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CASE REPORT

Designing and obtaining resistance structures through CAD-CAM technology in the case of fixed prosthetic restorations

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ABSTRACT

The CAD-CAM technology was initiated in the early 1980s, and in the last decade it has developed significantly. Currently, the functionality and aesthetics offered by CAD-CAM systems meet the expectations of patients and thus, in this material, several extremely interesting aspects are presented, regarding the technological process of designing and manufacturing structures made by CAD-CAM technology both from zirconium oxide, but also from other specific modern materials.

KEYWORDS: CAD-CAM, prosthetic restorations, technologies.

INTRODUCTION

The CAD-CAM technology was initiated in the early 1980s and has developed significantly over the past decade. This technology offers important advantages for both the dentist, the dental technician and the patient, as follows[1-3]:

The fitting of prosthetic parts is performed with greater precision than conventional techniques.

The possibility of intraoral scanning eliminates the occurrence of errors during the impression, casting of models and processing of materials used in these stages.

Digital modelling of the design is superior from a structural point of view and its obtaining process takes place in a much shorter time frame.

The emergence of this technology has favoured the emergence of new restorative materials, such as zirconium oxide, BioHPP, materials that can be digitally processed.

GENERAL DATA

The improvements that have been made to milling technology have led to much more precise results regarding the structure of prosthetic restorations made using CAD-CAM technology, improvements that bring a significant benefit to zirconium oxide, a material that strictly involves the use of this technology without which it could not be used in the manufacturing of those prosthetic pieces.

Currently, the functionality and aesthetics offered by CAD-CAM systems meet the expectations of patients. Thus, the medical team consisting of the dentist and the dental technician is able to combine the digital design of the resistance structure of the prosthetic restoration with the achievement of an aesthetics similar to the natural dentition, aesthetics offered by the veneering with ceramic masses.

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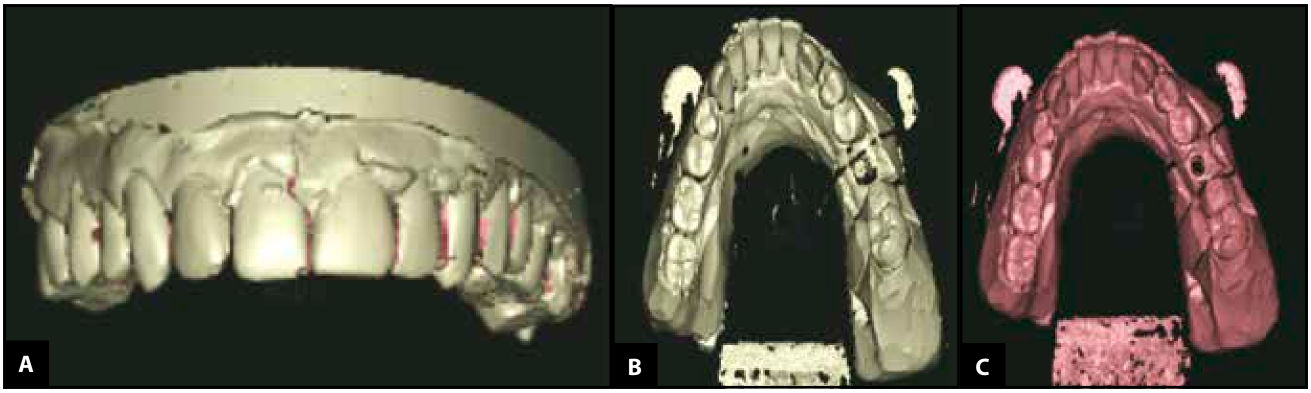

Figure 1. The virtual maxillary model **(a)**; The mandibular functional model without artificial gingiva **(b)**; The mandibular functional model with the artificial gingiva **(c)**.

