ijlpr 2023; doi 10.22376/ijlpr.2023.13.6.L104-L108

International Journal of Life science and Pharma Research

ISSN 2250-0480

Review Article

AI in Dental Applications

Artificial Intelligence: An Overview of Dental Applications

Gagan Agrawal[1*], Dr.Aarati Panchbhai[2], Dr. Amit Reche [3], Radha Deshmukh[4] and Vaidehi Borkar[5]

[1,4,5]*Intern, Sharad Pawar Dental College and Hospital Datta Meghe Institute of Higher Education and Research (Deemed to beuniversity), Sawangi (Meghe), Wardha 442001, Maharashtra, India,*

[2]*Professor, Department of Oral Medicine and Radiology, Sharad Pawar Dental College and Hospital Datta Meghe Institute of Higher Education and Research (Deemed to be University) Sawangi(Meghe), Wardha442001, Maharashtra,India*

[3]*Head of Department, Department of Public Health Dentistry Sharad Pawar Dental College and Hospital Datta Meghe Institute of Higher Education and Research (Deemed to be University) Sawangi(Meghe), Wardha442001, Maharashtra, India*

Abstract: Artificial intelligence (AI) is emerging as a promising modality and could be anticipated to shape the future of dental health care delivery. Artificial intelligence is the solution that assists doctors rather than replaces them, and hence is more likely to be accepted by healthcare professionals. Artificial Intelligence has several clinical applications and has encompassed almost all the specialties of the dental field. Common dental diseases such as dental caries, pulpal pathologies, bone loss, cysts, salivary gland disease, lymph node metastasis, etc., are easily diagnosed and well treated with the help of AI and robotics. AI and Machine learning has made an excellent and impactful way of changing dentistry. In dentistry, AI helps predict the future of disease, that is, prognosis and treatment planning. Additionally, it will open new avenues in research and development. Since the last few centuries, AI has shown significant growth and progress in digital technology. The applications of AI have been tremendously increased in terms of data sciences, robotic field machine intelligence and deep learning, and computer sciences. Now a day's, expert human minds get replaced by computer data, or the mind gets filled with robotic fields. When talking in the field of medicine and dentistry has various numbers of applications that improve the outcomes of the patient. In dentistry, AI has played a major role in diagnosis, identifying abnormal and normal structures, and resulting in the best treatment output. This review gives light on the importance of the robotic field in dentistry**.** This review covers a combination of all aspects of artificial intelligence in dentistry that should have been included in some articles. Most of the review studies focus on intelligence networks and the applications of artificial intelligence in dentistry. The article concludes that the implementation of sources of artificial intelligence in dentistry as well as in medical sciences with more precise results and minimum amount of error.

Keywords: Artificial intelligence, Machine learning, Deep learning, Dentronics, Computational technology, Dento-Sciences, Computational neurobiology, Electronic Brain, Cognitive learning

***Corresponding Author**

Gagan Agrawal , Intern, Sharad Pawar Dental College and Hospital Datta Meghe Institute of Higher Education and Research (Deemed to beuniversity), Sawangi (Meghe),Wardha 442001, Maharashtra, India

Received On 22 February, 2023
Revised On 9 May, 2023
Accepted On 31 May, 2023
Published On 1 November, 2023

Funding This research did not receive any specific grant from any funding agencies in the public, commercial or not for profit sectors.

Citation Gagan Agrawal, Dr.Aarati Panchbhai, Dr. Amit Reche, Radha Deshmukh and Vaidehi Borkar , Artificial Intelligence: An Overview of Dental Applications.(2023).Int. J. Life Sci. Pharma Res.13(6), L104-L108 http://dx.doi.org/10.22376/ijlpr.2023.13.6.L104-L108

