InternationalJournalofResearchinHealthandAlliedSciences

Journalhomepage:www.ijrhas.com

Official Publication of "Society for Scientific Research and Studies" [Regd.]

ISSN:2455-7803

Original Research

Use of artificial intelligence for detecting impacted third molars on cone-beam computed tomography scans

[1]Dr. Jaspreet Singh Khurana, [2]Dr. FarzanaWasi, [3]Dr. Shipra Singh, [4]Mohit Pandey, [5]Dr. Saurabh. S. Pillai, [6]Dr. G.S. Prasanthi

[1]Third Year Post Graduate Student, [2,3]2nd Year Post Graduate Student, Department of Periodontology, Career Post Graduate Institute of Dental Sciences & Hospital, Lucknow, U.P., India;
[4]BDS Final Year, Shree BankeyBihari Dental College and Research Center, Ghaziabad, U.P., India;
[5]Consultant Oral and Maxillofacial Surgeon, Bangalore, Karnataka, India;
[6]Reader, Department of Prosthodontics and Crown and Bridge, Sibar Institute of Dental Sciences, Guntur, Andhra Pradesh, India

ABSTRACT:
Background:A variety of etiological variables, including systemic, local, and hereditary, can lead to tooth impaction, a common pathological dental disorder. The present study was conducted to evaluate use of artificial intelligence for detecting impacted third molars on cone-beam computed tomography scans.**Materials & Methods:**50 patients of both genders were selected. Monitoring for impaction, the number of impacted teeth, the number of teeth's roots and canals, and the teeth's relationship to nearby anatomical features (maxillary sinus and inferior alveolar canal) were compared between the AI application and the human observer. The Kappa analysis was used to assess the recorded parameters agreement between the deep-CNN-based AI application and the human observer.**Results:**AI detected impacted tooth rightly in 86% and tooth number in 95%. The difference was significant (P< 0.05). In maxilla, sinus relation was correctly detected in 91%, root number in 69%, canal number in 67%. In mandible, canal detected correctly in 92%, canal relation in 85%, root number detection in 84% and canal number detection in 65%. The difference was significant (P< 0.05). There was moderate agreement between moderate in Inferior alveolar canal/ lower impacted molar, good in maxillary sinus/upper impacted molar, moderate in root number accuracy, and low in canal number accuracy.**Conclusion:** High accuracy values in identifying impacted third molar teeth and their correlation with anatomical features were demonstrated by the CNN approach employed in this investigation. The diagnosis of dentomaxillofacial architecture and diseases can be improved with the application of additional algorithms and machine learning techniques, particularly for the detection of third molars.
Keywords: artificial intelligence, cone-beam computed tomography, impacted tooth

Received Date: 25 December, 2024 Acceptance Date: 22 January, 2025

Corresponding author: Dr.Jaspreet Singh Khurana, 3rd Year Post Graduate Student, Department of Periodontology, Career Post Graduate Institute of Dental Sciences & Hospital, Lucknow, U.P., India

This article may be cited as: Khurana JS, Wasi F, Singh S, Pandey M, Pillai SS, Prasanthi GS. Use of artificial intelligence for detecting impacted third molars on cone-beam computed tomography scans. Int J Res Health Allied Sci 2025; 11(1):35-39.

INTRODUCTION

A variety of etiological variables, including systemic, local, and hereditary, can lead to tooth impaction, a common pathological dental disorder.[1] In the general population, its prevalence varies between 0.8% and 3.6%, while that of third molar impaction varies between 16.7% and 68.6%. Nonetheless, the most frequent causes of impaction include obstructions in the tooth's eruption path and a lack of room on the arc.[2] Dental infections such pericoronitis, periodontitis, orofacial discomfort, TMJ disorders, pathological fractures, cysts, and neoplasms can all be brought on by impacted teeth. Additionally, it may harm neighbouring teeth. Tooth extraction may be necessary for all of these reasons. The number of root canals in these teeth and how they relate to nearby anatomical structures should be assessed prior to dental surgery.[3]

