

# Artificial Intelligence: A New Era Of Evolving Dentistry

Amina<sup>1</sup>, Shua Aftab<sup>2\*</sup>

1. Assistant Professor Department of Prosthodontics, Dr Z A Dental College, Aligarh Muslim University, Aligarh, India

2. Junior Resident Department of Prosthodontics, Dr Z A Dental College, Aligarh Muslim University, Aligarh, India

---

## Abstract:

The advancement of science and technology has brought a new era of digitalization in the field of dentistry. Advancement of imaging technology has dramatically improved both diagnosis as well as treatment planning. For example, 3D skeletal dental analysis provided by cone beam computed tomography (CBCT) plays an important role in planning dental as well as skeletal surgeries by providing guidance for accurate, safe, and innovative treatment guidelines, medical spiral CT provides accurate information and further permits soft tissue and airway evaluation. The AI approach to 2D or 3D imaging technology is fundamentally changing the protocol of diagnosis and treatment planning in dentistry by providing high quality patient care and innovative research and development, facilitating advanced decision support tools.

**Keywords:** Artificial intelligence, Machine learning, deep learning, human intelligence

---

Date of Submission: 24-04-2024

Date of Acceptance: 04-05-2024

---

## I. Introduction:

The exponential growth in science and technology has led to the introduction of Artificial Intelligence where software or a machine can easily mimic human intelligence and perform specific activities. Term Artificial Intelligence was coined by John McCarthy [1], a mathematician in 1955, widely recognized as the father of artificial intelligence. In 1978 Richard Bellman, an applied mathematician defined artificial intelligence as the automation of activities associated with human thinking abilities, which includes learning, decision making and problem solving [2]. Artificial intelligence along with machine learning and deep learning constitutes intelligent systems. This technology continuously influences the world and improves quality of life of living being. For example, Alexa along with understanding different accents can also perform simple tasks like addition, bionic chips inserted in certain devices to handle the software demand of machine learning processes.

In healthcare system it plays a vital role in diagnosis and early intervention. The data of digital radiographs has improved the diagnosis process in radiology with the aid of artificial intelligence. AI installed wearable technology can predict life threatening crisis like stroke. Emergence of big scientific data improved diagnosis of human congenital anomalies. This article is meant to review current applications of Artificial Intelligence in health care and dentistry.

## II. Application Of AI Technologies In The Specialty Of Prosthodontics

The introduction of AI in the field of prosthodontics leads to a wide variety of novel options, such as customization of crown design according to existing tooth condition such as wear facets, accurately fabricated surgical guides, RPD frameworks, inlays, onlays, and crowns as well as bridges using CAD/CAM technology, digital planning and placement of intraoral and extraoral implants, as well as the design and fabrication of maxillofacial prostheses. Prostheses can be fabricated using CAD-CAM technologies such as additive manufacturing and subtractive milling technologies such as 3D printing. AI increases chairside use of CAD-CAM as it eliminates casting procedure making manufacturing of prosthetic restoration easy [3]. Apart from eliminating laborious and time-consuming process of traditional casting it also decreases the human error component in the final prosthesis. Best possible and aesthetically pleasing prosthesis can be fabricated taking a range of parameters into account, such as ethnicity, facial dimensions, anthropological calculations, and even the patient's demand [4]. CBCT when combined with intraoral scan can significantly improve treatment plan for dental implant. Lerner et al. [5] presented an AI model to reduce errors that occur when standard CAD/CAM technologies alone are applied for implant prosthesis cementation like positional mistakes, cementation errors, and occlusal or interproximal correction with an abutment. The use of an AI model in the production of zirconia implants for the posterior teeth yielded encouraging results, with a survival rate of 91% and a success rate of 93% [6]. Predictive AI models also play a crucial role in dental implantology. Predictive AI helps in prediction of implant success up to 99.2% efficiency using Machine Learning algorithms using implant system, patients'

