

Rehabilitation of a complex case with zirconium dental implants

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Fig. 1

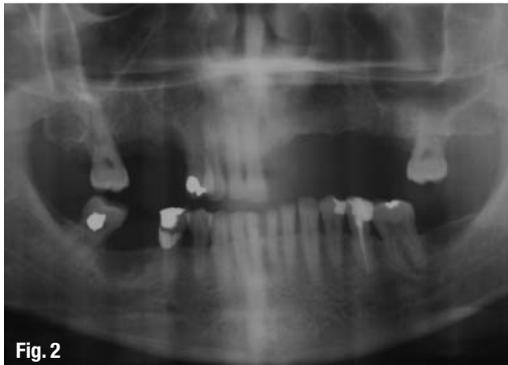


Fig. 2

Fig. 1 Pre-op clinical view.
Fig. 2 Pre-op radiograph.
Fig. 3 Preparation of implant site.

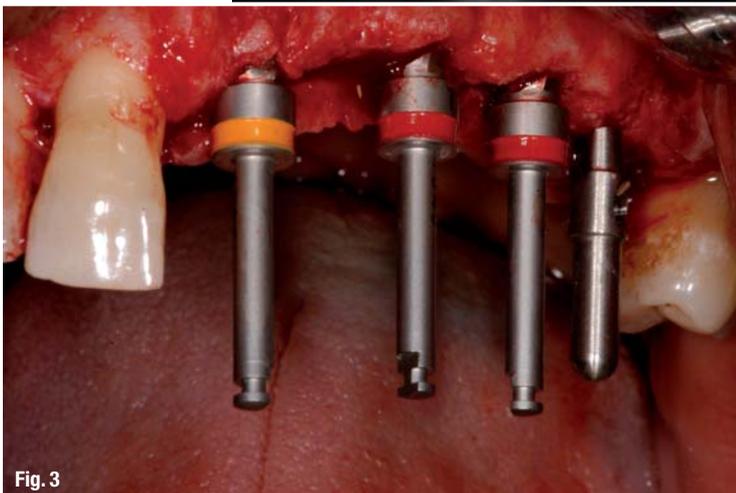


Fig. 3

Introduction

For several decades, dental implants have largely been used for the rehabilitation of completely and partially edentulous ridges with success. For this reason, implant dentistry has been the object of numerous investigations to further improve the effectiveness of this kind of device.^{1,2} Titanium is the material most often utilised for dental implants because of its favourable properties, such as its biocompatibility.^{3,4} However, aesthetic concerns may arise when restoring anterior teeth owing to the grey colour of this metal.

For this reason, new techniques and materials were developed to achieve better aesthetics, such as ceramic (zirconium) abutments^{5, 6} and metal-free restoration.^{7, 8} These prosthetic devices have already achieved assessable results. There are, however, some situations, resulting from a thin gingival biotype or incorrect tri-dimensional implant positioning, in which zirconium abutments and crowns are not able to obtain optimal aesthetics.^{9, 10}

Many authors¹¹ have attempted to solve these problems by coating titanium dental implants with white material such as ZrO_2 and Al_2O_3 . While the popularity of coating has increased, its use has remained controversial. Concerns have been raised owing to problems such as the dissolution and cracking of coatings, as well as the separation of coatings from metallic substrates, a phenomenon referred to as "delamination".

For the same purpose, Al_2O_3 implants have been tested in various clinical studies since the 1970s. They were commercialised in France, Germany, Japan and the USA. Among them, Tübingen implants are probably the most well known ceramic implants.¹² These im-



