

# Artificial Intelligence In Prosthodontics: New Paradigm Shift

**Dr. Rashmi P Karchi.**

*Department of AI and ML, Nagarjuna College of Engineering and Technology, Bangalore.*

**Dr. Nagaraj E.**

*Department of Prosthodontics, PMNM Dental College and Hospital, Bagalkot.*

**Dr. Rony T Kondody.**

*Department of Orthodontics and Dentofacial Orthopedics, Sri Rajiv Gandhi College of dental sciences, Bangalore.*

**Dr. Sanjeevakumar M Hatture.**

*Department of Information Science and Engineering, Nagarjuna college of Engineering and Technology, Bangalore.*

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## **Abstract**

*The World Is Buzzing With Excitement, Where The Future Of Humanity Across Various Scopes Of Engineering And Health Care Is Being Shaped By Artificial Intelligence. It Is Already The Main Driver Of The Latest Revolution Like Big Data, Robotics, And Iot, And It Will Continue To Act As A Technological Innovator For The Foreseeable Future. AI Has Also Revolutionized Various Sections Of Dentistry Including The Field Of Prosthodontics In Patient Diagnosis And Treatment Planning And Also Replacement And Rehabilitation Of Missing Teeth With The Help Of Fixed And Removable Prosthesisbiocompatible Substitutes Like Implants. This Review Focuses On Explaining The Prospect, And Insights Regarding The Future Of Artificial Intelligence In Prosthodontics Practice.*

**Keywords:** *Artificial Intelligence, Dentistry, Prosthodontics, Robotics*

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## **I. Introduction**

In the last decade, various advancements such as artificial intelligence (AI) and machine learning (ML) has emerged as important tool in engineering various sections of engineering as well as healthcare delivery systems. The Principle behind the working of AI is based on mimicking the human brain that could achieve results or tasks that need human intelligence.<sup>1</sup> While ML focus on designing and applying algorithms that can learn from previous cases. This includes parameters that need adjustments concerning underlying techniques such as the number of neurons and layers in a neural network technique; the size of the population, the rate of mutation, and the crossing-over rate in genetic algorithms.<sup>2,3</sup>

The concept of AI was there since 1950, now the advancements in technology have led to its use in dentistry and it's been adopted in all dental specialties like Prosthodontics, Orthodontics, periodontics, and operative dentistry. In dentistry, AI applies to diagnosis, decision-making, treatment planning, and prediction of treatment outcomes. AI is more common and precisely used for diagnosis and making the dentist more accurate in diagnosing and planning for their treatment.<sup>4-7</sup>

Artificial intelligence systems can perform tasks commonly associated with human cognitive functions such as interpreting speech and identifying patterns. Various benefits include A. Automation: AI is used to automate anything ranging from tasks that involve extreme labor to the process of recruitment. AI application tools help to free employees from tedious manual tasks and allow them to focus on complex tasks. B. Increased productivity: AI is being used to manage highly computational tasks that require maximum effort and time. C. Smart decision making: AI makes complex situations most simple and d. solve complex problems: AI helps in diagnosing complex medical conditions.<sup>8</sup>

With the rapid developments in the field, AI studies, which have started to radically change the sectors, will inevitably transform dentistry. The purpose of this section is to review the current and potential uses of AI applications in the field of prosthodontics

## **II. Artificial Intelligence and Prosthodontics**

Prosthodontics is the dental specialty about the diagnosis, treatment planning, rehabilitation, and maintenance of the oral function, comfort, appearance, and health of patients with clinical conditions associated with missing or deficient teeth and/or maxillofacial tissues by using biocompatible substitutes. AI in Prosthodontics is mainly concerned with diagnosis, treatment and fabrication of removable and fixed partial dentures, implant surgeries, and maxillofacial prosthesis. It is also used to select the shade of the prosthesis.<sup>9</sup> Artificial intelligence (AI) technology has arrived, and prosthodontic practice has incorporated it completely.

**A: Removable and Fixed prosthesis-** With the introduction of AI-based advancement in the field of prosthodontics, the digital method of impression-taking and also intraoral scanning methods have supported the fabrication of fixed and removable prosthesis with absolute accuracy. Also, a 3D face tracking system supported in creating dental prosthesis can be a treatment alternative compared to conventional methods. Clinical environments continually change, therefore maintaining a skeptical approach to its output is vital.<sup>10</sup>

**B. Implantology-** The application of AI in implantology offers the potential to combine both and develop future prosthetics. With the advent of implantology, various limitations of fixed and removable prosthesis can be solved. Implants provide the advantage of being more resistant to dental diseases, preserving residual ridge, and providing better support in distal extension cases.<sup>11</sup> Implants are widely used in dentistry to replace the missing tooth or for the entire mouth rehabilitation. Acceptance of implant prosthesis has been increased in recent years due to better aesthetics and stability.

In a study by Lee J and Jeong S, with the deployment of a convolutional neural network implants with the help of panoramic and periapical radiographs. From the results of this study, it can be concluded that the deep CNN model can be a helpful aid in classifying implant systems with almost equal or greater accuracy compared to humans.<sup>12</sup>

**C. Maxillofacial prostheses-** According to Ackerman in the year 1953 defined maxillofacial prostheses as the phase of dentistry that repairs and artificially replace parts of the face following injuries or surgical intervention.<sup>13</sup> This “Maxillofacial prosthodontics” is a subspecialty of prosthodontics that involves rehabilitation of patients with defects or disabilities that were present congenitally or developed due to disease or trauma. This prosthesis are mainly indicated for cosmetic and psychosocial reasons. These prosthesis are also desired for replacing areas to restore normal oral functions like swallowing, speech, and chewing.