data, and surgeons' operations as a guide [7]. AI was found to be helpful in anticipating the mechanical properties of a bioimplant system, reducing the high cost of computation involved with improving implant design variables [8]. AI plays an important role in planning and placement of extraoral prosthesis. Imaging techniques such as MRI and CT scan are done to capture the patient's soft and hard structures. This data with the help of Rapid Prototyping is used to fabricate the prosthesis. Only limitation is that RP techniques cannot precisely simulate skin curvature, so the wax cast is fitted to the patient and final minute features must be hand carved [9]. Bioniceye which is already under clinical has brought hope to million of people have lost their vision where vision could be achieved without requiring surgery. In this prosthesis, a smart camera is mounted on special glasses which enables the user to understand the text or recognize faces and expert analyses the camera's data and converts it into audio, which is then given to the visually impaired person's ears via a wireless earpiece. Artificial skin developed by researchers at the Federal Polytechnic School of Zurich, Zurich, Switzerland, and the California Institute of Technology, Pasadena, CA, USA has enabled the patients who have lost limbs to regain sensory capability. Artificial skin which is made up of a thin, translucent coating of water and pectin is able to detect temperature fluctuations between 5 and 50 °C [10]. Artificial olfaction, simulates the human olfactory structure, can recognize unique smells in a wide range of sectors such as disease diagnosis, environmental monitoring, public security issues, the food industry, and agricultural production [11].

### **III. Application Of AI Technologies In The Specialty Of Oral And Maxillofacial Radiology And Diagnostics:**

In radiology Artificial intelligence is becoming an important tool as it has ability to analyze large quantity of diagnostic images with improved accuracy and speed [12]. Abnormalities that are difficult to be detected by naked eyes can be easily detected by artificial intelligence. AI can do automated segmentation, which provides information on the functional performance of tissues, boundaries, and the extent of the disease, thereby reducing the need to carry out segmentation manually. Disease classification such as high or low risk, or a good or bad prognosis can be accurately done with the help of AI thereby enhancing quality of treatment that can be given to the patients [13].

### **IV. Application Of AI Technologies In The Specialty Of Orthodontics And Dentofacial Orthopedics**

As every case is a unique challenge, orthodontist must plan treatment based on his experience taking all factors associated with malocclusion and patient expectations into consideration. Diagnosis and treatment planning can be improved tremendously with the aid of AI as pre and post treatment facial photographs can be simulated and impact of orthodontic treatment can also be anticipated, thereby enhancing patients' motivation. Communication between orthodontist and patient can be greatly enhanced as anatomical landmarks and skeletal patterns can be clearly seen with the help of AI algorithms [14]. Bayesian-based decision support system developed to assess need for orthodontic treatment [15]. Xie et al. proposed an ANN model to evaluate whether extractions are needed from lateral cephalometric radiographs [16]. Bulatova et al. developed AI algorithms that identify cephalometric landmarks with accuracies comparable with human examiners [17]. Yuet al. proposed an automatic system based on AI that uses lateral cephalometric radiographs for skeletal classification [18]. All these AI algorithms are of great help for orthodontist as most of the orthodontic applications are on landmark identification and treatment planning, which are tedious procedures for even experienced orthodontists. Radiographs and full-arch 3D digital optical scans aid in treatment planning by segmenting and classifying teeth and alveolar bone. Cui et al. proposed several AI algorithms to automatically segment teeth on a digital teeth model scanned by a 3D intraoral scanner and CBCT images [19].

### **V. Application Of AI Technologies In The Specialty Of Endodontics**

The purpose of endodontic therapy is to bestow high quality care by early detection and timely treatment to prolong life of tooth and to prevent further spread of infection requiring extensive treatment. This is sometimes difficult to achieve by traditional methods especially in cases of deep fissures, tight interproximal contacts, and secondary lesions. Semiautomated documentation based on AI has decreased dentist's diagnostic time and effort. Multiple AI algorithms have been developed by various scientists for early diagnosis of dental caries. Lee et al. [20] developed a convolutional Neural Network (CNN) algorithm to detect dental caries on periapical radiographs. Kühnisch et al. [21] proposed a CNN algorithm to detect caries on intraoral images. Schwendicke et al. [22] showed that AI was more effective and less costly than traditional methods. Berdouses et al. [23] developed a computer-aided automated approach (ACDS) for the identification of occlusal caries lesions of posterior permanent teeth from photographic color tooth picture. AI algorithms like CNN and ANN (artificial neural networks) are a great tool to measure working length, determine root canal anatomy, detect periapical lesions and root fractures, predict the success of retreatment procedures and survival of stem cells in dental pulp. All these algorithms have improved the quality biomechanical preparation hence prolong the life of

