

Artificial Intelligence in Prosthodontics

Bodduluri Manisha^{1*}, C. Ravi Kumar¹, M. Sujesh¹, G Harilal¹, Ch. Kavitha¹, Sahaja Tadikonda²

¹Department of Prosthodontics and Crown and Bridge, Mamata Dental College and Hospital, Khammam, Telangana, India. ²Department of Prosthodontics, Vijaya Dental Hospital, Hanamkonda, Telangana, India.

Abstract

Artificial intelligence (AI) is rapidly changing dentistry and especially dentists by updating patient information, testing pain, and planning and managing treatment. These impact devices augment human intelligence and help to create artificial appliances and palatal orthodontics. While AI is useful, it cannot be constantly updated by dentists who interpret medical information and recommend treatments to individual patients. However, problems such as insufficient and inaccurate data have prevented its full implementation. This review explores the current applications of AI in prosthodontics and highlights the limitations and future potential of comprehensive dentistry.

Keywords: Artificial intelligence, Prosthodontics, Dentistry

INTRODUCTION

Artificial intelligence (AI) involves using machines and technology to perform tasks typically done by humans. According to Barr and Feigenbaum, AI involves creating intelligent computer systems that can perform human-like behaviors, such as understanding language, learning, reasoning, and problem-solving.^[1] In healthcare, big data enables machine learning-based decision support to prevent medical complications and increase diagnostic accuracy.^[2] AI has great potential in dental care by using machine learning algorithms to analyze patient data and develop effective plans.^[3] Prosthodontics focuses on creating artificial teeth, making dental implants, creating dentures, and making them perfect and beautiful with skill-based treatment strategies.^[4]

KEY ASPECTS OF AI^[5]

- Machine learning: Machine learning helps to compile the data by the computers by applying their own rules having high-level algorithms.^[3,6] Machine learning can be applied in various categories, which includes, such as e-commerce, automobile, internet exploration, sensor, robotics, speech recognition, and image recognition. Machine learning can be further discussed into four categories:
- Supervised learning: It contains the dataset which is traced by the computer and later corrected by a human expert.
- Unsupervised learning: It constitutes the clustered data that has been picked up without any guidance of an expert.

- Semi-supervised learning: This is the combination of both the clustered data set and the labeled data set, which improves the accuracy of the machine learning.
- Reinforced learning: As defined by Hal Varian, this is the form of sequential experimentation, which is attempted to increase the interaction with a dynamic external environment.^[7]
- Neural network: This is somewhat equivalent to the human brain and it works on the same as neurons which are artificial.
- Deep learning: This utilizes the network which consists of different computational sets to verify the data provided. This can also be defined as a conventional neural network.^[5]

AI IN PROSTHODONTIC TREATMENT

AI has great potential in the field of prosthodontic treatment, including the diagnosis, planning, and treatment of patients affected by missing or inadequate teeth and tissues of the mouth and face. Prosthetic dentistry mainly focuses on fabricating removable and permanent dental restorations, performing

Address for correspondence: Dr. Bodduluri Manisha,
Department of Prosthodontics and Crown and Bridge, Mamata Dental
College and Hospital, Khammam, Telangana, India.
Email: manisha.bodduluri@gmail.com

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dental implant surgery, fabricating palatal restorations, and providing margins for proper fit. AI technology can improve many treatments in this field.^[8]

The applications of AI in dentistry are in a broad way, which can be concluded as AI; computer-aided design/computer-aided manufacturing (CAD/CAM)

CAD/CAM

In prosthetic dentistry, CAD/CAM, is increasingly popular. CAD/CAM integration enhances the use of chairside expertise. We can use computer design and manufacturing to design, mill, or print according to the patient's preferences, saving time and effort. CAD/CAM technology typically creates two- and three-dimensional models, which are then used on computer numerical control machines.

