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STUDIES AND RESEARCH REGARDING THE CREATION OF A DENTAL MODEL, THROUGH RAPID PROTOTYPING TECHNOLOGIES

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ABSTRACT

The paper presents the creation of a dental bridge through two rapid prototyping technologies, SLA and FDM. The dental bridge model was made in a dental laboratory, being used later for 3D printing, through rapid prototyping, using the two technologies, FDM and SLA.

KEYWORDS: rapid prototyping, dental model, ceramic masses

1. Introduction

Rapid prototyping technologies can be used in: biomedicine and nanotechnology, supporting and developing the contribution of regenerative medicine. Engineering and medicine come together to improve the patients' life or even save their life.

Engineering has evolved a lot, through the application of top technologies, which help to easily create parts with increasingly complex geometries. In recent years, 3D printing technology has more and more applications in the medical field and is continuously developing. The 3D models made are widely used for various complex pathological studies, as well as in education.

Thanks to the advances in biomaterials used in 3D printing, and the research carried out, the range of applications of 3D printing has increased, in the manufacture of implants, prostheses, 3D scaffolds in tissue engineering, and regenerative medicine [1, 2].

2. Generalities, regarding the creation of models through rapid prototyping

The creation of the models includes the stage of creating the model with the help of a CAD software. In rapid prototyping technology, the STL format has been adopted. A three-dimensional scanner can also be used to digitize the object, but this method implies the existence of a previously created model.

Intraoral rapid scanning is used in the dental field. This procedure aims to produce images (3000 images/second). The configuration of the patient's teeth and jaw is rendered in 3D with very high accuracy.

The next stage is the modification of the CAD folder in STL format, which illustrates a three-dimensional surface of flat triangles. This file contains the coordinates of the vertices and the direction of the outward-facing normal of all triangles. Because STL files use planar elements, they will not accurately depict curved surfaces. By increasing the number of triangles, the accuracy improves significantly, but this increase in the number of triangles has the disadvantage of increasing the file size (Fig. 1).

For the next stage, a processing software is used, which is specialized, and which supports the construction of the STL (Standard Triangle Language) file in layers. Few programs exist, and most allow the user to modify the size, location, and orientation of the model.

Before processing, the software cuts the STL model after a certain number of layers of different thickness. The respective software can also generate an auxiliary structure, as a support for the piece, during manufacturing.

Next is the construction of the part itself, using a rapid prototyping technology.

The last stage is represented by the final processing (post processing). This includes removing the part from the prototyping machine, and removing the support brackets. Parts made of photosensitive materials must be treated before use [3, 4].

In the dental field, dental restoration materials have acquired a superior quality, being an increasingly used alternative in dental laboratories. Computer-aided design in the dental field is used for restorations or aesthetic work of dental models (Fig. 2).

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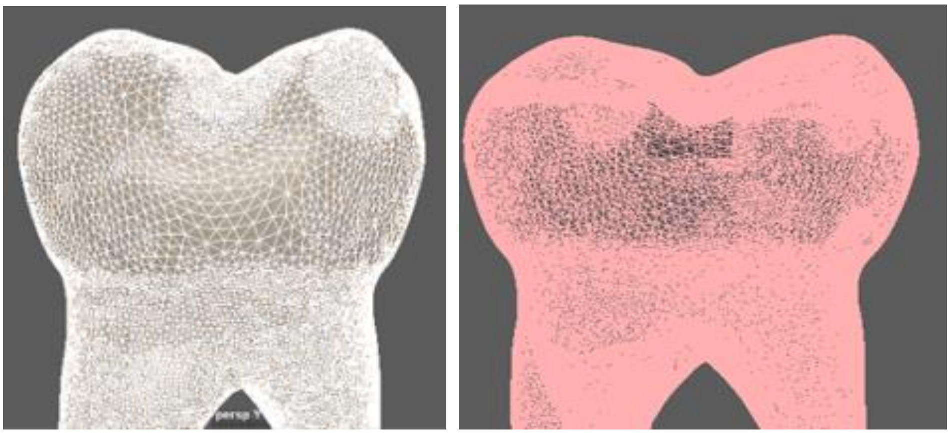

Fig. 1. *Different resolution files: left - fine resolution dental model; right - dental model with custom resolution*