tooth. [24]. Accessibility to root canals even curved or obliterated is made easy by AI-based diagnosis and assisted access cavity preparations [25]. Hiraiwa et al. [26] used deep learning systems (AlexNet and GoogleNet) to recognize the distal root shape of mandibular first molar on panoramic radiograph.

## VI. Application Of AI Technologies In The Specialty Of Periodontics

Periodontitis is one of the most common causes of tooth mobility and even tooth loss, even in young individuals if left untreated. It leads to financial burden and psychological trauma for billions of individuals. Early diagnosis and treatment planning is a key to prevent periodontitis. Clinical evaluation which is conventionally used has low reliability as it includes evaluating pocket probing depths and gingival recession that is based on the experience of dentists, and they may miss localized periodontal tissue loss. AI acts as an important aid to diagnose periodontitis and classify periodontal disease types [27]. Krois et al. used panoramic radiographs to detect periodontal bone loss using CNN. Lee et al proposed a CNN algorithm to detect periodontally compromised teeth automatically [29]. Yaune et al. [30] using health related data developed a CNN algorithm which could be used to analyze periodontal condition of the patients.

## VII. Application Of AI Technologies In The Specialty Of Oral And Maxillofacial Surgery

Oral and maxillofacial surgeons have to deal with a region which is extremely complex, including many critical anatomical structures such as the nerves, their ganglion, major vessels and parotid glands. Conventionally, Computed tomography (CT), magnetic resonance imaging (MRI) and other radiological examinations are commonly applied to diagnose various pathologies associated with maxillofacial region and their relation to critical landmarks. AI algorithms are also found to be successful in virtual surgical planning and thus are of help in reconstruction of facial defects and performing orthognathic surgeries. They are of great potential in the field of dental implants for assisting implant planning, evaluating implant performance and improving implant designs. Artificial intelligence (AI) models based on ML algorithms has been implemented in medicine to have demonstrated excellent performance in imaging data extraction and analysis and have increasingly matched specialist performance in medical imaging applications [31]. The integration of ML in oral and maxillofacial surgery has been proved to improve diagnostic accuracy, treatment efficacy, and prognostic estimation and reduce health care costs [32]. ML acts as important tool in early screening, accurate diagnosis, proper treatment and morbidity prevention. Treatment associated toxicity in the treatment of maxillofacial cysts, benign tumors, and malignant tumors can also be predicted with the help of ML.

## VIII. Conclusion:

Artificial intelligence technology has been widely applied in various fields of dentistry. Neural networks like ANN and CNN performs similarly to the dental experts with more accuracy and precision, even some AI models have also outperformed the specialists in some studies. With the help of artificial intelligence timely diagnosis and treatment planning enhances quality of medical care and hence improving overall life expectancy of the individuals. These applications are of more help to novices and non-specialists to get an expert opinion.

With the help of AI patients' motivation can be enhanced as surgical outcomes can be shown clearly. Further studies are still needed to assess the value of this AI in dental practice with the goal of providing high performance dental care that can rapidly improve optimum treatment options for the patients.

