Artificial Intelligence in Oral Surgery

Aravind Jayabalan[1], Indra Kumar Periyasamy[1], Saravanan Kandasamy[1], Arrvinthan SU[1], Infanta AJ[1], Narendar Ramesh[1]

[1]Department of Oral and Maxillofacial Surgery, Vivekanandha Dental College for Women, Ellayampalayam, Tiruchengode, Tamil Nadu, India.

*Corresponding author:
Indra Kumar Periyasamy,
Department of Oral and
Maxillofacial Surgery,
Vivekanandha Dental College
for Women, Ellayampalayam,
Tiruchengode, Tamil Nadu,
India.

kumarjeeth@yahoo.com

ABSTRACT

Artificial Intelligence (AI) has become a part of human life. The application of artificial intelligence in the field of oral and maxillofacial surgery is tremendous. This article focuses on the execution of algorithms in oral surgery to improve patient care and surgeons' skill. It also explores the biases, privacy and confidentiality and threat to human resources when used at a large scale.

Keywords: Artificial intelligence, Algorithms, Data

INTRODUCTION

With its genesis in 1900s, the word Artificial Intelligence (AI) was endorsed by John Macarthy in the 1950s.[1,2] AI is a subset of computer science that focuses on machine-driven intelligence. It refers to any machine or technology that can mimic human cognitive skills.[3] Fast forward many scientists and programmers abetted in the world of modern AI. The AI algorithms are designed to perform tasks that normally require human intelligence, such as visual perception, language processing, speech recognition and decision-making using real-time data.[4] With the help of digital data and sensors, they avail information from a variety of sources, analyze and take action upon the perception from the data and reach their conclusions.[3,4] These algorithms are capable of analysis and decision-making.

AI is rapidly growing in robotics, transportation, smart cities, financial analysis, and hotel industries, with its emerging presence in the field of medicine and dentistry.[2,5] The field of oral and maxillofacial surgery is slowly adapting to the world of artificial intelligence.[5] The American Medical Association has described artificial intelligence as 'Augmented Intelligence' as it increases the Physician's knowledge rather than replacing it.[1] In oral and maxillofacial surgery, it can be used to improve diagnosis, training of surgeons, deep learning and to ameliorate the outcome of treatment.[3] However, there are many practical and ethical challenges regarding their application in the healthcare system.

CLINICAL APPLICATION

With the help of various algorithms, numerous procedures can be done in oral surgery. Artificial Neural Network (ANN) is a subfield of artificial intelligence modeled after the brain. They have a biological neural network that mimics the structure of the brain and are interconnected to each other. They are called as nodes [Figure 1].[6,7] A subtype of ANN called convolutional neural network (CNN) has a special neuron architecture, which is similar to the frontal lobe of the brain. It is necessary for sound, image recognition and classification.[8]
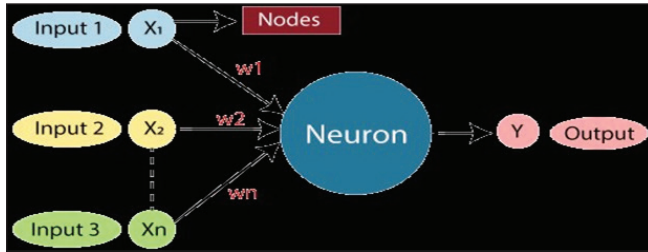
Figure 1: Inputs 1,2,3:Dendrites, X (nodes) 1, 2, 3:Cell nucleus, YAxon, W (weight) 1, 2, 3: Synapses.

ANN models can be used to know the extent of facial swelling during the third molar surgery that can aid clinicians in determining the prognosis of treatment.[9] CNN models can help analyze the lymph node metastasis in a wide range of sensitivity and specificity.[9] Telecytology (TC), a digitalization of the cytology slide, is used to detect the early onset of cancer and reduce the mortality rate.[9] The architectural variation of the epithelial layers and keratin pearls seen during image analysis are the key features for the diagnosis of oral cancer. They are more specific than textural analysis.[10] deep convolutional neural network (DCCN) was developed to automatically identify odontogenic cysts and tumors in panoramic images with high specificity and augmented datasets.[11] In orthognathic surgery, where the main goal is to re-establish occlusion and facial esthetics, AI intervenes at different levels for pre-acquisition and pre-analysis of images.[3,12] They have countless resolutions that can give the physician a more transparent view of the patients' morphology, which is necessary to get good treatment options.[12] The CNN approach is also used to identify oral squamous cell carcinoma and potentially malignant disorders with the help of intra-oral optical images.[9,5] ANN also distinguishes between malignant and dysplastic lesions in the oral cavity. In bone reconstruction surgery, the closest point (CP) algorithm is used for assessing the accuracy of virtual surgical planning by comparing it with the normal people's database that was collected before.[11] In terms of planning for assisted surgery, AI software can reduce the operation time and preserve the vital structures with high accuracy.[9] The machine learning algorithms can also analyze the surgeons' skills and provide feedback on their accuracy.[3,13]