1. INTRODUCTION

Artificial intelligence (AI) is being explored tremendously for possibilities of early diagnosis, appropriate treatment, and satisfying outcomes. Alan Turing was the first scientist to think about the computer sciences in 1950. He created or designed such an application that detects abnormality without less error and gives the best results. AI has been continuing since 1950 with much-advanced features till the date. AI uses applications in such a way that it is easy and simple for the general public and individuals. One can find the problem in the machine data and try to correct it. This is all possible with the help of devices or apps created by robotic sciences. It is an emerging discipline that includes setoff sciences, theories, techniques, computer science, and computational neurobiology. Machine learning, deep learning, and cognitive learning are the sub-class in the robotic world. It has been known to be progressing rapidly since last decade. It is intelligence demonstrated with the help of machines[1]. In 1956, Dartmouth College first coined the term Artificial intelligence may have several applications in the healthcare field of medicine and dentistry. From 1957 to 1974, the growth of artificial intelligence increased tremendously due to the increased awareness of computer and internet sources among individuals**.** Artificial intelligence is concerned with computational understanding and emphasizes the creation of intelligent machines. AI has made opportunistic routes, especially in medicine, radiology, ophthalmology, pathology, dermatology, etc. The 1950s would be the era where the role of artificial intelligence in health care was recognized. With the huge data collected in daily practice in dental health care, the range of tools and networks used in artificial intelligence may work to some extent as a human mind to handle this data, process, and analyze it to draw conclusions[1,2]. The need for machine assistance has arisen due to the piling of health care data which can be utilized for clinical applications, evidence, predicting the spread of diseases, and research developments using computational technologies based on which various clinical decisions can be made about in diagnosis, prognosis, and management[3].Combining oral health care with artificial intelligence will pave the way for newer possibilities in patients' dental care. However, utilizing Artificial intelligence requires skilled professionals to handle and interpret the data under investigation[4].The present review article focuses on the application of artificial intelligence in dentistry. In the 1980s, it developed through machine learning (ML) and expert systems. They are two opposite approaches to AI considering their theory. ML allows computers to learn by experience. The search strategy primarily included searches in Pubmed and Scopus to include various other databases. AI systems help clinicians get better results, with high-quality treatment given to the patients. It reduces errors regarding diagnosis, treatment planning, and result evaluation. It gives dentists a more special quality of work and decreases the workload. Future implications of AI in dentistry not only give the best results but also detects lesions or conditions that are not visible with the help of the human eye. Artificial Intelligence is considered to have clinical-based knowledge in dentistry; its speedy data handling and diagnosis enables its uses indentalfield[5]. Automated technology can speed up clinical processes and boost physician productivity (e.g., automatically completing electronic dental records by identifying the tooth and numbering). The accuracy of the diagnosis can be increased by using these systems for secondary views. The anticipated applications of Artificial Intelligence in various branches of dentistry have gained importance over time.

2. OVERVIEW

Artificial Intelligence has several clinical applications in every field of dentistry. It has encompassed almost all the specialties of the dental field[6]. Common dental diseases such as dental caries, pulpal pathologies, bone loss, cysts, maxillary sinusitis, salivary gland disease, lymph node metastasis, etc., are easily diagnosed and well treated with the help of AI and robotics[7]. AI has made an excellent and impactful way of changing dentistry. The multiparametric pattern is the computerized method of diagnosis and treatment plans in periodontics, prosthodontics, and oral and maxillofacial surgeries[8].AI has played an elegant role in stomatology. Oral and maxillofacial surgeries, oral medicine therapy, pre-prosthetic surgeries, implants, etc., are possible with the help of AI. AI has made possible avenues in guidance as well as in teaching[9]. Machine learning is the subpart of AI that helps dental graduates in research. In dentistry, AI helps predict the future of disease and its treatment planning. Automated dental imaging is done very simply with the help of AI[10]. AI has a tremendous role in clinical research and clinical dentistry. Model data and security data privacy are all relevant contents under AI. Commercial productions are progressing rapidly in day-to-day life with the help of AI. AI has decreased the workload of general physicians and dentists with their contribution to routine work[11]. AI has improved humans' decision-making powers and influences the human brain's power in everyday life.AI helps inappropriate diagnosis and superior patient care. Research and development and clinical aspects of dentistry are all included under AI. With the help of AI, the duration of longer treatment can be reduced[12].AI has parallel term i,e. Dentronics means computer science plus the dental world, that will help enhance and advance the future of dentistry. Diagnosis, prognosis, and treatment planning get easy in regards to AI[13,14]. Dentronics will help clinicians and researchers in disease pathogenesis and understanding the concept of lesions or dental defects with satisfying outcomes. Difficulties and misinterpretations will be reduced with the help of AI. Prediction of images, case records, and dental field research gets day by day easy only with the help of AI or robotic computer science. AI not only builds up public confidence but also helps to get their interest in the research field and clinical aspects[15]. AI has a powerful impact on dentists and dental students and makes their knowledge deeper.

3. SPECIALTY-WISE APPLICATIONS OF ARTIFICIAL INTELLIGENCE

3.1. Orthodontics

Malocclusion is the main domain under the entire orthodontics. So, with the help of AI, clinicians can decide and plan based on AI whether teeth should be extracted before treating the malocclusion[16].AI has made a tremendous approach in orthodontics that helps the dentist effectively and efficiently. Cephalometrics, part of orthodontics, has many applications based on artificial intelligence. AI has played a tremendous role in cephalometrics. When we compared the cephalometrics performed by authors as a gold standard. AI cephalometrics gives clinical application and appropriate precision. All in all, it plays a meticulous role in orthodontics[17].

