Journal of Carcinogenesis
Covering Genesis to Therapeutics

Journal of Carcinogenesis, ISSN: 1477-3163
2024; Vol 23: Issue 1, https://carcinogenesis.com/

Role Of Artificial Intelligence In Endodontics: A Review

Dr. Monika Sharma[1], Dr. Dinesh Chand Sharma[2], Dr. Meenu Bala[3], Dr. Monika Choudhary[4]

[1]Department of Dentistry, ECHS polyclinic , Bharatpur,

mailmonicasharma@gmail.com

[2]Department of Dentistry, Ananta institute of medical sciences, Udaipur

drdineshsharma1812@gmail.com

[3]Department of Conservative Dentistry and Endodontics, Surendera Dental College & Research Institute, Sri Ganganagar

meenuchugh162@gmail.com

[4]Department of Conservative Dentistry and Endodontics, Surendera Dental College & Research Institute, Sri Ganganagar.

1choudharymonika@gmail.com

ABSTRACT

In the field of dentistry, AI models are specifically crafted to contribute to the diagnosis of oral diseases, ranging from common issues such as dental caries to more complex conditions like periodontal diseases and oral cancer. AI has valuable application in the field of modern endodontics with promising results. Future holds the foundation for the evolution and broader adoption of AI models in the dynamic landscape of dental diagnostics and treatment planning.

Keywords: *Artificial intelligence, Endodontics*

How to Cite: Dr. Monika Sharma, Dr. Dinesh Chand Sharma, Dr. Meenu Bala, Dr. Monika Choudhary, (2024) Role Of Artificial Intelligence In Endodontics: A Review, *Journal of Carcinogenesis, Vol.23, No.1*, 494-498

1. INTRODUCTION TO AI

The ability of computers or other devices to acquire intelligence in order to carry out tasks that typically require human intelligence is known as artificial intelligence (AI). When cofounder Alan Turin famously asked, “Can machines think?” in 1995, the system known as AI was born.[1-4]

AI, which encompasses a wide range of technologies designed to simulate human intelligence, includes machine learning and its more sophisticated subset, deep learning. Machine learning, a branch of AI, involves the development of algorithms and statistical models that enable computers to perform tasks without explicit programming, instead relying on pattern recognition and inference.[5] Deep learning is a specialized area within machine learning that utilizes multilayer neural networks. These deep networks are designed to mimic the human brain’s capacity to learn from data. With the progression of computer hardware, AI can now process vast amounts of information, computationally analyze human behavior, and facilitate human-to-human interaction.[5,6]

AI particularly deep learning approaches such as convolutional neural networks (CNNs), has revolutionized medical image analysis across multiple specialties due to its capacity for high-throughput, reproducible detection of pathological features. [7] CNNs generate database output by learning the structural patterns of an input dataset and carrying out tasks on their own.[1]

AI IN DENTISTRY

AI technology has brought about a significant transformation in the field of dentistry . AI applications leverage models such as CNN and artificial neural networks (ANN) to perform a wide range of functions within dental practice. Virtual dental assistants powered by AI ensure precision and efficiency in dental offices, performing tasks with reduced manpower and high accuracy. AI's diagnostic capabilities are particularly useful in oral and maxillofacial surgery, aiding in procedures such as dental implants and tumor removal. Design assistants such as RaPiD contribute to prosthetic dentistry by ensuring optimal aesthetic prostheses through anthropological calculations and patient preferences. Moreover, AI facilitates personalized care in orthodontics by analyzing radiographs, predicting malocclusion, identifying cephalometric landmarks,

© 2024 Journal of Carcinogenesis | Published for Carcinogenesis Press by Wolters Kluwer-Medknow

eliminating the need for multiple laboratory procedures and offering more precise diagnostics than human perception alone. Forensic odontology benefits from AI applications that can determine biological age and gender and analyze bite marks. Dental radiology harnesses AI's ability to recognize teeth, diagnose conditions such as caries, and predict issues like root caries and TMJ osteoarthritis. Also, periodontics and endodontics benefit from AI algorithms that enhance the diagnosis of compromised teeth.[8-10]Hence, AI has the potential to replicate human intelligence to perform prediction and complex decision making in health care and has significantly increased its presence and relevance in various tasks and applications in dentistry, especially endodontics.[11]

2. ROLE OF AI IN ENDODONTICS

Endodontics, a branch of dentistry focused on the diagnosis, prevention, and treatment of diseases and injuries of the dental pulp and periapical tissues, is essential for maintaining oral health and function. [5]

Endodontic success relies on accurate identification, cleaning, shaping, and obturation of root canals. Failure to detect accessory canals or measure lengths correctly is a major cause of persistent apical periodontitis and treatment failure.[12]

Traditionally, the field has relied on the clinical expertise of practitioners and the interpretation of radiographic images.[5] Conventional imaging, including periapical radiographs and CBCT, provides critical visualization, but interpretation remains operator-dependent, with variability in accuracy.[12]

VARIOUS APPLICATIONS OF AI IN ENDODONTICS

AI in endodontics offers numerous applications, enhancing both diagnostic accuracy and treatment efficiency.

