CASE REPORT

Technological considerations regarding the use of CAD-CAM systems in the metal substructure design of some metal-ceramic prosthetic restoration

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ABSTRACT

In this material, two clinical cases are described, regarding the use of CAD-CAM technology for producing the wax pattern of the metal substructure for a fixed prosthetic restoration. In fact, in these cases, it is about making a digital design and milling from a block of wax the patterns of future fixed metal-ceramic prosthetic restorations.
KEYWORDS: wax patterns, fixed prosthetic restorations, CAD-CAM technology.

INTRODUCTION

The CAD-CAM technology was introduced in dentistry around the early 1980s. Thus, unlike the classic "lost wax technique" known and widely used in Romania, with the help of CAD-CAM systems, both prosthetic restorations, implant-supported restorations, but also certain components can be designed and processed with a very high precision, using a computer with integrated software, connected to a milling device.

GENERAL DATA

Over time, the hopes, expectations, but above all the wishes of both patients and dental specialists (dental doctors and/or dental technicians) have focused on the automation of dental medicine practices. Here, we refer specifically to digital CAD-CAM technologies, aiming to produce much more uniform and higher-quality prosthetic parts. This is achieved by using material blocks obtained industrially and marketed by specialized companies of dental products, seeking to standardize the restoration-modelling processes and reduce production costs.

This material describes two practical situations, regarding the use of CAD-CAM technology in modelling the metallic framework, in the manufacture of fixed prosthetic restorations. In fact, in these presented cases, it involves making a digital design and milling wax patterns from a block of wax for future fixed metal-ceramic mixed prosthetic restorations[1-6].

CASE PRESENTATION

Case no. 1

A 48-year-old patient presented to the dental office due to the absence of the mandibular first molar (3.6). The dentist, in agreement with the patient, decided to fabricate a metal-ceramic bridge, having 3.4, 3.5 and 3.7 as abutment teeth. In this sense, CAD-CAM technology was used to make the wax pattern of the future metal component of the prosthetic restoration (Figure 1).

Both the mandibular sectional model, as well as the

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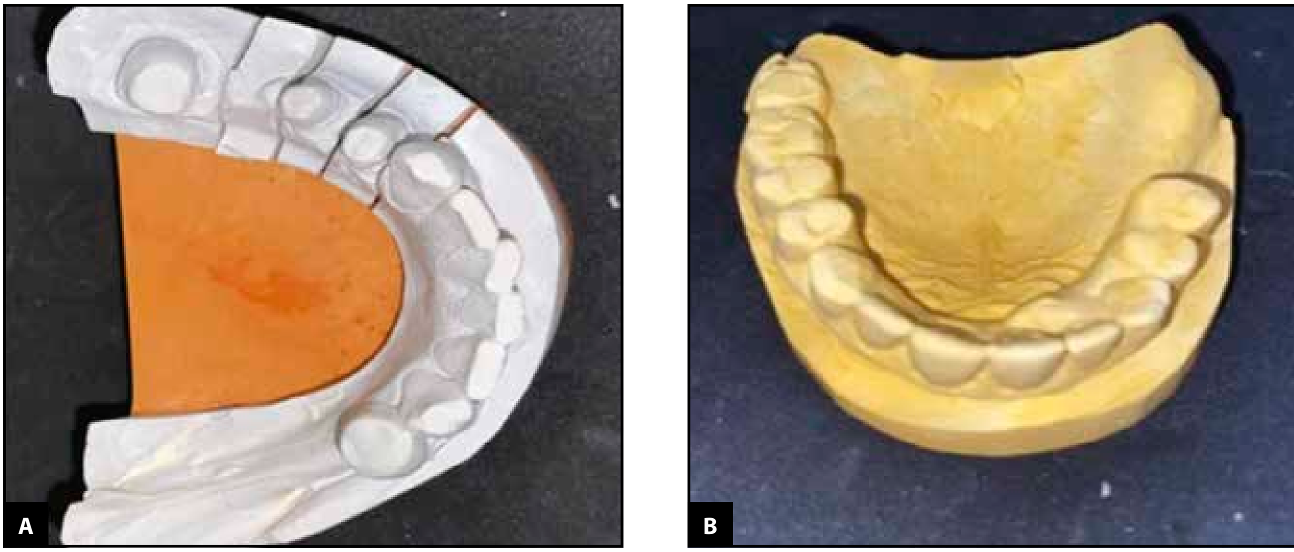

Figure 1. Mandibular sectional model obtained using Pindex technology **(A)** and maxillary model **(B)**.

