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Theoretical and practical aspects regarding the role of the working model in the workflow of porcelain fused to metal fixed restorations - Preliminary study

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Abstract

In dental practice, the fidelity of a model is given by the quality and type of material used, the technique by which it is made, and last but not least by the experience and skill of the dental technician. But, the emergence of CAD-CAM technology has led to a major change in the stages of making the working model, through the development of the virtual model. Thus, the purpose of this material is to perform a comparative study between several techniques for obtaining sectional working models, with or without pins, compared to the virtual model obtained by CAD-CAM technique.

Keywords: sectional models, pins, virtual model, porcelain fused to metal technology

INTRODUCTION

Dental medicine, including dental prosthetics, but also dental technology, are constantly being modernized. If technologies, devices and materials have improved more and more, some stages of a prosthetic restoration cannot be replaced.

Specifically, the techniques for making working models, materials from which the models are made, but also their characteristics are details that any dental technician should know in detail, because making the model in general and the working model in particular is an indispensable stage in the technological work-flow of making prosthetic restorations, regardless of their type: fixed or mobile.

OBJECTIVES

The fidelity of a model is given by the quality and type of material used (type 4 and type 5 dental stones, simple and diacrylic composite resins, different types of alloys, refractory investment materials, etc.), the technique by which it is made (sectional model using tray or pin systems), and last but not least by the experience and skill of the dental technician.

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The emergence of CAD-CAM technology has led to a major change in the stages of making the working model, through the development of the virtual model.

Sectional work models, created with tray or pin system, are the most suitable for porcelain fused to metal prosthetic restorations, sectional working models without pins gaining ground in recent years, because they are simple and cheap systems [1-10].

Sectional models are used by dental technicians in fixed prosthetic restorations, because the proximal faces and the marginal preparation can be approached more easily in the modeling stage by the fact that the abutment can be disinserted.

Thus, the purpose of this material is to perform a comparative study between several techniques for obtaining sectional working models with or without pins, compared to the virtual model obtained for the CAD-CAM technology [1-10].

MATERIAL AND METHOD

The ideal model for obtaining fixed metal-ceramic prosthetic restorations is the sectional one, which allow a better analysis of marginal preparation of the tooth, and also obtaining an accurate contact with neighboring teeth. With or without pins, the technology of obtaining sectional models involves specific equipment and technological workflow. For this study two methods of obtaining sectional model were choose, for pinned system and tray system, that are frequently used in practice. An alternative method using a virtual model is also presented in order to assess qualitative and quantitative differences between classic and modern technologies [1-10].

RESULTS

Sectional model using a pinned system (Pindex system)

Pindex system was chosen among the many techniques existing in practice of obtaining sectional models using pins. Is a more efficient method than the classic technique (Dowel pin system) and has a widespread use in practice by dental technicians. While the classic technique requires the insertion of the pins in the impression followed by the cast of the die stone, in the Pindex technique the pins are fixed in the model after the die stone is set.

This technique involves the following steps:

- after washing and disinfecting the impression, a type 4 dental stone paste is prepared and poured into the impression up to the cervical edge of the teeth, exceeding it by a few millimeters (Figure 1. a, b);

a

b

FIGURE 1. *a. Arch impression made with two consistency addition silicone (putty and normal body); b. The model after removing from impression and trimmed*

- after setting of the die stone (approximately 1 hour), the impression is removed, the model is trimmed, resulting in a model with a uniform smooth base and perfectly perpendicular to the insertion axis of the pins;
- before sectioning, for a good accuracy, the places where the model will be cut are marked on the basis of the model;
- the model is placed with the base on the drill stand. The device is provided with a light beam located on the same vertical with the drill for making holes for pins. These holes are drilled perpendicular to the base of the model and will be parallel to each other. The resulting dust will be removed with a brush or air jet (Figure 2, Figure 3);

FIGURE 2. *Making holes for inserting pins. The laser helps to visualize the future seat, for a perfect position when fixing the pin in the base of the model*

FIGURE 3. *Base of the model with holes made for pins*

- on the base of the model, retentions can be created with an acrylate bur, which will allow the abutment a precise fixation in relation to the base. Another method that prevents the rotation of the abutment is the use of double pins for each abutment and sleeves (Figure 4; Figure 5);

FIGURE 4. *Pins inserted in the base of the model. Each pin has a sleeve for easy remove later on*

