

AI IN DENTAL PRACTICE

Abstract

Artificial intelligence (AI) has grown dramatically in importance and use across many industries, including dentistry. In the healthcare sector, particularly in endodontics, artificial intelligence can replicate human intelligence effectively, enabling it to make intricate predictions and informed decisions. In the field of endodontics, convolutional neural networks and/or artificial neural networks have demonstrated numerous applications. These include studying the intricate anatomy of the root canal system, accurately predicting the viability of dental pulp stem cells, precise measurements of working lengths, efficient detection of root fractures and periapical lesions, and providing valuable insights into the potential success of retreatment procedures. These advanced technologies have significantly enhanced diagnostic and decision-making capabilities in endodontic practice.

This comprehensive study aims to explore the significant impact of artificial intelligence (AI) technology on dentistry by analyzing vast amounts of data, leading to improved clinical decision-making. The research extensively reviews various stages of clinical dentistry where AI is currently playing a crucial role. A compilation of documents spanning from 1990 to 2022 has been gathered, covering the major topics related to artificial intelligence-assisted dentistry. Through this investigation, the study seeks to shed light on the advancements and potential of AI in enhancing dental practices and patient care.

Keywords: Artificial Intelligence (AI), Machine Learning, Neural Network, Dentistry, Evidence-Based Dentistry.

Authors

Priya Singh

Tutor
Department of Biochemistry
Santosh Medical College and Hospital
Ghaziabad.

Juhi Aggarwal

Professor & Head
Department of Biochemistry
Santosh Medical College and Hospital
Ghaziabad.

I. BACKGROUND

The human brain is a captivating organ, and its complexities have intrigued scientists and researchers for centuries. The quest to create a perfect replica of the human brain has proven elusive for a significant period. As a result, the scientific community has dedicated extensive efforts towards the development of "artificial intelligence" (AI) as an alternative approach. AI research has opened new horizons and led to remarkable advancements in understanding intelligence and replicating cognitive processes. In 1956, John McCarthy first introduced the field of applied computer science, which we now know as artificial intelligence. This cutting-edge discipline aims to create machines that can perform tasks typically requiring human intelligence, driving innovation and transformative changes across various industries.

The literature evaluation involved the utilization of multiple AI models to investigate factors related to dental care. This study contributes to the existing knowledge in two distinct manners. Firstly, the Preferred Reporting Items for Systematic Reviews and Meta-Analyses technique was employed to comprehensively map the current trends in AI applications within dental care delivery systems. Secondly, the research provides valuable insights to academics by presenting diverse technological approaches for early detection of oral disorders. The remaining study centres on addressing three primary research objectives and obtaining meaningful answers to them.

II. INTRODUCTION

The ability of a computer to mimic analytical skills like learning and problem-solving, which are traditionally connected with the human brain and mental activity is referred to as intelligent machines. Clinical trials have extensively tested artificial intelligence algorithms, especially as aids in decision-making for prognosis, projection, diagnosis at each stage, and subsequent therapy. These advanced algorithms play a crucial role in assisting healthcare professionals by providing valuable insights and support throughout the patient's medical journey. Artificial intelligence algorithms have demonstrated remarkable capabilities and efficiency in identifying significant data patterns. Research has shown that AI can significantly enhance precision, accuracy, and efficiency to levels comparable to, or even surpassing, those of medical practitioners. Moreover, AI has the potential to achieve these outcomes in a quicker and more cost-effective manner, making it a valuable tool in the field of medicine.

The integration of various office and practice management software has already had a significant impact on our daily lives. Notably, software programs like Siri, Alexa, and other voice command devices have introduced highly advanced conversational user interfaces that can be seamlessly employed across multiple devices, applications, and environments. These innovations have revolutionized the way we interact with technology and made our interactions more efficient and user-friendly.

Robotics is one area where artificial intelligence is used both practically and virtually. It is incredibly important in mathematical formulas used in the virtual world for things like medication dose, diagnosis, prognosis, appointments, and prescription interactions from the pharmacy, electronic health records, and image analysis of medical images.

On the physical side, AI is leveraged in various areas such as telepresence, providing support for robotic surgery, aiding in rehabilitation processes, and assisting with companion robots designed to cater to the elderly care needs. These advancements demonstrate the wide-ranging impact of AI technology in improving healthcare services and enhancing the quality of patient care. In the realm of dental applications, supervised learning is the predominant approach, where training data consists of diverse samples, each possessing distinct characteristics or features, and associated ground truth information (e.g., whether an endodontic visit had occurred previously).

Artificial neural networks simulate the structure of the biological neuron system, incorporating multiple connections between neurons to facilitate "learning" and comprehend the correlations between attributes and real-world outcomes. Through this algorithmic process, artificial neural networks can effectively identify patterns and make informed decisions based on the learned connections between data attributes and desired outcomes.

