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Comparative study on manufacturing metal-composite vs. metal-ceramic prosthetic restorations – case presentation

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ABSTRACT

A mixed prosthetic restoration combines the strength provided by the metal component with the aesthetic appearance very similar to that of natural teeth provided by the physiognomic component. The metal component is made of dental alloys (noble, stainless Ni-Cr, Co-Cr, etc.), and the physiognomic component can be made of materials such as ceramic masses, composite diacrylic resins, etc. This material presents a comparative study of the manufacturing technology in the case of metal-composite versus metal-ceramic prosthetic restorations.

Keywords: prosthetic restoration, aesthetic, ceramic masses, composite diacrylic resins

INTRODUCTION

The aesthetic aspect is very important in society, often being a determining factor in social classification. For this reason, the most used prosthetic restorations in current practice are the totally physiognomic ones or those with a metallic and/or zirconium oxide resistance infrastructure, or the all-ceramic ones.

However, for various reasons, some of a functional nature (bruxism, traumatic occlusion, etc.), others of a financial nature, both dental practitioners and patients direct their therapeutic preferences towards fixed prosthetic restorations veneered with aesthetic materials.

GENERAL DATA

A partially physiognomic prosthetic restoration combines the strength provided by the metal infrastructure with the aesthetic appearance very similar to that of natural teeth provided by the physiognomic component. In general, the metal component is made of noble or base metal alloys, and the physiognomic component can be made of materials such as ceramic masses, diacrylic composite resins, classic acrylic resins, etc. Each material is chosen according to the clinical situation of the patient, but often the financial aspect is also a criterion of choice. The most used stainless alloys for dental use are those based on Ni-Cr or Co-Cr, both types being compatible for partial physiognomic prosthetic restorations with composite diacrylic resins or ceramic masses. A fixed, partially physiognomic mixed prosthetic restoration must restore the patient's physiognomic function and provide optimal occlusal functionality, to maintain the health of the temporomandibular joint and achieve correct guidance [1-6].

Thus, in this material, a comparative study of the manufacturing technologies of partially physiognomic prosthetic restorations made of metal-composite and metal-ceramics will be presented.

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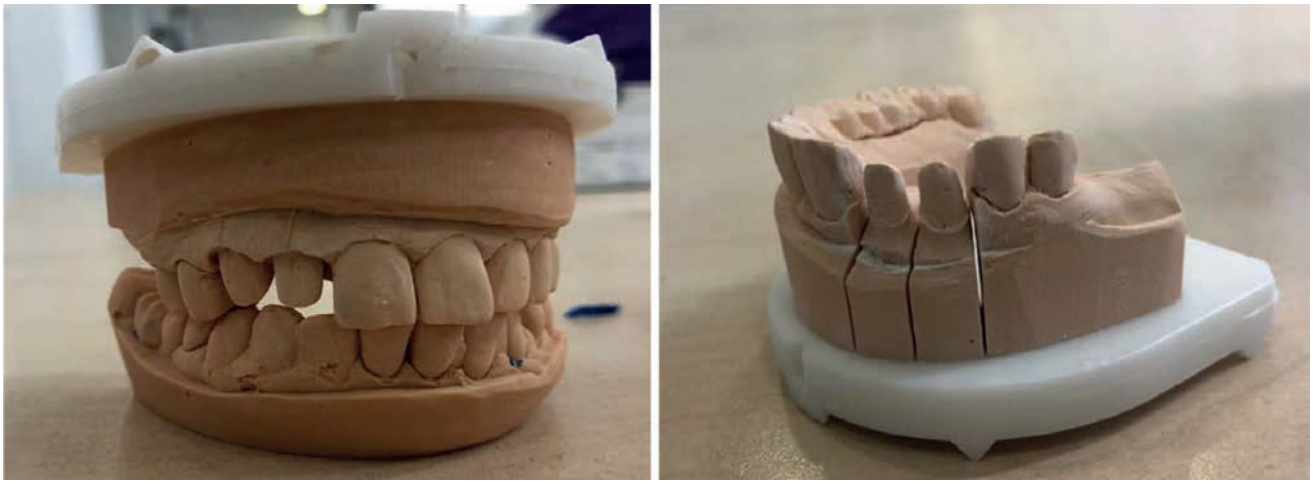
CASE PRESENTATION

