REVIEW ARTICLE

Artificial intelligence: A dentist's perspective

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Abstract

Artificial intelligence (AI) is a breakthrough in the field of technology which is rapidly progressing and has captivated the minds of researchers across the globe. Ever since, its inception dentistry has witnessed some of the exceptional achievements. Hence, this situation demands every dentist to get acquainted with this technology as the future of dentistry is abutting the implementation of its applications. While, in no ways, AI can replace the role of a dentist, it is of prime importance to be aware of the possibilities to integrate this technology in the future for a gratifying and successful practice.

Introduction

The human brain is an inimitable structure composed of networks of interlinked neurons which transmit signals throughout the body. This unexampled nature of human brain has always made researchers and scientists inquisitive from time immemorial. History dates back to as early as 400 BC when Plato envisaged a basic model of brain function.[1] Since then, the field of science has witnessed various inventions with the advent of technology for creating a model that can simulate the functioning of the human brain. The deed of the constant search has given rise to what is known as artificial intelligence (AI), which is a highly evolved system capable of mimicking functioning of the human brain. 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] Computer-based diagnosis is gaining momentum due to its ability to detect and diagnose lesions which may go unnoticed to the human eye, thereby paving way for a holistic practice. The various techniques of AI which are being applied in dentistry include artificial neural networks (ANN), genetic algorithms (GA), and fuzzy logic. Following its inception in 1959 when the first computational trainable neural networks were developed,[3] the field of medicine and dentistry has witnessed innumerable research using AI.

Artificial Intelligence in Dentistry

Correct diagnosis is the key to a successful clinical practice. In this regard, adequately trained neural networks can be a boon to diagnosticians, especially in conditions having multifactorial etiology. Recurrent aphthous ulceration is one such condition without a precise etiology, where clinical diagnosis is made only on the basis of recurrence and by the exclusion of other factors. In a study,[4] data from 86 participants were used to construct and train a neural network to predict the factors appearing to be related to the occurrence of recurrent aphthous ulcers. When this was further tested using untrained data of 10 participants the results revealed most accurate predictions such as gender, hemoglobin, serum Vitamin B12, serum ferritin, red cell folate, salivary candidal colony count, frequency of tooth brushing, and the number of fruits or vegetables consumed to be related to recurrent aphthous ulceration and appropriate for use as input data to construct ANNs. Internal derangements of the temporomandibular joint are yet another taxing situation where the expert examiners' decision based on clinical and imaging data is considered as gold standard. Hence, when trained ANNs were tested and compared with the diagnosis of a surgeon, the results revealed high sensitivity and specificity of ANN, thereby insisting on the importance of AI in achieving correct interpretations and reducing human errors.[3] The neural network may be of value for the identification of individuals with a high risk of oral cancer or precancer for further clinical examination or health education.[5]

This could quench the ever-existing need to devise a method for the early detection of oral cancer which accounts for 30% of all the cancers in India.[6] GAs and ANN are a promising tool for predicting the sizes of unerupted canines and premolars with greater accuracy in the mixed dentition period[7] and can also be optimized for predicting the tooth surface loss which is a universal problem that involves an irreversible, multifactorial, non-carious, physiologic, pathologic, or functional loss of dental hard tissues.[8]

In orthodontics, diagnosis forms the crux of the treatment. When a proposed model was trained in this aspect to assess the craniofacial skeletal and dental abnormalities in cephalometry followed by comparison with an expert opinion, the agreement between them was found to be equivalent. In addition, the model pointed out contradictions presented in the data that were not noticed by the orthodontists, thereby highlighting the contribution of AI in orthodontic decision support.[9] It can also be used to provide orthodontic consultations to general practitioners for the alignment of crowded lower teeth.[10]

In head-and-neck imaging modalities, AI provides additional leverage owing to its unique ability to learn. It can be integrated with imaging systems such as magnetic resonance imaging and cone-beam computed tomography to identify minute deviations from normalcy that could have gone unnoticed by the human eye. Examples include the accurate location of landmarks on radiographs, which can assist in cephalometric diagnosis.[2] ANN is found to act as a second opinion to locate the minor apical foramen, thereby enhancing the accuracy of working length determination by radiographs[11] and in diagnosing proximal dental caries.[12] It is also found to have sufficient sensitivity, specificity, and accuracy to be a model for vertical root fracture detection in digital radiography.[13]

Further progressing to the role of AI in treatment planning, the neural networks when optimally trained with respect to lower third molars are found to have high specificity and sensitivity equivalent to specialist consultation in categorizing tooth to "gold standard" based on NIH consensus criteria.[1] Added to this, the ANN can be employed to determine if extractions are necessary before orthodontic treatment.[14] ANN can also effectively be used in classifying patients into aggressive periodontitis and chronic periodontitis group based on their immune response profile.[15]

When it comes down to implementing ANN in clinical practice, it has sufficient precision for the design and chairside manufacturing of dental prostheses, based on digital image acquisition following tooth cusps assessment.[16] It can have a great potential in investigating the properties of dental materials such as chemical stability, wear resistance, and flexural strength.[17]

Other ingenious applications of AI include "bioprinting" where living tissue and even organs can be constructed in consecutive thin layers of cells which in the future may be used for reconstruction of oral hard and soft tissues lost due to pathological or accidental reasons and robotic surgery, where robotic surgeons perform semi-automated surgical tasks with increasing efficiency under the guidance of an expert surgeon.[2]

Advantages of AI

1. Accuracy in diagnosis
2. Standardization of procedures
3. Saves time.

Disadvantages of AI

1. The complexity of the mechanism
2. The cost involved in the setup.

Will AI Replace Dentists

While, in no ways, there exists a doubt in the supremacy of integrating AI into practice, it can never replace the role of a dentist since clinical practice is not only about diagnosing but also correlating with clinical findings and providing personalized patient care. Although AI can assist in numerous ways, final call has to be made by a dentist as dentistry is a multidisciplinary approach.

Conclusion

Applications of AI in everyday life are growing leaps and bounds. Dentists have always been at the forefront of implementing a technology. Hence, understanding the various concepts and the techniques involved will have a clear advantage in the future when it is time to adapt to the change with redefined roles for a rewarding practice.

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