An Introduction to 3D Printing in Dentistry

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ABSTRACT

Popular media now often present 3D printing as a widely employed technology for the production of dental prostheses. This article aims to show, based on factual information, to what extent 3D printing can be used in dental laboratories and dental practices at present. It attempts to present a rational evaluation of todays´ applications of 3D printing technology in the context of dental restorations. In addition, the article discusses future perspectives and examines the ongoing viability of traditional dental laboratory services and manufacturing processes. It also shows which expertise is needed for the digital additive manufacturing of dental restorations.

Keywords: 3D-Printing; Prosthetic dentistry; Dental prostheses.

INTRODUCTION

A proportional change was brought about in biomedical disciplines as a result of the development of fast prototyping in the 1980s, which allowed for the construction of models from a computed file. [1] As a result of these improvements, surgery planning, treatment, and the production of dental prostheses all benefit greatly from having access to a vital instrument. It can be challenging to build three-dimensional (3D) objects with complex geometries using traditional methods, but this technology makes it easier to do so. This is made possible by the use of additive manufacturing. [2] It is primarily an expression of additive or subtractive technology, in which the information of an object is obtained in all of its layers through various digital slicing, and then the information is physically reproduced by layers through an automated process using the information that was obtained. [3,4]

3D PRINTING IN PROSTHETIC DENTISTRY

Since its inception in 1987 by Francois

Duret and Chuck Hull, the technology has undergone tremendous advancement in recent years, enabling designers and printers to produce very accurate structures. [5,6] Printing accurate fixed dental prostheses, implant prostheses, and complete dentures are now all possible uses for prosthodontics thanks to recent advancements in the field. [3-6]

The technology provides a number of considerable benefits and only a few mild drawbacks. The technology has improved, and now greater focus is being placed on data collecting with accurate 3D details, the simplification of the designing of the prosthesis through the use of software, and the printing of the same with the best possible accuracy. Digital collection of the data received using intraoral scanners helped alleviate some of the problems that were inherent to analog impressions (IS). [6] The IS scanners include a miniature camera, a computer, and software that is embedded within the device. IS scanners have the capability of capturing extremely precise 3D images of the thing being scanned. The most recent generation of scanners deliver the most precise data, and the built-in software makes it easier to tessellate the images that have been acquired. STF files are the most typical format for storing the acquired data. In addition to standard triangle language (STL), stereolithography (SLA), Standard Tessellation Language, and standard triangle program, the acronym STF may also be used in these contexts. The names originate from the steps that are taken during the process. When using the STL procedure, the information regarding an item is always segmented off and saved in the form of triangles. Tessellation refers to the act of linking the surface with geometric shapes in order to prevent overlaps and gaps from occurring. The procedure known as Standard Tessellation Language is reached by stitching together the triangle data. The STL file contains all of the information that is necessary for the 3D modeling process that is necessary for printing. Printing is possible after the STL files have been linked with any of the available 3D slicers. [5-7]

Tessellation is used to encode the surface geometry of the objects that are stored in the STL file, which stores the surface geometry of the objects. Either the American Standard Code for Information Interchange (ASCII) encoding or the binary encoding can be used to store the information that is contained in an STL file. This information includes the coordinates of vertices and the vector unit. [4,7] In most cases, ASCII encoding is utilized for debugging purposes, although binary encoding is utilized when the file size is quite small.

Printing in three dimensions can be done in a variety of formats. The polygon file format is the most prevalent type of OBJ (object) format, and it is the one that holds color and texture files. The STL file does not store any additional information, like color or features that have been added. If you want superior printouts, you should consider using alternative formats. STL files are more appropriate for simple printers. [7]

TECHNOLOGIES USED IN 3D PRINTING IN PROSTHETIC DENTISTRY

One of the following technologies—fused deposition modeling (FDM), stereolithography (SLA), selective laser sintering (SLS), printing with PolyJet, or bioprinters—is typically utilized in the process of producing three-dimensional

prints. The method of printing differs depending on the type of material being used, the level of precision required, and its intended use. The FDM process is used to print thermoplastic polymers such as polylactic acid, polycarbonate, and poly ether ether ketone (PEEK). In order to print one layer on top of the next, the material is melted and then forced through a nozzle. This is the most popular type of printing, and it is also the least expensive. In the past, the FDM printing process was traditionally used to create the basic prototype models. In stereolithography (SLA), photopolymerizing resins are used to print orthodontic aligners, surgical guides, dental models, and crowns. Direct or selective laser printing is used to create metal crowns, FPD, and removable partial denture frames. This printing method sinters metal powders using a laser as the energy source. SLS employs polyamide energy to sinter materials at temperatures about 200 degrees Celsius, whereas dynamic light scattering use higher energy lasers at temperatures of 1600 degrees Celsius. In the process of producing implants, drills, and facial prosthesis, polyjet printing makes use of photopolymers. In order to print hard- and soft-tissue cell scaffolds, bioprinters use photopolymerizing materials that simulate cells. Some examples of these materials include chitosan, agar, and alginate. The clinical requirements will determine both the type of material used and the printer that will be utilized. [8-10]

SUMMARY AND LIMITATION

In recent times, there has been an explosion in the production of 3D printers for usage in prosthodontics. These printers range from commercial printers and scanners to indigenous printers that have been built. The proliferation of local printers has made the process of comprehension easier and has contributed to the acquisition of less expensive repairs. There are still several restrictions in place regarding the applications, convertibility, and materials that can be utilized for 3D printing. The marketplaces are completely saturated with locally produced printers and scanners. The students come up with original designs for a number of printers and conduct substantial primary study on the subject. It is encouraging to see the progress being made, but additional understanding on its transformation, evaluation of print accuracy, evaluation of material attributes, and expansion of clinical use are all required.

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