Case no 1: Metal-composite prosthetic restoration

In the first case, the manufacturing of a metal-composite prosthetic restoration (using composite diacrylic resin) is presented in a 57-year-old male patient who presented himself in the dental office for the prosthetic rehabilitation of teeth 1.2 and 1.3. Due to an extremely traumatic occlusion, at the suggestion of the dentist, the patient opted for a partially physiognomic metal-composite prosthetic restoration on teeth 1.2 and 1.3, with a metal component made using CAD-CAM technology.

In a first stage, the dentist performed the endodontic treatment of teeth 1.2 and 1.3, as well as a proper prosthetic preparation to support a metal-composite restorations. Both the functional maxillary impression and the impression of the antagonistic mandibular arch



a b

FIGURE 1. *The functional maxillary model and mandibular model in occlusal relationship (a); the maxillary model after cutting to obtain removable die (b)*

a b c

FIGURE 2. *The virtual maxillary model (a); the virtual mandibular model (b); the virtual models placed in occlusal relationship (c)*

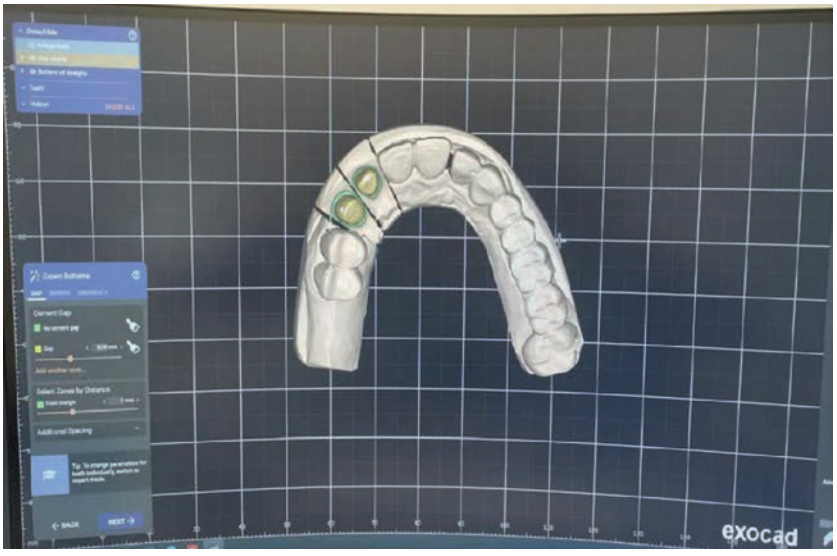


FIGURE 3. *Creating the design of the metal substructure of prosthetic restoration using Exocad software*

were made in standard impression trays with silicone condensation materials in a double consistency: putty and light body. The occlusal relationship was recorded using a strip of putty-consistency silicone condensing material. Subsequently, both the maxillary functional sectional model and the mandibular model were made of type IV dental stone.

After trimming, both maxillary and mandibular models were scanned using a dental laboratory scanner to obtain virtual models.

After finalizing the design of the metal framework of the prosthetic restoration, the data was sent in Stl. format to a milling center, where the metal infrastructure will be obtained by computerized milling from a Ni-Cr based dental alloy. The metal component resulting from computerized milling was adapted and processed, so that it fits as intimately as possible on the removable dies the maxillary sectional model. This process was followed by the try in of the metal framework in the dental office.

The aesthetic component will be applied on the metallic component thus obtained. The first layer is represented by the opaque material with the role of blocking the transmission of the color of the metallic component through the physiognomic material. After the setting of this layer, the application of the composite diacrylic resin begins in order to obtain both the morphology and the appropriate aesthetics of the restored teeth. Being a mixed metal-composite restoration, retention beads with a diameter of approximately 150µm were used to fix the resins on the surface of the metal framework. Finally, after the composite diacrylic resin was applied, the prosthetic restoration was finished and polished, and then sent to the dental office for cementation.