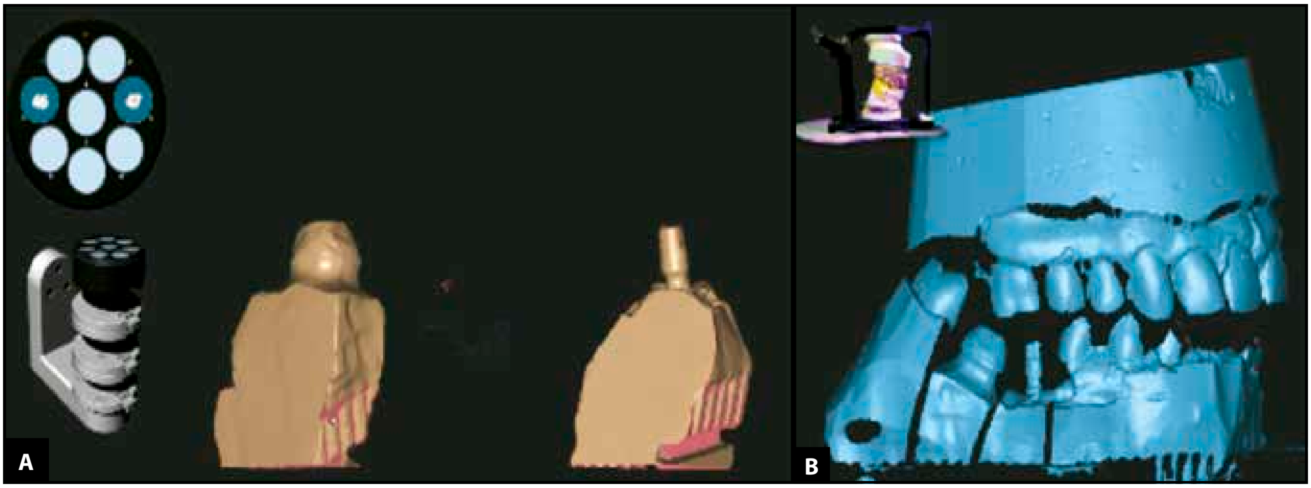

Figure 2. The prosthetic abutment (4.7) and the implant abutment (4.6) after scanning **(a)**; The virtual maxillary and mandibular models placed upon the occlusal registration **(b)**.

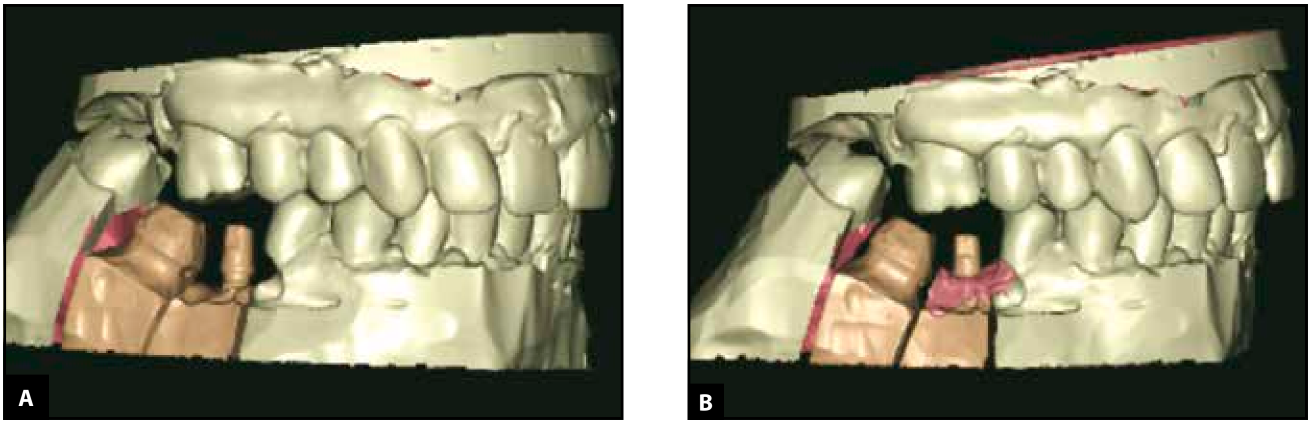

Figure 3. The virtual models in occlusion, the mandibular without **(a)** and with **(b)** the artificial gingiva around implant abutment.

Starting from the previously mentioned aspects, in this material we have tried to present several extremely interesting aspects regarding the technological process of designing and manufacturing structures made using CAD-CAM technology, both from zirconium oxide, but also from other specific modern materials.

