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ARTIFICIAL INTELLIGENCE IN DENTAL RADIOLOGY: A BIBLIOMETRIC ANALYSIS OF CURRENT TRENDS AND FUTURE PROSPECTS (PART 1)

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ШТУЧНИЙ ІНТЕЛЕКТ У СТОМАТОЛОГІЧНІЙ РАДІОЛОГІЇ: БІБЛІОМЕТРИЧНИЙ АНАЛІЗ СУЧАСНИХ ТРЕНДІВ ТА МАЙБУТНІХ ПЕРСПЕКТИВ (Частина 1)

INFORMATION

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ABSTRACT

Modern dentistry is undergoing a global digital transformation, where the quality of diagnostics directly determines the success of subsequent treatment. Over the past decades, radiological technologies have evolved from traditional film-based radiography to high-precision cone-beam computed tomography (CBCT), which has significantly improved the visualization of anatomical structures in the maxillofacial region. Predicting the prospects for the application of artificial intelligence (AI) in the diagnostic process in dentistry through the analysis of scientific sources devoted to this topic, as an indicator of the global dental scientific community's interest in developing this strategy, represents a highly relevant issue.

Aims: To evaluate the effectiveness of statistical analysis methods in identifying current trends and research directions in diagnostic radiological technologies in dentistry, and to assess the degree of integration of artificial intelligence (AI) solutions into clinical practice based on publication activity.

Materials and Methods: An analysis of publications in the scientometric electronic database PubMed/MEDLINE was conducted using the keywords "orthopantomography and dentistry," "computed tomography and dentistry," as well as "orthopantomography, dentistry and artificial intelligence" and "computer tomography, dentistry and artificial intelligence" for the period from December 31, 2015, to December 31, 2025; separately for the periods from December 31, 2019, to December 31, 2025, and from December 31, 2024, to December 31, 2025; and also over 84 months broken down quarterly – four quarters (Q1, Q2, Q3, Q4) per year. Evaluation of the obtained results was performed using methods of statistical analysis: descriptive statistics and inferential statistics (correlation and regression analysis) with the application of time series analysis methods. Regression analysis was conducted to examine the dependence of the number of publications containing the keyword pairs "CT (computed tomography) + AI" and "OPTG (orthopantomogram) + AI" in dentistry on the quarter during the period 2022-2025. For this purpose, in the Origin package [OriginPro, Version 9.8.0.200, OriginLab Corporation, Northampton, MA, USA], the data were

approximated by polynomial functions of various orders, as well as by exponential and power functions.

Results. Over the 10-year period, we identified 18,976 sources related to “CT and dentistry” compared to 3,799 for “OPTG and dentistry” – nearly 5 times more. The trend toward an even greater increase in the number of publications concerning CT in dentistry persists over both the 5-year and the most recent 1-year periods, exceeding those for OPTG by 6.07 and 5.41 times, respectively. Dental researchers devote greater attention to the use of computed tomography (CT) in the diagnostic process. The number of studies dedicated to the diagnostic process without the use of artificial intelligence exceeds the number of studies involving AI by 26,6 times over the 10-year study period. During the 2022–2025 period, the number of publications involving the application of AI in dentistry increased significantly.

Over the 2022–2025 period, there was a strong linear growth in publications on CT combined with AI: an average annual increase of approximately 18 articles per year ($R^2 = 0.84$), rising from about 20 articles in 2022 to 70 in 2025. In contrast, growth in the area of orthopantomography combined with AI was more moderate and nonlinear: an average annual increase of approximately 8 articles ($R^2 = 0.65$ for the linear model), but better described by a second-degree polynomial ($R^2 = 0.67$), increasing from roughly 20 articles in 2022 to 50 in 2025.

AI is being implemented more actively in dental computed tomography, where the growth trend is more stable and intensive than in orthopantomography.

Conclusions. 1. Bibliometric analysis can successfully identify and substantiate current trends and directions in the development of diagnostic technologies.

2. The results of the analysis showed that the current trend in dental radiology is computed tomography (CT). The use of artificial intelligence in diagnostic radiological technologies in dentistry is still in the developmental stage compared to the use of classical analysis of radiographic findings.

3. Despite the rapid integration of artificial intelligence technologies into the diagnostic process in dentistry, the use of classical methods of statistical analysis for assessing the reliability of obtained results will remain a priority in the near future.

