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Soft tissue management and zirconium oxide – an ideal addition to the field of perioprosthetics: a clinical case study

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KEY WORDS *perioprosthetics, perio-restorative interface, soft tissue management, zirconium oxide*

At present the field of prosthetics focuses on reducing periodontal and alveolar defects related to missing teeth, as well as using suitable restorative techniques and materials to ensure supplements are as biocompatible and functional as possible. Zirconium oxide is a relatively new material, and the evidence suggests that it could be an ideal restorative supplement for reconstructed periodontal and mucosal tissues. This case study of a patient with periodontal deficiencies provides some insight into the coordination of soft tissue management, including the shaping of zirconium oxide, and use of this exceptional material as a supplement, through to an optimised 'gum-tooth' perio-restorative interface.

■ Introduction

Fully ceramic restorations are becoming increasingly popular for anterior teeth, as they are particularly suitable when aesthetics is a key consideration. Thanks to its physical qualities, zirconium oxide opens up new possibilities for fixed partial denture design, for both larger spans, and individual teeth. According to a study carried out by Brodbeck[1], no other ceramic substance currently available can compete with the resistance of zirconium oxide (Table 1).

After some initially disappointing results from attempts to use zirconium oxide for dental implantology conducted by Cranin et al[5], the material proved its worth in a variety of different medical fields, such as hip implant femoral heads, implant abutments and root canal posts[6-9].

In recent years, zirconium oxide dental implants have been capturing more of the limelight, although according to Geis-Gerstorfer[10] there is still a limited amount of evidence available for implant osseointegration and long-term stability. However, animal experiments have produced some very promising results[11,12].

From a purely mechanical point of view, zirconium oxide already seems to have the potential to be classified as a clinically safe framework for crown and fixed partial denture reconstructions, even for wide-span fixed partial dentures, as proved by prospective long-term human studies[13-17].

In addition to aesthetics, biological considerations play a particularly important role in relation to periodontal deficiencies and the therapies required to treat these deficiencies. Zirconium oxide's high degree of oxidation ensures biocompatibility[18-20].

Degidi et al[21] produced convincing evidence that zirconium oxide abutments perform far better than titanium abutments (which are known to have good tissue reactions) in terms of developing an inflammatory infiltrate and the expression of immunocompetent factors. Animal testing carried out in 1988 by Abrahamsson et al[22] indicated the superior

Table 1 Material characteristics of dental ceramics according to Geis-Gerstorfer et al[2], Lüthy[3] and Rieger[4].

Material	Bending strength [MPa]	Fracture toughness [Mpa-m$^{1/2}$]
Zirconium oxide	900[34]	9.00[34]
Industrial alumina	547[25]	3.55[25]
Split cast aluminium	419[25]	2.48[12]
Dicor MGC	220[25]	2.02[25]
IPS Empress	182[25]	1.77[25]
Omega sintered ceramics	85[25]	0.99[25]

biocompatibility displayed by ceramic surfaces in peri-implantation. Research carried out by Rimondini et al[23] and Scarano et al[24] highlighted this aspect by proving that zirconium oxide surfaces experience lower levels of bacterial colonisation.

As zirconium oxide abutments look very similar to teeth when used for prosthetic reconstructions, it is easier to recreate the way light plays on natural teeth. This material also avoids aesthetically unappealing grey gingiva as dark frames or visible strips of metal are not used. One final point is that it is not necessary to use adhesive material to insert crown and fixed partial denture products with zirconium oxide frames as it is possible to use conventional glass ionomer cement or zirconium oxide phosphate cement for the same purpose[25].

The consequences of previous extractions always pose a challenge to even the most technically advanced prosthetics. Alveolar volume can decrease by more than 30%, mainly in the buccal area, after just 3 to 6 months, and by up to 50% after 12 months[26]. The information gathered by Schropp et al[26] demonstrated that individual teeth in a largely stable environment can lead to difficult restorative treatment scenarios in previously damaged periodontal situations, particularly when multiple teeth are involved[27,28]. The findings give rise to specialised anterior teeth treatment strategies for preventing aesthetic and phonetic complications as well as guaranteeing the long-term biological stability of reduced periodontal structures with sufficient hygiene[29]. Therefore, we recommend changing the pontic design, filling volumes and shaping tissue with periodontal plastic surgery[30].

