Exploring the New Era of Dentistry: Impact of Artificial Intelligence on Dental Diagnosis

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Summary

This manuscript aims to analyse the impact of AI in stomatological diagnosis. A review of the existing literature on the use of AI in dentistry was conducted, specific tables were created for key categories by organising data in spreadsheets, and the results show the predominance of the successful application of AI in the analysis and diagnosis of radiographic images, concluding that oral and maxillofacial radiology in dentistry has been significantly influenced by AI, particularly CNNs. The article describes a future in which dentistry and AI will completely redefine oral health.

Keywords: *Artificial intelligence; Oral diagnosis; Dentistry; Dental technology; Technology and innovation in health.*

Introduction

Artificial intelligence (AI) is a general term that refers to the performance of human activities through the use of technology. [(1)] has the particularity to identify important problems in oral health, as dentistry constantly struggles to provide high quality care. Oral and maxillofacial radiology has shown that the use of AI through convolutional neural networks for radiographic diagnosis and image analysis is beneficial. However, to take full advantage of this technology, it must work in tandem. [(2)]

In further research, an AI method has been created that uses convolutional neural networks to identify and classify caries in intraoral images, the AI achieved 92.5% accuracy in caries detection in all tests. [(3)]

Software such as AssistDent AI has significantly improved caries detection accuracy by 75.8%. These findings highlight the importance of artificial intelligence in the prevention and diagnosis of dental disease. [(4)]

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Types of Artificial Intelligence

It is essential to deepen the knowledge of some fundamental terms in the field of dentistry that are widely used and relevant, there are many terms and concepts in this broad field that are crucial to understand the advances and challenges in stomatology, in this new era of technological advances, these fundamental terms are not only the basis of dental terminology, but they are also fundamental to understand how AI improves the quality of care, by studying these concepts, we can better understand how AI is redefining how dental professionals perform dental procedures, which could prevent oral diseases. [5]

Types of Artificial Intelligence Used for Cephalometric Analysis

Nº	Type of intelligence	Concept
1	Machine Learning (ML)	The term originated with Arthur Samuel in 1952. Unlike symbolic AI, which uses examples instead of rules previously established by humans, its main goal is to allow machines to learn from data and find solutions without human intervention.
2	Deep Learning (DL)	A subdivision of machine learning where computers find features in data, it represents the current evolution of neural networks and has enabled the complexity of problems to be solved as technology and processing power has advanced.
3	Artificial Neural Network (ANN)	They are composed of interconnected artificial neurons that facilitate information assimilation and process data in response to external stimuli, tackle complex problems without clear computational solutions and outperform traditional programming successfully used for diagnosis and image analysis.
4	Convolutional Neural Network (CNN)	They are a type of deep learning, they allow computers to process images by identifying key elements and differentiating them, they outperform traditional classification algorithms in their ability to understand the complexity of images, they can be used in dentistry to detect pathologies.
5	Generative Adversarial Networks (GAN)	By Goodfellow 2014, they changed artificial intelligence and deep learning. GANs are generative techniques that learn the distribution of real data to create realistic images, showed promise in tasks such as cross-modality synthesis and image enhancement. they are used in dentistry to create realistic images of teeth and oral tissues for applications in teaching, treatment planning and clinical case visualisation, as well as improving the quality of dental radiographic images, which are essential for making accurate diagnoses and designing appropriate treatments.

Source: According to Aravind Kumar Subramanian and Rongguang Wang (Modified).

This article takes us on a fascinating journey of innovation and discovery, examining how AI has changed the stomatological world and how it has contributed to the ongoing evolution of various specialties within the medical sciences. Early detection of dental disease is a major challenge facing dentistry, and by comprehensively analysing radiological and clinical data, AI has proven to be a useful resource for optimising and enhancing treatments, reducing diagnostic errors and facilitating complex decisions.

Today, these techniques and innovations have been successfully implemented in dentistry, enabling the detection of even the most subtle features in dental X-rays, which are necessary for the staff involved, AI promises to improve early detection of dental problems and improve the personalisation and accuracy of treatments, the ability to analyse individual data allows it to deliver highly personalised recommendations, ensuring patient-centred dental care with accurate treatment plans for the best outcomes.