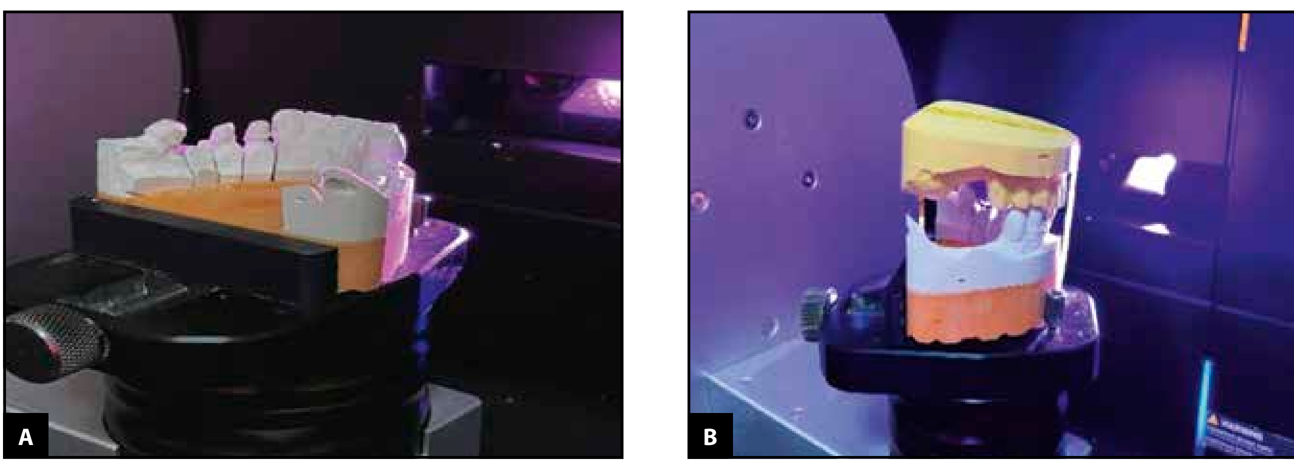

Figure 2. Scanning of the functional model and related mobile dental abutments **(A)**, as well as models in occlusal relationship **(B)** using a dental laboratory scanner.

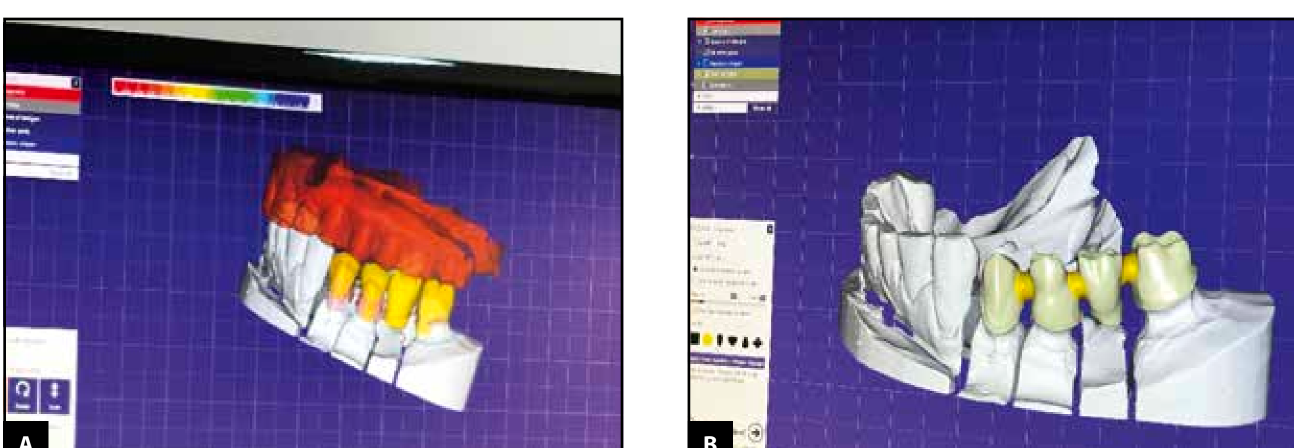

Figure 3. The design of the virtual pattern of the future metal component of the prosthetic restoration in occlusal relationship with the antagonistic teeth **(A)**, as well as the design of the connectors between virtual copings of the prosthetic restoration **(B).**

