Introduction

This article is written in celebration of zirconium oxide, a material which has firmly established itself in the dental laboratory over the past 15 years or so. If appropriately used, zirconium oxide restorations produce very strong and durable results. They also satisfy demanding aesthetic requirements due to their translucent properties. The following case study shows how monolithic zirconium oxide is effectively incorporated into the digital manufacturing chain to produce highly cost-effective dental restorations without having to compromise on aesthetics. In the case presented, a wax-up was crafted which served as a basis for fabricating a provisional restoration (TelioR CAD for Zenotec, Wieland Dental) and a permanent restoration (Zenostar Zr Translucent, Wieland Dental) with one digital data set and CAD/CAM milling equipment.

Preoperative situation

The patient presented to the dental practice with a fractured ceramic inlay restoration in tooth 26 which she wished to have replaced. The tooth had been restored many years previously. Since tooth 25 and tooth 35 were discoloured as a result of root canal treatment, they were included in the treatment plan. The existing tooth structure of tooth 26, which had been prepared to accommodate the inlay in the past, was preserved to the best possible extent. The patient had very high aesthetic expectations and wanted the explicit assurance that the crowns would look completely natural. Nonetheless, we decided to use a very efficient fabrication method in which monolithic restorations are produced with translucent zirconium oxide (Zenostar Zr Translucent). Three options are available for fabricating monolithic restorations with this approach:
1. milling, sintering, glazing (efficient, cost-effective);
2. milling, sintering, individualization with ceramic characterization materials, glazing;
3. milling, individualization with infiltration liquids, sintering, glazing (highly aesthetic).

We chose to pursue the third method, which would be very cost-effective as a result of the benefits offered by the digital workflow.

**Advanced zirconium oxide**

Zirconium oxide is more than twice as strong as other dental ceramics, and it exhibits excellent mechanical properties. Due to its translucent characteristics, the material has been fulfilling highly aesthetic requirements for quite some time now. The material is used to fabricate full-contour (monolithic) restorations and 20 frameworks that provide a base for individualized veneers. The zirconium oxide material Zenostar Zr Translucent shows excellent light transmission. In this system, efficiency teams up with aesthetics to offer impressive results. The wide range of discs, the matching stains and the brush infiltration technique allow lifelike effects to be imparted to restorations in a relatively short time.

**Preparation**

The following aspects were paramount in preparing teeth 25, 35 and 26 for the ceramic restorations: avoidance of sharp edges and observation of a minimum wall thickness. The benefits of using zirconium oxide include the material’s high strength and as a consequence, the fact that very little tooth structure needs to be removed. The cavity in tooth 26 already showed extensive preparation. However, in order to properly anchor the new restoration, re-preparation was shown to be inevitable. The cavity had to be extended towards the buccal aspect. Despite being very
Fabrication of long-term temporaries

According to the treatment plan, the patient would have to wear long-term temporaries for a period of several months. In order to fabricate these restorations, a wax-up was created (Figs. 1 & 2). In this type of situation we prefer to use the manual wax-up technique, because we have found this method to be faster. Alternatively, the restorations could have been virtually designed. Irrespective of the method used, a lasting result can only be achieved if the technician has an in-depth knowledge of the principles of functional occlusion.

The waxed up crowns were transformed into long-term temporaries with CAD/CAM equipment. First, the physical models and wax-ups were digitally scanned (Zenotec D500, Wieland Dental) and the STL file was imported into a corresponding design software (Dental Designer™, 3Shape) (Fig. 3). Then, all the parameters were suitably adjusted and the construction data was transferred to the milling machine (Zenotec select, Wieland Dental), where the restoration was cut from a PMMA-based disc (Telio CAD for Zenotec) (Figs. 4 & 5).

The milled crowns were re-worked only minimally and then placed on the model. In order to impart the PMMA restorations with a natural-looking appearance, their surface texture was finished in such a way that a natural play of light was achieved. The crowns were subsequently polished with a special polishing medium and goat’s hair brushes (Fig.6a). Next, the clinician removed the chairside provisional restorations and cemented the long-term temporaries with a suitable luting composite (TelioR CS Link) (Fig. 6b).

Fig. 5. The milled crowns before they were trimmed from the PMMA disc.

Fig. 6a. The completed long-term temporaries made of PMMA on the model and…

Fig. 6b. … in the mouth.

Fig. 7. Same digital data set: preparation for the fabrication of the zirconium oxide crowns (Zenostar Zr Translucent) with CAD/CAM equipment.
Fabrication of the permanent restorations

Three months later, it was time to focus on the permanent restorations. In an effort to keep the treatment with monolithic restorations as straightforward as possible, the existing data set, which had been validated by means of the long-term temporaries, was used (Fig. 7). We selected the translucent zirconium oxide Zenostar Zr Translucent for the restorations. This material comes in disc form and in six different shades. We decided to use the “sun” variant, which would give the restorations a warm, reddish foundation. Various possibilities of finishing the restoration were available after the milling process (Zenotec select) (Fig. 8). In this case, the unsintered structures were characterized with the colour infiltration method.

