**FUTURISTIC TRENDS IN DENTISTRY**

**Artificial Intelligence --- A New Diagnostic Software in Dentistry**

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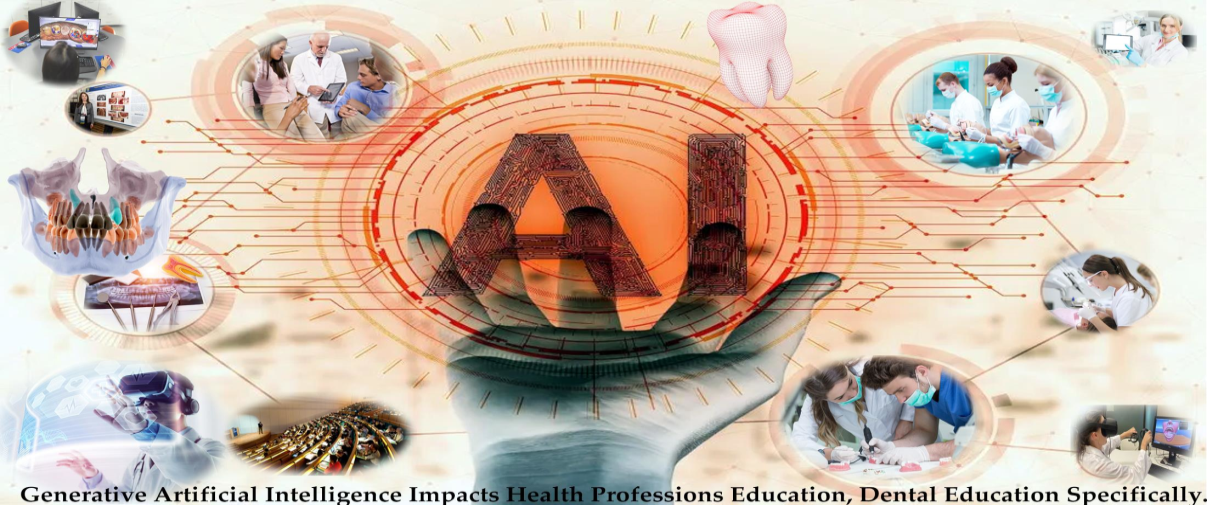
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**Abstract:**

Pros weighs more than cons in relation to Artificial Intelligence (AI) leading to fastness, accuracy, economy and error free. Health care becomes very feasible with the help of Artificial Intelligence. High quality patient care will be provided by means of artificial intelligence. Along with AI, certain trends are in use, like 3D printing, Teledentistry, Machine Learning, and Smart Dental Devices. These are just a few of the many ways that technology is changing dentistry. As technology continues to advance, there will be more innovative and ground breaking developments in this field in the coming years. Albert Einstein said, “Imagination is the highest form of research.” so one needs to be National Dental Thinker providing innovative Dental Solutions1. Nanotechnology, stem cells, and gene therapy are also innovative methods that are used in dentistry 2. This review describes few present and future applications of all the above trends in dentistry.



**Figure1: Graphical Abstract**

**Courtesy:** Thurzo A, Strunga M, Urban R, Surovková J, Afrashtehfar KI. Impact of Artificial Intelligence on Dental Education: A Review and Guide for Curriculum Update. Education Sciences. 2023; 13(2):150. <https://doi.org/10.3390/educsci130201503>