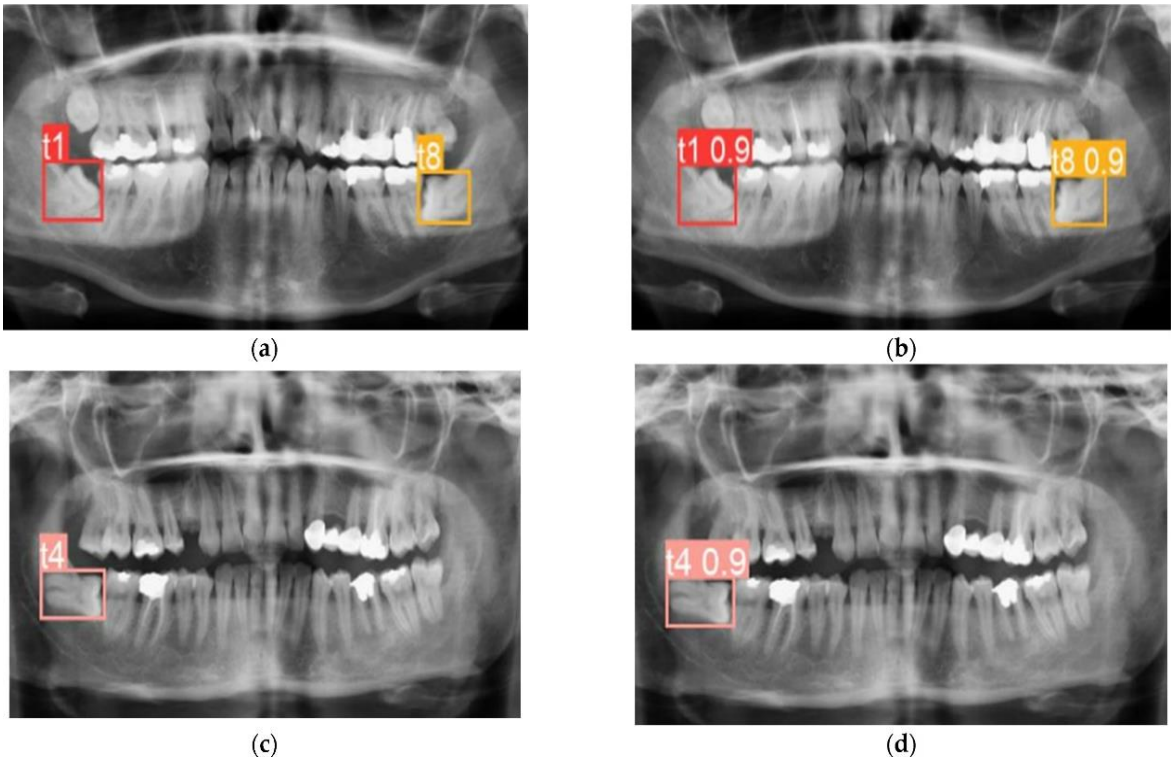
Periapical or panoramic radiographs are the most often used radiographic techniques for diagnosing tooth impaction. The inferior alveolar canal in the lower jaw, the quantity and shape of root canals, and

the link between the upper jaw's teeth and the maxillary sinus cannot be assessed because of the superimpositions.[4] CBCT is recognized as the gold standard for radiographic assessment of impacted third molars because of this. Additionally, artificial intelligence applications have begun in dental radiology with the goal of lowering the inaccuracies in subjective assessments pertaining to the individual.[5]Numerous studies have been conducted in the medical field about the use of diagnostic AI in areas like bone age detection, orthognathic surgery, benign malignant tumors, aneurysms, polyps, and lymph node detection.[6,7]The present study was conducted to evaluate use of artificial intelligence for detecting impacted third molars on cone-beam computed tomography scans.

MATERIALS & METHODS

The study was carried out on 50 patients of both genders. All gave their written consent to participate in the study.

Data such as name, age, gender etc. was recorded. Monitoring for impaction, the number of impacted teeth, the number of teeth's roots and canals, and the teeth's relationship to nearby anatomical features (maxillary sinus and inferior alveolar canal) were compared between the AI application and the human observer. The Kappa analysis was used to assess the recorded parameters agreement between the deep-CNN-based AI application and the human observer.Results thus obtained were subjected to statistical analysis. P value < 0.05 was considered significant.



Deep Learning Based Detection Tool for Impacted Mandibular Third Molar Teeth

RESULTS

Table I Impacted tooth and number detection frequencies of AI

Accuracy	Impacted tooth detection	Tooth number detection
Right	86%	95%
False	14%	5%
P value	0.01	0.01

Table I, graph I shows that AI detected impacted tooth rightly in 86% and tooth number in 95%. The difference was significant (P< 0.05).

