Editorial

An overview on 3D printing in prosthodontics

The evolution of rapid prototyping in the 1980s to construct models from a computed file brought in a proportional change in biomedical disciplines.[1] The advancements have developed into an essential tool in surgical planning, treatment, and fabrication of dental prosthesis. The technology aids in the construction of three-dimensional (3D) structures with complex geometries with ease that can be difficult to fabricate by other methods.[2] It is majorly an expression of additive or subtractive technology where the information of an object is obtained in all layers through various digital slicing and physically reproduced by layers through an automated process from the information obtained.[3,4]

In recent years, the technology has advanced rapidly to design and print accurate structures from its invention by Francois Duret and Chuck Hull in 1987.[5,6] The prosthodontic applications have widened to print accurate fixed dental prosthesis, implant prosthesis, and complete dentures.[3-6] The technology has significant advantages and moderate limitations. The technology has advanced and more concentrations are on data acquisition with accurate 3D details, simplified designing of the prosthesis with software and printing same with the highest accuracy.

The limitations of analog impression were reduced with digital acquisition of the data obtained through intraoral scanners (IS).[6] The IS scanners consist of a mini camera, integrated software, and a computer. The IS scanners capture the 3D images of the object at the highest accuracy. The present generation scanners provide the most accurate data, and the integrated software aids in tessellation of the captured images. The data obtained are commonly stored as STF file. The abbreviation STF is also used for standard triangle language (STL),stereolithography (SLA), Standard Tessellation Language, or standard triangle program. The names are derived from the process involved. The information of an object is always broken down and stored as triangles giving process of STL. The tessellation is the process of linking the surface with geometric shapes to avoid overlaps and gaps. Stitching the triangle files leads to the process of Standard Tessellation Language. The STL file has all information required for 3D modeling process that is required for printing. When the STL files are linked with any 3D slicers it allows for printing.[5-7]

The STL file stores the surface geometry of the objects and this information is encoded by the process of tessellation. STL file holds information as coordinate of vertices and vector unit in the American Standard Code for Information Interchange (ASCII) encoding or in the binary encoding.[4,7] Mostly, Binary coding is used if the file size is small and ASCII encoding is followed in debugging situations.

Many formats are available for 3D printing. The most common OBJ (object) format that that stores color and texture files is polygon file format. The STL file does not store special information on color and added details. It is advisable to use other formats for better printouts. STL files are more advisable for simple prints.[7]

Three-dimensional printings are commonly done with one of the following technologies – fused deposition modeling (FDM), SLA, selective laser sintering (SLS), PolyJet printing, and bioprinter. The printing procedure varies with choice of material, need of accuracy, and its use. Thermoplastic polymers such as polylactic acid, polycarbonate, and poly ether ether ketone (PEEK) are printed by FDM procedure. The material is melted and extruded through a nozzle to print layer by layer. This is the most common and inexpensive printing method. Conventionally, the simple prototype models were printed using FDM technique. SLA uses photopolymerizing resins to print surgical guides, aligners, dental models, and crowns. Metal crowns, FPD, and removable partial denture frames works are printed through selective laser or direct laser printing which sinters metal powders through laser energy source. SLS sinter materials around 200°C using polyamide energy, whereas dynamic light scattering uses higher energy lasers at temperatures around 1600°C. PolyJet printing uses photopolymers to print implants, drills, and facial prosthesis. Bioprinters use photopolymerizing materials simulating cells such as chitosan, agar, and alginate to print hard- and soft-tissue cell scaffolds. The choice of material and type of printer is chosen in accordance with clinical needs.[4-8]

Recent days, 3D printers have been extensively manufactured for prosthodontic use – from commercial printers,scanner to indigenous printers have been developed. The rise of indigenous printers has simplified the understanding and aids in obtaining more inexpensive restorations. The limitations still persist on the application, convertibility, and the materials used for 3D print. The markets are engulfed by indigenous scanner and printers. Many printers are designed by the students and extensive primary research is done on the same. It is promising to see the advancements, but it requires more elaborate knowledge on its transformation, evaluation of print accuracy, evaluation of material properties, and broader clinical use.[8-10]

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