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CASE REPORT

Replacement of congenically missing maxillary permanent canine with a zirconium oxide dental implant and crown. A case report from an ongoing clinical study

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Abstract

This article describes a case report of an ongoing clinical investigation with zirconium oxide (ZrO_2) dental implants. The patient was a young female who was missing an upper right canine. A one-piece (implant + abutment) ZrO_2 implant (CeraRoot) with acid-etched surface (ICE surface®) was implanted. The preoperative situation was ideal in terms of soft tissue and bone preservation, and the surgery was done transmucosally without having to raise a flap. The soft tissue healed successfully around the implants within few days. The case was finally restored with a ZrO_2 crown (CeraCrown) and ceramic characterisation.

Clinical relevance

Today, it is accepted that zirconium oxide is a highly biocompatible material and it is being used in restorative dentistry for many years. The scientific evidence shows that zirconium oxide dental implants osseointegrate well, but the relative smooth surface of this material osseointegrate with lower bone-to-implant values compared with roughened surface titanium implants. Acid-etched zirconium oxide dental implants have a novel rough surface that is being clinically studied with promising results. This article is a case report of an ongoing clinical study with zirconium oxide dental implants.

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Conflict of interest: Drs Oliva are clinical advisors of Oral Iceberg s.l.

Introduction

The material of choice for dental implants is commercially pure titanium because of its well-documented biocompatibility and suitability for tooling. This biocompatible material[1] has been used for about 30 years as implant substrate and has shown high success rates[2]. A possible alternative to titanium might be tooth-coloured materials such as ceramics[3,4]. Ceramic materials are highly biocompatible and can be used as dental devices[5]. One ceramic material that has been used in the past as dental implants is aluminium oxide (Al2O3). This was the so-called Tübingen implant made by Frialit (Dentsply-Friadent, Germany)[6–8]. This material apparently osseointegrated well but did not have sufficient mechanical properties for long-term loading, and the product was withdrawn from the market.

Recently, another ceramic material with potential for future use as dental implant material was introduced. Zirconia as a metal substitute possesses good physical properties, like a high flexural strength (900–

1200 MPa), hardness (1200 Vickers) and Weibull modulus (10–12)[9,10,11]. Marx *et al*.[12] stressed the importance of the threshold stress intensity factor of zirconia ($K_{10} = 3.1 \pm 0.2 \text{Mpa}\sqrt{\text{m}}$) for determining the long-term stability of such material. Furthermore, its biocompatibility as a dental implant material has been demonstrated in several animal investigations[13–20]. Also, *in vitro* experiments showed that the material is capable of withstanding simulated long-term load; however, the mechanical properties of zirconia seems to be influenced by mechanical preparation of the material[17,21]. Moreover, the exposure of zirconia implants to the artificial mouth has no statistically significant influence on the mean fracture strength values of the implants[21]. Kohal *et al*.[22] published a case report of a machined zirconia implant and zirconia crown in one patient achieving an excellent aesthetic result. Modern implant research shows that a rough surface topography is desirable to enhance the bone integration process[23], but the turning of zirconia rods result in a relatively smooth surface. In this line, Senerby *et al*.[20] demonstrated a better implant retrieval torque resistance of porous zirconia surfaces in rabbits and similar results were obtained by Gahlert *et al*.[24]

In a recent publication, we[25] reported the preliminary results of an ongoing clinical study with zirconium implants and the success rate was comparable to titanium implants. This ongoing investigation started with two kinds of rough surfaces (one coated and one non-coated) and after the new development of the acid-etched surface (ICE), it was implemented into the study. This case report is part of the ongoing clinical investigation and the zirconium implant has the ICE surface.

Case presentation

A 35-year-old female missing an upper right maxillary canine was referred to the office. The upper right deciduous canine had exfoliated a few weeks before without any pain or inflammation. The patient had a history of smoking a pack of cigarettes a day for more than 5 years and had been infected of hepatitis A at the age of 20. The patient asked for a simple treatment to restore the missing tooth.

Initial examination

The initial soft tissue examination revealed a complete healing of cuspid 13 area, with a total preservation of the horizontal and vertical soft tissue dimensions. An adequate keratinised mucosa and gingival contour was also present. A panoramic radiographic examination confirmed that the maxillary right permanent canine was congenitally missing and the left canine was impacted in the maxilla with the deciduous cuspid still in place. The occlusion was a molar and cuspid class I. Overjet and overbite was normal and there was a large diastema between the two upper central incisors. All teeth of the mouth presented tetracycline stains (Fig. 1).

