

Role of Artificial Intelligence (AI) in Dentistry: Boon or Bane? - A Narrative Review

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Abstract: *Yesterday's imagination became today's practicality. Whenever the new technology comes, we all are imbibing it and enjoying the fruits of it. Initially we scare to use the new technology, because of apprehensions, felt it may land us in trouble. But we will slowly start using and adopt the same as usage of social media, Siri, Hay Google and Chat GPT etc. One such technology started to spread its tentacles almost Seven decade back and now it became a revolutionary technology, using worldwide in all the fields including medical and dental fields called Artificial Intelligence (AI). A less percentage of dentists are successfully using AI applications while rendering dental services to their patients. Still majority of dentists throughout the world were not aware of AI applications in dentistry and some of the dentists are apprehensive about AI applications may replace dentists in the future, responsibility for treatment failures while using AI applications. This narrative review aimed to discuss various applications in dentistry, its limitations.*

Keywords: Artificial Intelligence; AI in Dentistry; Virtual Dental Assistant; Machine Learning; AI Algorithms

1. Introduction

For the patient education and better understanding regarding the final outcome of the treatment, AI can provide virtual dental treatment simulations as well as tailor made treatment options considering the patient specific aspects.^{1, 2} The technology which is mimicking human brain is called Artificial Intelligence (AI) and it is a branch of science and engineering.³⁻⁵

Advances in AI offer a glimpse of such health care benefits as decreasing postoperative complications, increasing quality of life, improving decision-making and decreasing the number of unnecessary procedures.⁶ To perform any exercise AI needs human acumen.⁷ Machine learning is the branch of AI and is commonly using in health care sector.⁸ Whereas nowadays the application of deep learning became more popular in medical and dental fields.⁹ Various specialities in dentistry already utilizing the AI algorithms such as Forensic Odontology and Oral Pathology, Diagnosis and Radiology, Periodontics, Endodontics, Prosthodontics, Implantology, Pedodontics, Orthodontics, and Maxillofacial Surgery.¹⁰

Uses of AI in Dentistry: For accurate patient data documentation and time saving, dentists are using speech recognition technology powered by AI.¹¹ For virtual appointments and remote consultations are possible with AI assisted tele-dentistry.¹²

AI assisted dental materials are available, which can react according to the situation such as if bacterial growth present, the materials release antimicrobial agents to pacify the situations, and these materials are called 'smart materials'.¹³ AI - powered wearable devices could enable patients to monitor their oral health in real-time and receive personalized recommendations for oral hygiene and preventive care.¹⁴

AI is increasingly being used in implantology to improve the accuracy and precision of implant placement and to enhance the predictability of implant treatment outcomes such as 3D images of jaw bones analysed by AI applications, may accurately provide the location for placement of implant.¹⁵ Feedback for the dentist to place implant exactly with predetermined angulation, with the help of AI assisted navigation system, resulting in accuracy of placement and reduction of hazardous obstacles.^{16, 17}

Occlusal analysis AI algorithms can analyse digital impressions.¹⁸ and patient bite to identify any occlusal errors especially in TMJ disorder conditions.¹⁹ As well Virtual Articulation to simulate the movement of the patient's jaws.²⁰ AI - powered CAD/CAM technology can reduce the lab preparation time compared to manual applications with commendable accuracy and fit.²¹ During dental procedures addressing the pain and anxiety of the patient is very important. Wiederhold MD et al.,^{22, 23} stated that, the application of virtual reality along with AI algorithms, can reduce the anxiety of the patient as well management of pain can be controlled in non-pharmacological way. The

application of Artificial Intelligence also using in the dental student education. Few of the dental institutions already practicing this in student education and learning. According to Bharadwaj D et al., the AI teaching can develop better knowledge and skills.²⁴

2. Discussion

There is huge trepidation regarding usage of AI in dental treatments. According to Ding H et al.,²⁵ AI is a useful tool to provide precise and accurate diagnosis, decision making, planning exact treatment protocol, and assessing the treatment results as well the prognosis of the disease in advance. For the patient education and better understanding regarding the final outcome of the treatment, AI can provide virtual dental treatment simulations as well as tailor made treatment options considering the patient specific aspects.^{1, 2}

According to Agarwal P and Nikhade P²⁶, with its massive patient data, AI can expedite in the field of dental research which may give scope to develop better dental treatment opportunities. Also provides Virtual assistants for the clinicians, which can assist in patient appointments too, which can result in improving the patient treatment outcomes. As per Kishimoto N et al.,²⁷ some of the dental teaching institutes already using the AI applications in dental education by providing training with simulations for better exposure to students.

For accurate patient data documentation and time saving, dentists are using speech recognition technology powered by AI.^{1, 2} For virtual appointments and remote consultations are possible with AI assisted tele - dentistry. According to Agarwal P et al.,²⁶ Schwendicke F et al.,²⁸ and Hung KF et al.,²⁹ AI never become a threat to dentists. They felt that dental treatment is more of personalized one, and patients always prefer the interaction of dentists rather than the machines and human touch cannot be substituted by the AI applications. AI in dental field is not a replacement for the dentists, rather it is supportive algorithms. Khanna SS et al.,³⁰ also under opinion of AI cannot replace the dentists, whereas as per Rao et al.,¹¹ from their survey research on dental teaching faculty in India, found that majority of the participants felt that AI in the future may become threat for the dentists. Holzinger A et al.,³¹ also mentioned that AI technology as a threat. Hung KF felt²⁹ that, AI applications in dentistry called as P4 dentistry, which means: more personalized, preventive, predictive and participatory dentistry. According to Zhang K et al.,³² and Tuzoff DV et al.,³³ the expertise of clinicians whose precision rate while diagnosis is more than AI algorithms.

Patient confidentiality maintaining should be the priority and to keep privacy of AI support clinical services, proper system should be adapted to relieve the apprehensions from the clinicians mind.³⁴ Enigmatic responsibility while using AI applications in the patient treatment is a big concern. When the treatment failed, whom to take the accountability for the error, is it AI technology or the dentist is a big question raised by Nguyen TT et al.³⁵ The future research must show the path for this doubt. As per ICMR Guidelines in healthcare AI may create menace, which includes the patient data may misused or stolen; AI may preserve existing

bias and inequalities; few models of AI are very convoluted as well as arduous to learn; if insufficient data used by AI, may lead to do mistakes and ethical concerns.³⁶

Some of the AI incorporated instruments / equipment invented recently into the realm of dentistry includes: 'DeXVoice' - digital dental assistants are available in the market.^{37, 38} Also the dental chairs are available with voice command from AI algorithms.³⁹ The patient - c These human relations are missing in mechanical dental equipment. The recent inventory is 'Haptic Glove' with sense of touch to fulfil the human touch relations.⁴⁰ The dental chair light with AI software called Bio/Screen oral examination light is available which can differentiate healthy and unhealthy tissues easily.⁴¹ A mile stone development recently in the medical field is 'bioprinting' of both hard and soft tissues of human body with the AI software.^{42, 43}

3. Conclusion

The AI technology advancing in rapid phase. All the dental clinicians should be in position to transform them selves and grab the advantages of AI applications and render better services to their patients. The published study data reveals that the AI cannot replace the dentist, it will only assist them to perform expertise clinical work. If we use AI technology with proper knowledge and training, then AI will become a boon for the dental practice.

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