**Introduction:**

**Artificial Intelligence:**

In dentistry, dental implant plays a pivotal role in replacement of tooth. The main objective is to analyse the accuracy of artificial intelligence and machine learning in the diagnosis of different dental diseases or conditions4,5. “John McCarthy”, a mathematician from Dartmouth University, is known as the “Father of Artificial Intelligence”6 and he defined the term “artificial intelligence” (AI), as “computerized synthetic human cognitive function”7. Definition of artificial intelligence was given by “Richard Bellman” as automated learning, problem solving and decision making on par with human beings8. Diagnosis of oral diseases can be easily done by artificial intelligence thereby, reducing workload of dental and health care professionals9. Based on various advantages of Artificial Intelligence based technologies, health care and dentistry have gained many benefits10. Artificial Intelligence played an important role during the pandemic era of severe acute respiratory syndrome (SARS)-CoV-2, where numerous people became carriers of the disease11. As per Occupational Safety and Health Administration (OSHA) guidelines, oral cavity was considered as high risky category which was dealt efficiently by the dental professionals12, 13. Simulation of human brain via neural network is the blue print of artificial intelligence. The neural network comprises of neurons which plays an important role in diagnosis of diseases. Lack of methodology, creativity and practice is to be overcome in the future to upgrade dentistry into the field of artificial intelligence14. Main advantages of artificial intelligence in dentistry include high quality dental care and treatment by eradication of dental diseases. Specialities of dentistry such as oral medicine, oral radiology, oral and maxillofacial surgery, oral and maxillofacial pathology, prosthodontics, conservative dentistry, endodontics, periodontics, paediatric dentistry, oral onchology and public health dentistry might rely on AI in the future15. In oral radiology, interpretation of oral and maxillofacial radiological images can be improved by deep learning, algorithms and graphic processing units16, 17. The process of machine learning is significantly improving with the help of deep learning, that enables the computer to process numerous algorithms with graphic processing units18. Neural networks comprises of convolutional and artificial types which helps in diagnosis of dental caries, salivary gland pathology, oral and maxillofacial trauma, oral cancer, endodontic lesions and dental-skeletal growth diseases19. AI enables in the creation of a virtual database to assist the professionals in the treatment and also helps in follow-up and emergencies20. The results showed that the accuracy and precision of the disease is about 90%–96% when the above CNN and ANN algorithms are used21. AI can be involved in the process of locating canals during control trials and radiographic images which shows damaged or decayed tooth22. Step-wise flow chart of diagnosis, investigations and treatment plans can be executed with the help of AI.

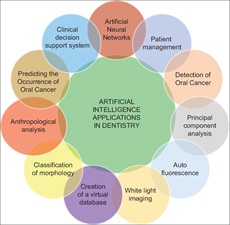


Figure 2: Different applications of Artificial Intelligence in dentistry

Courtesy: Lingam, Amara Swapna, Koppulu, Pradeep L, Akhter, Fatema, Afroz, Mohammed Malik, Tabassum, Nafeesa, Arshed, Maheen, Khan, Tahseen, E1Haddad, Sally. Future Trends of Artificial Intelligence in Dentistry. Journal of Nature and Science of Medicine 5(3):p 221-224, Jul-Sep 2022. | DOI:10.4103/jnsm.jnsm 2 2223

**The future of Artificial Intelligence:**

Artificial intelligence in health care may involve activities from simple to very advanced activities which may include medical record review, population health analytics, radiological image interpretation, and clinical diagnosis and treatments24. Clinical operational commands by dental professionals can be implemented by AI with the help of voice recognition centres25. AI is the boon to the medical records department by virtual storage of patient data. Patient’s health status can be tracked and updated. Precision in each and every step can be delivered with the help of cutting-edge technology26. Improved Diagnostic Accuracy, Predictive Analytics, Personalized Treatment Planning, Dental Robotics, Augmented Reality, Digital Impression Scanning, and Improved Patient Communication are included, which can be done by the AI models in the coming future.

**Challenges of Artificial Intelligence:**

Cons include errors related to safety and quality of algorithms in relation to Artificial Intelligence. This drawback can be overcome by “Software as Medical Device”, an innovation by the United States Food and Drug Administration (USFDA) under a new drug category which helps in safety of the patients. In the use of AI systems, the other concern is Ambiguous accountability which is very challenging for AI to get into day to day life27.