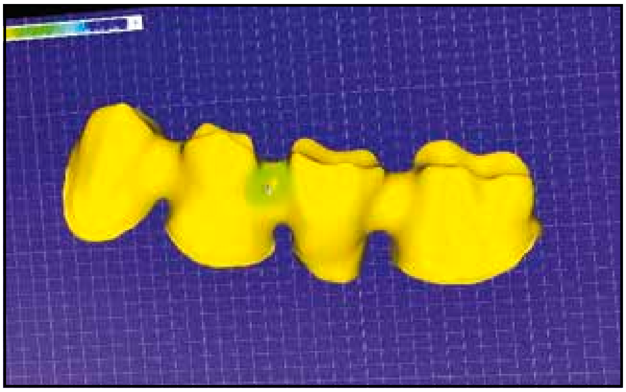

Figure 4. The final design of the virtual pattern of the prosthetic restoration.

maxillary antagonist model were scanned with the help of a special dental laboratory scanner (Figures 2-5).

The wax pattern was prepared for investing, thus for each element of the prosthetic restoration an individual sprue rod was attached and all were connected to a feeder bar. The feeder bar was subsequently connected to the crucible former cone (Figure 6).

The wax pattern is invested, the mold is heated and prepared for inserting the dental alloy. Using an automatic casting machine the chromium-based alloy is inserted in the mold, according to the manufacturer's instructions, in order to obtain the metal substructures of the prosthetic restorations (Figure 7).

After de-vesting, the metal substructure is sand

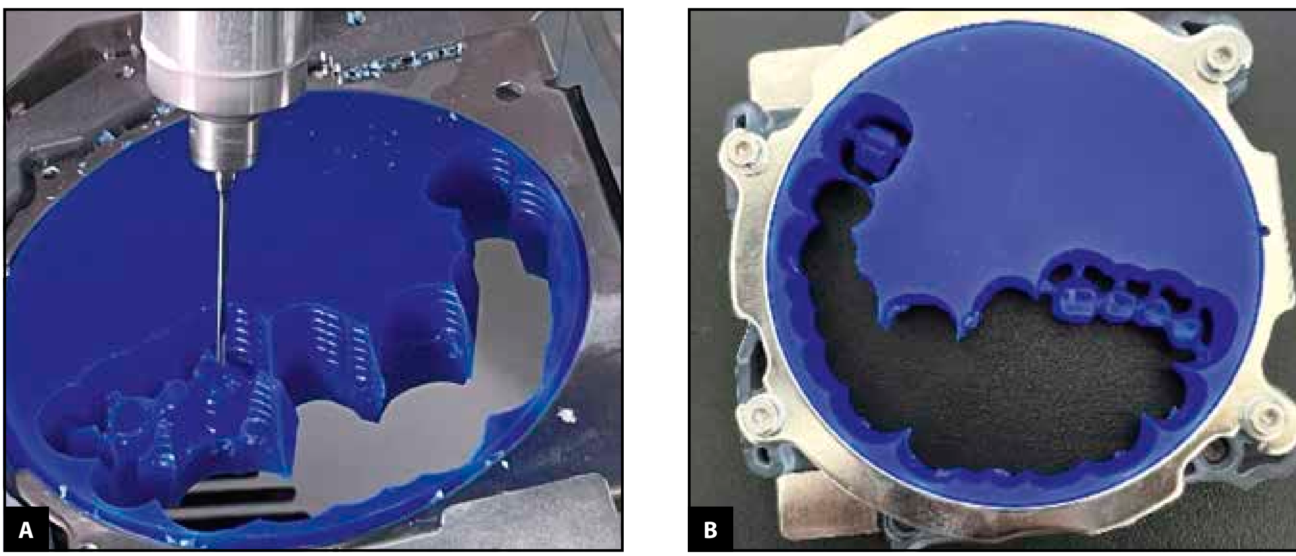

Figure 5. The aspect of the wax pattern of the metallic component of prosthetic restoration while milling **(A)** and at the end of the milling process **(B)**.

