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CASE REPORT

Use of zirconia in full maxillary rehabilitation on implants. Clinical case report

Zirconia para rehabilitación completa maxilar sobre implantes. Caso clínico

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ABSTRACT

Zirconia (ZrO_2) is a ceramic material possessing suitable mechanic properties for usage in frameworks over implants. Presently, there is availability of zirconia cores for fixed partial prostheses in anterior and posterior teeth and implants. Accuracy and precision in framework manufacturing are a pre-requisite for long-term success in restorations supported by implants. Manufacturing of zirconia framework requires wide knowledge and skill in clinical operators as well as technicians in order to achieve suitable adjustment and passiveness. The present article describes the manufacture of a ZrO_2 structure and individual crowns to rehabilitate the maxillary segment with six implants.

RESUMEN

La zirconia (ZrO_2) es un material cerámico con propiedades mecánicas adecuadas para uso en estructuras sobre implantes. Los núcleos de zirconia para prótesis parcial fija en dientes e implantes anteriores y posteriores ahora están disponibles. Actualmente la exactitud y precisión en la elaboración de estructuras son un prerrequisito para el éxito a largo plazo en restauraciones implanto soportadas. La elaboración de estructuras de zirconia requiere de un amplio conocimiento por parte del clínico y el técnico para lograr un adecuado ajuste y pasividad. En este artículo se describe la elaboración de una estructura de ZrO_2, y coronas individuales para rehabilitar el segmento maxilar con seis implantes.

Key words: Zirconia, dental implants, ceramic restorations.
Palabras clave: Zirconia, implantes dentales, restauraciones cerámicas.

INTRODUCTION

Zirconia is a zirconium crystalline dioxide. Its mechanical properties are very similar to those of other metals. It exhibits a tooth-like color.[1] In 1975, Dr. Garvie proposed a model to rationalize zirconia mechanical properties, for this reason it has been called «ceramic steel».[2] Zirconia crystals can be organized into three different patterns: monoclinic (M), cubic (C) and tetragonal (T). When ZrO_2 is added to other metallic oxides, like, for example, MgO, CaO or Y_2O_3, considerable molecular stability is achieved.[1] Zirconia stabilized with yttrium is known as polycrystalline, tetragonal zirconia (PTZ), and presently it is the most studied combination.[3]

The first medical use of zirconia was effected in 1969, in orthopedics, mainly as a new material used to replace the head of the femur, which traditionally, up to that date, had been replaced with alumina and titanium prostheses.[4]

Zirconia exhibits properties similar to those of stainless steel. It is a radio-opaque material, and presents resistance to traction which can range from 900 to 1,200 MPa, as well as resistance to compression neighboring 2,000 MPa.[5]

The resistance to fracture exhibited by zirconia oxide is due to the fact that, when a fissure occurs, it produces energy increase and thus elicits tangential pressures as well as a change in structure; it then passes from its tetragonal shape to the mono-clinical shape (with 4.7% more volume) and therefore, the progress of the fissure is arrested due to the effect of compression forces.[6]

Recent studies have shown that zirconia surfaces accumulate a lesser amount of bacteriae when

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compared to commercially pure titanium.[7] Other research papers have assessed resistance to fracture of totally ceramic appliances (Al_2O_3 and ZrO_2). Resistance of both appliances exceeds maximum values established for incisal load as reported in scientific literature. Nevertheless, zirconia appliances were twice as resistant as Al_2O_3.[8] Several studies have additionally demonstrated ZrO_2 high tissue biocompatibility and suitable tolerance after having been sub-cutaneously placed during a six to twelve month period.[9]

Single-tooth restorations are the most common indication for modern ceramic material. Nevertheless this must be supplemented by the increase in the use of dental implants as well as multiple units of fixed prostheses.[10] Presently, materials chosen for treatments over implants include titanium (titanium) alloys, densely synthesized aluminum oxide ceramic (alumina) and synthesized zirconia oxide ceramic (zirconia).[11] In 1993, the first totally ceramic component was introduced as an alternative to the commonly used titanium appliances. This was the result of the constantly growing demands for esthetic restorations over implants.[12]

In the field of implantology, several studies have documented the successful application of ceramic and titanium for appliance manufacturing. Appliances then acquire great stability and biocompatibility. Use of totally ceramic materials has increased in spite of the greater resistance to fracture exhibited by metal-ceramic crowns cemented on titanium appliances when compared to fully ceramic crowns cemented on ceramic appliances.[13] Ceramic appliances exhibit excellent esthetic potential, when manufacturing is meticulous, they equally offer long term stability.[14]

Zirconia oxide ceramic (ZrO_2) is presently a material used for the manufacture of implant frameworks and appliances.[15]

Precision and accuracy are essential pre-requisites when manufacturing super-structures for the long-term success of implant-retained restorations.[16] Presently, promising and interesting materials for manufacturing appliances and frameworks are ZrO_2 ceramic as well as yttrium-stabilized tetragonal zirconia dioxide (Y-PTZ). These are ceramic materials that can be used in any area of the oral cavity. Nevertheless, long-term clinical data are yet to be assessed.[17]

The present article documents the use of zirconia oxide (ZrO_2) as an option to manufacture frameworks for restorations over implants. The primary objective is the passive fit of the framework as well as inter-phase sealing with the aim of avoiding premature loosening of screws during function, as well as providing long-term stability. Other important factors are biocompatibilty and esthetics.

