

THE AESTHETIC TRIANGLE IN COMPLETE DENTURE: ROLE OF ARTIFICIAL INTELLIGENCE

Dr. Sandhia Sundaram¹, Dr. Hardilpreet Singh¹, Dr. Ganaraj Shetty^{2*}

¹Post Graduate, Department of Prosthodontics & Crown and Bridge, A B Shetty Memorial Institute of Dental Sciences, NITTE (Deemed to be University), Mangaluru, 575018, India

²Reader, Department of Prosthodontics & Crown and Bridge, A B Shetty Memorial Institute of Dental Sciences, NITTE (Deemed to be University), Mangaluru, 575018, India

Corresponding Author:

Dr. Ganaraj Shetty

Email: drganarajshetty@nitte.edu.in

ABSTRACT

Edentulousness, a prevalent condition among the aging population, severely impacts both the functional and aesthetic quality of life. Replacing lost teeth not only restores oral function but also plays a vital role in reestablishing a patient's facial aesthetics and smile, boosting their confidence. Complete dentures are especially crucial for geriatric patients, providing a solution to tooth loss due to various causes. The success of complete dentures is determined by their ability to offer comfort and satisfaction to the patient. The aesthetic outcome of dentures is shaped by the "Aesthetic Triangle," consisting of three key factors: teeth selection, shade selection, and gingival color. Each factor must be tailored to the patient's unique features and preferences to achieve a natural and harmonious result. With the advent of artificial intelligence (AI), the field of dentistry has seen significant improvements in treatment outcomes. AI tools streamline the design and fabrication processes, allowing for more accurate and

personalized denture arrangements. These advancements not only reduce treatment time but also enhance patient satisfaction by optimizing the overall aesthetic and functional aspects of dentures. This paper discusses the role of AI in refining the creation of complete dentures and its positive impact on enhancing patient outcomes.

Keywords: Complete Dentures, Aesthetic Triangle, Artificial Intelligence, Patient Satisfaction.

INTRODUCTION

Edentulousness is one of the most common problem faced among the ageing population. It is considered as a major problem affecting the quality of the patient's life^[1].

Replacing teeth are not merely just about restoring the function of the absent tooth but it also plays a major role in establishing the natural aesthetic appearance of the patient's facial appearance and smile. It helps

the patient gain back the confidence which they would have lost because of the loss of teeth. Complete dentures play a major role in the life of patients especially the geriatric patients who have lost their teeth due to various reasons. These complete dentures which are fabricated must be of utmost comfortability to the patient and should provide the patient with satisfaction^[2]. With the advancements of technology and advent of artificial intelligence the outcome of dental treatments can be improved.

The teeth arrangement has 3 basic factors which are to be taken into considerations – namely the teeth selection, shade selection and gingival colour forming the aesthetic triangle. These components must be meticulously tailored to each patient's unique facial features, skin tone, and personal preferences to achieve a visually pleasing and harmonious result.

With the advancement in technology there are various artificial intelligence tools in the field of dentistry which help in easing our work flow and as well improves the patient satisfaction after the insertion of the complete dentures.

History on traditional complete dentures

Teeth selection can be done on basis of three major factors the shape, size and colour of the patient. Generally the usage of various guides such as pre-extraction records and photographs can be used as a tool^[3]. Other methods such as using ratios of the facial structures help us in determining the shape and size of the tooth anthropometric measurements can also be useful in determining the tooth form^[4]. The most commonly used method of selecting teeth are the dentogenic factors which are taken into account.

Although these factors are precise and help

us in proper selection of teeth there seems to be some unsatisfaction with the complete denture patients regarding esthetics. These traditional method of teeth selection does not help the patients visualize the dentures before they receive the dentures.

With the advent of facial scan and artificial intelligence we are able to show the patients the various types of tooth shape, size and colour which are available and provide them with a better explanation regarding the best suitable denture for them. This provides the patient with better visualization the dentures which they will be receiving in the future. As a result the satisfaction of the patient can be improved.