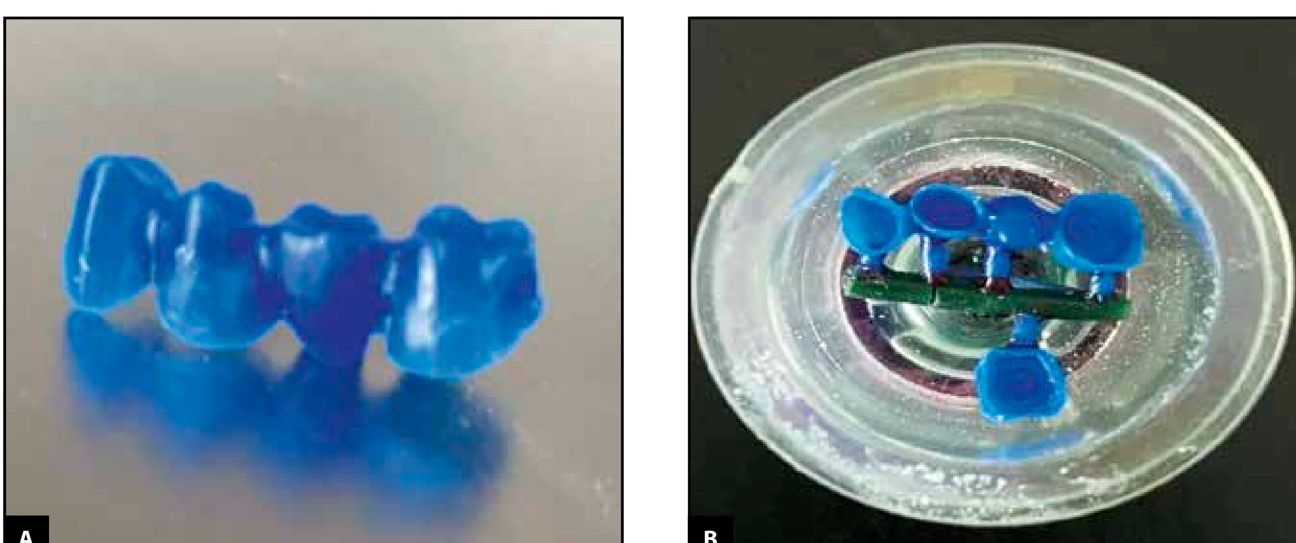

Figure 6. The wax pattern of the metallic component **(A)**, prepared for investing **(B)**.

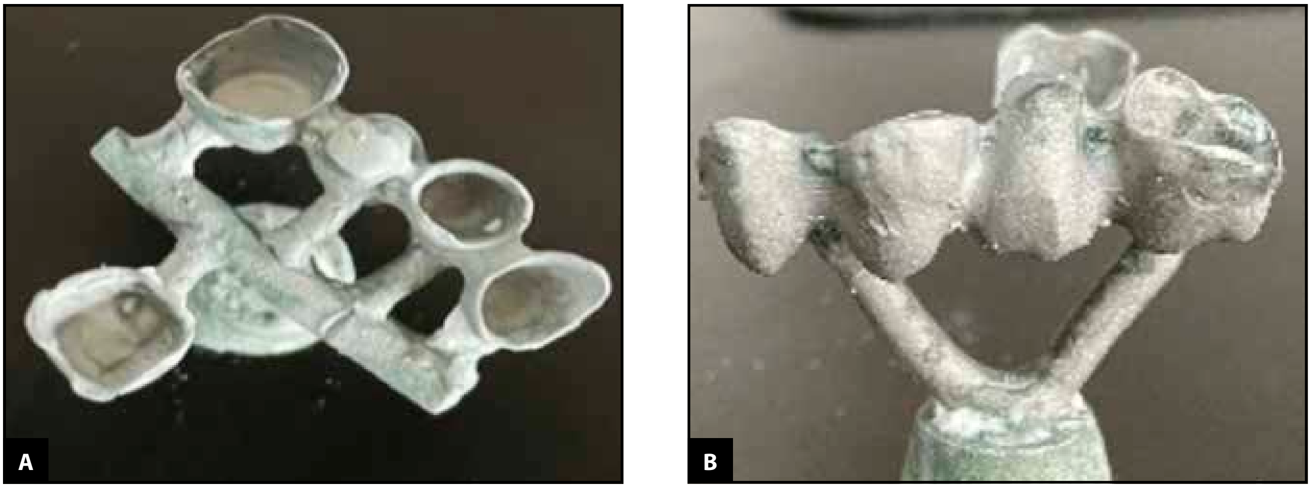

Figure 7. Metal substructure of prosthetic restoration after de-vesting, mucosal view **(A)**, labial view **(B)**.