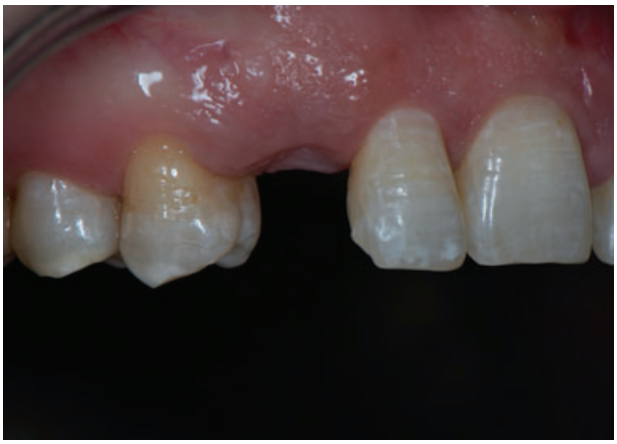

Figure 1 Tetracycline stains on teeth.

Treatment plan

The patient's chief complaint was to restore tooth number 13 with a simple procedure. The patient was completely satisfied about the aesthetics of her smile and for this reason, the patient refused to undergo orthodontic treatment to close the midline diastema by widening bilateral canine's space, and to bring left permanent canine into the arch or any restorative procedure to improve the appearance of her smile. She did also refuse any global restorative procedure. It was planned to place a CeraRoot® (Oral Iceberg s.l. Barcelona, Spain) zirconium oxide dental implant transmucosally. The main selection criteria for this implant is that it has a scallop contour for the final reconstruction that allows placing the restorative margin paragingivally or slightly subgingival, and thus eliminating subgingival implant connections and restorative margins that may induce bone remodelling because of the bacterial colonisation in these sites.

Surgery

The space for cuspid number 13 was insufficient for a normal cuspid implant and crown. For this reason,

CeraRoot implant type 14 was selected which has an ovoid section (Fig. 2) and is normally used to restore bicuspids. Standard osteotomy with the sequential drilling procedure of the system was performed. Special attention was taken with the drills to achieve a good mesiodistal and bucolingual inclination. Following, the implant was positioned into the site manually and then impacted with the use of the seating instrument and the hammer, until it reached the desired vertical position of the margin for the restoration. Oral care instructions were given to the patient, and also to pay special attention during mastication, to avoid overloading the implant prematurely. The patient was advised to quit or reduce smoking for 15 days before surgery and 25 days after surgery. The post-operative panoramic x-ray revealed a good implant position (Fig. 3).

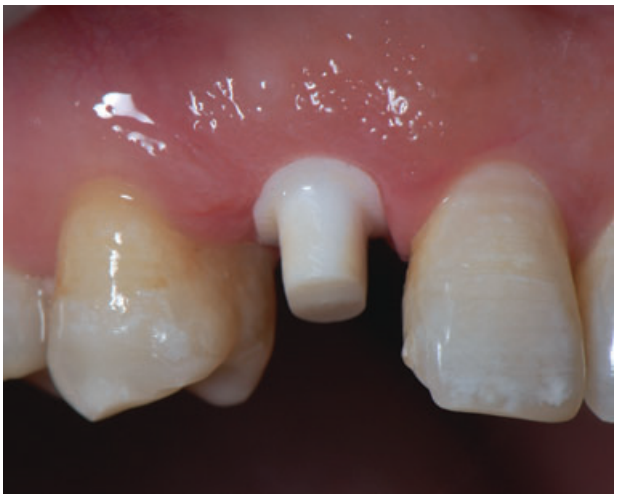

Figure 2 CeraRoot implant 14. Note the implant margin at gingival level.

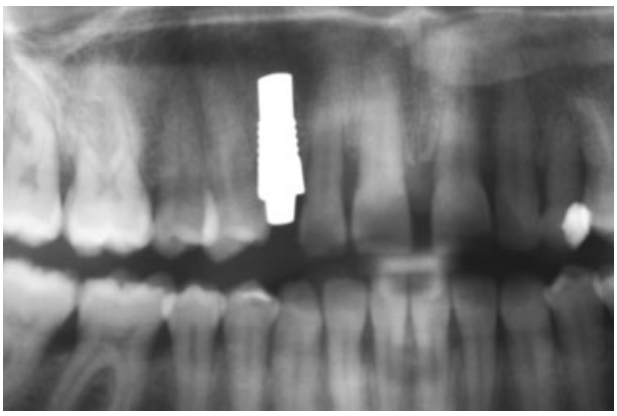

Figure 3 Post-operative panoramic x-ray.