This article embarks on an exploration and understanding of the future of AI-centric dentistry. We ask important questions: How does AI contribute to more accurate and personalised dental diagnostics, how could the quality and reliability of AI-based diagnostics be ensured, and what will be the impact of this technology on routine dentistry and patient satisfaction? We approach the creation of artificial intelligence that will revolutionise the diagnosis and prevention of dental diseases by unravelling these answers. We perceive through examples such as its use in radiology and early caries detection that, although AI is a new technology, its exponential impact on dentistry and medicine will be evident over time.

The aim of this manuscript is to analyse the impact of Artificial Intelligence in stomatological diagnosis.

Methods

The present systematic review was developed under the IMRYD format, to analyse the impact of artificial intelligence in Stomatology, several bibliographic sources were consulted to provide a solid context for the study, which enriched the research.

An exhaustive search was carried out with the application of equations with Boolean operators in five databases of significant relevance: PubMed/MEDLINE (National Library of Medicine), Scopus, Science Direct, Scientific Electronic Library Online (SciELO) and Hindawi. We resorted to external sources to complement our search and clarify technical terms due to the limited availability of information in this emerging field, relevant keywords were used in the literature search such as, artificial intelligence, dentistry, neural networks, diagnosis, machine learning, AI results, disease diagnosis and dentistry with artificial intelligence, 45 articles were initially identified in the databases mentioned, only 29 met the objective of the search taking into account inclusion and exclusion criteria as follows:

Inclusion Criteria: Articles written in English with application of AI-based software, articles that address the use of AI in various dental specialties and that include a specific focus on the diagnosis of stomatological diseases and pathologies.

Exclusion Criteria: articles that did not meet the stated time period and paid-for articles were excluded.

Following this assessment, 29 open access manuscripts were systematically selected and analysed, with a thorough analysis of the data collected from these articles, focusing on the general characteristics of each, as well as on the study and control groups mentioned above.

The research instrument is a comparative table designed to facilitate the collection and comparison of key data extracted from articles on the use of artificial intelligence in the field of dentistry, being an essential tool for the present research because it allows to evaluate and summarise the relevant information of each article, composed of eleven sub categories (Table

2), Direct access link to the table: https://docs.google.com/spreadsheets/d/1T9-BN67-LljlWADX501j8yyXXtmjapg7btu3KBbqBfU/edit?usp=sharing

Comparison of the Research Instrument

1	Title	The title of the research article.
2	Type of article	The category of the article, such as review, case study, clinical trial, etc.
3	Area of expertise	The specific branch of dentistry to which the article refers, such as diagnostics, orthodontics, implant dentistry, etc.
4	Contribution and degree of impact	The value and influence of the article in the field.
5	Year of publication	The year in which the article was published to contextualise the temporal relevance of the information.
6	AI software and method	The restrictions and challenges mentioned in the article
7	Sample size	Number of cases or data analysed in the study
8	Conclusions	The key conclusions of the article.
9	Limitations	The constraints and challenges mentioned in the article.
10	Source	The database or source from which the article was obtained, such as PubMed/MEDLINE, Scopus, ScienceDirect, SciELO and Web of Science.
11	Country of origin	The country where the study

Source: Own Elaboration.

**Table 2**: Instrument: Comparative Table Open (Ctrl+Left Click).

Source: Own Elaboration.

Results

After completing the organisation stage of the research instrument, the data was systematised using Microsoft Excel spreadsheets to accurately capture data from the categories detailed above. These individual tables became vital tools that facilitated the task of summarising and organising the relevant information from each of the subcategories of data mentioned in the instrument (Table 2), the use of this comprehensive technique allowed for a complete understanding of the most relevant elements present in the selected articles.

The tables provide a solid and reliable basis that will help to understand and discuss the findings of our research, to meet the objective of a deeper analysis of the diversity and scope of the application of AI in the field of dentistry will be possible thanks to their organised and detailed structure.

