Journal of Oral Medicine and Dental Research

Genesis-JOMDR-4(2)-47
Volume 4 | Issue 2
Open Access
ISSN: 2583-4061

Hidden Health Issues: The Role of AI in Diagnosing Oral Infections and Inflammation

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Citation: Molayem S, Pontes CC, Soleiman M. (2023) Hidden Health Issues: The Role of AI in Diagnosing Oral Infections and Inflammation. J Oral Med and Dent Res. 4(2):1-7.

Received: November 05, 2023 | **Published:** November 20, 2023

Abstract

The connection between oral health and systemic well-being is increasingly recognized in healthcare. One of the significant aspects of this interplay is the presence of low-grade chronic inflammation within the oral cavity, which can evade conventional diagnostic methods. This article explores the transformative role of Artificial Intelligence (AI) in unveiling oral infections and inflammation in radiographs, emphasizing its potential for early detection and treatment.

Keywords

Artificial intelligence; Accuracy; Dental communities; AI technologies; AI-driven diagnostics

Introduction

The number of individuals affected by chronic diseases has epidemic proportions [1]. Diseases in the oral cavity are also ubiquitous, affecting 3.5 billion individuals globally. Pain, restricted chewing, reduced mouth opening, chronic infection, and inflammation from oral issues can decrease quality of life, social interactions, and work productivity [2]. Untreated conditions in the oral cavity can profoundly influence an individual's overall health. Thus, chronic health issues call for a full body search of potential inflammation triggers for improved disease management [3]. The oral cavity can take years before chronic issues manifest signs and symptoms [4]. Therefore, radiographs are paramount for the early identification of changes that can promote disease. Groundbreaking artificial intelligence (AI) technologies can scrutinize radiographs for potential sources of low-grade chronic inflammation that often elude the human eye. Thus, combining radiographs routinely taken during dental appointments and AI diagnostic tools can revolutionize the search for hidden sources of imbalance and disease within the medical and dental communities [5].

The integration of AI into dentistry and medicine has enhanced diagnostic accuracy. AI-driven tools have emerged as invaluable assets, particularly in detecting latent sources of low-grade chronic inflammation in radiographic images with remarkable accuracy, representing a significant leap forward in healthcare by enhancing precision and efficiency. While it can be challenging for the human eye to discern subtle abnormalities, advanced AI algorithms can process vast amounts of data and recognize patterns that often elude human perception [6]. It enables practitioners to detect subtle conditions in dental and osseous tissues that may contribute to systemic health disruption.

The capacity of AI technologies to identify oral conditions has been researched in the diagnosis of periapical changes, dental caries, cysts, alveolar bone loss, tumors, osteoporosis, peri-implant conditions, and cephalometric measurements. In this review, we discuss the landscape of AI-driven diagnostics, exploring the significance of early detection and intervention in the context of hidden sources of oral infection and inflammation, which can potentially affect an individual's well-being, from neurological and immunological to general health. By shedding light on this emerging paradigm, this article aspires to facilitate a deeper understanding of the potential that AI offers in the realm of oral health and to encourage further research and adoption of these technologies for the betterment of healthcare practices and patient well-being.

Tracing Oral Issues in Patients with Chronic Conditions

Chronic illness, with inflammation at its core, remains a conundrum in modern medicine. Yet, one of the most understated origins of chronic imbalance is the oral cavity. While the detrimental effects of periodontitis on overall health are well-documented, its clinical and radiographic diagnosis is typically straightforward. The challenge often lies in diagnosing localized changes that can create subtle inflammatory triggers for the immune system [7]. In these problematic areas, microorganisms, their products, and inflammatory cytokines produced locally can infiltrate the bloodstream, possibly interacting with other organs and systems and promoting imbalance [8]. Routine clinical check-ups will likely oversee these conditions, especially if minor and asymptomatic. Moreover, the ability to diagnose such issues may

vary based on the dental practitioner's experience and radiographic characteristics [9-11]. Identifying and diagnosing such oral inflammation triggers is vital to unlock systemic benefits [12].

Increasingly, physicians are becoming aware of oral health issues that can influence overall well-being despite the ongoing communication gap between doctors and dentists [13]. With chronic inflammation as the common factor for a multitude of chronic systemic conditions, such as autoimmune diseases, cancer, neurological, vascular, and metabolic disorders, AI-based tools can help unveil silent immune and inflammatory triggers in the oral cavity with remarkable efficacy.

Enhanced Dental Care with AI Diagnostic Capabilities

Radiographic interpretation is highly uncertain due to the variability in imaging equipment and techniques, diagnostic limitations, and the visual-perceptual and cognitive processes required for image analysis [15]. Dentists face additional challenges given the intricate nature of oral anatomy and the dynamic course of oral diseases [16].