Case no. 2: Metal-ceramic prosthetic restoration

In the second case, the manufacturing of a metal-ceramic prosthetic restoration is presented in a 63-year-old male patient, who presented himself in the dental office for the prosthetic rehabilitation of an edentulous first upper molar, 1.6. Due to a traumatic occlusion, at the dentist's suggestion, the patient opted for a metal-ceramic dental bridge, with 1.5 and 1.7 as abutment teeth, with a metal component made using lost wax technique and an automatic casting device. Due to the reduced mezio-distal span, the dentist to-

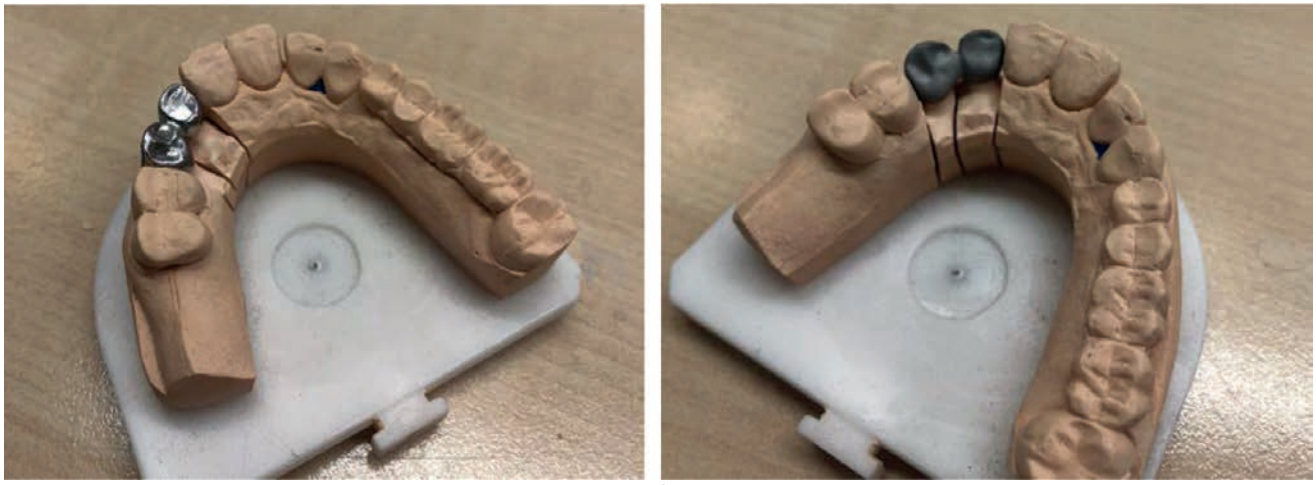


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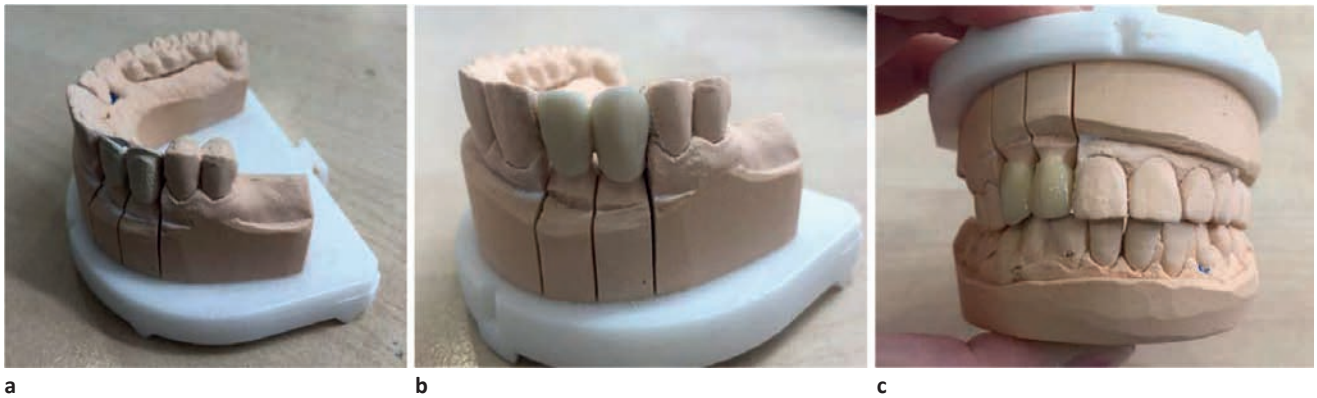
FIGURE 4. *The metal framework processed and fitted on the functional model (a); the metal framework after sandblasting (b)*



