

From the patient's perspective: Design, implementation and prosthetics

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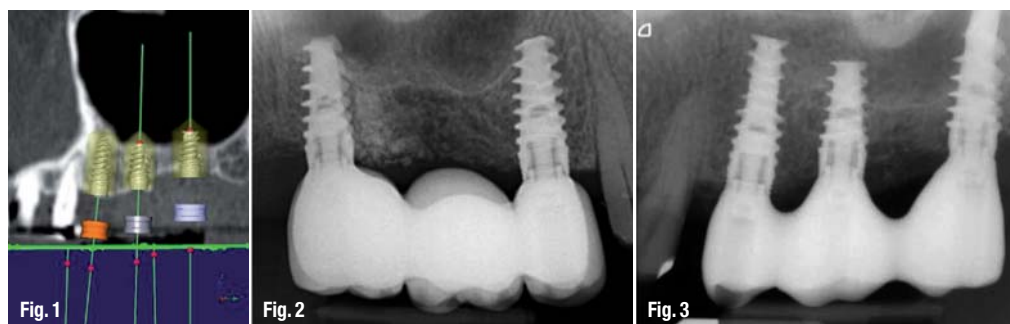


Fig. 1_ Owing to precise NobelGuide 3-D planning, a sinus lift was not necessary.

Figs. 2 & 3_ NobelActive implants enable high primary stability even in compromised bone.

The cases presented in this article differ in level of difficulty in order to illustrate that navigated implant placement is the procedure of choice for many cases. We also wish to demonstrate that template-guided navigated implant placement is advisable not only in very complex cases. From the very first time the patient presents to the dental office, the focus of the entire team contributing to the treatment is on thinking and acting from the patient's perspective and his or her foremost wish to receive a treatment that is safe, not time-

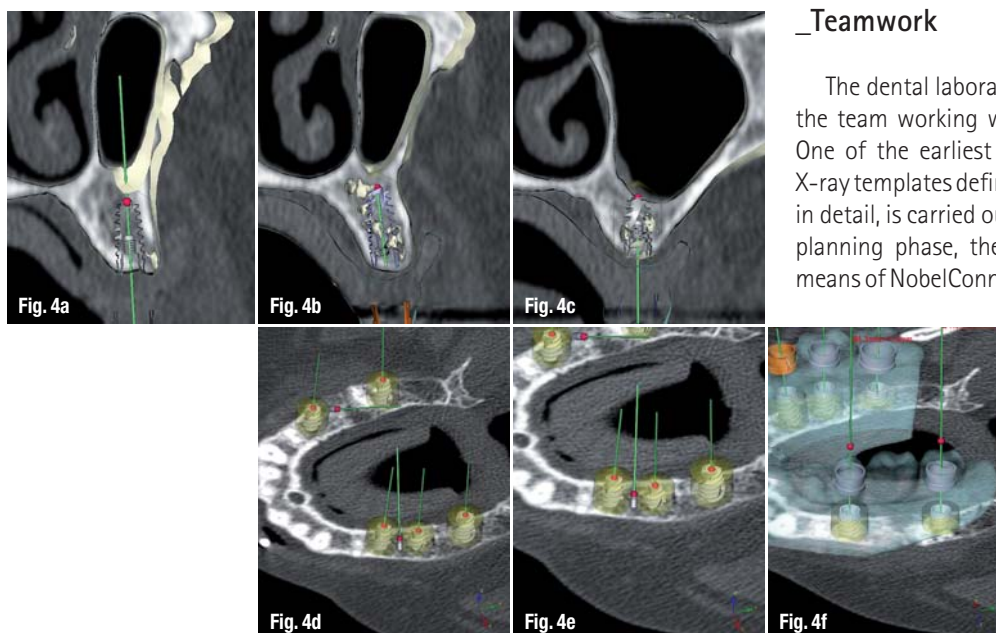
consuming, and associated with as little pain as possible.

The advantages of case planning with the NobelGuide software (Nobel Biocare) in combination with template-guided navigated implant placement include:

- _backward planning;
- _pre-surgical planning in the dental laboratory;
- _maximal certainty of the diagnosis;
- _minimally invasive intervention;
- _evaluation of complications ahead of time, to the extent possible; and
- _optimal prosthetic preparation (Figs. 1–3).

As a concept, navigated implant placement can even be utilised for the purposes of patient marketing, mainly through word-of-mouth communication, as will become evident in case II.

Figs. 4a–f_ Treatment plan.