The role of artificial intelligence in complete dentures

AI can assist in selecting the ideal teeth by analysing multiple factors that affect the aesthetics and functionality of dentures, creating a more personalized and natural result^[5]. Revilla Leon et al did a study on assessing the performance of AI in prosthodontics. He found out that there is better shade selection when using than conventional shade selection^[6].

Various methods have been formulated by various dentists in fabrication of complete dentures using the digital method.

After scanning the entire denture surface, Kawahata et al. created a prosthodontic wax type using a CNC machine and conducted research on the duplication process [15]. After defining the anatomic landmark for fake teeth and edentulous tissue, Sun et al. created a denture using 3D data of the edentulous area and artificial teeth. Following that, a tooth arrangement method was developed, and using a 3D printer, individual physical flasks were produced. However, they haven't developed a

comprehensive approach in their study, and choosing artificial teeth based on the age and sex of edentulous individuals is challenging.^[16] The base and artificial teeth of a single complete denture were scanned independently using a three-dimensional (3D) cone-beam computed tomography (CBCT) by Kanzawa and Inokosh, who then used the scanning data to design a new one. RP and fast milling were combined to provide an entirely wax-free manufacturing process for an acrylic resin denture base. Ultimately, the teeth were modified and cemented into the machined base's sockets. The logical formulation of automatic tooth selection for complete dentures by CAD was explored by Wang Y et al., although the various models that are accessible were not discussed. A traditional way of choosing artificial teeth and arranging the entire denture was detailed by Wu et al.; this method can serve as a guide for digital denture manufacture. When compared to traditional tooth arrangement, digital teeth arrangement and selection offer several benefits, including steady tooth arrangement accuracy, no human error, reduced chair time, and low cycle times.

Role of Artificial intelligence in teeth selection:

The customization of dentures to meet patient-specific needs and design preferences is a critical aspect of creating complete dentures. Artificial intelligence plays a valuable role in designing CDs and can independently recommend optimal designs tailored to the individual patient^[7].these AI models and conventional neurak networks(CNN) help in classifying the various types of arches and help in fabrication of complete detnures[8]

AI-powered software significantly enhances the process of selecting teeth by

advanced technologies to analyze a patient's unique facial features and anatomical data. By integrating sophisticated 3D facial recognition systems with powerful machine learning algorithms, the software can accurately propose ideal tooth shapes, sizes, and arrangements that complement the individual's natural appearance. Additionally, these systems allow for real-time simulation of various tooth arrangements, enabling patients to visualize different outcomes before committing to a final decision[9]. This interactive and data-driven approach not only empowers patients to make more informed choices but also minimizes the likelihood of human error. Ultimately, these innovations lead to highly personalized and precise results, improving the overall quality of care and ensuring greater patient satisfaction with the end result[10].

Role in shade selection

Artificial intelligence has the potential to improve the process of shade selection by employing cutting-edge digital shade-matching tools. These tools are designed to precisely measure and capture the exact color of a patient's natural teeth (if they are present) or the surrounding soft tissues. By leveraging this highly detailed data, AI algorithms can analyze and identify the most suitable tooth shade that not only complements the patient's natural coloration but also harmonizes seamlessly with their overall complexion. This ensures an end result that is both visually appealing and natural-looking.

Digital tools like cameras, colorimeters, spectrophotometers, and intraoral scanners are used to accurately record dental shades, reducing errors common in traditional visual methods. Software options such as ClearMatch, ShadeWave, Color Scanner

2006, Adobe Photoshop, MATLAB, EasyMatch QC, CT&A, PatchTool, SpectraMagic NX/DX, and Color iMatch further enhance shade matching by analyzing digital images. These tools are especially helpful when existing teeth are to be extracted before creating dentures.

Beyond technical precision, AI systems introduce a more personalized dimension to the shade selection process. These advanced systems consider individual preferences, even broader factors like cultural aesthetics to offer shade options tailored to the patient's unique characteristics. Furthermore, some of the most sophisticated AI-driven systems utilize machine learning capabilities to examine the patient's historical preferences or past dental choices. By doing so, they can predict and recommend an ideal shade that aligns with the patient's expectations. This integration of data-driven accuracy and personalized customization not only simplifies the decision-making process for dental professionals and patients but also enhances the overall experience by delivering results that are both precise and deeply satisfying.