In a 2001 study on two-dimensional ultrasound imaging, the authors suggested that the human eye can only identify 8–16 shades of gray, while an ultrasound image has 256 shades of grey [17]. While conventional X-rays present 16-25 shades of grey, digital radiographs have 256 shades of grey, similar to ultrasound images [18]. With all these limitations in mind, it is easy to understand why radiographic interpretation is prone to human error.

AI systems are meticulously trained on diverse datasets by experts from various fields, ensuring the recognition of subtle radiographic alterations. As a result, AI tools can sift through complex imaging data with accuracy surpassing traditional methods. AI offers a means to automatize the analysis of dental X-rays, including panoramic radiographs, bitewings, and periapical X-rays, through deep learning (59% of dental studies), machine learning (26% of dental studies), and other methods [19]. In the realm of deep learning, convolutional neural networks (CNNs) have emerged as the preeminent AI instrument for the identification and categorization of oral diseases [6]. Different AI applications can be used for X-ray image enhancement, disease classification, detection, and segmentation to aid diagnosis [6-20]. These models can identify potential areas of interest for more thorough evaluation with higher precision and effectiveness [21]. Consequently, integrating AI into diagnostic processes represents a pivotal step toward improving care quality and patient outcomes [22].

AI precision in oral diagnosis

Broadly speaking, research suggests that AI-automated systems demonstrate outstanding performance, closely emulating the precision of trained dental experts. Some studies have even reported that these systems can surpass dental specialists' diagnostic performance. Devito et al. (2008) conducted a study demonstrating that an AI model substantially enhanced proximal caries detection, resulting in an almost 40% improvement [23]. Furthermore, a randomized study indicated that AI significantly augmented clinicians' capacity for detecting dental caries [24]. Subsequently, in 2018, a research investigation delved into the efficacy of AI for identifying dental cavities on periapical X-rays, unveiling accuracy rates of 88-

89% for premolars and molars [25]. More remarkable findings emerged from another investigation, which reported an astonishing 97.1% accuracy rate for AI in identifying cavities [26].

AI models proved to be equally effective as experienced dental practitioners in identifying periapical lesions and periodontal bone loss [27]. In a study by Lee et al., an automated AI model successfully classified six distinct implant systems using a dataset of 11,980 panoramic and periapical radiographs, surpassing the performance of most dental professionals [6,28,29]. Moreover, automated diagnosis of cracked teeth achieved an average accuracy rate of 90.39%, and when classifying various dental restorations in panoramic images, the overall accuracy reached 93.6% [30]. In the detection of cysts and tumors within the oral cavity, AI results present high accuracy, with higher sensitivity observed for cysts [31,32].

Early Detection and Intervention – Inflammation Screening as a Paradigm Shift

The early identification of potential sources of low-grade chronic inflammation using AI enables timely intervention and promises to reduce the broader impact on overall health. Once suspected localized inflammatory areas are detected, they can be addressed and possibly prevented from causing systemic consequences. Low-grade chronic inflammation in the oral cavity, often inconspicuous and frequently underdiagnosed, has been linked to various systemic conditions [34].

AI-powered radiographic analysis in dentistry can assist in identifying early changes before disease development, such as the loss of lamina dura, and assess conditions affecting treatment decisions, such as bone defect types in relation to the risk of periodontal or peri-implant diseases. This also applies to identifying early alterations in dental tissues and alveolar bone associated with impacted or extracted teeth regions, periapical pathologies, cysts, and tumors. Consequently, AI can assist dental practitioners in identifying oral health issues that can impact neurological aspects, immunity, metabolism, and other physiological factors contributing to imbalance [5].

Advantages of AI Diagnostic Dental Tools

The utilization of AI dental diagnostic tools offers multiple advantages. Firstly, AI models exhibit exceptional sensitivity, attributed to their capacity for making finely detailed grayscale distinctions. Additionally, AI is devoid of distractions, fatigue, forgetfulness, or haste, thus eliminating the potential for errors [35]. However, AI's inexhaustible capacity for continuous learning is possibly the most noteworthy benefit. It possesses the potential to assimilate the collective knowledge and experiences of a vast number of practitioners and patients.