## References:

- [1] Rajaraman V. John Mccarthy Father Of Artificial Intelligence. Reson. 2014;198e207.
- [2] National Research Council. Funding A Revolution: Government Support For Computing Research. Washington, DC: The National Academies Press, 1999:302.
- [3] Zivko-Babić J, Lisjak D, Curković L, Jakovac M: Estimation Of Chemical Resistance Of Dental Ceramics By Neural Network. Dent Mater. 2008, 24:18-27. 10.1016/J.Dental.2007.01.008
- [4] Vera V, Corchado E, Redondo R, Sedano J, Garcia AE: Applying Soft Computing Techniques To Optimize A Dental Milling Process. Neurocomputing. 2013, 109:94-104. 10.1016/J.Neucom.2012.04.033
- [5] Lerner H, Mouhyi J, Admakin O, Mangano F: Artificial Intelligence In Fixed Implant Prosthodontics: A Retrospective Study Of 106 Implant-Supported Monolithic Zirconia Crowns Inserted In The Posterior Jaws Of 90 Patients. BMC Oral Health. 2020, 20:80. 10.1186/S12903-020-1062-4
- [6] Chen YW, Stanley K, Att W: Artificial Intelligence In Dentistry: Current Applications And Future Perspectives. Quintessence Int. 2020, 51:248-57. 10.3290/J.Qi.A43952
- [7] Alarifi A, Alzubi AA: Memetic Search Optimization Along With Genetic Scale Recurrent Neural Network For Predictive Rate Of Implant Treatment. J Med Syst. 2018, 42:202. 10.1007/S10916-018-1051-1
- [8] Ciocca L, Mingucci R, Gassino G, Scotti R: CAD/CAM Ear Model And Virtual Construction Of The Mold. Jprosthodont. 2007, 98:339-43. 10.1016/S0022-3913(07)60116-4
- [9] Runte C, Dirksen D, Deleré H: Optical Data Acquisition For Computer-Assisted Design Of Facial Prostheses. Int J Prosthodont. 2002, 15:129-32.
- [10] Shajahan PA, Raghavan R, Joe N: Application Of Artificial Intelligence In Prosthodontics. Int J Sci HealthCare Res. 2021, 1:57-60.