Fig. 4

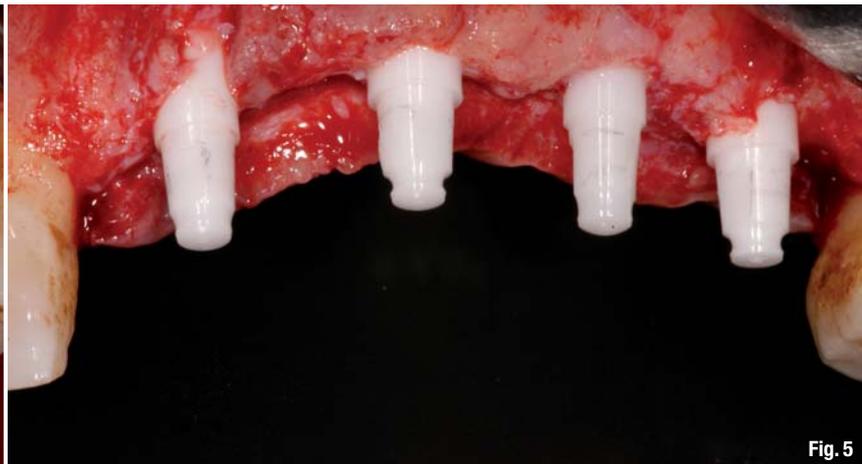


Fig. 5

plants were soon abandoned because of frequent implant fractures, mobilisation, loss of osseointegration and peri-implant bone loss. Most of these problems probably occurred owing to the inadequate mechanical characteristics of Al_2O_3 .^{13,14}

More recently, ZrO_2 has been introduced to dentistry for its good mechanical properties and high biocompatibility, combined with excellent aesthetics. While ZrO_2 has been largely used and documented in prosthetic dentistry, only few studies have reported clinical experiences with zirconium implants.^{15,16}

The aim of this article is to present a five-year follow-up study of a complex implant-prosthetic rehabilitation with ZrO_2 dental implants.

Case report

A 55-year-old male patient presented with partial edentulism in the left maxilla in regions 21 to 26 at the Department of Oral Surgery at the Dental Clinic at the University of Milan. The patient was in general good health and a non-smoker. However, lately he had had financial difficulties that had led to him taking inadequate care of his oral health and consequently losing teeth. After professional hygiene and oral hygiene instructions, the patient was re-evaluated for an implant-prosthetic rehabilitation. His edentulism was complex owing to the lack of numerous teeth and because the alveolar process had undergone moderate resorption. Yet, it was sufficient to insert four dental implants. There was no need for an augmentation procedure and the predictable level within the gingival marginal profile was not considered a problem because of the patient's low smile line (Figs. 1 & 2).

After a diagnostic wax-up, the surgical guide was created. A mucoperiosteal flap was raised with a vertical releasing incision distal to tooth 1.2. Four one-piece yttria-stabilised ZrO_2 (YSZ) implants (whiteSKY, bredent) were inserted. Two 4 x 12 mm implants were

positioned in regions 2.1 and 2.3, and two 4.5 x 12 mm implants in regions 2.5 and 2.6 (Fig. 3). After the implant sites had been prepared, implant insertion was performed using a surgical contra-angle handpiece and then a dynamometric key, at a maximum torque of 40 N. The fixtures were screwed in until the sanded surface reached the bone crest level, leaving the polished part untreated at transgingival level. A heterologous bone graft (Bio-Oss, Geistlich Pharma), together with a double layer resorbable membrane (Bio-Gide, Geistlich Pharma), was positioned on the implant placed in region 2.1 because of the thin cortical wall and to reduce bone resorption. A sinus lift was performed using Summers' osteotome technique to insert the implant with an adequate length (12 mm) in region 2.6 (Figs. 4–7). The flaps were sutured with non-absorbable 4.0 monofilament (Premilene, B. Braun). The removable partial denture was adapted in order to avoid any contacts with the implants.

The patient was prescribed a soft diet, antibiotic therapy with 1 g amoxicillin and clavulanic acid (Laboratori Eurogenerici) every eight hours for seven days and a 0.2% chlorhexidine mouth rinse (Corsodyl, GlaxoSmithKline) twice a day for 15 days. The patient attended a follow-up visit ten days later. The sutures were then removed and the implant stability was checked. The supra-gingival portion of the one-piece zirconium implant was minimally prepared with ETERNA burs (bredent) to achieve parallelism of the implant axes. Then the partial denture was replaced with a temporary acrylic resin bridge to enhance soft-tissue healing and guide the gingival profile (Fig. 8). In the temporary phase, particular attention was given to occlusion to ensure centric contact that was as slight as possible and to avoid contacts in eccentric movements.