ІНФОРМАЦІЯ

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АНОТАЦІЯ

Актуальність. Сучасна стоматологія перебуває на етапі глобальної цифрової трансформації, де якість діагностики безпосередньо визначає успішність подальшого лікування. Протягом останніх десятиліть рентгенологічні технології еволюціонували від традиційної плівкової радіографії до високоточних методів конусно-променевої комп'ютерної томографії (КПКТ), що дало можливість значно підвищити візуалізацію анатомічних структур щелепно-лицевої ділянки. Прогнозування перспектив застосування ШІ в діагностичному процесі в стоматології через аналіз наукових джерел, присвячених цій темі, як показника зацікавленості наукової спільноти стоматологів усього світу в розробці цієї стратегії є дуже актуальним питанням.

Мета – визначити ефективність застосування методів статистичного аналізу для виявлення сучасних тенденцій і напрямів розвитку діагностичних рентгенологічних технологій у стоматології та оцінити рівень інтеграції ШІ-рішень у клінічну практику на основі публікаційної активності.

Методи дослідження. Було проведено аналіз публікацій у наукометричній електронній базі даних PUBMED/MEDLINE за ключовими словами *orthopantomography and dentistry, computed tomography and dentistry, a також orthopantomography, dentistry and artificial*

intelligence i computer tomography, dentistry and artificial intelligence за період з 31.12.2015 по 31.12.2025, окремо за періоди 31.12.2019 – 31.12.2025 та 31.12.2024 – 31.12.2025, а також за 84 місяці поквартально – 4 квартали (Q1, Q2, Q3, Q4) відповідно на рік. Оцінка отриманих результатів проводилась із застосуванням методів статистичного аналізу: описової (описової) статистики та інферентної статистики (кореляційного й регресійного аналізу) з використанням методів аналізу часових рядів. Регресійний аналіз залежності кількості публікацій, що містять пари ключових слів «КТ (комп'ютерна томографія) + ШІ» та «ОПТГ (ортопантомограма) + ШІ» у стоматології, залежно від кварталу в період 2022–2025 рр. Для цього в пакеті Origin [OriginPro, Version 9.8.0.200. OriginLab Corporation, Northampton, MA, USA] дані апроксимувалися поліноміальними функціями різних порядків, експоненційною та показниковою функціями.

Результати дослідження. За період 10 років нами виявлено 18 976 джерел, що стосуються «КТ і стоматологія», проти 3799 – «ОПТГ і стоматологія». Це майже в 4 рази більше. Тенденція до ще більшого зростання кількості публікацій, що стосуються КТ у стоматології, зберігається і за 5 років, і за останній рік, що більше в 6,07 та 5,41 рази відповідно, ніж ОПТГ у стоматології. Більшу увагу у своїх дослідженнях стоматологи-науковці приділяють використанню комп'ютерної томографії (КТ) в діагностичному процесі. Кількість робіт, присвячених діагностичному процесу без використання штучного інтелекту, у 45,5 рази перевищує кількість робіт, які стосуються використання ШІ за дослідний період 10 років. За період 2022–2025 років кількість публікацій із застосуванням ШІ в стоматології значно зростає. У напрямі КТ + ШІ спостерігається сильне лінійне зростання: середньорічний приріст ≈ 18 статей на рік ($R^2 = 0,84$), з приблизно 20 статей у 2022 р. до 70 – у 2025 р. У напрямі Орто + ШІ зростання помірніше та нелінійне: середньорічний приріст ≈ 8 статей ($R^2 = 0,65$ для лінійної моделі), але краще описується поліномом 2-го ступеня ($R^2 = 0,67$), з приблизно 20 статей у 2022 р. до 50 – у 2025 р. ШІ активніше впроваджується в комп'ютерну томографію стоматології, де тенденція до зростання стійкіша та інтенсивніша, ніж в ортопантомографію.

Висновки. 1. Бібліометричний аналіз може успішно визначати й обґрунтовувати сучасні тренди та тенденції напрямів розвитку діагностичних технологій.

2. Результати аналізу показали, що трендом сучасної стоматологічної радіології є комп'ютерна томографія (КТ). Використання штучного інтелекту в діагностичних радіологічних технологіях у стоматології все ще перебуває на стадії розвитку порівняно з використанням класичного аналізу результатів рентгендіагностики,

3. Незважаючи на стрімке залучення технологій штучного інтелекту в діагностичний процес у стоматології, найближчим часом використання класичних методів статистичного аналізу для оцінки достовірності отриманих результатів залишатиметься пріоритетним.

