A system like natural teeth: Elastic inside, harder outside

To date, no material has been able to imitate natural teeth precisely. However, in the course of the CAD/CAM revolution, we are moving one step closer to this target. The restorations presented in this article emulate the physics of the natural tooth through a material system with a buffer effect.

Case report

A 48-year-old patient was no longer satisfied with his telescopic restoration in the maxillae. This involved a framework with veneers from tooth #14–24. Removing it in the evening was difficult. Furthermore, there were gaps visible in his dentition at regions #15, 35 and 45, and these were making him increasingly unhappy. He had finally decided to call his dentist’s office with the request for implants and correction of his old restoration. The clinical findings showed that periodontitis had developed owing to the old restoration sitting badly and the difficult hygiene. This was initially treated and brought to a halt before further measures were begun. The telescopic bridge was readjusted so that the patient could continue to use it. The mandible showed abrasions and overlapping of the anterior teeth, which was to remain untreated for the time being.

Therapy decision after patient briefing and consultation

After the periodontitis had healed and instruction in personal oral hygiene had been given, implants were recommended to the patient during a consultation. Such a restoration would prevent tooth migration, stabilise the current situation, and ensure a permanent fit of the present maxillary restoration. The bone available for the implants was sufficient in regions #15, 35 and 45. This condition could alter with time and could both complicate and raise the cost of a future implantation necessitating augmentation meas-
ures; the timing was therefore ideal for implantation.

When selecting the material, it is important to determine whether the patient already has a metal restoration. Additionally, it should be taken into consideration that implants greatly increase the resulting masticatory pressure owing to the lack of Sharpey’s fibres and the restricted transmission of stimuli. Hämmerle et al. have shown that the threshold of tactile sensitivity perceived with implants is on average nine times greater than with natural teeth.¹

In order not to increase the amount of metal in the mouth, on the one hand, and to protect the bones, joints and antagonists through the buffer effect, on the other hand, the bionic restoration

Figs. 9a & b. Transfer to the CAM software for nesting (a). The zirconium dioxide blank with the abutments milled from it (b).

Fig. 10. Fitting the abutments on the plaster model.

Figs. 11a & b. Attaching the abutments to the implant abutments using Sebond Implant (Schütz Dental).
(Schütz Dental) came into consideration. This material system consists of a framework made of Tizian Zirconia Reinforced Composite and the dialog Occlusal veneering composite (see the discussion section). A restoration made from these materials is slightly elastic, as well as abrasion resistant, and it mimics the physical properties of the natural tooth with flexible dentine and hard enamel. Chipping, as seen with hard zirconium dioxide with layered ceramic veneers, is minimised with restoration using Tizian Zirconia Reinforced Composite.

Furthermore, the patient can be offered bionic restoration at a more favourable price than a fully ceramic restoration. This was relevant in the case presented in this article.

**The initial steps:**

**Implant placement, impression taking and scanning**

Implant placement in regions #15, 35 and 45 (IMPLA implant system, Schütz Dental) using cortical and extension drills proceeded without problems, as was expected. All three implants were placed during the same appointment.

After healing, conventional impressions were taken, frameworks were cast (Fig. 1) and gingival masks created (Fig. 2), and the necessary scans taken (Figs. 3 & 4a & b).

**Virtual construction of abutments and finishing in zirconium dioxide**

Individual abutments provided a clean emergence profile and good hygiene capability without undercuts. Abutments made of zirconium dioxide provided the appropriate colour base for the dental prosthesis. Owing to the sparsity of the teeth in the molar region, tooth #15 was considered as tooth #16 for the reconstruction (Fig. 5) and tooth #35 as tooth #36 (Fig. 6). This measure allowed for terminal occlusion (Fig. 7) to be achieved.

The CAD software (Tizian Creativ RT, Schütz Dental) matched all of the scans and made suggestions for three abutment models in the Tizian Creativ RT Abutment Designer module (Fig. 8). These were adjusted slightly and transferred to the CAM software for nesting (Fig. 9a). The framework was milled on a Tizian Cut 5 smart tabletop.

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**Figs. 12a & b.** Scan of the plaster model with mounted adhesive titanium bases and abutments.