Graph I Impacted tooth and number detection frequencies of AI

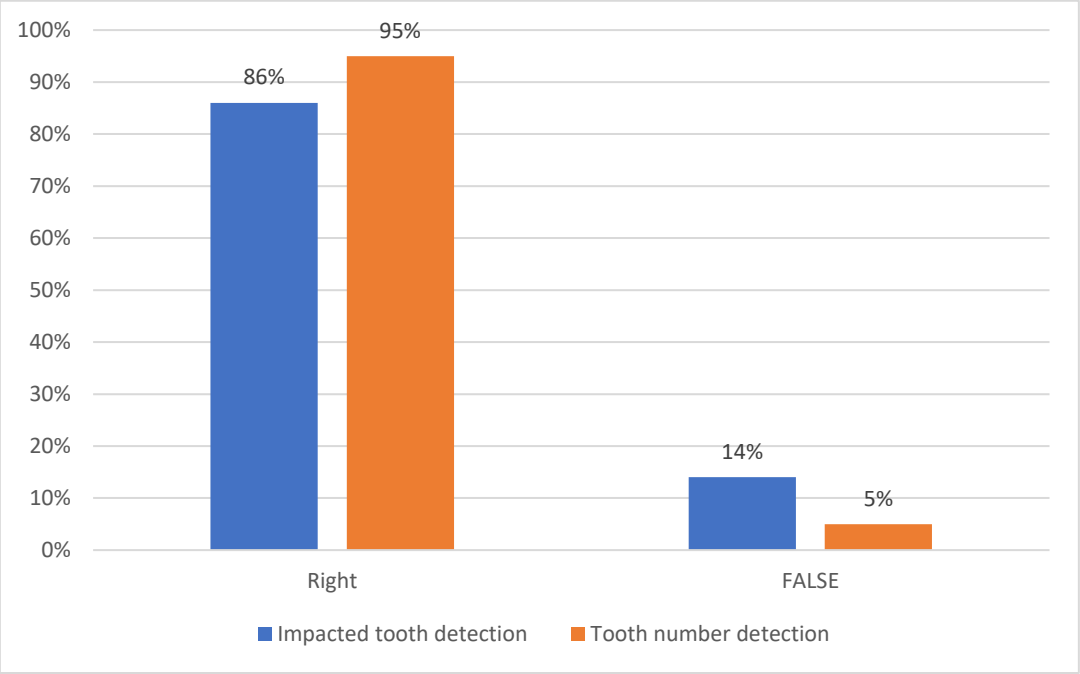


Table II Accuracy of AI

Parameters	MAXILLA			MANDIBLE			
	Sinus relation detection	Root no. detection	Canal no. detection	Canal detection	Canal relation detection	Root no. detection	Canal no. detection
Right	91%	69%	67%	92%	85%	84%	65%
False	9%	31%	33%	8%	15%	16%	35%
P value	0.01	0.02	0.02	0.01	0.05	0.05	0.02

Table II shows that in maxilla, sinus relation was correctly detected in 91%, root number in 69%, canal number in 67%. In mandible, canal detected correctly in 92%, canal relation in 85%, root number detection in 84% and canal number detection in 65%. The difference was significant (P< 0.05).

Table III Agreement between manual detection and detection by the AI

Parameters	Kappa	P value
Inferior alveolar canal/ lower impacted molar	0.75	0.01
Maxillary sinus/upper impacted molar	0.87	0.02
Root number accuracy	0.63	0.01
Canal number accuracy	0.45	0.03

Table III shows that there was moderate agreement between moderate in Inferior alveolar canal/ lower impacted molar, good in maxillary sinus/upper impacted molar, moderate in root number accuracy, and low in canal number accuracy.

