CASE STUDY „Kay & Knut Amberg“

Optimum exploitation of available space thanks to the use of digital technologies

Dental Surgeon Knut Amberg, MTD Kay Amberg

Thanks to the many years of continuous development invested in CAD/CAM systems for dental technology, the dental laboratories of today have sophisticated hard and software solutions at their disposal with which they can produce different types of restorations efficiently. We have come a long way since the days when the sole use of such systems was for the production of crowns and bridges. Nowadays they also represent an expedient solution for complex dental care – e.g. individual implant abutments or implant-supported bars. One advantage in this respect is that the dimensions and alignment of the crown and abutment can, for example, be reconciled with each other early on in the planning phase. Thanks to exact backward planning the necessary wall thicknesses for the abutment, framework and veneering can be observed even in situations where space is a problem.

A CAD/CAM system from Zfx is used in the Kay Amberg dental laboratory in Munich to design implant-supported restorations digitally and then have these produced externally. The following case study is used to illustrate the procedure.

Patient case
The 51-year-old patient expressed his wish for restorative treatment of his right lower jaw. Teeth 45 and 46 had already been extracted 20 years earlier. The adjacent teeth 44 and 47 had moved slightly into the gap. The anxious patient desired treatment that would involve as little time and expense as possible. After much discussion of various treatment options the decision was made to insert two Tapered Screw-Vent® Implants (TSVT) from Zimmer Dental, each with a diameter of 4.1 mm and a length of 8 mm. Single crowns made of zirconia on individual titanium abutments were decided upon for the prosthetic restoration, with production of the abutments and crown frameworks to be carried out using the CAD/CAM system from the company Zfx (Dachau). A crown for tooth 37 was made at the same time.

Implantation
A Poncho design was selected to ensure minimally invasive insertion of the implants into the local bone. Due to the angulation of the adjacent teeth and the resulting lack of space as well as the limited amount of horizontal bone available, the implants had to be inserted too close together from a prosthetic point of view (Fig. 1). The stitches were removed one week after implantation and suturing and after a three-month healing period the implants were uncovered and then treated with gingiva formers (Fig. 2).

Fig. 1: X-ray image after insertion of the implants.

Fig. 2: Situation after insertion of the gingival formers.
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**Digitalisation of the model**

One week later the impression was made using a perforated tray and multifunctional fixture mounts/impression posts from Zimmer Dental. Figure 3 shows the impression in the individual tray with transferred model analogs. Based on the impression a plaster model with a detachable gingival mask (Majesthetik®-Gingiva, picodent) was produced in the laboratory (Fig. 4). Next the mandible model was digitalised using the Zfx Scan III lab scanner, once with and once without gingival mask and a third time including scanbodies. A scan of the models of the maxilla and mandible in occlusion was then carried out (Fig. 5).

![Fig. 3: Impression in the individual tray with transferred model analogs.](image1)

![Fig. 4: Model with gingival mask.](image2)

![Fig. 5: Model of the upper and lower jaw in the scanner.](image3)

**Design and production of the abutments**

The scan datasets were imported once the Zfx CAD software was started, a new patient case created and the appropriate positions and desired types of restoration selected in the dental notation. Figure 6 shows the dataset of the model including scanbodies. After this the gingival line was mapped based on the scan with the gingival mask and a fully anatomical proposal for the crowns generated by the software (Fig. 7 and 8).

This was not used for the final crown design, but as an aid for optimum design of the abutments whose size and alignment were based on the existing available space within the full anatomy. The design of the abutments was also calculated by the software using the saved connector geometry for Tapered Screw-Vent® implants. The angulation of the abutments and their height and diameters can be modified subsequently (Fig. 9 and 10).

In our case the angles in particular had to be modified individually in order to allow optimum use of the available

![Fig. 6: Imported dataset including scanbodies.](image4)

![Fig. 7: Mapping of the gingival lines.](image5)

![Fig. 8: Fully anatomical design proposal](image6)
space and to create the space required for the planned crowns despite how closely the implants were positioned to each other. Once the design is completed a final check of the dimensions can be carried out with the crown contours superimposed transparently. If desired, the model of the opposing arch can also be superimposed again for control purposes.

The design data were sent to the Zfx milling centre in Munich via the online platform Zfx Dental Net and the abutments milled from titanium in accordance with the connector geometry. An industrial machining unit is used here that can achieve an excellent level of precision even in the case of complex geometries. After the individual abutments were delivered they were checked for correct fitting on the model (Fig. 11 and 12).

**Design and production of the crown frameworks**

As the fit turned out to be very good no modifications were necessary, so scan powder was applied directly to the abutments. The model was digitalised again, this time with abutments and without gingival mask. Once the data was imported, the abutments in regions 45 and 46 were displayed individually in an enlarged view (fig. 13). Figure 14 shows the manually modified, fully anatomic design proposal of the software. This was then automatically reduced anatomically in order to ensure optimum support of the veneer ceramic by the framework (Fig. 15).

Minimum adjustment was made to the dimensions of the copings using the appropriate tools and the surface of the virtual framework smoothed down. The final design was then checked on the screen before the design data were transmitted to the milling centre (Fig. 16). The copings were produced from zirconia and then delivered to the laboratory.
Veneering and insertion
The model revealed the accurate margin fitting of the coping (Fig. 17). Trimming of the margins was all that was necessary before the veneer ceramic HeraCeram Zirkonia (Heraeus Kulzer) was applied using a layering technique. It could be seen quite clearly on the model that the restoration filled the existing space ideally thanks to the individual abutments.

The extremely positive result was also confirmed in the dental surgery. The implant abutments were screwed into place and the crowns cemented directly with Ketac Cem Glass Ionomer fixing cement (3M ESPE). The patient was highly satisfied with both the result and the uncomplicated process (Fig. 19 and 20).

Concluding remarks
The patient case study described above shows clearly that the use of CAD/CAM technology can aid the optimum design of dental prostheses, especially where difficult situations are concerned. The planning of individual abutments that fit into the available space exactly facilitates the production of restorations that are ideally adapted to the given circumstances. These can be inserted without the need for extensive reworking thanks to the high-precision machining technology.
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Master Dental Technician Kay Amberg
- 1992 – 1996 Training as a dental technician
- 2002 – 2003 Course of studies at the Master School in Munich
- 2003 Degree as master dental technician with distinction “Master’s Award from the Bavarian State Government”
- 2004 – 2009 Geschäftsführer in Dentallabor in München
- 2003 Degree as master dental technician with distinction “Master’s Award from the Bavarian State Government”
- Since 2009 owner of his own lab “Zahntechnisches Labor Kay Amberg” in Munich/Schwabing
  E-Mail: k.amberg@gmx.de

Dental Surgeon Knut Amberg
- 1999 – 2004 Dental studies at the Ludwig-Maximilian-University in Munich
- 2004 Licence to practice dental surgery
- 2004 Licence to practice dental surgery
- Since 2008 own surgery in Munich/SollnIn
  E-Mail: info@solln44.de