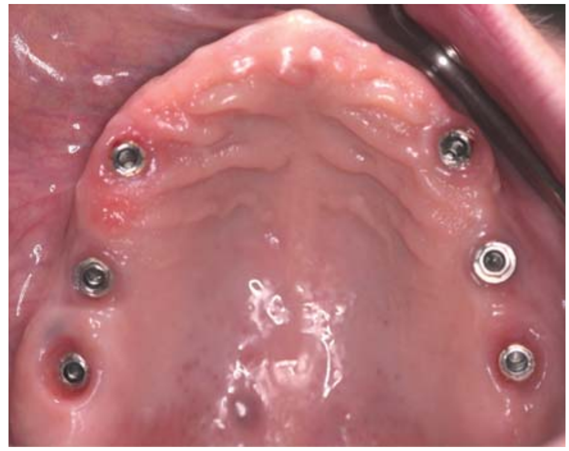

Figure 1. Initial circumstances.

CASE PRESENTATION

A 66 year old female patient attended the Implantology Department of the Research and Graduate School, National School of Dentistry, National University of Mexico (UNAM). The patient exhibited total edentulism in the upper jaw as well as multiple ceramic restorations in the lower jaw *(Figure 1).* Clinical and radiographic examination revealed the following in the upper jaw: bilateral elevation of the maxillary sinus floor as well as six bone-integrated implants (Intra-lock® System, Biolock) measuring 4.0 x 13 mm. Implants were asymptomatic and integrated to bone tissue. Placement locations corresponded to absent canines, second premolars and first molars.

TREATMENT PLAN

When dealing with full rehabilitation over implants, initial selection of type of permanent restoration is not always easy. The shape of the upper arch bears influence upon the treatment plan and it represents the first factor to be analyzed in the treatment plan. The shape of the patient's dental arch is determined by the final position of the teeth in the pre-maxillary area.[18] The three typical shapes of the dental arch are: quadrangular, ovoid and triangular. In quadrangular arches, as was the case for this patient, central and lateral incisors only created a small projection (cantilever) towards the vestibular direction. In canine implants, the mandible excursive movement as well as occlusal forces can be reduced. As a result, canine implants can be sufficient, especially

Figure 2. Provisional prosthesis.

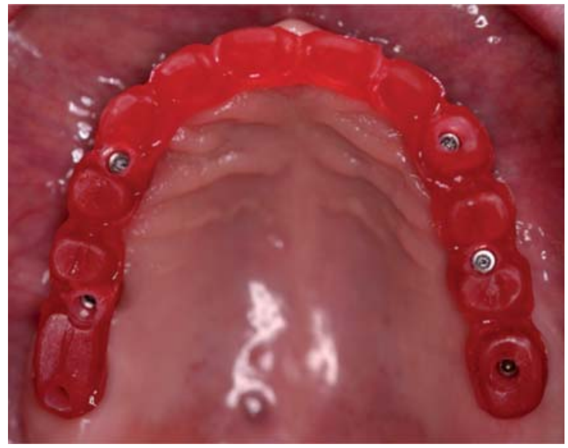

Figure 3. Framework test in resin.

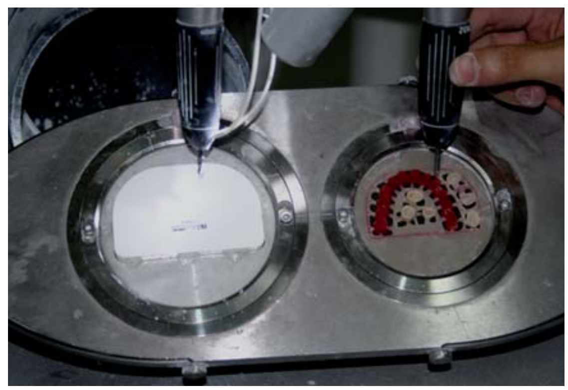

Figure 4. Zirconia framework manufacture.

