A skilful combination of CAD/CAM and manual work

Modern materials and manual skills skilfully combined to achieve long-lasting esthetic restorations

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The aim of a restorative treatment is to re-establish the esthetic properties of the tooth structure to ensure that it blends in with the shade and vitality of the natural surroundings whilst using the least invasive methods possible. Severe discolourations often aggravate the initial preoperative situation in addition to misalignments, damaged teeth and/or existing restorations. Extensive reconstructions require the combination of modern materials and technologies with manual skills. Outstanding results can be achieved by carefully selecting suitable materials, masking discoloured preparations and implementing an optimum preparation design. The success can be seen in restorations that remain stable and intact over many years.

This report describes the restorative treatment with a lithium disilicate glass-ceramic – a material that features excellent long-term clinical properties. A CAD/CAM manufacturing process was chosen to enhance the efficiency of the treatment. After a try-in in the blue (non-crystallized) state, the restoration was finalized and customized by hand in the laboratory to provide a final result with excellent esthetic properties.

Questions to explore

1. How can CAD/CAM technologies be combined with manual skills to achieve outstanding restorative results?
2. How to select suitable materials to mask discoloured substrates and take advantage of an intelligent app (SNA) to select an appropriate shade and translucency?
3. How can severely discoloured tooth preparations be masked and their shade matched to the shade of the neighbouring teeth?

Preoperative situation

A 29-year-old female patient consulted the practice with the wish to have a natural beautiful smile. She was dissatisfied with her upper anterior restorations and the appearance of the surrounding soft tissue. She wished for a functional and esthetic solution **(Fig. 1)**. Photographs of the oral situation were taken during medical history-taking and the patient's expectations were discussed. The intraoral examination revealed severe discolouration, devitalized teeth and poor esthetics. In addition to an inappropriate shade, the upper anterior crowns and veneers were out of proportion, causing an inharmonious smile line **(Fig. 2)**. An X-ray confirmed the suspicion that the endodontic fillings on the two central incisors were defective. The lateral incisors had been repaired with large composite restorations. Due to the inadequate contouring of the underlying composite, the patient showed clear signs of periodontitis in the area of all four anterior teeth.

An impression of the situation was taken. The study model provided a physical reference that was used to mark the relevant lines and planes, align the longitudinal axes, adjust the lengths and implement cosmetic optimizations in line with the digital design concept **(Fig. 3)**. A diagnostic wax-up was created. Then, a silicone key was produced from the wax-up for the fabrication of the temporaries. The silicone key also served as a guide in the preparation of the teeth.

Preliminary treatment

The existing restorations on the upper anterior teeth were removed. Teeth UR2 to UL2 were prepared with a rounded shoulder of 1 to 1.2 mm and equigingival margins, according

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01 — *Initial appearance of the smile*

02 — *Preoperative oral situation with periodontitis, discoloured restorations and devitalized teeth. Inadequate esthetic characteristics of the individual teeth and inharmonious smile line*

03 — *Smile design with newly proportioned length and width of the incisors in line with the digital smile design concept*

to the preparation guidelines for all-ceramic crowns. The depth varied slightly due to the shade of the preparation and degree of discolouration. The dark discolouration on the dentin of the right central incisor required a deeper preparation in order to be able to mask the shade of the remaining tooth structure (Fig. 4). Teeth UL3 and UR3 were prepared for veneer placement with an equigingival chamfer, 0.5-mm buccal reduction and 1-mm incisal reduction (Fig. 5). An impression of the resulting situation was taken using A-silicone and then direct temporaries were created with the help of the silicone key (Fig. 6). The periodontal situation was monitored over the following two weeks. Gingival healing was uneventful. The temporary restorations allowed the final result to be visualized. At this stage, intraoral adjustments could be made to achieve a harmonious symbiosis between the lips, smile and face.