3.2. Endodontics

In the field of endodontics, it allows us to reveal the finer details as AI helps in such a way that one can determine whether the distal root of the mandibular molar has one or more than one canals. This helps in treatment planning as well as in endodontic root canal therapy.

3.3. Periodontics

Periodontitis is the main culprit in periodontics and has two main forms Aggressive and chronic periodontitis; AI-enabled the finer differentiation between aggressive and chronic periodontitis. So that patient gets diagnosed easily and treated efficiently.

3.4. Oral Pathology

With the help of artificial intelligence, any pathological condition gets easily diagnosed and treated. Normal and abnormal structures are diagnosed more simply with the help of AI. Ameloblastoma and OKC have similar clinical and radiographic symptoms. At the time of diagnosis AI play an effective role. Using various modalities AI has made diagnosis quicker. For example, without AI, it takes longer to diagnose these tumors; but with AI within seconds, it is possible to assimilate and interpret data to diagnose and treat ameloblastoma and OKC.

3.5. Oral and Maxillofacial Surgery

In dental radiology, identifying maxillofacial defects using a robotic world has made a clear, simple, and efficient way to treat the problems[18]. Orthognathic surgeries and dentofacial deformities can be very well diagnosed radiologically and treated with the help of AI.

3.6. Public Health Dentistry

AI has increased the thinking power of public healthcare professionals. With the help of AI, it is very easy for dental professionals to improve public health with good results and satisfying outcomes[19]. There will be a positive correlation between clinical files and AI in the future. AI is a promising tool, and every dental and medical has to work under AI towards progression.

3.7. Oncology

AI has provided novel approaches in oncologic study, although the applications regarding oral oncology need to be substantiated[20].AI enabled the elaborated and discrete study regarding oral cancers. Therefore, in the future, scientists may progress with AI's help in oral oncology.

3.8. Oral Medicine and Radiology

The data handling and diagnosis have been easy for highly prevalent oral potentially malignant disorders. The precancerous and cancerous lesions and potentially malignant diseases are well diagnosed with the robotic tool. With the help of AI, radiologists are using the updated forms of radiography[21].The intervention of AI has augmented the way radiology is being practiced nowadays. It helps to detect landmarks as well as pathologies more clearly than before. The robotic world is known to have an accuracy of 99.5 and a sensitivity of 74.9. The side effects of the drugs may be well detected with the help of AI. The great future we can predict with the help of AI. AI makes the upcoming challenges better. The use of artificial intelligence may be crucial in assessing the side effects. A healthier future can be envisaged using artificial intelligence-guided new scientific accomplishments in pharmacovigilance.

Table 1: Applications Of Artificial Intelligence In Dentistry

Branches	Applications In Dentistry
1. Orthodontics	Malocclusion, Cephalometrics, Model Analysis
2. Endodontics	Root Canal Therapy
3. Periodontics	Helps In the Detection Between Aggressive And Chronic Periodontitis
4. Oral Pathology	Odontogenic Cysts, Tumors, And Lesions
5.Oraland Maxillofacial Surgery	Orthognathic Surgeries, Dentofacial Deformities
6. Public Health Dentistry	Surveys, And Improve the Results of Health Care Domain.
7. Oncology	Detection Of The Oral Cancers.
8. Oral Medicine And Radiology	Detection Of Potentially Malignant Precancerous And Cancerous Lesion.

4. CHALLENGES OF ARTIFICIAL INTELLIGENCE IN MEDICAL PRACTISE

There are various reasons why AI is less popular in dentistry. But the main reason is that, like other data, medical and dental data is not available easily. Although it is in the most organized form and in a structural way, the medical and dental field includes large information such as the whole history of the patient, treatment is given, and medicinal prescription. It is difficult to store such a huge amount of data in the computer of many patients. The medical and dental field's storage capacity takes up larger space than other data that take up small spaces. The medical sciences data is multi-dimensional, complex, and descriptive manner. But the other data are in the form of standard terms. Sampling leads to the selection of bias. It creates difficulty for the user who tries to understand the data associated with the medical field. By overcoming all these factors, it will be easy for dental professionals to get familiar with AI machines. These will lead to more use of AI among dentists.