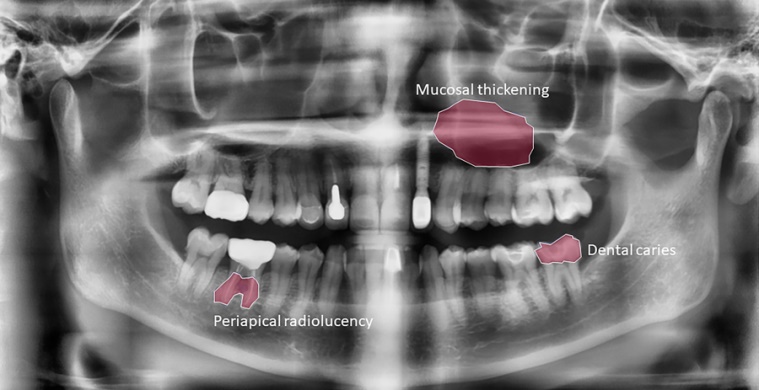


Figure 3: AI dental image analysis

Courtesy: Lee, S, Kim, D, Jeong, HG, (2022) Detecing 17 fine-grained dental anomalies from panoramic dental radiography using artificial intelligence. Research Outreach. Scientific Reports, 12, 5172. doi.org/10.1038/s41598-022-09083-2 DOI: 10.32907/RO-130-277329587628

**Clinical Application of AI in Dentistry:**

**Osteoarthritis classification:** AI has demonstrated the ability to classify 3D images of the mandibular condyle into structural degenerative changes, achieving 91% close agreement with clinician consensus and an established classification system29.

**Cancer Detection:** In a recent study, an AI model was able to achieve an F1 score (which includes precision and recall) of 87% for the identification of images containing lesions30.

**Radiology:** Diagnosis and treatment planning can be done effectively with the help of artificial intelligence by reproduction of radiological aspects of intraoral periapical radiography(IDPA), computer tomography(CT), magnetic resonance imaging(MRI) and cone beam computed tomography (CBCT)31.

**Orthodontics:**Developmental and functional disorders of oral and maxillofacial apparatus can be rectified by orthodontic treatments relying on artificial intelligence32.

**Periodontics: Diseases of periodontal tissues resulting in tooth mobility, loss of tooth and alveolar bone loss combined with gingival diseases, can be managed in the better and precise manner with the help of artificial intelligence33, 34.**

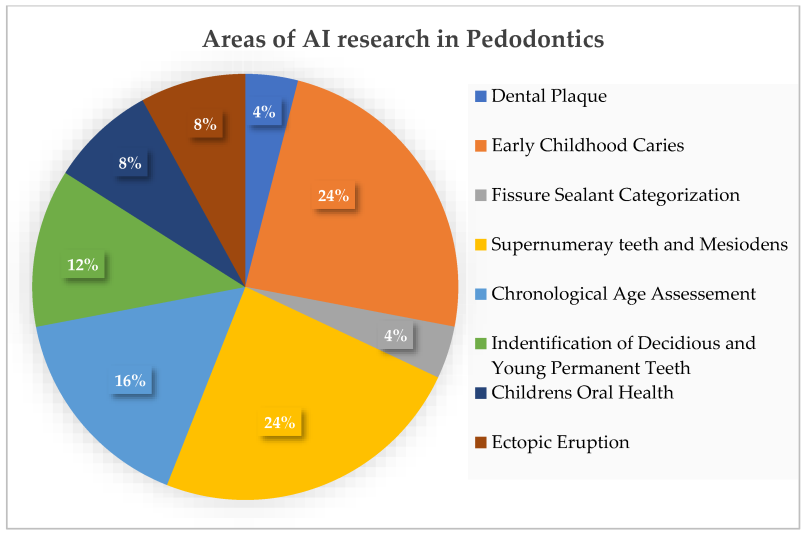


Figure 4: Areas of AI research in Pedodontics

Courtesy: Vishwanathaiah S, Fageeh HN, Khanagar SB, Maganur PC. Artificial Intelligence- Its Uses and Application in Pediatric Dentistry: A Review. Biomedicines.2023;11(3):788. https://doi.org/10.3390/biomedicines1103078835

**Endodontics:** Endodontology is a branch of dentistry in relation to pulpal and periapical pathology36.

**Oral pathology37:** Implementation of Artificial intelligence helps in efficient, and accurate histopathological analysis38.

