The challenge of reconstructing a central incisor with an implant-borne restoration

A 28-year-old female patient fractured her right central incisor in a fall. Despite immediate dental treatment, the natural tooth could not be saved and had to be extracted. A removable temporary denture was fabricated and inserted to replace the missing tooth (#11). The patient was referred to us for the placement of the implant and the subsequent prosthodontic work.

Owing to the good condition of the hard and soft tissue, pre-implantological augmentation was unnecessary. As Figure 1 clearly demonstrates, the Precur- lation to the following procedure. This measure was taken to prevent gingival recession around the implant bed at a later stage. After three months of non-submerged healing, an impression was taken with a tray that was modified to allow the impression past to project. A master cast was subsequently fabricated in the dental laboratory.

The successful outcome of such a difficult case (high smile line, normal-to-pronounced curv- of the gingiva, thin soft tissue) depends on two main factors: the proper three-di- mensional positioning of the implant, and the material and design of the abutment. We prefer to use zirconium-oxide (ZrO2) abutments with a tita- nium base, which ensures ex- cellent fit in the implant owing to the industrially milled tita- nium base. Furthermore, the ZrO2 abutment (emergence profile) can be individually cus- tomised.

The emergence profile of tooth #11 was subsequently waxed up. The wax-up was then used to create a silicone tem- plate of the palatal aspect and another one of the vestibular aspect. The abutment base (ST, Astra Tech) was screwed into the laboratory analogue, and the ground emergence pro- file and the base were isolated (Ceramill Sep) and light-curing resin composite (Ceramill Gel, both from Girrbach) was ap- plied (Fig. 5). Preliminary cur- ring was considered to be neces- sary at this stage to achieve complete polymerisation of the light-curing material in the depth of the sulcus. Subse- quently, the super-gingival part of the abutment was built up and light-cured. In order to obtain flat sur- faces and a defined preparation margin along the abutment, the cervical areas were milling para- gingivally. The labial proximal and the palatal surfaces were machined to produce a conical shape with a two-degree gradi- ent.

The gradient and the palatal surface were cut by hand. The available space was checked with the previously fabricated wax-up.

In our laboratories, the abut- ments are rendered in ZrO2 us- ing the copy milling technique. Alternatively, this step can be conducted with CAD/CAM sys- tems by using the double scan method or abutment design software.

The green body was smoothed after copy milling. A chamfer was cut at the gingival level for the subsequent creation of a ceramic shoulder. Then the restoration was shaded and sintered (Fig. 4). After the sinter- ing process, only very fine adjustments had to be made in order to ensure the final fit. In this case, the abutment was coated with IPS e.max Ceram ZirLiner (Ivoclar Vivadent). Next, the reduced shoulder made of IPS e.max Ceram was briefly fired on the restoration (Fig. 5). Furthermore, a thin layer of ceramic was placed over the entire ZrO2 abutment.

The abutment created in this way has three advantages. The glass-ceramic coating allows the abutment to be etched, which is a prerequisite for adhe- sive bonding of the crown and the abutment. Light transmis- sion in the gingival areas decreases dramatically owing to the light transmission of 3 mm ZrO2 layers in the para-gingival areas of the abutment dropping to almost zero. Finally, once IPS e.max Ceram ZirLiner and the layering ceramic have been ap- plied to the restoration, fluores- cence increases significantly. Usually, the fluorescence of ZrO2 is quite low.

An important aspect of this type of abutment is the bond between the titanium base and the ZrO2. We advise against the use of popular laboratory luting agents such as Nintamic Cem or Astra Cem. A study con- ducted by Prowital under the direction of R. Meyer, MDT, has recently shed some light on this frequently neglected working step.

The latest development in this industry segment is Multi- link Implant (Ivoclar Vivadent). This material has advanced the standards for the handling and physico-chemical properties of these products. According to the study mentioned above, the bond strength of this self-curing luting composite, which can also be light-cured, is 45 per cent higher than that of the pre- viously used KERAMIT PATH (Kuraray) and about 25 per cent higher than that of RevaLink (5M ESPE). That Multilink Implant quickly cures without exposure to light is an advan- tage when thick abutments are involved, as in these cases light may rather escape away with all areas of the restoration and may therefore fail to adequately cure the cement.