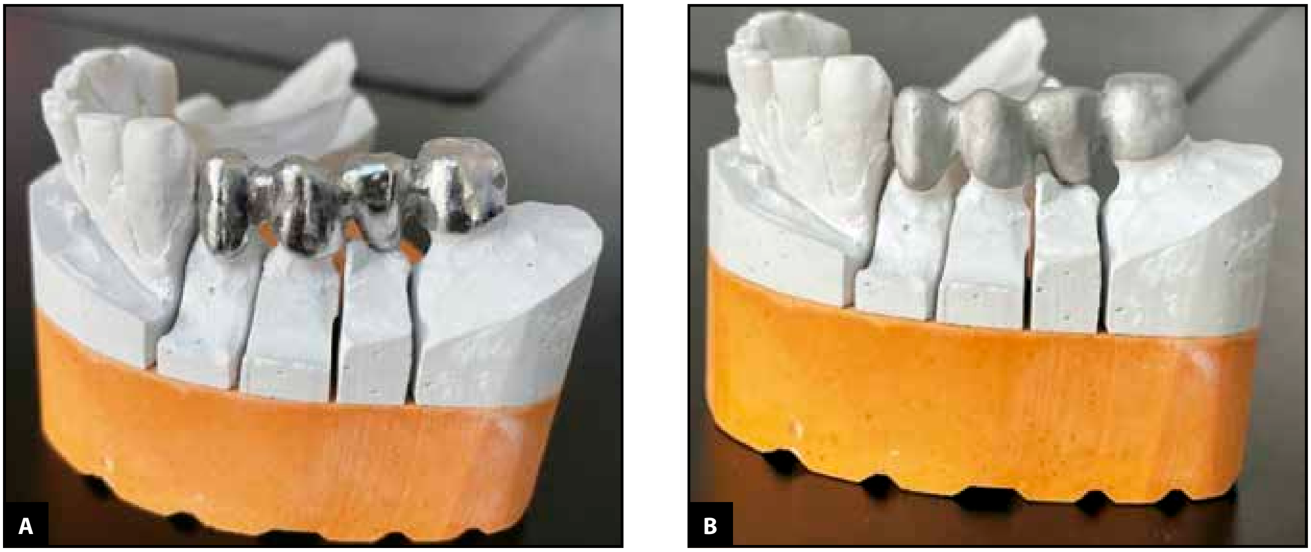

Figure 8. The metal substructure processed and fitted on the working model **(A)**, and, after sand blasting, ready for veneering with ceramic masses **(B)**.