**Machine Learning:** Large data patterns can be analysed followed by performance of intelligent tasks devoid of human intention. **Deep learning (DL)** involves both patterns and compostable hierarchies of patterns39.

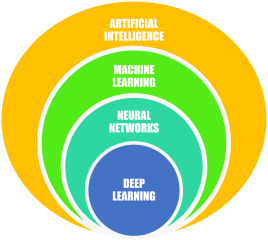


Figure 5: Key Aspects of Artificial Intelligence

Courtesy: Sanjeev B. Khanagar, Ali Al-ehaideb, Prabhadevi C. Maganur, Satish Vishwanathaiah, Shankargouda Patil, Hosam A. Baeshen, Sachin C. Sarode, Shilpa Bhandi, Developments, application, and performance of artificial intelligence in dentistry-A systematic review, Journal of Dental Sciences, Volume 16, Issue 1, 2021, Pages 508-522,

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**3D printing:**  It is being used to create custom dental restorations such as crowns, bridges, and dentures; well, it allows dentists to create these restorations quickly and accurately. The lost anatomy of the oral and maxillofacial apparatus can be regained by 3D scans and virtual models which help in production of aligners which in turn decides which teeth should be moved and the amount of pressure exerted based on the pressure points for each and every teeth41.

**Teledentistry:** Clinical information can be exchanged from remote places leading to efficient consultation and treatment planning42. Pros of teledentistry involve access to dental care by all category of patients, avoidance of waiting period, and minimisation of travel43. The most important application of artificial intelligence in teledentistry is deduction of costs leading to economical status of the patient44, 45.

**Smart Dental Devices:**The diagnosis of the oral and maxillofacial conditions in a timely manner leads to correct treatment rendering good quality of life for the patient via artificial neural networks (ANNs). This is very prominent in the identification of risk groups who are more susceptible to oral cancers. It also helps in the prediction of erupted canine sizes or premolars as well as tooth surface loss.

**Computer-aided design (CAD) technologies:** Computer-aided design (CAD) technologies introduced in the last decade into the dental industry have signiﬁcantly facilitated achievements in dentistry46.

**Robotics in dentistry:** The word Robot was introduced by “Karel Čapek” in 1920 meaning “Robota,” similar to “labour”48. The main advantages of robotics in dental field includes reduced operation time, accuracy of treatments, real-time navigation, surgical plan designed in relation to implant dentistry, comparative and co-relative analysis of diagnosis of oral and maxillofacial lesions followed by data collection pertaining to oral and maxillofacial imaging and finally 3-dimensional digital scanning of the implant site pertaining to prosthodontics47,49,50.

**Conclusion:**

The above overview depicts that artificial intelligence has emerged a lot in current times and might emerge as a common tool in ultramodern dentistry in the upcoming future51. The benefits of this system are effectiveness, delicacy, bettered perfection, bettered monitoring, and time savings52. From the researcher point of view, dentistry will be a boon via artificial intelligence in the near future. Last but not the least, diagnosis, management, and quality of life can be improved with the help of artificial intelligence53. Clinical research pertaining to dentistry can be implemented in a systematic way with the help of artificial intelligence. The benefits of the digital applications will help professionals to achieve improved and cost-efficient healthcare for patients54. Teledentistry will help dentists to assist patients without any contact and that too in remote areas and also without adding the risks of infections55. These are just a few of the many ways that technology is changing dentistry. In coming future, as technology continues to advance, AI will be the best view as an intelligent assistant in therapeutic and diagnostic care, providing reliable data to inform clinical decision-making and ultimately this could help in translate to improved protocols and health outcomes for patients. To have the full benefit of the technology, one should have a clear understanding of the concepts and models of AI. Dentists and clinicians also should ensure the collection and providing authentic data in their database to have accurate results from the models. Future research involves exploring the Augmented Reality(AR) and Virtual Reality(VR) in relation to dentistry.

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