Review Article

Artificial intelligence in dental practice: An integrated approach

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A B S T R A C T

Artificial intelligence (AI) has grown tremendously in importance and has presence in many different industries, including dentistry. By mimicking human intelligence, it can make complex forecasts and judgments in the medical field, particularly in endodontics. A variety of artificial intelligence models, such as convolutional neural networks and/or artificial neural networks, have shown promise in endodontics. These models have been used to study the anatomy of the root canal system, predict the viability of dental pulp stem cells, measure working lengths, identify periapical lesions and root fractures, and predict the outcome of retreatment procedures.

Artificial intelligence (AI) technology is utilized in dentistry to expedite the comprehension of massive amounts of data and provide clinical decision-making support. This work aims to comprehensively review the areas in which artificial intelligence (AI) is now having a significant impact on clinical dentistry. Artificial intelligence (AI), which is evolving at a rapid pace, has the potential to replace physical expertise in dentistry. To reduce mistakes and oversight, these technologies must also be employed carefully and under human supervision. Early and accurate diagnosis of oral problems leads to better outcomes for patients.

1. Background

The brain is one of the most fascinating organs in the human body, and scientists and researchers have always been interested by it. The creation of an ideal mimic of the human brain has never been fully understood by science. For a long time, the advancement of "artificial intelligence" (AI) has been the subject of extensive scientific study. John McCarthy originally mentioned the field of applied computer science that is today known as artificial intelligence in 1956. It's also known as artificial intelligence at times. The "fourth industrial revolution," or artificial intelligence, refers to the use of computer technology to simulate human-like judgment, reasoning, and intelligent behaviour.[1]

Various AI models were employed in the analysis of the literature, and dental care-related elements were looked into. This work makes two distinct contributions to the corpus of knowledge. We mapped the literature on current trends in artificial intelligence (AI) in dental care delivery systems using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) approach. It also gives scholars a glimpse into the future by showcasing a range of technological approaches to predict oral problems.

2. Introduction

In the field of computer science, artificial intelligence refers to the study of computers with intelligence, or any system that understands its surroundings and acts in a

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way that maximizes its chances of success. The phrase "artificial intelligence" refers to the ability of a computer to simulate analytical abilities like "learning and problem-solving" that people generally associate with other human brains. Artificial intelligence methods have been extensively tested as clinical trial instruments, particularly to support prognosis and projection decision-making, as well as every stage of diagnosis and treatment planning. Artificial intelligence methods have proven to be quite proficient in identifying significant patterns in data. It has been demonstrated that artificial intelligence can more swiftly and affordably raise precision, accuracy, and efficiency to the level of medical specialists.

Every day, we are already impacted by it because of various office and practice management software. Siri, Alexa, and other voice command devices are just a few examples of applications that have developed sophisticated conversational user interfaces using artificial intelligence for any device, application language, or environment. In the healthcare sector, artificial intelligence finds use in both virtual and real (robotics) contexts. The mathematical formulae for medication dose, diagnosis and prognosis, appointment scheduling, drug interactions, electronic health records, and imaging are the core areas of the virtual type. The physical side includes tele-presence, robotic help during surgery, rehabilitation, and companion robots for geriatric care.[2]

Most dental algorithms use supervised learning, where the training data consists of multiple samples, each with a unique attribute (like photos of the patient, their age, sex, number of cavities, and so on) and ground truth determination (like whether or not there was a previous endodontic visit). Artificial neural networks (ANNs) use an algorithm to grasp the relationship between attributes and truth by mimicking the organic neuron system, which has many connections between neurons and is used for "learning."

By providing solutions for a range of clinical problems and making doctors' jobs easier, artificial intelligence (AI) has the potential to completely transform the medical and dental industries. Applications of artificial intelligence in the dental field are currently rare. However, robotic assistance, dental imaging diagnostics, caries detection, radiography and pathology, and computerized recordkeeping have all been impacted by the development of these technologies. Research on endodontic artificial intelligence has grown in step with the advancement of other dental specialties.

Endodontists need to keep up with the latest developments in artificial intelligence. Technology advancements have led to increased efficiency in dental practices using digital dentistry and enhanced visualization for diagnosis. Dental informatics is the field of dentistry that deals with communication, information management, and the use of new technology in clinical practice and research. Information created while interacting directly with patients, scheduling appointments, and managing dental practices is stored and used in dental offices.

