

EXPLORING THE ROLE OF ARTIFICIAL INTELLIGENCE IN PROSTHODONTICS

Abstract

AI based dentistry is turning into reality. AI is revolutionized in many fields due to the breakthrough in intelligence innovation. In prosthodontics, AI aids in designing prostheses, fabricating functional maxillofacial appliances, patient documentation, diagnosis, treatment planning, and to develop patient specific prosthesis. Predictive modeling using AI algorithms enables prosthodontists to assess prosthodontic outcomes and make informed decisions. Real-time feedback and suggestions during treatment procedures further enhance treatment precision and outcomes. However, challenges including ethical considerations, integration with electronic health records, and advancements in AI technologies need to be addressed for successful implementation and future progress in prosthodontics.

Keywords: prosthodontists, designing prostheses, fabricating functional maxillofacial appliances, patient documentation, diagnosis, treatment planning.

Authors

Dr. Tamizhesai Balavadivel

Reader
Department of Prosthodontics
Tagore Dental College And Hospital
Chennai, India.

Dr. Venkateshwaran Rajendran

Professor
Department of Prosthodontics,
Asan Memorial Dental College And
Hospital, Chennai, India.

Dr. Keerthivasan

Senior Lecturer
Department of Prosthodontics
Tagore Dental College And Hospital
Chennai, India.

Dr. Cakku Jalliah Venkatakrishnan

Principal, Professor, Head of the
Department
Department of Prosthodontics
Tagore Dental College And Hospital
Chennai, India.

I. INTRODUCTION

The ability of machines to carry out tasks that ordinarily require human intelligence is known as artificial intelligence (AI). John McCarthy coined the phrase "Artificial intelligence" in 1955 [1]. The father of artificial intelligence is the mathematician John McCarthy. Artificial intelligence refers to a machine's capacity to mimic human thought and conduct. In 1959, Arthur Samuel introduced the concept of machine learning, which he described as the mechanism that allows computers to learn without explicit programming [2].

The concept and development of computers that can carry out functions that would typically need human intellect, like speech recognition, translating languages, and perception of images are included in its description. Since artificial intelligence has made a significant advancement in the field of intelligence innovation, it is attracting interest on a global scale. The words "digital transformations," "digitised workflows," and "technological developments" describe some of the paradigm-shifting developments of the twenty-first century, both in social life and dental treatment. The use of smartphones, tablets, and other mobile devices, as well as easy access to technology and the Internet, have altered cultural norms of our culture as a whole [3]. It is hardly surprising that more sophisticated technologies are being used more frequently in daily life, such as artificial intelligence (AI). Artificial intelligence (AI) applications are widely used in digital daily life, such as in the form of virtual assistants like "Siri" or "Alexa" [4]. AI has been adopted by a wide range of business sectors, covering robots, shipping, urban planning, financial evaluation, etc. Medical and dental imaging evaluations, decision-making, precision and digital medicine, drug discovery, etc. are a few examples. Healthcare monitoring, robotics, and digital and wearable aides all being a dental practitioner and medical professional. Though less pronounced than in medicine, technological advancements are becoming more apparent in dentistry. The standardisation of digital dental procedures is ongoing, and they are increasingly being incorporated into established treatment protocols [5-7]

Prosthodontics, or the study of dental prostheses, is an important subject that has a big impact on different stages of a dentist's career. As a result of positive developments in digital dentistry, prosthodontics experienced exponential growth in the areas of materials used, diagnostic and treatment planning, and even prosthesis fabrication. A multitude of techniques can be used to create dental prosthesis. An alternative to missing teeth is the development of prosthetics such as fixed dental prostheses, removable partial dentures, or implants [8–10]. The kind of implant used and the state of the remaining alveolar ridge determine how rehabilitation is carried out. Multiple strategies are required during this recovery process [11,12].

AI systems for creating occlusal surface designs for crowns that take into account intraoral wear facets, automatic complete denture set-up designers, tools for figuring out the emergence profile in implantology, and tools for automatically creating frameworks for removable partial dentures are just a few of the novel options that could be produced by fusing AI technologies with prosthodontics. Lee J et al. [13] identified implants employing convolutional neural networks (CNNs) in conjunction with AI using panorama and apical radiographs. The outcomes of the research demonstrate that the AI-CNN algorithm is nearly as effective at categorizing implant techniques.