In the Prowital study, which examined surface-conditioning and curing methods, the high- est bonding properties were achieved under the following conditions. The inner surface of the ZrO2 abutment was cleaned with 10 µm aluminium oxide (Al2O3) at 1 bar pressure, and the titanium base was cleaned with 50 µm Al2O3 at 2 bar pressure. Both bonding surfaces were coated according to the manufacturer’s instructions (Ivoclar Vivadent), which was allowed to react for one minute before it was dried with blown air. Then Multilink Implant was applied to the inner surface of the ZrO2 abutment and the ti- tanium base was attached to it (Fig. 6). Like all composites, Multilink Implant is susceptible to oxygen inhibition, that is, the uppermost layer (approxi- mately 100 µm) of the material does not completely cure dur- ing the polymerisation process because it is exposed to oxygen.

There are several ways to prevent this problem. After the zirconium part has been at- tached to the bonding surface, excess composite can be com- pletely removed and a glycerine gel (for example, AIRBLOCK, DENTSPLY) applied to prevent the formation of an inhibited layer. The application of a glycerine gel, on the other hand, can also be left in place. The cement joint was not cleaned after the two had been joined and the excess cement was removed with a sharp instrument after poly- merisation. It is important to
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Contact Info

Dr Michael Fischer maintains a private dental practice in Pfullingen in Germany. He can be contacted at michael.fischer@web.de.

Benjamin Votteler maintains a dental laboratory in Pfullingen in Germany. He can be contacted at dentaltechnik@votteler.eu.

Dr Anthony G. Sclar has been Professor and Chairman of the Department of Periodontics at the University of Washington, Seattle, USA. Dr Hans-Peter Weber is Director of the Institute for Restorative Dentistry and Artificial Organs, University Dental Clinic, University Medical School, Pfullingen, Germany. Dr John Kois is the President of the Kois Center, West Bend, Wisconsin, USA.

Discussion

Tackling a complex abutment design of this kind is only possible if the gingival biotype is thin and normal (according to lllans-Peter Weber and John Kois). Thin, scalloped gingival tissue (the keratinised gingiva is 0.6 to 0.9 mm thick) is characterised as follows:

- small amount of attached gingiva:
- triangular clinical crown with narrow interdental contact zones;
- soft-tissue recession as a reaction to surgical/prosthetic interventions;
- predisposition to the formation of defects due to resorption processes after tooth extrac-
tion with collapse of the interdental papilla; and
- outline of a periodontal probe shows through the gingival tissue.

All these aspects have to be taken into consideration in order to achieve lifelike results. If the gingival biotype is thick (the keratinised gingiva is 1.0 to 1.5 mm thick), the selection of the abutment does not have such a great influence on the pink aesthetics of the restoration. In these cases, a metal abutment or a ZrO2 abutment without an additional fired ceramic shoulder would suffice.

Nevertheless, ZrO2 is far superior as an abutment material with regard to white aesthetics. Unlike metal substrate materials, it allows light to penetrate from different angles (for example, light from the side). The thick gingival biotype exhibits an even soft tissue and bone architecture:

- minimal difference amongst buccal, marginal and proximal soft tissue and bone heights;
- short interdental papilla;
- firmness of soft tissue;
- tendency to scar;
- square anatomic crowns with rounded convex surface;
- large contact area between clinical crowns;
- minimal tendency to recede; and
- a periodontal probe does not show through the gingival tissue.

Non-submerged healing

The decision to follow a non-submerged protocol was based on the following reasons:

1. ample time for maturation of the soft tissue before the prosthodontic work begins;
2. avoidance of a second surgical procedure;
3. maintenance of blood supply to the area; and
4. reduction in the treatment time and less inconvenience for the patient (according to Anthony G. Sclar).

This approach is only possible if there is adequate gingival attachment. If soft tissue has to be augmented, submerged healing is essential. In the present gingival biotype, the enamel lamina had to be relocated, since it extended into the attached gingiva and may have caused the tissue to recede.

In the case discussed, an inter-socket incision was made without a relieving incision. This approach allowed the vestibular bone lamella to be visually checked. Only very little connective tissue could be removed.

As a result, there was minimal bone loss and scarring did not occur.