To treat extensive facial defects, we need to make an impression of the entire face and the defect site. This requires different impression materials. The problems associated with these procedures are discomfort for patients, chances of material engaging in undercuts, difficulty in breathing, soft tissues may be distorted, time-consuming, and difficult procedures. Due to advancements in the field of technology, computerized three-dimensional data processing can obtain entire facial morphology measurements by using a non-contact 3D laser morphological measurement system

Maxillofacial reconstruction involves implanting artificial substitutes for intraoral and extraoral structures such as the eyes, ears, nose, maxilla, mandible, palate, etc.<sup>14</sup>

The success of any maxillofacial prosthesis depends on its retention as it improves comfort and confidence in the patient. Various methods used to improve retention are adhesives, implants, eyeglasses, and combinations. Various advances in techniques used for adhesives of the maxillofacial prosthesis and the materials used have been remarkable.<sup>15</sup> Over the past two decades, Osseointegrated implants have been used for enhancing retention in the craniofacial regions. Various systems that are currently available in the market include bar and clip systems, magnets, mushroom, and ball retention methods.<sup>16</sup> Also these prostheses can now be fabricated using digital technologies.<sup>17,18</sup>

The creation of maxillofacial prosthesis utilizing CAD/CAM technology starts with imaging techniques that record the patient's soft and hard tissues. Software is subsequently used to transform this data into an RP model. Then, utilizing reproduction techniques, the RP models are transferred into wax directly or in acrylic resin. The silicone elastomer prosthesis can be built from the cast.<sup>19-21</sup> This approach needs less time than the conventional approach.

**D. Computer- Aided Designing and Computer-Assisted Manufacturing (CAD-CAM)-**Additive manufacturing, subtractive manufacturing, 3D printing are commonly used CAD-CAM technology for fabrication of prostheses in Prosthodontics.

CAD-CAM system has got 3 components:

1. Digital impressions: Collection of data of prepared teeth and adjacent tissues from dentist and later transform into visual impressions. These are later transferred to the laboratory. 2. Designing the final prosthesis

and preparing for milling. 3. Milling phase: After the design of the final prosthesis, fabrication of the prosthesis is done by milling suitable restorative material.

**1. Digital impressions/scanners:**-Conventional impression techniques are the ideal ways of recording prepared teeth and adjacent dental tissues. Regardless of advancements in material sciences, there are many drawbacks of impression materials. Till recently we do not have one common ideal impression material available for all kinds of procedures. With the advancements in the field of technology, intraoral scanners were developed to overcome the drawbacks of the conventional impression.<sup>22</sup>

**Advantages:** 1.No need for conventional impressions – comfort for the patient. 2. No need for any impression material, or disinfection control protocol. 3. Fewer chances of error when compared with conventional impressions. 4. Fewer laboratory procedures like pouring impressions. 5. Can review preparations immediately after scanning, if required can modify preparation and rescan. 6. Data collection of impression can be immediately transferred to dental laboratory.

**Disadvantages:** 1. Trained or skilled person is required 2. More cost.

**2. Designing final prosthesis-** After receiving the scanned impression of prepared tooth from the dentist in the laboratory, the data are processed by design software. Final 3-dimensional image can be designed which exactly looks like provisional restoration. The designed final prosthesis can be transferred to dentist for approval, if required the final design can be modified. After designing the final prosthesis, the data is transferred to the special milling device.<sup>23</sup>

**3.Milling phase-**After steps 1 and 2 where design is completed, data is transferred to the centralized milling/production centre. Suitable restorative material can be milled by using additive technique, subtractive technique or 3D printing technique.<sup>24</sup>

**Advantages:** 1. No materials required for procedures like die materials, investment material. 2. Time saving because of no casting procedures 3. No human errors during casting procedures which leads to casting failures. 4. Precise final restorations can be obtained. 5. Time-saving.

**Disadvantages:** 1. Trained technician is required 2. More expensive.

### **III. Future Prospects of Artificial Intelligence**

The future of AI will provide new hope for mankind with further advancement in every aspect of technology at its best. With regards to, hybrid intelligence is going to be the one that will be creating a new era of the combination of human and machine intelligence. The use of a newly developed hybrid intelligent image fusion method to combine multimodal images for better diagnosis and treatment planning will become widespread.<sup>25</sup>

Although the AI models used have high success rates, it is still necessary to verify the generalizability and reliability of these models using adequate, representative images from multiple institutions before using these models in clinical applications.

AI digital systems have indisputably changed future predictions and development in the practice of dentistry.<sup>26</sup>It is obvious that these networks play An important role in the decision-making and minimizing of systematic errors during the execution of treatment planning and also in advanced research.

### **IV. Conclusion**

As with any newer advancement that is happening across the globe there is always a divide among professionals about the active role of technologies in healthcare settings. However, the future in AI implementation was exciting as this provided a decentralization in the process of treatment. AI-enabled medical and dental professionals to do remote treatment in a better way. Accuracy of diagnosis of disease will be higher in the future as AI will make a prediction that can be integrated with the human diagnosis to enhance the possibilities of proper diagnostics.

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