The benefits of using subepithelial connective tissue transplants for filling moderate arch ridge defects were proven back in the early 1980s[31,32]. Despite repeated attempts to compensate for soft tissue defects with alloplastic materials, autologous tissue transplants are still considered to be the 'gold standard'[33]. Further randomised studies are required if this situation is to be fundamentally altered[34]. A microsurgical application, combined with the use of suitable surgical instruments, optical magnification aids and suturing materials between 6.0 and 7.0, so as to make interventions as atraumatic as possible and optimise the outcomes of surgery, is increasingly becoming standard in plastic periodontal surgery[35,36].

The following case report gives an overview of the implementation of a biocompatible, mechanically stable and simultaneously aesthetically pleasing zirconium oxide restoration with adequate soft tissue management to compensate for periodontal and mucosal deficiencies.

■ Case description and results

A 46-year-old female patient presented for treatment of chronic periodontitis as she had become aware of occasional bleeding of the gums and recession of periodontal structures (Figs 1 and 2). She also complained of worsening phonetic problems caused by

Fig 1 Initial situation with inflammation, poor oral hygiene and prosthetic deficiencies.

Fig 2 Periodontal findings at the beginning of treatment.

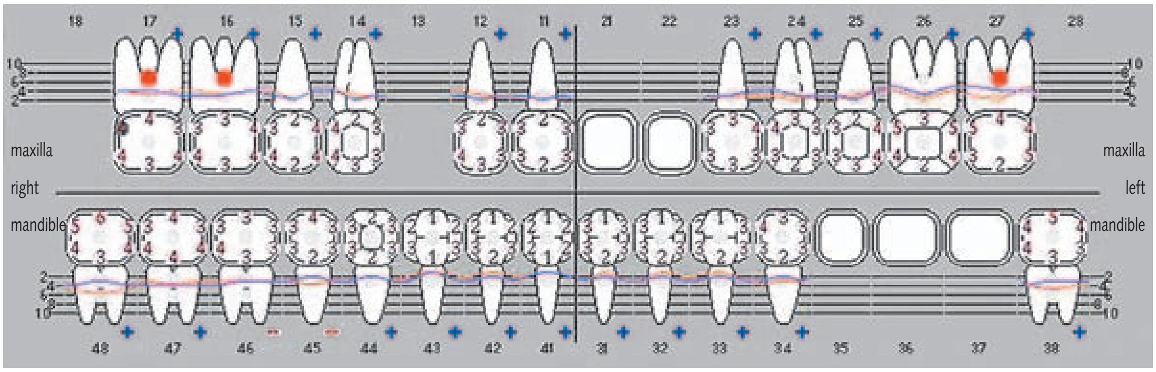

Fig 3 Alveolar deficiencies in around teeth 21 and 22, with insufficient prosthetic compensation.

Fig 4 Radiographic status of maxillae at the beginning of treatment.

labial displacement in the area of the alveolar deficiencies around teeth 21 and 22 (Fig 3), as well as the asymmetric design of her previous restoration.

The initial examination and radiographic findings (Fig 4) also indicated overlapping crown margins and the inadequate functional design and surface texture of the previous dental prosthesis. A retained tooth 13 and gap closure, which was not functionally compensated, were further aggravating factors.

The tooth loss in regions 21 and 22, which preceded the initial prosthesis around 12 years previously, had brought about an alveolar ridge loss in transition from Seibert class I to class III[28]. Restorative efforts to compensate for the situation by lengthening and performing a palatal transplant in the anterior region were not fully successful (Fig 5). The causal relationship of the functional, visual and phonetic impairment was obvious.

Fig 5 Alveolar crest loss of Seibert class I in transition to class III. Situation after removal of old dental prosthesis.

Fig 6 Preparation of recipient bed by conservative ridge incision.

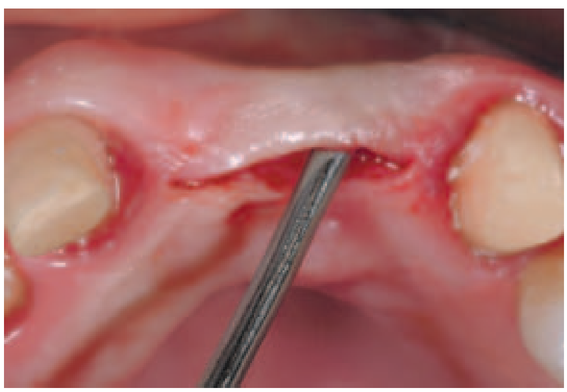

Fig 7 Recipient bed as pouch; maximum extension with minimum access opening.