a b c

FIGURE 5. *Opaque layer applied on the surface of metal framework (a); the diacrylic resin applied and shaped to recreate the morphology of teeth (b); the final aspect of prosthetic restoration before being sent to dental office (c)*

gether with the dental technician decided to make the metal-ceramic pontic in the shape of a premolar.

In a first stage, the dentist performed both a correct endodontic treatment of the teeth 1.5 and 1.7, and also performed specific preparations by grinding to turn teeth into dental abutments. For greater precision, an arch impression was chosen, both for the maxilla and for the mandible. Standard impression trays and silicone condensation materials in double consistency: putty and light body were used. The occlusal relationship was registered using a silicon-based bite registration material. The functional sectional maxillary model was made using Zeiser technique and type IV die stone while the mandibular model was made using type IV die stone for the main model and type III die stone for base of the model.

The surface of abutments was coated with die spacer and the wax pattern was designed in accordance with neighboring teeth as well as antagonistic teeth. After finishing, the was pattern was invested using a refractory material and placed in a burnout furnace. At the end of the heating program the mould was obtained and using an automatic casting machine the Ni-Cr dental alloy was inserted to obtain the metal component. After cooling, the metal framework was de-vested, sandblasted and processed. The metal framework is cut off from the sprue using a carborundum disc and checked for fitting on the functional model. The surface of the metal was finished and polished to prevent the appearance of cracks in the ceramic mass. The metal component was sent to the dental office for try-in and after that it was inserted in the ceramic furnace for oxidation (figure 7).

The first step in applying ceramic is the opaque layer. On the buccal side, where the aesthetic component will be applied, the layer of opaque material, necessary to block the color of the metal, is applied by brushing (Figure 8).