_Teamwork

The dental laboratory is an important partner in the team working with the NobelGuide software. One of the earliest steps, the preparation of the X-ray templates defining the later prosthetic targets in detail, is carried out in the laboratory. During the planning phase, the results can be discussed by means of NobelConnect, an Internet-based network of all participating specialists, and the necessary decisions concerning the fine-tuning between surgery and later prosthetic requirements can be made. Accordingly, the resulting case designs were developed on the basis of teamwork and are therefore supported by the entire team.



The NobelGuide team always includes the dental technician, the prosthetic expert, the surgeon, the patient, and, if applicable, the radiologist recording the 3-D images. The advantages of integrating 3-D diagnostics, 3-D planning and 3-D templates outweigh the disadvantages, such as increased radiation exposure and associated costs, which are the ones most mentioned.

The definite advantages of this approach include certainty of diagnosis, precise surgical implementation, avoidance of angular deviations at depth during the surgery, expansion of the range of indications, and prevention of clinical and prosthetic complications to a large degree, especially in the application of NobelActive implants, as is described below. The NobelActive implant system was developed for experienced surgeons in order to be able to attain high primary stability even in compromised bone and under difficult conditions.

Two new tools—NobelClinician and NobelConnect—enable even better networking between the participating team partners for collaborative purposes by granting each partner access to the current state of the case—from 3-D planning to the insertion of the implant restoration—through a dedicated software interface. This facilitates communication, especially if team members do not work in the same locale.

After taking the history and arriving at a clinical diagnosis, the 3-D analysis is performed and the results are discussed to determine the treatment plan. NobelGuide, being both a surgical and a prosthetic system, is advantageous in that it allows a temporary restoration to be fabricated by the

dental laboratory prior to surgical intervention, provided this is needed and indicated. The laboratory can utilise the drilling template made in a centralised industrial production facility to transfer the planned implant positions to a model such that the temporary restoration can be fabricated without the risk of transfer losses.

Case I: Lateral tooth restoration

The first case presented concerns a 75-year-old female patient and documents a situation that is commonly encountered. The plan was to treat tooth #14 with a single crown and place a bridge on two implants. Furthermore, teeth #23 and 24 were each to receive single crowns and, in addition, an implant bridge on three implants was planned (Figs. 4a–f). In this case, what made the use of NobelGuide so attractive for patient, dental technician and surgeon?

Easier handling

Owing to the exact 3-D design with NobelGuide, the surgeon was able to proceed despite the reduced amount of available bone. A sinus lift was not necessary. It was possible to place all five implants without having to generate a flap, mini-

Fig. 5_The impression for preparation of the master model over teeth and implants was taken in the same surgical session.

Figs. 6 & 7_Procera Crowns Alumina and Procera Implant Bridges with screw retention at implant level.

Fig. 8_Screw-retained abutment and bridge are made of the same material.

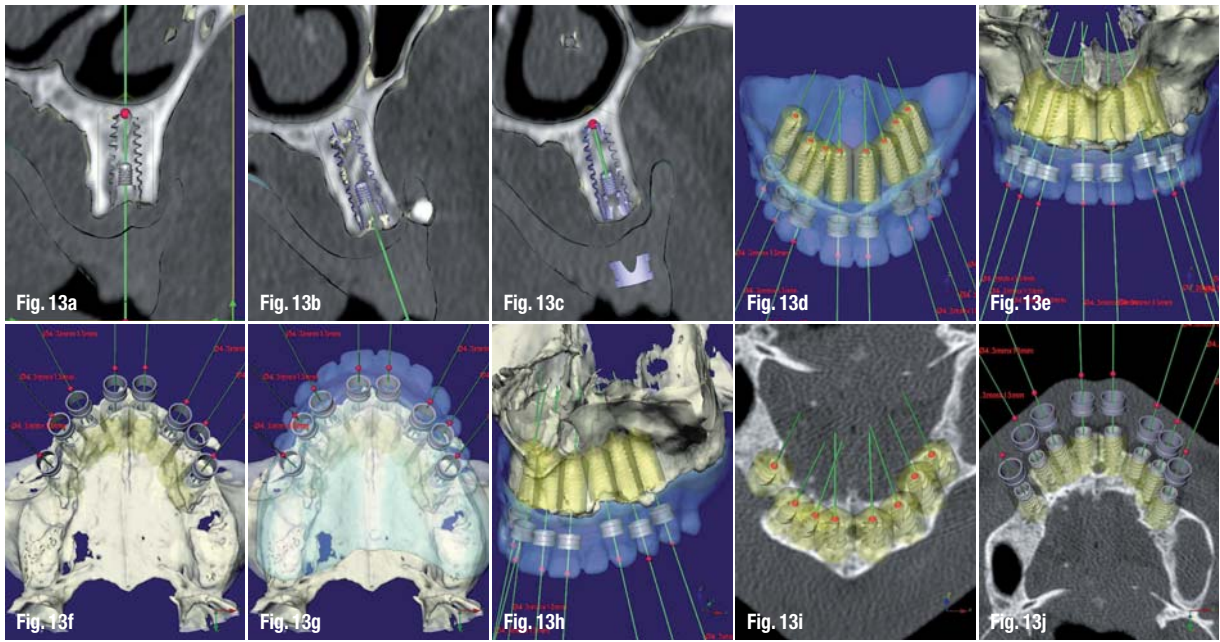
Fig. 9_Very high quality milled titanium material and no gingival irritation is caused by a cement gap, since there is no such gap.