- [11] Chang JB, Subramanian V: Electronic Noses Sniff Success. *IEEE Spectr.* 2008, 3:50-6.10.1109/MSPEC.2008.4457857
- [12] Lee JH, Kim DH, Jeong SN, Choi SH. Diagnosis And Prediction Of Periodontally Compromised Teeth Using A Deep Learning-Based Convolutional Neural Network Algorithm. *J Periodontal Implant Sci.* 2018;48: 114–123. [PMC Free Article] [PubMed] [Google Scholar]
- [13] Axer H, Jantzen J, Keyserlingk DG, Berks G. The Application Of Fuzzy-Based Methods To Central Nerve Fiber Imaging. *ArtifIntell Med* 2003; 29: 225-39.
- [14] Junaid N, Khan N, Ahmed N, Abbasi MS, Das G, Maqsood A. Development, Application, And Performance Of Artificial Intelligence In Cephalometric Landmark Identification And Diagnosis: A Systematic Review. *Healthcare.* (2022) 10(12):2454. Doi: 10.3390/Healthcare10122454.
- [15] Thanathornwong B. Bayesian-Based Decision Support System For Assessing The Needs For Orthodontic Treatment. *Health Inform Res.* (2018) 24(1):22–8. Doi: 10.4258/Hir.2018.24.1.22
- [16] Xie X, Wang L, Wang A. Artificial Neural Network Modeling For Deciding If Extractions Are Necessary Prior To Orthodontic Treatment. *Angle Orthod.* (2010) 80 (2):262–6. Doi: 10.2319/111608-588.1
- [17] Bulatova G, Kusnoto B, Grace V, Tsay TP, Avenetti DM, Sanchez FJC. Assessment Of Automatic Cephalometric Landmark Identification Using Artificial
- [18] Intelligence. *OrthodCraniofac Res.* (2021) 24:37–42. Doi: 10.1111/Ocr.12542
- [19] Yu H, Cho S, Kim M, Kim W, Kim J, Choi J. Automated Skeletal Classification With Lateral Cephalometry Based On Artificial Intelligence. *J Dent Res.* (2020) 99(3):249–56. Doi: 10.1177/0022034520901715
- [20] Cui Z, Li C, Chen N, Wei G, Chen R, Zhou Y, Et Al. Tsegnet: An Efficient And Accurate Tooth Segmentation Network On 3D Dental Model. *Med Image Anal.* (2021)69:101949. Doi: 10.1016/J.Media.2020.101949
- [21] Lee J-H, Kim D-H, Jeong S-N, Choi S-H. Detection And Diagnosis Of Dental Caries Using A Deep Learning-Based Convolutional Neural Network Algorithm. *J Dent.* (2018) 77:106–11. Doi: 10.1016/J.Jdent.2018.07.015
- [22] Kühnisch J, Meyer O, Hesenius M, Hickel R, Gruhn V. Caries Detection On Intraoral Images Using Artificial Intelligence. *J Dent Res.* (2021) 101(2). Doi: 10.1177/00220345211032524.
- [23] Schwendicke F, Rossi J, Göstemeyer G, Elhennawy K, Cantu A, Gaudin R, Et Al. Cost-Effectiveness Of Artificial Intelligence For Proximal Caries Detection. *J Dent Res.* (2021) 100(4):369–76. Doi: 10.1177/0022034520972335
- [24] E. D. Berdouses, G. D. Koutsouri, E. E. Tripoliti, G. K. Matsopoulos, C.J. Oulis, And D. I. Fotiadis, “A Computer-Aided Automated Methodology For The Detection And Classification Of Occlusal Caries From Photographic Color Images,” *Computers In Biology And Medicine*, Vol. 62, Pp. 119–135, 2015.
- [25] V. Nagendrababu, A. Aminoshariae, And J. Kulild, “Artificial Intelligence In Endodontics: Current Applications And Future Directions,” *Journal Of Endodontics*, Vol. 47, No. 9, Pp. 1352–1357, 2021
- [26] B. Majumdar, S. Sarode, G. Sarode, And S. Patil, “Technology: Artificial Intelligence,” *British Dental Journal*, Vol. 224, No. 12, P. 916, 2018.
- [27] T. Hiraiwa, Y. Arijji, M. Fukuda Et Al., “A Deep-Learning Artificial Intelligence System For Assessment Of Root Morphology Of The Mandibular First Molar On Panoramic Radiography,” *Dentomaxillofacial Radiology*, Vol. 48, No. 3, P. 20180218, 2019.
- [28] Kim E-H, Kim S, Kim H-J, Jeong H-O, Lee J, Jang J, Et Al. Prediction Of Chronic Periodontitis Severity Using Machine Learning Models Based On Salivary Bacterial Copynumber. *Front Cell Infect.* (2020) 10:698. Doi: 10.3389/Fcimb.2020.571515
- [29] Krois J, Ekert T, Meinhold L, Golla T, Kharbot B, Witteimer A, Et Al. Deep Learning For The Radiographic Detection Of Periodontal Bone Loss. *Sci Rep.* (2019) 9(1):1–6. Doi: 10.1038/S41598-019-44839-3
- [30] Lee J-H, Kim D-H, Jeong S-N, Choi S-H. Diagnosis And Prediction Of Periodontally Compromised Teeth Using A Deep Learning-Based Convolutional Neural Network Algorithm. *J Periodontal Implant Sci.* (2018) 48(2):114–23. Doi: 10.5051/Jpis.2018.48.2.114
- [31] Yauney G, Rana A, Wong LC, Javia P, Muftu A, Shah P. Automated Process Incorporating Machine Learning Segmentation And Correlation Of Oral Diseases With Systemic Health. 41st Annual International Conference Of The IEEE Engineering In Medicine And Biology Society (EMBC) (2019). IEEE.
- [32] Seyyed-Kalantari L, Zhang H, McdermottMBA, Chen IY, Ghassemi M. Underdiagnosis Bias Of Artificial Intelligence Algorithms Applied To Chest Radiographs In Under-Served Patient Populations. *Natmed* 2021; 27: 2176-2182 [PMID: 34893776 DOI: 10.1038/S41591-021-01595-0]
- [33] Shan T, Tay FR, Gu L. Application Of Artificial Intelligence In Dentistry. *J Dent Res* 2021; 100: 232- 244 [PMID: 33118431 DOI: 10.1177/0022034520969115]