Technological guiding principles for manufacturing full-contour zirconia prosthetic restoration using the CAD/CAM method

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Technological guiding principles for manufacturing full-contour zirconia prosthetic restoration using the CAD/CAM method

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ABSTRACT

The introduction of CAD/CAM technology in dentistry opened the way for the use of numerous materials for prosthetic restorations: dental alloys, ceramic masses, zirconia, PMMA, etc. One of the materials suitable for CAD/CAM technology is zirconia, used either ceramic-plated or full-contour, through its mechanical and optical properties. Zirconia, proves to be a real competitor for dental alloys used in porcelain fused to metal technology, with great result on posterior and frontal areas of dental arches. Prosthetic restorations made of zirconia in transit areas (including canines and premolars) exemplify the perfect combination between mechanical resistance and aesthetics of this material.

Keywords: zirconia, full-contour, CAD/CAM

INTRODUCTION

Computerized milling of zirconium dioxide with the help of CAD/CAM (Computer Aided Design - Computer Aided Manufacturing) technology has also advanced considerably in our country and many steps, which were once done only manually and represented a long processing time, are now carried out digital, saving

a lot of time in the technological process of manufacturing fixed prosthetic restorations (1-4).

Nowadays time is very important and it is necessary to learn how to manage it precisely. Thus, CAD/CAM technology provides a wide range of colors and shapes of the teeth, but also precisely outlines certain qualities of very varied materials. The predominant material that is processed through CAD/CAM technology in dental practice, with reference to prosthodontic practice, is zirconium dioxide or zirconia, an extremely robust material, white in color, which can be processed and brought through different processes to whatever color is necessary, according to the color of the teeth next to the edentulous gap and/or according to the wishes of the patients (1-4).

PURPOSE

Computer-aided design (CAD) and computer-aided manufacturing (CAM) have become an increasingly popular part of dentistry over the past 25 years. The technology that is used both in the dental laboratory and in the dental office can be applied to obtain a very varied range of prosthetic restorations, usually fixed but also mobile. At the same time, this CAD/CAM technology also has applications in orthodontic practice. The purpose of this material is actually to present technological aspects regarding the manufacturing process of zirconia fixed prosthetic restorations using the CAD/CAM technology.

MATERIAL AND METHOD

CAD/CAM technology was developed to solve 3 challenges (1-4):

- To ensure adequate strength of the prosthetic restorations, especially for the posterior teeth;
- To create prosthetic restorations with the most natural appearance;
- To obtain prosthetic restorations as easily and quickly as possible, with an adaptation as precise as possible.

In some cases, CAD/CAM technology provides patients one day prosthetic restorations treatment. Both dentists and dental technicians present a wide variety of ways in which they can approach this revolutionary technology.

In the following, several technological guiding principles will be presented regarding the manufacturing of fixed prosthetic restorations from zirconia (full zirconia) using the CAD/CAM method.

RESULTS/ CASE PRESENTATION

A 53-year-old male patient presented in the dental office for the treatment of edentulous areas caused by missing first premolars, 1.4 and 2.4 respectively. The dentist, in agreement with the patient, decided to restore the two edentulous spaces using 3-unit zirconia bridges, using 1.3 and 1.5, respectively 2.3 and 2.5 as abutment teeth. After the endodontic treatment of the previously mentioned teeth, they were prepared to obtain an abutment shape.

Both the functional impression (of maxillary arch) and the impression of opposing teeth (of mandibular arch) were taken in standard impression trays, using condensation silicon material in double consistency, putty and light body. The occlusal relationship was recorded using a fast-setting addition silicone.