In a healthcare information system (CIS), computers are used to record, preserve, and alter clinical data about patients. These IT solutions can be used separately or across the board in the healthcare sector. Integration, collection, and management of data from many sources are all part of CIS's support function for patient data management and healthcare administration. Dental departments use information systems designed to store large amounts of data and facilitate data processing. With CIS, further information on a patient's diagnosis and treatment can be acquired right away. Virtual reality training, practice, and more instruction are usually combined with web-based technologies, email communication, Internet search, and promotion practices.[3]

In clinical practise and research, contemporary instruments such as intraoral cameras, x-ray equipment, and medical literature retrieval are employed. Researchers have shown that when artificial intelligence (AI) adapts, it becomes more prevalent and effective. AI is also useful for the analysis and interpretation of images. Dental pictures, including intraoral photos, cone beam computed tomography (CBCT) scans, panoramic radiographs, and X-rays, can be analyzed by AI algorithms. AI models can identify and categorize a range of dental disorders, such as dental caries, periodontal disease, bone loss, impacted teeth, and oral tumours, by utilizing deep learning techniques. Artificial intelligence (AI) can help dentists spot anomalies, offer a helpful second opinion, and lower the possibility of human error.

Artificial intelligence (AI)-driven computer-aided detection (CAD) systems can help dentists with their analysis by automatically identifying and highlighting possible anomalies in dental pictures. Concerning areas, including suspicious lesions or early indications of oral illnesses, might be marked by CAD systems. Early detection enables dentists to intervene promptly, improving patient outcomes. Robotic arms, instruments, and sensors created especially for dental procedures make up the robotic systems utilized in dental care. Dentists operate these systems, directing and monitoring the robot's movements during the course of therapy. Robotic arms, instruments, and sensors created especially for dental procedures make up the robotic systems utilized in dental care. Dentists operate these systems, directing and monitoring the robot's movements during the course of therapy.

Robotics-assisted dentistry encompasses a variety of dental procedures, such as orthodontics, root canal therapy, crown or veneer insertion, and dental implant placement. Compared to traditional manual procedures, the robotic system helps accomplish precise and repeated jobs with a better level of accuracy. Advanced imaging technologies

like intraoral cameras and cone beam computed tomography (CBCT) are frequently integrated into robotic systems. Real-time, high-resolution images are provided by these imaging devices, which help with dental procedure planning and guidance. Dentists' ability to see the treatment region from various viewpoints and angles helps them make better decisions.[4]

Dentistry with robotic assistance can be done with less intrusive techniques. When preparing teeth or performing other operations, dentists can preserve healthy tooth structure thanks to the robotic system's precise and controlled movements. Patients may experience less discomfort during surgery and recover more quickly as a result. It is imperative to acknowledge that the job of dentists is not substituted by robotics-assisted dentistry. Rather, it functions as a tool to enhance their abilities and provide them more control and precision when doing processes. To guarantee the best possible results and patient safety, dentists continue to be actively involved in treatment planning, patient interaction, and robotic system supervision.

Significant progress has been made in the dentistry industry thanks to information systems and technological breakthroughs. Dental specialization has led to the development of specialized information technologies (IT), and applications related to dentistry still require unique development. Physicians and dentists will have access to patient medical information via standardized dental software. Artificial intelligence is arguably used to diagnose diseases with a degree of precision that is on par with that of medical professionals. Particularly with dental radiography and artificial intelligence oral imaging scans, artificial intelligence has significantly advanced dentistry. The most prevalent disease affecting humans is dental caries. The main goals of the dentistry profession continue to be dental caries prevention, early diagnosis, and timely treatment. As a result, artificial intelligence has emerged as a crucial diagnostic and prognostic tool.

Hao Ding et al[5] recently suggested that in the realm of dentistry, new technologies are developed and embraced quickly. One of the most promising technologies is artificial intelligence (AI), which has advantages like great accuracy and efficiency when trained properly and with unbiased training data. AI is a useful tool that dentists can use to lessen their burden and increase precision and accuracy in diagnosis, decision-making, treatment planning, outcome prediction, and illness prognosis.

AI need to be seen as an augmentation tool, supporting and even relieving dentists of some of their more labor-intensive duties, such integrating patient information and fostering stronger professional relationships. Modern artificial intelligence is very good at extracting meaning from large volumes of data and applying structured knowledge. However, its capacity to form associations is inferior to that of the human brain, and its ability to make complex decisions in a clinical setting is only partially developed. Higher-level comprehension, which is dependent on dentists' experience, is particularly required in ambiguous situations in order to do physical examinations, take medical histories, assess aesthetic outcomes, and encourage dialogue. It is important to emphasize that effective communication between the dentist and the patient depends on the dentist assessing the patient's hopes, fears, and expectations nonverbally.[6]

Before beginning treatment, the most crucial phases in orthodontics are diagnostic and planning. AI is being developed to schedule treatments that include extraction versus non-extraction. These choices are often made by the orthodontist using data from study models, radiographs, and preoperative photos. Therefore, it was not shocking to learn that the AI under test struggled to decide whether to extract or not to remove based only on radiographs.[7]