COMPREHENSIVE AI-BASED PATIENT MANAGEMENT

AI predicts potential complications or treatment outcomes using patient history and data analysis. It streamlines the documentation process to maintain accurate and up-to-date patient records, while AI chatbots enhance patient communication by providing information and follow-up care instructions to improve patient engagement and education.This integrated approach ensures personalized care, enabling healthcare providers to focus more on clinical tasks while reducing administrative burdens. Ultimately, such advancements lead to improved patient satisfaction and more efficient healthcare delivery.[13]

DIAGNOSIS

AI-powered tools analyze dental X-rays and 3D scans with advanced algorithms, enabling a more accurate identification of pulp infections, tooth fractures, and periapical lesions. These systems learn from vast datasets, reducing the incidence of misdiagnosis and ensuring that clinicians can detect issues that might be overlooked by traditional methods.[13] In a comprehensive approach, Lee *et al*.[14] adopted a thorough method by training, validating, and testing a deep learning model with 4,129 periapical radiographs. Their results highlighted deep learning's potential to boost both the accuracy and reliability of assessing dental caries and periapical periodontitis in these images. This progress in AI applications demonstrated the profound impact that technology can have on enhancing diagnostic abilities and elevating overall results in dental care.[13]

CARIES DIAGNOSIS

Accurate diagnosis of dental caries is essential for effective prevention and treatment of tooth decay, but traditional methods can be imprecise and inefficient. AI integration, particularly machine learning and deep learning algorithms, offers significant potential for enhancing the accuracy and efficiency of caries diagnosis. Caries Net is an advanced deep learning model created to improve the diagnosis of dental caries. This AI system has shown significant promise in improving the accuracy and efficiency of caries detection compared to traditional manual methods. Utilizing deep learning techniques for classifying dental caries with the ICDAS™ scoring system holds significant promise. [15]

PERIAPICAL LESION DETECTION

The current gold standard for the detection of periapical radiolucency is the periapical radiograph. However, periapical radiographs have several drawbacks such as anatomical noise, geometrical distortion, and giving a 2-dimensional image for a 3-dimensional object which is the tooth. Therefore, the existence of cone-beam computed tomography (CBCT) has increased the detection of periapical lesions due to its increased sensitivity and specificity. It has been shown that apical periodontitis affects almost 50% of the adult population. Therefore, the early detection of apical periodontitis may increase the success of treatment and avoid the spread of the disease to the surrounding tissues.[16] In addition, the implementation of AI in the detection of periapical lesions from periapical radiographs and CBCT is potentially applicable which may reduce the effort and time of the clinician.

© 2024 Journal of Carcinogenesis | Published for Carcinogenesis Press by Wolters Kluwer-Medknow

ROOT FRACTURE DETECTION

The diagnosis of root fractures is quite challenging for the clinicians and could lead to misdiagnosis and unnecessary treatment for the patient. For the fracture to be detectable on a radiograph, the X-ray beam should be parallel to the fracture line, which may be difficult to achieve. Therefore, CBCT imaging was found to be superior to periapical radiographs for the detection of root fractures in untreated teeth. The current literature on the use of AI in the detection of root fractures is lacking. However, it is not applicable to everyday practice as panoramic radiographs are rarely used by clinicians to diagnose vertical root fracture.[16]

DETERMINATION OF WORKING LENGTH

The accuracy of working length determination is vital in achieving a successful root canal treatment. Several methods are used in determining the working length including radiographs, tactile sense, and the use of an apex locator. Radiographs are mostly used in determining the working length; however, it could be misleading due to the anatomical noise or geometrical distortion. Therefore, a more accurate method in determining the working length is needed. AI was used to determine the location of the apical foramen on radiographs, increasing the accuracy of determining the working length. Hence, the use of AI could be important in determining the accurate working length which subsequently leads to a successful root canal treatment.[16]