Gingival colour selection

AI has opened up new possibilities for creating lifelike gingival colours by using advanced imaging and scanning technologies. AI-based systems can analyze the patient's mouth and gums, mapping the subtle variations in natural gum tissue. This data can then be used to create a gingival colour that closely matches the natural tissue, complete with texture and gradation in hue. Machine learning algorithms can also simulate the effects of aging and gum recession, adjusting the colour and texture to reflect these changes, enhancing realism and ensuring the final result looks natural.

The Future of AI in Denture Aesthetics

While AI is already playing a critical role in the denture design process, the technology is continually evolving. In the near future, we can expect even more sophisticated AI applications that will further streamline the aesthetic customization of complete dentures. Some possibilities include:

Patients could use augmented reality (AR) or virtual reality (VR) to try on digital renditions of their dentures before the physical creation process begins. This would allow them to see how different teeth shapes, shades, and gingival colours will look on their face, enhancing patient satisfaction and reducing the number of adjustments needed (pic 3).[13]

: AI could analyze a patient's facial expressions, emotions, and voice to help design dentures that not only look natural but also align with their personality. This data could be used to create dentures that better reflect the patient's emotional and social needs.

It could also automate much of the design and fabrication process, using 3D printing and robotic manufacturing to create dentures with unparalleled precision. This will also help in speeding up the production while maintaining a high level of aesthetic and functional quality.

Different AI softwares which can be used for fabrication of complete dentures:-

1. Denture Design Software (e.g., Exocad): This software includes modules for designing dentures and selecting teeth, using AI to optimize aesthetics and fit based on patient scans.
2. 3Shape Dental System: This software integrates AI to assist in the design and customization of dental prosthetics, including teeth selection based on facial morphology.

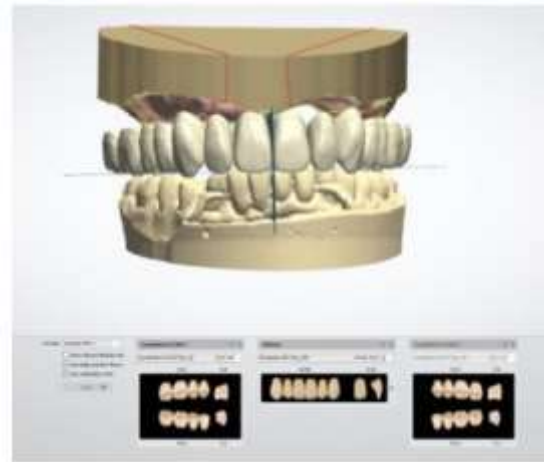
3. BlueSky Bio: Offers software that utilizes AI to facilitate treatment planning and tooth selection, enhancing the design process for dentures and implants.
4. Dental Monitoring: This platform uses AI to analyze oral conditions and can help in selecting appropriate teeth based on patient-specific data and preferences.
5. Carestream Dental: Their imaging and CAD software incorporate AI for enhancing the design of dentures, including teeth selection tailored to individual patient anatomy.
6. Zirconzahn: This software includes tools for aesthetic planning and teeth selection, leveraging AI to ensure a natural look and fit.

These tools streamline the process, allowing for better customization and improved outcomes in denture fabrication.

CONCLUSION

The most important factor has a dentist which has to be taken into consideration is the patient satisfaction after the delivery of the denture.

When a patient comes to our clinic it is our responsibility to give the patient possible treatment outcome which satisfies the patient. This can be possible with the usage of artificially driven softwares which provides us with various of options of tooth models from their libraries which can be further be shown to the patient and helps in better visualization of the dentures thereby increasing the potential outcome of the denture.



Digital teeth selection and arrangement from the library of the teeth available [13]



Customised teeth arrangement with corrections made according to the patients requirement [13]



Showing the patient- the denture before the fabrication of the final prosthesis.

Right:-final prosthesis after fabrication of the denture[14]

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