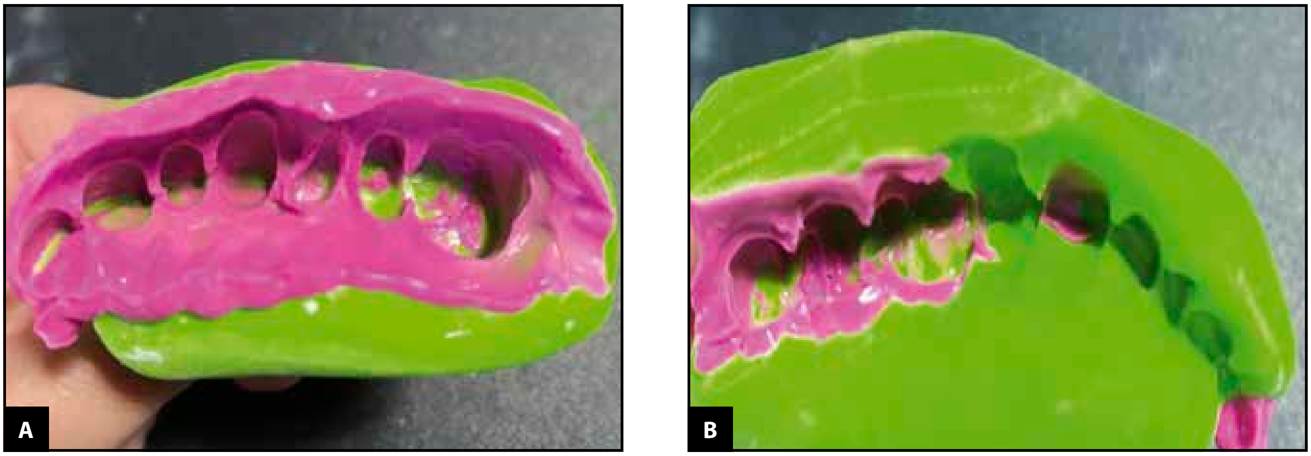

Figure 9. The quadrant dual arch impression maxillary **(A)** and mandibular **(B)**, made with silicon impression materials in double consistency: putty and light body.

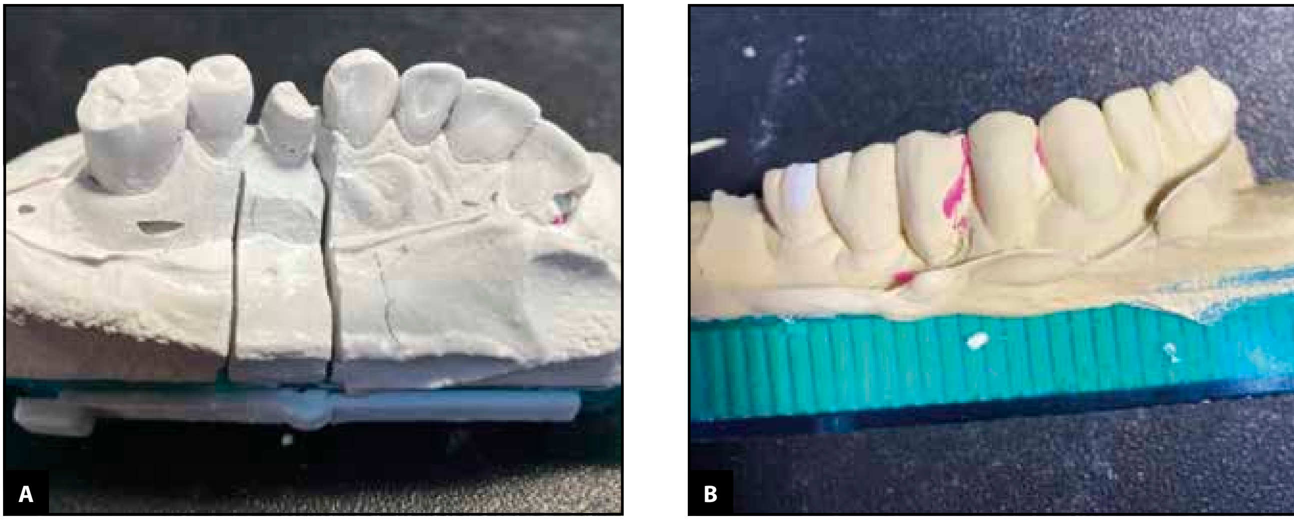

Figure 10. The maxillary sectional model obtained **(A)** the antagonistic model of the mandibular quadrant arch **(B)**.

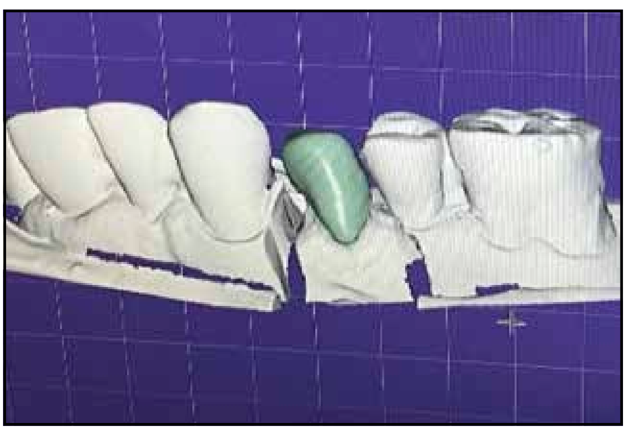

Figure 11. The design of the virtual pattern of metal substructure.

blasted to remove any remaining investing material and oxides from the surface, the sprue rods are removed. The metallic framework is processed by removing any excess material that prevent it from fitting on the working model or that can prevent the adhesion of the aesthetic material (Figure 8).

