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Clinical case

Complete Implant-Supported Fixed Metal-Ceramic Prostheses with Milled Metal Occlusal Surfaces Designed and Manufactured with CAD/CAM

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ABSTRACT

Introduction: Fixed prostheses on dental implants are made of various materials and designs. The most frequent mechanical complications are delamination and wear of the materials. **Objective:** To demonstrate the advantages of prostheses with milled metal occlusal surfaces to reduce mechanical complications. **Case presentation:** Two full-arch fixed prostheses on implants were planned to treat an 80-year-old patient whose teeth presented periodontitis and caries. CAD/CAM technology with milling technique was used in the structure. Once the polished prostheses were placed in the patient's mouth, it was observed that when she smiled, the milled metal occlusal surfaces were imperceptible, in addition to reducing the risk of delamination and providing a better passive fit. **Conclusions:** CAD/CAM technology allows obtaining milled metal occlusal surfaces that favour the reduction of mechanical complications, and a better passive adjustment at competitive costs.

Keywords: metal occlusal surfaces, CAD/CAM technology, milling technique.

INTRODUCTION

The advantages of implant-supported fixed prostheses include retention and stability, the ability to preserve bone and ensure occlusal contacts[1-3]. On the other hand, it has the disadvantage that the treatment is prolonged, expensive, and involves surgical procedures. To place implant-supported fixed prostheses, there must be alveolar ridges of sufficient thickness and height, adequate lip support and a low smile line[4]. These prostheses can be supported by a minimum of four implants, and are made of various designs and materials. The most common are those made of acrylic-metal, which are also the most economical if made with a metal alloy base[5,6]. However, occlusal wear can decrease the vertical dimension, which can cause anterior teeth to break. Furthermore, with wear they tend to fracture partially or as a block and, over time, acrylic becomes pigmented[7-10], unlike metal-porcelain prostheses that tend to delaminate[10-12].

Zirconia-porcelain prostheses have the disadvantage that zirconia tends to delaminate[13-15], its bond is weaker than that of metal-porcelain prostheses; its attachments thicken it, which makes hygiene difficult, and there are no varied shades of pink porcelain[15]. Compared to zirconia-porcelain prostheses, monolithic zirconia prostheses have the advantage of being more resistant[14,16-18], although it is unknown how long it will take for titanium cylinders to become dislodged[15]. Zirconia prostheses with individualized crowns and metal prostheses with individualized crowns are the ones with the most disadvantages, both due to their high cost and because the marginal seal of the crown becomes pigmented and they often fail at the junction of the crown, the structure and the gum[9,19]. Likewise, crowns are difficult to recover if they need to be removed.

In the case of metal-porcelain prostheses with metallic occlusal surfaces, they have advantages such as being resistant to occlusal wear, the vestibulolingual thickness can be increased in the cantilever in its mesial part, to reduce mechanical problems[20], and they can be economised by making them with a base metal alloy such as cobalt-chromium. Additionally, it has the highest bond to porcelain of the base metals and is the best alloy for a superstructure from a biomechanical point of view. However, it should be taken into account that it may compromise aesthetics, the occlusal adjustment depends on the resin test and the casting of the structure requires good handling when pouring it, otherwise it may lack passivity. Although they have disadvantages, they can be mostly eliminated with Computer-Aided Design and Computer-Aided Manufacturing (CAD/CAM) technology. In the present case, fixed prostheses on teeth with metal occlusal surfaces from the past are resumed, but using CAD/CAM technology with the milling technique, which offers a better passive fit and precision.

CLINICAL CASE PRESENTATION

An 80-year-old female patient visited the UNAM Oral Prostheses and Implantology Clinic for consultation regarding her loosened removable prostheses. She inquired about possible solutions due to having few remaining teeth, which had impacted her diet, self-esteem, and social interactions (Figure 1). The diagnosis was based on clinical and radiological examination. Several treatment plans were described with their advantages and disadvantages, and the patient chose the bimaxillary implant-supported fixed prostheses.