After four months, the temporary bridge was removed. Implant stability, probing depth and gingival health were examined. Furthermore, the occlusal surface of the temporary restoration was modified and

Fig. 4 Sinus lift using Summers' osteotome technique in region 2.6.

Fig. 5 The four implants are positioned.

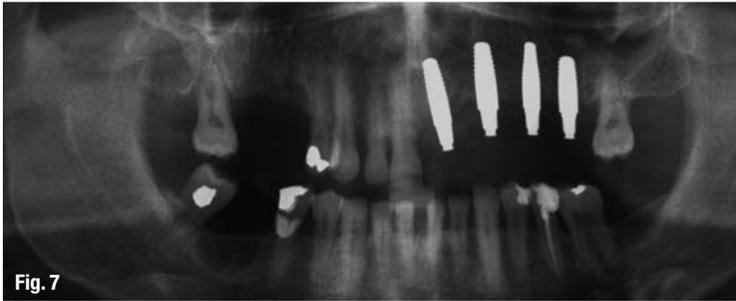


Fig. 6_ Occlusal view of the implants.
Fig. 7_ Post-op radiograph.
Fig. 8_ The acrylic resin temporary bridge is placed.
Fig. 9_ Clinical view of the all-ceramic ZrO₂ bridge five years after surgery.

the implants were loaded. Six months after surgery, the YSZ implants were definitively restored with a ZrO₂ bridge. A light-pink ceramic layer was applied to the marginal areas of regions 2.1 to 2.3 to better support the upper lip and limit the width of the interdental space (Fig. 9).

Follow-up appointments were scheduled for six months after prosthesis delivery and thereafter once a year. Periodontal indices were measured and standardised periapical radiographs were obtained. The plaque index and bleeding on probing scores were 1, except at the last follow-up. No implants had probing depth values of less than 5 mm. Mobility was not present at any site. No pain (spontaneous or on percussion) or paraesthesia was reported. From baseline to

five years after surgery, radiographical evaluation observed the absence of peri-implant radiolucency and no implant exhibited marginal bone resorption at any follow-up (Figs. 10 & 11).

Discussion

Titanium dental implants have proved to be highly successful in replacing missing teeth. Several studies have demonstrated the successful osseointegration of this material and its use for restoration in patients with partial or total edentulism.¹⁷ In recent years, numerous studies have focused on the development of implant surfaces to ensure better and faster osseointegration and to re-establish masticatory function in a shorter period.^{18, 19} Although excellent results have been obtained in the maxillary anterior region by several clinicians, aesthetics remains a challenge for implant dentistry.

Titanium implants are of a grey colour, which can shine through gingival tissue, particularly in thin biotypes or in patients with a high smile line. Moreover, it must be considered that soft tissue around dental implants may shrink or develop gingival recession, or that peri-implantitis may occur, thus compromising the overall treatment outcome, particularly if treatment entails an aesthetic region.

In recent years, several solutions to this problem have been proposed. Various authors have suggested placing implants 3 to 4 mm apical to the cemento-enamel junction or free gingival margin of adjacent teeth, considering that soft-tissue margins around implants tend to re-establish a biological width.²⁰ Implants positioned too far apically in an attempt to establish appropriate biological width can cause gingival recession.²¹ Gingival recession may also develop in thin gingival biotypes because these tissues are more sensitive to trauma and inflammation. For these reasons, surgical approaches such as connective tissue grafts have been suggested to augment tissue thickness and improve peri-implant aesthetics.^{22, 23} However, these techniques are not always completely predictable from an aesthetic point of view. Moreover, morbidity of the donor site and patient discomfort must also be taken into account. Other authors²⁴ have recommended colouring the implant neck, thus changing the optical appearance of peri-implant mucosa. For the same reason, a great number of investigations have been conducted on tooth-coloured implants. Various ceramics have been tested as coating material, such as ZrO₂ and Al₂O₃.^{13, 26} However, even if the studies conducted in the 1990s showed better results than earlier investigations, these implants did not have adequate mechanical properties for long-term loading²⁷ or required large diameters that were incompatible with use in the anterior region with lim-