Potential error-causing variables include incorrect placement, poor cementation, occlusion, and interproximal repair. An AI model was proposed by Lerner et al. [14] to lower the likelihood of these errors. Takahashi et al. [15] conducted extensive research to create an AI architecture that would classify arches and use CNN to assist in denture production. Computer-based unsupervised methodologies for learning were utilised for organising the instructional information. AI enhanced reality raised patient pleasure while reducing patient worry. Appointment scheduling, playing the patient's preferred music and entertainment, and even assisting with relaxation will all improve with AI.

II. IN FIXED AND REMOVABLE PROSTHESIS

Designing the many parts that go into an RPD is a significant stage in prosthetic fabrication [16]. FPD will have their natural teeth inspected, and software is going to be utilised to evaluate the issue and offer potential courses of action. The application programme will offer a suggestion for an RPD design for partial edentulism. A case-based reasoning and ontology-based clinical decision support model for detachable prosthodontics has been shown to be capable of recommending the development of customised RPDs. On the other hand, this model based its suggestions on the database's most likely situation. Because clinical environments are dynamic, it is crucial to keep a watchful eye on the outcomes. Core competency artificial intelligence (AI), which is its capacity to evaluate and learn from data, is the cloud-based database of millions of doctor-approved crowns. In order to learn from successful restorations, the computer evaluates how each high performance restoration is built to achieve optimal operation. Based on the idea of occlusion, contacts, and margins suitable for each circumstance, this is done.

The traditional method of employing manual tooth preparation kits required more time and included more mistake. Zhang et al. investigated the deep learning (DL) model to accurately identify margins. This study utilised 380 models. The dental preparation technique produced a labelled sparse point cloud. During the inquiry, an eight-depth octree framework was created. The production of data sets for training, validating, and testing. The CNN models were made by identifying dental treatments. Reverse projection, a tooth preparation line, and boundaries extraction techniques have been left out of the research so as to address the drawbacks of manual practice. The average rate of precision was 97.43%. This increased accuracy showed ways AI can fix mistakes made by people, resulting in a suitable successor. [17]

III. IN CAD CAM IN PROSTHODONTICS

It refers to a field of dental whereby solutions are produced to replace the patient's lost aesthetics and functionality via the proper prosthetic components. Diminished look and functionality spurred on by flaws in tissues around the tooth. The preparation and assembly of prosthetic restorations must follow a series of exact stages that can be carried out using conventional methods or digital ones, such as CAD/CAM, gained popularity recently. It outlines a technique for creating materials required for prosthetic treatment with the aid of computer design and production know-how.

Some of the problems that need to be resolved in order to optimise the digital phases of CAD/CAM systems is often innovative software. It has been discovered that the cutting-

edge soft computing optimisation technique outlined in the research will greatly lower the expenses associated with putting up and altering machines functionality while also enhancing the efficiency of enterprises in refining machine parameters for manufacturing procedures. [18]. Dentists employ artificial intelligence (AI) to create prostheses. By taking into consideration a range of elements, including anthropological calculations, face measurements, and patient expectations, AI helps to construct the best and most visually acceptable prosthetic.

Using standard CAD/CAM technology to cement implant prostheses can result in a number of problems, including placement errors, cementation errors, and potential faults during occlusal correction with an abutment. In a study that sought to eliminate these errors and delays, an AI model was utilised to produce posterior zirconia implants with a 93% success rate [19]. In a study that used the CNN model to build the segmentation network structure for tooth preparations, an accuracy rate of 97.43% was reached [20]. CNN is able to remove border line through acquiring the properties of the margin line zone of the tooth's prepare. The outcomes of an investigation to determine the tooth's characteristics of remains. Teeth were accurately collected enough. The goal of the venture was to construct just one dental prosthetic for the molars that had a typical, normal tooth-like structure. This was rendered possible via a built-in AI program.