CASE PRESENTATION

Case no 1

This case describes the manufacturing of fixed prosthetic restorations made of zirconium oxide using CAD-CAM technology. This involves the manufacturing of two porce-

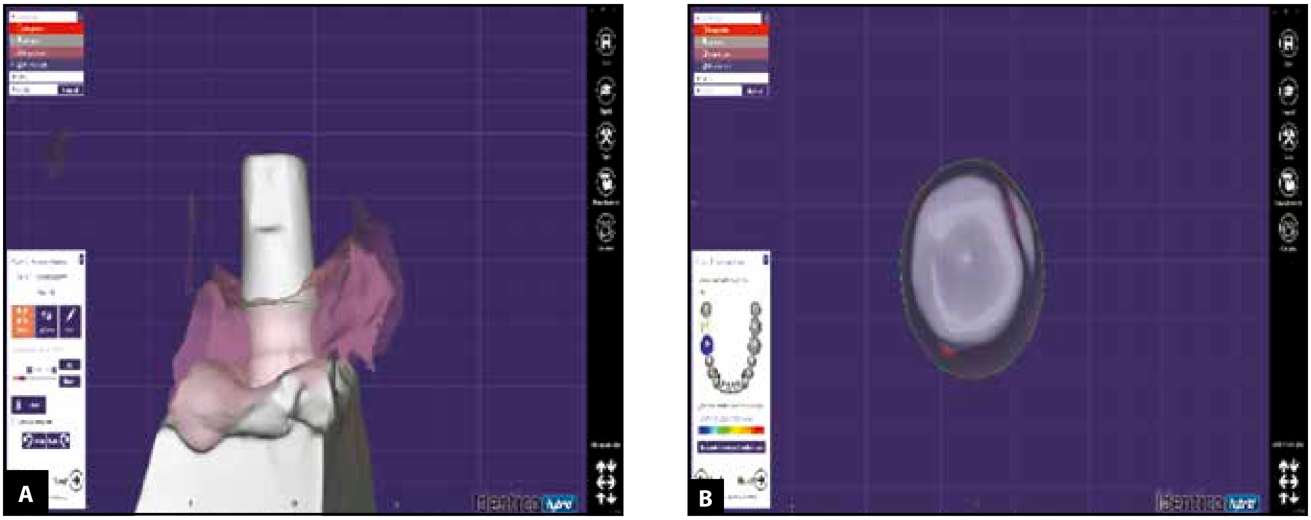

Figure 4. Tracing the marginal line on the prosthetic abutment **(a)**; Setting the insertion axis **(b)**.

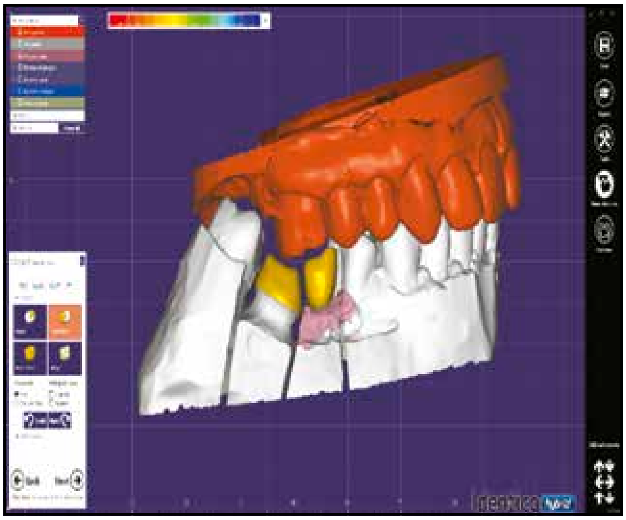

Figure 5. The final aspect of virtual patterns of zirconia copings fitted on the working model.

lain fused to zirconia crowns: one to restore tooth 4.7 and the second, an implant-supported crown to restore tooth 4.6. The focus will be on the implant-supported crown. Prior to the scan, a standard implant abutment was selected, which was customized for this clinical case. The zirconia copings will be individual to create a more natural appearance of the final restorations.

