

Artificial Intelligence in Prosthodontics: An Overview

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Abstract

Artificial intelligence (AI) has gained interest of many researchers in the last decade. Every field has embraced artificial intelligence including dentistry. AI is useful for patient care since the inception of recording patient history to diagnosis. AI is of great help in prostheses planning and fabrication of complicated maxillofacial prostheses. It makes the workflow of dental operator more streamlined by helping in maintaining records, diagnostic aid for planning the treatment and predicting prognosis, making dental treatment more predictable. AI is changing the face of healthcare like any other sector. Improved accessibility of efficient healthcare to population and practicing evidence based dentistry will have positive influence in a long run.

Keywords: Artificial intelligence; Dentistry; Prostheses; Maxillofacial appliances; Diagnosis; implantology; CAD/CAM.

INTRODUCTION

McCarthy was the one who coined this interesting terminology Artificial Intelligence (AI).¹ It is also sometimes known as 'machine intelligence'² or the 'fourth revolution'.³ With the advances in technology, AI can now process large datasets and human behavior also. In simpler terms,

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AI mimics the human brain. With the advances in digitalization, every field today is influenced by AI including dentistry.⁴ In our day to day lives also siri, alexa, google voice commands are just a few examples of AI.⁵

Machine learning, neural networks and deep learning are all sub categories of AI. Machines just like human beings can learn data to build algorithm and solve problems of prediction. Neural networks are allegedly artificial neurons similar to human neural network and function in a similar manner to make decisions and solve problems. Neural networks can be simplified as: input layer (information entering), hidden layer (processing of data) and output layer (outgoing command). Deep learning is that part of the process where computer learns how to process data.⁶⁻¹⁰

Medical health care too is reaping the benefits of AI. Simple tasks like calculating medication dosage,

scheduling the appointments, diagnosis, predicting prognosis, etc. to robotic surgery are all handled by AI.⁵ AI has a vast scope in dentistry too. Example in the field of radiology with more emphasis on diagnostic in terms of digital IOPAS/RVGS, 3D Scans, CBCT. Lot of information can be gathered and computed to create an AI for aiding quick diagnosis and treatment planning. We are now using AI in routine dental procedures to complex treatments. AI has proved to be beneficial to the dentists by providing high quality patient care and predictable treatment outcomes.

As we march into the digital era, every field is being influenced by AI. In the last few decades when AI was in stages of inception, it was not happily accepted by many since many argued that it is replacing human intelligence. But since the COVID pandemic, more and more fields including healthcare are accepting AI as an adjuvant aid. AI based technology are taking fast shape and acceptance in every part of society including healthcare and dentistry alike. This article explains in detail of how AI is changing the face of dentistry.

AI in health care

In June 2021, WHO in their world report on AI mentioned that AI holds enormous potential in improving health of population if used cautiously.¹¹ Administrative work accounts for 30% of health care cost. By aid of AI the tedious task of maintain hospital records will be taken care of, diagnosis, clinical decision making, predicting the prognosis. Expensive and difficult surgeries will be replaced by robotic governed surgeries which will be cost effective and faster. In a developing country like India, AI will decrease the load on health care by providing faster and economic aid.

We are now in the era of 'Modern dentistry'. Replacement of teeth with help of implants is a concept now readily accepted by the patients also. AI is slowly nudging its head in the field of Prosthodontics and will continue to do so. AI is involved in prosthodontics since the inception of the treatment till the follow up of the patient.

Interplay of diagnosis and AI in prosthodontics:

Intraoral scanners (IOSs)^{2,12} and cone-beam computed tomography (CBCT)⁴, together with computer assisted design (CAD) software,¹³ have changed diagnostic precision, treatment plans, and workflows.¹⁴ These functions are enabled by machine learning (ML), through which computers learn rules from data, capturing their intrinsic statistical patterns and structures.^{15,16} In one recent

in vitro study, AI was employed for assisted implant planning¹³ in guided implant surgery, without using any software which can help in 3-D planning and streamline the workflows.^{7,9} The standard tessellation language (STL) models using the swgments of CBCT files can make this possible.²⁵ In an interesting study they found that determination of the mandibular canal was successful using AI in CBCT.¹⁷ Consequently, using these systems in implant planning will both facilitate the work of physicians and will be a support mechanism in implantology practice. The success of the present study in the detection of sinus/mandibular canal and missing teeth and the measurements it offers in implant planning reinforces this possibility. There is a need for more extensive studies in which environmental anatomical formations are evaluated by AI for the development of convolutional neural network (CNN) systems in implant planning.¹⁷

Recent advances in CAD/CAM supported by AI

Precision of prosthesis is of utmost importance in Prosthodontics. It is the interplay of manpower and machinery. As we know, CAD-CAM has been a boon to fabricate precise prosthesis, however there are some fall outs. Incorporating AI in CAD/CAM generates a large database with ability to assess and learn from the millions of doctor-approved crowns, and continuous update of the database by regular entry of new information.¹⁸

Conventional CAD-CAM system is known to induce errors while cementation. Reasons for such errors can be varied.¹⁹ Henriette Lerner *et al* proposed an AI model to minimize these errors. This AI model was to help in the fabrication of fixed implant prosthesis using monolithic zirconia crowns. The deployment of the AI model to assist in the detection of subgingival margins of the abutment. For the study, the patient recorded from 2016 to 2019 was used in the study with 106 zirconia implant prosthesis in posterior teeth. The gender diversity of the study was with male to female ratio was 7:11 in 90 patients. Data sets for the training purpose of AI models comprised intraoral scans, radiographs, photographs and CAD scenes (images). The promising results were observed with the usage of AI model in the fabrication of zirconia implants for the posterior teeth with a survival rate of 91% and success rate of 93%. Since results from the AI model showed a high survival and success rate, which showed the proficiency of the model to be integrated into this field.²⁰

AI and data processing in prosthodontics

AI is increasingly being applied to dentistry including prosthodontics research. AI functions better with digital images. Hence, the data from scanning techniques can be easily used.^{15,21} This is just the brim of the beginning of AI revolution in dentistry. In near future, AI technologies will become the central part of all patient care from data management, advances in healthcare and will make the medical and dental care customise for each and every patient.¹⁵

AI and Implantology

Successful implant placement is a multitude of many factors. Implantology has gained tremendous benefits from AI. CAD software can save the STL file of the abutment to be made available whenever needed.²² After the temporization or provisional period, the prosthodontist need not worry about the visibility of abutment margins even if they are subgingival. Following this, dentist can proceed to make a new intraoral impression of the hybrid abutment in the correct position, after removal of the temporary restoration. The details or the mesh recorded with this intraoral impression is then imported into the CAD software. Interestingly, the portion corresponding to the individual abutment, captured in the oral cavity, is automatically recognised and eliminated because it is replaced with the original STL file of the zirconia abutment, previously modelled by the dental technician.²⁰

CONCLUSION

The last decade has seen strides in Artificial intelligence. Every field of health care is reaping benefits of AI. Prosthodontics has also seen tremendous changes owing to AI. Nevertheless, any technology should be used wisely. Moreover, no dentist should be afraid of losing his/her position due to these advancements in AI. On the contrary, dentist will be the best equipped to interpret the findings with the help of AI and DL, in turn, may lead to new research ideas.

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