The findings of this work demonstrate that single-molar prosthetic teeth can be created using AI. That was stressed that with further instruction and algorithmic tuning, the precision of biomimetic AI-designed. The size of dental prostheses can be raised [21]. the creation of uses for AI has the potential to allow the independent production of innovative restorations for dentistry that comply with the strictest standards for fit, performance, and appearance. oral, facial. Innovations in this area will have an enormous effect on maxillofacial prosthetics.

IV. IN IMPLANTOLOGY

CBCT and intraoral images utilised for successfully construct dental implant therapy plans. Future prosthetics that integrate the two could be made possible via implantology using AI. Experts from the University Hospital of Tampere, Planmeca, Before the procedure for implants, the Alan Turing Institute and the Finnish School for AI suggested an improved algorithm to accurately and autonomously predict the location of the mandibular canal. Panoramic radiography data can be utilised to identify implant systems using DL-based object recognition. Artificial intelligence (AI) in implant dentistry used to identify the kind of an implant using periapical and panoramic radiographs [22].

Artificial intelligence (AI) will automatically combine the intraoral and CBCT scans after being acquired, Pattern the eventual rehabilitation, and then, taking into account the patient's individual history of illness, tissue width, bone category, and width, put the proper implants with an appropriate architecture in the optimal location. Once surgical guide has been established, the procedure can start. [23].

Lerner et al. introduced a model based on artificial intelligence to reduce these errors. This artificial intelligence (AI) model was created to make it easier to construct fixed implant prostheses with monolithic zirconia crowns. In order to locate abutmentsubgingival margins,

an AI model is used. This methodology allowed the dentist to focus on tooth preparation while maintaining interproximal connections. To cut down on errors and postponements, this ease was devised. Using patient information between 2016 to 2019, the investigation using posterior zirconia implant prosthesis looked at the information available. Ninety individuals were included in the trial, with a male to female ratio of 7:11.106 implants in total were employed in present research. One of information types employed to construct AI graphics was CAD scenarios. Other data sets include dradiographs, photographs, and intraoral scans. With 91% of patients survive, and 93% of patients succeed, zirconia implants for back teeth were successfully created using an AI model. The AI model's performance, which showed a high survival and success rate, validated the model's suitability for inclusion in this industry. prediction model designs were created using machine learning algorithms with a forecasting AI algorithms might prove useful for implant dentistry in two main aspects. Firstly, focus on bone levels and distinct clinical outcomes. Through evaluating the implantation system, patient information, and surgery techniques, a recurrent ANN with memetic seek efficiency obtained 99.2% reliability in outcome estimates. Second, it was proposed that artificial intelligence (AI) may eventually replace modern technology in predicting the mechanical attributes of a bioimplant structure, reducing the substantial computational costs related to optimisation implant design parameters. While employing AI to the risk minimization of bioimplants, additional investigation is required. [24].

V. IN MAXILLOFACIAL PROSTHESIS

Maxillofacial prosthesis rehabilitation replaces missing structures brought on by facial injuries or anomalies to restore function and appearance. Patient's experience genetic diseases, cancer, or trauma that results in malformations of the maxilla facial region. Because of the aesthetic and psychological concerns that these anomalies generate, high-quality prosthetic care is typically required. In many cases, it may be challenging to treat maxillofacial anomalies while achieving outstanding cosmetic results. Individuals can choose from a variety of dental prosthetic alternatives from prosthodontists to improve both function and appearance. Avoiding the hazards associated with an operation, a beautiful and practical maxillofacial prosthetics reduces patient anxiety and improves their standard of existence.

Designing and producing maxilla facial prostheses as well as planning and placing extraoral implants digitally are both made possible by technology. Prior CAD/CAM, a wax mould had to be painstakingly carved by hands to accurately represent a person's facial contour with a maxillofacial prosthetic. As a result of technological improvements, maxillofacial prostheses can now be digitally created. [25]

Imaging techniques that capture both the soft and hard aspects of an individual come first in a typical treatment procedure for maxillofacial prosthesis manufacture employing CAD/CAM technology. Then, Utilising software for computers, such information is transformed onto an RP framework, such as Materialise Mimics, Leuven, Belgium. RP models replicated into an acrylic resin or wax-based wax cast using replication techniques. The final details manually created in wax cast as skin curvature can't be perfectly recreated using RP techniques. After being fitted to the cast, silicone elastomer prosthetics are typically built. An immediate maxillofacial prosthetic can be created using a form selected from a computerised library whenever the normal form of the face is altered, like with the nose.