Since one of the prosthetic restorations will be made on implant support, the impression of the clinical case was made with a polyether to render as accurately as possible the details of the prosthetic field and to avoid positional changes at the level of the transfer abutment. The impression of the antagonist arch was made in a standard impression tray using a condensation silicone. In the same session, the occlusion registration was made using a condensation silicone of a putty consistency. Subsequently, the impressions were washed under tap water for 20 seconds, after which they were decontaminated by immersion in chemicals with antimicrobial potential, following the instructions recommended by the manufacturers. The mandibular sectional model was cast using the Accu-trac system and an extra-hard type IV dental stone, with appropriate preparation of the gingival area surrounding the implant and an appropriate analogue abutment. The antagonist model was cast using the classical method and type III dental stone. Using occlusal registration, the 2 models, mandibular and maxillary, were mounted in an occlusal simulator.

Next, the dental technician scanned the two models (the mandibular functional model with and without the artificial gingiva and the maxillary antagonist model) (Figure 1), the dental prosthetic abutment, the implant abutment, as well as the intermaxillary occlusion relationship, using a laboratory scanner (Figure 2).

After scanning all components, the three-dimensional modelling program performs the spatial arrangement of the virtual components (Figure 3).

Using the data obtained through scanning, the dental technician traced the preparation margins for the two restorations, established the insertion axis, as well as specific parameters such as thickness and the space for the luting material (Figure 4). The design of the virtual pattern of the zirconia copings was generated by the software and adjusted by the dental technician (Figure 5).

The final design of the virtual copings was sent in an STL format document to a professional milling centre to obtain zirconia copings from a prefabricated disc. At the end of the milling process, the copings were removed using a high-speed handpiece and diamond burs. They were processed before the sintering process because at this stage the material is soft and can be easily adjusted. The copings were then placed in the sintering furnace for thermal processing, based on a specific program recommended by the producer (Figure 6).

After sintering and cooling, the zirconia copings were

Figure 6. Zirconia copings at the end of the sintering process.

Figure 7. Substructure components made of zirconia placed on the working model, ready to be sent to the dental office for try-in.

checked for fitting on the working model, small adjustments were made and then sent to the dental office for try-in (Figure 7).

The final stage was the veneering with ceramic masses on the surface of the zirconia copings to obtain the aesthetic appearance of the prosthetic restorations.

Case no 2

The second case presented in this material exemplifies the manufacturing of a thimble-type dental implant superstruc-

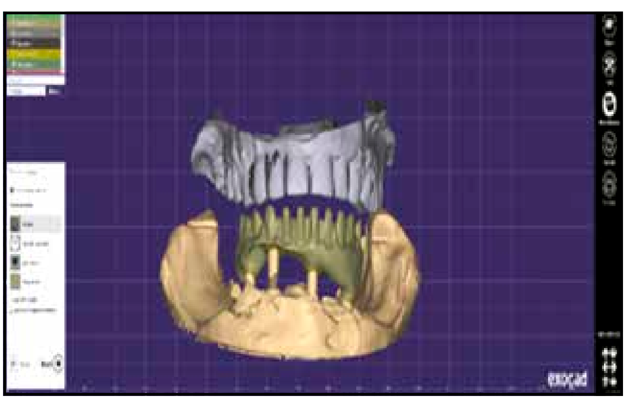

Figure 8. The virtual thimble framework at the level of the working model without the gingival material.

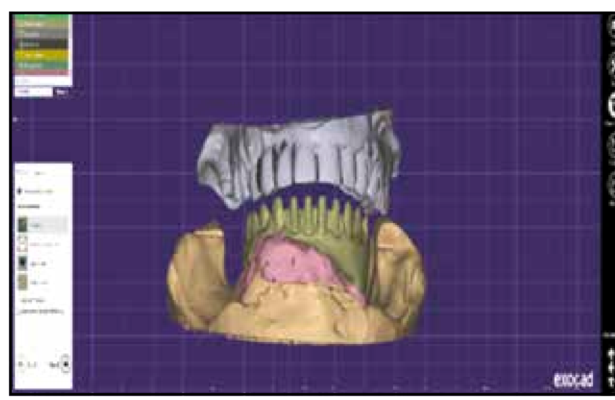

Figure 9. The virtual thimble framework on the working model with the gingival material.