Relevance. Modern dentistry is undergoing a global digital transformation, where the quality of diagnostics directly determines the success of subsequent treatment. The latest achievements in technological progress inspire the continuous search for new methods of detecting and predicting the course of dental diseases (Turosz et al., 2024; Sharma et al., 2025). The development of diagnostics

in dentistry has been shaped by the evolution of the complex of medical and biological sciences, as well as technological progress. Over the past decades, radiological technologies have evolved from traditional film-based radiography to high-precision cone-beam computed tomography (CBCT) methods, which have significantly improved the visualization of anatomical structures in the maxillofacial region

(Bruce et al., 2020; Miller, 2017; Stera et al., 2024). The use of cone-beam computed tomography (CBCT) has become an integral part of modern prosthetic and surgical dentistry, providing detailed three-dimensional images of the maxillofacial region. High-quality diagnostic imaging using CBCT is critically important for accurate planning of prosthetic rehabilitation, including diagnosis, analysis, implant placement planning, and the fabrication of prosthetic constructions employing digital technologies. This is particularly relevant in complex cases where dental pathology (such as chronic periodontitis) is comorbid with systemic diseases (including diabetes mellitus, metabolic disorders, cardiovascular diseases, immunodeficiencies, and others). However, manual processing and analysis of these large volumes of CBCT data remain a labor-intensive and subjective process.

However, the rapid growth in the volume of graphical data and the increasing complexity of diagnostic tasks place new demands on the speed and objectivity of image interpretation.

The key trend of the present day has become the implementation of artificial intelligence (AI) technologies, particularly machine learning and deep learning algorithms (Alharbi & Alhasson, 2024; Al-Haj Husain et al., 2023; Vieira et al., 2025). The rapid progress of artificial intelligence (AI) is leading to transformations and promising results across all fields of medicine. Therefore, predicting the prospects for the application of AI in the diagnostic process in dentistry through the analysis of scientific sources devoted to this topic, as an indicator of the global dental scientific community's interest in developing this strategy-represents a highly relevant issue (Alharbi & Alhasson, 2024; MacDonald & Telyakova, 2024; Waqas et al., 2025). Accordingly, we hypothesized that by analyzing the number of literary sources related to this problem, it would be possible to obtain answers regarding the main trends and directions in the development of diagnostic technologies (Alassiry, 2022; Jaju & Jaju, 2014; Sharma et al., 2025; Waqas et al., 2025). Therefore, we continued our search for literary sources and applied methods of statistical analysis to determine the level of interest among researchers in this issue (Al-Haj Husain et al., 2023; Jaju & Jaju, 2014; MacDonald & Telyakova, 2024).

Bibliometric analysis is a critically important tool for assessing the dynamics of scientific progress, as it allows the identification of the most promising research vectors and the evaluation of the level of integration of AI solutions into clinical practice based on publication activity (National Center for Biotechnology Information, n.d.; Bruce et al., 2020; Kapila & Nervina, 2015; Miller, 2017).

Thus, conducting a bibliometric analysis of scientific output will not only summarize the

current state of development of radiographic technologies in dentistry but also predict future technological breakthroughs in this field (Alharbi & Alhasson, 2024; Bruce et al., 2020; National Center for Biotechnology Information, n.d.).

Objectives. This study aimed to determine the effectiveness of applying statistical analysis methods for identifying current trends and directions in the development of diagnostic radiological technologies in dentistry and to evaluate the level of integration of AI solutions into clinical practice based on publication activity.

Materials and Methods. In accordance with the set objectives, a review of informational and available literary sources was conducted regarding the use of modern radiological diagnostic technologies in dentistry, identifying the most common radiological examination methods. According to informative sources, the most popular radiological methods for examining dental patients are orthopantomography (OPTG) and computed tomography (CT). Therefore, our further searches focused on publications in the scientometric electronic database PubMed/MEDLINE using the keywords "orthopantomography and dentistry," "computed tomography and dentistry," as well as "orthopantomography, dentistry and artificial intelligence" and "computer tomography, dentistry and artificial intelligence." The specified search parameters included clinical trials in humans, case reports, and systematic reviews. Relevant studies were selected and analyzed according to the study design. The analysis of publications covered the period from December 31, 2015, to December 31, 2025. Data for the periods from December 31, 2019, to December 31, 2025, and from December 31, 2024, to December 31, 2025, were analyzed separately.