Figure 5. Soft tissue characterization.

when they are splinted with other posterior implants.[19] According to scientific literature, implant -borne maxillary fixed full prostheses are manufactured with an average of six standard- diameter implants.[20] Another important factor in the treatment plan is the relationship between horizontal and vertical planes. The space filled by a crown in an edentulous area varies considerably. If the crown surpasses 15 mm; it indicates that there is vertical loss of alveolar bone and soft tissue. This will entail a problem for fixed restorations. Artificial teeth are elongated, and it is necessary to increase gingival hue in esthetic zones. The longer the shape is, greater will be the impact on the implants, and the more will the force moment increase, therefore, greater will be the risk of a fracture.[21] Based upon the aforementioned data, it was decided to manufacture an upper fixed prosthesis with six implants, zirconia framework and crowns cemented upon it.

The first phase of the treatment included taking impressions with polyvynilsiloxane (Elite HD Zhermack Spa), use of standard impression copings (Intra-lock® System, Biolock) and acrylic impression tray. Models were mounted on a semi-adjustable articulator and were analyzed in order to assess inter-occlusal distance and position. A provisional, full upper denture was manufactured with suitable dental contour, shape and size. Occlusal function was then established *(Figure 2)*. The provisional prosthesis was screwed into the implants with provisional appliances (Intra-lock® System, Biolock) immersed into the acrylic denture.

ZIRCONIA FRAMEWORK

The master model was achieved with a technique involving an open tray, linking impression copings with Duralay acrylic resin (Reliance Dental Mfg). Copings had been previously linked and sectioned to decrease distorsion.[22] The master model was mounted on a semi-adjustable articulator (Hanau Modular 190, Teledyne Water Pik Ft Collins USA). Suitable vertical dimension was secured. In order to achieve suitable tooth position, shape and size, a matrix was obtained from the provisional prosthesis as well as for the manufacturing of the zirconia framework. Preparations for the crowns were achieved using burs.[23]

After the aforementioned process, a self-polymerizing acrylic resin (Pattern Resin, GC) framework was achieved with UCLA type appliances immersed within the resin. Patient passiveness was then assessed *(Figure 3)*. After that, the framework was positioned in the resin plate of the Zirkon-zahn® system which is placed in the right plate of the burr milling device, while on the left plate we placed the corresponding zirconia block. The rehabilitation's complete volume was drilled with a bur, including the implants' conical bases.

In order to drill the implants' exits we had to ensure that they were parallel to the drilling burr. This forced the rotation of the model to the right or left so as to achieve that parallelism *(Figure 4)*.

Once the model had been drilled we proceeded to remove it from its supporting structure. At this point, using tungsten burrs at low speed, suitable detail was achieved. Once this was achieved, the model was sintered during six hours at 1,600 °C. With this process it would decrease its volume by 25%, achieving thus all the properties of sintered zirconia.

Once the framework was completed, restoration's passiveness was assessed. The high fusion point of the material will preclude concerns about ceramic firings.

After this, equally with zirconia, we proceeded to establish the final restoration's cores. Over them, initially, an even, thin layer of ceramic wash was applied. The oven's temperature was raised by 20-30° over the firing temperature of the dentin. This improved zirconia-ceramic bonding.

Crowns, as well as soft tissue characterization were completed with ceramic mounting (Ice Zirkon Keramik) *(Figure 5)*. Crown morphology, vestibular position and esthetics were based on the provisional prosthesis which played the role of a matrix in the manufacturing of the final restoration.

Finally, the restoration was made of a zirconia oxide framework with six incorporated UCLA appliances, twelve preparations for full crowns, as well as the corresponding crowns manufactured with zirconia oxide and ceramic (Ice Zirkon, Keramik).

Restoration insertion, with the help of X-rays, consisted on confirming the sealing of the appliances on the platform implants applying torque to 35 Ncm screws, obliterating the screw's access, and finally, crown cementation using glass ionomer cement *(Figure 6)*.[24]

Figure 6. Prosthesis insertion.

DISCUSSION

Complex clinical situations require careful treatment planning. The design of the final restoration must follow basic restoration requirements such as: function, phonetics and esthetics, as well a use of appropriate materials.

Zirconia oxide (ZrO_2) is presented in scientific literature as a ceramic material which exhibits mechanical properties suitable for prosthetic use in the field of Dentistry.

Use of ZrO_2, up to the present, has increased in the field of Implantology, since 1993, when the first ceramic appliance was presented. Presently, zirconia plays an important role in the manufacturing of fixed partial prostheses supported by teeth or implants. Fixed partial and single restorations with pontics are possible in anterior and posterior areas due to the mechanical circumstances of the material.[25]

In our days, extension of a partial fixed prosthesis using ZrO_2 is no longer a limitation. There are reports of restorations of up to five units.[26] Nevertheless, further supporting research is still needed to assess viability of full-arch extension prostheses.[27]

CONCLUSIONS

Zirconia exhibits biocompatibility, suitable mechanical properties and sealing reliability in restorations used in dentistry.

Long-term clinical evaluations are an essential requirement when using zirconia in full-arch frameworks to be used with implants.

In this type of restorations, adequate patient selection and suitable combination of clinical and technical protocols are imperative to achieve successful results.

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