a b

FIGURE 6. *The functional maxillary model (a); the mandibular model (b)*

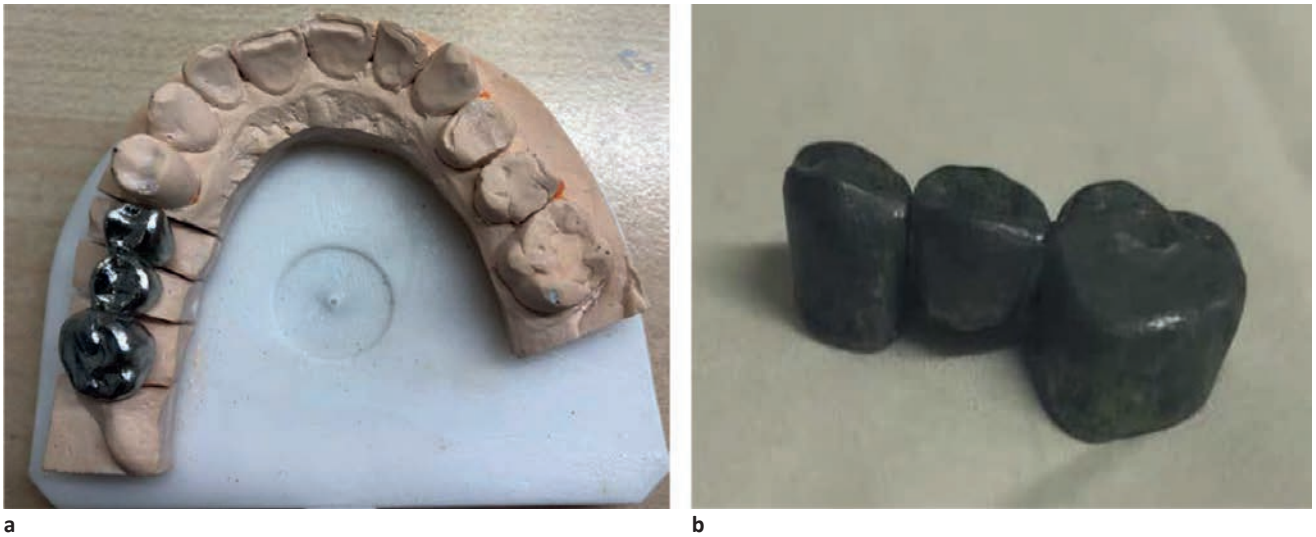


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FIGURE 7. *The metal framework processed and fitted on the functional model (a); the aspect of metal component at the end of the oxidation process (b)*

FIGURE 8. *The opaque layer applied on the buccal side*

After the thermal processing of the opaque layer, application of ceramics began, layer by layer for the specific components: cervical, dentin and enamel (figure 9).

According to the recommendations made by the dentist after the try-in, the dental technician apply correction material, and at the end of the process the layer of glaze to create a natural appearance (Figure 10).

FIGURE 9. *The prosthetic restoration with the necessary modifications recommended after the try-in*

DISCUSSIONS

Composite diacrylic resins were introduced into dental practice in response to the demand of practitioners, but especially patients, for materials with an appearance similar to dental hard tissues. Used both as materials for direct restorations and for prosthetic restorations made in the dental laboratory, they have been the materials of choice for a long period of time. The appearance of ceramic masses led to the reduction of the use of composite diacrylic resins, especially due to the optical properties and color stability that these materials present over time.

The mechanical properties of composite resins are inferior to those of ceramic masses, especially after the aging process [7]. There are also big differences between the types of resins on the market in terms of color stability [8-10]. However, numerous studies have shown that composite resins used in fixed prosthetic restorations take on part of the occlusal forces, reducing the stress on the teeth or dental implants and surrounding bone on which they are made by 15% to 25% [11-13].

FIGURE 10. *The final aspect of the prosthetic restoration*

In limited space conditions or exaggerated pressures at the occlusal level, it is possible to use partially aesthetic prosthetic restorations, which ensure resistance to occlusal pressures by covering the active cusps with the metal component, while in the labial part the dental alloy is covered with aesthetic material. This is also used when the technical endowment of the laboratory or the material conditions represent an impediment, especially since the existing composite resins present significant improvements, which bring them closer to those of ceramic masses.

CONCLUSIONS

Some particular aspects emerge from the two detailed case presentations during this study:

- Mixed prosthetic restorations, partly aesthetic, are mainly used nowadays because they restore both the physiognomic and the functional aspect. They can be made of different materials.
- The metal infrastructure can be made by different methods and from different dental alloys such as noble, base (Ni-Cr, Co-Cr) or titanium alloys.
- The aesthetic component can be made from ceramic materials, composite diacrylic resins, simple acrylic resins, etc. The ceramic veneer must have a minimum thickness of 0.8 mm. At the same time, the wax pattern of the metal component is prepared differently depending on the type of aesthetic material chosen, the connection between the two components being made in a different way. For metal-composite restorations, retention beads with a diameter of approximately 150µm are required, while, for metal-ceramic restorations, the connection between the ceramic and the dental alloy is made on the basis of the oxide layer formed on the surface of the alloy.
- Composite diacrylic resin presents a simpler production technology and requires much cheaper equipment than the technology of veneering with ceramic masses.
- Compared to the composite diacrylic resin, the ceramic mass shows increased strength. The production technology is more complex, and the processing presents an increased difficulty, and requires an increased attention.
- A partially physiognomic joint mixed prosthetic restoration completed and correctly made must provide optimal occlusal functionality, to maintain the health of the temporomandibular joint and achieve correct guidance.

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