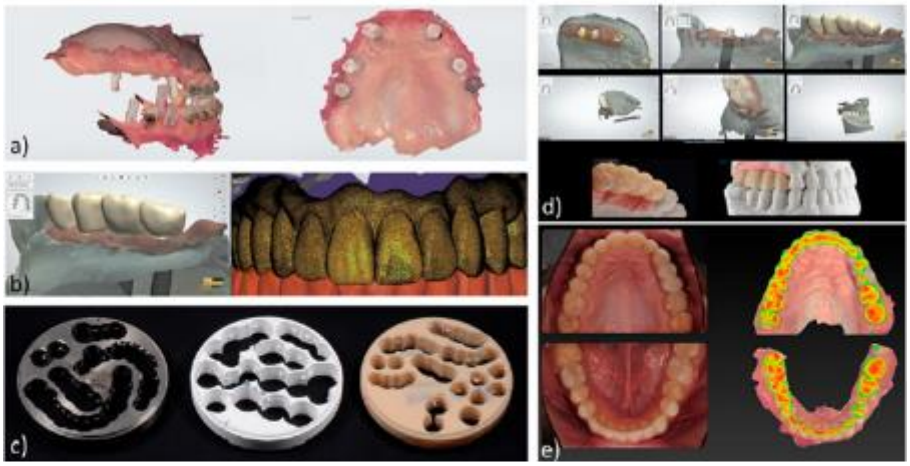

Fig. 2. *Representation of the steps of temporary restoration of dental models, made with the help of computer-aided design. a - 3D scan; b - dental prosthesis design; c - materials used (alloy, zirconium, polymer); d - design and final result of dental replicas; e - brief analysis*

3. Obtaining the dental bridge in a dental laboratory

Before making the dental bridge through the prototyping methods, we made the model in a dental laboratory.

The dental models were made in the dental technique laboratory, going through the following stages:

- the impression and the dental wax prosthesis are made by the dentist;
- the final impression renders with maximum precision, both the support area and the suction area. With the help of this final impression, the final model was obtained;
- the formwork follows, which consists of applying a strip of wax around the impression, then follows the preparation of the plaster paste;
- pouring the gypsum paste, and shaping the plinth;
- a pink wax base is made, (Fig. 3) and on this pink wax base, the acrylic teeth will be fixed;
- making the metal-ceramic dental bridge;
- casting and processing of the metal frame (Fig. 4);
- application of ceramic masses and glazing;

Fig. 3. *Dental prosthesis made of dental wax*

Fig. 4. *Dental bridge with metal structure*

Fig. 5. *Dental bridge*

4. Making the dental bridge using FDM and SLA technologies

The dental model made in the dental laboratory was later used to make the dental bridge through prototyping.

The first stage in the creation of the dental bridge, through the FDM prototyping method, was represented by the execution of the part model, with the help of a software. Autodesk Maya (Maya) software was used. With the help of this software, it is possible to create numerous pieces from many fields such as medical, design, architecture, etc. The

Autodesk Maya software has many uses such as, for example, making various 3D parts, animations, simulations, having numerous tools and functions. This 3D modeling software is one of the most popular, due to its performance, being chosen by many designers (Fig. 6).

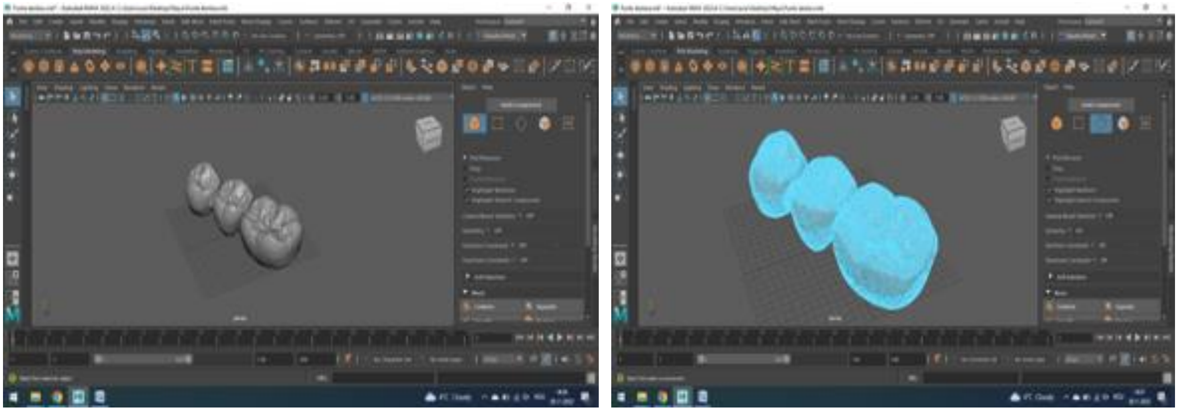

Fig. 6. *Creation of the 3D model of the dental bridge, made with the help of Autodesk Maya software*

After the model of the part was made, the next step was to modify the model in STL format [5].