The remaining teeth were extracted and immediate prostheses were placed. After six months of bone maturation, permissive surgical guides for the maxillae and mandible were fabricated. Local anaesthesia with vasoconstrictor (Medicaine 1/100,000 (articaine-epinephrine), Septodont Holding, Saint-Maur-des-Fossés, France) was applied to both arches, a plateau was made in the anterior part of the mandible so that the implants would be at the same height on the alveolar ridge, and the implant manufacturer's surgical protocol was followed (Nobel Active® RP, Nobel Biocare Services AG, Kloten, Switzerland), four in each arch: two straight anterior implants and two inclined posterior implants[21,22]. The mandibular implants received trans-mucosal abutment (Multi-unit abutment, Nobel Biocare Services AG, Kloten, Switzerland): 2 straight anterior abutments and 2 17° posterior abutments with a torque of 35 Newtons to correct the angulation of the implants and convert the immediate denture to a screw-retained fixed total prostheses. Two months after surgery, the maxillary trans-mucosal Multi-unit abutments were placed: 2 straight anterior abutments and 2 17° posterior abutments (Figure 2).

To take the impression, splinting of the impression pins was used. Polyvinyl siloxane impression material (Elite HD+, Zhermack SpA, Rovigo, Italy) was used with a customised light-curing tray (Palatray® XL, Kulzer GmbH, Hanau, Germany), and type IV plaster (Elite Rock Sandy Brown, Zhermack SpA, Rovigo, Italy) was poured into the impression. To retain the registration bases with the rollers and obtain the maxillomandibular relationships, two healing screws were placed in each arch. The obtained models were mounted on a semi-adjustable articulator (Hanau™ Mate™, Whip Mix, Kentucky, USA) and the teeth were aligned at approximately 22° with an occlusal scheme based on bilateral group. After intraoral evaluation of the try-in teeth, aesthetics, occlusion, vertical dimension of occlusion (VDO) and phonetics were confirmed[23].

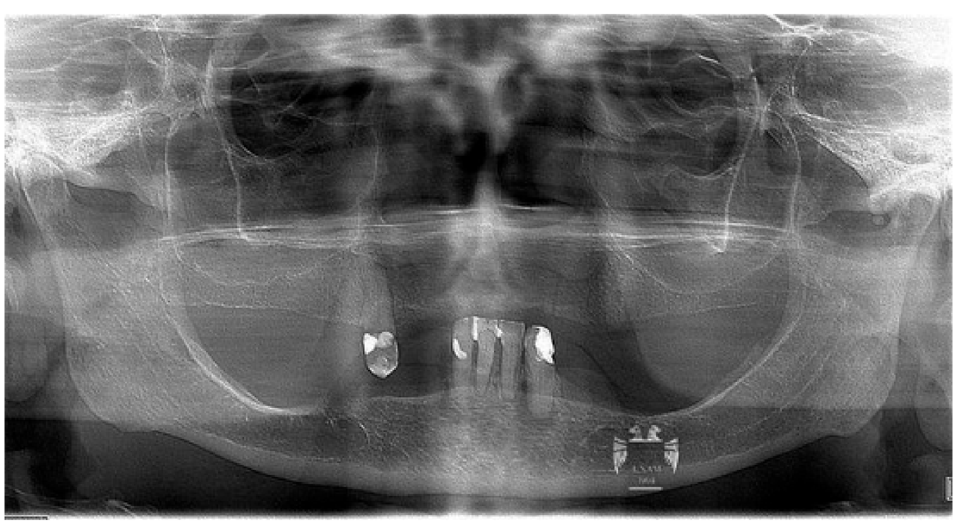

Figure 1. Preoperative orthopantomography.

