# Artificial Intelligence: A Dental Odyssey.

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## Abstract

Electronic globalization with such a gigantic technological advancement during last few decades have made a huge impact on our everyday life. Artificial intelligence has been a breakthrough in hi-tech progression and has entranced the brains of scholars worldwide. It is field of technological science dealing with computer science and ability of computers to mimic the function of human brain to perform the tasks readily. Ever since its commencement in the field, dental science has witnessed modernization. From patient data records preservation, diagnosis and treatment planning to robots performing surgeries in supervision of clinician has now become possible because of artificial intelligence. In current scenario, it has become necessary for dental professionals to get oriented with clinical as well as technological advancement to provide easy, quick, relatively cost effective and excellent patient care. Though artificial can't replace all the traits of human mind, it has made a huge contribution in reducing a dentists efforts and assisting him in decision making. It is of prime importance for a practioner to be alert of the potentials of artificial intelligence to assimilate this technology for a enhancing his practice in forthcoming years.

***Keywords:*** *Artificial intelligence, technological advancement, computer science, diagnosis, treatment planning, dental professionals.*

## Introduction

In the era of hi-tech world, with such a speedy advancements in the field of technology, machines have become a big part of human life. In an attempt to reciprocate the functions of a human brain containing some traits of its mind,technological advancement have been witnessed over time. Advanced technology provide specific tools to unravel problems encountered when decision making and investigation is done. Hence, the involvement of computers in health industry has lately became a much of significance. The main object of this paper is to enlighten the readers about present-day accomplishments of artificial intelligence in clinical science.

Artificial intelligence 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)"[(1)]. Artificial intelligence signifies nothing but machines that performs human tasks and so often

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referred as machine intelligence. The AI research have been significantly based on reasoning, natural knowledge processing, planning, learning, interpretation, logistics, ability to move and ease of knowledge representation.

Artificial intelligence has been classified into two subdomains; machine learning and deep learning. Machine learning (ML) was first referred by Arthur Samuel[2] which is based on set of rules to learn the arithmetic frameworks and edifices in data which permits prediction of concealed data. ML model are neural networks (NNs) which can outdo conventional ML systems specifically on dynamic figures.

Deep learning is precisely useful for complicated data because of their skill of image representation and its organizedtopographies. It is a machine learning method where the models are trained using artificial neural networks (ANN).ANN is a group of numerous organized processing elements whiche valuatedata by their computerized potent response to external inputs. It has established substantial results in many non-health and wellness programby means of computer imaging and natural language processing. Deep neural networks are considered universal approximation machines (Hornik 1991)[3].

**History:** AI was founded in the year 1956 at a conference but it gained much recognition from 1980s with the arrival of neural networks[4]. The beginning of AI can be traced back to more distant past and typically linked with the discovery of first functioning computers after the Second World War, or in the year 1956 when John McCarthy used the term in its full meaning for the first time[1]. Hence, known as father of Artificial intelligence[5]. Philosophers and mathematicians have offered explanations of the development of anthropological intellectual and decision making, determined to describe overall forms and guidelines underlying the process since prehistoric times. The first real successes to create 'intelligent machine' have arisen with the encounter of digital electronic computers and scientific papers of a British mathematician, Alan Turing who laid the foundation of artificial intelligence and created the Turing test which is "a test to measure a machine's aptitude to reproduce human intelligence" in 1950[6,7]. Electronic diagnostics & decision making codes extemporize the course of evidence based guidelines, apt clinical medical assessment and be a foundation for education and investigation.[8,9]

**Application of Artificial Intelligence in dentistry[10-23]:**

| Author | Year | Inference |
|---|---|---|
| Hammond et al | 1993 | Growth of design assistant, RaPiD for use in prosthodontics. |
| Speight et al | 1995 | Risk assessment of oral cancer |
| Käkilehto et al | 2009 | To compare the life expectancy of different dental restoration material by analysing the electronic dental records using data mining AI techniques. |
| Miladinović et al | 2010 | Finding and linking the major factors that may have effect on the reasons of tooth extraction. |
| Bas et al | 2012 | Diagnosis of subtypes of TMJ disorders by using ANN as a diagnostic tool. |
| Kikuchi et al | 2013 | Evaluate how VRS affected students knowledge and skills associated with porcelain fused to metal crown (PFM) preparation. |
| Jung and kim | 2016 | Diagnosis of the need of orthodontic extraction |
| Thanathorwong | 2018 | AI clinical decision support |
| Patcas et al | 2018 | Treatment outcome analysis |
| Lee et al | 2018 | Diagnosis and interpretation of periodontally compromised teeth. |
| Feres et al | 2018 | Differentiate between chronic and aggressive periodontitis. |
| Lee et al | 2018 | Diagnosis of caries |
| Kim et al | 2018 | Prediction of medication related osteonecrosis of jaw. |
| Wenzhe et al | 2020 | Detection of dental plaque on primary teeth by deep learning based AI technique. |

**General dentistry:** AI has been significantly used toper form different tasks in routine dental practice. Because of this the need of man power has been reduced and fewer errors with increase in precision in comparison to human has been achieved. From the date of admission of patient, case history recording, arriving at clinical diagnosis of a disease, interpreting X-rays and then making a detailed treatment plan for patient has now become easier with the help of these computer systems[24].

**Endodontics:** Endodontics has always been the most rapidly developing branch in dentistry. With the use of AI, devices has been made to measure the pain level of patient and thus providing proper medication. Studies have been done in an attempt to make accurate diagnosis of caries. AI has contributed to test the vitality of tooth which has always been a crucial factor of treatment planning by introducing various method such as electric pulp testing, pulse oximetry, laser dopplemetry etc. The operating microscope and ultrasonics has heightened the quality of treatment and represent a modern aide in treatment of tough cases[25].

