# Artificial Intelligence in Dentistry: An Overview

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**Abstract:** *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. The introduction of robotics to the field of surgery has increased the precision and made surgical procedure more successful. Virtual assistants that apply Artificial Intelligence software are helping dentists to diagnose cases accurately and treat patients efficiently without missing any relevant genetic information. Nevertheless, this is a growing field and its future aspects seem extremely promising.*

**Keywords:** Artificial Intelligence, Neural Networks, Clinical Decision Supporting System, Virtual Reality, Dentistry

## 1. Introduction

The human brain has been one of the most sought out structures to researches and technologists for as long as the history dates back to replicate. And over centuries newer technologies have tried and tested to mimic the functions of a human brain such as ability to reason and the ability to think on its own and make decisions. However, perfecting it is a long duration goal and is still at its budding stages. An enormous amount of modern computer and technologies were inspired by Aristotle's early attempts to formulate the logic and thinking through his syllogisms (a three part deductive reasoning), which is from the combination of a general statement (the major premise) and a specific statement (the minor premise)a conclusion is deduced.[1]

Artificial intelligence (AI) 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 [2]. In computer science, AI research is defined as the study of intelligent agents, any device that perceives its environment and takes action that maximize its chance of successfully achieving its goals (Russell and Norvig 2003). Colloquially, the term "AI" is applied when a machine mimics, cognitive functions that human associates with other human minds, such as "learning and problem solving."[3] Dentistry is a unique profession in the scope of medicine and is extremely demanding as requires knowledge as well as clinical skills to ensure a proper treatment [4]. Technology has revolutionized the field of dentistry in the last decade. [5]

**Artificial Intelligence in Dentistry:**

**1. Augmented and Virtual Reality:**

Augmented reality is defines as "interactive experience of a real-world environment where the objects that reside in the real world are enhanced by computer-generated perceptual information, sometimes across multiple sensory modalities including visual, auditory, haptic, somatosensory and olfactory." [6] Using AI, patients can try potential prosthesis virtually and upon acceptance by

the patient, the final prosthesis can be delivered [7].This can revolutionize not just the field of dentistry but also the world of craniofacial / orofacial prosthetics.

Virtual reality (VR) can be differentiated from augmented reality as it is a three dimensional representation of an environment. According to a meta-analysis conducted by Nansi Lopez-Valverde et al [8] analyzing 32 studies, they concluded that VR is an effective distraction method to reduce pain and anxiety in patients undergoing a variety of dental treatments.

**2. Field of radiology:**

Radiology has becoming increasingly important in the field of dentistry as we depend on Intra Oral Periapical radiographs (IOPA), Cone Beam Computed Tomography (CBCT), and other 3D scanning modalities.

AI has also made its way into the field of orthodontics. AI is now available for orthodontic diagnosis, treatment planning, and treatment monitoring. 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 in terms 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 aligner 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. In 2019, Hattce Kok et al used AI algorithms for growth and development by cervical vertebrae stages in orthodontics.[9]H. J.Yu et al[10] created an automated skeletal classification with lateral cephalometry wherein instead of the manual tracing, they incorporated an convolutional neural network (CNN) into a 1-step, end-to-end diagnostic system.

**3. Artificial Neural Networks:**

Artificial Neural Networks were modeled based on the human brain and its intricate working capabilities [11]. Kim et al [12] used artificial neural networks to build an AI that can predicate dental caries and toothache based on frequency of tooth brushing, the time taken, using of

dental floss, the frequency of tooth brush replacement and other broad factors such as diet and dental visits. This model was deemed a success and recognizes stress, the eating patterns and oral hygiene maintenance to predict toothaches. Bayesian network analysis is used to identify relationships between various factors affecting the diagnosis and final treatment outcome of impacted maxillary canines. In this study all the pretreatment and post treatment data of the patients was gathered along with patient related variables to identify links between these variables. The study inferred that Artificial intelligence could be used in dentistry to assist dental professionals [13].

Study done by Kakilehtoetal. Observed that the mean and median survival time (MST) of the amalgam restorations for the occlusal surface was 16.8 years within the 1960 cluster, 13.6 years within the 1970 cluster, and 7.9 years with in the 1980 cluster. For glass ionomer and composite resin restoration on the occlusal surface MST was 4.9 years within the 1970 cluster and 7.3 years within the 1980 cluster. The observations were obtained by data mining analysis, the only role of dental professional was to collect and tabulate the data [14].

Today there are mobile applications available which help the patients and clinicians to identify the caries activity such as Cariogram which can assess the dental caries risk upon details entered such as diet, fluoride program, saliva secretion, buffer capacities and so on.

From the studies we can infer that AI in the field of dentistry is already growing and diagnose and deliver prognosis through data collection from the varied medical information fed to them. In conclusion, the actual examination, diagnosis and treatment is done by dentists and AI only plays a role in assisting the dental professional.

### 4. Clinical Decision Support System CDSS:

The CDSS consist of a network between a dynamic (medical) knowledge base and an inferencing mechanism that are usually a set of rules derived from evidence-based medicine by experts and they are implemented through medical logic modules based on a language such as Arden syntax.[15]

Genetic Algorithms are stochastic search methods which can diagnose based on mutation, inheritance, selection and crossover. The greatest advantage of genetic algorithms over conventional methods is that it works on the basis of problem solution instead of analytical relations concept of conventional methods.

An example of is when Łodygowski T and coworkers [16] used genetic algorithms for optimization of dental implant system to reduce the problem of mechanical fracture and to provide long term strength to the implant. Another study done by Li H et al.[17] used genetic algorithm along with back propagation neural network to improve the tooth color matching.

### 5. Head and Neck Cancer:

With cancer cases increasing rapidly, investigations are constantly being done to find new diagnosing modalities. There are mobile applications available which help the patients to identify malignant melanomas by comparing the pictures from the patient with a vast interphase of pictures of lesions from around the world. (eg. Mole Check App, OnlineDermClinic, SkinXM )[18]. A study on Head and Neck Canceruses Convolutional Neural Networks (AI) for performing segmentation of organs at risk from head and cancer in Computed Tomography images.[19]

### 6. Benefits of AI in Dentistry:

1. Performing tasks in shorter time
2. Accurate diagnosis
3. Procedures can be standardized

### 7. Disadvantages of AI in Dentistry:

4. Complexity of the system
5. Expensive
6. Appropriate training and knowledge is required
7. Data bias

## 2. Conclusion

Artificial Intelligence is the future in dentistry. Their application in every area is growing day by day. Through it will never replace the role of a dentist; it could become a very important tool for the dentist as an assistant. Soon AI will be completely implied in orthodontics, endodontics and restorative dentistry. The only limitation to use of AI presently is the availability of insufficient and inaccurate data. Hence, it's the responsibility of dentists and clinicians to focus on collecting and entering the authentic data in their database that will be fully utilized for AI in dentistry in near future.

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