Fig 8 Size of the connective tissue augmentation, fixed with template technology.

Treatment

After an extended initial hygienic phase, the previous dental prosthesis was removed and appropriate interim maintenance began. Before the new dental prosthesis was integrated, the opportunity was taken to combine it with an augmentation of the connective tissue of the alveolar ridge in zones 21 and 22. This focused primarily on carrying out quantitative filling of the most recent pontic areas, while keeping access as non-invasive as possible. A primary, sufficiently angled post-palatal incision was made (Fig 6) without any impact on neighbouring papillary areas. After this, a sufficiently large pouch was formed well into the vestibule, reaching laterally above the root protrusion of each neighbouring tooth by alternating between sharp and blunt (Fig 7) and leaving the periosteum at the base. In general, a much larger area of the recipient bed should be prepared than the tissue to be transferred. It is helpful to transfer the desired extension with the help of a simple, tailored paper template (Fig 8). This avoids the covering tissue putting excessive pressure on the graft and causing subsequent pressure necrosis.

An appropriate connective tissue graft was gathered by placing the template on the palate. By shifting both main incisions (peripheral and periosteum) in a median direction and leaving sufficient layer strength of about 1 mm, an epithelial collar was left at the connective tissue graft site (Figs 9 and 10). This measure generally leads to quantitative increase and secondary qualitative improvement in the recipient bed. The epithelial collar spreads the entrance out like an inlay (the inlay technique), leading to the keratinised tissue being significantly enlarged (Fig 11). At the beginning of the subsequent passive and active conditioning of the pontic bed, the epithelial collar has the advantage of greater volume stability compared with uncovered connective tissue[37].

A microsurgical procedure at the donor site on the palate ensured that the covering structures were

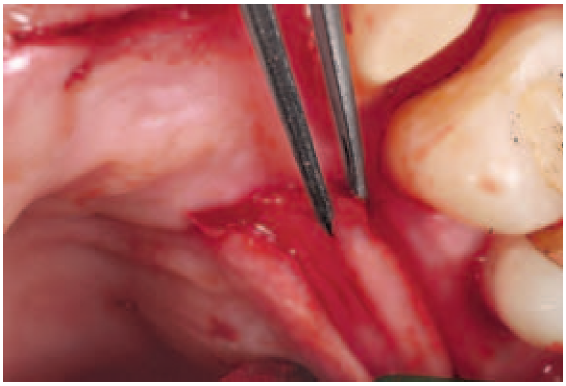

Fig 9 Removal of connective tissue transplant with epithelial collars.

Fig 10 Connective tissue transplant with epithelial collars before insertion (cf. Fig 6: template technology).

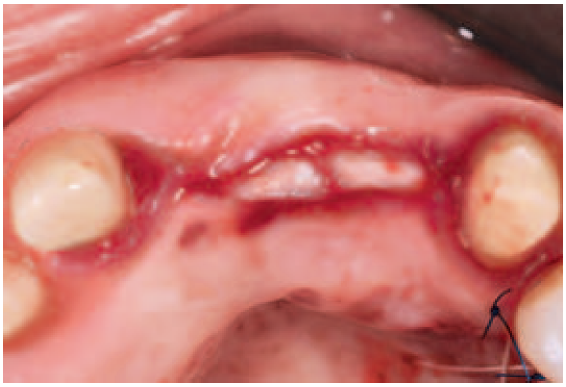

Fig 11 Spreading of recipient bed with inlay technology after transplant insertion.

