Chapter 18
Recent Trends in 3D Printing of Dental Models:
Rapid Prototyping in Dental Implants

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ABSTRACT

This chapter introduces the recent trend in 3D printing (3DP) in dentistry. The advantage and disadvantages of 3DP are discussed. It elaborates on different types of 3DP techniques involved and their significance. The chapter further discuss about the biomaterial used. It also describes the complete steps involved in 3DP such as image acquisition, modeling, segmentation, and printing techniques. The merits and demerits of the different methodologies pertaining to steps involved in 3DP are illustrated. Rapid prototyping in dental implants is discussed in detail. It ends with review of a case study in implementing the technique.

INTRODUCTION

This chapter reviews the incipient role of 3D printing in dentistry, a topic of growing relevancy (Schubert, Van Langeveld, & Donoso, 2014). Further this chapter gives an insight in bioprinting that aids medical community to design structurally complex 3D constructs by comprehensive positioning and aiding complex patterns that are formed by different structures of cells, biomaterials and bioactive molecules within a single make. With the evolution of several bioprinting strategies during recent period, 3D bioprinting is applied in several research areas that include dental implant (Klein, Lu & Wang, 2013).

Bioprinting has emerged over the past decade as a prominent technology in the field of dentistry (Banks, 2013). Implementation of 3D printer helps in reducing the cost, it enhances the speed of production and is easy method for implementation in dental rehabilitation. It supports the surgeons in planning for surgery in resection and reconstruction. It represents as an exceptional aid for the academicians to train their students (Bertassoni, Cecconi, Manoharan, Nikkhah, Hjortnaes, Cristino, & Khademhosseini, 2014). Medical Rapid Prototype based pre-bended reconstruction helps in decreasing the resection dura-

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tion, rate and anaesthesia menace bared by the subjects (Mertz, 2013). The need for reconstruction for dental rehabilitation is continuous challenge.

The very purpose of reconstruction is the repair of appropriate aesthetics and regularty of facet. Reconstruction also helps in stabilising arrangements and the strengthening the jaw (Salgueiro, & Stevens, 2010). The defects in ideal model in reconstruction is obtained by using titanium plate during resection. For mandibular reconstruction, is not easy to shape the titanium plates and the whole procedure is time consuming (Cohen, Laviv, Berman, Nashef, & Abu-Tair, 2009). The intraoperative prearrangement leads to extensive surgical operation and upsurges the budget (Yovchev, Stanimirov, & Mihaylova, 2014). The appropriate alteration of the plate to match the skeletal structure is indispensable to get a positive outcome.

BACKGROUND

The dental prosthesis fabrication includes many of manual laboratory processes and the quality of restorations depends on the dentists and dental technician's skill and expertise. The dental restoration is also a very individual and complex process. Computer aided manufacturing (CAM) is methodology is introduced to overcome the disadvantage in manual process. Introducing CAM for the processing procedure will highly rise the manufactured quality of dental restorations. The manufacturing process includes: data acquisition, data processing and model fabrication (Nayar, Bhuminathan, & Bhat, 2015).

3D Printing Intial Steps

The first step often used towards 3d printing involves, Computer Tomography scan with field of view within twenty cm, the slice thickness usually selected is slightly more than one cm (equal to scan spacing) and the gantry tilt of zero degree is set. During the whole procedure the patients are not allowed to move and the occlusal planes are set parallel to the gantry. The whole arrangement helps in reducing the artefacts in the anatomic model. The acquired images are stored in DICOM file format.

The open source 3D imaging software is used to process CT DICOM images. The commonly used software version is Vesalius 3.0.0 version. The bone mask is created using the tool for mask creation in Hounsfield unit range. The 3D surfaces are crated using the bone mask as reference. Finally, the data is transferred in stereolithography (STL) file. The process takes few minutes depending the CPU configuration.

The Autodesk Meshmixer 2.9.1 version is used for editing STL file. The selection/analysis tools are used to isolate and repair the mandible. Further the compatible model for printing is produced by transforming the complex geometry of the bone. Finally mesh of the mandible is prepared for the slicing using open source Matter Control and printing is performed using the ROBO 3D R1 with 1.75mm polylactid acid filament.

Imaging Modalities

The first step important step towards 3D printing is imaging. The imaging techniques such as CT, MRI, digital photography is commonly used.

The objectives of diagnostic imaging depend on