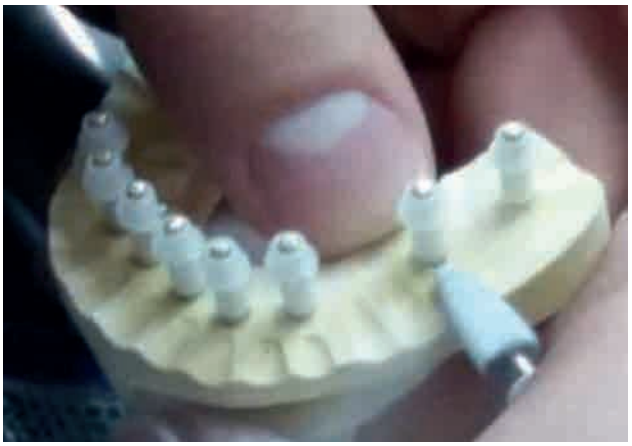


FIGURE 5. *The base of the model is prepared with a bur, indentations are created in order to facilitate the removal of abutments*

- after fixing the pins in places with epoxy resin, they are cover with plastic or metal sleeves;
- the free ends of the pins are joined with a band of wax, in order to favor the easier detachment of the abutments;
- on the base of the model, an insulating solution is applied in order to easily separate the model from the future base;
- the base of the model is pour using a conformer. The conformer is fill with plaster and the model with pins seated inside the conformer (Figure 6);

FIGURE 6. *Creating a new base for the model using a mold and type IV die stone*

- after the set of the plaster, the conformer is removed and the model is separated from the base;
- the model is sectioned following the markings lines made initially, in order to mobilize the abutments (Figure 7, Figure 8);
- with a pencil, the cervical limit of the preparation is marked, and with an acrylate bur a ditch is made, in order to highlight the cervical limit (Figure 9);
- the next step is obtaining the wax pattern.

FIGURE 7. *The model is sectioned using a diamond die-cutting disc*

FIGURE 8. *Sectional model final aspect, occlusal view*

FIGURE 9. *Cervical preparation of abutments*

The main advantage of the Pindex technique is that the holes are made with a laser drilling machine, the pins being placed parallel and fixed more precise than with the classic method.

Sectional models using a tray system (Modelsystem 2000)

The desire to obtain new technologies of obtaining sectional models and the need of facilitate the activity of dental technicians lead to develop of techniques that involves the use of tray systems for the base of the model. Among many tray systems the Modelsystem 2000 from Baumann Dental GMBH was chose for exemplification [10].

The novelty of this system consists in the presence of a plastic plate with metal pins fixed to it. The models have a very good accuracy, all the parts can be easily removed and replaced accurately. At the same time, this optimized design guarantees the ergonomic repositioning of each mobilizable segment.

The components of the Modelsystem 2000 are the following:

- the pin base plate;
- the split cast plate;
- the cuff;
- the press-out plate;
- the lifting device.

The steps of obtaining sectional model using Modelsystem 2000 can be described as follows:

- the impression, after being disinfected and washed, is cut to give it good stability (Figure 10 a, b, c; Figure 11);
- the mid-sagittal line is drawn with a marker both on the impression and on the pin base plate;
- the cuff is attached to the pin base plate;
- an insulating substance is applied to the pin base plate, thus covering the surface of the pins, and left to dry for 1-2 minutes (Figure 12);
- extra hard dental stone mixed using a vacuum-mixer is pour in the impression. A vibrating table is used to help the dental stone to fill all the spaces of the impression;
- the pin base plate is cover with the same plaster until the pines are covered;
- the impression is positioned on the plate, respecting the mid-sagittal line (Figure 13. a, b; Figure 14);
- the excess of dental stone is removed before setting;
- after the setting of the plaster, the impression is removed;
- after removing the cuff, the pin base plate is carefully detached from the model using the lifting device;
- each segment of the model is separated with a disk and prepared for creating the wax pattern (Figure 15 a, b);
- each segment is repositioned on the base plate and thus the model is prepared for the next stage in the technology of making fixed metal-ceramic prosthetic restorations (Figure 16. a, b).

a *b* *c*

FIGURE 10. *Parts of Modelsystem 2000 components: a. the pin base plate, b. the split cast plate, c. the cuff*

FIGURE 11. *Full arch impression made with condensation silicone (putty and light body consistency) and the cuff mounted on the pin base plate and split cast plate*

FIGURE 12. *Insulating the pin base plate to facilitate the removal of abutments*

a

b

FIGURE 13. *a. The class 4 die stone poured in impression and assembled system till it covers the pins; b. the impression placed on the assembled system with the correspondence of the middle line*

