Customised CAD/CAM abutments and crowns made of zirconium dioxide

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In dental practice all-ceramic restorations have been experiencing enormous growth for years now. In Germany over two million all-ceramic restorations were inserted in 2006 – after all, metal-free restorations are highly desirable for patients. In implant prosthetics as well there is a distinct trend towards the use of all-ceramic systems. In implant dentistry long-term success and a predictable aesthetic outcome depend on the position of the implant and – where indicated – on the use of augments and sinus procedures. Recently, however, numerous studies have been pointing to the fact that instead of the implants themselves it is more often the prosthetic superstructure which is crucial to long-term success. With regard to biological and mechanical properties considerable improvement must be attributed to the abutment as the interface between the crown and the intraosseous implant.

For highly aesthetic restorations the manufacture of ceramic abutments and metal-free superstructures has been recommended for some time now. However, fabricated implants made of aluminium oxide ceramics, which are still available from many manufacturers, are far too weak and often lead to an unsuccessful outcome. From our experience they are therefore now regarded as obsolete. The superior properties of high-strength zirconium dioxide ceramics, a framework material with universal applications, has brought about a paradigm change in implant prosthetics. We have been providing implant patients with metal-free zirconium dioxide superstructures for six years now without exception.

Zirconium dioxide ceramics: material properties

Owing to its monophasic crystalline nanostructure yttria-stabilised zirconium dioxide has a superior flexural strength of 900 MPa to 1,000 MPa. This offers plenty of scope for using the material as an absolutely tension-free framework material in implant prosthetics, even over large spans or in boundary situations. On high-polished zirconium dioxide ceramics the plaque deposition is up to 40% less on titanium and dentine. In particular, compatibility with biologic hygiene is of major importance for the long-term success of implant-supported restorations. According to histological study[1] zirconium dioxide abutments have significantly fewer inflammation parameters than titanium abutments. A study to measure the gain of soft tissue[2] confirms that ceramic abutments are significantly superior to ones made of titanium. On the other hand, Albrehamsson et al. were able to prove that gold abutments and PBM crowns cause soft tissue recessions and a resorption of crestal bone. Zirconium dioxide abutments ensure active protection of the peri-implant tissue.

Advantages of zirconium dioxide in CAD/CAM manufacture

In the case of metal abutments dark metal parts can become exposed on account of the gingival sulcus, thus preventing the grey of opaque metal parts from showing through the peri-implant tissue. Even if the mucosa is thick at 2.5 mm, the abutment has an influence on the shape perceived of the covering mucous membrane. Customised zirconium dioxide abutments are the best way of ensuring predictable aesthetics.

Owing to the need for substantial material grinding the process of prefabricated build-ups made of zirconium dioxide, aluminium oxide or titanium is problematic. If the ceramics overheat, cracks occur in the microstructure of the material. In addition, reprocessing is always very time-consuming because it has to be performed manually. In the case of cast mesostructures made of precious metal it is often not possible to budget for the cost, and the use of large quantities makes it difficult to create a pore-free cast. With zirconium dioxide the dental technician has, for the first time, a material at his disposal whose absolute homogeneity is not altered by further processing. In the case of customised CAD/CAM abutments and zirconium dioxide crown frameworks the ZENO® Tree system (WIELAND, Pforzheim, Germany), in conjunction with wital implant systems (WIELAND, Wiernsheim, Germany) is setting new standards in terms of ease friendliness, economy and flexibility.

Case study: initial situation

For a 41-year-old female patient the plan was to provide her single gap at tooth 40 with a wital implant (diameter 4.5 mm, length 15 mm). Since the bone available was more than sufficient and the proportion accounted for by soft tissue was acceptable, no augmentative procedure was performed in this case. In the aesthetic sensitive anterior area we would nowadays always perform augmentation even though the bone available may seem sufficient.

Implantation

After exposing the bone by means of a partially mobilised mucoperiosteal flap the pilot hole was drilled with a diameter of 2.0 mm (Fig. 2). This was followed by two more drillings with an diameter of 4.5 mm and 4.5 mm (Fig. 3). In order to place the implant in a very compact bone as episcrally as possible the cortical bone wasreamed with the inserter reliably and the bone available may seem sufficient.

Taking the final impression

After 14 days the final impression was taken using an impression post customised in the dental laboratory, under absolute irritation-free conditions. For the closed impression we use Impregum™ (3M Espe, Seefeld, Germany). The standard impression post was customised with GC® Pattern Resin LS (GC Europe, Leuven, Belgium) and when the impression was taken in the sulcus ensures positional stability without a retaining screw. Consequently, with this procedure as well – as with all the other steps – there is no need to provide manual protection against rotation. With many other makes of implant system this simple procedure is not possible because the thread of the build-up only stop just above the shoulder of the implant, deep into the sulcus.