Fig. 10_Optimal aesthetics and integration of restoration.

Fig. 11_Disastrous clinical situation.

Fig. 12_Teeth could not be conserved and had to be removed.





Figs. 13a-n_ Treatment plan.

misgiving the post-operative consequences such as pain, swelling and the formation of haematomas. Moreover, it allowed the impression for preparation of the master model over teeth and implants to be taken in the same surgical session (Fig. 5). The dental laboratory contributed to the production of the X-ray templates early in the planning phase, was familiarised with the case and involved in the discussion about the desired implant positions. The benefits for the patient included a safe operation, since the surgeon planned the entire operation beforehand and thus expected a predictable result. A difficulty in the present case was the relatively soft quality of the bone. Under these circumstances, NobelActive is beneficial for the experienced surgeon since it rotates into the bone much like a compression screw, which allows good primary stability to be attained.

The NobelActive implant

The TiUnite surface of NobelActive implants affords osseointegration down to the level of the implant shoulder rather than to just below the implant shoulder owing to the biological width of at least 1 mm as is customary for conventional

implants. This is associated with significant advantages for the aesthetics of the red-white transition. The gingiva is more stable and resection is less pronounced, which leads to the volume being maintained. This effect is of crucial importance for the success of an implant treatment in the anterior region, where aesthetic appearance is extremely significant.

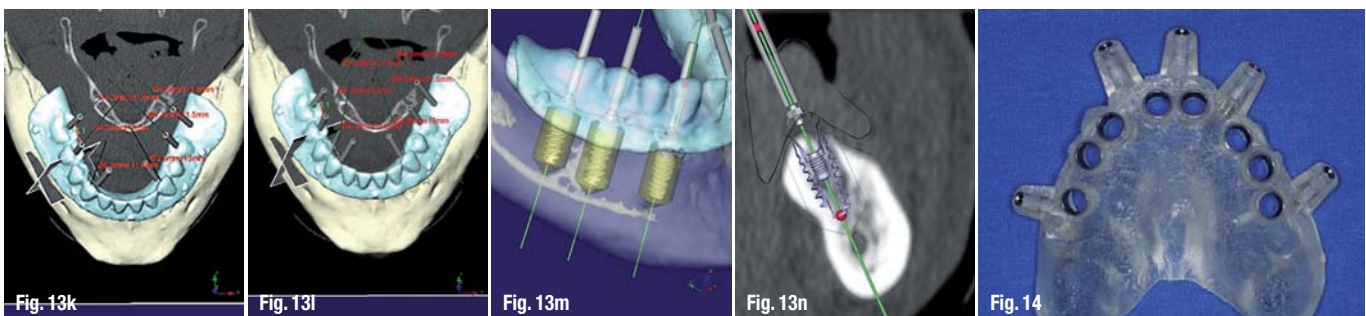
Ceramic-veneered and screw-retained implant bridges made of titanium

For dental management of the final restoration, CAD/CAM-fabricated Procera Implant Bridges with screw retention at implant level were produced. The available framework materials for this purpose are zirconium-oxide ceramics and titanium. Titanium was selected in the present case (Figs. 6 & 7).

Additional advantages of this technique are:

- _ screw-retained abutment and bridge (Fig. 8);
- _ tension-free framework;
- _ bridge construction and implant are made of the same material;

Fig. 14_ Surgical template upper jaw.



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Figs. 15 & 16 _A surgical template in combination with a specifically matched surgical kit allowed for exact transfer of the 3-D computer planning to the patient's mouth.
Fig. 17 _Fixed temporary bridges.

_very high quality milled titanium material;
_no problems with chipping;
_bridges are aesthetically pleasing and easy to remove; and
_no gingival irritation is caused by a cement gap, since there is no such gap (Fig. 9).

were tried-in during the same session. The definitive incorporation of the final restoration was only effected after a healing time of three months though. Owing to this specific surgical and prosthetic protocol, no additional session for try-in was required, which the patient considered very convenient (Fig. 10).

