Ceramics and digital solutions from a single source: where manual and automated techniques go hand in hand

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"Is an industrial revolution awaiting us in dental technology?" The author of the article addresses this question and comes to the conclusion that great digital technologies are helpful, but do not replace many of the manual skills of the dental technician. Rather, both go hand in hand. By means of a patient case, he presents the possibilities that result from the interplay of digital technologies, modern materials and dental skills.

Success can be planned: a patient case

A patient consulted the dental practice with the desire to have nice front teeth. Teeth 12 and 21 were restored with composite restorations and severely discolored (Fig. 1). Together with the prosthetic work team, it was decided to restore both teeth with zirconia-based crowns. There are certain requirements from a preparatory and material point of view. For a detailed scan, the stumps should have an ideal geometry: that is the basis for an ideally fitting restoration. In order to meet the high aesthetic demands, the crowns had to be veneered manually. An adequate rounded chamfer, soft shapes with rounded angles and sufficient space in the veneering area ceramic offer the best conditions for a functional, aesthetic, long-term stable restoration.

Fig. 1: Initial situation. Teeth 12 and 21 are to be restored.

Fig. 2: Teeth prepared in accordance with the guidelines for ceramic restorations.

Fig. 3: The model with the prepared dies. a) Vestibular view; b) Oblique view

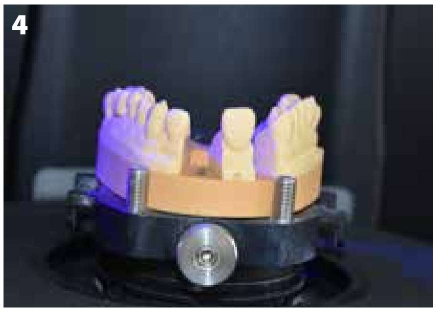

Fig. 4: The dental die-cut model in the Aadva Lab Scan 2. Direct insertion of the model through a magnetic multi-split base or adapter plate.

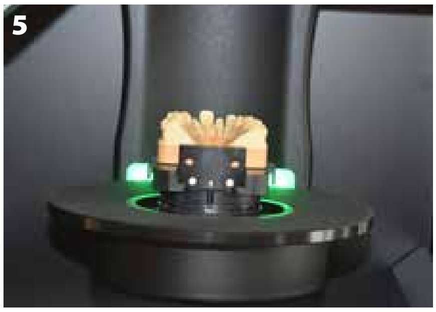

Fig. 5: The open design of the scanner offers a spacious work area.

The teeth were prepared accordingly. (Fig. 2).
While the scanner can capture almost all geometries that are in the visual range, preparation areas that are complex in terms of milling technology are difficult to display. In the case of unsuitable geometries, the software is sometimes not able to capture the shapes correctly. The consequences are long post-processing times and laborious adjustments to the scaffolding. Basic requirements, e.g. minimum thickness, must also be taken into account with regard to the framework design: these are often already stored in the CAD software. If all specified parameters are strictly adhered to, a good fit and high stability of the CAD/CAM-fabricated framework can be achieved.

After the impression was taken, models were made. The preparation margin was precisely demarcated on the master model (Fig. 3).

Digital exactitude: scanning and CAD construction

The models were digitized in a very short time with the Aadva Lab Scan 2 (GC), which offers a very high scanning accuracy (4 µm - ISO12836). The open design of the scanner allows direct access to the spacious work area with a measuring field spectrum no less than 85.2x58.1x82 mm (XYZ).

The model was clamped correspondingly (Figs. 4 and 5). Another advantage of this scanner became apparent here: the anti-slip mat on the system plate ensures optimum stability. Navigation through the user software is intuitive (Fig. 6). The object to be scanned is automatically guided into the measuring field: the automated Z-axis moves the model to the correct height so that the scanning process is carried out in the optimal focus area (Fig. 7). The scanner offers an astonishingly high flexibility; even though the program suggests a sequence of scan tabs for data acquisition, the user can freely decide whether or not this sequence should be modified according to individual needs.

Fig. 6: Filling out the order form in the Aadva Lab Scan 2 software

Fig. 7: Automatic alignment of the Z-axis

Fig. 8: Defining the margins of the preparation (finish lines)

Fig. 9: Determining the direction of insertion

Fig. 10: The palatal framework is shaped like a garland

Fig. 11: The constructed zirconia frameworks

The digital model preparation also followed an intuitive process: a wide variety of configurations can be made in the scanner software, such as adapting the fit parameters (Fig. 6 to 9).