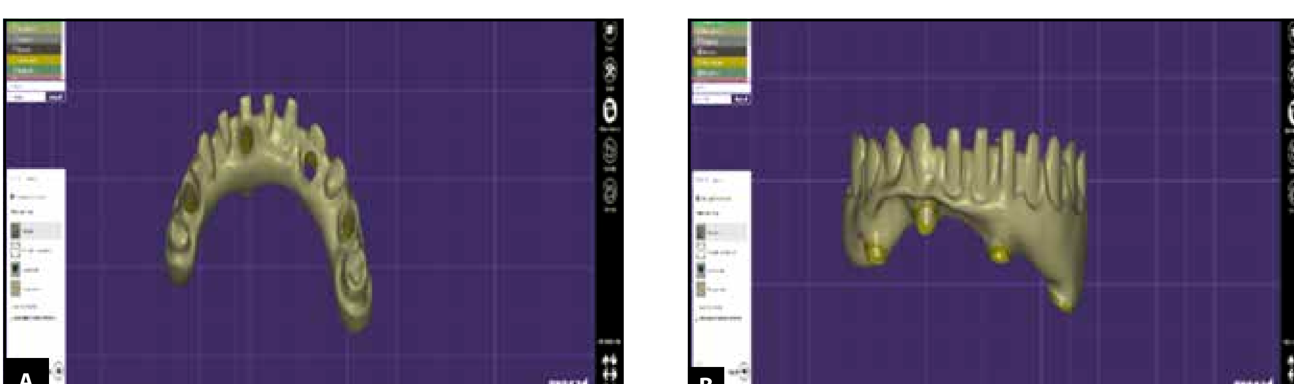

Figure 10. The virtual thimble frame work - occlusal view **(a)** and labial view **(b)**.

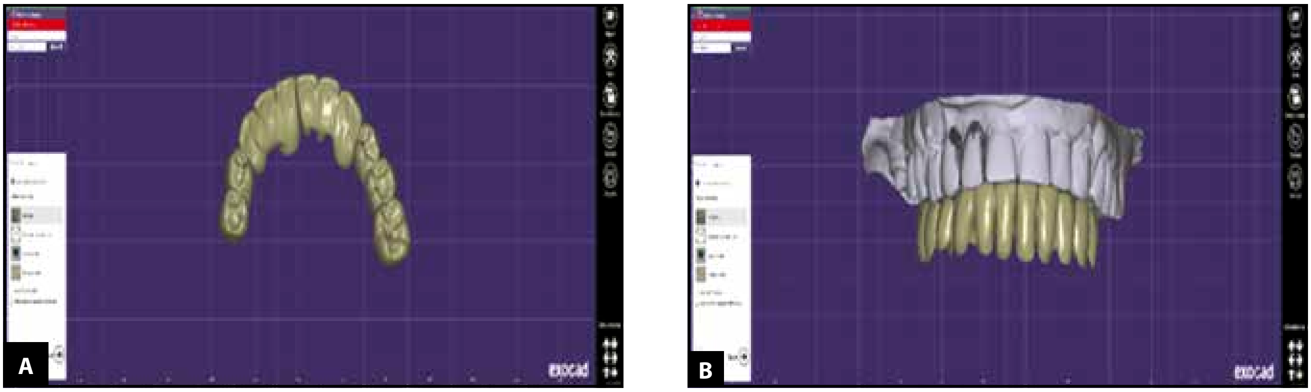

Figure 11. The design of aesthetic components.

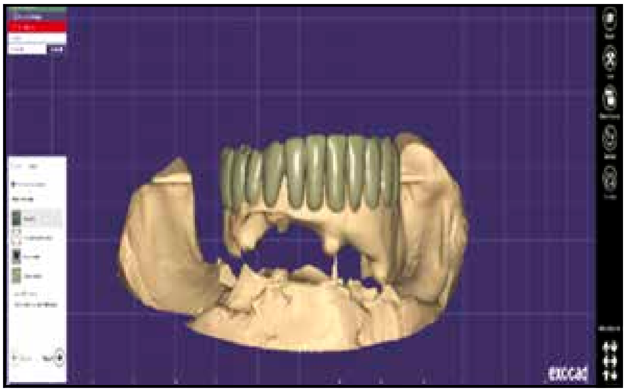

Figure 12. Virtual image aesthetic restorations and the thimble framework overlapped.

ture from a material introduced into dental technology relatively recently, namely BioHPP (Figures 8-14). This material is a high-performance polymer based on polyethylene ether ketone (PEEK), which was introduced by the Bredent company as a dental material for the manufacture of superstructure prostheses on dental implants. The material has constant homogeneity due to the very small size of the granules, approximately 0.3-0.5μm, which gives it special resistance and elasticity compared to that of bone. The material is also easily tolerable, being indicated for patients with allergic manifestations and for patients who complain of the metallic taste, in the case of prosthetic restorations with a metal component.