Stripping and impression-taking

A three month settling in phase was followed by stripping. A first impression in situ with a standard impression post in the same session (Fig. 6) was used to prepare a customised healing abutment. Initially the patient was provided with a fabricated gingiva former.

Laboratory manufacture of a customised gingiva former

For the emergence profile a customised gingiva former was made ofZENO® PMMA Dust A/ B. The impression data was then processed in the system’s own software DentalDesigner™. The margin of the gingival former has to be made above the mucosa because there is an increase in volume when tissue is displaced. When the resin had been milled, it was cemented with a titanium insert. A resin cement called Super Bond C&B (J. Morita, Dietzenbach, Germany) has proved reliable. After that the surplus was ground away and the entire build-up was given a high polish.

The scan build-up was screwed in to the emergence profile. The data obtained was then processed in the system’s own software DentalDesigner™. The margin of the gingival former has to be made above the mucosa because there is an increase in volume when tissue is displaced. When the resin had been milled, it was cemented with a titanium insert. A resin cement called Super Bond C&B (J. Morita, Dietzenbach, Germany) has proved reliable. After that the surplus was ground away and the entire build-up was given a high polish.

Cross-referencing text:

Fig. 1: Exposed titanium abutments.

Fig. 2: Bone situation after exposure with a partially mobilised flap.

Fig. 3: Preparation of the implant bed with a shaping drill.

Fig. 4: Model situation after transfer of the emergence profile with a customised titanium post.

Fig. 5: Implant inserted flush with the bone.

Fig. 6: First impression with standard impression post and transfer coping on exposure.

Fig. 7: Milled healing abutment made of ZENO® PMMA Dust, shade A.5.

Fig. 8: Screw ing in the customised gingiva former with manual torque assistance even in conventional cases.

Fig. 9: Screw ing in the customised gingiva former with manual torque assistance even in conventional cases.

Fig. 10: Stripping and impression-taking.

Fig. 11: Preparation of the implant bed with a shaping drill.

Fig. 12: Easy removal of the implant from the ergonomic post with countersink.

Fig. 13: Implant inserted flush with the bone.

Fig. 14: Very compact bone as episcrally as possible the cortical bone wasreamed with the inserter reliably and the bone available may seem sufficient.
ensures perfect allocation even in confined gaps. On the order sheet created the design can be freely selected to suit requirements: first the build-up is defined and then the crown is mounted. On request an anatomical crown can also be designed with PMMA, with the aid of which the veneer is made later by the CAO (Computer Aided Overpress) method.

When designing, first of all the transition is defined between the build-up and the crown (Fig. 11). This area should not be made deeper than 1 mm subgingivally because the cement surplus has to be removed under visual control. Now the emergence profile is finished off (Fig. 12). In doing so it is possible to keep the point of implant emergence much slimmer and only allow greater width at the top. The cross-section provides a good overview here. The 3D view is displayed in the adjacent window. When the parameters have been defined, build-up can commence.

The program indicates the basic shape of a molar. However, it can be replaced by any other shape of tooth, for example, only a premolar will fit the gap. The build-up can be customised quickly; its size can be increased or reduced by dragging the corners (Fig. 13). It can also be completely moved. By turning at the arrows the build-up can be tilted and adapted to the line of the crown. For the extent of the groove a preset can be selected. Then material can be applied or eroded.

Now the screw diameter is defined. Here it is possible to widen the screw opening to suit requirements so that the screwdriver is not guided too closely (Fig. 14). After completing this operation the computer blocks out the screw opening and proposes the prep line for the crown. The cement gap is also defined. Manual customisation by the technician is possible here as well (Fig. 15). Owing to the option of scanning the opposite jaw and displaying it on the monitor, when designing a cusp-supported crown the occlusal space can be measured out accurately for the veneer porcelain. If an anatomical crown is to be made of resin by the CAO method, it is now first brought into position. Owing to deformation

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points the shape can be properly adapted to the antagonist. Making the tooth seemingly abraded is therefore feasible. Only when the anatomical design has been finalised is the crown computed in such a way that it represents an anatomically reduced shape (Fig. 16).

Finally the data is saved and three data records are generated (Fig. 17). This way each element can be milled from a different material. For the build-up we have selected the pre-shaded ZENOX® Zr Discs B2 (Fig. 18). The latter were also re-shaded with Zircolor in order to obtain a dental neck in the shade A 5.5. The crown itself was milled from an unshaded Disc (Fig. 19) and then brought up to shade A 2 with the dye Zircolor. The overpress crown was milled from ZENOX® PMMA Discs (Fig. 20). After fusion there are three parts available with excellent fit (Fig. 21). Cementing is again performed with Super Bond C&B. The titanium connector was blasted with the aid of the Rocatec™ system (3M ESPE) and conditioned with silane solution ESPE™ SL. The emergence profile was high-polished. For this purpose we use diamond burs of various grain sizes. An optimum transition is achieved by affixing the crown margin to the build-up direct. Valuable production time is saved by simultaneous fusion of crown and build-up.

