

Original Research

Artificial Intelligence: Boon to Dentistry

¹Radha Chauhan, ²Susheel Kumar, ³Kanika Chopra, ⁴Milind Rajan, ⁵Vishal Shrishail Kudagi, ⁶Aarti P. Mali

¹Senior lecturer, Department of Prosthodontics and Crown and Bridge, Mahatma Gandhi Dental College and Hospital, Jaipur, Rajasthan, India;

²Senior lecturer, Department of Pedodontics and Preventive Dentistry, Panineeya Dental College, Hyderabad, Telangana, India;

³Postgraduate Student, Department of Pedodontics and Preventive Dentistry, SCB Dental College and Hospital, Cuttack, Odisha, India;

⁴Postgraduate student, Department of Pedodontics and Preventive Dentistry, Coorg Institute of Dental Sciences, Virajpet, Karnataka, India;

⁵Lecturer, Department of Orthodontics, JSS Dental College and Hospital, Mysore-15, Karnataka, India;

⁶Postgraduate student, Department Oral and Maxillofacial Surgery, College of Dental Science and Research Center, Ahmedabad, Gujarat, India

ABSTRACT:

Artificial Intelligence is slowly but steadily invading into dentistry and revolutionizing the field. It is a field of both engineering and science, associated with the perceptive of intelligent behavior, and creating artifacts that replicate such behavior. Artificial Intelligence can serve as a useful modality in diagnosis and treatment of lesions of the oral cavity and can be employed in screening and classifying suspicious altered oral mucosa undergoing premalignant and malignant changes. The current review aims to highlight the role of artificial intelligence in dentistry.

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Corresponding author: Radha Chauhan, Senior lecturer, Department of Prosthodontics and Crown and Bridge, Mahatma Gandhi Dental College and Hospital, Jaipur, Rajasthan, India

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INTRODUCTION

Artificial intelligence (AI) refers to the mimicking of human intelligence in machines that are programmed to think like humans and mimic their action. The essence of artificial intelligence is its capability to rationalize and execute accordingly increase the probability of achieving a specific goal. New decade holds promising advances in healthcare system. Dentistry, with due credits to artificial intelligence is seeing revolutionary transformations too. The dentists of the modern era have never held themselves back from acclimatizing newer technologies with promising prospects.¹ With the growing need for proper documentation and maintenance of patient information, an advanced form of computation of this data is a necessary. Artificial Intelligence has become a necessity and growing demand due to need for advanced data processing, diagnosis and need in

dental education. Artificial intelligence has found a number of applications in the field of medicine and dentistry.²

The concept of artificial intelligence was given by John McCarthy in the year 1956. Constant search for the model has led to the development of AI. Artificial intelligence is defined as a field of science and engineering concerned with the computational understanding of what is commonly called intelligent behavior, and with the creation of artifacts that exhibit such behavior.³ The current review aims to highlight the role of artificial intelligence in dentistry.

CONCEPTS OF ARTIFICIAL INTELLIGENCE

Concept of Artificial intelligence includes machine learning, representation learning, and deep learning.^{4,5,6}

MACHINE LEARNING

Machine learning (ML) is the scientific study of processes that computer systems use to effectively perform a specific task without using explicit instructions, relying on patterns and inference instead. Machine learning processes build a mathematical model based on sample data, commonly called as "training data", so that it can take decisions without being explicitly programmed to perform the task.

REPRESENTATIONAL LEARNING

It is a subtype of ML, in which, the computer algorithm learn the features require for classifying the provided data. Unlike machine learning it does not require hand labeling of data.

DEEP LEARNING

Deep learning is part of a broader family of machine learning methods based on artificial neural network⁶. Deep learning architectures such as deep neural networks, deep belief networks, recurrent neural networks and convolutional neural networks has been applied to fields. including drug designing, radiological image analysis, and histopathological diagnosis where they have produced results comparable to and in some cases superior to human experts.

APPLICATION OF AI IN DENTISTRY

AI IN DIAGNOSIS

Artificial intelligence can be used as a useful modality in diagnosis and treatment of lesions of oral cavity and can be employed in screening and classifying suspicious altered mucosa undergoing premalignant and malignant changes. AI has revolutionised field of diagnosis. With simple mobile applications, pictures of lesion can be uploaded in the application and diagnosis can be made by comparing the pictures from the vast data available around the world. Thus, doctors can prioritize the appointment when necessary and patients have easy access to expert opinion.