The metal substructure is fitted on the working model and also tried on the natural teeth. Subsequently, it is sandblasted in order to prepare the surface for applying the ceramic masses.

Case no. 2

A 49-year-old patient presented himself in the dental office, in order to prosthetically restore the upper maxillary first premolar (1.4). After the examination, the dentist together with the patient decided to make

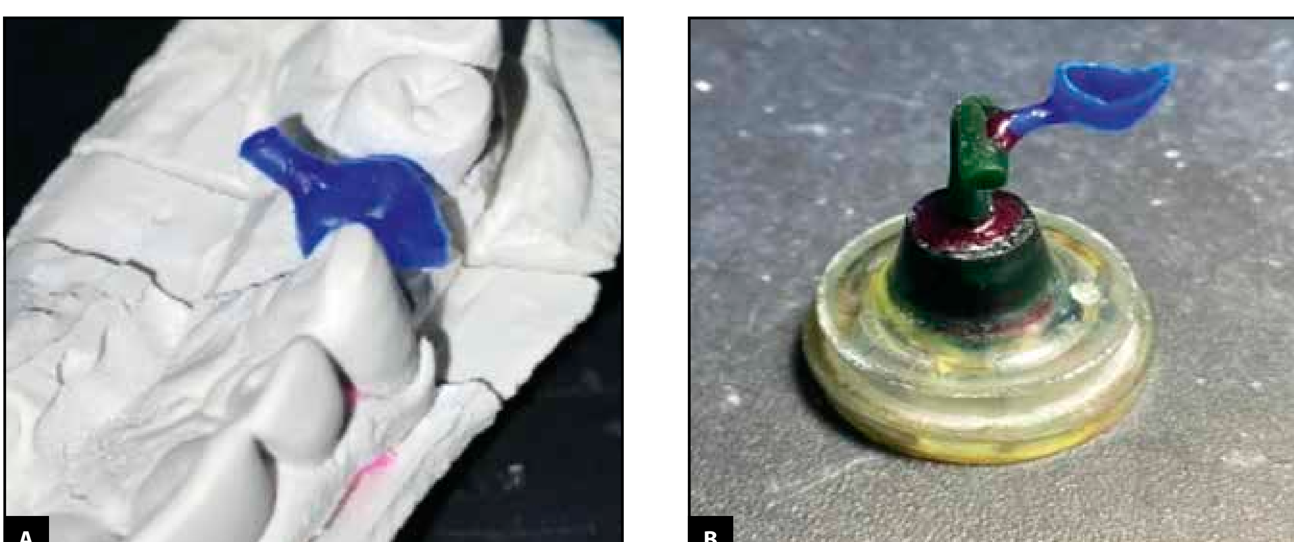

Figure 12. The wax pattern fitted on the working model **(A)** and then prepared for the investing process **(B)**.

Figure 13. The silicone cylinder is attached to the crucible former cone to check the distance between the wax pattern and the walls of the cylinder.

a metal-ceramic crown at the level of 1.4. As in the previous case, CAD-CAM technology was used to make the wax pattern of the metal component of the prosthetic restoration (Figure 9). Afterwards, the maxillary functional model, the prosthetic abutment, the antagonist model and the occlusal relationship were scanned using a dental laboratory scanner (Figure 10, Figure 11).

At the end of the milling process, the wax pattern was tested for fitting on the working model and prepared for investing using the ringless investment technique (Figure 12). Using a wax sprue rod, the wax pattern is connected to the crucible former cone (Figure 13).

As in the previous case, after the wax pattern is prepared and invested, the mold is heated to remove the wax and for thermal expansion. Thus, the mold is prepared for inserting the chromium-based dental alloy, using an automatic casting machine. At the end of the casting process, the metal component is de-vested, processed and checked for fitting on the working model (Figure 14, Figure 15).

