ejpmr, 2021,8(8), 316-320.

SJIF Impact Factor 6.222

EUROPEAN JOURNAL OF PHARMACEUTICAL AND MEDICAL RESEARCH

www.ejpmr.com

Review Article

ISSN 2394-3211

EJPMR

ARTIFICIAL INTELLIGENCE IN ENDODONTICS

***Dr. Nitin R. Rao, Dr. Dharam Hinduja, Dr. Abdul Mujeeb, Dr. Raghu K. N., Dr. Ashwini K. S.**

SJM Dental College and Hospital Chitradurga Karnataka 577501.

***Corresponding Author: Dr. Nitin R. Rao**

SJM Dental College and Hospital Chitradurga Karnataka 577501.

Article Received on 16/06/2021 **Article Revised on 06/07/2021** **Article Accepted on 26/07/2021**

ABSTRACT

Artificial intelligence is an enormous spectrum of emerging technologies that has become increasingly popular in health care field by emphasizing its assistive and supplementary role to medical and dental professionals by enabling them to share health-related big data and deliver insights that improve patient care. They offer high degree of performance and are becoming economically more relevant by in dentistry through the democratized use of modern dental technologies. A proactive attitude should be maintained toward AI to ensure its affirmative development so as to revolutionize dental practice.

INTRODUCTION

Artificial intelligence (AI), first named by John McCarthy [1] refers to machines that have ability to mimic human knowledge and behavior. It consists methods from classical artificial intelligence such as tree-search algorithms and symbolic task planning that are used to autonomously plan a sequence of actions in order to achieve a desired goal[2] .Artificial intelligence (AI) intends to reproduce the cognitive process of humans and can achieve the same outcome as medical professionals within a much shorter time frame [3]. Machine learning and its allied fields including deep learning, cognitive computing, natural language processing, robotics, expert systems, and fuzzy logic are subcategories of AI. In Machine learning (ML) algorithm are applied to learn the intrinsic statistical patterns and structures in data; the primary goal is to allow automated learning without human arbitration This allows for predictions of unseen data. AI can perform a number of simple tasks in the dental clinic with less staffing. It also allows for greater precision than human counterparts. This includes booking and coordinating regular appointments to assisting the clinical diagnosis and treatment planning. AI can automatically identify and categorize dental restorations on panoramic radiographs. It also provides assistance in the detection of dental and maxillofacial pathologies including periodontal diseases, root caries, bony lesions.[4] It excels in extracting information from historical data and benefits physicians by automating time-consuming tasks.[3]

A popular field in machine learning is “deep learning,” where multilayered (deep) neural networks are used to learn hierarchical features in the data.[5] These are particularly useful for complex data structures since they are capable of representing an image and its hierarchical features.[7] Deep learning refers to the process of data (e.g., images) and corresponding labels (e.g., “carious tooth,” or “specific area on an image where a caries lesion is present”. A deep learning-based convolutional neural network (CNN) algorithm considerably performed well in detecting dental caries in periapical radiographs.[6] Deep learning has been utilized not only in face detection, but also in dental radiology can be used for diagnosis of dental caries, with the accuracy of identifying dental caries in premolars, molars, and between premolars and molars.[7]

Applications

As AI-based services have turned up into the market, their assistance for the dental office is becoming more prominent.[8] AI has become a thriving topic in dentistry, as it benefits clinicians with high- quality patient-care, and simplifies complicated protocols by providing a predictable outcome. Its applications evolve rapidly day by day. AI has been used to improve image interpretation in dental radiology,[8] This infers that more accurate and efficient diagnosis will be achieved with the integration of AI into existing dental clinical workflow.[9]

In Endodontics

With the ability to perform automated lesion segmentation, DL with CNN has become the predominant AI component used in endodontic diagnostics.[10] AI allows to integrate different and heterogeneous data domains, for example, medical/dental history, socio demographic and clinical data.[4]

DL identified proximal carious lesions by focusing on the binary presence or absence of lesions, from near-infrared trans illumination images with an area under the receiver operating characteristic curve of 0.856.[11]