CAD/CAM technology simplifies the dental prosthetic manufacturing process by digitally scanning teeth and creating ceramic blocks directly, eliminating the need for the traditional casting process. This method is used to create many dental restorations, including inlays, onlays, crowns, and bridges;^[9] it provides speed and precision over traditional methods while reducing the risk of human error in the final turn. Dentists are using AI to improve the design, including features, such as facial symmetry, ethnic characteristics, anthropological data, and patients. Moreover, restoration work. AI and CAD/CAM optimize the diagnostic process while improving the quality of removable prostheses. Confining the process of controlling the process allows dentists and dental surgeons to enhance the accuracy and reproducibility of restorations. This reduces the total time required for patient treatment. The software also supports the laboratory in defining and classifying the analysis for data quality management and classification by experts. In addition, AI-based programs can further advance dental preparation and enable dental labs to improve milling and digital design processes.^[10]

AI AND REMOVABLE DENTAL PROSTHESIS

AI is improving rapid product development (RPD) manufacturing through 3D printing, providing efficiency and cost-effectiveness over traditional methods. AI algorithms analyze patient data to personalize RPD design, fit, and function through computer-aided assessment. This revolutionary technology promises to provide customized treatment and better outcomes for some edentulous patients.^[11]

AI AND FIXED DENTAL PROSTHESIS

AI in prosthesis could help improve the accuracy and efficiency of prosthetics. AI algorithms can examine and learn from many well-used models to provide information on the best shape, dimensions, and edges of teeth in each case. AI can also assist in tooth preparation by accurately cutting and removing edges, a task that previously required skilled workers and took up a lot of staff time. Zhang *et al.* used a sparse octet convolutional

neural network (CNN) model, and the study had a success rate of 97.43%. These results demonstrate the potential of AI to improve the accuracy and function of teeth prepared for permanent restoration.^[12]

AI AND DENTAL IMPLANT PROSTHODONTICS

AI is used to optimize implant placement and preparation by analyzing cone beam computed tomography (CBCT) images and creating 3D models of the patient's jaw. This will help to figure out the best location and angulation for implant placement, thus enhancing the success of the whole treatment procedure. AI algorithms are also used to determine the quality and quantity of bone, which is important for successful implantation. By using AI to analyze CBCT images, doctors can take more accurate measurements and diagnose bone or disease.^[13]

AI is also being used in dental implants to predict the stability and success of dental implants. Intelligent algorithms can predict the outcome of successful implants by analyzing patient data and features, such as bone structure, implant length, and implant diameter. This can help doctors make more informed decisions when planning dental surgery and provide patients with more accurate information about the benefits of the treatment, implantation, and overall progress. By analyzing patient data and images, AI can provide doctors with valuable information that will help improve clinical outcomes. However, it is important to remember that intelligence should be used as a tool to assist doctors rather than human intelligence and reasoning. Preparation and placement of dental implants, design and manufacturing of prosthetics. Digital maps allow doctors to create virtual surgical guides that can be used to guide the implant during surgery. The technology could soon be used to create anatomical surgical guides that can be used to verify implant placement during surgery. This approach increases the accuracy and precision of implant placement, reduces the risk of complications, and increases the overall success of the procedure. Overall, the use of advanced technology in implantology and prosthetics has revolutionized the field by providing greater accuracy, precision, and personalization in treatment planning and delivery.^[14] In this study, CNN AI-based technology was used to identify implants using panoramic and periapical radiography. According to the findings, the AI-CNN system was almost as good as humans in classifying implants. Takahashi and colleagues have done great research and developed an AI system that can classify dental arches and use CNNs to help create dental arches. Distribution of educational materials using computer-based autonomous learning. Many problems can occur when using traditional CAD/CAM techniques to maintain dental prostheses. Errors can result from incorrect positioning, incorrect attachment, or the use of a base for incorrect occlusal or interproximal correction. Lerner *et al.*^[15] proposed a cognitive model to subside the errors. This AI model was developed to initiate the manufacturing of implants fixed to monolithic zirconia. Use a skill model to help locate the subgingival edge of the

abutment. This model also allows the dentist to focus on preparing the teeth and maintaining occlusal contacts. This facility is introduced to reduce errors and waiting time. This study of zirconia implants restorations on teeth using patient data from 2016 to 2019. A total of 106 plantations were included in this study. The data used to create the AI model (image) includes radiographs, photographs, CAD scenes, and intraoral scans. The wisdom model was used to create zirconia posterior implants with a 91% survival rate and 93% success rate with support. The research results of the AI model show survival and success, proving the application of the model to the field. Analysis and data from different types of surgeries to create a treatment plan for each patient. This will help ensure the success of the dental procedure and improve patient outcomes.^[16]

Predictive modeling capabilities can be used in two areas of dental implantology. The first area is the use of machine learning algorithms to predict clinical outcomes. A recurrent neural network (ANN) with mem-based optimization can analyze patient data to predict implants and surgeon performance with 99.2% efficiency. The second is the use of AI to predict the supply of herbal products and reduce costs, including the development of plant models.^[17] [28]. However, more research is needed to further develop the use of AI in dental implants.