Table 1: Intelligence Immersion According to Specialisations.
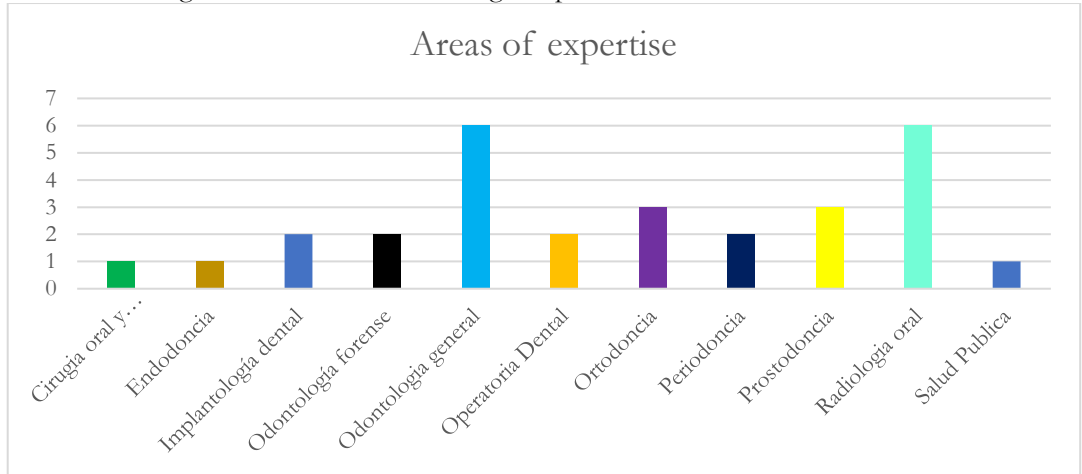
Source: Own Elaboration.

Table 1 shows the specialisations in the application of AI in dentistry shows two main areas where it has gained popularity: oral radiology and general dentistry. Oral radiology is an important field of focus where AI is essential for the interpretation and analysis of radiographic images, which helps to improve early detection of pathologies and accurate clinical decision making, AI is used in general dentistry to promote patient-centred dental care through early detection of common dental diseases and personalisation of treatments, these results highlight the importance of AI in improving dental practice, with an emphasis on diagnostic accuracy and highly personalised care, which has the potential to change the quality of dental care. It is important to mention that prosthodontics and orthodontics are the most widely used dental specialties in the application of AI in dentistry. These results highlight the growing importance of AI in improving dental practice and highlight its ability to significantly increase diagnostic accuracy. AI has revolutionised orthodontic treatment planning by enabling more accurate assessment of bite and dental alignment and significantly complementing dental radiology, resulting in more efficient treatments and better patient outcomes, as well as the customisation of dental prostheses and restorations using AI is crucial for Prosthodontics, as it improves functionality and appearance.

Table 2. Types of Articles Selected for the Database.
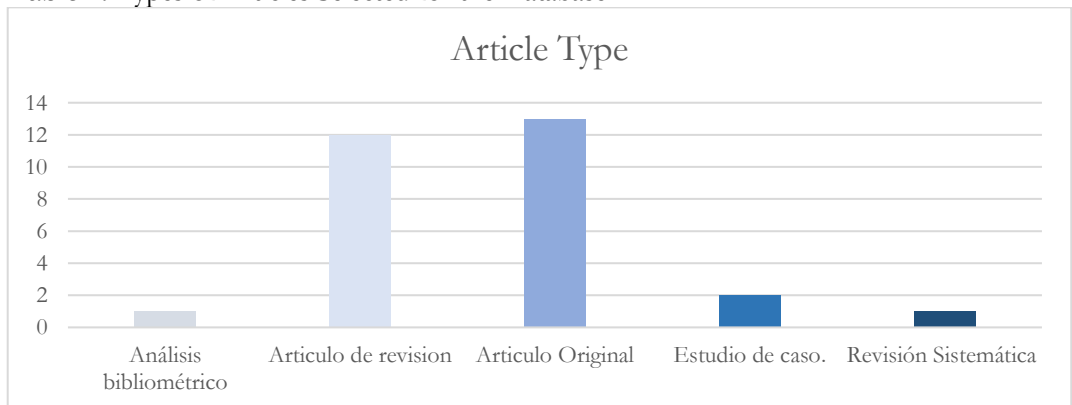
Source: Own Elaboration.