DISCUSSION

The ability of a machine to carry out intricate activities that mimic human cognitive processes, such as problem-solving, object and word recognition, and decision-making, is known as artificial intelligence (AI).[8] The field of artificial intelligence known as machine learning is when computers automatically pick up knowledge from the accumulation of data.[9] When performance on subsequent tasks improves following data observations, it is referred to as the learned situation. Increased data exposure helps machine learning algorithms grow; they don't just follow rules; they also gain experience and learn to provide precise answers by analyzing vast volumes of data.[10]The majority of AI techniques for picture interpretation are based on deep learning, a subset of machine learning. Convolutional neural networks (CNNs), a type of deep learning structure with multiple layers of backpropagation algorithms, are mostly used for processing huge and complicated images and are capable of extracting numerous features from abstracted layers of filters.[11]The present study was conducted to evaluate use of artificial intelligence for detecting impacted third molars on cone-beam computed tomography scans.

We found that AI detected impacted tooth rightly in 86% and tooth number in 95%. Orhanet al[12]evaluated the diagnostic performance of artificial intelligence

(AI) application evaluating of the impacted third molar teeth in Cone-beam Computed Tomography (CBCT) images. In total, 130 third molar teeth (65 patients) were included in this retrospective study. Impaction detection, Impacted tooth numbers, root/canal numbers of teeth, relationship with adjacent anatomical structures (inferior alveolar canal and maxillary sinus) were compared between the human observer and AI application. Recorded parameters agreement between the human observer and AI application based on the deep-CNN system was evaluated using the Kappa analysis. In total, 112 teeth (86.2%) were detected as impacted by AI. The number of roots was correctly determined in 99 teeth (78.6%) and the number of canals in 82 teeth (68.1%). There was a good agreement in the determination of the inferior alveolar canal in relation to the mandibular impacted third molars (kappa: 0.762) as well as the number of roots detection (kappa: 0.620). Similarly, there was an excellent agreement in relation to maxillary impacted third molar and the maxillary sinus (kappa: 0.860). For the maxillary molar canal numberdetection, a moderate agreement was found between the human observer and AI examinations (kappa: 0.424).

We found that in maxilla, sinus relation was correctly detected in 91%, root number in 69%, canal number in 67%. In mandible, canal detected correctly in 92%, canal relation in 85%, root number detection in 84% and canal number detection in 65%. Yamada et al[13]evaluated the course of the inferior alveolar nerve and its branches, the detectable branches were investigated with dental cone beam computed tomography (CBCT).Patients in whom the lower third molar (M3) and inferior alveolar nerve canal showed overlapping in the initial panoramic image were included. One hundred twelve impacted lower M3s were extracted after examination with dental CBCT. The detection ratio, the course of the branches, and their relation with the M3 were retrospectively investigated.One hundred fifty-five branches were observed in 106 cases (94.6%, 106/112) around the M3. Most branches coursed under the M3 (55.5%, 86/155), and 85 branches (54.8%, 85/155) were in contact with the M3. The inferior alveolar nerve canal and branch(es) were mostly in contact with the M3 (57.5%, 61/106).Dental CBCT can detect most tubular structures representing branches in the impacted lower M3 region.

We found that there was moderate agreement between moderate in Inferior alveolar canal/ lower impacted molar, good in maxillary sinus/upper impacted molar, moderate in root number accuracy, and low in canal number accuracy.Hiraiwa T et al[14]examined the diagnostic performance of a deep learning system for classification of the root morphology of mandibular first molars on panoramic radiographs. Dental cone-beam CT (CBCT) was used as the gold standard.CBCT images and panoramic radiographs of 760 mandibular first molars from 400 patients who had not undergone root canal treatments were analyzed. Distal roots were examined on CBCT images to determine the presence of a single or extra root. Image patches of the roots were segmented from panoramic radiographs and applied to a deep learning system, and its diagnostic performance in the classification of root morphplogy was examined.Extra roots were observed in 21.4% of distal roots on CBCT images. The deep learning system had diagnostic accuracy of 86.9% for the determination of whether distal roots were single or had extra roots.The deep learning system showed high accuracy in the differential diagnosis of a single or extra root in the distal roots of mandibular first molars.

The shortcoming of the study is small sample size.

CONCLUSION

High accuracy values in identifying impacted third molar teeth and their correlation with anatomical features were demonstrated by the CNN approach employed in this investigation. The diagnosis of dentomaxillofacial architecture and diseases can be improved with the application of additional algorithms and machine learning techniques, particularly for the detection of third molars.