DISCUSSIONS

The use of the CAD-CAM method in the technological process of making metal-ceramic restorations is limited, as was also described in this study, to manufacturing the metal component[7,8]. After the digital design is done, the manufacturing process can follow two major directions. On the one hand, the information can be transmitted to laser sintering or milling machines in pre-sintered discs for making dental alloy copings[9]. On the other hand, a pattern of the copings can be made by milling or printing, in

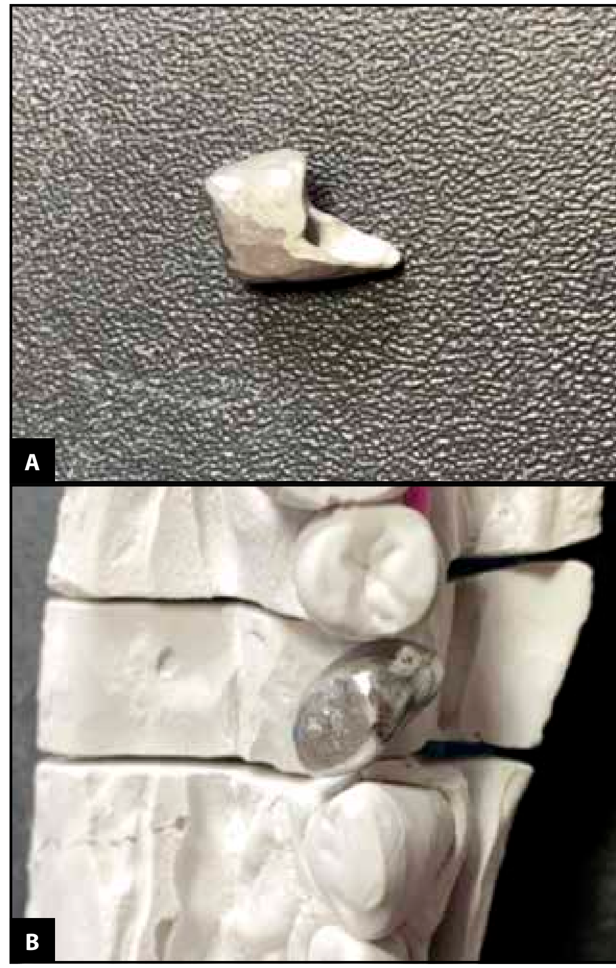

Figure 14. The metal coping after de-vesting and processing **(A)**, and fitted on the working model **(B)**..

Figure 15. Metal-ceramic restoration, at the end of the technological process, placed on the working model to verify the occlusal adaptation.

wax or special resins, which will later follow the classic process of making metal structures: lost wax technique[10,11].

The purpose of obtaining wax patterns through CAD-CAM technology is to increase precision, to obtain a pattern with uniform thickness, but also to decrease the actual working time that the dental technician must allocate for creating the wax patterns[7,12]. Given the price difference, a Co-Cr alloy disc is about 32 times more expensive than a milling wax disc, but also the equipment required for further processing of the pre-sintered metal components make the use of milled wax patterns an easy and affordable alternative to increase the accuracy of prosthetic restorations but also to increase productivity in the dental laboratory[13,14].

Numerous studies have shown that milled wax patterns have similar or even better accuracy/fit than the classic wax patterns and superior thickness control[7,11]. Due to the possibility of analysing and magnifying the virtual model to establish the edges of the preparation, marginal adaptation is as accurately as possible[15,16].

Even the proximal areas of dental abutments can be analysed easily. Regarding the thickness of the alloy coping, the analysis program generates the image of the future prosthetic restoration (porcelain fused to metal restoration) and subsequently establishes the ideal thickness for the coping so that the strength of the restoration is not affected by excessive thinning of the cap, nor the aesthetics of the future restoration by reducing the space allocated to the ceramic mass[17].

CONCLUSIONS

The use of CAD-CAM technology in manufacturing the wax pattern of the metal substructure results in a complex restoration that is faster, more efficient and sometimes more accurate than that obtained by the classical technology (lost wax technique).

CAD-CAM systems have improved dental practice by providing high-quality prosthetic restorations.

The evolution of CAD-CAM technology has led to its greater use in the field of dentistry.

The metal component made using the CAD-CAM system provides high dimensional accuracy, more efficient working time, reduced labour and superior quality control.

The presented cases highlighted the fact that the CAD-CAM technology used in manufacturing the wax pattern of the metal infrastructure remains an accessible and satisfactory option both for the patient and for the dental medical team (dentist – dental technician) from the point of view of its fabrication.

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