To identify general trends in the development of radiological examination methods in dentistry, the number of available literary sources in the electronic database PubMed/MEDLINE was analyzed over 84 months, broken down by quarters (Q1, Q2, Q3, Q4) per year.

Evaluation of the results obtained from the analysis of literary sources in the electronic database PubMed/MEDLINE was performed using methods of statistical analysis: descriptive statistics and inferential statistics (correlation and regression analysis), incorporating time series analysis methods.

Results and Discussion. Analysis of the search results for literary sources from the scientometric electronic database PubMed/MEDLINE using the keywords "orthopantomography and dentistry" and "computed tomography and dentistry." Over the 10 years, we identified 18,976 sources related to "CT and dentistry" compared to 3,799 for "OPTG

and dentistry” – nearly 5 times more. The trend toward an even greater increase in the number of publications concerning CT in dentistry persists over both the 5-year and the most recent 1-year periods, exceeding those for OPTG by 6.07 and 5.41 times, respectively (Table 1, Figure 1).

The results of the literature search from the electronic database PUBMED/MEDLINE using the keywords “orthopantomography, dentistry and artificial intelligence” (“orthopantomography, dentistry and artificial intelligence”) and “computed tomography, dentistry and artificial intelligence” (“computer tomography, dentistry and artificial intelligence”) showed that over 10 years, 713 sources

were published related to “CT, dentistry and AI”, compared to 436 for “OPG, dentistry and AI”. This is 1.6 times more. This trend persists over 5 years, and in the last year, the ratio reached 1.8.

These indicators suggest that dental researchers are paying greater attention to the use of computed tomography (CT) in the diagnostic process. The number of studies dedicated to the diagnostic process without the use of artificial intelligence exceeds the number of studies involving AI by 26.6 times over the 10-year study period.

To identify statistical and mathematical patterns in the development trends of radiological examination methods in dentistry, we employed

Table 1

Ratio of the number of studied literary sources in 2015–2025, units

| Study | 10 y. 31.12.2015 – 31.12.2025 | 5 y. 31.12.2020 – 31.12.2025 | 1 y. 31.12.2024 – 31.12.2025 |
|--------------------------------------|-------------------------------|------------------------------|------------------------------|
| 1. CT and dentistry, units (1) | 18976 | 10993 | 2911 |
| 2. CT; dentistry and AI, units (2) | 713 | 656 | 275 |
| 3. OPTG and dentistry, units (3) | 3799 | 1810 | 538 |
| 4. OPTG; dentistry and AI, units (4) | 436 | 394 | 154 |
| Absolute deviation, units | | | |
| (1)–(3) | 15177 | 9183 | 2373 |
| (1) – (2) | 18263 | 10337 | 2636 |
| (3) – (4) | 3363 | 1416 | 384 |
| (2) – (4) | 277 | 262 | 121 |
| (1)/(3) | 4,99 | 6,07 | 5,41 |
| (1)/(2) | | | |
| (3)/(4) | | | |
| (2)/(4) | | | |

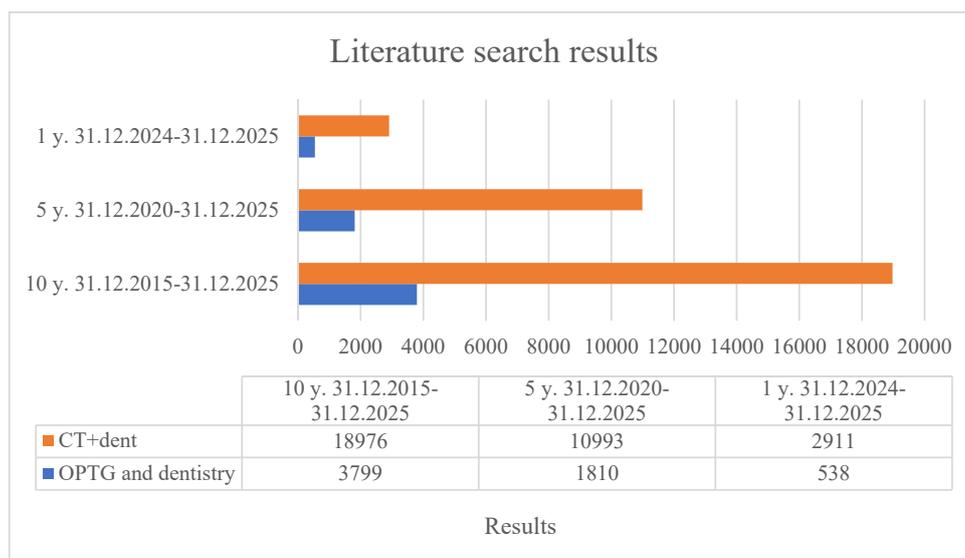


Fig. 1. Results of literature search using the keywords “orthopantomography and dentistry” and “computed tomography and dentistry” over 10 years