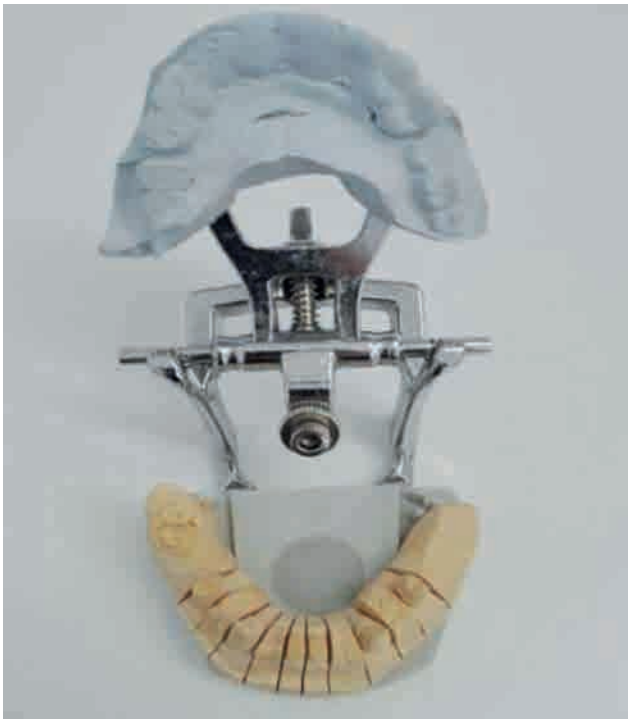
FIGURE 14. *Working model before sectioning of removable parts*

a

b

FIGURE 15. *a, b Sectioning the model based on support abutments of metal-ceramic prosthetic restoration*

a



b

FIGURE 16. *a. Removable parts of sectional model placed on the pin base plate; b. Maxillary and mandibular model mounted in occlusal simulator*

Virtual model

Recently introduced in the technological workflow of obtaining fixed prosthetic restorations, this technology is more expensive than classic alternatives. There are two main methods for obtaining virtual model depending on the type of scanner used.

The firs method involves the use of a dental laboratory scanner. In the first stage the sectional model is obtained following classic technology, with pins or with tray. The obtained model is then scanned in order to obtain the virtual model. In this case the dental laboratory is the one who have to invest in equipment and professional training.

The second method requires the use of an intraoral scanner, the virtual model of working dental arch, of

opposite arch and of occlusal registration is obtained in the dental office. The use of intraoral scanner involves equipment and professional training investment from the dental office.

In this study will be presented the method that use intraoral scanner, an effective method that reduce the working time and the amount of material used without a loss of quality. Images obtained with the intraoral scanner were sent to dental laboratory through internet (Figure 17; Figure 18; Figure 19).

Scans in STL format were loaded in Exocad software in order to create the virtual pattern of prosthetic restorations (Figure 20).

Using Exocad software the teeth are selected, the marginal preparation is established and the type of prosthetic restoration is selected. The software will automatically render the shape of restorations, shape that can be adjusted by dental technician if needed (Figure 21).

DISCUSSIONS

Recently emerging in technology of fixed prosthetic restoration, the virtual model has evolved with the improvement of scanning equipment. The firs type of scanners was limited to scanning preparations made on a single tooth with difficulties in differentiating between hard and soft tissues [11,12].

In order to compensate those limitations, a combined technique was used. Dental impression and model casting was done using classic technology. The model obtained was then scanned using a special dental laboratory scanner, more complex and more accurate than existing intraoral scanners [13,14]. They allow detailed