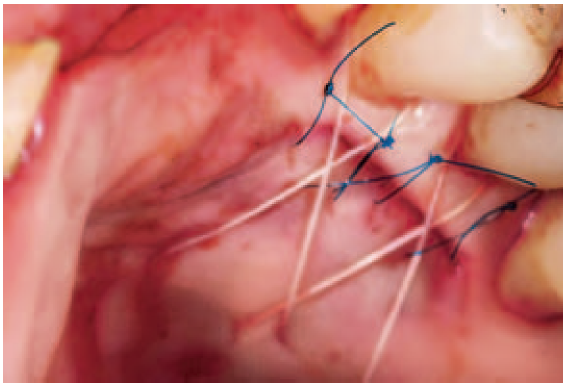

Fig 12 Sealing of removal site with crossed mattress stitches (Gore 5-0) and supplementary micro-surgical situation stitches (Seralon 6-0; Serag Wiessner, Naila, Germany).

Fig 13 Interim supply directly after the intervention with low bearing pressure and convex pontic design.

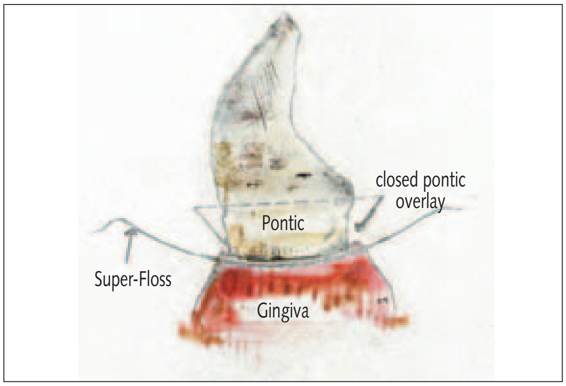

Fig 14 Closed pontic support according to Körner und Müterthies.

sufficiently thick and that the edge of the wound adapted safely (Fig 12), thus eliminating the possibility of complications arising during the healing process. Directly after the graft was inserted into a sufficiently large pouch (the split technique), pontic shaping (Fig 13) was passively introduced underneath the periosteum. This was done by inserting the interim supply with only a small amount of pressure.

The post-operative oedema leads to the tissue volume shifting into the interproximal and marginal areas when the restorative overlay is designed

Fig 15 Interim supply after finishing tissue profiling; shaping into mock-up.

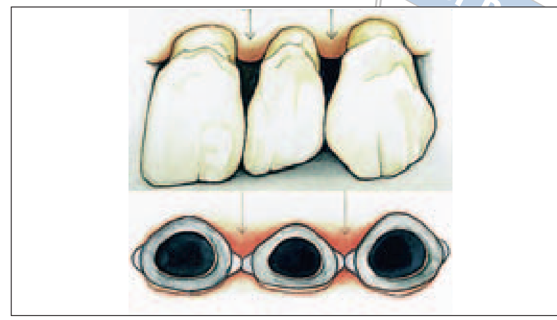

Fig 16 Ceramic 'reshaping' for compensating periodontally reduced tissue.

Fig 17 Ceramically lined zirconium oxide fixed partial dentures directly before insertion.

Fig 18 Cemented, ceramically lined zirconium oxide bridges three months after insertion. Tissue integration to be observed.

Fig 19 Zirconium oxide as base for ceramic anterior teeth supply.

Fig 20 Tooth 12 before being supplied with a ceramically lined zirconium oxide-based individual crown and tooth 14 before shaping with a feldspar ceramic veneer.

correctly. This does not follow the original principle of the 'ovate pontic' technique[38], and the so-called closed pontic overlay[39] is given precedence (Fig 14). The size of the overlay corresponds to the diameter of the root of the tooth in question, with a relatively sharp transition from the basal to the exterior surface with a lightly convex gradient approximately 2 mm beneath the level of the neighbouring gingiva. This configuration can be achieved relatively quickly, either passively during the initial procedure or actively by adding resin composite to the base in one to two sessions 1 week apart.

After around 2 to 3 months, the final restoration phase began. The interim replacement was used as the basis for a mock-up, to adjust the prosthesis to fit the functional and aesthetic requirements of the patient (Fig 15). A mock-up in restorative procedures is an illustration or model of the final appearance produced for the patients by means of simple plastic masking or altering an existing interim prosthesis in such a way that it can be altered again in the future if necessary.

Any remaining gaps resulting from periodontal and mucosal reduction can be aesthetically compensated for (Fig 16) with ceramic reshaping carried out[38] to avoid 'black holes'.

Fig 21 Veneer tooth 14; preparation of adhesive attachment under rubber dam.