time series analysis, which is one of the primary approaches in statistical analysis. We analyzed the number of available literature sources in the electronic database PUBMED/MEDLINE over 7 years, i.e., 84 months, on a quarterly basis (Q1, Q2, Q3, Q4) per year. During the analysis, we identified a period in which the number of publications for both keyword sets was equal (4 sources each), which can be considered the starting point.

Time-series analysis of publication trends in radiological examination methods for dental patients over 84 months revealed a gradual increase

in the number of scientific sources in both research areas up to the third quarter of 2022 (Table 2).

In the fourth quarter of 2022, the number of publications was practically equal (23 for CT + AI versus 25 for OPG + AI). During the analysis, we established that the number of sources using the keywords “CT, dentistry, and AI” increased 3.2-fold starting from the first quarter of 2023. For comparison, the number of sources using the keywords “OPG, dentistry, and AI” increased 1.4-fold over the same period.

In this study, we conducted a regression analysis of the dependence of the number of

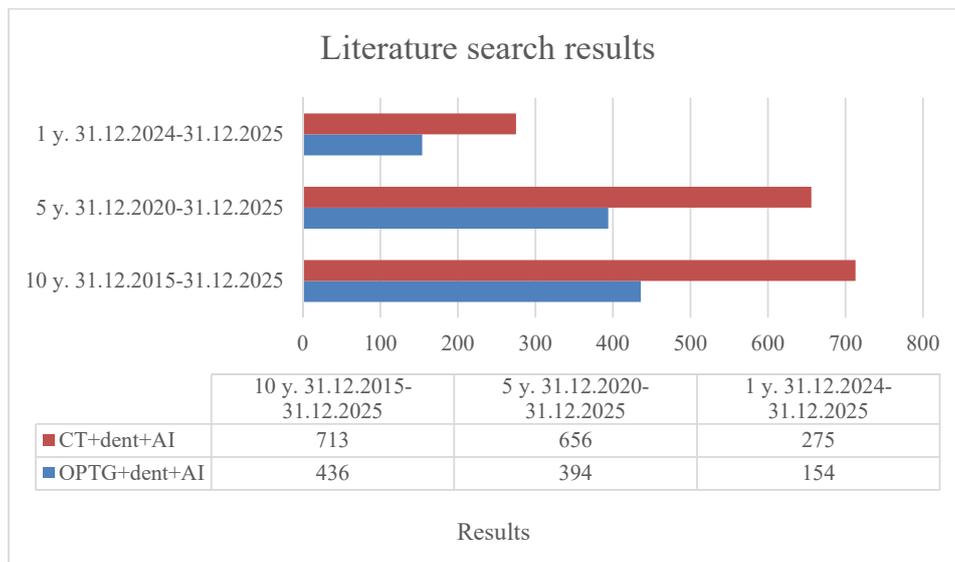


Fig. 2. Results of literature search using the keywords “orthopantomography and dentistry and artificial intelligence” and “computed tomography and dentistry and artificial intelligence” over 10 years