5. FUTURE WITH ARTIFICIAL INTELLIGENCE

In the upcoming years, there will be a synchronized correlation between clinicians, researchers, human brain using AI[22]. The future, with the help of AI, is a promising tool in the form of practicing dentistry. Not only in dentistry, but AI has also played a significant role in medicine. With the help of AI, there will be progressive and remarkable changes in the field of dentistry innearfuture.AI, Robotics, Dentronics have a powerful impact on the human brain. Nowadays, Dentronics has gained attention in the clinical as well as surgical fields. Dentronics and Robotic Neural Networks

have greatly influenced the perspective of the dental and medical world. It has several clinical applications that are essential for oral and dental health. Robotics and Dentronics have created new brain power concerning healthcare research. Robotics has several knowledge and information-based application in clinical research[23].

A. Machine Learning

Machine learning, robotics, and Plantronics will keep changing the ideas and contentregarding dentistry and the medical field. Advanced dentistry is envisaged to impact the dental field highly. Many similar studies have been successfully done at our university with great effort and determination. Major challenges and difficult work become easy with the help of the robotic world and advanced technology. The people can handle difficult situations in a very elegant manner. Machine learning is a basic part of AI. With the help of machine learning, a great future can be assumed. AI has various roles in robotics, neural networks, deep learning, recording data, etc. Machine learning will help the dentist and clinicians in diagnosis and treatment planning. It makes the difficult work very simple. One can do skillful work with the help of machine learning. Machine learning has various scopes in the field of AI as well as in the healthcare field. In the year 1950 idea of AI developed not only in dentistry and medicine but also in medicinal therapy. AI is very useful and essential in pharmacotherapy[24]. We can research a variety of approaches in the field of AI. A maximum amount of online data is required for machine and deep learning[25]. Thought, imagination power, thinking ability, etc., improve with the help of AI. AI is useful in making decisions as well as in maintaining records. It has many knowledge-based applications in the healthcare field. The combination of AI and healthcare will help to maximize the outcomes in the healthcare field. Machine learning and Artificial intelligence may parallel the human mind.

B. Deep Learning

Deep learning is characterized by entity machine learning. This system includes varieties of data for the individual in terms of learning pattern and the pattern that helps build on each other[26]. Combining learning patterns and their application profoundly impacts the Artificial Intelligence sciences. For example, a child sees a cat on the computer, but in the first vision, he is not able to understand the cat; with the help of deep learning, he can understand part by part of the cat, and then later a picture of a whole cat gets into his mind. An Artificial Neural Network is an important entity under the class DL. It consists of small communicating units called neurons or signals that are arranged in a simpler and organized way. It contains three layers, the output layer, the input layer, and the hidden layer that is situated in between the output and input layers. The hidden layer is not visible. This pattern of neurons suggests the neural network and its effect on deep learning, which further stimulates the AI to initiate the work, which in turn helps the clinicians in the best way.In medicine and dentistry, one of the most commonly used subclasses of Artificial Neural Network**s** is the convolutional neural network (CNN). The convolutional neural network has the intricacy of work using a unique neuron connection design. It uses mathematical operations to process digital signals such as sound, image, and video. Convolution neural networks use a sliding window to scan a small neighborhood of inputs at a time, from left to right and top to bottom, to analyze a wider image or signal[27]. They are extremely well adapted to the image classification task and are the most-used algorithm for image recognition.

6. CONCLUSION

Artificial intelligence is playing an essential role in dental practice. Artificial intelligence would be the ultimate version of advancements in technology applicable to the healthcare field. However, we can get incrementally closer to that, and that is basically what we work on. Shortly, it would enable us to understand exactly what a dentist wants, and it would be able to perform it rightly. The rapid advancement in automation may change working in the healthcare industry swiftly. Data handling and knowledge-based management would be two important arms of artificial intelligence. Artificial intelligence applications can deal with the enormous data available in the healthcare sector and configure the new data, thus evolving gradually. Artificial intelligence may soon become a useful tool. Artificial intelligence is emerging as a promising modality and could be anticipated to shape the future of dental healthcare delivery. Artificial intelligence is the solution that assists doctors, rather than replaces them, and hence more likely to be accepted by health care professionals.

7. AUTHORS CONTRIBUTION STATEMENT

Gagan Agrawal has carried out data collection and has prepared the manuscript. Dr. Aarati Panchbhai has guided the preparation of the manuscript and reviewed the manuscript. Dr.Reche and Dr. Mishra have provided kind support in literature data and guided necessary changes in the review.

8. CONFLICT OF INTEREST

Conflict of interest declared none.

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