In the present case study two crowns were made on the build-up: one for conventional veneering by means of ZIROX® veneer porcelain (WIELAND) and another for overpressing with the ceramic PressX™ Zr (WIELAND). The crown made of PressX™ Zr is chiefly made on a machine. We prefer it as a low-cost alternative to the all-ceramic crown. Since the finishing of the PMMA crown is performed with a relatively large tool (diameter 1 mm), the fissures are finished with a smaller contour. Shading the structures reduces the light transmission capacity of the crowns to a certain extent. Light refractive effects take places in the extrinsic dye, which is why this technique is reserved for the posterior region (Fig. 22). The layered crown does not leave much to be desired. Depending on the many modifiers and well-matched dentines a highly aesthetic crown can be achieved with minimal input.

**Insertion**

The CAD/CAM custom-shaded ZENOX Tec abutment was screwed into place under torque control (Fig. 23). The groove comes to rest exactly para-marginally in the hygienically uncritical area. We cement final crowns to implant abutments on a semi-permanent basis using the cement ImProv™ (Dentegris, Düsseldorf, Germany) (Fig. 24).

**Sources of error**

Since patients with implant-borne restorations can bite firmly again and attachment of the implant abutments is not (tegmental slightly resilient) as with teeth, masticatory forces are enormous. It is therefore important for the dental technician to model the zirconium dioxide coping with cusp support in order to ensure that the layer thickness of the veneer porcelain is consistent. Here the ZENOX Tec system provides reliable, flexible design and monitoring options. For example, ceramic fractures, so-called chipping, can be avoided. In order to allow perfect light transmission through the crown into the ceramic abutment down to the subgingival area we do not use opaque glass ionomer cements or zinc phosphate cements in the aesthetically relevant region. They would cause the cement margin to be revealed. Apart from causing technical difficulties, the use of prefabricated abutments constitutes the risk of positioning the shoulder too far subgingivally. As a result, this area cannot be monitored in implant restorations (slightly resilient) as with teeth, masticatory forces are enormous. It is therefore important for the dental technician to model the zirconium dioxide coping with cusp support in order to ensure that the layer thickness of the veneer porcelain is consistent. Here the ZENOX Tec system provides reliable, flexible design and monitoring options. For example, ceramic fractures, so-called chipping, can be avoided. In order to allow perfect light transmission through the crown into the ceramic abutment down to the subgingival area we do not use opaque glass ionomer cements or zinc phosphate cements in the aesthetically relevant region. They would cause the cement margin to be revealed. Apart from causing technical difficulties, the use of prefabricated abutments constitutes the risk of positioning the shoulder too far subgingivally. As a result, this area cannot be monitored in implant restorations (slightly resilient) as with teeth, masticatory forces are enormous. It is therefore important for the dental technician to model the zirconium dioxide coping with cusp support in order to ensure that the layer thickness of the veneer porcelain is consistent. Here the ZENOX Tec system provides reliable, flexible design and monitoring options. For example, ceramic fractures, so-called chipping, can be avoided. In order to allow perfect light transmission through the crown into the ceramic abutment down to the subgingival area we do not use opaque glass ionomer cements or zinc phosphate cements in the aesthetically relevant region. They would cause the cement margin to be revealed. Apart from causing technical difficulties, the use of prefabricated abutments constitutes the risk of positioning the shoulder too far subgingivally. As a result, this area cannot be monitored in implant restorations.

**Conclusion**

Whilst there were no clinical studies available during the initial phase of making restorations with zirconium dioxide, there are now results from several multi-centre long-term studies. CAD/CAM restorations made of zirconium dioxide prove to be just as reliable as the golden standard. However, especially in implant dentistry...
they allow a quantum leap in terms of biocompatibility and aesthetics. By optimising the software, improving milling strategies, increasing the level of automation and extending the range of materials available some systems, including the ZENO® Tec system, have succeeded in raising the level of economy and precision substantially. In this instance the flexible design software does not limit dental technicians or dentists in their many different decisions to be taken with regard to treatment and design. In addition, particularly in the combination of implant dentistry and metal-free prosthetics made of zirconium dioxide frameworks, the fact that the ZENO® Tec system is fully compatible with the implants in the w.l.l system is of inestimable importance to patients, dentists and dental technicians.

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