After converting to STL format, the next step was to divide the model into thin transverse layers. To achieve this stage, another software was added, namely the PrusaSlicer software, to transform it into G-code. The transition from the STL format to the G-code, was made, because the printer used, does not recognize the STL format (Fig. 7).

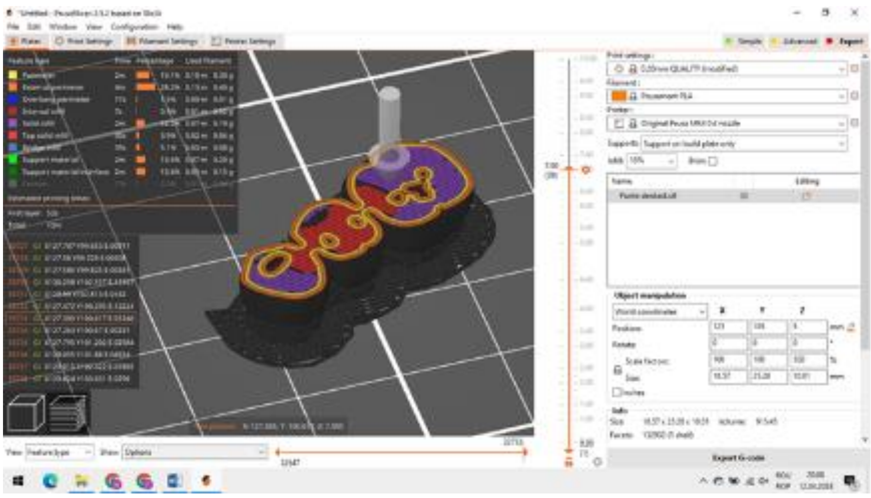

Fig. 7. *Representation of the dental model in layers, using the PrusaSlicer software*

The PrusaSlicer software, in addition to the role of "slicing" the 3D model in layers, also offers us the simulation of the 3D part, that is, the software shows me how it will be printed line by line, from bottom to top, layer by layer. The software also shows where the extrusion of the material will take place, the movements required for the table of the machine, and the extrusion head, and at what speeds they should move relative to each other [6].

The material used is PLA type plastic, and the temperature of making the model is 60 °C. After the 3D printing, the post-processing operation follows, representing the removal of impurities and the finishing of the part (Fig. 8).

The same dental bridge model was also made by SLA (stereolithography) technology. The material used for this technology is photopolymer resin. It was used the CHITUBOX software, as shown in Fig. 9.

The CHITUBOX software "slices" the 3D model into layers, but at the same time, shows how they will be printed, from bottom to top, layer by layer.

After creating the 3D model in the computer, and making the necessary adjustments, the speed and thickness of the layer, the actual printing followed.

Fig. 8. *The final dental bridge model, made of PLA using FDM technology*

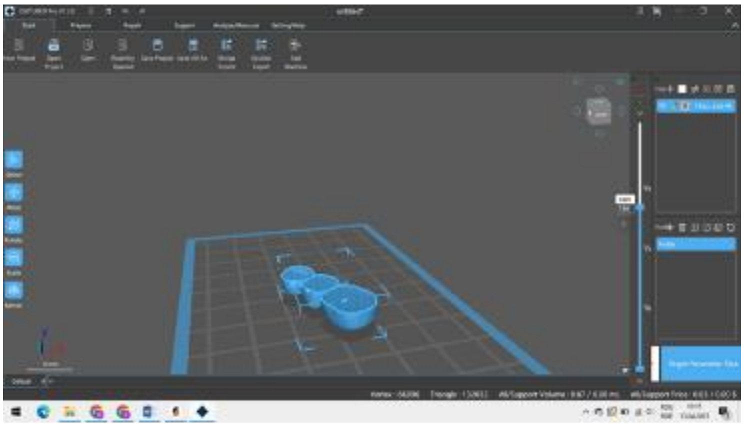

Fig. 9. *Representation of the dental model in layers, using the CHITUBOX software*

Fig. 10. *The final dental bridge model, made of photopolymer resin, using SLA technology*

5. Conclusions

The two models, made by FDM and SLA technologies, were compared, and we reached the following conclusions:

- the piece made with SLA technology has a high level of detail compared to the dental model made with FDM technology;

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- the manufacturing time, for the dental bridge made with the help of SLA technology, was about 2 hours, and with FDM technology about 15 minutes;
- the dental model made with FDM technology is much more resistant than the SLA model;
- from the point of view of the resistance of the model, and the time for its realization, the study recommends the use of FDM technology for the creation of the dental bridge;
- the costs of making the dental bridge, through FDM technology, are lower, which recommends the use of this technology.

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