

Customized Handle for Toothbrush by Using 3D Printer

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Abstract

Three-dimensional (3D) printing technology and digital dentistry have been significantly impacting dental and laboratory procedures, providing custom-made products, ease of use, time efficiency and accuracy. This article describes a new method of implementing 3D printing technology in order to fabricate customized toothbrush handle by using Poly Lactic Acid (PLA) material and 3D printers. This modification of toothbrush handle aims to improve tooth brushing ability and effectiveness in children, patients with restricted hand and fingers movements, special needs and the elderly, with the purpose of maintaining their oral health.

Keywords: Customized handle, Poly Lactic Acid Three-Dimensional, Toothbrush handle.

Introduction

Toothbrush handle design and length play major role in providing patients with comfort and ease of control they

need for effective brushing. Both the toothbrush handle design and length have been recently studied, documented and proven to improve brushing effectiveness and quality. This is particularly true with toothbrushes for children under 8 years old, whose dexterity may not be sufficiently developed [1,2], and for patients with history of stroke ischemic hemiparesis who have problems in grasping, manipulating or controlling toothbrushes [3].

Various modifications have been used to modify toothbrush handles for patients with poor fine motor skills and restricted hand and finger movements, cerebral palsy, and the elderly [4,5]. Some of these modifications on manual toothbrush handles are: larger sized handles, handles with an elastic cuff, handles that resemble those of a bicycle, tennis ball handles, handles with attached strap, and customized handles [6,7].

Three-dimensional (3D) printing has been an area of digital technology growth [8]. 3D or rapid prototyping has

been used in different fields of dentistry, including surgical planning [8], making fixed and removable dental prosthodontics [9,10], orthodontics [11], and implant dentistry [12]. Advances in this technology will have a significant impact on dentistry. Affordable desktop 3D printers along with user friendly 3D software provide opportunities for the use of polymer-based 3D-printed materials across all aspects of dentistry [8,13]. The greatest advantage that 3D printers provide in medical applications is the freedom to produce custom-made medical products and equipment [14].

This report introduces a new method of toothbrush handle modification. This modification includes 3D printed customized toothbrush handle by using PLA material.

Technique

A method for fabricating a customized handle for toothbrush:

1-Select a suitable toothbrush that fits comfortably in patient's hand with consideration in mind for the extra thickness required for PLA material. Toothbrush should be straight-handled for simple toothbrush insertion and removal from customized handle.

2-Lubricate handle with Vaseline to prevent impression material from sticking to toothbrush handle, use Poly Siloxane putty impression material (Zhermack, Badia Polesine, Italy) to cover the handle and instruct patient to hold toothbrush in their hand as if they are preparing to brush their teeth and gently squeeze the Poly Siloxane material to mold it and record their finger positions, in order to obtain a mold of the patient's grip. As shown in figure 1 impression was taken for a seven-year old child. (Fig.1)

3-Instruct the patient to hold that position for 3 minutes until the material sets.

4-Use the three dimensional scanner (CS ULTRA PRO SCAN, CAD star, Munich, Germany) to record two digital

impressions. One digital impression is done for the entire toothbrush/impression complex and the second is on the toothbrush itself.

5-Process both impressions using Exocad software (Exocad 2018, Germany), to create an electronic copy of the customized handle. (Fig.2)

6-Print the customized handle with a three dimensional printer (Dedibot DF3 3D Printer; Hangzhou DediBot Intelligent Technology Co., Ltd, Hangzhou, China) and Poly Lactic Acid material (Zhejiang Flashforge 3D Technology Co., Ltd.; Zhejiang, China). This will result in a customized handle that precisely fits into patients grip and has a hollow to insert a toothbrush.

7-Insert the toothbrush into the toothbrush handle. (Fig.3)

Discussion

A technique for fabricating customized toothbrush handle for children, elderly and patients with restricted hand and fingers movements. Using customized handle makes it more comfortable, more effective and easier for patients to brush their teeth.

Several studies have shown significant improvements in the patient's ability to control and better manipulate toothbrush which in turns leads to better brushing and dental plaque control. In Pasiga study [15], determined the effect of using a special grip of toothbrush for dental plaque reduction in the elderly with full dental prosthesis. The result of the study, there was higher plaque reduction in the special grip group, indicating that the special toothbrush grip can improve elderly's ability to control toothbrush which lead to better plaque reduction.

Other study has proven the effectiveness of customized handle by monitoring the difference in oral health evaluations before and after using toothbrush with customized handle in patients with stroke ischemic. It has also been proven that using this kind of special handle in

patients with stroke ischemic helps in keep their teeth clean [3].

