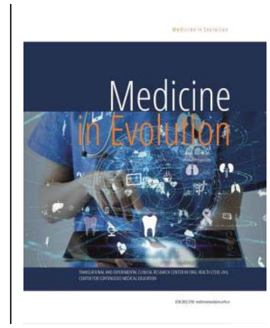
Processing Technologies of Polymers for Provisional Prosthesis



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Abstract

Aim and objectives

Dental practice is tending to remove the metallic component of fix partial prosthesis due to unfavourable mechanical behaviour. The polymers are used for prosthesis with metal free infrastructures and optimal function.

Material and methods

Polymers used for provisional prosthesis can be used with different technologies and have different mechanism of initiating the polymerization. Thermoplastic and chemoplastic polymers need different technologies and technological alternatives are: subtractive CAD-CAM, milling, printing technology and polymers injection.

Results

The chosen materials and manufacturing technologies may influence the success of the final prosthetic treatment. The standard and quality of provisional restoration is decisive for a successful prosthetic treatment.

Conclusions

Materials used are highly biocompatible and resistant to dental plaque adhesion. Present polymers induce low periodontal inflammation due to the lack of residual monomers.

Keywords: matrix, composite, optical microscope

INTRODUCTION

Fixed temporary dental restorations made through traditional or CAD-CAM procedures are crucial in dental treatment due to the diagnosis esthablishment, traeatment planning improvement and protective benefits. Cemented provisional restorations help maintain hygiene, guide marginal gingiva healing and prevent the successive abutment movement (1).

The introduction in current practice of alternative technologies for processing polymers by injection, the CAD/CAM systems, subtractive and additive techniques, made possible to obtain long-term temporary restorations. Polymers can be processed due to the implementation of subtractive technologies and the use of high-performance scanning systems. The processing of polymers as well as milled or printed polymers involves the mastery of a new technology and major investments in software and hardware (2, 3).

The long-term success of a fix prosthodontic restoration is influenced by several factors. A temporary restoration achieved by conventional or alternative technologies allows the aesthetic results to be predictable. The use of materials with increased biocompatibility and favourable mechanical strength, respectively the absence of residual monomers and polymerization shrinkage became possible by using the injection of thermoplastic polymers, milled or printed (4,5).

The implementation of CAD-CAM technologies in the dental office and laboratory, increases the efficiency of the treatment stages. The temporary restorations made with digital design will allow the correct identification of therapeutic solutions, but at the same time allow a constructive cooperation between the doctor, patient and dental laboratory (6,7,8).

Aim and objectives

The aim of this study is to discuss the advantages and importance of fixed temporary prosthodontic restorations in dental practice. Also, it points out the development of alternative technologies including subtractive and additive techniques. Aditionally the introduction emphasizes how the implementation of CAD-CAM technologies increases the efficiency of the treatment stages.

MATERIAL AND METHODS

Processing polymers by printing and milling improves clinical activity. The usage of CAD-CAM enhances the efficiency of the therapeutic process with design and computer-aided manufacturing components (9).

In this study were prepared and evaluated with non-invasive techniques, four groups of temporary fix partial prostheses. Group 1 made with thermoplastic polymers reinforced with fiberglass, group 2 provisional restauration made with injected polymer, group 3 provisional restauration made with milled technology and group 4 printed provisional restorations. For each group was made six samples.

The four groups were compared to the control group, in which the restorations were made with self-curing acrylic resin by classical technique. The control group was made using an impression key of the wax-up. The Temdent Classic Schutz Dental polymer was prepared by mixing the powder with the liquid in the proportion recommended by the manufacturer. When the polymer reached the plastic phase it was introduced into the impression key and applied on the cast. After polymerization of the material, the temporary restoration was finished and polished.

Manufacturing the samples of group 1, temporary restorations reinforced with glass fibres, followed the protocol: on the wax pattern of non-metalic framework was obtained the transparent pattern from EG CORE followed by the adaptation of EG Fiber on dental cast. The polymerisation was made in Hereus curing oven for 60 sec. The aesthetic component was made from Estenia C&B composite resin which is a high-filled hybrid ceramic (Fig.1). The last stage is represented by thermal treatment in the Biodent SystomatD oven (De Trey).

Figure 1. Group 1, reinforced fiber temporary restoration

The second group of samples were made using two injected thermolpastic polymers BioHPP - Bredent and Pekkton® Ivory (Cendres + Métaux). After making the non-metallic framework by injecting thermoplastic polymers with the help of PEKKtherm and PEKKpress injection systems, the physiognomic veneering was made with Nexco light-curing DRC (Ivoclar Vivadent) (Fig.2a, 2b).