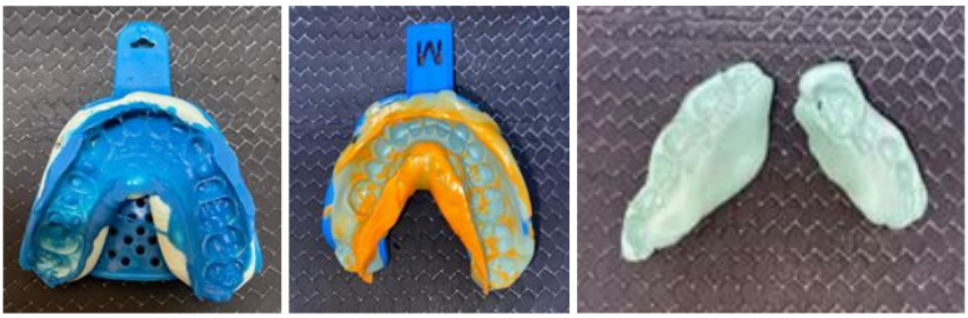

FIGURE 1. – Functional impression (left), opposing teeth impression (center) and occlusal record (left).

A sectional model was chosen using the Accu-Trac system, casted with type IV dental stone. The mandibular model was cast by the classic method using type III dental stone.

FIGURE 2. Functional maxillary model obtained using the Accu-Trac system.

Using the occlusal record previously determined by the dentist in the dental office, the dental technician mounted the 2 models in an articulator.

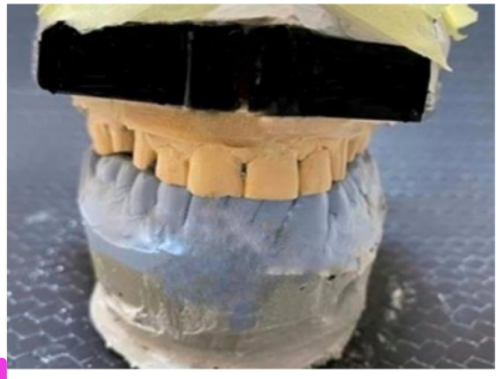

FIGURE 3. Maxillary and mandibular models mounted in articulator.

The two models were scanned separately, but also together in the occlusal relationship, with the help of a dental laboratory scanner. The software used for processing the virtual images of the models was Exocad.

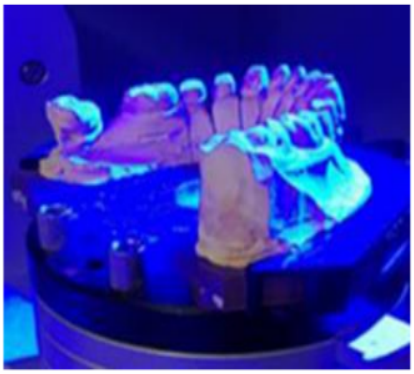

FIGURE 4. Scanning of the maxillary functional model.

FIGURE 5. The virtual maxillary model.

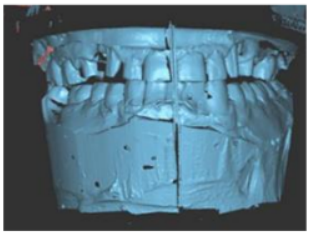

FIGURE 6. Virtual models in occlusal relationship.

The design of prosthetic restorations begins with drawing the edge of the preparation for the abutment teeth, determining the space required for the fixation cement, generating the initial shape of the restoration by the computer, and then modeling and adjusting it by the dental technician based on the experience gained to create a frame as close as possible the natural shape of the teeth in accordance with the remaining teeth at the level of the maxillary arch.

Fig. 9. Trasarea coletului fiecărui bont în parte.

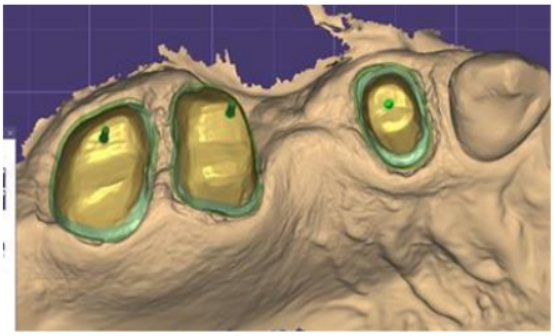

FIGURE 7. For each abutment tooth the edge of the preparation is marked and the space for adhesive cement established.