Dental imaging algorithms require extensive training with datasets, allowing them to compare new images against a larger volume of radiographs than a single dentist could feasibly review in a lifetime [23]. This enables the development of universally applicable algorithms, transcending age, gender, and ethnicity boundaries. Such diagnostic assistance has the potential to foster a transformative era in dental care, effectively introducing an additional set of perpetually vigilant and well-trained eyes into the diagnostic process. This can contribute to reducing diagnostic discrepancies and increasing reliability. For the dentist,

it ensures comprehensive coverage, leaving no potential issues overlooked [36]. In the patient's case, AI can clarify ambiguous images, thus enhancing the overall objectivity and trust. Lastly, AI-based diagnostic tools can enhance collaboration between healthcare providers and dental professionals [22].

Limitations and Future Perspectives

The need for extensive labeled datasets to train AI algorithms effectively is a significant constraint in diagnostic models. This can be particularly challenging for rare dental conditions. Additionally, the interpretability and transparency of AI systems remain areas of concern, hindering their widespread acceptance among dental professionals.

Despite these limitations, the prospects of AI diagnosis in dental care are compelling, and the broader implications are profound [36]. Integrating clinical and radiographic data can ultimately help practitioners make better clinical decisions, enhance diagnostic precision and efficiency, and promote the streamlining of health data management and the integration of oral and systemic health. Further research is required to continuously enhance the robustness and reliability of AI systems [23].

Conclusion

AI diagnostic models can enhance the capabilities of dental practitioners, streamline workflow, and bolster patient trust. In essence, AI is facilitating a transformative shift in oral healthcare. The utilization of advanced AI technology in diagnosing silent oral infections and inflammation signifies a pivotal leap toward chronic health issues while strengthening the connection between the mouth and the body. By leveraging AI's capabilities, early detection and treatment of hidden issues can impact millions of patients suffering from chronic diseases worldwide.

References

1. GBD 2016 Disease and Injury Incidence and Prevalence Collaborators. (2017) Global, regional, and national incidence, prevalence, and years lived with disability for 328 diseases and injuries for 195 countries, 1990-2016: a systematic analysis for the Global Burden of Disease Study 2016. Lancet. 390(10100):1211-59.
2. Dye BA. (2017) The Global Burden of Oral Disease: Research and Public Health Significance. J Dent Res. 96(4):361-63.
3. Jin L, Lamster I, Greenspan J, Pitts N, Scully C, et al. (2016) Warnakulasuriya S. Global burden of oral diseases: emerging concepts, management and interplay with systemic health. Oral Dis. 22(7):609-19.
4. Furman D, Campisi J, Verdin E, Targ S, Miller AH, et al. (2019) Chronic inflammation in the etiology of disease across the life span. Nat Med. 25(12):1822-32.
5. Zhu J, Chen Z, Zhao J, Yu Y, Li X, et al. (2023) Artificial intelligence in the diagnosis of dental diseases on panoramic radiographs: a preliminary study. BMC Oral Health. 23(1):1-11.
6. Putra RH, Doi C, Yoda N, Astuti ER, Sasaki K. (2022) Current applications and development of artificial intelligence for digital dental radiography. Dentomaxill Radiol. 51(1):51.
7. Corbet EF, Ho DKL, Lai SML. (2009) Radiographs in periodontal disease diagnosis and

management. Aust Dent J. 54 Suppl 1:S27-S43.

