

## Review Article

### Glimpse of 3D Printing in Dentistry: A Review

<sup>1</sup>Dr. Chitradeep Chakraborty, <sup>2</sup>Dr. Gunna Madhuri, <sup>3</sup>Dr. Niharika Sharma, <sup>4</sup>Dr. Smita Ranjan, <sup>5</sup>Dr. Sharda Ade, <sup>6</sup>Dr. Deepak Pusa

<sup>1</sup>Postgraduate student, Department of Oral and Maxillofacial Pathology and Microbiology, Dr. R Ahmed Dental College and Hospital, Kolkata, West Bengal;

<sup>2</sup>Postgraduate student, Department of Pediatric and Preventive Dentistry King George's Medical University, Faculty of Dental Sciences, Lucknow, Uttar Pradesh;

<sup>3</sup>Postgraduate student, Department of Pediatric and Preventive Dentistry Kothiwal Dental College and Research Centre, Moradabad, Uttar Pradesh;

<sup>4,5</sup>Postgraduate student, Department of Conservative Dentistry and Endodontics, Vyas Dental College and Hospital, Jodhpur, Rajasthan;

<sup>6</sup>Postgraduate student, Department of Oral & Maxillofacial Surgery, Panineeya Institute of Dental Sciences, Hyderabad, Telangana

#### **ABSTRACT:**

Three-dimensional (3D) printing is an additive manufacturing method in which a 3D item is formed by laying down successive layers of material. 3D printers are machines that produce representations of objects either planned with a CAD program or scanned with a 3D scanner. The implications of 3D printing in dentistry include orthognathic surgeries, surgical templates for implants, micro guided endodontics, drilling and cutting guides, digital orthodontics, crowns, bridges, pre-operative treatment planning, fabrication of splints and restorations. This article reviews the recent advances in the applications of 3D printing in dentistry.

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**Corresponding author:** Dr. Chitradeep Chakraborty, Postgraduate student, Department of Oral and Maxillofacial Pathology and Microbiology, Dr. R Ahmed Dental College and Hospital, Kolkata, West Bengal.

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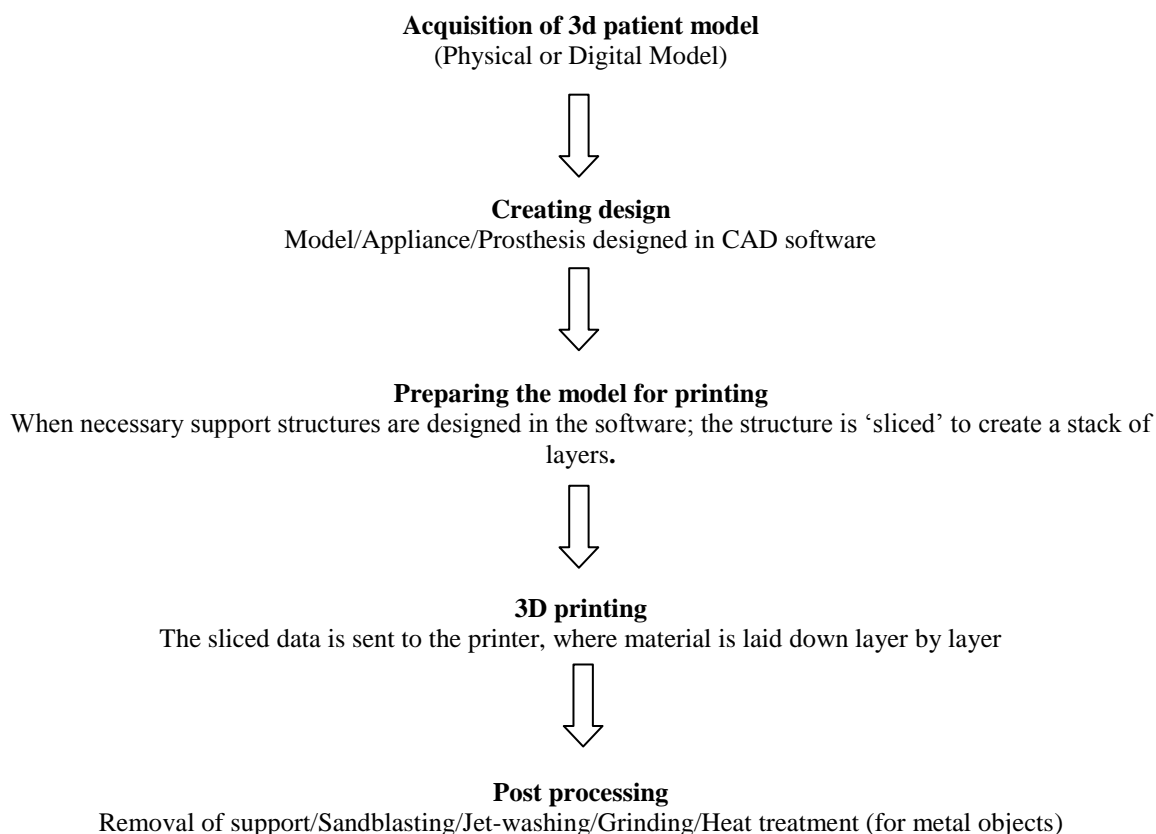
#### **INTRODUCTION**