The table presents an intriguing overview of the field of dentistry and AI for diagnostics, the use of original articles is the predominant trend, indicating growing innovation and unique contributions to the field. This pioneering research approach provides fertile ground for the development of new technologies and breakthroughs that could redefine the way we approach artificial intelligence in dental diagnostics.
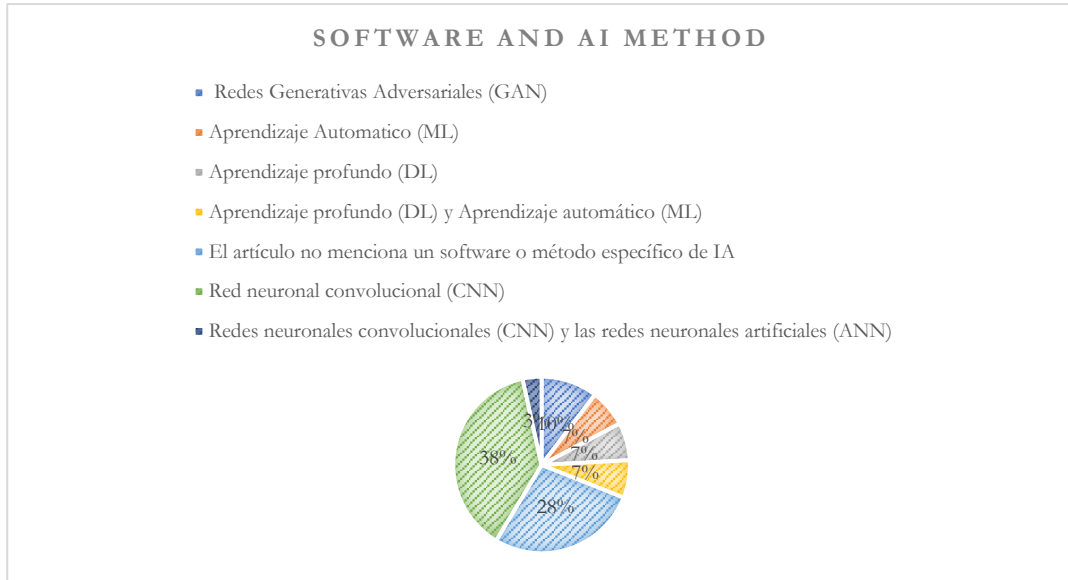

Figure 1: Artificial Intelligence Designs by Structure.
Source: Own Elaboration.

The table on artificial intelligence methods used in dental research shows that the convolutional network method (CNN) is clearly predominant, indicating a preference for AI in this field. Convolutional networks, a deep learning technique that is particularly suitable for image processing, suggest that the scientific community is focused on the analysis and diagnosis of radiographic images and other visual data related to dentistry. In dental practice, the widespread use of CNNs highlights the importance of radiographic image interpretation, early detection of pathologies and improvement of diagnostic accuracy. Furthermore, this focus on CNNs reflects the importance of AI in image interpretation and analysis in dentistry, which greatly advances patient care and accurate diagnosis of dental conditions.

Table 3: AI by Country of Origin.
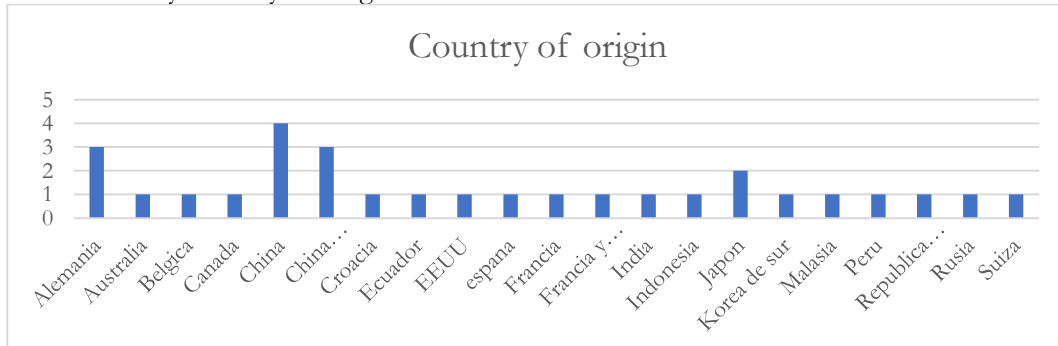
Source: Own Elaboration.

