Review Article

# Application of AI in dentistry – Review, present scenario, and future outlook

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## Abstract

Artificial Intelligence (AI) is revolutionizing dentistry by enhancing diagnostic accuracy, treatment planning and outcomes across various dental specialities. Key elements of AI such as Machine learning, Deep learning and Data analysis are being used as important tools in analysing clinical data impacting training and education in the field of dentistry and allied sciences like forensic odontology. AI systems using large language models help in optimising restorative designs, provide digital workflow, automated record management and improve patient supervision. This review article synthesises the present landscape and charts future roadmap for AI evolution in Dentistry.

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## 1. Introduction

Artificial intelligence utilizes computer technology to perform tasks that typically require human intelligence. It can simulate human intelligence to make intricate predictions and decisions in the healthcare field. Alan Turing wrote in his paper "Computing Machinery and Intelligence"[1] in the 1950 issue of Mind: "I believe that at the end of the century (20th), the opinion of educated persons will have altered so much that discussing the idea of machines thinking will no longer be met with opposition". His words have proven right. The concept of AI was first introduced by John McCarthy in 1956.[2] The brain is considered the most fascinating part of the body by scientists and researchers. To date, scientists have not yet fully understood how to simulate the brain using a machine model.[3]

In AI, Computer mimics analytical functions, such as "learning and problems that humans frequently associate with other human brains".[4] The biological neuron system, with a large number of connections of neurons that are utilized in "learning," is mimicked by artificial neural networks (ANNs) and is used by its algorithm to comprehend the relationship between attributes and the ground truth.[5]

Other names – Machine Intelligence, Fourth Industrial Revolution[5]

Definition - "the theory and development of computer systems able to perform tasks normally requiring human intelligence, such as visual perception, speech recognition, decision making, and translation between languages".[6]

### 1.1. Key elements of AI

Some key elements of AI are

1. Machine learning: These are the methods used to predict results from a data set. It makes it easier for machines to acquire data already available. The main goal is to resolve problems without human intervention.[7]
2. Deep learning: It has numerous computational layers that create a network of neurons that identifies patterns on its own, thereby improving detection.[7]

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3. Data science: It is a process of analysis of data and extraction of information from the analysed data.[8]
4. Big data: AI analyzes a huge amount of data that is steadily expanding in the right direction over the years to give consumers correct information.[9]

## 1.2. Types of AI

1. Virtual and Physical (Robotics)
2. Strong and Weak, also known as Narrow

## 1.3. Virtual type

Medication dosage, diagnosis and prognosis, appointment scheduling, drug interactions, electronic health records, and imaging are the main areas of the virtual type. Siri, Alexa, and other voice commands are examples.

## 1.4. Physical type

Rehabilitation, telepresence, robotic support in surgery, and companionable robots for elderly care.

## 1.5. Weak AI

Also known as narrow AI. It uses an algorithm to solve single or specific tasks. Most of the AI used at present is weak AI. Examples are

1. Reinforcement learning, e.g., AlphaGo
2. Natural language processing, e.g., Google translation, Amazon chat robot
3. Computer vision, e.g., Tesla Autopilot, face recognition
4. Data mining, e.g., market customer analysis.[10]

## 1.6. Strong AI

It has the ability and intelligence of AI equalling that of humans. It has its awareness and behaviour as flexible as humans. [11] Strong AI aims to create a multi-task algorithm to make decisions in multiple fields. There are currently no strong AI applications since research on strong AI needs to be extremely cautious due to potential ethical concerns and dangers.

## 2. AI in Dentistry

AI can be used in dentistry in many ways. These are

### 2.1. General use in dentistry

1. Increase accuracy, efficiency, and precision at par with medical experts more quickly and affordably
2. Electronic record-keeping and patient appointment scheduling
3. Analysis of clinical data
4. For training and education
5. The Dental Chair- The most recent innovation is a voice-command dental chair that doesn't require the doctor to physically do anything. Voice commands are used for all operations. Soon, dental chairs will be able to monitor a patient's vital signs, anxiety level, weight, and the length of the process while also comforting the patient, and warning the operating doctors if any variations are found.
6. AI can be used in bioprinting. Bioprinting is a technique that allows living tissue and even organs to be created in successive thin layers of cells. AI can be used to reconstruct oral hard and soft tissues that have been lost due to pathological causes.[12]