Semi-crystalline polymers have been used in medicine for over fifteen years. In recent years, they also entered the field of prosthetic restorations. Bio HPP and Pekkton is a high performance thermoplastic polymer. It has been used for 20 years in medicine for making different types of prostheses (10, 11).

a  b 

Figure 2. Group 2, 2a. Pressed Pecton framework, the appearance after removing the investmant material, 2b. Aplying the veneer layer

For the third group of temporary restorations were used milled polymers. The term "subtractive system" includes techniques that allow to obtain restorations by successive reduction from a polymeric disk. These systems consist of three components: the scanner-3D Neway Open Technologies, the software Exocad for processing the data, and a milling system.

The milling process was performed with an Imes-Icore 350i five-axis milling machine that works in a dry environment. The chosen material was PMMA (polymethylmethacrylate) from Aidite (Fig.3).

Figure 3. Group 3. The milling process

The fourth group followed the protocol for making the printed restorations. The first step was to send the design file to the Asiga Max printing unit. The material used is a Detax Freeprint temp UV polymer resin, shade A2. The liquid polymer is positioned in the tank, where a suitable homogenization is performed before starting the printing process.

The materials used in 3D printing technology are liquid resins, which are light cured using UV wavelengths of 385nm. The system has the ability to process translucent materials (Fig.4). The Asiga System generates the polymerization parameters of each material, so the materials are polymerized accurately and the results are repeatable. The internal radiometer actively monitors the intensity of the LED during each polymerization ensuring a correct exposure to light for each layer. The successive deposition of layers, allows the making of the 219 layers for the prosthetic restoration at a temperature of 23.40C and an estimated working time of 58 minutes. To complete the polymerization and stabilize chemically the restoration was introduced into the UV chamber for 10 min. (6).

Figure 4. Group 4. Image during printing of the restoration

RESULTS

To evaluate the differences between the temporary restorations in the control group made by indirect Scutan technique from self-curing resin and the group of fix prostheses made by alternative milling technologies it was used a minimally invasive system, the radiography. X-rays of the restorations were made, both from the buccal side and from the occlusal side (Fig.5).

Analysing the X-ray, results showed both in the buccal and occlusal side the existence of air inclusions in the thickness of the self-curing resin. These defects can determine a decrease in the mechanical resistance of the fix provisional prostheses.

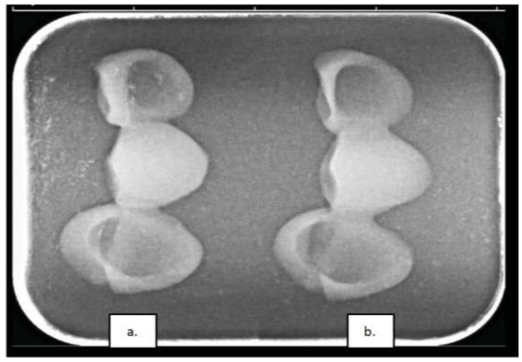

Figure 5. Rx-occlusal view. a. The restoration made by Scutan technique, control group b. The restoration made by milling, control group 3

The fixed partial prostheses reinforced with fiberglass were investigated using the Optical Coherence Tomography, a noninvasive imagistic technology, working at 1300 nm, in Time Domain Mode. The cross-section ensures a proper assessment of the material. The images showed the presence of inclusions especially at the level of the polymer-fiberglass interface in both B scan and C scan mode (Fig.6).

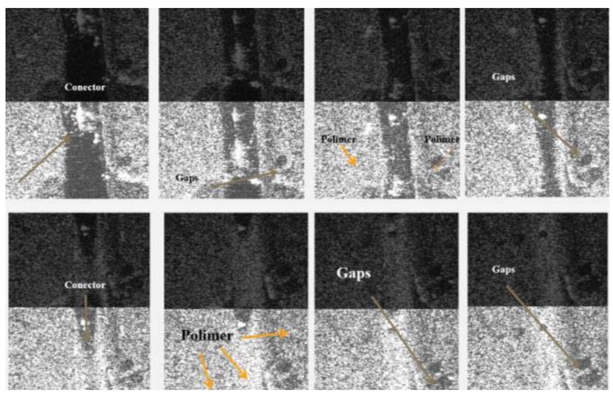

Figure 6. OCT Time Domain Mode C SCAN. Sample 1, Group 1- Reinforced polymer

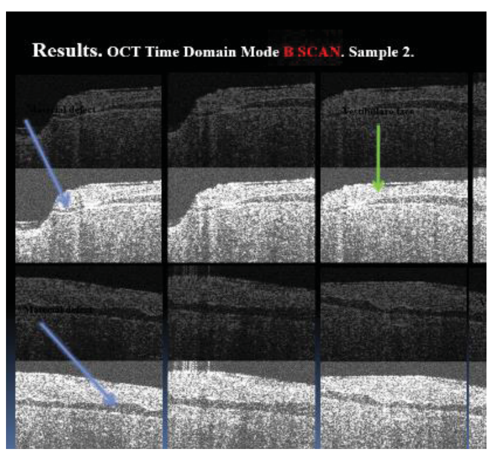

Figure 7. Group 2.OCT Time Domain Mode B Scan, Injected polymer- The gaps between the polymeric layers can be a favourable factor for chipping