Fig 22 Veneer tooth 14 attached with adhesive for functional reshaping.

Fig 23 Supply of tooth 14 with veneer and tooth 12 with zirconium oxide-based individual crown.

Fig 24 Perioprosthetic treatment outcome after 2 years in recall.

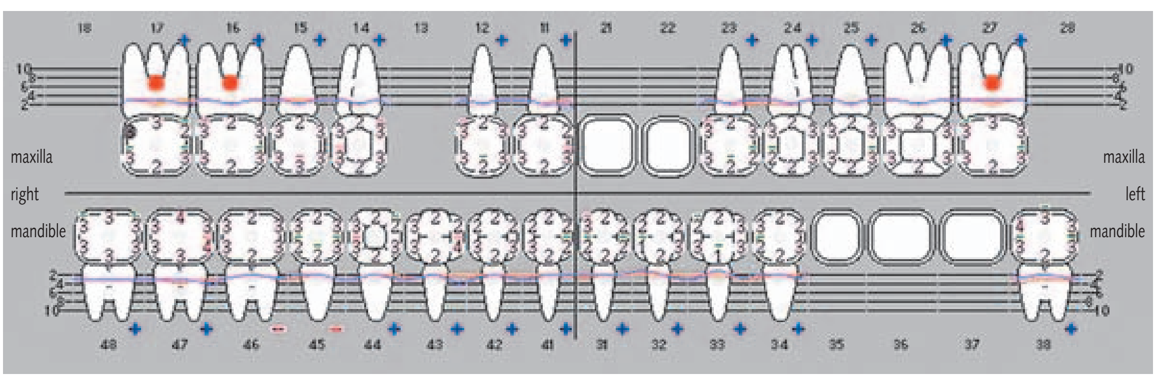

Fig 25 Periodontal findings during maintenance therapy 30 months after the beginning of treatment.

Three months after the beginning of treatment, the solid ceramic fixed partial denture based on zirconium oxide was inserted in an area of biologically unremarkable conditioned soft tissue (Figs 17 to 19). In addition to the individual crowns produced at the same time and in the same way in region 12, tooth 14 was functionally reshaped with the help of a conventional feldspar ceramic veneer, compensating for the absence of tooth 13 in the row of teeth. These measures also led to a positive tissue reaction around the affected teeth (Figs 20 to 23).

The patient then entered series of focused recall visits every 3 months (Fig 24) to maintain the outcome of the perioprosthetic treatment. If the condition of the prosthesis remains stable, the gap between appointments can be increased within reason (Fig 25).

■ Discussion

The use of implants was discussed with the patient, but was rejected because additional bone augmentation would be required.

Presenting the patient with the difficulty that creating sufficient papillae height between two implants and the advantage of the dynamic design possibilities for soft tissue contours provided by pontic conditioning[40] was instrumental in the patient's decision.

The augmentation of soft tissue with subepithelial tissue transplant is predictable for recorded deficiencies[41], remains the 'gold standard'[33] and, in addition to quantitative multiplication, allows keratinisation to spread, which is not to be underestimated in terms of periodontal stability and hygiene capabilities.These biological advantages are supported by zirconium oxide[21]. In comparison with conventional solutions, the decreased plaque affinity, aesthetic simplicity and periodontally cost-effective boundary alignment of zirconium oxide points the way to the future of dental prosthetics[1].

The first results of long-term tests and constant improvement of CAD/CAM procedures, particularly the Cercon® system (DeguDent, Hanau, Germany), mean that conventional metallic solutions will be increasingly replaced by zirconium oxide in the design of ceramic frames.

■ Conclusions

Modern perioprosthetic treatment is increasingly focusing on providing primary cause-related therapy for periodontal defects. In addition to traditional attachment therapy, periodontal plastic surgery is beginning to form the basis for implant-supported soft-tissue and bone reconstruction procedures[42]. New patient-oriented treatment approaches such as the 'concept of beauty'[43] or 'smile design' require the acquisition or reconstruction of natural tissue. Restorative materials that complement and protect periodontal tissue and contribute to a functional biological and aesthetic symbiosis (in terms of the materials used and technical implementation, particularly for periodontally damaged patients) are also needed.

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Originally published (in German) in Parodontologie 2008;19:153-162.