## 3. Diagnosing Oral CA

AI can detect even the smallest changes at the single-pixel level that the human eye could miss. Artificial intelligence can correctly identify a large population's genetic propensity for oral cancer.[3]

### 3.1. In oral and maxillofacial surgery

The development of robotic surgery, in which human body motion and intellect are replicated, is the biggest use of artificial intelligence in oral and Maxillofacial surgery. Removal of tumours and foreign objects, biopsies, and temporomandibular joint (TMJ) surgery are examples of image-guided surgical procedures. Lesser operation time, higher intraoperative accuracy, and safer manipulation around delicate structures have been reported with the use of AI. Robotic surgeons carry out semi-automated surgical procedures under supervision.[13]

### 3.2. In prosthodontics

A design assistant takes into consideration numerous aspects like anthropological calculations, face dimensions, ethnicity, and patient preferences to present the patient with the optimal aesthetic.[3] Integrating AI with CAD/CAM or 3D/4D printing can achieve a more desirable workflow with high efficiency.[14]

### 3.3. In orthodontics

Orthodontic diagnosis, planning, and treatment monitoring is now all possible using AI.[4] Analysis of radiographs and images taken by intraoral scanners and cameras can be used for diagnosis and treatment planning. In addition to avoiding the need for numerous laboratory processes and patient impressions, this method yields results that are frequently significantly more accurate than human perception.[3] Utilizing accurate 3D scans and virtual models, it is simple to 3D print the aligners according to a unique treatment strategy. The Artificial Intelligence-assisted aligners promise to shorten treatment times.[4] AI also plays a role in managing cleft lip and palate in risk prediction, diagnosis, pre-surgical orthopedics, speech assessment, and surgery.[14]

### 3.4. In Forensic Odontology

It is employed for analyzing bite marks and predicting mandibular morphology.[15]

### 3.5. In operative dentistry

AI has promising results in early lesion detection, with the same accuracy or even better compared with dentists. Collaboration across multiple disciplines is necessary for this accomplishment, involving computer scientists and doctors. While the computer scientists construct the dataset and machine learning algorithm, the clinician manually marks the radiographic pictures with the site of caries. Finally, clinicians and computer scientists jointly check and verify the accuracy.[16]

### 3.6. In periodontics

AI has been utilised to diagnose periodontitis and classify plausible periodontal disease types.[17,18]

## 4. Impact of Artificial Intelligence on Dentists

AI will change dentistry in many ways, but it will never completely replace dentists. Oral health care is not possible by machines in the absence of a human connection. The intangible perception, clinical intuition, and empathy that are necessary for competent and tailored healthcare delivery cannot be replicated by machines. The most fascinating aspect of human-to-human communication cannot be easily translated into computer language.[19]

## 5. Limitations and Prospects for the Future

Although the AI models that have been presented have shown encouraging results, it is still important to confirm their generalizability and reliability by utilizing relevant external data that has been gathered from other dental facilities or recently enrolled patients.

## 6. Summary of Dental Applications of Artificial Intelligence

AI technologies can help professionals provide their patients with high-quality dental treatment. AI systems can be used by dentists as an additional tool to increase the accuracy of diagnosis, treatment planning, and treatment outcome prediction. Clinical procedures can be completed more quickly and doctors can work more productively. The accuracy of the diagnosis can be increased by using these systems for secondary views.[20]

## 7. Conclusion

AI should be viewed as an augmentation tool to assist dentists in carrying out more useful tasks, such as integrating patient information and strengthening professional relationships. Modern artificial intelligence is great at applying organized information and extracting meaning from massive volumes of data, but it is not as good at forming connections as the human brain is, and it can only make limited decisions when faced with complex clinical scenarios. More in-depth understanding is dependent on dentists' experience in ambiguous situations. Physical examinations must be performed, medical histories must be obtained, aesthetic outcomes must be assessed, and dialogue must be encouraged.

## 8. Source of Funding

None.

## 9. Conflict of Interest

None.

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