Visuo-haptic simulators are another invention, which are highly useful in the field of surgery. They use the sense of human touch by furnishing force and vibration that simulate real-life experience. Training in oral surgery may be limited due to the scarcity of cadaver resources, so haptic simulators can become an alternative to traditional training and improve manual dexterity.[14] In cleft lip and palate, it plays a major role in areas such as risk prediction, diagnosis and

surgery. Statistical modeling using three dimensional (3D) facial surface data is employed to assess the outcome of the surgery.[11] This 3D facial imaging can be used alone or in combination with computed tomography (CT) or magnetic resonance imaging (MRI) that can help the entire clinical team to arrive at a treatment plan and perfect measurement of volumes.[11]

CHALLENGES

Although AI has excellent features, it has many shortcomings like ethical dilemmas, privacy, data protection, informed consent, medical consultation and empathy.[1] The algorithms need certain data in order to perform, but patient data must be protected at any stage. So, it is necessary to ensure that all the stages of designs and use of algorithms must maintain privacy and confidentiality of the patient.[11] The patient must be informed prior to collection of their data. It is also time-consuming as labeling is manually done and can lead to errors.[15] Sometimes, biases occur due to age, gender, race, and disabilities. Such biased artificial intelligence can lead to false diagnoses and can pose a threat to patient's safety, hence this needs oversight to establish safety. At the end, the physician must contemplate and follow all four ethical principles - Justice, Autonomy, Beneficence and Non-Maleficence.

CONCLUSION

AI is becoming a threat to all other fields but in the healthcare system, substantial experience, clinical judgment, compassion and empathy towards the patient is an absolute necessity, which the AI lacks. We need better understanding that artificial intelligence is there to improve patient care and not to replace human beings. Financial resources and open-mindedness to new innovations are required in the future. As we are moving forward towards the new age, careful understanding and implementation is the need of the hour.

Ethical Approval

The Institutional Review Board approval is not required.

Declaration of patient consent

Patient's consent not required as there are no patients in this study.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

Use of artificial intelligence (AI)-assisted technology for manuscript preparation

The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript and no images were manipulated using the AI.

REFERENCES

1. Hui AT, Ahn SS, Lye CT, Deng J. Ethical challenges of artificial intelligence in health care: A narrative review. Ethics in Biology, Eng Med: An Int J 2021;12.
2. Bashir U, Zulfiqar K. Artificial intelligence in dentistry: Hype or hope? J Islam Int Med Coll (JIIMC) 2023;18:1–3.
3. Rokhshad R, Keyhan SO, Yousefi P. Artificial intelligence applications and ethical challenges in oral and maxillo-facial cosmetic surgery: A narrative review. Maxillofac Plast Reconstr Surg 2023;45.
4. What is artificial intelligence? Brookings. Available from: https://www.brookings.edu/articles/what-is-artificial-intelligence/ [Last accessed on 2023 August 15].
5. Ding H, Wu J, Zhao W, Matinlinna JP, Burrow MF, Tsoi JK. Artificial intelligence in dentistry—A review. Front Dent Med 2023;4:1085251.
6. Nguyen TT, Larrivée N, Lee A, Bilaniuk O, Durand R. Use of artificial intelligence in dentistry: Current clinical trends and research advances. J Can Dent Assoc 2021;87:1488–2159.
7. Awati R. What is convolutional neural network? - Definition from WhatIs.com. Search Enterprise AI. 2022. Available from: https://www.techtarget.com/searchenterpriseai/definition/convolutional-neural-network [Last accessed on 2023 August 15].
8. Lamba GS, Singh H, Grover S, Oberoi SS, Atri M, Yadav P, *et al.* Artificial intelligence in modern dentistry. Int J Health Sci (Qassim) 2022;6:8086-98.
9. Krishna AB, Tanveer A, Bhagirath PV, Gannepalli A. Role of artificial intelligence in diagnostic oral pathology-A modern approach. J Oral Maxillofac Pathol 2020;24:152.
10. Yan KX, Liu L, Li H. Application of machine learning in oral and maxillofacial surgery. Artif Intell Med Imaging 2021;2:104–14.
11. Bouletreau P, Makaremi M, Ibrahim B, Louvrier A, Sigaux N. Artificial intelligence: Applications in orthognathic surgery. J Stomatol Oral Maxillofac Surg 2019;120:347–54.
12. Artificial Neural Network Tutorial - Javatpoint. www.javatpoint.com. Available from: https://www.javatpoint.com/artificial-neural-network [Last Accessed on August 15].
13. Frąckiewicz M. AI in Robotic Oral and Maxillofacial Surgery. TS2 SPACE. 2023. Available from: https://ts2-space.webpkgcache.com/doc/-/s/ts2.space/en/ai-in-robotic-oral-and-maxillofacial-surgery/ [Last accessed on 2023 August 15].
14. Chen X, Hu J. A review of haptic simulator for oral and maxillofacial surgery based on virtual reality. Expert Rev Med Devices 2018;15:435–44.
15. Rasteau S, Ernenwein D, Savoldelli C, Bouletreau P. Artificial intelligence for oral and maxillo-facial surgery: A narrative review. J Stomatol Oral Maxillofac Surg 2022;123:276–82.