**Figs. 13a & b.** Design suggestion for the three crowns.

**Fig. 14.** Checking of the virtually modelled crowns.

**Fig. 15.** Nesting of the three crowns.

**Fig. 16.** Crowns milled from the Tizian Zirconia Reinforced Composite blank.
milling machine from Tizian Blank zirconium dioxide (Fig. 9b). Trying on the plaster model showed a perfect fit (Fig. 10). Thus, try-in in the patient’s mouth was not necessary, and the abutments were permanently attached (Figs. 11a & b).

_The way to definitive crowns_

In order to prepare for fabrication of the definitive crowns, the plaster models were scanned with the mounted titanium adhesive bases and abutments (Figs. 12a & b). The software again generated the design suggestion for the three crowns (Figs. 13a & b). These were viewed and measured from every angle. This applied particularly to the occlusal relief and the basal side (Fig. 14). For later finishing with veneer composite, the crown constructions were slightly reduced cervically and occlusally. After this adjustment and approval, the next, fully automated, step was the creation of the STL datasets and the nesting of the crowns (Fig. 15). The milling procedure was then performed using a Tizian Zirconia Reinforced Composite blank in the A3 shade (Fig. 16). It was dry milled, without water-cooling.

The blank received a code for patient identification. This means that several jobs can be performed at the same time without confusion. As the data for nesting are archived, it is possible to use the same blank again later.

The fit of the milled crown fully satisfied expectations. Finally, a razor-thin layer of dialog Occlusal was applied in order to give the restoration the bionic function (Figs. 17 & 18). Cervical, dentine and incisal masses were used to give the restoration a certain vivacity. This should be discrete, and the obtained shade was to mirror the colour of the natural teeth. The patient did not want the fissures to be coloured (Figs. 19a & b). Integration in the patient’s mouth took place to the satisfaction of everyone involved; the implant restoration was harmoniously incorporated into the remaining dentition (Fig. 20).

_Discussion_

The bionic restoration material system, made of Tizian Zirconia Reinforced Composite framework material and dialog Occlusal veneering composite, counters in particular the chip problem of veneered zirconium dioxide. This especially becomes a factor for implants, as the masticatory forces are particularly high and the restoration is accordingly placed under high strain. Furthermore, the questions of increased wear of natural antagonists and of the effect on the jawbone and the temporomandibular joint remain. In this case, it appears to be appropriate to select implant restorations from materials that can create a buffer effect; this is the case for Tizian Zirconia Reinforced Composite in combination with dialog Occlusal. In comparison with zirconium dioxide, the modulus of elasticity of Tizian Zirconia Reinforced Composite is low at 3,050 MPa, meaning the material is comparatively elastic, and the Vickers hardness is 196 MPa. It takes on the function of natural dentine in the restoration. In contrast, the veneer composite is harder—just like natural enamel. The system of bionic restoration achieves a Vickers hardness of 560 MPa, whereas the Vickers hardness of natural enamel is around 550 MPa.
The total elasticity of the dental prosthesis helps to distribute the selective masticatory strain and to reduce the stress on the implant, bones, joints and antagonists. The physics of the natural tooth are mimicked. This is of benefit for patients with temporomandibular joint dysfunction or bruxism, as well as any other patient.

Additionally, the cost factor has proven favourable for the patient, the office and the laboratory. Should it be necessary to make an adjustment or repair, this can be done in the patient’s mouth. The veneer composite is light cured. This has shown to be positive for the laboratory, as it means that there are no additional outlay costs after acquiring a CAD/CAM system. Furthermore, there is no shrinkage, unlike with zirconium dioxide, and this means it is easier to achieve a perfect fit. The colour also reflects the final result right from the start: unlike with ceramic restorations, the colour does not change during the manufacturing process. However, the tooth surface appears like ceramic and solid, very similar to the natural tooth. All these properties make the bionic restoration a straightforward, reproducible, aesthetic and economical application.

## Concluding remark:
“It doesn’t rattle anymore!”

Patients greatly appreciate the natural appearance without the masticatory feeling of ceramic and specifically of zirconium dioxide. In the following final example, a zirconium dioxide piece in the mandible was extended using a bionic restoration: a full restoration of the mandible with 13 crowns on eight implants and five natural stumps (Figs. 21 & 22). In this case, chipping had been a problem before. The patient felt comfortable with the bionic restoration. He reported that the new restorations were not as hard and instead felt like his own teeth. The restorations have a “nice soft feel” and “It doesn’t rattle anymore!” he summed up happily.