8. Chen L, Deng H, Cui H, Fang J, Deng J, et al. (2018) Inflammatory responses and inflammation-associated diseases in organs. Oncotarget. 9(6):7204-18.
9. Scannapieco FA. (2004) Periodontal inflammation: from gingivitis to systemic disease? Compend Contin Educ Dent. 25(7 Suppl 1):16-25.
10. Seymour GJ, Ford PJ, Cullinan MP, Leishman S, Yamazaki K. (2007) Relationship between periodontal infections and systemic disease. Clinical Microbiology and Infection. 13:3-10.
11. Fine N, Chadwick JW, Sun C, Khoury N, Barbour A, et al. (2021) Periodontal Inflammation Primes the Systemic Innate Immune Response. J Dent Res. 100(3):318-25.
12. Hegde S, Gao J, Vasa R, Cox S. (2023) Factors affecting interpretation of dental radiographs. Dentomaxillofacial Radiology. 52(2):20220279.
13. Herrera D, Sanz M, Shapira L, Chapple L, Frese T, et al. (2023) Association between periodontal diseases and cardiovascular diseases, diabetes and respiratory diseases: Consensus report of the Joint Workshop by the European Federation of Periodontology (EFP) and the European arm of the World Organization of Family Doctors (WONCA Europe). J Clin Periodontol. 50(6):819-41.
14. Khanagar SB, Al-ehaideb A, Maganur PC, Patil S, Sarode S, et al. (2021) Developments, application, and performance of artificial intelligence in dentistry – A systematic review. J Dent Sci. 16(1):508-22.
15. Bruno MA. (2017) 256 Shades of gray: Uncertainty and diagnostic error in radiology. Diagnosis. 4(3):149-157.
16. Fourcade A, Khonsari RH. (2019) Deep learning in medical image analysis: A third eye for doctors. J Stomatol Oral Maxillofac Surg. 120(4):279-88.
17. Dambrosio F, Amy D, Colombo A. (1995) B-mode color sonographic images in obstetrics and gynecology: preliminary report. Ultrasound in Obstetrics and Gynecology. 6(3):208-15.
18. Todd R. (2014) Dental imaging—2D to 3D: a historic, current, and future view of projection radiography. Endod Topics. 31(1):36-52.
19. Chen YW, Stanley K, Att W. (2020) Artificial intelligence in dentistry: current applications and future perspectives. Quintessence Int. 51(3):248-57.
20. Schwendicke F, Golla T, Dreher M, Krois J. (2019) Convolutional neural networks for dental image diagnostics: A scoping review. J Dent. 91: 103226
21. Shafi I, Fatima A, Afzal H, Lipari V, Ashraf I, et al. (2023) A Comprehensive Review of Recent Advances in Artificial Intelligence for Dentistry E-Health. Diagnostics. 13(13):2196.
22. Kabir T, Lee CT, Chen L, Jiang X, Shams S. (2022) A comprehensive artificial intelligence framework for dental diagnosis and charting. BMC Oral Health. 22(1):480.
23. Khanagar SB, Al-ehaideb A, Maganur PC, Patil S, Bhandi S, et al. (2021) Developments, application, and performance of artificial intelligence in dentistry – A systematic review. J Dent Sci. 16(1):508-22.
24. Devito KL, de Souza Barbosa F, Filho WNF. (2008) An artificial multilayer perceptron neural network for diagnosis of proximal dental caries. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 106(6):879-84.
25. Mertens S, Krois J, Cantu AG, Arsiwala LT, Schwendicke F. (2021) Artificial intelligence for caries detection: Randomized trial. J Dent. 115:103849.

26. Lee JH, Kim DH, Jeong SN, Choi SH. (2018) Detection and diagnosis of dental caries using a deep learning-based convolutional neural network algorithm. J Dent. 77:106-111.
27. Geetha V, Aprameya KS, Hinduja DM. (2020) Dental caries diagnosis in digital radiographs using back-propagation neural network. Health Inf Sci Syst. 8(1).
28. Chang HJ, Lee SJ, Yong TH, Shin NY, Kim JE, et al. (2020) Deep Learning Hybrid Method to Automatically Diagnose Periodontal Bone Loss and Stage Periodontitis. Scientific Reports. 10(1):1-8.
29. Lee JH, Kim DH, Jeong SN, Choi SH. (2018) Diagnosis and prediction of periodontally compromised teeth using a deep learning-based convolutional neural network algorithm. J Periodontal Implant Sci. 48(2):114-23.
30. Lee JH, Kim YT, Lee J Bin, Jeong SN. (2020) A Performance Comparison between Automated Deep Learning and Dental Professionals in Classification of Dental Implant Systems from Dental Imaging: A Multi-Center Study. Diagnostics. 10(11):910.
31. Guo J, Wu Y, Chen L, Ge G, Tang Y, Wang W. (2022) Automatic Detection of Cracks in Cracked Tooth Based on Binary Classification Convolutional Neural Networks. Appl Bionics Biomech. 2022:9333406.
32. Abdalla-Aslan R, Yeshua T, Kabla D, Leichter I, Nadler C. (2020) 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. 130(5):593-602.
33. Yu D, Hu J, Feng Z, Song M, Zhu H. (2022) Deep learning based diagnosis for cysts and tumors of jaw with massive healthy samples. Scientific Reports. 12(1):1-10.
34. Sanz M, Ceriello A, Buysschaert M, Chapple L, Tonetti M, et al. (2018) Scientific evidence on the links between periodontal diseases and diabetes: Consensus report and guidelines of the joint workshop on periodontal diseases and diabetes by the International Diabetes Federation and the European Federation of Periodontology. J Clin Periodontol. 45(2):138-49.
35. Fatima A, Shafi I, Afzal H, Brenisa J, Ashraf I, et al. (2022) Advancements in Dentistry with Artificial Intelligence: Current Clinical Applications and Future Perspectives. Healthcare. 10(11):2188.
36. Schwendicke F, Samek W, Krois J. (2020) Artificial Intelligence in Dentistry: Chances and Challenges. J Dent Res. 99(7):769-74.