The evaluation of the temporary restorations created by milling technique was made with a microscope with the following features: Video capture resolution: 160x120, 320x340, 640x480, 1280x1024, 1600x1200, Still Image Capture Resolution: 160x120, 320x340, 640x480, 1280x1024, 1600x1200, Light Source In built White LED x 8 PCS, Snapshot Software and

Hardware. With the help of the digital microscope, the images from the cervical adaptation were captured. The inaccuracies of the cervical adaptation were measured, and found values between 0.207-0.070 mm for the milled ones (Fig.7) and 0.022 mm and 0.106 mm for the printed restorations (Fig.8).

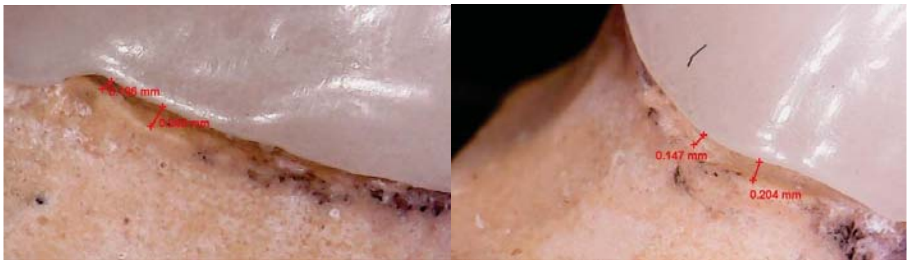

Figure 8. Microscopic evaluation of the cervical adaptation of the group 3 milled restoration. Spacing between the crowns margin and the limit of the marginal preparation

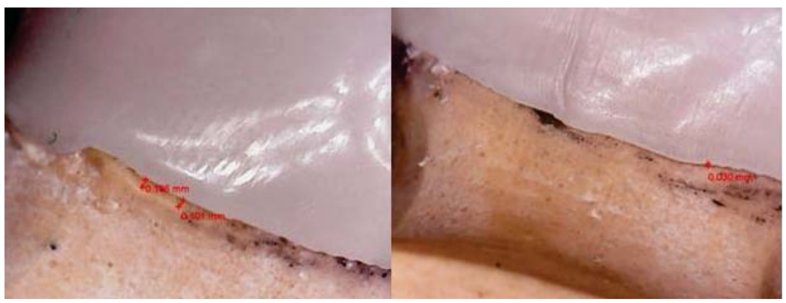

Figure 9. Microscopic evaluation of the cervical adaptation of the group 4, printed restoration. Spacing between the crowns margin and the limit of the marginal preparation

DISCUSSIONS

Compared to other materials used for temporary fix partial prostheses, the advantage of milled PMMA is that it has exceptional optical properties, good mechanical resistance and strength. Milled PMMA is considered a technological alternative to the classic technique of making fix partial temporary prostheses in dental offices or dental laboratories (9).

Making polymeric fixed partial prostheses on non-metallic frameworks obtained by injecting thermoplastic polymers is a viable technological alternative in complex therapies, where long-term temporary restorations must be kept functional in the oral cavity for a longer period of time (11).

The implementation of computer-assisted additive and subtractive technologies in current practice is justified by the advantages of CAD/CAM systems (12, 13). The marginal adaptation inaccuracies can be caused by errors in drawing boundaries in the digital design stage, or because of the manual finishing of the restoration after the detachment from the polymer disk, or from the printing blank.

Substractive systems are widely used in dental labs and offices while additive methods are less prevalent. Casting and printing are more common than temporary restoration printing. The materials used for temporary restorations should be assessed for cytotoxicity (14,15,16,17).

The use of temporary milled restorations, obtained as a result of mock-up and wax-up are tools that will allow us to evaluate the smile line, the position of pontics in the buccal-oral direction, the profile line and an evaluation of the space for physiognomic component of the final fix partial prostheses with natural abutments or implant support (18).

CONCLUSIONS

The temporary restorations are made for morphological and functional rehabilitation on a limited period of time. The chosen materials and manufacturing technologies may influence the success of the final prosthetic treatment. The standard and quality of temporary restoration is decisive for a successful prosthodontic treatment.

Milled, printed, injected or light-cured, the temporary restorations are reproducing the exact shape, colour and size of the treatment's final result. The materials used must be highly biocompatible and resistant to dental plaque adhesion, and the cytological testing are required before the introduction of new materials into the oral cavity. The absence of residual monomer in milled and injected polymers induces low periodontal inflammation, which represents an important advantage of these alternative materials and technologies.

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