CAD/CAM fixed prosthetics: A case report

Author_Tero Rakkolainen, Finland

Fig. 1_A clinical photograph of the patient with the implants and healing abutments in place.

Fig. 2_The work models before the actual work was started in the laboratory.

Fig. 3_The starting point for CAD/CAM work is a carefully filled out order form.

Fig. 4_The scanning abutments manufactured were fixed on the model.

Fig. 5_The scanning abutments on the model defined the position of the implants in 3-D space.

Fig. 6_The complete CAD work model with scanning abutments and a separate gingival mask scan.

CAD/CAM fixed prosthetic implant restorations raise many questions among dental technicians. Unfortunately, if a technician is not familiar with CAD/CAM technology, he or she might have many misconceptions about it. The design and manufacture of fixed prosthetics still requires the professional skills of an experienced technician. Without input, clicking a button on a computer does nothing. This case report demonstrates the multiple phases and challenges of dental technology work even when CAD/CAM technology is used in design and manufacture.

Case report

A middle-aged male patient had an old fibre-reinforced anterior bridge. The abutment teeth of the old bridge had severe caries and the structures of the bridge had reached the end of their lifespan. The bridge was removed. Dr Juha-Pekka Lyytikä (Hammas-Pulssi dental clinic) extracted the teeth that could not be saved and placed three XIVE implants (Ø 3.8 mm; DENTSPLY Implants) in positions 14, 12 and 22. When the healing period was over, the construction of the final prosthetic restoration began.

The implants and healing abutments were in place (Fig. 1) and, since the position and direction of the implants were optimal, screw-retained zirconia structures were chosen. Being able to detach screw-retained bridges and crowns when necessary offers significant benefits for both the patient and the entire dental team. Zirconia abutment bridges and crowns are usually very well tolerated by patients and can be cleaned easily, which is a critical factor in the retention of bone and gingival volume.

The work models were fixed in the articulator before the work was started in the laboratory (Fig. 2). It is not necessary to divide the work model into
sections when using the 3Shape scanner for implants. A normal gingival mask and high-quality plaster models are sufficient.

The starting point for CAD/CAM work is a carefully filled out order form in a software program (Fig. 3). The order form specifies the work in question and the material to be used for manufacture. The form also specifies the milling centre to be used for manufacture, as well as the abutment library to be used. Moreover, the order form links specific design parameters to the work in question.

Next scanning abutments (Turun Teknohammas) were fixed on the model with screws (Fig. 4). This ensured that the position of the implants remained precise during the entire process. The scanning abutments on the model defined the position of the implants in 3-D space. The software compares the scanning results to the files in the abutment library (Fig. 5).

The complete CAD work model with scanning abutments and a separate gingival mask scan was shown on the screen (Fig. 6). The opposing arch was also scanned (Fig. 7). The work model and opposing arch scan are combined at the end of the scanning phase (Fig. 8). At this stage, it is possible to remove unnecessary data from the scans, such as the base of the plaster model.

Next, the software closes the scan and opens the 3Shape Dental Designer program. This software program places the basic units in the correct places (Fig. 9). It also offers many tools for editing the results.

The preparation limit of the abutments can be configured by dragging the dots to the desired location (Fig. 10). This is where you can also change the shape of the subgingival parts of the abutment to, for example, offer support or make more room, depending on the type and volume of the gingiva.

Fig. 7. Opposing arch scan.
Fig. 8. The work model and opposing arch scan are combined at the end of the scanning phase.
Fig. 9. 3Shape Dental Designer program.
Fig. 10. The preparation limit of the abutments can be configured by dragging the dots to the desired location.
Fig. 11. The virtual articulator in Dental Designer.
Fig. 12. The completed bridge ready to be sent for milling.
Fig. 13. The complete abutment, combining the anatomy from the library files and the created plan.
Fig. 14. A zirconia block.
Fig. 15. The complete zirconia abutment sits completely passively on the model.
Dental Designer uses a virtual articulator (Fig. 11). The virtual articulator mimics movements the same way as a real articulator does. In addition, you can use the colour-marking feature to detect contact areas. Movements can be simulated automatically or by moving the mouse.

The software also contains preset values for configuring, for example, the strength of pontics and alerts the user if these pre-sets are changed. Figure 12 shows a completed bridge ready to be sent for milling and Figure 13 the complete abutment, combining the anatomy from the library files and the created plan.

The fact that today we can mill custom-made abutments and screw-retained bridges from zirconia is the result of a cross-disciplinary effort between dental technology and engineering. After years of hard work, we are now able to mill parts to tolerances of less than 5 µm. The milling of implant bridges requires a five-axis milling machine. The STL file generated by the CAD system is only one of the steps in creating the final product (Fig. 14).

The complete zirconia abutment sits completely passively on the model after correctly executed computer-aided design, milling and sintering (Fig. 15). As part of quality control, the completed abutment is test-tightened to the correct torque on the model. The flexural strength of carefully modified custom-made abutments can be up to twice as high as that of standard zirconia abutments. Stress tests conducted at the University of Turku strained the abutments at a 45-degree angle using up to 1,500 N of force.

The completed abutments accurately matched the design, including the opposing arch and the gingival margin. In this particular case, the abutments were coloured using regular colour (Fig. 16).

The veneering work was performed at Turun Teknohammas's laboratory using conventional methods (Fig. 17). The ceramic used was IPS e.max (Ivoclar Vivadent) and the work was performed by Jaakko Siira, the technician in charge.

The completed screw-retained bridge and the abutment were tried on the model (Fig. 18), as was the screw-retained zirconia crown (Fig. 19). Then the completed work was ready to be sent to the clinic (Fig. 20). Figure 21 shows the final clinical situation of the completed product, tightened to the desired torque.

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**Fig. 16** The completed abutments accurately matched the design.
**Fig. 17** The veneering work was performed at the laboratory using conventional ceramic methods.
**Fig. 18** The completed screw-retained bridge and the abutment on the model.
**Fig. 19** The screw-retained zirconia crown.
**Fig. 20** The completed work ready to be sent to the clinic.
**Fig. 21** The final clinical photograph.

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_Contact_

Tero Rakkolainen  
Käsityötäiskatu 7  
20100 Turku  
Finland

www.intodental.fi