Artificial intelligence can be useful in screening and diagnosing suspicious oral lesions into premalignant and malignant lesions. AI provides both qualitative and quantitative data based on data input to the practitioner and thus improving accuracy in early detection, diagnosis, treatment planning.⁷

AI IN TREATMENT PLANNING

The neural networks when optimally trained with respect to lower third molars are found to have high specificity and sensitivity equivalent to specialist consultation in categorizing tooth to "gold standard" based on National Institutes of Health (NIH) consensus development program which describes a well defined criteria for the removal of third molars. It can also be employed to determine if extractions are necessary before orthodontic treatment. Additionally it can be used in classifying patients into aggressive

periodontitis and chronic periodontitis group based on their immune response profile.⁸⁻¹⁰

AI IN PATIENT MANAGEMENT

Patient management in the operatory, "virtual dental assistants can accomplish the tasks with minimal errors and higher accuracy, also less workforce is required. Artificial intelligence software is helpful in the documentation of necessary data more efficiently and comprehensive virtual data can be used later for providing ideal treatment to the patients as and when required. Also, it can be used for managing appointments, insurance, and collecting all required dental records.^{11,12}

AI IN DENTAL EDUCATION SYSTEM

Clinical dentistry is an essential part of dentistry for learning the skills, to enhance patient care. Traditionally, pre-clinical operative training for dental students was combination of theoretical teaching and practical learning. Recently artificial intelligence has been incorporated into tutoring intelligent education system and training in dentistry.

These technologies have the ability to create virtual reality that enables simulation of the practical procedures in three dimensions that enable simulation and allow assess to clinical and surgical techniques. The practice sessions can be done several times till the skill set is expertise by students over the subject prior to actual handling of real clinical cases reducing the risk of iatrogenic damage. This method of training proves to be more efficient, inexpensive and reliable.¹³

AI IN PEDIATRIC DENTISTRY

Artificial intelligence is gaining momentum in all fields and is opening up new frontiers in pediatric dentistry as well. Beginning with examination and diagnosis, behavior management, pain control, orthodontic tooth movement and restorative dentistry, artificial intelligence has a myriad of potential applications and it can change the way we teach and practice modern dentistry.

AI in combination with emerging technologies such as VR in the form of a digital learning platform can benefit more children and provide a personalized adoptive learning paradigm.¹⁴

AI IN PROSTHODONTICS

AI aids in prosthodontics by the use of computer aided design and computer aided manufacturing technology for precision fit of prosthesis, but with innovation in generative adversarial networks, laboratories are using AI to automatically generate advanced dental restoration for custom fit and ideal function and also, improvised aesthetic appearance. Using Artificial Intelligence, the computer will actually direct the dentist through the whole process of creating a digital impression and assist in making an ideal impression. It helps in analyzing arch pattern

and helps in designing the partial or complete removable dentures. The advancement of virtual reality has made the process of providing cosmetic prosthetics and meeting patient needs much simpler. The patient can try on a virtual prosthesis with the aid of AI systems and augmented reality, which can be changed until the patient is pleased, and the final prosthesis is made exactly according to these requirements.^{15,16}

The introduction of AI in the field of implantology has made designing the prostheses to accurately and automatically and helps in identifying the exact location for implant placement. AI embedded tongue drive system is capable of analyzing tongue motions in the oral cavity and acting in accordance with the commands stated in the guidelines.¹

AI IN ORTHODONTICS

The most talked about recent innovation is in AI driven customized orthodontic treatment. With precise 3D scans and virtual models, it is easy to 3D print the aligners with customized treatment plan. As the vast data get computed, it creates an algorithm which intelligently decides how a patient's tooth or teeth should be moved, with how much pressure, even identifying pressure points for that particular tooth or teeth. The AI aided aligners not only deliver precise treatment execution but also helps in monitoring the progress as well and claim to reduce treatment time as well as appointment schedules.¹⁷

AI IN PERIODONTICS

Recently artificial intelligence has been incorporated into tutoring intelligent education system and training in dentistry. These technologies have the ability to create virtual reality that enables simulation of the practical procedures in three dimensions that enable simulation and allow access to clinical and surgical techniques. The practice sessions can be done several times till the skill set is expertise by students over the subject prior to actual handling of real clinical cases reducing the risk of iatrogenic damage. This method of training proves to be more efficient, inexpensive and reliable.^{18,19}

In a study conducted by Shankarapillai R et al. (2010) AI has been used successfully in the periodontal risk assessment based on data from 230 patients. In their algorithm many items have been included, such as age, bleeding on probing, average pocket probing depth, presence of root calculus, and vertical bone loss as being assessed on dental films.²⁰

ADVANTAGES OF AI²¹

1. Tireless performance of the tasks which saves time
2. Logical and feasible decisions without any involvement of human emotions which results in an accurate diagnosis
3. It is an effective tool or aid to recognize patterns, predict events, and for grouping objects

4. Standardization of procedures

DISADVANTAGES OF AI²¹

1. The complexity of the system
2. The cost involved in the setup
3. Enormous data is required for training and precision and therefore it is difficult to achieve accuracy in rare conditions or diseases.
4. May not adapt with new imaging software or new machine immediately

CONCLUSION

AI is growing tremendously but it can never replace human knowledge, skill, and decision ability. The field of artificial intelligence is relatively young but has still come a long way in the fields of medicine and dentistry. Hence, there is a need for the dentists to be aware about its potential implications for a lucrative clinical practice in the future

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