# AI's Impact on Dentistry: Enhancing Patient Care And Treatment Outcomes: A Review Article

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**Abstract**
The field of artificial intelligence (AI) is a rapidly developing field that has captured the attention of scientists worldwide. Artificial intelligence (AI) in healthcare is becoming more widely used and is drastically altering the way that healthcare is provided. AI is being used in a wide range of contexts, such as clinical labs, research institutions, and hospitals. Some of the remarkable advancements in dentistry have occurred since its start, from data processing and relevant information retrieval to the use of neural networks for diagnosis and the inclusion of augmented and virtual reality in dental education. The diagnosis and treatment suggestions, patient involvement and adherence, and administrative tasks are the main uses. The requirement for accurate patient data recording, efficient and reliable robotic therapy techniques, and the discipline of surgery has promoted the use of these software tools to help dentists diagnose and treat patients effectively. However, this technological development is still in its early stages, and the purpose of this article is to illustrate how artificial intelligence is used in dentistry.

**Keywords**: Artificial Intelligence, Dentistry, Diagnosis and Treatment

## Introduction

In the fields of dentistry and medicine, artificial intelligence (AI) is becoming more and more significant.It is useful in a variety of disciplines where emerging technology may support and benefit humans. The developments in AI started in 1943 but the term "Artificial Intelligence" was created in 1956 at a conference in Dartmouth by John McCarthy [1]. AI has been described as the "fourth industrial revolution," which uses computer technology to simulate intelligent behavior, critical thinking, and decision making similar to humans [2].

John McCarthy defined AI as "The science and engineering of making intelligent machines."[3] There are two kinds of AI accessible in healthcare: virtual and physical (robotics). The virtual kind addresses medication dosage algorithms, drug interactions, electronic health records, imaging and osteoporosis, appointment scheduling, diagnosis and prognosis, and mathematical algorithms. The physical component includes socially supportive robots for senior care, telepresence, robotic aid in surgery, and rehabilitation.

## Methodologies of AI

Strong and weak AI are the two sub-concepts that separate the entire range of meanings that are now encompassed by the word "AI." Strong AI was designed to function through artificial and non-natural hardware and software reconstruction in a manner similar to that of human intellect. Weak AI tries to put

312

in place a system that evolves the capacity to solve problems on one's own by employing some of people's senses and thought processes. One has to be familiar with a number of terminologies in order to comprehend the principles of AI.

### Machine Learning (ML)

Computer science's machine learning field creates algorithms that are informed by data.

### Deep Learning

Specialized type of learning based on neural network techniques.

### Artificial Neural Networks (Anns)

In order to apply the model to independent data, it is necessary to use networks of highly linked computer processors that can learn from previous examples, assess non-linear data, manage imprecise information, and generalize. An really appealing analytical instrument in the medical domain.

### Augmented Reality

Defined as "a technology that superimposes a computer-generated image on a user's perspective of the real world, accordingly giving a composite view". [4]

### Virtual Reality

A computer-generated reenactment of a three-dimensional image or environment that can be communicated with, in an apparently real or physical path by an individual utilizing unique electronic equipment.

### Applications in dentistry

Various procedures in a standard dental setup can be carried out using with the use of virtual dentistry, less work and more accuracy partners. Coordinating appointments, managing insurance and paperwork, and alerting the dentists are some of these responsibilities regarding the subject's comorbidities and behaviors, such as smoking and alcohol misuse. Dental patients would benefit from teleassistance crises in which the physician is not accessible. The seat voice command can effectively handle functions like positioning, water delivery, and light control without requiring any manual input from medical professional.

### AI In Dentomaxillofacial Radiology

With the use of AI, the diagnosis and management of oral cavity lesions may be screened for and categorized into suspected changed mucosa undergoing premalignant and malignant alterations. A widespread genetic susceptibility to oral cancer might be precisely forecast by AI. Artificial neural networks, or ANNs, can be used by dentists as an adjuvant diagnostic tool to identify subtypes of temporomandibular disorders, predict the factors that seem to be connected to the occurrence of recurrent pharyngitis, predict the occurrence of BRONJ (Bisphosphonate-related osteoradionecrosis of jaw) in patients receiving bisphosphonates for the management of osteoporosis, and identify and correctly diagnose patients with various facial pain syndromes, to categorize mandibular condyle morphological variants that provide the precise location of the morphological alterations on the condylar surface. It will help physicians better understand the morphological changes that TMJ osteoarthritis patients experience.