Modern dentistry has made extensive use of computer-aided design and manufacture (CAD/CAM) technology, particularly in the areas of maxillofacial surgery, prosthetics, implantology, and orthodontics. For instance, orthodontic appliances, maxillofacial surgical templates, provisional/final restorations, and surgical implant guides can all be made with CAD/CAM technology. The majority of these applications—such as intraoral/facial scanning and the scanning of dental casts and impressions—are predicated on 3D hard and soft tissue images produced by CBCT and optical scanning. The most precise technique for digitalizing the three-dimensional shape of teeth and gingiva is intraoral scanning. Consequently, the scanning of dental casts or impressions is rapidly being replaced by the intraoral scanning technology, which is also widely utilized in CAD/CAM systems.[8]

Artificial intelligence in dentistry may be viewed differently depending on the social context and technological predictions. It is assured that the combination of artificial intelligence and information systems would result in precise diagnosis of common mouth disorders. Furthermore, patient trust can both increase and decrease confidence in dental diagnosis and its application. The advancement of health information systems, particularly standardized clinical coding systems, has greatly aided researchers and quality measurements. Clinical decision support systems that repurpose digitized dental data have received little attention. Additionally, the pedagogical value of health information systems for dental practitioners' working settings has not been thoroughly investigated.[9]

3. Discussion

This study aims to provide insight into the evolving role of artificial intelligence in the diagnosis and treatment of dental diseases. We found that artificial intelligence is widely used in dentistry and that it could be beneficial to

dentists at all stages of diagnosis and treatment. Artificial intelligence models may help in dental diagnosis, according to some evidence. Various techniques were used to collect and evaluate data to create artificial intelligence systems.[10] In this way, dentists are able to identify dental defects with accuracy and minimize human error. Artificial intelligence can access vast datasets and do more thorough analysis, but its application in daily life is constrained by ethical, technological, and societal concerns.[11]

The field of endodontics has made extensive use of artificial intelligence technology. Neural networks performed more precisely and accurately than dental experts, according to studies on the application of AI in endodontics. In several research, artificial intelligence models have also performed better than experts. The results suggest that novices and non-specialists may find these applications more helpful than expert opinions.[12] Artificial intelligence is best viewed as a supplement to, and occasionally a substitute for, dentists' more advantageous tasks, such as integrating patient data and establishing professional relationships. Artificial intelligence in the modern era excels at utilizing organized data and deriving conclusions from massive amounts of information.[13]

It is only partially capable of making complex judgments in a therapeutic situation, and unlike the human brain, it is incapable of making associations. In particular, in unclear situations, higher-level comprehension—which depends on the experience of dentists—is needed to do physical examinations, take medical histories, evaluate aesthetic outcomes, and promote conversation.[14] It must be emphasized that comprehending the patient's hopes, worries, and expectations through nonverbal clues is crucial to effective patient-dentist communication. This is true even though there are contentious debates about whether affective robots' algorithms that mimic human emotions should include empathy or not. These are irrational and spontaneous channels of communication.[15]

Dental practitioners use bitewing radiographs in addition to tactical and visual examinations of the mouth cavity as part of their diagnosis process. Bitewing radiographs are neither reliable or valid for diagnosing dental decay. In one study, bitewing X-rays were found to have a low sensitivity of 0.24–0.42 for detecting dental caries. When using dental X-rays to diagnose caries, false positive and false negative results are also common. Several recent studies have shown that artificial intelligence-based devices can identify cavities on dental radiographs more accurately than dentists.[16]

Near-infrared scans have been found to be more accurate than bitewing X-rays in identifying carious lesions inside the mouth. The development of algorithmic software systems that support dental diagnostics and data management commonly makes use of artificial intelligence. Dental artificial intelligence has improved accessibility to dental care, and AI-based solutions can offer medical practitioners professional recommendations during clinical evaluations. In the field of healthcare, artificial intelligence has advanced significantly, and numerous studies have been published.[17]

Despite the fact that dental analysis has shown artificial intelligence to be credible, practitioners still misunderstand the technology. Some dentists may even view the technology as dangerous until it is widely used by the industry.[18] Despite common worries in other industries, dentists shouldn't be concerned about artificial intelligence taking over their jobs.[19] An artificial intelligence assistant can aid them in a similar way to how a torch might because they are not certified radiologists and seeing X-rays is only a small portion of their work. Throughout the diagnostic stage, dentists are obliged to continue treating and caring for their patients. But to encourage trust in this innovative method, dentists and dental students need to be informed.[20]

4. Conclusion

AI technology has changed the healthcare sector and encouraged businesses and researchers to make investments in the medical area. The authors believe that as artificial intelligence (AI) in dentistry advances, it will help researchers and clinicians combine various fields of expertise and enhance patient care. Nonetheless, it's critical to be conscious of the possibility of mistakes when interpreting data using AI systems. Right now, it makes sense to mix AI technology with conventional approaches to reduce output errors. According to the authors, the advancement of artificial intelligence in dentistry would depend heavily on a novel kind of inter-professional coordination between researchers, clinicians, and engineers.

5. Source of Funding

6. Conflict of Interest

None.

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