REFERENCES

1. Devito KL, de Souza Barbosa F, FelippeFilho WN. An artificial multilayer perceptron neural network for diagnosis of proximal dental caries. Oral Surg Oral Med Oral Pathol Oral RadiolEndod. 2008;106(6):879-884.
2. Orhan K, Bayrakdar IS, Ezhov M, Kravtsov A, Özyürek T. Evaluation of artificial intelligence for detecting periapicalpathosis on cone-beam computed tomography scans. IntEndod J. 2020;53(5):680-689.
3. Lee JH, Kim DH, Jeong SN, Choi SH. Detection and diagnosis of dental caries using a deep learning-based convolutional neural network algorithm. J Dent. 2018; 77:106- 111.
4. Fourcade A, Khonsari RH. Deep learning in medical image analysis: A third eye for doctors. J Stomatol Oral Maxillofac Surg. 2019 Sep;120(4):279-288.
5. Hiraiwa T, Ariji Y, Fukuda M, et al. A deep-learning artificial intelligence system for assessment of root morphology of the mandibular first molar on panoramic radiography. DentomaxillofacRadiol. 2019;48(3):20180218.
6. Jaskari J, Sahlsten J, Järnstedt J, Mehtonen H, Karhu K, Sundqvist O, Hietanen A, Varjonen V, Mattila V, Kaski K. Deep Learning Method for Mandibular Canal Segmentation in Dental Cone Beam Computed Tomography Volumes. Sci Rep. 2020;10:5842.
7. Kwak GH, Kwak EJ, Song JM, Park HR, Jung YH, Cho BH, Hui P, Hwang JJ. Automatic mandibular canal detection using a deep convolutional neural network. Sci Rep. 2020; 10:5711
8. Yates EJ, Yates LC, Harvey H. Machine learning "red dot": open-source, cloud, deep convolutional neural networks in chest radiograph binary normality classification. ClinRadiol. 2018;73(9):827-831.
9. Hosny A, Parmar C, Quackenbush J, Schwartz LH, Aerts HJWL. Artificial intelligence in radiology. Nat Rev Cancer. 2018;18(8):500-510.

10. Dratsch T, Caldeira L, Maintz D, Dos Santos DP. Artificial intelligence abstracts from the European Congress of Radiology: analysis of topics and compliance with the STARD for abstracts checklist. Insights Imaging. 2020;11(1):59.
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- 354
12. Orhan, K., Bilgir, E., Bayrakdar, I. S., Ezhov, M., Gusarev, M., &Shumilov, E. (2020). Evaluation of artificial intelligence for detecting impacted third molars on cone-beam computed tomography scans. Journal of Stomatology, Oral and Maxillofacial Surgery. doi:10.1016/j.jormas.2020.12.006
13. Yamada T, Ishihama K, Yasuda K, et al. Inferior alveolar nerve canal and branches detected with dental cone beam computed tomography in lower third molar region. J Oral Maxillofac Surg. 2011;69(5):1278-1282.
14. Hiraiwa T, Ariji Y, Fukuda M, et al. A deep-learning artificial intelligence system for assessment of root morphology of the mandibular first molar on panoramic radiography. DentomaxillofacRadiol. 2019;48(3):20180218.
15. Singh H, Kumar P, Goel R, Kumar A. Sex hormones in head and neck cancer: Current knowledge and perspectives. Clin Cancer Investig J. 2012;1(1):2-5. https://doi.org/10.4103/2278-0513.95011.
16. Kumar A, Bindal R, Shetty DC, Singh HP. Primary oral malignant melanoma: Clinicopathological series of four cases. Dent Res J (Isfahan). 2012 May;9(3):338-44. PMID: 23087742; PMCID: PMC3469903.
17. Nayar, Amit; Singh, Harkanwal Preet1,;Leekha, Swati. Pulp tissue in sex determination: A fluorescent microscopic study. Journal of Forensic Dental Sciences 6(2):p 77-80, May–Aug 2014. | DOI: 10.4103/0975-1475.132527
18. Sodhi, Surinder Pal Singh; Brar, Ramandeep Singh; Singh, Harkanwal Preet1,; Kaur, Tajinder1; Dhawan, Rohan. A rare occurrence of basal cell adenoma of palate: A case report with comprehensive immunohistochemical analysis. Journal of Cancer Research and Therapeutics 11(4):p 1023, Oct–Dec 2015. | DOI: 10.4103/0973-1482.147391