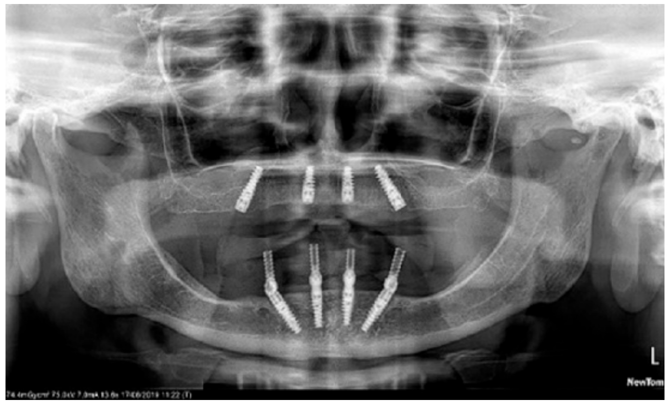

Figure 2. Orthopantomography of dental implants in both arches, with trans-mucosal abutments in the mandible.

The teeth test was sent to the lab, where it was scanned together with the models with a 3shape scanner (3Shape A/S, Copenhagen, Denmark). The prostheses' structure was then designed and milled with water on a cobalt-chrome disk, using a milling machine (*imes-icore* GmbH, Eiterfeld, Germany) that can move on five axes, which allowed the occlusal surfaces to be milled.

The metal test was verified intraorally, using radiographs and the Sheffield test to confirm passivity (Figure 3), and the occlusion was adjusted. After confirming the fit of the prostheses, the porcelain test was performed[24], the occlusal scheme was verified based on the bilateral group with cusps of approximately 22° and was left without anterior guidance to avoid delamination of the anterior teeth[25]. The final prostheses were subjected to porcelain try-in and sent to the laboratory for glazing and then screwed into the mouth with a torque of 15 Newtons.

By milling the prostheses, a better passive fit was achieved in the connections, avoiding the formation of bubbles caused by casting, as well as the contraction that results in a lack of passive fit. When the patient smiles, the metal occlusal surfaces are imperceptible (Figure 4). The metal occlusal surfaces are intended to maintain the vertical dimension in the long term and reduce porcelain delamination.

Figure 3. Passivity of structures with connections.

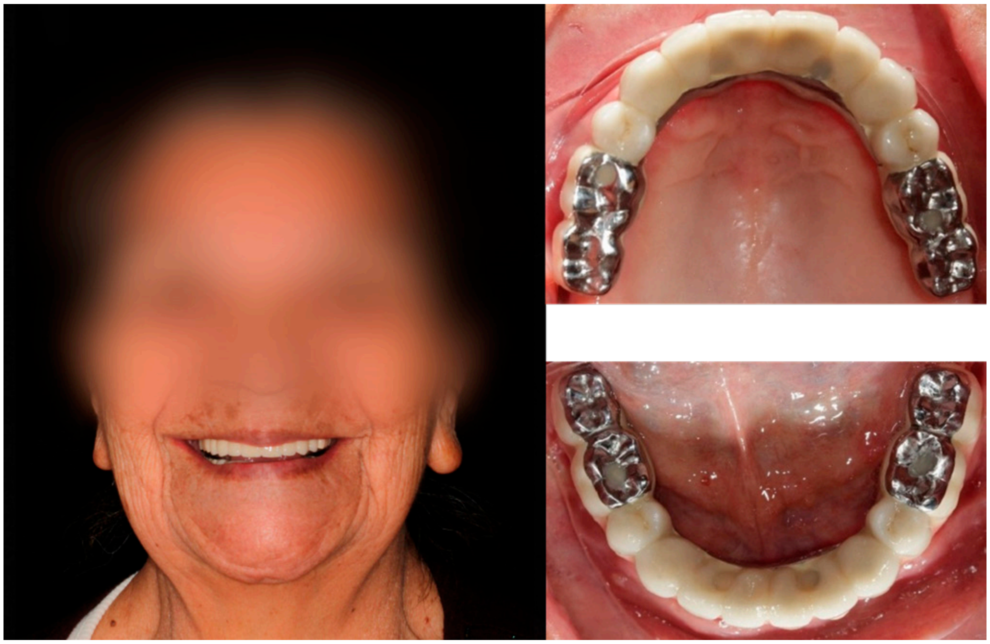

Figure 4. Smile with the final try-in with the glazed prostheses with metal occlusal surfaces.