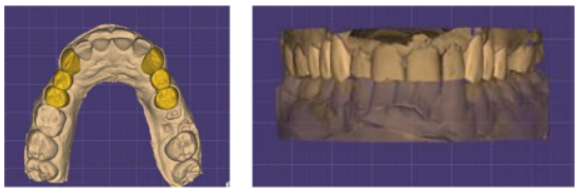

FIGURE 8. The design of prosthetic restorations in accordance with the remaining teeth, occlusal view (left), labial view (right).

The teeth were arranged according to the proximal space and antagonist teeth, the occlusal landmarks but also according to the physiognomy of the neighboring teeth.

After establishing the final shape of the restorations, they were placed at the level of the virtual image of the zirconia disc with the attachment of the support connectors. All the information was later sent to the milling machine for the physical manufacturing of the restorations.

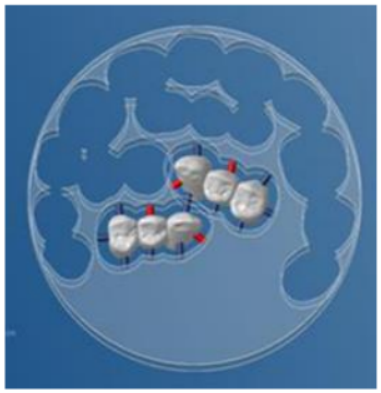

FIGURE 9. Attaching virtual restorations at the level of virtual zirconia disc. The computer ensures enough space around restorations to avoid gaps or other defects, and place supporting rods to ensure stability of restorations during milling process.

The milling of the restorations is carried out based on the information transmitted by the computer, the accuracy being high.

FIGURE 10. Computerized milling of the two prosthetic restorations in the zirconium dioxide disc.

FIGURE 11. The appearance of the restorations at the end of the milling process.

After removal from the zirconia disk, by sectioning the supporting rods, the restorations are subjected to the sintering process. This process is carried out in special furnaces, the sintering program having a duration of approximately 600 minutes, with a gradual heating process, the maximum temperature being approximately 1430-1470 °C, temperatures at which the restorations are maintained for approximately 120 minutes.

FIGURE 12. Prosthetic restorations at the end of the sintering program.

In the last stage, the dental technician made the final color touch-ups by applying pigments according to the recommendations given by the doctor, and later applied the glaze layer on the surface of the two zirconia prosthetic restorations.

FIGURE 13. The final aspect of 3-unit full-contour zirconia prosthetic restorations fitted on the functional model, ready to be sent to the dental office for try-in and adhesive cementation.

DISCUSSIONS

The way of designing the treatment plan in the case of missing teeth, and the restoration using fixed prosthetic works gained new meaning with the introduction of zirconia as a restorative material [5,6]. Appearing as a byproduct of CAD/CAM technology, zirconia, through its mechanical and optical properties, proves to be a real competitor for metal alloys used in porcelain fused to metal technology [7,8]. The mechanical strength recommends this material for use in the lateral areas of the arches, where masticatory forces are significant [9,10].

The aesthetic part is significantly improved by the matte color of the material, which eliminates the need to mask the gray appearance given by the usual dental alloys or even the color changes at the level of the dental abutments [11,12]. Even the use of post and core made of dental alloys is no longer an impediment, especially

in the frontal area, zirconia restorations, full-contour or plated with ceramic masses, having a much more natural appearance with superior integration at the level of the dental arches [13,14]. This is also visible in the presented clinical case, where the prosthetic restorations aimed the transition area of the arch, at the transition between the frontal and lateral areas [15,16]. Thus, zirconia has been used both to give resistance to prosthetic restorations and to restore the aesthetics of affected areas [17,18].

The aesthetic component is helped by the color tinting applied by the dental technician in the last part of the technological process, but also by the existence on the market of zirconia discs for CAD/CAM processing in different shades [19]. This helps to achieve a natural-looking restoration with a color that comes from the depth of the work, not just from the superficial layers that can erode over time [20].

CONCLUSIONS

At this moment in Romania, CAD/CAM technology is in continuous development, and this gives more confidence in future collaborations. The range of materials, but also of devices, offers safety to dental technicians, these prosthetic restorations being particularly resistant and above all allowing to considerably reduced the working time.

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