Working length determination is one of the pivotal steps for a successful endodontic treatment. According to the results of various studies it was observed that AI-based models are particularly efficient in determining the apical foramen and working length.[12]

AI facilitates research and discovery, by integrating silico experimentation options to conventional research set up, complementing other research degrees and existing modeling methodologies.[4,13]

Micro-robots possessing catalytic ability can be used to destroy biofilms within the root canal and this system is tested In vitro. Furthermore, the authors discussed the use of these systems for other applications such as prevention of tooth decay or peri-implant infection.[14,15]

It is essential that a dentist should have thorough knowledge and also have an efficient diagnostic tool for identifying the root morphologies. A study reported of CNN-based AI model applied to identify the root morphologies on CBCT images. The model demonstrated admirable results.[16] VRFs are mostly insidious, as they show only minute symptoms and most of the time wit no symptoms.[17] The model proved to be very efficient in diagnosing the VRFs on CBCT images in comparison to periapical radiographs.[18]

Table 2: Characteristics of selected studies (n = 33).

Author and year	Study design	Groups		Application	Assessment method	Follow-up period	Outcome
		Study	Control				
Bouchahma et al.[6] 2019	Clinical trial	CNN	NM	OD and endodontics	Prediction of three types of treatments; fluoride, filling, and root canal treatments. The model was trained to learn on dataset of 200 Xray images of patients' teeth collected	NM	DL overall accuracy was 87%. fluoride treatment showed the best prediction of 98%, followed by RCT detection 88% and filling 77%
Ekert et al[19] 2019	Clinical trial	CNN to detect AL	Six independent examiners detect AL	Endodontics and OD	NN was trained and validated via 10 times repeated group shuffling. Results were compared with the majority vote of 6 examiners who detected ALs on an ordinal scale	NM	A moderately deep CNN showed satisfying discriminatory ability to detect ALs on panoramic radiographs
Saghiri et al.[20] 2012	Clinical trial	ANN	Endodontist's opinion	Endodontics	Working length was determined and confirmed radiographically by endodontists and compared with ANN, and stereomicroscope as a gold standard after tooth extraction in cadaver	NM	ANN was more accurate than endodontists' determinations when compared with measurements by using the stereomicroscope
Setzer et al.[21] 2020	Clinical study	Evaluation of periapical lesion by DL method	Rating by OMF radiologist, an endodontist, and a senior graduate student	Endodontics	The CBCT segmentation was assessed by DL, CNN detection	NM	DL algorithm trained in a limited CBCT environment showed excellent results in lesion detection accuracy
Arisu et al.[22] 2018	Clinical tria	ANN	NM	Restorative dentistry	Obtained measurements and data were fed to an ANN to establish the correlation between the inputs; composite	NM	ANN showed that the light-curing units and composite parameter had the most significant

					shade curing units and outputs; tooth number		effect on the bottom to top Vickers hardness ratio of the composites
Yamaguchi et al.[23] 2019	Clinical tria	12 dislodge CAD/CAM composite resin crowns with DL	12 trouble-free CAD/CAM composite resin crowns	Restorative dentistry	Convolution neural network (CNN) technique was used to predict debonding of composite crowns using 2D images captured from 3D stereolithography model	NM	Deep learning with CNN model showed good performance in terms of dislodgement predictability of composite crowns through 3D stereolithography models
Li et al.[24] 2020	Clinical trial	50 oral images and 274 anterior through automated photo integrating system	Manual segmentation system	Esthetic dentistry	The facial and intraoral key points were detected by an automatic algorithm and compared with manual segmentation on standard photographs	NM	The proposed automated system can eliminate the need for dentists to employ a laborious image integration process and it's use can be further extended into the field of esthetic dentistry
Li et al.[25] 2015	Experimental study	BPNN and GA neural network	Traditional neural network	Esthetic dentistry	The weighs and threshold values of GA and BPNN were compared for assistance in tooth color matching in dentistry	NM	GA and BP have practical application and can make teeth color matching objective and accurate

NA: not applicable; NM: not mentioned; OD: oral diagnosis; AL: apical lesion; CNN: convolutional neural networks; ANN: artificial neural networks; 3D: three dimensional; DL: deep learning; CAL: computer-assisted learning; CAD/CAM: computer-aided design/computer-aided manufacturing; 2D: two dimensional; BPNN: back-propagation neural networks; CDS: clinical decision support systems; ; CBCT: cone-beam computerized tomography; GA: genetic algorithm; serum CTX: serum C-terminal telopeptide; AUC: area under the curve.