Images of the oral cavity for remote interpretation by specialists can be captured using Mobile Mouth Screening Anywhere (MeMoSA) app. [5]

Over the past 20 years, image identification utilizing AI systems has moved from science fiction to the real world in radiology practice. Because of its unique learning capabilities, artificial intelligence (AI) offers a significant edge in head and neck imaging. It can be used with other imaging modalities, such as CBCT and MRI, to identify minute deviations from normalcy that the human eye would have missed. Examples include the use of cephalometric analysis, pinpointing the placement of landmarks on radiographs to help detect vertical root fractures, diagnosing maxillary sinusitis on panoramic and Waters' radiographs, and using CT to identify Sjogren syndrome. These might, in turn, lead to significantly better patient care from an economical standpoint.

Artificial Intelligence integration with 3D printing facilitates prefabrication production. Artificial intelligence software may be used to predict potential printing process failures and solve the overhang issue. With Smart Algorithms can handle any issue in a timely manner, making it possible for 3D printers to operate efficiently and for guidance to address any quality concerns.

Future recommendations for radiologists include learning about the terminology and hierarchy of artificial intelligence, starting to incorporate health informatics, computer science, and statistics courses into their curricula, training radiologists in logic, statistics, and data science, and being aware of additional information sources like genomics and biometrics, in order to combine clinical condition data from various sources with data from other sources. Radiologists need to be aware of the difficulties involved in creating training data sets for closely monitored instruction.

## AI In Endodontics

A multifunctional endodontic micro-robot was created in 2007 by Dong et al. to enhance root canal therapy. By fixing it on the patient's teeth, one may comprehend the automatic treatment method through computer control for probing, drilling, cleaning, and filling. In order to reduce iatrogenic damage, robots can also help clinicians prepare cavities by controlling the drill to achieve precision and smoothness.

Nelson et al. produced preprogrammed instructions that robots may follow to choose and use the required instruments. Experiments revealed a 4.4% reduction in treatment time. [6]

AI in endodontics might precisely identify caries-prone teeth, identify intricate peri-apical pathology, and characterize limits of the lesion and allow for their distinction. The Logicon Caries DetectorTM software (Logicon Inc., USA) has developed an AI-based tool for the detection and characterization of proximal caries with the aim of supporting dentists. [7] Also, knowing the lifespan of restorative materials and, in appropriate situations, making informed decisions about them improves the working length accuracy by helping to locate the small apical foramen.

Guided endodontics: Root canal treatment for calcified root canals is a high-difficult case, with localization and negotiation through the apical being particularly challenging. Guided endodontics is proposed to prevent complications, shorten treatment times, and increase success rates by combining CBCT, 3-D printing, and digital intraoral impressions. This technology is also used for treating anomalous teeth, apical surgery, and ultraconservative access cavities. A high-resolution CBCT and digital impression of teeth are acquired and co-registered using image processing software. A template is designed using the data, which is then placed on the teeth and treated with burs and files. Clinicians can adapt burs specific to the case or use commercially available access burs with long shafts and small heads. Microguided endodontics emerged as a method for treating smaller roots.

## AI In Pediatric Dentistry

AI offers a wide range of possible uses that might transform behavioral pediatrics in the future. Pediatric restorations would benefit greatly from AI-enabled restorative dentistry with computer-aided design and manufacture, as it would reduce turnaround times and aesthetics.ANN may be used to forecast the sizes of unerupted premolars and canines throughout the mixed dentition stage.

Injectable-free pedodontics is the new, better approach using AI-enabled pain management devices. Pediatric patients can benefit from the usage of virtual reality-based games, videos, animations, and different 4D goggles as a behavior change tool.

## AI In Orthodontics

In orthodontics, the diagnosis forms the core of the treatment plan. Artificial intelligence facilitates planning and analysis therapy, as well as the course of treatment, using radiograph and picture analysis. Clinical decision-making can be aided by artificial neural networks (ANNs). To get effective outcomes in orthodontics, meticulous treatment planning is essential. Artificial intelligence (AI) software may be used to forecast tooth motions, organize orthodontic therapy, determine anchoring pattern, and determine treatment result (extraction or no extraction). AI-assisted orthodontic aligners are available to assist in treatment execution, tracking of treatment progress, and a reduction in treatment duration and appointment scheduling.

