

**Artificial Intelligence: Current Applications and Future Perspectives In Periodontology and Implantology**

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**Abstract**

Due to the emergence of artificial intelligence (AI), rapid pace of digital development is being observed in daily life of human including dentistry in general and periodontics in particular. Artificial intelligence (AI) circumscribes a broad spectrum of developed technologies that influence our daily life. The evolution of AI provides reliable information and improves the decision-making process by analysing big data. This article throws light on the principles of AI and review development of AI and how it is being applied in periodontics and implantology. As because of accurate diagnosis and superior patient care, AI technology continues to influence the health care field specifically in dentistry.. In order to understand the applications of AI in periodontics and implantology, electronic searching were carried out to ascertain the details of AI-based services in the said field. The current applications of AI in clinical periodontology and implantology have been summarized. In the future, the AI-based comprehensive dental care system is expected to establish high-quality

patient care and innovative research and development, which may facilitate advanced decision support tools. The authors believe that an innovative inter-professional coordination among periodontologist, researchers, and engineering personnel will be the instrumental to AI development in the field of periodontology and implantology.

**Keywords:** Artificial Intelligence, Periodontology, Implantology, Diagnosis.

**Introduction**

Artificial intelligence (AI) refers to machines that can imitate human knowledge and behavior in the process of machine learning. The name AI was first coined by John McCarthy in 1950s. By sequences of algorithms, this intelligent capability of AI can be implemented. With the improvement of computer hardware, it is possible for AI to process large datasets, computationally to reveal human behavior and allow interaction with people. This technology qualitatively improves lives of people and influences the world in large way.

Ever since the field of science has originated, researchers and technologists have been busy in solving the complexity of the human brain that is a maze of neurons interconnected with each other and transmitting signals to the whole body [1]. To design a model that will mimic just like the human brain has remained a big puzzle to solve for the scientific community. Constant effort and hard work of researchers from several years results in the evolution of 'Artificial Intelligence'. The term refers to the idea of designing machines that are capable of performing tasks that are normally done by humans. It is at times called as machine intelligence.

The present decade is regarded as the decade of extraordinary achievements in development of AI. The AI based technologies has become so natural and convincing that the readers did not even distinguish whether it is human written, or system written when go through the natural language. It even recognise the face accurately and finally, AI based technologies is impacting every part of life i.e. society, healthcare and education. Dentistry is not untouched. Since artificial intelligence is the machine or technology that is more able to mimic human cognitive skills like problem solving, data analysing and recommending inferences, it is highly useful in healthcare and specifically dental care. The recent pandemic has affected the work style of the dentists and is compelling them to accept new ways of operating and dental treatments. The experience of the pandemic years have made all dentists necessary to accept a pathway through which novel technology-driven processes will gain entry. It includes computer vision, predictive analytics, AI solutions for diagnosis, treatment planning, and business intelligence. Such technology has the greatest advantage of solving complex problems for conventional system. In dentistry, AI was introduced primarily with the digitalization of

dental records and by using these records, this setup enables automated localization of anatomical landmarks, recognition of diseases and classification of tumours. The prospects of AI in the dental field and specifically periodontology and implantology are infinite and its use is rapidly advancing. The potential dental applications reviewed were [8], success in detecting precancerous lesions and metastases [2], effectiveness in improving the quality of maxillofacial radiology [3], success in orthodontic treatment [4], and orthopedic rehabilitation [5], as well as concurrent application with virtual reality to decrease anxiety in young patients [6]. However, the aforementioned reviews did not systematically explore the current diagnostic capabilities of AI in identifying common orofacial diseases and disorders and/or the subsequently elicited pain [7].

## **Discussion**

### **AI Application In Periodontology**

Periodontal disease is an inflammatory complex disease caused by multiple factors simultaneously and interactively. These are the most common oral diseases affecting human. A billion people globally are being affected by periodontal diseases, thus destroying alveolar bone which lead to tooth loss. AI can improve the dental status of the patients if can be used for early diagnosis. Lee et al. [9], reported that, continuous progression of the disease will eventually lead to the loss of teeth in the adults. Studies have been done and are being continuing to ascertain AI technology application in diagnosis and prediction of periodontal diseases. Lee et al. [10], mentioned use of CAD system, based on a deep convolutional neural network (CNN) algorithm for diagnosing and predicting the teeth that are being compromised with periodontal health. Yauney et al. [11], used an AI based system included CNNs for correlating poor periodontal health with systemic health

outcomes and reported that AI can be used for automated diagnoses and can also be useful for screenings for other diseases. Papantanopoulos and colleagues [12] used an ANN to distinguish between aggressive periodontitis and chronic periodontitis in patients by using immunologic parameters, such as leukocytes, interleukins and IgG antibody titers. Wang et al. developed a Digital Convolution Neural Network based system that consists of 16 convolution layers and two fully connected layers for detecting periodontitis of premolars and molars [13]. Deep learning analysis using radiographs can help in diagnosing and treatment planning of periodontal diseases by the early detection of periodontal changes [14, 15]. This helps in early intervention in implantology.