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04 — *Crown preparations of central and lateral incisors and veneer preparation of both canines*

05 — *A deeper preparation was required in the buccal area of the upper central incisor on the right because of the pronounced dark discolouration present in that area compared with the neighbouring tooth*

06 — *Direct temporaries created on the basis of the smile design wax-up*

Shade selection

The desired tooth shade and the existing shade of the tooth preparations were determined under daylight conditions. When photos of the teeth were taken, darker and lighter shade tabs were held against the natural teeth, the flash was turned off and all photos were taken from a similar angle. These photos were also very helpful in the fabrication of the restorations in the laboratory **(Figs 7a and b)**.

Material selection in favour of clinically proven properties

The decision fell on a tried-and-tested glass-ceramic that offers long-term clinical stability along with high strength and impressive esthetics: IPS e.max® lithium disilicate. This material is suitable for both conventional press methods and CAD/CAM applications. It can be processed to provide fully anatomical restorations or restorations that can be customized with veneering ceramics. As this case had already taken us onto a digital route with the 2D smile design software, we decided to continue with the digital option. The situation was digitalized with a D2000 scanner (3Shape). The restorations were designed in the software in line with the proportions previously established and then ground from IPS e.max CAD blocks using a Zenotec select hybrid CAD/CAM machine **(Fig. 8)**. The IPS e.max blocks were processed in their crystalline intermediate stage ("blue" phase), which is optimally coordinated with the grinding process, providing highly accurate results. Subsequently, the restorations were crystallized in a conventional ceramic furnace, in the course of which they acquired their final material properties (e.g. shade). Once crystallized, the strength of the material increases up to 530 MPa (mean biaxial strength). IPS e.max CAD blocks are available in different translucency levels, ranging from medium opaque to highly translucent (MO, LT, MT, HT), and in two opalescent shades. The material can be used to create frameworks for veneering or to fabricate monolithic restorations (e.g. veneers, inlays, crowns and three-unit bridges). It is also indicated for hybrid abutment restorations. IPS e.max CAD is suitable for an unrivalled wide range of indications for CAD/CAM glass-ceramics. It is even suited for minimally invasive restorations such as thin veneers (0.4 mm) and adhesive crowns (1 mm).

Block selection with an app

In terms of colour saturation, shade 1M2 (Vita 3D-Master) was ideal and would have come closest to the A1 shade (A-D shade guide). However, the brightness in the central third was higher than that of the IPS e.max CAD LT block in shade A1. And yet, the colour saturation of a brighter block (e.g. LT BL4) would have been too high for the veneer. The IPS e.max CAD HT (High Translucency) blocks in the Bleach shades might have been a suitable choice. However, using

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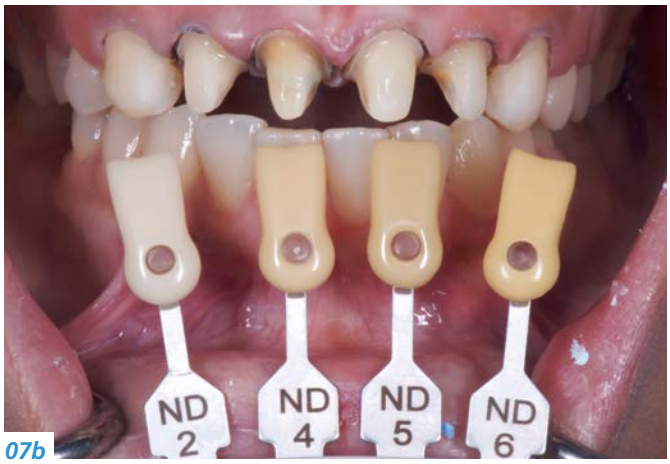