The classic die-cut model was saved with the Hybrid Scan module. The Smart Scan module automatically delivered hole-free scans. The Occlusion Scan module was used; hence, a vestibular scan was not needed. The digital data for producing the scaffold caps were prepared for the milling center and then sent (Figs. 10-11).

Various production methods are available for all-ceramic restorations. Zirconium oxide crowns can be customized using the micro-layering method (thin layer of veneering ceramic). In this particularly demanding case of anterior crowns with a complex colour structure, the restorations were individually veneered with GC Initial Zr-FS. The zirconium oxide frameworks were milled in an anatomically reduced tooth shape. During the shade selection on the patient, internal colour structures, various opacities and translucencies should be determined. Due to the variety of materials in the respective layered ceramic system, all naturally occurring light-optical characteristics of a natural tooth can be imitated. In this case, too, the veneering technique was the optimal route to the goal.

Finishing the zirconia copings

Due to the high precision of the scanner and the fact that the frameworks were manufactured by an experienced milling center, the framework caps were fit on the master model with little effort. By fitting under a stereo microscope, any early contacts on the framework on the preparation margin can be precisely removed. In order to be gentle on the material, the caps were worked out with suitable rotating tools under water cooling. In the present case, the copings were designed with a zirconium oxide border (garland) in the palatal area (Fig. 12).

Fig. 12: Zirconium oxide coping with palatal garland on the model

Fig. 13: Vestibular close-up of the coping on tooth 21

Fig. 14: Vestibular close-up of the coping on tooth 12; the marginal fit is close to perfect.

Experience has shown that the small edge adapts well to the soft tissue and guarantees a high level of stability from a material-technical point of view.
The incisal edge was reworked in an irregular course in order to make the light refraction as natural as possible (Figs. 13 and 14).

Classic craftsmanship: The layering

When veneering frameworks, layering is a matter of great craftsmanship. The dental technician should be able to handle his ceramic materials well. In this case, veneering was done with GC Initial Zr-FS (GC).

Prior to veneering, a wash fire was done with Initial Lustre Pastes (Fig. 15). The colour compounds give the zirconium oxide framework its natural fluorescence. At the same time, they provide more chroma and depth and thus form the basis for the subsequent individual ceramic layering. The desired depth of shade was additionally supported by the difference in structure of the highly chromatic INside Zr-FS powders on the copings fired with Lustre Pastes (Fig. 16). By layering INside 41 (IN-41 Flamingo), a natural-looking incisal structure was achieved. The materials were layered in the concave and convex prepared dentine areas creating an undulating interplay. An intermediate layer with "CLF materials" was used to reinforce three-dimensionality and the effect of depth; similar to a so-called protein layer between dentine and incisal enamel on natural teeth. The incisal as the last layer of the veneer was applied to the proximal ridges with a blueish incisal compound (EOP 3) and built up in the central incisal area with a mixture of "E57" and approx. 20% "EOP 2".

Fig. 15: Wash fire with Initial Lustre Pastes

Fig. 16: Interplay of concave and convex areas for depth and three-dimensionality

The result

After a final firing, both crowns exhibited a high degree of naturalness and a lively interplay of colours (Fig. 17). The congruity of a ceramic restoration with the neighbouring teeth is basically determined by an infinite number of factors. The more of it is taken into account and implemented, the greater the adaptation to the natural teeth. The all-ceramic crowns 12 and 21 fit perfectly and show harmony in the shape and colour of the neighbouring teeth (Fig. 18).

Despite all technical progress and the use of modern technologies, diversity, creativity and craftsmanship are in many cases indispensable. However, the developments in digitalisation contribute to increasing precision, function and aesthetics and should therefore be seen as an opportunity. When evaluating the process, the same high standards should be applied that are placed on dental technicians in manual production.

Fig. 17: The finished veneered crowns show a high degree of naturalness and a lively interplay of colours.

Fig. 18: Integrated! The all-ceramic crowns 12 and 21 integrate inconspicuously and naturally into the row of teeth; **a)** Front view; **b)** Oblique view.

Acknowledgement

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