LIMITATIONS

Like the nature of data mining,[26] AI might only reflect the results subjectively with associations, not with causality. Only limited options are available for triangulating or validating data on each patient as they are complex, multi-dimensional, and sensitive.[27]

Apart from limitations encountered in other medical fields, such as insufficient data curation and sharing[28] the lack of information on data processing, measuring, and validating is another blemish in dental AI research.

AI programs still need to be developed in collaborations that involve experienced clinicians and expert computer engineers to minimize potential risks of AI.[29]

CONCLUSION

AI is fast progressing with potential applications extending over various domains including diagnosis, treatment, and prognosis predictions. Although there is a pertaining concern about data protection and data security and about handing over critical medical decisions to computers; AI however, has the potential to revolutionize healthcare and, with it, dentistry; AI techniques assist dental practitioners in numerous ways, from decreasing the chairside time, saving extra steps and achieving superior infection control, all of which, would ensure quality treatment with accuracy and precision. According to the studies reported on the application of AI in endodontics, it may be concluded that neural networks showed comparable performance to that of experts. To add to the benefits, they also work with better accuracy and precision.

REFERENCES

1. McCarthy J. Artificial intelligence, logic and formalizing common sense. In: Thomason RH (ed).

Philosophical logic and artificial intelligence. Dordrecht: Springer, 1989; 161–190.
2. Russell S, Norvig P. Artificial intelligence: a modernapproach. Global Edition Pearson Education Limited, 2016.
3. Shan T, Tay FR, Gu L. Application of artificial intelligence in dentistry. Journal of Dental Research, 2021 Mar; 100(3): 232-44.
4. F. Schwendicke, W. Samek, and J. Krois, "Artificial intelligence in dentistry: chances and challenges," Journal of Dental Research, 2020; 99(7): 769–774.
5. Barr, E. A. Feigenbaum, and P. R. Cohen, The Handbook of Artificial Intelligence, vol. 1-3, William Kaufmann Inc., Los Altos, CA, 1981
6. M. Bouchahma, S. Ben Hammouda, S. Kouki, M. Alshemaili, and K. Samara, "An automatic dental decay treatment prediction using a deep convolutional neural network on X-ray images," in 2019 IEEE/ACS 16th International Conference on Computer Systems and Applications (AICCSA), pp. 1–4, Abu Dhabi, United Arab Emirates, 2019.
7. Hornik K. Approximation capabilities of multilayer feed forward networks. Neural Netw, 1991; 4(2): 251–257.
8. Chen YW, Stanley K, Att W. Artificial intelligence in dentistry: Current applications and future perspectives. Quintessence Int., 2020 Mar 1; 51(3): 248-57.
9. Bouletreau P, Makaremi M, Ibrahim B, Louvrier A, Sigaux N. Artificial intelligence: applications in orthognathic surgery. J Stomatol Oral Maxillofac Surg, 2019; 120(4): 347–354.
10. Anwar SM, Majid M, Qayyum A, Awais M, Alnowami M, Khan MK. Medical image analysis using convolutional neural networks: a review. J Med Syst, 2018; 42(11): 226.
11. Casalegno F, Newton T, Daher R, Abdelaziz M, Lodi-Rizzini A, Schürmann F, Krejci I, Markram H. Caries detection with near-infrared transillumination using deep learning. J Dent Res, 2019; 98(11): 1227–1233.