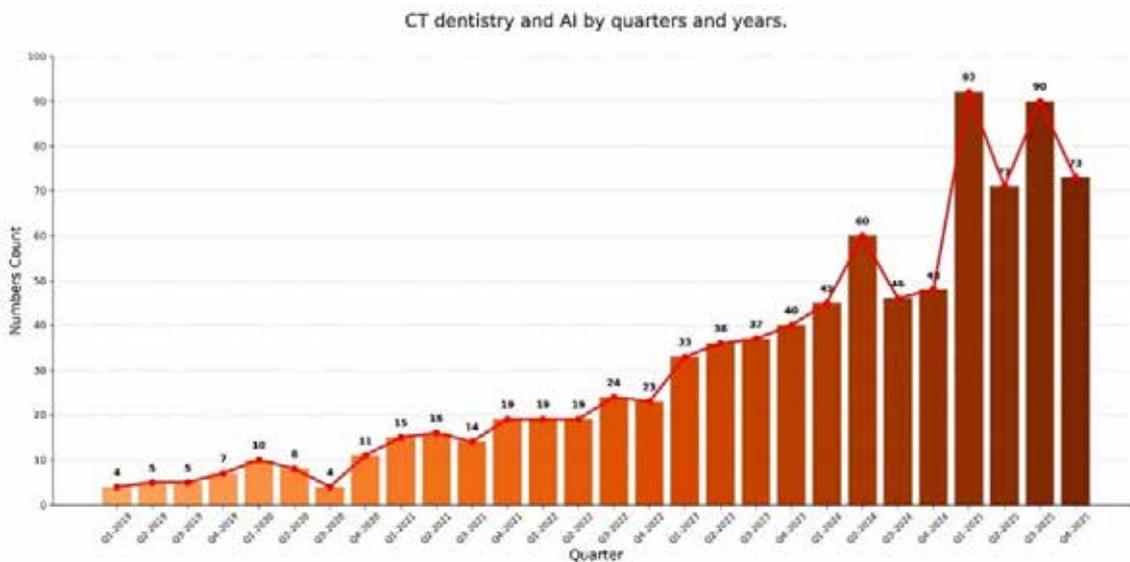


Fig. 3. Dynamics of the number of literature sources using the keywords “computed tomography, dentistry, and artificial intelligence” in 2019–2025, quarterly (Q1, Q2, Q3, Q4)

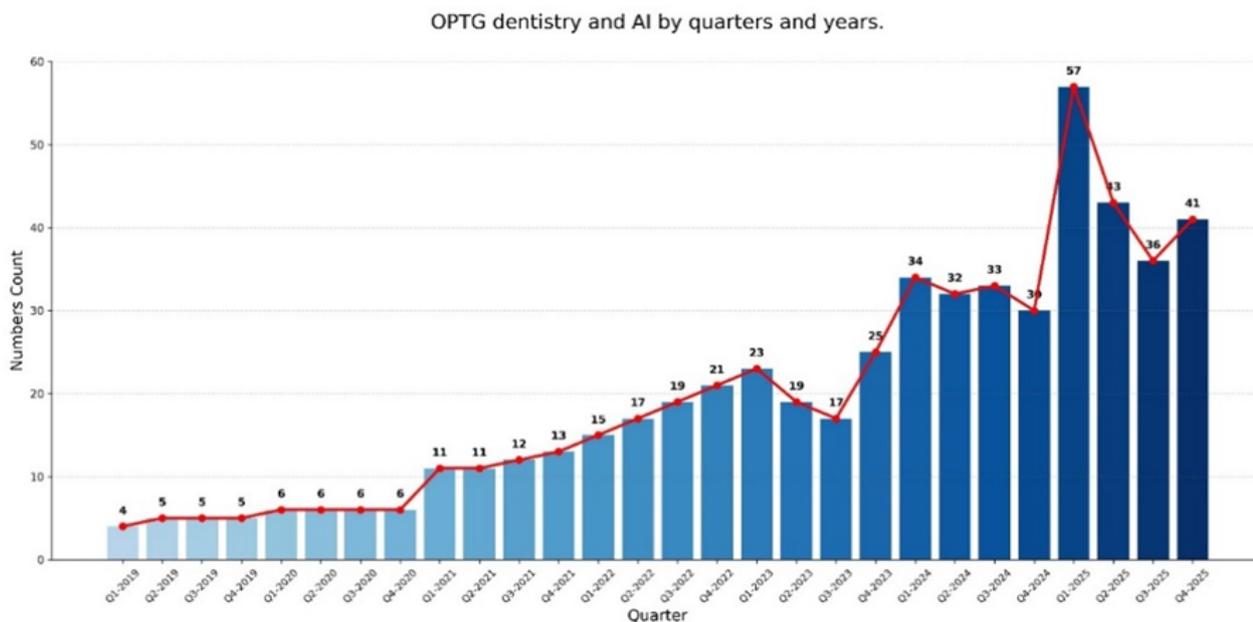


Fig. 4. Dynamics of the number of literature sources using the keywords “orthopantomography, dentistry, and artificial intelligence” in 2019–2025, quarterly (Q1, Q2, Q3, Q4)