3D printing generally describes a manufacturing process that creates an object by building one layer at a time adding multiple layers which results in the formation of an object. 3D printing can be precisely described as Additive manufacturing or Rapid prototyping.<sup>1</sup>

With the help of 3D Imaging and CAD/CAM Technology 3D printing is in the forefront position hugely impacting on all aspects. It enables to create a complex geometrical form using a variety of materials from digital data in specific patients. In prosthetic treatments, computerized scanning systems and 3D

printing systems have come largely to replace traditional techniques for producing prosthetic works.<sup>2,3</sup> The applications used in the development of 3D printed parts use mostly technology for manufacturing various mechanical parts, and special computer programs that contain libraries of objects are needed to achieve design pieces.<sup>4</sup> Dental work patterns can be imported by scanning various prosthetic fields or using computerized imaging results (cone beam computed tomography). Dentistry is familiar with the CAD/CAM technique.<sup>5</sup> The new techniques of making prosthetic restorations largely eliminate the help given by dental laboratories.

## 3D PRINTING PROCESS<sup>1</sup>



### VARIOUS APPLICATION OF 3D PRINTING IN DENTISTRY

#### APPLICATION IN PROSTHETIC DENTISTRY

Crowns, fixed partial dentures, copings and implant abutments can be printed precisely using 3D printing technology. The major advantage of 3d printing is lesser post processing procedures.<sup>1</sup> Hussein et al. (2014)<sup>6</sup> states that manufacturing RPD framework using rapid prototyping is a simple, fast, precise method and a successful alternative to the conventional technique of fabrication. As dental prosthesis demands customization and have complex geometries, SLM /SLS techniques can be preferred. The procedure is mainly of 3 steps: 3D scanning and processing of the dental cast, planning the design of the denture framework using 3D software and fabrication of the framework using SLS/SLM.<sup>7</sup>

3D printing also plays an imperative role in the fabrication of dental implants as precision of the implant structure plays an indispensable role in the success of the prosthesis. Implants with complex geometries can be fabricated using 3D printing technology which is an advantage over the milling system.<sup>8</sup> 3D printed models also help in fabrication of customized surgical guides that help in implant placement. 3D models can also be utilized for treatment planning and selection of the required materials for the procedure, e.g., in the case of ridge augmentation, the 3D model enables the operator to

visualize the defect, measure it and consequently select the type of implant and material.<sup>7</sup>

#### 3D PRINTING IN ENDODONTICS

The use of 3D printing and digital technology have significantly increased the rate of success and also improved the quality and precision of dental operative work. 3D printing can be utilized for tooth fillings which will reduce the treatment costs in comparison to CAD-CAM (Computer Aided Design/Computer Aided manufacturing) restoratives and decrease the technique sensitivity of placement of the restorative material. It can be used to restore a complex cavity involving multiple surfaces that cannot be restored directly.<sup>9</sup>

3D cell printing technique can be utilized for replacing pulp tissue. The structure of the pulp tissue can be recreated by using an ink jet device by dispensing layers of cells that are suspended in hydrogel. This helps in precisely positioning the cells and this mimics the natural pulp tissue of the tooth. This is achieved by systematic positioning of cells that includes positioning of the odontoblastic cells at the periphery and fibroblasts within the core with a supportive network of vascular and neural cells. Research is focusing on in vivo creating a functional tissue like pulp.<sup>10</sup>