MORPHOLOGY OF THE ROOT CANAL

Teeth exhibit several morphological differences. Efforts are exerted in determining different classifications for root canal morphology. Therefore, knowledge of the root canal system is important for decreasing mishaps by the clinician and increasing the success of root canal treatment. Due to its higher sensitivity, CBCTs were found superior in accuracy in assessing the root canal morphology than periapical radiographs. However, it cannot be applied to every case due to radiation hazards. [16]

EXTERNAL ROOT RESORPTION

Detecting external root resorption (ERR) at an early stage is vital to prevent progressive and irreversible damage, which can lead to tooth loss in severe instances. The periapical radiograph is a commonly used imaging technique for identifying ERR. Although it provides high-resolution images, it has limitations such as the overlapping of two-dimensional images, which may not accurately depict the full extent of ERR.[15]

ENDODONTIC SURGERY

Endodontic microsurgery (EMS) becomes a crucial alternative option when nonsurgical endodontic retreatment is insufficient or its outcome is uncertain.ML has a promising role in various aspects of EMS focusing on diagnosis, including computer-aided detection of periapical lesions in CBCT images, distinguishing cystic periapical lesions from granulomas, identifying cracks, and automating the segmentation of teeth and the mandibular nerve canal as well.

REGENERATIVE ENDODONTICS

AI can help to enhance the processes of dental pulp tissue repair using stem cells with the help of the analysis of factors that define cells' differentiation, creating an optimal scaffold for cell growth, and predicting the effectiveness of the treatment. Neuro-fuzzy inference technique can be used in examining dental pulp stem cells in multiple rejuvenation treatment modalities, predicting cell viability, following microbial infection.[15]

IMPACT OF AI ON ENDODONTIST

AI significantly impacts endodontists by enhancing diagnostic precision, optimizing treatment planning, and improving patient outcomes. It automates routine tasks, allowing endodontists to focus on complex cases, reduces human error, and provides decision support through data analysis. Consequently, AI elevates efficiency, effectiveness, and the overall quality of endodontic care.[13]

FUTURE PROSPECTIVE OF AI

Photorealistic 3D Reconstructions

An exciting area that has been gaining more interest is the use of AI enhanced algorithms is to create photorealistic 3D reconstructions of the root canal space and the tooth anatomy. This innovative reconstruction technique is known as cinematic rendering (CR). CR can create these photorealistic 3D images based on CBCT data sets by using high dynamic range rendering lightmaps to create a natural lighting environment.

Robotics and Microbots AI-guided robots, already used in neurosurgery and orthopedics, are being developed for implant dentistry to aid in implant placement with accuracy comparable to static and dynamic navigation systems. Future applications are expected to include similar AI-guided systems for endodontic microsurgery and routine endodontic treatments. Besides AI guided robots, AI-guided microrobots have significant potential in endodontics, in improving the

© 2024 Journal of Carcinogenesis | Published for Carcinogenesis Press by Wolters Kluwer-Medknow

strategies for eradicating bacterial biofilm colonies that adhere to dentin in complex root canal areas.

Recently, laser, ultrasound, or light energy-assisted systems combined with self-propelled micro-robots have been introduced in endodontics. These microbots, smaller than a pinhead, convert environmental energy into mechanical energy, increasing their ability to penetrate biofilm. They can be manipulated through augmented reality to deliver disinfectants, drugs, and assist in opening and shaping infected spaces.

ARTIFICIAL INTELLIGENCE CHATBOTS

AI chatbots like ChatGPT and Bard have been recognized as transformative tools in various fields, including dental education. Despite AI's significant advancements in dentistry since 2020, especially in diagnostics, treatment planning, and telemedicine, the integration of chatbots in dental education remains limited. This highlights the necessity for curriculum updates to include advanced AI and deep learning methods, as chatbots can support decision-making and improve clinical reasoning skills. Studies have found that chatbots such as ChatGPT provided.[15]

Henceforth, AI is set to revolutionize endodontics by enhancing precision and personalization in dental care. It enables more accurate diagnostics, catching anomalies undetectable to the human eye, thus improving patient outcomes. AI personalizes treatment by analyzing individual data like medical history and lifestyle, recommending tailored treatment options, enhancing effectiveness and patient satisfaction. As an educational tool, AI offers simulations for skill refinement and integrates with AR and 3D printing for minimally invasive procedures. It automates routine tasks, streamlining workflows. Addressing ethical concerns like data privacy is crucial to maintain patient trust and adhere to standards.[13]

3. CONCLUSION

Artificial intelligence has the potential to replicate human intelligence to perform prediction and complex decision making in health care and has significantly increased its presence and relevance in various tasks and applications in dentistry, especially endodontics. Future holds the foundation for the evolution and broader adoption of AI models in the dynamic landscape of dental diagnostics and treatment planning.

