

CAD / CAM Technology: The Paradigm Shift in the Prosthetic Rehabilitation of Facial Defects

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Received: December 16, 2016; **Published:** December 24, 2016

Maxillofacial prosthetics is a sub-specialty or often called as super-specialty of Prosthodontics, it is defined as "The branch of Prosthodontics concerned with the restoration and/or replacement of the stomatognathic and craniofacial structures with prostheses that may or may not be removed on a regular or elective basis". One of the most important objectives of maxillofacial prosthetics is the improvement or restoration of the esthetic or cosmetic appearance.

CAD/CAM is an acronym for Computer-Aided Designing and Computer-assisted Manufacturing that have invaded our practices during the past few years and has become extremely popular. It is widely being used, in the dental laboratory and in the dental office, to design and machine various dental restorations [1,2]. In this respect, some terms are very popular and should be fully understood;

Non-Contact Surface Digitizing, is a non-contact, non-destructive technology that digitally captures the shape of physical objects (e.g patient's face) using a line of laser / white light to create "point clouds" of data from the surface of this object. In other words, it capture a physical object's exact size and shape into the computer world as a digital 3-dimensional representation.

Computer-Aided Design (CAD), is the use of computer software and systems to design and create 2D and 3D virtual models of goods and products for the purposes of testing.

Rapid Prototyping (RP), is the automatic construction of physical objects using solid freeform fabrication. Rapid prototyping takes virtual designs from Computer Aided Design (CAD) or animation modeling software, transforms them into thin, virtual, horizontal cross-sections and then creates each cross section in physical space, one after the next until the model is finished.

In recent years, as a result of the development of these technologies, many studies have focused on the design and manufacturing of facial prostheses using computer-aided design (CAD) and rapid prototyping (RP) technologies. In such studies, a three-dimensional (3D) image of the surface of a patient's face was reconstructed either by mirroring the normal portion of interest on the defective side or use the digital library of ear and nose, and the design of the facial prosthesis was completed. Then, a sacrifice pattern of the facial prosthesis or even the prosthesis itself was processed through RP technology. With these methods, the precision and efficacy in processing facial prostheses have been greatly improved [3,4].

CAD/CAM has revolutionized the field of prosthetics. The rapid simulative rehabilitation system for maxillofacial defects is approaching completion. With this system, the fidelity and precision of the prosthesis can be increased, manual labor can be simplified, less fabrication time would be needed, and the definitive rehabilitative effect for maxillofacial defects could be improved [5].

Although there are some variations according to many factors like the type and extent of the defect, as well as the mean of retention but there are common steps for fabrication of a prosthesis using these digital techniques and can be summarized as follow:

1. First, the patient's facial defect and surrounding anatomical structures, should be scanned with a three-dimensional scanner to get a digital model of the entire face. The face should be scanned from different perspectives around the patient's head to detect all undercuts (The acquisition of data corresponding to the patient's facial surface will be performed in a point cloud format with the 3-D Laser/ white light scanning).
2. The 3D point cloud data of the facial surface will be transmitted to a personal computer.
3. With computer-aided technology, the original 3D facial image is designing the customized virtual prosthesis using a mirroring-based approach or with the support of an "Facial Digital Library," which is used mainly when a contra lateral healthy side of the patient's face is not available to develop a prosthesis.
4. The virtual retention structure if needed is constructed using the CAD. and then it will be merged with the provisional facial prosthesis to obtain the definitive virtual facial prosthesis.
5. Rapid prototyping is then using the definitive virtual facial prosthesis to manufacture the wax pattern of the final prosthesis or a two-part mold and vacuum casting that used to produce the final prosthesis or even direct fabrication of the prosthesis itself.

Conclusion

The introduction of the digital techniques including CAD/ CAM technology in the management of the patients with facial defects led to a paradigm shift in the construction of facial prostheses which not only improved the patient's satisfaction, shortened the working time but also enabled better prediction and maximized the outcome of the prosthetic rehabilitation.

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Volume 6 Issue 6 December 2016

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