The potential of artificial intelligence (AI) to revolutionize the fields of medicine and dentistry is significant, offering solutions to various clinical challenges and simplifying clinician's tasks. While applications of AI in the dental industry are relatively scarce, there have been notable developments in electronic recordkeeping, radiography and pathology, caries detection, robotic assistance, dental imaging diagnostics, and caries detection.

As other dental specialties continue to progress, research into endodontic artificial intelligence has also advanced. However, endodontists need to keep themselves updated with the latest knowledge and developments in the use of artificial intelligence to effectively leverage its potential in their practice. Embracing these technologies can lead to enhanced patient care, improved diagnosis, and more efficient treatment strategies in endodontics.

Technological advancements have led to the widespread adoption of digital dentistry, enabling more effective visualization for accurate diagnosis in dental practices. Dental informatics is a specialized field within dentistry that focuses on information management, communication, and the integration of new technologies in both clinical practice and research.

In a dental office, various information generated through patient interactions, appointment scheduling, and practice management is efficiently managed and utilized. The preservation and effective use of this information play a vital role in optimizing dental services, enhancing patient care, and facilitating seamless operations within the dental practice.

Clinical information systems utilize computers to record, store, and modify patients' clinical data in a structured manner. These systems can be utilized independently or in conjunction with other healthcare industry platforms. The integration of clinical information systems streamlines medical recordkeeping, enhances data accessibility, and fosters efficient communication among healthcare specialists, consequently resulting in better patient care.

Clinical information systems play a crucial role in supporting healthcare management and managing patient data by integrating, acquiring, and effectively managing data from various sources. In dental offices, information systems are utilized to store extensive amounts of data and streamline data processing, enabling efficient recordkeeping and enhancing the

overall workflow within the dental practice. Utilizing a clinical information system enables swift retrieval of additional patient diagnosis and care details. These systems often integrate web-based technology, email communication, internet searching, and marketing techniques, along with virtual reality training, practice sessions, and ongoing training to enhance the overall efficiency and effectiveness of patient care.

Information systems and technological advancements have significantly propelled the dentistry industry forward. Despite the creation of specialized information technologies for dental specialties, the development of dental-related apps remains a distinctive and essential aspect.

Standardized dental software enables dentists and physicians to access patient medical information efficiently, facilitating seamless collaboration and enhancing the quality of patient care. The integration of these advancements has revolutionized the way dental professionals operate and has led to substantial improvements in dental services and patient outcomes.

One could argue that artificial intelligence is increasingly employed to diagnose diseases with a level of accuracy comparable to that of medical professionals. The field of dentistry has significantly benefited from the integration of artificial intelligence, particularly in areas like dental radiography and AI-powered oral imaging scans. These technological advancements have proven to be invaluable tools in enhancing diagnostic capabilities and delivering more precise and efficient dental care. Dental caries remains one of the most prevalent diseases affecting humans. The fundamental goals of the dentistry profession continue to centre on prevention, early diagnosis, and prompt treatment of dental caries. In this regard, artificial intelligence has emerged as a critical tool in facilitating the diagnosis and prognosis of diseases. Its integration into dental practices has significantly improved the precision and efficiency of disease detection, allowing for time saving and effective treatment strategies. The perception of artificial intelligence in dentistry can be influenced by societal perspectives and technological projections. The integration of information systems and artificial intelligence is expected to lead to more accurate diagnostics of prevalent mouth disorders.

Patient trust can serve as a catalyst for boosting dentists' confidence in their diagnostic abilities, fostering a positive outlook on the use of AI in dental practice. However, it may also engender scepticism and hesitation among some dentists who are uncertain about fully embracing AI advances in technology. Balancing modern advancements and advancement and preserving the patient-dentist relationship is essential for successful implementation and acceptance of AI in the field of dentistry.

Health information systems, especially standardized clinical coding systems, have played a vital role in supporting researchers and enhancing quality assurance procedures. However, there has been limited research conducted on clinical decision support systems that utilize electronic dental data. Similarly, the instructional value and impact of health information systems on the working conditions of dental professionals remain relatively unexplored areas in the research landscape. Further investigation in these domains could provide valuable insights into optimizing dental practice and improving the overall efficiency and effectiveness of healthcare delivery.

Artificial intelligence's perception in dentistry can be influenced by societal perspectives and technological projections. The integration of information systems and artificial intelligence is expected to yield highly accurate diagnostics of prevalent mouth disorders. Moreover, patient trust can enhance dentists' confidence in their diagnostic capabilities; however, it may also lead to scepticism and reluctance regarding the adoption of AI technologies. Balancing these factors is essential to effectively harness the potential of AI in dental practice while maintaining patients' trust and ensuring ethical and responsible implementation.