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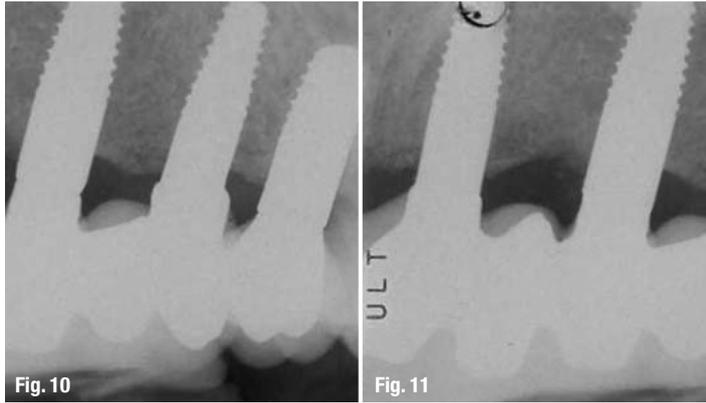
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Figs. 10 & 11 Periapical radiographs five years after surgery.

ited space.²⁸ Consequently, the indications for these implants were limited and they were withdrawn from the market.

More recently, YSZ has been utilised for dental implants. This new generation of ceramic implants exhibits good mechanical properties, combined with good optical properties and high biocompatibility. In fact, YSZ has a flexural strength similar to titanium and a textural strength similar to stainless steel.²⁹

A number of animal studies have demonstrated good osseointegration.^{30, 31} In further studies,³² the same authors have demonstrated osseointegration stability after a long-term loading period. Scarano³³ analysed the bone-implant interface in rabbit tibia, and observed neither fibrous tissue nor inflammation, with good bone-to-implant contact (68%). Similar results were obtained in monkeys by Kohal.³⁴

In another study, the same author compared stress distribution in YSZ implants and titanium implants, and observed similar stress distribution patterns.³⁵

Sennerby³⁶ studied the effect of varying surface roughness on extraction torque and bone-to-implant contact with YSZ implants compared with titanium implants six weeks after implant insertion. The results demonstrated that when surface roughness was enhanced, the two materials exhibited similar behaviour. Other studies^{37, 38} have confirmed that a treated YSZ implant surface provides good osseointegration at all times and after a long-term loading period.

These promising results led a still limited number of authors to test ZrO₂ implants on humans. The first few clinical studies are quite recent. Among these, Blatsche and Voltz³⁹ observed 98% osseointegration in 66 implants in 34 patients in a period of between two and five years. Kohal and Klaus⁴⁰ reported the stability of an YSZ implant in a fresh extraction socket with a graft material after loading. Oliva et al.⁴¹ reported one-year results for 100 YSZ implants with two different surfaces, in some cases combined with bone

augmentation and sinus lift procedures. Within this observation period, the authors reported a 100% survival rate and a 98% success rate in terms of absence of bleeding on probing, signs of inflammation, mobility and radiolucency. Similar results (93% success) were reported by Mellinghoff⁴² in a one-year follow-up study on 189 implants in 71 patients. These studies suggest that YSZ implants exhibit a good rate of osseointegration.

Improvements in zirconium surface characteristics will probably lead to interfacial biomechanical properties comparable to treated titanium surfaces in the future. Compared with titanium, plaque adhesion to zirconium surfaces is very limited because no chemical or physical bonding between ZrO₂ and plaque occurs.⁴³ This is an important feature for long-term survival.

These findings, together with the good mechanical properties characteristic of zirconium implants, are encouraging. However, further histological and clinical studies are needed to investigate long-term success and stability.

Conclusion

In conclusion, it can be stated that it is logical to use a ceramic material for the aesthetic regions. Zirconium dioxide is particularly suitable, since it offers tissue friendliness and a resistance comparable to titanium. Its increased tensile strength, superior mechanical properties, unsurpassed integration with tissue and aesthetic appearance, as well as the possibility of easy fabrication of the prosthetic restoration, may well result in partially YSZ becoming the most commonly used material in implant dentistry for aesthetic regions.

This case report has demonstrated that YSZ implants offer a successful rate comparable to titanium, with a higher aesthetic performance in the anterior region. For this reason, the authors recommend the utilisation of YSZ implants in cases like the one in this article.

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