There have now been 12 blind people who have taken part in US bionic eye trials. Without the need for surgery, these AI-powered devices help patients restore their vision.

A professional decodes the audio from the camera information, converts it into audio, and then sends it wirelessly to the blind person's ears. Individuals whom resection has left them without tactile function in certain areas. Scientists from the Federal Polytechnic School of Zurich in Zurich, Switzerland, and the California Institute of Technology in Pasadena, California, are altering this experience by creating prosthetic skin. Tissue has a thin, translucent pectin and water layer that allows it to sense fluctuations in temperature from 5 and 50 °C. Synthetic sense of smell is essential to robotics since it replicates human's smelling structure, and is able to discriminate among odours in an assortment of fields such as diagnosing illnesses, tracking the environment, and problems related to public security, food production, and the production of crops.

VI. IN FORENSIC DENTISTRY

Identifying a person's gender and age from their skeletal remains is a crucial topic in forensic study. Age estimation is a helpful tool for a variety of tasks, such as solving forensic cases and treating the injured after natural disasters. Teeth are among the strongest tissues in the human body, so even after death, their shape is retained. Due to this, forensic dentistry is very important in identification. Comparing the number and types of teeth in a dental radiograph taken from a cadaver with earlier records is one method that is effective. 96% accuracy was reached when determining age and gender from digital X-ray pictures [31]. 20% of them were dental photos, and the other 80% were used for educational purposes. Patil et al. recently investigated the previously unexplored subject of employing length of roots to predict age. The right third molar mesial root length is a reliable age marker, using the Deep Learning model surpassed the performance of the machine learning model, the research found. It is highlighted that more radiographs representing more sources ought to be included to the training dataset a variety of domains to improve, expand, and use the algorithms in therapeutic approach. [32].

VII. DENTISTRY EDUCATION

Indulgences of AI that aim to change the current structure of dental education at faculties are still being researched. AI apps are widely used to create scenarios that mimic clinical work on patients, reducing potential educational dangers. The preclinical virtual patient input from the students has significantly improved, it has been reported. The main goal is to create fantastic learning environments that let students evaluate their work and compare it to the ideal output.

Dental students participate in preclinical training to develop their manipulative skills before they deal with patients. The trainer provides feedback to the learner while conducting studies on skill development utilising the traditional phantom models used in this training. Instead, the input that the virtual patient provides to students while they are being monitored by a trainer throughout the same practises may improve the learning process. Students advance more quickly towards the required skill level, according to studies examining the effectiveness of various approaches.

These days, there are even robotic replicas that can replicate motions like bleeding and salivation and move the mouth and tongue in response to discomfort. Robotic models are being used in preclinical dental labs to help students develop their core motor skills [33]. Because of the increased research being done in this field and the declining costs of robotic instrument hardware and software, robotic applications will be employed more frequently in dental facilities.

Along with boosting education, another critical aspect of using AI in education is the inclusion of AI-based courses in the curriculum. Given the ongoing research in virtually every sector and the current apps in use, it is apparent that dental candidates will be both users and developers of these applications in the future. Dental students will benefit from learning essential AI principles and jargon, which will advance this field that was developed with human intelligence.

VIII. CONCLUSION

In prosthodontics, AI has been employed in increasing numbers. Results of the implementation are comparable to, and often times even better than, human performance. Artificial intelligence (AI) has the potential to improve every part of medicine, including the classification of maxillofacial prosthesis and denture fittings, the removal of marginal lines, and the reduction of implant solidifying a human accident. AI is able to help doctors in performing their professional responsibilities; it can't take advantage of human understanding, skill, or strategy for treatment. Despite the fact that there are still issues to be resolved, including those relating to data collection, interpretation, computer power, and ethical considerations, AI is typically seen as a wonderful aid for dentists.

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