III. DISCUSSION

Through this systematic study, we aim to shed light on the progressive role of artificial intelligence in the detection and management of dental diseases. The research reveals that dental professionals stand to gain significant advantages from utilizing artificial intelligence at every stage of diagnosis and treatment due to its widespread adoption and effectiveness in the dental field.

Based on statistical data, artificial intelligence models have shown promising potential in assisting with dental diagnosis. To compile and evaluate the data, various techniques were employed, leading to the development of sophisticated artificial intelligence systems.

As a consequence, the comparison of studies posed challenges. Nevertheless, incorporating artificial intelligence allows dentists to identify dental problems more accurately while minimizing human error. Despite the benefits of accessing vast databases and conducting more thorough analyses, the practical application of artificial intelligence in daily life is limited by social, technological, and ethical constraints.

In the field of endodontics, artificial intelligence technology is extensively utilized. Research on the application of artificial intelligence in endodontics demonstrates that neural networks outperformed dental specialists in terms of precision and accuracy. Multiple research studies have indicated that artificial intelligence models have consistently outperformed experts in various domains. The findings suggest that these AI applications might prove to be more advantageous for beginners and non-specialists, offering valuable insights and guidance beyond the scope of traditional professional advice.

Artificial intelligence should be seen as an enhancement tool in dentistry, as it complements and, at times, relieves dentists of some of their more administrative responsibilities, such as patient data integration and record management, allowing them to focus more on developing professional relationships and delivering personalized patient care.

Present-day artificial intelligence excels at analyzing structured data and drawing conclusions from extensive datasets. However, it lacks the ability to create associations, and its capacity to make complex decisions in therapeutic situations is only partial. In ambiguous situations, higher-level understanding is crucial for conducting physical examinations, including medical histories, assessing aesthetic results, and fostering meaningful patient conversations. Dentists' expertise plays a pivotal role in providing the necessary insights and making informed decisions based on their in-depth knowledge and experience.

To ensure effective patient-dentist communication, understanding the patient's hopes, worries, and expectations through nonverbal cues is imperative. This remains significant despite the ongoing debates about whether empathy should be integrated into the algorithms utilized by affective robots to mimic human emotions. These lines of communication are intricate and deeply rooted in human interactions.

As part of their diagnostic process, dental experts utilize bitewing radiographs in addition to visual and tactile examinations of the oral cavity. However, it is important to note that bitewing radiographs are not always reliable or valid for diagnosing tooth decay. In one experiment, bitewing X-rays were found to have a low sensitivity of 0.24–0.42 in detecting dental cavities. Dental X-rays, when used for caries diagnosis, often produce false positive and false negative results. Recent research indicates that artificial intelligence-based technologies outperform dentists in identifying cavities on dental radiographs.

Near-infrared scans have been found to be more accurate than bitewing X-rays in detecting carious lesions inside the mouth. The advancement of algorithmic software systems, which aid dental diagnostics and data management, predominantly involves the application of artificial intelligence.

IV. CONCLUSION

Dental artificial intelligence has played a significant role in enhancing access to dental care, providing competent counsel to medical practitioners during clinical exams through AI-based solutions. The healthcare industry, as a whole, has witnessed remarkable achievements in artificial intelligence, as demonstrated by the multitude of studies published on the subject. Despite the reliability of artificial intelligence in dental analysis, practitioners may still encounter challenges in its correct interpretation. Some dentists may even perceive the technology as a risk until it gains widespread adoption in the field. Dentists need not worry about artificial intelligence taking over their jobs, unlike common concerns in other industries. Instead, AI assistants can provide valuable support, similar to how a torch assists them in illuminating specific tasks. Since dentists are not certified radiologists, examining X-rays constitutes only a small portion of their overall responsibilities, and AI can serve as a helpful tool in enhancing their diagnostic capabilities and streamlining certain aspects of dental practice. Even as the diagnostic process incorporates cutting-edge methods like artificial intelligence, dentists are expected to continue their commitment to treating patients and providing quality care. To foster trust and confidence in this advanced approach, it is essential to educate dentists and dental students about the principles and applications of artificial intelligence in dentistry. This knowledge will not only enhance their proficiency in utilizing AI technologies but also ensure that patients understand and have faith in the benefits of these innovative methods.

REFERENCES

- [1] The field of dentistry and Machine Intelligence: Existing Ideas and a Look Ahead. John S. and Alexander B. *Int J Adv Res.* 2018;30:1105-1108.
- [2] Benefits of neural networks in dentistry today and in the future. *J Endod.* 2021;47:1352–1357. Aminoshariae A, Kulild J, Nagendrababu V.