**Prosthodontics:** Fabrication of prosthesis has been most technical process. It requires accuracy, time and effort from the dentist and even the patient. With the increasing need of prosthesis various technology has been used to make the task easier. AI in combination with the designing software's can help the clinician to make the finestpossible and aesthetic prostheses bearing in mindnumerous factors like facial form, colour, patient desire, etc[26].Since 1980, 'digitizing the impression procedure'and 'computer aided design and computer aided manufacturing (CAD/CAM) technology' was made known todentistry[27]. To minimize the error in impression making, digitalized impression recording was introduced. CAD/CAM is the most enormously emerging part in dentistry. In the current scenario there are two possible method for using the CAD/CAM system in fabrication of dental crowns, laminates, veneers electronically: the direct and the indirect method[28]. Laboratories are using CAD/CAM to mechanically produce unconventional dental restoration, planned to seamless fit and supreme function beyond aesthetic outlooks [29].

**Forensic odontology:** It is the appropriate handling andinspectionwith thoroughevaluation of dental evidence which can be presented as a evidence in the interest of justice. Age estimation is the main area of practice for dentist in forensic odontology. Recent studies has shown that along with the tooth eruption pattern and tooth wear the deposition of cementum has shown the annual pattern of deposition. Age estimation using facial pattern has been under research since a long time.With arrival of AI, there are numerous software design by using ANN whichcommands the computers to inevitably estimate the age.[26]

**Oral medicine and radiology:** Computer-based diagnosis has become much popular and reliable because of its capability to spot and diagnose lesions which are difficult to diagnose and difficult to catch by the human eye[30]. Breakthroughs in image interpretationwith the addition of artificial intelligence Systems has been transformed from a myth to reality in the radiology practice within a short span of time. In the context of head and neck and imaging, AI offers additional power with its inimitable skill to learn.Ultrasonography helped in differentiating benign and malignant tumors, cystic and non-cystic lesions and also helped in on screen nodal measurement[31]. 3D imaging systems such as 'Cone Beam Computed Tomography (CBCT)'along with 'Magnetic Resonance Imaging(MRI)' has provided advantage in determining the extend and progression of lesion that may have gone unnoticed to human eye. The introduction of digitialized radiographs have eliminated the use of the manual processing of radiographs thereby reducing the chances of errors in processing of radiographs. This has also helped to keep the dental records digitalized making it accessiblefor future reference. Additional 3D system has been used in dental radiology such as intraoral scanners. These intraoral scans are then examined by dental inspection software. In order to locate minor apical foramen, artificial neural networks has been found to improve the working length determination for root canal treatment by radiographs[32], cephalometric analysis and diagnosis of caries[21].It also given adequate sensitivity, specificity, and accuracy with digital radiographs in detection of vertical root fracture [33].Study has shown use of artificial neural network (ANN) help to establish a diagnostic tool to diagnose subtypes of temporomandibular joint (TMJ) disorders[14]. Artificial intelligence has helped to establish relation of oral cancer to genetic factor significantly in large population and to differentiate between premalignant and malignant lesion helping us to categorize the disease and providing treatment appropriately.

**Orthodontics**: Movement of the teeth in the position where maximum function and esthetic can be achieved

has always been difficult to achieve. How much force to be applied for tooth movement keeping in mind the anatomic landmarks and the outcome of treatment is now done using AI [34]. Orthodontic diagnosis, treatment planning and long term monitoring of treatment is being done by analysing digital radiographs and facial photographs records (35).A model was trained to evaluate the craniofacial skeletal and dental anomalies in cephalometry and the same was compared with the expert opinion. The analysis results of both were found to be equal. Furthermore, the model also showed inconsistencies offered in the datawhich were missed by the clinicians, thus stressing on the importance of AI in orthodontic analysis [36].

**Oral Surgery:** Introduction of Robotic surgery in oral and maxillofacial surgery has been the greatest contribution of AI where human body motion and intelligence is imitated by robots while performing surgery in the guidance of expert [37]. AI s has abetted the surgeon in planning surgeries by preserving the vital structures around the lesion with higher intra operative precision with reduced operation time there [38]. The oral soft and hard tissue structures when lost due to some pathology or accidental reasons can be reformedthroughan advanced AI technique known as "bio-printing" through which organs and living tissues are formed in consecutive thin layers of cells in the future [39].

**Periodontics:** Deep learning AI is used in early detection, diagnosing and treatment planning of periodontal diseases using intraoral radiographs by aiding the initial finding of periodontal changes[40], furcation involvement, bone loss, and scoring bone density. Peri-implantitis recognition also help in primary intervention during placement of implant.[41]With help of electronic toothbrush now it has become easy for patient to asses the level of plaque in their oral cavity on their mobile screen.

## Conclusion

Artificial intelligence has made a huge contribution in the health care sector. It has certainly helped us in improving the patient health care system. Technologies have helped clinicians and research workers to assimilate different arenas of knowledge. That day is not far, when dentistry will totally be revolutionized with the advancement of artificial intelligence based technology and we will be familiarized to errorless clinical procedures with greater accuracy and increase in patient care. Though it can never replace a dentists judgment, but it will surely aid the dentist in decision making. Therefore, to understand the countless notions and the system involved in artificial intelligence will have a strong benefit in the future. AI may assist in addressing the weaknesses harshly criticized in conventional dental care (Watt et al. 2019).

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