An alternative to customized 3D printed toothbrush handle is handle fabricated by using heat-polymerized acrylic resin to increase the volume of toothbrush holder, it can be made after obtaining a silicone mold. Although acrylic resins are low cost, but processing time is long, and laboratory procedures are complicated [16], or it can be made with a clay material that has low cost but it has to be replaced with every tooth brush [15], or it also can be made with light-polymerized composite material, which is simple and process time required is short. However, drawbacks for this technique is high cost of the light polymerizing box [4].

In this article 3D printer was used to produce customized toothbrush handle made from PLA material. This technique has multiple advantages:

- The main advantages to use 3D printing are the freedom to produce custom-made medical products and equipment [14], accuracy of the process, speed, efficiency, affordability, accessibility, reproducibility and possibility to make more than one handle at the same time [17].
- The ability to store all impressions on the computer, reducing the need for a large storage place, and since a digital record of the handle is kept, making it very simple to print a new handle in case of the original is lost or damaged. A new handle can be made without taking a new impression [18].
- Production cost is low.
- Users are able to keep the handle and replace the brush when needed.
- PLA is a biodegradable polymer with good strength, biodegradability is the most outstanding property, since it is highly needed in production of newer components through 3D printing. It also has good mechanical

properties as the ability to tolerate elongation under tension or compression [19], and it is available in multiple colors.

Summary

Customized handle is made by creating a mold of a patient's grip with rubbery material, then taking a digital impression of the mold by using a scanner and sending it to computer software, which will then be converted into a three-dimensional electronic analog. Electronic analog will be printed with 3D printer and PLA compound resulting in customized handle identical to the patient's grip impression.

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Legend Figures



Figure 1: Taking patient's grip impression by using Poly Siloxane material.

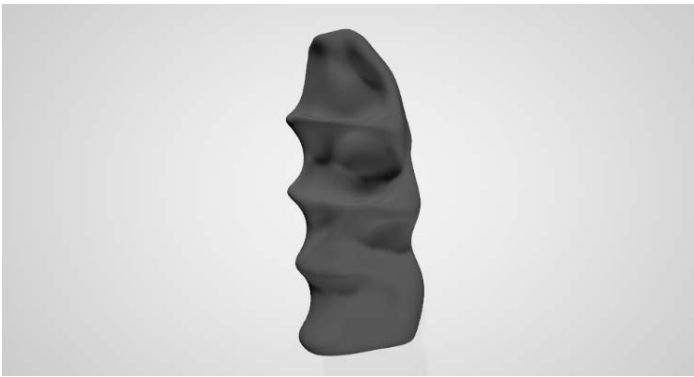


Figure 2a: Frontal view of electronic copy of the customized handle.

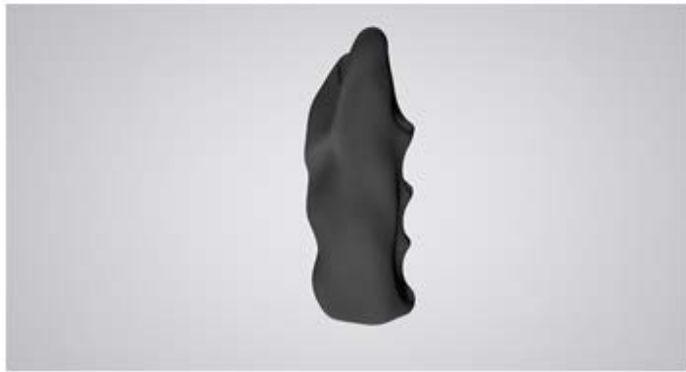


Figure 2b: Back view of electronic copy of the customized handle.

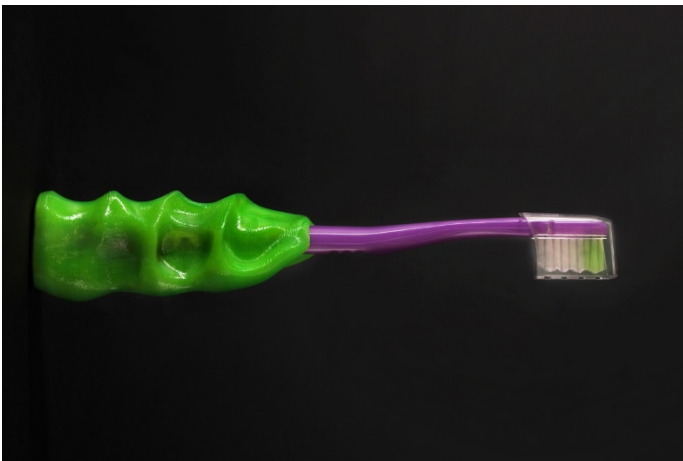


Figure 3: Toothbrush in PLA customized handle.