REFERENCES

[1] Thakkar CR, Goel S, Verma K, Saloni, Sharma P, Makhijani B. Study Among Dentists of Udaipur Regarding their Awareness Among Artificial Intelligence in Oral Medicine and Radiology: A Cross-Sectional Study. J Pharm Bioallied Sci. 2025 May;17(Suppl 1):S884-S886.

[2] Oh S, Kim JH, Choi SW, Lee HJ, Hong J, Kwon SH. Physician confidence in artificial intelligence: An online mobile survey. J Med Internet Res. 2019;21:e12422.

[3] Tiwari A, Gupta N, Singla D, Ranjan Swain J, Gupta R, Mehta D, et al. Artificial Intelligence's use in the diagnosis of mouth ulcers: A systematic review. Cureus. 2023;15:e45187.

[4] Sur J, Bose S, Khan F, Dewangan D, Sawriya E, Roul A. Knowledge, attitudes, and perceptions regarding the future of artificial intelligence in oral radiology in India: A survey. Imaging Sci Dent. 2020;50:193–8.

[5] Dennis, Siriwan Suebnukarn, Min-Suk Heo et al. Artificial intelligence application in endodontics: A narrative review. Imaging Sci Dent. 2024 Dec;54(4):305-312.

[6] Matla, R. K. (2025). AN AI-DRIVEN AUGMENTED ANALYTICS FRAMEWORK FOR ENHANCING DECISION-MAKING EFFICIENCY IN MID-SIZED ENTERPRISES: ACASE STUDY APPROACH. International Journal of Engineering Sciences & Research Technology, 14(10), 1–11. https://doi.org/10.29121/ijesrtp.v14.i10.2025.1

[7] Xu Y, Liu X, Cao X, Huang C, Liu E, Qian S, et al. Artificial intelligence: a powerful paradigm for scientific research. Innovation (Camb) 2021;2:100179.

[8] Doumani M, Almaqboul F, Alduwaysan S S, et al. Effectiveness of Artificial Intelligence in Endodontic Diagnosis and Treatment Evaluation: A Systematic Review. Cureus 2025; 17(11): e96091.

[9] Asgary S. Artificial Intelligence in Endodontics: A Scoping Review. Iran Endod J. 2024;19(2):85-98.

[10] Agrawal P, Nikhade P. Artificial Intelligence in Dentistry: Past, Present, and Future. Cureus. 2022;14(7):e27405.

[11] 10. Rajaram Mohan K, Mathew Fenn S. Artificial Intelligence and Its Theranostic Applications in Dentistry. Cureus. 2023;15(5):e38711.

[12] Koomson E P, Borsah A A (2025). ENHANCING DIABETES DIAGNOSIS IN GHANA THROUGH MACHINE LEARNING: A CASE STUDY OF THE GHANA HEALTH SERVICE. International Journal of Engineering Sciences & Research Technology, 14(10), 12-22. https://doi.org/10.29121/ijesrtp.v14.i10.2025.2

[13] 11. Anita Aminoshariae, Jim Kulild, Venkateshbabu Nagendrababu. Artificial Intelligence in Endodontics: Current Applications and Future Directions. Journal of Endodontics 2021;47(9):1352-1357.

[14] 12. Leelamma LK, Suprit SP, Swargam VT, M.R .MF, Amrutha AS, Vinay VR. AI in Endodontics: Automated Root Canal Detection and Measurement. Journal of Contemporary Clinical Practice. 2025 Sep;11(9):838-842.

[15] 13. Kumar MSS, Rai A, Singh N, Shroff Y, Rao V, Prasad KV, Surana P. Artificial Intelligence (AI) in Endodontics: A Review. J Pharm Bioallied Sci. 2025 May;17(Suppl 1):S96-S98.
[16] 14. Lee SJ, Chung D, Asano A, Sasaki D, Maeno M, Ishida Y, et al. Diagnosis of tooth prognosis using artificial intelligence. Diagnostics. 2022;12:1422.
[17] 15. Rucha Harde., et al. “Artificial Intelligence in Endodontics - A Literature Review". Acta Scientific Dental Sciences 2025;9(10): 29-37.
[18] 16. Bakhsh, Abdulaziz A. A narrative review on the current uses of artificial intelligence in endodontics. Saudi Endodontic Journal 2024; 14(2):p 164-171.