In this case, this type of framework was chosen because a similar one made from titanium or titanium alloys would have made the final work too heavy and uncomfortable. The patient presented with 4 mandibular dental implants and severe bone resorption.

DISCUSSIONS

CAD-CAM-based technologies allow the use of diverse materials in dental workflows that would otherwise be difficult or impossible to use[4,5]. From dental alloys to ceramics or plas-

Figure 13. The thimble framework made of BioHPP together with aesthetic crowns on the working model **(a, b, c)**.

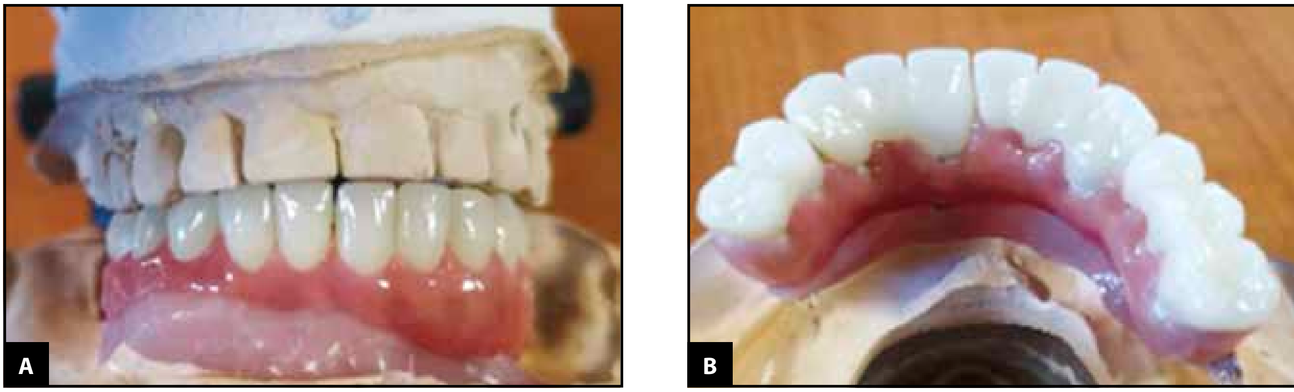

Figure 14. The final aspect of prosthetic restoration, crowns and thimble, after applying the gingival material, labial view **(a)** and occlusal view **(b)**.

tics, the use of these technologies relies on the increased accuracy of the final product.

Zirconia, or zirconium dioxide, has opened up new ways for prosthetic treatment, both as a substructure and as single material[6,7]. Its colour and physical properties have made it a preferred material for both practitioners and patients, despite the classic metal-ceramic systems[8,9].

Hybrid systems used in large implant-supported restorations also benefit from new materials in the digital technological flow. BioHPP is a ceramic-reinforced high-performance polymer that combines the strength and biocompatibility of ceramics with the elasticity of polymers[10,11].

Thus, it offers good bio integration with the tissues it comes into contact with and at the same time, through elasticity, it takes over part of the occlusal forces transmitted to the dental implants on which the prosthetic work is supported[12,13].

CONCLUSIONS

Several aspects can be concluded after reviewing this material.

CAD-CAM technology is considered a future-oriented technique, in continuous evolution, important for both the dental technician and the dentist.

In recent years, full coverage prosthetic restorations have been increasingly requested by patients, and the CAD-CAM technique ensures a fast, precise and predictable workflow.

Patients were satisfied with the aesthetics of the prosthetic pieces, as it is well known that the materials used presented in this article have ideal chromaticity and excellent colour stability over time.

The CAD-CAM system is ideal for making prosthetic restorations such as: inlays, onlays, dental veneers, bridges, crowns, by creating a personalized design for each individual case.

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