12. Saghiri MA, Asgar K, Boukani KK, et al. A new approach for locating the minor apical foramen using an artificial neural network. Int Endod J, 2012; 45(3): 257–265. DOI: 10.1111/j.1365-2591.2011.01970.x.
13. Naylor CD. On the prospects for a (deep) learning health care system. JAMA, 2018; 320(11): 1099–1100.
14. Nelson CA, Hossain SG, Al-Okaily A, Ong J. A novel vendingmachine for supplying root canal tools during surgery. JMed Eng Technol, 2012; 36: 102–16.
15. Hwang G, Paula A, Hunter E, Liu Y, Babeer A, Karabucak B,et al. Catalytic antimicrobial robots for biofilm eradication.Sci Robot, 2019; 4: 2388.
16. Hatvani J, Andras H, Jerome M, et al. Deep learning-based superresolution applied to dental computed tomography. IEEE Trans Rad Plasma Med Sci., 2019; 3(2): 120–128. DOI: 10.1109/TRPMS.2018.2827239. ISSN 2469-7311.
17. Tsesis I, Rosen E, Tamse A, et al. Diagnosis of vertical root fractures in endodontically treated teeth based on clinical and radiographic indices: a systematic review. J Endod, 2010; 36(9): 1455–1458. DOI:10.1016/j.joen.2010.05.003.
18. Johari M, Esmaeili F, Andalib A, et al. Detection of vertical root fractures in intact and endodontically treated premolar teeth by designing a probabilistic neural network: an ex vivo study. Dentomaxillofac Radiol, 2017; 46(2): 20160107. DOI: 10.1259/dmfr.20160107.
19. T. Ekert, J. Krois, L. Meinhold et al., "Deep learning for the radiographic detection of apical lesions," Journal of endodontics, 45(7): 917–922.e5.
20. M. A. Saghiri, F. Garcia-Godoy, J. L. Gutmann, M. Lotfi, and K. Asgar, "The reliability of artificial neural network in locating minor apical foramen: a cadaver study," Journal of Endodontia, 2012; 38(8): 1130–1134.
21. F. C. Setzer, K. J. Shi, Z. Zhang et al., "Artificial intelligence for the computer-aided detection of periapical lesions in conebeam computed tomographic images," Journal of Endodontia, 2020; 46(7): 987–993.
22. H. Deniz Arısu, E. Eligüzeloglu Dalkilic, F. Alkan, S. Erol, M. B. Uctasli, and A. Cebi, "Use of artificial neural network in determination of shade, light curing unit, and composite parameters' effect on bottom/top Vickers hardness ratio of composites," BioMed Research International, vol.2018, Article ID 4856707, 2018; 9.
23. S. Yamaguchi, C. Lee, O. Karaer, S. Ban, A. Mine, and S. Imazato, "Predicting the debonding of CAD/CAM composite resin crowns with AI," Journal of Dental Research, 2019; 98(11): 1234–1238.
24. M. Li, X. Xu, K. Punithakumar, L. H. Le, N. Kaipatur, and B. Shi, "Automated integration of facial and intra-oral images of anterior teeth," Computers in Biology and Medicine, 2002; 122: 103794.
25. H. Li, L. Lai, L. Chen, C. Lu, and Q. Cai, "The prediction in computer color matching of dentistry based on GA+BP neural network," Computational and Mathematical Methods in Medicine, vol. 2015, Article ID 816719, 2015; 7.
26. Gansky SA. Dental data mining: potential pitfalls and practical issues. Adv Dent Res., 2003; 17: 109–114.
27. Gianfrancesco MA, Tamang S, Yazdany J, Schmajuk G. Potential biases in machine learning algorithms using electronic health record data. JAMA Intern Med, 2018; 178(11): 1544–1547.
28. Hosny A, Parmar C, Quackenbush J, Schwartz LH, Aerts H. Artificial intelligence in radiology. Nat Rev Cancer, 2018; 18(8): 500–510.

29. Strickland E. IBM Watson, heal thyself: How IBM overpromised and underdelivered on AI health care. IEEE Spectrum, 2019; 56(4): 24–31.