are becoming integrated into artificial intelligence-supported automated decision-support systems.

The limitations of the present study include the use of only the WoSCC database, the restriction of search terms to the English language, and the inability of bibliometric analysis methods to evaluate the methodological quality and clinical effectiveness of the studies despite quantitatively assessing scientific production, conceptual structure, and thematic trends related to the subject. However, the highly standardized indexing structure of the WoSCC database and the widespread use of English in the scientific literature support the reliability of this research.

Conclusion: In conclusion, the literature related to radiomics in oral and maxillofacial radiology was observed to show a growing trend. Radiomics analysis methods appear to be increasingly integrated with artificial intelligence-based applications alongside technological advancements. Future studies are recommended to be conducted using different databases.

References

1. Mohammad N, Ahmad R, Kurniawan A, Mohd Yusof MYP. Applications of contemporary artificial intelligence technology in forensic odontology as primary forensic identifier: A scoping review. Frontiers in artificial intelligence. 2022;5:1049584.
2. Leite AF, Vasconcelos KdF, Willems H, Jacobs R. Radiomics and machine learning in oral healthcare. PROTEOMICS–Clinical Applications. 2020;14(3):1900040.

3. Ding H, Wu J, Zhao W, Matinlinna JP, Burrow MF, Tsoi JK. Artificial intelligence in dentistry—A review. Frontiers in Dental Medicine. 2023;4:1085251.
4. Jacob ESoRcmoNEdSNBABAABCDCFV. What the radiologist should know about artificial intelligence–an ESR white paper. Insights into imaging. 2019;10(1):44.
5. Armogida NG, Angelone F, Soltani P, Esposito L, Sansone M, Rengo S, et al. Beyond dental radiographs, a radiomics-based study for the classification of caries extension and depth. Journal of Dental Sciences. 2025.
6. Liew C. The future of radiology augmented with artificial intelligence: a strategy for success. European journal of radiology. 2018;102:152-6.
7. Tarakçı ÖD, Kış HC, Amasya H, Öztürk İ, Karahan E, Orhan K. Radiomics-Based Diagnosis in Dentomaxillofacial Radiology: A Systematic Review. Journal of Imaging Informatics in Medicine. 2025;38(4):2428-61.
8. Santos GNM, da Silva HEC, Ossege FEL, Figueiredo PTdS, Melo NdS, Stefani CM, et al. Radiomics in bone pathology of the jaws. Dentomaxillofacial Radiology. 2023;52(1):20220225.
9. Hegde S, Babu GS, Ajila V, Shama B. The role of radiomics in dentistry and oral radiology. Journal of Stomatology. 2024;77(2):147-52.
10. Donthu N, Kumar S, Mukherjee D, Pandey N, Lim WM. How to conduct a bibliometric analysis: An overview and guidelines. Journal of business research. 2021;133:285-96.
11. Kumar M, George RJ, PS A. Bibliometric analysis for medical research. Indian journal of psychological medicine. 2023;45(3):277-82.
12. Ahmad P, Slots J. A bibliometric analysis of periodontology. Periodontology 2000. 2021;85(1):237-40.
13. Xie B, Xu D, Zou X-Q, Lu M-J, Peng X-L, Wen X-J. Artificial intelligence in dentistry: a bibliometric analysis from 2000 to 2023. Journal of Dental Sciences. 2024;19(3):1722-33.
14. Long J, Yang L, Dou J, Zhang L, Tan X. Artificial intelligence in dentistry: a bibliometric analysis: Artificial intelligence in dentistry: a bibliometric analysis. British Dental Journal. 2025:1-7.
15. Zatt FP, de Oliveira Rocha A, Dos Anjos LM, Caldas RA, Cardoso M, Rabelo GD. Artificial intelligence applications in dentistry: a bibliometric review with an emphasis on computational research trends within the field. The Journal of the American Dental Association. 2024;155(9):755-64. e5.
16. Shirani M. Trends and classification of artificial intelligence models utilized in dentistry: a bibliometric study. Cureus. 2025;17(4).
17. Vandenberghe B. The digital patient–Imaging science in dentistry. Journal of dentistry. 2018;74:S21-S6.
18. Wyatt CC, Pharoah MJ. Imaging techniques and image interpretation for dental implant treatment. International Journal of Prosthodontics. 1998;11(5).
19. Rogers W, Thulasi Seetha S, Refaee TA, Lieverse RI, Granzier RW, Ibrahim A, et al. Radiomics: from qualitative to quantitative imaging. The British journal of radiology. 2020;93(1108):20190948.
20. Van Timmeren JE, Cester D, Tanadini-Lang S, Alkadhi H, Baessler B. Radiomics in medical imaging—"how-to" guide and critical reflection. Insights into imaging. 2020;11(1):91.
21. Mahdian M, Ahmed AA, Bhattacharya M, Prasanna P. Deep learning and radiomics-based vascular calcification characterization in dental cone beam computed tomography as a predictive tool for cardiovascular disease: a proof-of-concept study. Oral Surgery, Oral Medicine, Oral Pathology and Oral Radiology. 2025;139(4):462-9.
22. Ali M, Irfan M, Ali T, Wei CR, Akilimali A. Artificial intelligence in dental radiology: a narrative review. Annals of Medicine and Surgery. 2025;87(4):2212-7.
23. Bonny T, Al Nassan W, Obaideen K, Rabie T, AlMallahi MN, Gupta S. Primary methods and algorithms in artificial-intelligence-based dental image analysis: a systematic review. Algorithms. 2024;17(12):567.
24. Khalifa M, Albadawy M. AI in diagnostic imaging: revolutionising accuracy and efficiency. Computer Methods and programs in biomedicine update. 2024;5:100146.
25. Lambin P, Leijenaar RT, Deist TM, Peerlings J, De Jong EE, Van Timmeren J, et al. Radiomics: the bridge between medical imaging and personalized medicine. Nature reviews Clinical oncology. 2017;14(12):749-62.
26. Koçak B, Durmaz EŞ, Ateş E, Kılıçkesmez Ö. Radiomics with artificial intelligence: a practical guide for beginners. Diagnostic and interventional radiology. 2019;25(6):485.
27. Najjar R. Redefining radiology: a review of artificial intelligence integration in medical imaging. Diagnostics. 2023;13(17):2760.
28. Alamri HM, Sadrameli M, Alshalhoob MA, Alshehri MA. Applications of CBCT in dental practice: a review of the literature. General dentistry. 2012;60(5):390-400; quiz 1.

29. Reda R, Zanza A, Mazzoni A, Cicconetti A, Testarelli L, Di Nardo D. An update of the possible applications of magnetic resonance imaging (MRI) in dentistry: a literature review. Journal of imaging. 2021;7(5):75.
30. Shehata M, Abouelkheir RT, Gayhart M, Van Bogaert E, Abou El-Ghar M, Dwyer AC, et al. Role of AI and radiomic markers in early diagnosis of Renal Cancer and Clinical Outcome Prediction: a brief review. Cancers. 2023;15(10):2835.
31. Orhan K, Ünsal G. Artificial intelligence in dentistry. Digital Dentistry: An Overview and Future Prospects: Springer; 2024. p. 285-301.