

Endodontic Applications of 3 D Printing

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Abstract

3D Printing is a method of additive production supply that includes computing layer next layer to optimal form a target. It is helpful in managed endodontic and accurate cavity preparations. Also, can be practiced for dental pulp recovery by following pulp tissue. Since 3D printing is dependent in an additive manner, it reduces wastage that is usually connected with subtractive methods identified as milling. It performs for significant time conserving as well as is one of the largest free digital media. Moreover, it can be readily used in various situations proceeding for easy applicability as well as versatility to produce multiple images.

Introduction

In this paper, discussed the relationship between 3D technology and the application in the field. Also, mentioned the advantages of 3d printing technolog. 3D printing is extensively used nowadays in organ printing and is particularly suited for manufacture when it comes to complex structures with resources that are extensively utilized in dentistry as well as surgery [1].

Literature Review

3D-printing provides a greater customization level. It can be automated, as well as can simply have objects given via network records. Each system has its benefits, though, everyone has its ruins. Subtractive fabrication creates additional loss, is restricted from performing some geometry, as well as needs an experienced hand to manage the tools [2]. 3D-printing can perform a protection danger for its elements of scraps into the atmosphere, moving delayed at manufacturing parts, plus the idea of a part moving quickly received plus settled within a network file. In this study, the various new courses in 3D-printed microfluidic methods are presented [3]. Additionally, a center is provided to the invention features of those things, with the ESI including specific directions for creating a mixture of buildings including a microfluidic course, threads to provide practical fluidic connections, a stream splitter; a model for PDMS course casting; as well as how to merge various devices into a separate tool. The benefits, as well as weaknesses of 3D-printed microfluidic materials, are completely addressed, as are any likely areas for the course [4]. This article examines as well as presents the possible forms of 3D printed designs plus models as well as haptic simulators in the education plus control of endodontic systems. Knowledge of the relevant technology compared to the creation of 3D printed things including the development of the haptic simulator is too performed.

What is 3D Printing and What Has Been This Technology's Historical Relationship and Applications in the Field of Medicine and Dentistry?

3D printing also known as 3DP is a process of additive manufacturing simply because the procedure involves adding layer after layer to ultimately form an object. 3D Printing involves bonding and joining small elements to create solid 3D objects from a digital file using a 3D printer. Developed first in the 1980s, the technology has widespread applications today in the medical field especially dentistry, ranging from medical modelling, prosthodontics, orthodontics and implantology. It is the leading technology being used in the field of digital dentistry today. It is thanks to the development of computer technology that we have seen rapid development and use of latest 3DP technology [5]. The CAD software enables creation of objects, while there is easy availability of volumetric data such as the computed tomography data (CT) data and cone beam computed tomography data.

Modern and affordable technologies such as CT scan and imaging have also helped in the growth of its widespread use. For the application of these technologies, dentistry relies on a technology called milling which involves removing of materials to create an object. While earlier, the formative and subtractive processes were used, the additive modelling technique has gained good traction owing to ease of use, cost effectiveness, better printing quality and reliability. Regenerative medicine, tissue reengineering, and research are the fields where 3D printing methods are finding extensive use [6].

Today's dentistry uses objects used in CAD and does away with the need to work with metal casting alloys. It allows the dentist to use materials that were otherwise too difficult to work with which

in turn removes the labour-intensive work. This enables the dentist to be more creative in the layering process. 3D printing is widely used today in organ printing and is especially suited for fabrication when it comes to complex structures with materials that are widely used in dentistry and surgery. It can be used to create cells and other bio materials and construct a tissue like structure. Another useful application of this technology can be in the creation of customized, multi-ingredient tablets that have been manufacture by adding complex multilayers [7].

What Steps the 3D Printing Technique Involve?

3DP is a three-pronged procedure involving procurement of data, processing and actual fabrication using additives. First, images are obtained from the CT scans based which the object would be modelled. After this the 3D printer starts doing its job to model the object, moving its servo motors along the x, y and z axis. Other details such as the color, texture and thickness are to be fed. Materials such as ABS plastic, polylactic acid, epoxy resins, glassfilled polyamide, etc. are used in the process [8].

Major 3 DP Technologies

Power Binder is a process involving spraying water from an inkjet printer onto a powder bed to create the object. It's easy and cost effective but disappoints on resolution. Photopolymer, Stereo lithography and digital light processing are based on light cure resin. These processes are expensive but produce output pretty fast and of high quality [9]. Other technologies include selective laser sintering melt sinter powder to a point below melting and then project laser to fabricate the object. This process is perhaps the most expensive due to its high capex and maintenance costs and poses some health risks as well.

What are the Applications of 3DP in Endodontics?

3D printing can be used for creating tooth fillings and fabricating tooth restorations at an affordable cost in place of Computer Aided Design (CAD) or Computer Aided Manufacturing (CAM). A 3D tooth model is reconstructed and then planted onto the cavity using a proper adhesive material. 3D printing is also useful in guided endodontics which involves a guided access to root canals and accurate cavity preparations. A digitally designed stent which conveniently fits each tooth could herald the beginning of an endodontic access that's not too invasive. Printed 3D templates also have a strong use in guided implant surgery. Here, one doesn't have to depend entirely on the physician's skill and accuracy but can rely on guides. It minimizes the chances of errors and allows more precision and accuracy [10]. Creating 3D scaffolds would help in repairing defects caused by accidents or surgery. The scaffolds would act as a perfect replacement for soft tissues as they are comparable in terms of elasticity achieved through high density constructs. 3D Printing could also be used for dental pulp regeneration by replacing pulp tissue. The tissue is created through layers of cells which are suspended in hydrogel and then sprayed upon using an inkjet device. By dispensing the cells, an ideal positioning of the cells is obtained, with odontoblastic cells at the fringes and fibroblasts cells situated at the core. It is a composition that mimics the pulp tissue of the actual tooth. 3D printing could also be used in teeth auto transplantation. The image of the teeth to be extracted can be scanned and the new tooth can be modelled on the scanned image and altered accordingly before being placed in

the extraction socket [11]. Apart from medical uses, 3D printing in endodontics could also be extended in the field of preclinical training, by simulating real world environment. Here students can easily operate on a modelled tooth instead of an actual extracted tooth for improving their skills and learning. With 3D printing, a large number of similar prototypes can easily be created and used in pre-clinical research [12]. Resin teeth and other teeth prototypes can be used to conduct experiments and other simulation exercises. Any number of tooth copies could be printed and used for study purposes. This is especially convenient in times where actual extracted teeth are limited in terms of availability. The 3D printed teeth are modelled as close to real for conditions like root defects, pulp stones and other problems in order for students to accurately visualize the situation and operate on them and ultimately gain more knowledge in the field of endodontics.

What are the Advantages and Disadvantages of 3D Printing?

Since 3D printing is based on an additive process, it substantially reduces wastage that is commonly associated with subtractive processes known as milling. It makes for considerable time saving and is probably one of the best available digital tools. Also, it can be easily applied in many situations making for easy applicability and versatility to create multiple models [13]. There are however certain disadvantages associated with it as well. One of them is high costs of conducting things. Secondly the work requires exceptionally trained hands to perform them, which may be not be easy to find all the time.

Owing to the layered process, it may also sometimes become difficult to obtain support materials to complete the process [14]. All in all it can be said that more research is needed in the fields as it can lead to more breakthroughs and invention of ways in which things could be done in a more cost effective manner. 3D printing could be made a part of curriculum in all endodontic courses to allow knowledge to grow. So far it has done an outstanding job in enhancing the efficacy of treatments. More research would take digital dentistry to break new ground and provide good patient care [15,16].

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