AI AND OCCLUSION

AI is innovating dentistry by creating occlusal patterns in the design to ensure precise fit and function, even when worn or broken. Similarly, AI can adjust teeth to reflect bite and function. AI also streamlines the design of the extraction framework, increasing the accuracy and efficiency of the design process. These advances promise to improve the outcome of dental implants.^[18]

AI IN AESTHETICS

Advances in digital technology have revolutionized the smile, allowing teeth to be adjusted in size, color, and position, resulting in improved aesthetics for each patient's face and personality. In addition, digital software allows dentists to simulate tooth movement and create personalized treatment plans, including using 3D printing technology to create realistic adjustments like Invisalign. Overall, digital dentistry powered by AI and machine learning can improve diagnosis, treatment planning, and rehabilitation, with the potential to improve people's disease relief and dental care.^[9,19,20]

AI IN MAXILLOFACIAL PROSTHETICS

AI has advanced maxillofacial prosthetics using CNNs to create functional and aesthetic prosthetic devices for patients with facial deformities or injuries.^[21] For example, AI-powered prosthetic eyes could improve vision without the need for surgery, while a smart reading mask with voice technology could help blind people in learning to read and verify faces. AI

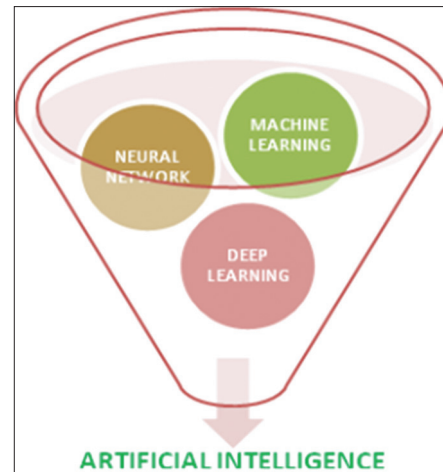


Figure 1: Artificial Intelligence

also supports tissue engineering to create skin grafts for wound healing in terms of artificial olfaction, to create electronic nose models to direct the smell of the deaf, and to use in many areas such as medical diagnosis and environmental monitoring.^[22]

Limitations

There are also ethical issues related to the use of AI in dentistry. There are focused on patient privacy and confidentiality, and the ethical use of making diagnosis or treatment recommendations based on expertise. Bias in intellectual property can lead to unfair or discriminatory outcomes. There are concerns that while AI is changing the dental profession, these professions will not be replaced. To address these issues, dentists need to be aware of the limitations and biases of AI technology.^[23]

Future scope of AI

In addition to using good data, they also need to ensure that their algorithms are constantly updated and reviewed. Ethics and governance need to be established to ensure the responsible and effective use of AI. Hybrid intelligence, which combines human and machine capabilities, will usher in a new era of innovation. Applications such as hybrid intelligent image fusion methods will increase the accuracy of diagnosis and treatment planning with different types of images. However, before rolling out to clinical practice, it is important to validate AI models using different data and representatives from different organizations to ensure they have confidence and performance. AI-driven digital technology is revolutionizing dentistry, playing a key role in decision-making, reducing errors in treatment planning, and accelerating research.^[24]

CONCLUSION

The implementation of AI sparks discussion among healthcare experts worldwide. However, AI holds the promise of decentralizing the medical process and enabling better remote monitoring of medical and dental care. By combining predictive capabilities with human intelligence, it increases diagnostic accuracy, improving overall diagnostic outcomes. Addressing ethical issues such as data privacy and algorithmic

fairness are crucial to making the most of AI, and the aim should be to develop the role of AI as a tool to support human intelligence instead of a substitution. Through careful design and implementation, AI can improve dentistry by reducing errors and improving the outcomes of procedures such as dental checkups and dental implant identification.

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