The table showing the countries of origin in artificial intelligence research in dentistry highlights that China has the largest number of articles and developments in this field. These findings show that China is leading the way in AI research in dentistry, demonstrating its strong commitment to adopting advanced technologies in the field of dental health. China's prominence in AI product manufacturing and research in dentistry highlights its influence and leadership in the development of this discipline. This trend also reflects the role of AI in Chinese dentistry and its contribution to the global advancement in the quality of dental care.

Discussion

The role of artificial intelligence in dentistry, particularly in oral and maxillofacial radiology is highlighted in the present study. Convolutional neural networks are the main area of application of AI because they have been shown to work well for various purposes from radiographic diagnosis to improving image quality.

The importance of radiologists' active participation in AI implementation should be emphasised, in line with research led by Min-Suk Heo et al. 2021[2] it is essential that healthcare professionals and information technologists work together, especially when creating accurate datasets, most of the artificial intelligences used in dentistry, especially in diagnostics, are in the field of radiology, and practitioners prefer convolutional neural networks, according to the present analysis.

The work of J Kühnisch et al. 2022[3], which focused on the analysis of intraoral photographs for automatic caries detection, shows how CNNs improve diagnostic performance, the present study confirms that general dentistry and diagnosis are key factors in the choice of AI for diagnosis, and practitioners again prefer convolutional neural networks.

This study highlights the importance of CNNs in the application of AI in dentistry, from radiology to diagnosis, healthcare professionals and technology experts must work together to overcome obstacles and maximise the potential of artificial intelligence to continuously improve dental practice.

In the study conducted by Hugh Devlin et al. in 2021[4] , it was revealed that artificial intelligence provided by dental software such as AssistDent significantly improves the ability of dentists to detect caries, this development could be considered a valuable tool to support preventive dentistry in general practice, we fully agree with this perspective, as artificial intelligence tools are of great use for professional development and the achievement of increasingly accurate diagnoses.

Finally, analysing the limitation of the studies vary according to the author's level of importance, a considerable number of reviewed studies do not clearly state their limitations, which raises doubts about the validity and transparency of the results obtained. [7, 13, 19, 24, 35] At the same time, limitations related to data are important, as a major problem is the need for large databases which contain quality and positively influence the training of these AIs. Therefore, the need to collect larger and more representative datasets will be positive to improve the validity and generalisability of the results. [8, 12, 32]. Other data limitations are the problem with complex computer terms which, if taken into account, are very useful in choosing which type of tool or processing to use. [24]

On the other hand, the practical issue of AI was analysed. Many studies carried out in simulated environments in order to train and see the experience that these tools acquire, as well as to avoid errors in real cases, which is undesirable, although it has minimal margins of error, it is

not reliable that it is commonly used [10, 20, 21, 34]. In general, the limitations of these tools are diverse, such as data in relation to their origin, quality and the scarcity of these data, which make their evolution and improvement of these tools impossible.

Conclusions

Oral and maxillofacial radiology is the field where artificial intelligence has had a significant impact on the dental field. Convolutional neural networks have been highlighted as a very promising method for radiographic diagnosis and image analysis, and have been shown to be effective in raising expectations in dental practices.

Information professionals must work together to achieve successful AI implementation, underscoring the need for accurate data. This finding not only corroborates previous studies, but also highlights the importance of working together across disciplines to help combine emerging technologies in dental care.

The research highlights the impact of convolutional neural networks on the evolution of AI-driven dental diagnostics, with practitioners showing a preference for them, especially for radiographic image interpretation and clinical analysis.

Statement

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