3D printed templates can be utilized to gain guided access to root canals and various in vitro research studies proved that accurate access cavity preparation

upto apical third of the root could be obtained through 3D template guided Endodontic procedures(13). This would be useful to clinicians while facing challenging canal morphologies. 3D guided access stent which is digitally designed to fit each tooth could pave the way to minimally invasive endodontic access and minimize the chances of iatrogenic errors.<sup>13</sup>

#### **APPLICATION IN ORTHODONTICS**

Invisalign System realigns the patient teeth digitally to make a series of 3D printed models for construction of aligners, where the patient will be receiving a new set of aligners every 2 weeks and reposition the teeth over a period of time. This technology will be time saving, patient data set can be digitally saved, printed when needed and minimises the physical storage requirement. With the help of CAD/CAM technology two separate processes of bracket production and bracket positioning are fused into single unit. In this method the need for maximum individuality with reduced space requirements is put into practise.<sup>12</sup>

#### **APPLICATION IN PERIODONTOLOGY**

Uses of 3D technology in periodontology comprises bio-resorbable scaffold for periodontal repair and regeneration, bone and sinus augmentations procedures, socket preservation, guided implant placement, peri-implant maintenance, and implant education.

3D-printed scaffolds show acceptable outcome for bone and tissue regeneration as well as sinus and bone augmentation. Implant placement using 3D printing surgical template increases the accuracy, reduces variation in position, incidence of complications, surgical time, postoperative pain, and swelling. 3D-printed models have a promising role as an education tool.<sup>13</sup>

#### **APPLICATION IN ORAL AND MAXILLOFACIAL SURGERY**

Anatomical models made using rapid prototyping methods are a novel approach to surgical planning and simulation. Such methods allow the replication of anatomical items, including three-dimensional physical models of the skull or other structures that allow the surgeon to obtain an overview of complex structures before surgery. The migration from a visual environment to one that allows both visual and touch interactions introduces a new code called “touch to comprehend”<sup>14</sup>

#### **APPLICATION IN PEDIATRIC DENTISTRY**

Kids and teens with gag reflexes and special needs can especially find difficult for making impressions for crowns, fillings and other dental restoration. Scanning and 3D printing treatment not only faster but friendly and more comfortable.<sup>15</sup>

The use of 3D printing in pediatric dentistry, initially, an ideal mixed dentition cast was poured of a standard dye, for a trial design of 3D printed SM by digital

scanning and designing. The cast was scanned using a 3D digital dental scanner followed by the designing of the band and loop similar to the conventional SM, on the Dental CAD 2.2 Valletta. Two types of SMs were printed: (i) using titanium based powdered metal material by Micro Laser Sintering Technology which offers all benefits of an additive manufacturing process and (ii) using a clear photopolymer resin by Formlabs.<sup>16</sup>

#### **ADVANTAGE OF 3D PRINTING<sup>17</sup>**

1. Time saving
2. Accurate details and reproduction of scan providing good quality of work and consistent results
3. It is possible to print complex geometric shapes and interlocking parts that require no assembly
4. Reduction of production-related material loss
5. It is possible to produce single objects, in small quantities, at low cost and fast delivery

#### **DISADVANTAGE OF 3D PRINTING<sup>1,17</sup>**

1. Cost and availability material
2. Required individual training
3. Finishing of final product is time consuming and requires skill
4. Likely the largest limitation of 3D printing is the final part quality. Due to the way each successive layer is deposited on top of the last in typical 3D printing methods, an inherent weakness is literally built into the design.
5. Depending on the material, it may still need additional treatment to reach full strength.

#### **CONCLUSION**

The introduction of digital dentistry has not only made procedures less time consuming, but also simplified the approach to providing a better quality of treatment to the patients. 3D printing has revolutionized dentistry, proving beneficial in surgical and restorative dentistry; and continues to expand its applications in research and dental education. The key to its success lies in the fact that various materials such as metal, resin, plastic etc. can be used in this technique; thereby, enabling its usage in most fields of dentistry.

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