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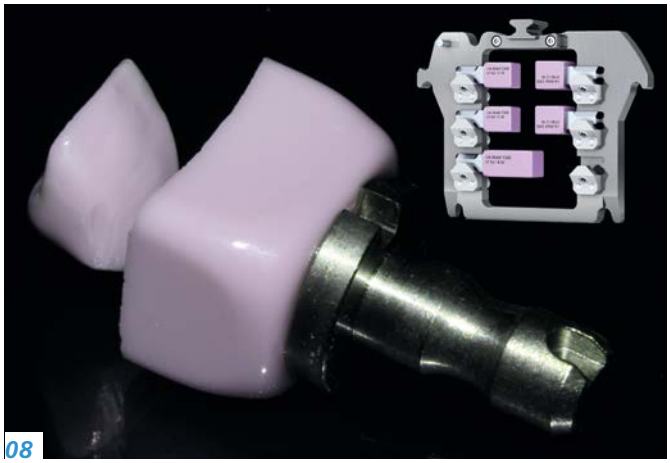

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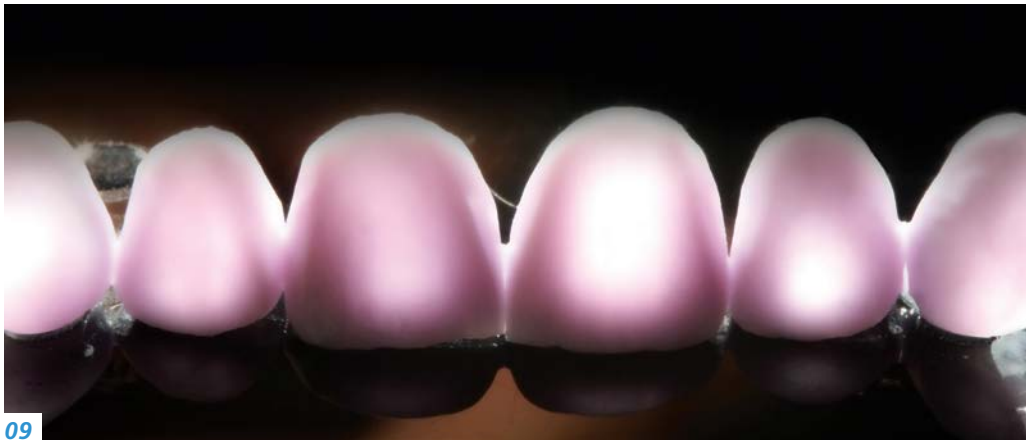
07a — Determining the shade of the lower teeth

07b — Selecting the shade of the tooth preparations using the IPS Natural Die Material shade guide

08 — Lithium disilicate block (IPS e.max CAD) in the blue intermediate crystalline stage on the e.matrix holder (for the Zenotec select millling machine) ready for wet machining



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09 — Restorations in transmitted light prior to crystallization (blue stage): note the differences in material thickness

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10 — Try-in of the restorations in the blue intermediate crystalline stage

highly translucent materials in restorations with slightly increased wall thicknesses always entails the risk that the restoration may be less bright and the chroma could be higher than the actual shade. For these reasons, the HT block was not seen as ideal for the crowns on teeth UL2 and UR2.

The IPS e.max Shade Navigation App (SNA) was used to find the most suitable material. This app takes all the factors affecting the shade of a restoration into account to identify the block that is best suited to achieve the given shade. The app is fast and easy to use. You only have to enter the data pertaining to the case at hand. The app delivers an excellent result.

Initial input for the crowns:

- → Desired tooth shade: 1M2 (= A1)
- → Indication: crowns for UL1, UL2, UR1, UR2
- → Preparation shade: ND2
- → Material thickness: 1.2 mm
- → Material: IPS e.max CAD

Based on the data entered, the app recommended an IPS e.max CAD block in shade MT BL4. This block was required to mask the small area of discolouration (ND4) on the UL1 and to offset the slight drop in hue and value caused by the buccal reduction and the ceramic veneering.

