

Review Article

Role of artificial intelligence in prosthodontics

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ABSTRACT:

Purpose: The main purpose of the study to review the articles regarding the application of Artificial intelligence (AI) in the field of Prosthodontics. AI has been used for many purposes like identification of normal & abnormal structures, diagnosis of the disease & planning the treatment procedures. In the field of prosthodontics, AI has various functions such as Fabrication of CAD- CAM dentures, smile designing software, Tooth arrangement robot for complete dentures fabrication, Prediction of facial deformation after long-term wearing of complete dentures, Tooth preparation for crown placement, AI Models for implant type recognition, implant success prediction, robot for drilling the implant site, Mac RPD to aid in design of RPD. **Conclusion:** Application of AI in dental field has progressed. Most studies that were included in this review showed good results. A clear understanding of techniques & concepts of AI has advantages in the future. However, availability of insufficient & inaccurate details is the only disadvantages.

Keywords: Artificial Intelligence, Machine learning, Robots, Prosthodontics

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INTRODUCTION

Artificial Intelligence is mostly associated with Robotics. It can be defined as series of past technologies which enables digital system/ computer to perform specific tasks. It imitates human behavior. John McCarthy known as "Father of Artificial Intelligence" was the person who coined the term Artificial Intelligence in 1955^[1]

Certain terminologies to be known for better understanding of AI are:

- Machine learning: It is a branch of AI was first mentioned by Arthur Samuel in which systems/ technologies learns to perform tasks without human assistance. It is accomplished by tuning the system by defining the objective & optimizing it to reach it.^[2]
- Neural networks: set of algorithms. These are created to function like human brain.
- Deep learning: utilizes network from different computational layers to analyze the input data. It is also called as convolutional neural networks (CNN).

The field of Artificial Intelligence (AI) has a spectacular development & growth over past decades. AI has been used for variety of purposes, specifically identification of normal & abnormal structures, diagnosis of disease & prediction of treatment outcome. The purpose of this study is to review the articles regarding the application of Artificial Intelligence (AI) in field of Prosthodontics.

APPLICATION OF ARTIFICIAL INTELLIGENCE IN PROSTHODONTICS

AI in prosthodontics has various uses such as CAD- CAM dentures, smile designing software, Tooth arrangement robot for complete dentures, Prediction of facial deformation after long-term wearing of complete dentures, Tooth preparation for crown placement, AI Models for implant type recognition, implant success prediction, robot for drilling the implant site, Mac RPD to aid in design of RPD.

1. AI IN PATIENT MANAGEMENT

- AI can be used to book a patient's appointment in clinic, taking proper medical & dental history, adequate diagnosis & treatment planning.

2. AI IN COMPLETE DENTURE PROSTHESIS

- As the conventional technique of complete denture fabrication has many disadvantages like impression taking, cast preparation, base plate adaptation, Digital technique such as CAD- CAM has been advocated in fabrication of complete denture.

CAD-CAM dentures have been made through pre-polymerized PMMA blocks & 5 axis milling with computer software.^[3]

CAD-CAM dentures are found to be as good as conventional dentures.

- Software & Digital technologies have been developed for smile designing through the assessment of facial & dental structures. Even 3 dimensional models can be designed by using the data obtained from the patient.^[4]
- **TOOTH ARRANGEMENT ROBOT:** A Software/ system using industrial robot was first presented in 2001 for tooth arrangement in complete denture prosthesis. ^[5-7]Due to the distortion of dental arches after the loss of dentition, it is important to design & generate a dental arch that adapts patient's jaw morphology. As the traditional method of reproducing dental arch has numerous errors, an automatic acquisition of dental arch implementing motion planning & synchronized control of dental arch generator of multi- manipulator tooth arrangement robot for use in full denture manufacture has been designed.^[8]
- Prediction of facial deformation after complete denture prosthesis using BP neural network.^[9]

3. AI IN FIXED PARTIAL DENTURE PROSTHESIS

- The main application of AI in FPD is tooth preparation for crown placement. An automatic tooth preparation robot with the three-dimensional motion planning software was developed, which controlled an Ultra short pulse laser (USPL) beam to complete tooth preparation process.^[10]
- Yamaguchi in 2019, conducted a Retrospective Cohort study to access the validity of deep learning with CNN method to predict the debonding probability of CAD-CAM Composite resin restorations from 2D images captured from 3D STL models of a die scanned by a 3D oral scanner ^[11]
- Lerner in 2020, conducted a Retrospective cohort study to present a protocol for the use of AI to fabricate implant- supported monolithic zirconia crowns cemented on customized hybrid abutments, via a full digital workflow. ^[12]

4. AI IN IMPLANT DENTISTRY

- AI models are used in implant dentistry for implant type recognition, implant success prediction by using patient risk factors & ontology criteria, implant design can be

optimized by combining finite element analysis (FEA) calculations & AI models. ^[13-15]

- One of the unsolved problems in implantology is interfacial stress distributions between implant components, as well as between implant surfaces & contacting bone. In order to overcome this, a measurement system for mastication force after dental implantology was established by University of Kentucky.^[16]
 - The use of robot for drilling the implant site in preparation for insertion of the implant is proposed.^[17]
 - An image- guided robotic system for automated dental implantation, is constructed by Old Dominion University.
 - Predictive AI models are useful in focusing on clinical outcome & individual bone levels which are constructed with ML algorithms.^[18]
- ## 5. AI IN REMOVABLE PARTIAL DENTURE
- Mac RPD is a micro-computer-based program developed to aid in the design of removable partial denture.

It has interactive user interface that poses questions & requests answers based on Kennedy Classification system, to select major connectors, presence/ absence of modification spaces, choice of direct retainers.

The user provides numerical input with computer keyboard, prompted by questions that appear on computer screen.^[19]

- Several trials have been conducted to develop an AI System for designing RPDs where the computer itself needs to acquire information about the dental arch & residual teeth by using a questionnaire

Designing RPDs using AI involving the classification of dental arch using CNN.^[20]

ADVANTAGES OF AI IN PROSTHODONTICS

- Accuracy in Tooth Preparation
- Minimal Tooth loss
- Performing tasks in almost no time
- Accuracy in making decisions.

DISADVANTAGES OF AI IN PROSTHODONTICS

- More expensive
- Adequate training is required.
- Accurate & Appropriate data is required to avoid error.

CONCLUSION

Application of AI in dental field has progressed. Most studies that were included in this review showed good results. A clear understanding of techniques & concepts of AI has advantages in the future. However, availability of insufficient & inaccurate details is the only disadvantages.

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