Table 2

Ratio of the number of literature sources using the keywords “computed tomography, dentistry and artificial intelligence” (CT-dent-AI) and “orthopantomography, dentistry and artificial intelligence” (OPG-dent-AI) in 2019–2025, quarterly (Q1, Q2, Q3, Q4)

| Quarter | Year | ORTO_dent_&_AI | CT_dent_&_AI |
|--------------|------|----------------|--------------|
| Q1-2022 | 2022 | 21 | 19 |
| Q2-2022 | 2022 | 17 | 19 |
| Q3-2022 | 2022 | 23 | 24 |
| Q4-2022 | 2022 | 19 | 23 |
| Q1-2023 | 2023 | 15 | 33 |
| Q2-2023 | 2023 | 19 | 36 |
| Q3-2023 | 2023 | 17 | 37 |
| Q4-2023 | 2023 | 25 | 40 |
| Q1-2024 | 2024 | 34 | 45 |
| Q2-2024 | 2024 | 32 | 60 |
| Q3-2024 | 2024 | 33 | 46 |
| Q4-2024 | 2024 | 30 | 48 |
| Q1-2025 | 2025 | 57 | 92 |
| Q2-2025 | 2025 | 43 | 71 |
| Q3-2025 | 2025 | 36 | 90 |
| Q4-2025 | 2025 | 41 | 73 |
| Total | | 462 | 756 |

publications containing the keyword pairs “CT (computed tomography) + AI” and “OPG (orthopantomogram) + AI” in dentistry on the quarter during the period 2022-2025. For this purpose, the data were approximated in the Origin package [OriginPro, Version 9.8.0.200. OriginLab Corporation, Northampton, MA, USA]

using polynomial functions of various orders, as well as exponential and power functions. The assessment of the coefficient of determination for the specified approximations showed that for articles simultaneously mentioning “CT + AI”, the increase in the number of articles over time can be described by a linear law, while for articles simultaneously mentioning “OPG + AI”, a nonlinear increase is observed in recent years (Figure 6). Over the period 2022–2025, the number of publications on the application of AI in dentistry has significantly increased. In the CT + AI direction, strong linear growth is observed: average annual increase ≈ 18 articles per year ($R^2 = 0.84$), from approximately 20 articles in 2022 to 70 in 2025. In the OPG + AI direction, growth is more moderate and nonlinear: average annual increase ≈ 8 articles ($R^2 = 0.65$ for the linear model), but better described by a second-degree polynomial ($R^2 = 0.67$), from approximately 20 articles in 2022 to 50 in 2025. AI is being more actively implemented in dental computed tomography, where the growth trend is more stable and intensive than in orthopantomography.

These results may indicate greater interest among specialists in leveraging the capabilities of artificial intelligence when working with computed tomography in dentistry. At the same time, the studied data do not allow for definitive conclusions regarding the form of the dependence, as the coefficient of determination for the best approximations presented in Figure 6 did not exceed $R^2 \approx 0.84$, while for other investigated functions it was below 0.5 (not shown

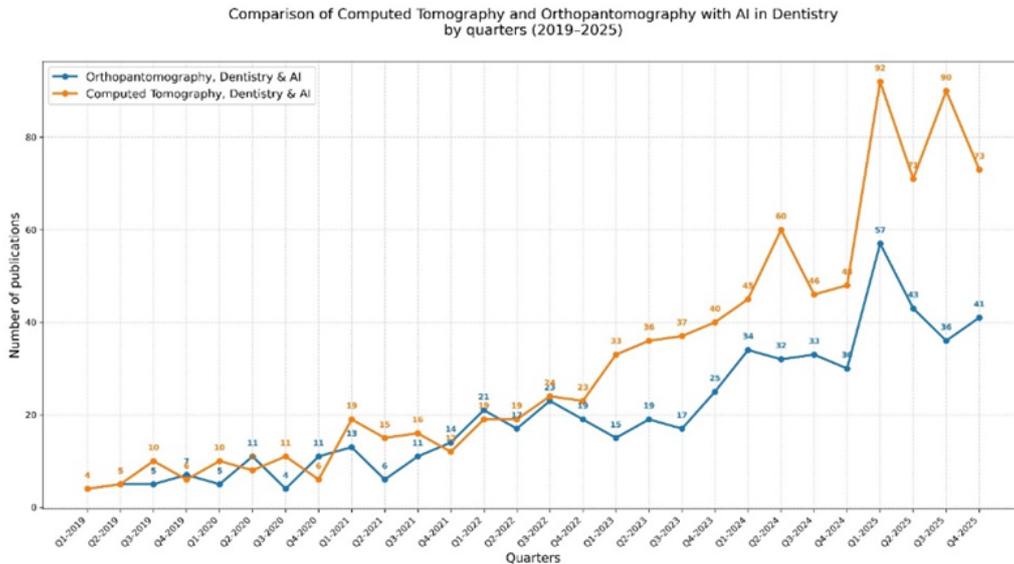


Fig. 5. Ratio of the number of literature sources using the keywords “computed tomography, dentistry and artificial intelligence” to “orthopantomography, dentistry and artificial intelligence” in 2019–2025, quarterly (Q1, Q2, Q3, Q4)