Ozden et al. (2015) examined the use of a support vector machine (SVM), decision tree (DT), and ANN to identify and classify periodontal disease and found that SVM and DT were more accurate as diagnostic support tools compared to ANN [16]. Nakano et al. (2018) used deep learning (DL) to detect oral malodor from microbiota. DL showed a predictive accuracy of 97% compared to SVM, which showed 79% [17]. ANN has been used to predict the occurrence of recurrent aphthous ulcers. Gender, serum B12, hemoglobin, serum ferritin, folate levels, candida count in saliva, tooth brushing frequency, the number of fruits and vegetables consumed daily, were related to the occurrence of ulcers [18] Danks et al. (2021) used a deep neural network to measure periodontal bone loss with the help of periapical radiographs. The examination showed promising results, which can be further improved upon by experimentation and cross-validation with extended data sets [19].

AI can be a valuable tool in supporting diagnosing diseases of the dental caries, tooth fracture, the maxillary sinus disease, the salivary gland disease, the

osteoporosis, the temporomandibular joint disorder and oral cancer. DL models can, in some instances, be superior to radiologists. AI has the potential to be used as a tool to predict the recurrence of salivary gland malignancies [20]. Facial nerve injury after surgical treatment for a salivary gland tumor is a severe complication. Chiesa-Estomba et al. (2021) used clinical, radiological, histological, and cytological data to predict the occurrence of facial nerve palsy in patients and reported that AI can be used as an assessment tool for the prediction of facial nerve injury so that both surgeons and patients are well aware of the complications in advance [21]. In addition to promoting our understanding of periodontitis, this technology serves as a bridge to incorporate conventional indicators and immunologic and microbiological parameters into periodontal diagnosis [22].

AI is also instrumental to periodontal drug prescription through telemedicine system. It optimises drug delivery process also. LDD facilitate fast drug target validation which is also an important aspect of AI.

### **Application In Implantology**

Revella Leon M. et.al. (2023) [23] made a systematic review and concluded that, the AI application in implant dentistry by using radiographical images were the more developed application of AI having an overall accuracy ranging from 93.8% to 98%. The AI models developed to predict osteointegration on implant success varied from 62.4% to 80.5% among the studies carried out by them. The studies that developed AI models to improve and optimize implant designs minimize the stress at the implant-bone interface by optimizing the implant design porosity, length, and diameter, accurately determining the elastic modulus of the implant bone interface.

Kurt Bayrakdar et.al. 2021 [24] in their study found that the application of the artificial intelligence (AI)

system in implant planning using three-dimensional cone-beam computed tomography (CBCT) facilitate the work of physicians and will be a support mechanism in implantology practice. The success of their study in the detection of sinus / mandibular canal and missing teeth and the measurements offers and reinforces the possibility of application of AI in implant planning.

The AI can be used in implantology for detection of maxillary sinus, detection of alveolar bone loss and detection of mandibular nerve. In addition to this it can be used for recognizing implant type and designs, to predict implant success by using patient risk factor, to predict the osteointegration of the implant and to minimize stress at implant bone interface.

#### **Future Considerations**

Artificial Intelligence can be considered for future applications are:

1. Accuracy of predicting the need for extraction
2. Detecting precancerous lesions and metastases
3. Effectiveness in improving the quality of radiology
4. Application with virtual reality to decrease anxiety in young patients
5. Identifying common orofacial diseases and disorders and subsequently eliciting pain.

#### **Conclusion**

AI models are still in developed stage though have the potential to optimize implant designs, recognize implant type, and predict implant success by using ontology criteria. The application of AI in implant dentistry is rapidly expanding, the effectiveness and reliability of AI models must be evaluated in intervals for better results.

AI cannot replace the role of periodontal surgeon but it can correlate with various clinical findings and provides a specific better treatment to the patient with accuracy.

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