Fig. 8  The milled crowns before they were trimmed from the zirconium oxide disc.

Figs. 9a & b  The unsintered structure is carefully ground and smoothed.

Figs. 10a & b  Brush infiltration before sintering: The colouring liquid is applied in the cervical areas.
In the brush technique, the milled structures (crowns) are infiltrated with a colouring liquid (Zenostar Color Zr, Wieland Dental). In this process, the restorations acquire a lifelike appearance, showing a tooth-like progression of shade, already before the sintering procedure. All the A-D shades can be reproduced with these colouring solutions. Five additional characterization stains are available. In the case at hand, the bar joints were removed from the milled crowns 26, 25 and 35 by grinding, and the surfaces were smoothed (Figs. 9a & b). Subsequently, the colouring liquid was selectively brushed on the cusp tips, around the margins and in deep fissures (Figs. 10a to 11b).

The charm of this colourless liquid lies in the fact that it can be made visible. For this purpose a drop of colour concentrate (Zenostar VisualiZr, Wieland Dental) is added to the solution. As a result, the individual liquids can be easily distinguished from each other when they are brushed on the restoration. The colouring material is composed of organic pigments which fire without leaving any significant residue. Next, the restorations were sintered at 1,450°C (Zenotec Fire P1, Wieland Dental). After the sintering process, the crowns appeared lifelike and showed a warm and natural glow due to the reddish zirconium oxide used. Only a few minor adjustments had to be made on the basis of the inspection on the model. As a result, this approach not only ensures savings in terms of time and money, but it also heightens quality assurance.

At this stage—before the staining materials were applied—the zirconium oxide crowns were polished and the surfaces were smoothed (Fig. 12). This effectively counteracted the common concern of abrasion.

Before the crowns were fired, a glaze (Zenostar Magic Glaze, Wieland Dental) was sprayed on their surfaces in order to establish an even base for the application of the staining materials. Stains in paste form (Zenostar Art Module Pastes, Wieland Dental) were used to characterize the restorations. The pastes had to be mixed to a soft, smooth consistency before they could be applied. The cervical and incisal areas of the restorations were individualized with the stains (Fig. 13). A film of glaze was sprayed on the restorations (Fig. 14) before they were fired. The combination of the stains and the lightly fluorescent spray glaze produced a three-dimensional effect.
After the final firing, the crowns did not appear any different from layered restorations. On the contrary, they looked very lifelike and showed a natural internal play of colour. In the next step, the occlusal contacts were checked in the articulator and the proximal contacts on the model. Then the crowns were sent to the dental practice for placement.

_Seating of the restorations_

Teeth 25, 35 and 26 were suitably prepared for the permanent restorations. Unfortunately, the attempt to save tooth 26 failed. The buccal crown wall fractured when the long-term temporary was removed. Right from the beginning, we were aware of the fact that the remaining part of this tooth might not be strong enough to withstand the treatment.

At this stage, therefore, it became quite clear that the tooth could not be preserved. Consequently, the long-term temporaries were re-seated and a new treatment plan was presented to the patient for tooth 26 on the basis of a detailed analysis. A few weeks later, the permanent all-ceramic crowns were cemented (SpeedCEMR) on tooth 25 and tooth 35. The plan was to replace tooth 26 with an implant-supported restoration at a later date.

**Conclusion**

The monolithic zirconium oxide crowns on tooth 25 and tooth 35 were indiscernible from the other teeth (Figs. 15 & 16). The patient reported that she was able to chew comfortably and naturally. The CAD/CAM fabrication protocol allowed the crowns to be cost-effectively produced. The translucent material (Zenostar Zr Translucent) that was used in this case showed a high level of light transmission. Therefore, it offered the ideal basis for reproducing the optical properties of the natural teeth. The described approach will help to satisfy the rising number of cost-conscious and aesthetically discerning patients, since it offers an attractive alternative to individually layered ceramic crowns and cast crowns made of precious or non-precious metal.

_Figs. 13 & 14_ The stains were applied and sprayed with another coating of glaze.

_Fig. 15_ The zirconium oxide crown on tooth 25 immediately after it was placed. Tooth 26 was provisionally restored with a PMMA crown.

_Fig. 16_ A suitable alternative to a veneered crown and a cast crown – the full-contour zirconium oxide crown on tooth 35. It smoothly blends into the surrounding dentition.

**contact**

_Dieter Knappe, CDT_
Knappe Zahntechnik GmbH
Weinstraße 14
67889 Schweigen-Rechtenbach
Germany
dieter.knappe@orange.fr