DISCUSSION

According to Box *et al.*[9], González *et al.*[11] and Papaspyridakos *et al.*[12], delamination is one of the main disadvantages of implant-supported fixed prostheses made of acrylic metal, metal porcelain, zirconia or metal with individualized crowns and monolithic zirconia and/or porcelain-coated. Therefore, in this case, metallic occlusal surfaces were created in the posterior sector, which can reduce porcelain delamination and maintain the vertical dimension of occlusion in the long term. Likewise, as suggested by AlBader *et al.*[20], with the metal structure it is possible to increase the thickness of the cantilever to make it more resistant and reduce its fracture. Another advantage of this treatment is that it allows the use of a non-precious metal of adequate strength such as cobalt-chromium, which is compatible with the tissues and is less expensive for the patient. Finally, another benefit is that with the milling technique there is a better passive fit and bubbles and metal defects are avoided unlike the cast technique.

One of the disadvantages of this treatment is that the posterior metal occlusal surfaces could compromise aesthetics. Even so, in our clinical case, when the patient smiles the metal occlusal surfaces are imperceptible. Similarly, if metal occlusal surfaces were placed only on the molars, there could be delamination of the porcelain on the premolars due to occlusal loading, which would be avoided by placing metal occlusal surfaces on the premolars. In the present case, the patient opted only for the placement of metal occlusal surfaces on the molars. Thirdly, if the structure is made using the casting technique, good casting management is necessary, as suggested by Han *et al.*[26]. According to Albader *et al.*[20], the greater or lesser difficulty of occlusion adjustment depends on the planning.

On the other hand, Fischer *et al.*[27] propose placing metallic palatal surfaces to avoid fractures in the anterior teeth. In the present case, it was proposed to leave the prostheses without anterior guidance to avoid fracture of the porcelain of the anterior teeth. It was also proposed to use the recent CAD/CAM technology to design and manufacture the structure of the prostheses. This technology allows for the virtual placement of attachments, models and waxing, and replaces traditional casting techniques for precious or non-precious metals in the manufacturing of structures. Grageda *et al.*[4] propose that this process has a better cost-benefit ratio, is more accurate and makes it possible to use more materials such as titanium, zirconium and cobalt-chromium to manufacture the structures.

In our case, the subtractive CAD/CAM technique was used by means of the *imes-icore* milling machine, which can read and cut any type of structure in various materials such as cobalt-chrome using a five-axis system. Thus, several disadvantages of the casting technique are eliminated and a better passive fit and greater bond strength between metal and porcelain are achieved, while bubbles and other defects are also avoided, as well as human error. Another advantage of prostheses with metallic occlusal surfaces is that the desired design is made in a resin test for better planning, which allows verification of the most appropriate and repeatable centric relation (CR), and the occlusion is adjusted precisely so that the milling machine reproduces it perfectly. In the case described, the resin test was not performed due to a discrepancy with the laboratory, which, despite requesting the resin test, omitted it and went directly to the metal test, so adjusting the occlusion in the metal resulted in hours spent in the unit with the patient.

While the casting and milling technique has several advantages, the literature indicates that the selective laser fusion technique shows better properties, such as orderly solidification of the framework, greater precision and greater bond strength of porcelain to metal. The technique minimizes operator error and defects. As demonstrated by Fischer *et al.*[27], Wu *et al.*[28], Svanborg *et al.*[29] and Hitzler *et al.*[30], unlike the milling technique, no material is wasted because the remaining powder can be used. On the other hand, the use of cobalt-chromium in the structure of fixed prostheses on implants is gaining popularity because it is an economical and resistant material, because of its biological compatibility and because it allows corrosion problems to be avoided.

CONCLUSIONS

CAD/CAM technology allows us to make milled metal occlusal surfaces that help maintain the vertical dimension. At the same time, it results in a metal free of bubbles and with a better fit in the connections, thereby reducing mechanical complications such as fractures in the long term, at competitive costs. However, it requires the preparation of a resin test to confirm the aesthetic, phonetic and passivity of fixed prostheses on implants, especially in the occlusion, because once the occlusal surfaces are finished in metal, only small adjustments can be made to the occlusion.

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