FIGURE 17. *Maxillary arch scan*

FIGURE 18. *Mandibular arch scan*

FIGURE 19. *The scan of mandibular and maxillary arches in occlusion*

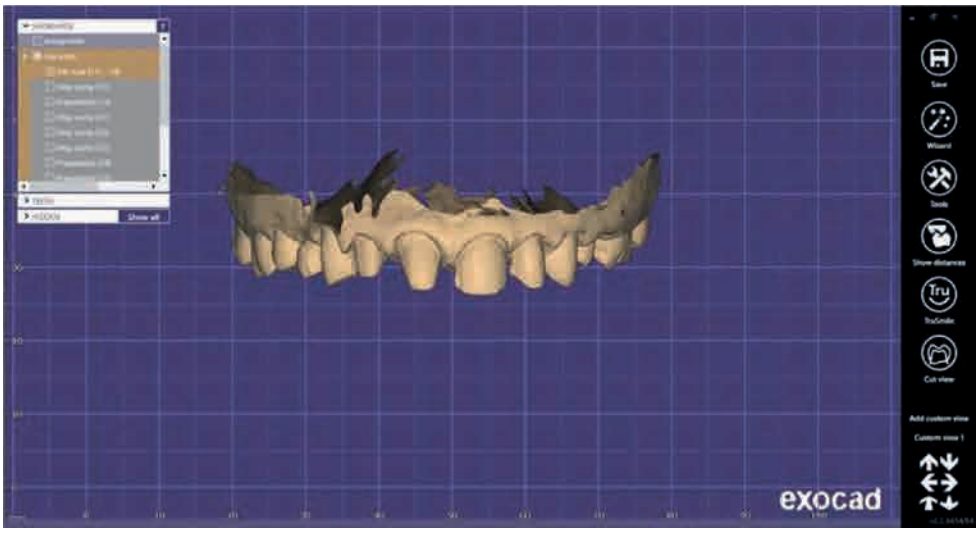


FIGURE 20. *Maxillary arch scan loaded in Exocad software*

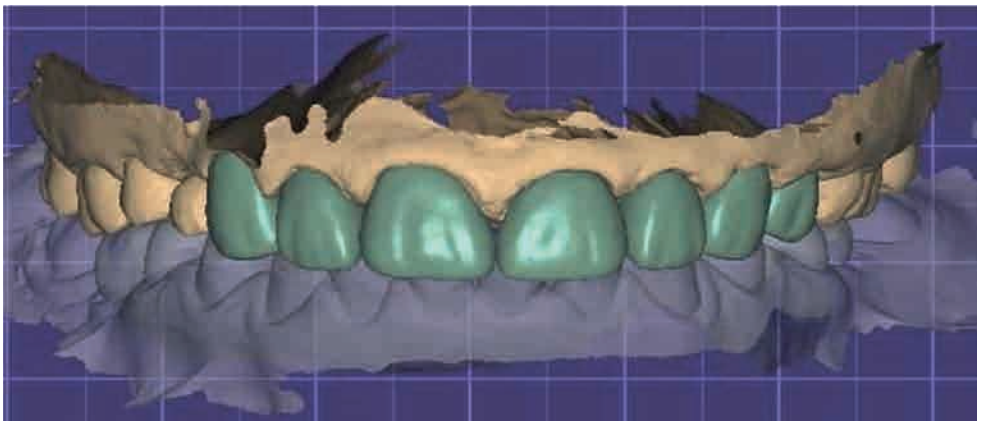


FIGURE 21. *The virtual pattern of prosthetic restoration*

scanning of the prepared teeth, highlighting the marginal preparation. Of course, all this would have been useless if the technology of transposition from the virtual reality to the physical reality of prosthetic restorations by means of milling machines controlled by the computer had not been developed [15,16]. Advanced research has made the prosthetic restorations done in this way to have a higher accuracy by reducing the errors introduced in the technological process by the use of many devices and variables.

Technological development has allowed the obtaining of high-precision intraoral scanner without the errors of the first generation [17-19]. This allowed the technological process to be simplified by eliminating the impression and the physical model without changing the quality of the final prosthetic restoration. The use of this technology has removed the previous limitations, being currently used in fixed prosthodontics, removable prosthodontics, orthodontics, making surgical guides in implantology.

The use of new technologies requires material effort and superior professional training, but the benefits are found in the technological workflow, the time saved by reducing the technological stages, but also the ease of carrying out the maneuvers by the dental technician through the possibility of magnifying of model working area. In this way, a superior control is achieved at the level of marginal preparation, a control that is affected when the models are made using classic technology, because, with the passage of time, occupational disorders appear, and here is about vision impairment of dental technicians [20-22].

CONCLUSIONS

Metal ceramic fixed prosthetic restorations now represents one of the most used restoration methods used by dentists.

For an accurate prosthetic restoration each stage must be realized without mistakes. One of these stages is the obtaining of working model, using the functional impression of dental arch.

The working model can be made using different techniques and materials that, over time, have been gradually and substantially developed, contributing to the evolution of dental technology. But numerous techniques and materials that appeared in time, had a very important purpose, namely to obtain a working model of maximum precision.

However, sectional models using tray system have gained ground in recent years, thanks to the simplicity offered by the lack of pins and the precision given by the fact that the model itself and the base are cast from the same material in the same working stage.

The computer technology has many advantages in dental technology. The most accurate model is the virtual model, made by scanning of the prosthetic field using an intraoral scanner.

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