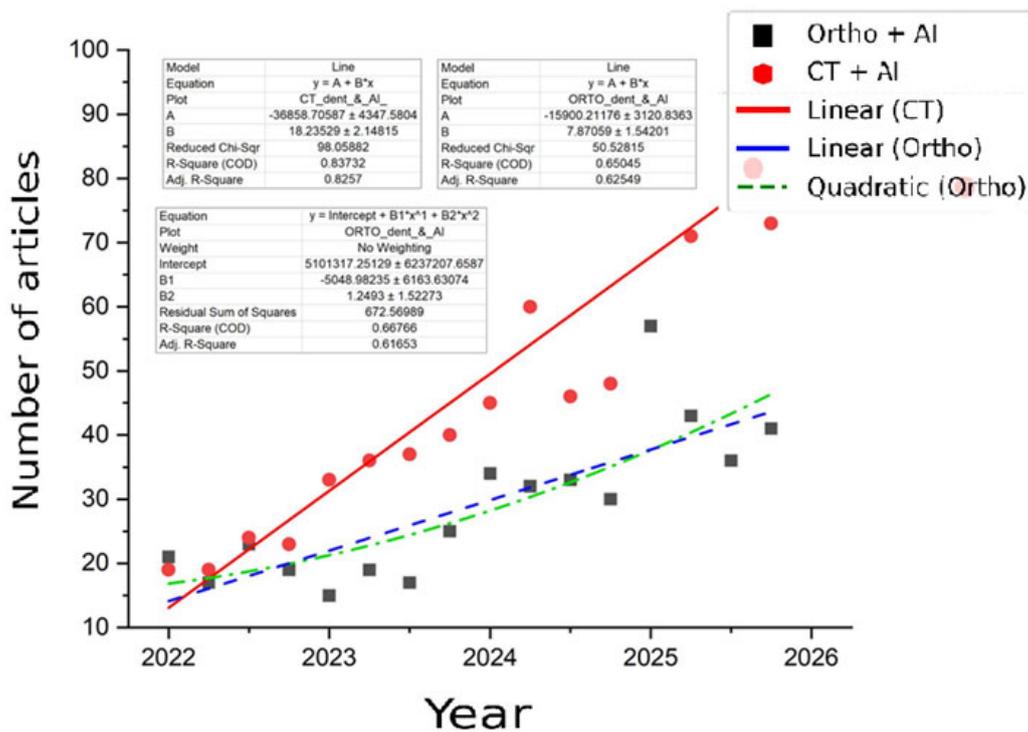


Fig. 6. Dependence of the number of literature sources using the keywords “computed tomography, dentistry and artificial intelligence” (CT + AI) and “orthopantomography, dentistry and artificial intelligence” (OPG + AI) on time in 2022–2025, quarterly

in the figure). Further research will require an increase in the data sample for analysis, for example, by extending the studied time interval or incorporating data from other scientometric databases.

Prospects for Further Research. In the context of the article “Artificial Intelligence in Dental Radiology: A Bibliometric Analysis of Current Trends and Future Prospects,” it is worth noting that this field represents a highly relevant and

rapidly evolving direction in modern dentistry. The discussion of future prospects here covers only part of the broader landscape, while the next section will delve deeper into specific pathologies and more targeted practical applications.

Conclusions. 1. Bibliometric analysis can successfully identify and substantiate current trends and tendencies in the development of diagnostic technologies.

2. The results of the analysis showed that the current trend in modern dental radiology is

computed tomography (CT). The use of artificial intelligence in diagnostic radiological technologies in dentistry is still in the developmental stage compared to the use of classical analysis of X-ray diagnostic results.

3. Despite the rapid integration of artificial intelligence technologies into the diagnostic process in dentistry, in the near future, the use of classical methods of mathematical analysis for assessing the reliability of obtained results will remain a priority.

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