A Convolutional Neural Network (CNN) model that has been pre-trained examined the facial movements before and after orthodontic treatment pictures. The results, such as a decrease in age appearance and an increase in face attractiveness, will be shown by AI that recognized the outcomes. The patient's treatment result may be prospectively visualized with the use of machine learning.

## AI In Periodontology

Probably the most well-known mouth condition affecting humans is periodontal disease. This is, in fact, the main cause of a tooth's early loss. Deep learning analysis of radiographs can help diagnose periodontal disease and arrange therapy for any early changes in the periodontium, vertical or horizontal bone loss, and surrounding bone density. By employing virtual reality (VR) distraction as an efficient means of pain management, artificial intelligence (AI) can reduce discomfort during periodontal operations such as scaling and root planing. CNN models using radiographs might predict periodontal problems in the oral cavity. SVM stands for support vector machine used to detect microbial profiles in the sublingual plaque in order to distinguish between aggressive and chronic periodontitis. [8] AI models can identify dental plaque on permanent teeth, dental plaque on ceramic crowns, and dental plaque on implants in addition to primary teeth.

## AI In Prosthodontics

Artificial intelligence (AI) is being used by research facilities to automatically create dental restorations for precise fit, optimal function, and aesthetic appearance. Prosthodontics benefits from AI through the use of computer-planned design and computer-supported manufacturing technology. Not only will this help and support dentistry, but it also has a great deal of potential to impact oro-facial or craniofacial prosthetics. Virtual reality simulation (VRS) technology can be used to replicate facial profiles in post-treatment settings.[9]

Artificial Intelligence (AI) can assist computers in digital impression procedures, enabling the dentist to create the best possible impression.

Implantology: AI is capable of accurately identifying the kinds and thickness of cortical bone, which may be crucial in determining the best site for implant implantation.

## AI In Public Health Dentistry

Analysis of the connection between public health preventative and treatment methods as well as analytics of patient results ought to be the main objectives of AI in dentistry.

Artificial intelligence (AI) has been created for a variety of applications, including personalized medicine, biomedical pharmacy, diagnosis suggestions, patient monitoring, and even worldwide epidemiological disease expansion forecasting.

For predicting the DMFT index and caries risk in 12-year-old children, machine-learning models are more helpful than statistical models. They can also be used to predict the DMFT score and can independently determine the life-long mean index of carious teeth, extracted teeth, and/or filled permanent teeth. [10]

"Denta Mitra" is a smartphone app that tracks oral health using artificial intelligence (AI). [4] The app's AI-based scanner allows users to keep an eye on their dental health, measure and remind them about good oral hygiene on a regular basis, and connect them with nearby dentists for appointments and virtual consultations.

AI is also capable of demonstrating its competence in any kind of disaster or pandemic. In light of the current global health crisis, the medical community is searching for innovative technology to track and manage the COVID-19 epidemic. It is helpful in real-time infection control, accurately detects high-risk individuals, and tracks the spread of virus.[11]

### Advantages of AI

1. AI enhances precision and accuracy by reducing human error and is always available. Service robots analyze personalities and perform daily tasks, increasing human capacity and emotional well-being.
2. AI can analyze patient's health problems, making accurate diagnoses. Predictive analytics, developed by Google, can predict future health issues based on millions of symptoms.
3. Predictive analytics can also improve healthcare facility management by predicting non-contagious and hereditary genetic diseases, enabling health experts to take appropriate measures.

### Disadvantages of AI

1. AI, being complex machines, requires significant expenses and often fails to develop a strong bond with humans, which is crucial for healthcare delivery.
2. AI can only perform tasks designed to be performed, and experience is not enough to improve it. To ensure accurate diagnoses, AI databases should have sufficient information about patients from specific backgrounds.

3. Frequent software updates are necessary, and breakdowns can be costly and time-consuming.

4. The AI field currently has few experienced programmers, and few practical products have reached the market.

## Conclusion

Over the past ten years, artificial intelligence has experienced exponential growth, revolutionizing the fields of dentistry and medicine.

In dentistry, intelligent systems are crucial because they provide prompt diagnostic and treatment recommendations for intricate issues. Artificial intelligence has countless clinical uses, and the field is still in its early stages with active research being conducted on a continual basis. Maxillofacial radiology and general dentistry both have bright futures ahead of them.

AI might not be able to completely replace a human dentist, though. Artificial Intelligence (AI) has the potential to enhance dental professionals' performance by eliminating human error and simplifying their tasks. With artificial intelligence and other innovative technologies becoming the norm in every field, the future of dentistry is bright.

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