Healing period

The patient was recalled 1 month post-surgery for a dental hygiene and implant check-up. There were no signs of inflammation in the peri-implant soft tissues and there was no pain on implant percussion (Fig. 2). The patient was then appointed for final impressions 2 months post-surgery.

Impressions

Impressions were taken directly with a polyether (Impregrum, 3M-ESPE) without the need of any implant preparation.

Final reconstruction

A ZrO_2 CeraCrown® (Oral Iceberg s.l. Barcelona, Spain) was then characterised with ceramic layering technique to simulate the tetracycline stains of her natural dentition. The final cementation was done with a resin modified glass ionomer (Fuji II, GC America, Alsip, IL) and the excess was easily removed because the margin of the restoration was at gum level. Although the mesiodistal space was insufficient for a normal cuspid, the final reconstruction achieved an acceptable look and integrated harmoniously with the natural dentition, the soft tissues and gingival profile (Fig. 4).

Follow up

One year after final cementation, the clinical performance and aesthetic result of the ZrO_2 implant and ZrO_2 restoration was good and the patient expressed her satisfaction.

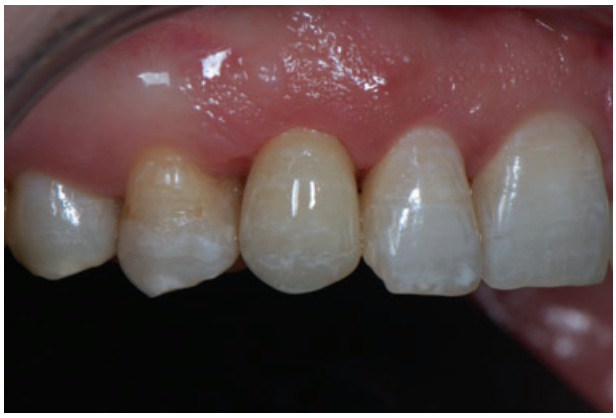

Figure 4 Zirconium Oxide final reconstruction.

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Discussion

During the healing phase, no temporary restoration was placed because for this patient, it was not critical. However, a vacuum splint or temporary crown is usually placed to satisfy the aesthetic demanding patients.

The main selection criteria for this type of implant is that it has a scallop contour for the final reconstruction that allows placing the restorative margin paragingivally or slightly subgingival, and thus eliminating subgingival implant connections and restorative margins that may induce bone remodelling because of the bacterial colonisation in this sites. Another advantage of placing such implant in this case is that once it is placed, the restorative procedure is converted into a tooth-like restorative system where the final impressions are taken directly into the abutment without the need of any impression components, and the stone model is also made directly without the need of an implant replica. The white colour of zirconia allows the clinician to restore the most aesthetic demanding cases with more translucent ceramic materials that considerably improved the final aesthetic result.

Regarding the prognosis of ZrO_2 implants, there is no published long-term clinical data. This case report is part of an ongoing clinical study[25] that we have previously published. The 5-year follow up will soon be published with an expected success rate around 95%. Moreover, no implant fractures or bone loss has been reported up to now.

Conclusions

The high biocompatibility of ZrO_2 material is globally accepted today and supported by many publications and investigations. Scientific evidence also shows that ZrO_2 might be a good alternative to produce dental implants routinely in the future. Machined and smooth implant surfaces seem to have low bone-to-implant contact scores. The latest research on rough surface ZrO_2 implants shows that it significantly increases the bone-to-implant contact scores. In this sense, the good long-term prognosis of this acid-etched (ICE) surface must be demonstrated. The mechanical properties of ZrO_2 dental implants have also been studied in different publications. It is shown that implants have sufficient strength to be used as dental implants. However, it is demonstrated that preparing these implants with diamond burrs might alter this mechanical strength and compromise the long-term integrity of implants, and thus it might be cautious to use ZrO_2 dental implants that must not be prepared at all.

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