A Review of 3D Printing in prosthodontics

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ABSTRACT

3D printing the innovative and rising technology in dentistry. As various developments made significant impact in prosthodontic dentistry, where3D printing is also necessary. This fabrication method has high accuracy, it is time saving and can easily create complex geometry. This article gives an outline of currently available 3D printing and its applications in the field of prosthodontic dentistry.

INTRODUCTION

The notion of computer-aided design/computer-aided manufacturing (CAD/CAM) of various objects was discovered before a long time in 1970s and is being applied in dentistry field for decades for dental restorations fabrication in prosthodontics[1]. Currently, tooth restorations which are 3D printed are mainly used as provisional or interim restorations for fixed prostheses.

History of Application in Dentistry:

In 1979, Heitlinger and Rodler first applied CAD-CAM technique to mill a stone model to make crown, inlay and pontics. Moermann and Brandestini in 1980 took single picture and milled only the coronal surface of inlay[2]. The initial dental CAD-CAM prototype was presented at the Garanciere Conference (France) in 1983 and the first crown has been publicly milled and installed in oral cavity without any lab involvement in the year 1985

Dental applications

Fixed prosthesis

The Computer aided designing and Computer assisted manufactured dental prosthesis milled from the ceramic solid cubes or composite that correctly matches with shade of the tooth to be restored. Alloys of metal , including zirconia, can be milled[3]. These materials need processing like baking and sintering followed by milling. This system is useful in chair-side, laboratory setting, and also in a production centre,"

Removable partial denture

Traditional design of RPD involves production of the stone casts, geometrically characterized tooth and the soft tissues which are related to path of insertion, and designation of the RPD components (the major and the minor connectors, the rests, the clasps, and the base retention) by using the direct waxing technique . Currently available digital technologies will enable designing of RPD components on 3D representation of patients instead of the stone casts using the geometric analysis tools which creates the designs of micrometer-level and accuracy that is viewed in the cross section[6]. The virtually obtained model can be used for printing wax for the casting metal framework or direct printing or the milling of the metal and resin frameworks. The field of dentistry has been using computer-aided design/computer-aided manufacturing (CAD/CAM) for decades to fabricate dental restorations in prosthodontics. The concept was first introduced in the 1970s.

Complete dentures

Complete dentures are currently created mostly using conventional methods, involving a variety of clinical and laboratory tests. Dentists who are edentulous usually need to visit the dental clinic five times to receive complete dentures. This includes taking initial and final impressions, measuring the jaws,

placing a trial denture, and placing and inserting the final complete denture.

A new method for designing and fabricating CDs is called CAD/CAM. Dental professionals have been using CAD/CAM technology since the early 1980s. However, due to a lack of appropriate CAD software until recently, the use of CAD/CAM in the production of complete dentures was limited, in contrast to the widespread use of modern technology in other areas of dentistry5. AvaDent digital dentures and the 3 Shape System are only two of the many commercial CAD software programs that are now available for designing complete dentures. Patients can acquire their entire set of dentures in just two appointments thanks to this CAD/CAM technology. It is necessary to complete all impressions, jaw relationships, occlusal plane orientation, shade selection, tooth mold, and maxillary front tooth alignment.

Inlays and Onlays

An attempt to solve some of problems which are associated along with the posterior conventional ceramic restorations were made by Mormann and Brandestini .They used CAD-CAM device to digitalize and also to electronically store cavity preparation measurements and then computerized electrically driven milling device used to shape restoration from the ceramic ingots. The system is inked to a small milling machine that can trim ceramic restoration to accurate fit of cavity preparation. Information regarding cavity preparation is transferred to the computer by a infrared video camera which transmits image on to the screen for viewing restoration which can be adjusted by dentist before milling[7].

The final restoration is ground from a block of ceramic material by a computer-controlled milling machine once the dentist is happy with the design. Within ten minutes, the restoration is often prepared for intraoral bonding. This method has the benefit of not requiring imprints, stone casts, or dies because the entire process—from cavity preparation to bonding—can be finished in a single session. An opposing cast and articulator mounting are not necessary when adjusting the occlusion in the mouth.Facilities for laboratories are not necessary. As this is a one-visit treatment, it is not necessary to create the temporary restoration and deal with issues like micro-leakage effects, sensitivity between sessions, and lost temporaries.

However, the one-session method has its drawbacks.

Advantages of using CAD/CAM technology for dentists are:

- The patient spends less time in the office.
- A simplified procedure
- Significantly reduced costs for dental technical laboratories.

Advantages of using CAD/CAM technology in dental-technical laboratory:

- Easier way of producing.
- More precisely made restorations
- Lower consumption of materials.
- Higher productivity.

Disadvantages of using CAD/CAM technology

- If there are issues with the optical impression, costly chair time is lost and modifications to the design and milling process are required.
- Since a die is not available, we must inspect and make corrections after milling mouth interferences caused by seating.
- This frequently necessitates more chair time in comparison to restorations made in a traditional laboratory.
- The additional time required could conflict with appointments for other patients can increase the stress levels of office workers, patients, and operators. At workplaces having distributing the CAD/CAM unit across several practitioners (to control the cost).
- Avoid scheduling appointments at the same time. FABRICATION OF MODELS

ADDITIVE MANUFACTURING

The procedure of mixing materials, usually layer by layer, to make objects from 3D model data, as opposed to subtractive manufacturing processes, is known as "additive manufacturing." Each new predefined layer is "joined" to the preceding layer through a process of melting, fusing, or polymerization. Many additive manufacturing technologies have been developed by engineers. In dentistry, the most common techniques are laser powder forming, fused deposition modeling, stereo lithography, and selective electron beam melting. First, using specialized software, the digital image of the object is cut in a CAD unit to begin the layer-by-layer structuring of the actual dental restoration. Subsequently, the 3D

prosthesis is manufactured using a method that is akin to printing on paper: layer upon layer. The term for it is "3D-printing."

CONCLUSION

Without a doubt, the traditional manual denture-making process will be completely replaced by additive technologies, with specialists just needing to oversee and assist in the visualization phase of the CAD/CAM process. The primary benefits of utilizing resin-based polymer (RP) manufacturing for dental restorations are the notable reduction in production cycle time and final restoration cost. Additionally, it encourages cooperation between the dental laboratory and the office10. The risk of dimensional alterations in casts and impressions is eliminated by new technologies, which bypass these steps and allow the prosthetic field to be scanned and the model to be printed directly without causing any tissue disruption. These days, the dental lab doesn't need any additional square meters because everything is kept on the computer hard drive.

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