To identify a suitable block for the veneers on teeth UL3 and UR3, "Add new restoration" was activated on the app and the following data was entered:

- → Desired tooth shade: 1M2 (= A1)
- → Indication: veneers for UL3 and UR3
- → Preparation shade: ND1
- → Material thickness: 0.5 mm
- → Material: IPS e.max CAD

The "Free selection" option was used to see if the shade was also suitable for the crowns. It was possible to assess if the MT BL4 was appropriate for all restorations, which it was. So, the MT BL4 shade was employed for both the crowns and the veneers.

Try-in and insertion

After the grinding process, a clinical try-in was performed while the restorations were still in their blue intermediate crystalline stage (**Figs 9 and 10**). The evaluation was carried out with the dentist's specifications and the patient's expectations in mind. In this context, photos of the lips and face of the patient play an essential role for the quality of the technician's work. Adjustments can be applied as required and the photos can be viewed from various angles.

Layering OR staining?

A straightforward and uniform result could have been achieved by simply glazing/staining and crystallizing the "blue" restoration in a single firing process. In this case, however, we are talking about an esthetically demanding situation. The crowns and veneers were therefore completed with the IPS e.max Ceram layering ceramic after they had been crystallized to attain a natural looking result, increase the translucency and achieve an optimum match in terms of depth, chroma, value and hue. Initial characterizations were already applied to the cervical and interdental areas during the crystallization process (e.g. with IPS e.max CAD Crystall./Shades).

Transferring the preparation shade to the model

The dentin shade of the tooth preparations had to be transferred to the model before the layering scheme and ceramic veneering materials could be selected. This is essential to keep a consistent shade match throughout the manufacturing process up to the insertion of the restoration. Model dies were created using IPS Natural Die Material. Even some of the existing orange spots on the dentin (e.g. cervical area of right central incisor) were reproduced on the model dies (using light-curing characterization materials from the SR Nexco® range).

Finalizing the restorations

Following a simple cut-back in the incisal third, a natural-looking transition was created between the layers using the IPS e.max Ceram Mamelon and Opal materials as well as a variety of brighter shades **(Fig. 11)**. After firing, a great deal of care was invested in perfecting the texture, contours and surface characteristics **(Fig. 12)**. At the end, the shade match was checked on the model dies. A variety of (try-in) materials can be used to adjust the brightness between veneers and crowns at the try-in and subsequent seating of the restorations. In addition, a natural-looking lustre blends in harmoniously with the natural surroundings in the patient's mouth. Glaze firing is therefore an important and critical firing process. It should be the result of the interplay between manual polishing, quality of gloss and the firing parameters **(Fig. 13)**.

11 *— Restorations on the working model: restorations in the blue stage on one side and the result on the other, i.e. tooth-coloured restorations after crystallization and veneering with IPS e.max Ceram*

12 *— Verifying the contours and microtexture with gold powder*

13 *— Examination on unsegmented model: closed interdental spaces after Glaze firing and manual polishing*

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14 — Result after four weeks. Note the soft feminine alignment of the teeth

15 — Restorations after six months. The restorations harmonize with the teeth in the lower jaw – the slightly lighter shade was requested by the patient

16 — Restorations after 4.5 years: The four crowns and two veneers are durable, their shade has remained stable and the soft tissues surrounding them looks healthy.

Cementation and recall

The crowns and veneers were placed adhesively using Variolink® Esthetic luting composite. This material is ideally suited for the permanent cementation of demanding ceramic restorations. Excess composite was removed with the help of fine diamond burs, rubber finishers and polishers. Occlusal interferences were eliminated. At the first recall, the restorations were inspected and some last modifications implemented **(Fig. 14)**.

Conclusion

Ceramic restorations have been used in cosmetic dentistry for over thirty years. Past experience has shown that the quality and longevity of these restorations depend to a considerable extent on the experience of the treatment team. Modern materials, however, are offering ever more reliability and flexibility. The restorations described in this report were re-inspected after approx. 4.5 years **(Figs 15 and 16)**. They continued to be in very good condition, reflecting the effectiveness of the material and the manufacturing process.

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