Screw-retained bridges and milled titanium are very popular forms of management today. Their production in the dental laboratory is no longer fraught with the earlier difficulties of cast titanium restorations, such as an alpha case layer. Accordingly, the veneering with titanium ceramic materials, made by VITA in the present case, has become much simpler. In a template-guided implant placement procedure, the axes are aligned such that the screw retentions can be implemented later exactly according to plan. This makes the work much easier and improves the quality of the restorations. Consequently, implant restorations can be achieved that are attractive to the patient owing to their reasonable pricing and high quality aesthetic appearance.

_Case II: Management of upper and lower jaw

It was easy to conclude from the initial situation of this case that the patient, a 63-year-old male, had eschewed visiting a dentist for a long time. Accordingly, the teeth were in need of much dental work (Fig. 11). Following a comprehensive diagnostic work-up, all teeth had to be removed, since they could not be conserved (Fig. 12). The patient was phobic and well aware of the poor condition of his teeth but had not perceived an adequate treatment option for his needs in the past. Talking to an acquaintance, he had been made aware of the availability of surgery with a template without "cutting" and detailed pre-surgical planning on a PC in order to minimise the attendant risks. By his own account, he would not have made the decision to have classical surgery. For the surgeon, the outcome obtained in this case would not have been possible without this technique except with much difficulty and significantly more surgical effort and trauma.

Procedure according to treatment plan

It is very convenient for the treatment team to be able to proceed according to a detailed plan. Each member of the team is aware of all tasks and

In this case, the master impression was taken during the surgical session. With respect to the skull, the models were mounted in an articulator by means of face-bow transfer via the impression posts. The natural teeth were treated with NobelProcera Crowns Alumina, which is another CAD/CAM-based method for fabricating all-ceramic dental restorations. For this purpose, a framework coping and the implant frameworks were tried-in at the subsequent session. At the third session already, the tooth-borne crowns were incorporated and the finished implant bridges

Figs. 18a & b _The terminal molars (teeth #36 and 46) were fabricated as titanium single tooth crowns and screw-retained at implant level.

Fig. 19 _Distal-splinting in the lower jaw.

Fig. 20 _The Procera Implant Bridge Titanium on multi-unit abutments was veneered completely, including gingival regions, using VITA titanium ceramic.





when they need to be addressed. In particular, the prosthetic pre-surgical planning, which is of great importance, attains a completely new function as it can be compared, in a quality management approach, to the final result obtained after the treatment is completed in order to determine the degree to which the plan was actually implemented. Following radiological digitalisation of the patient by means of a double-scanning procedure and conversion to virtual 3-D models, the surgeon can start to design the implants. In the present case, we planned to place six implants in the lower and eight in the upper jaw (Figs. 13a–n). The transitional dentures required after extraction of the residual teeth also served as scanning templates (Fig. 14).

Surgery

In cases of a large number of implants to be placed, our team likes to implement a two-stage implant placement procedure. The lower jaw implants are inserted on the first and the upper jaw implants on the subsequent day. The patient was not subjected to general anaesthesia. It was possible to treat the phobic patient only with local anaesthesia without any problems. The surgical template used in combination with a specifically matched surgical kit allowed for exact transfer of the 3-D computer planning to the patient's mouth (Figs. 15 & 16). As in the first case, NobelActive implants were inserted, which afforded good primary stability even under the strongly reduced bone conditions present in this case. This is owing to the special surface and the design of the implants. Following surgery, fixed temporary

bridges, which had been fabricated ahead of time based on the existing planning, were inserted (Fig. 17).

Procera Implant Bridge

As before, the definitive form of management selected in this case was a NobelProcera CAD/CAM restoration. There were some particularities to take into account in the management of both the lower and the upper jaw. The true quality of the teamwork of dental office and laboratory becomes evident in the smooth production of very sophisticated rehabilitative restorations that can be fabricated without complication and incorporated into the stomatognathic system of the patient without any difficulties.

As part of the production of the restorations for the lower jaw, the terminal molars (teeth #36 and 46) were fabricated as titanium single tooth crowns and screw-retained at implant level (Figs. 18 a & b). It was thus possible to take into account the 3-D twist of the arching lower jaw bone such that tensions at the level of the distal implants were prevented, which might otherwise have caused bone loss or even implant loss. We only splinted inter-foraminally in the lower jaw, between teeth #35 to 45 (Fig. 19). A distal cantilevered pontic substituting for teeth #36 and 46 was not used in this case, as implants #45 and 35 were only NobelActive implants with a diameter of 3.5 mm. The Procera Implant Bridge Titanium on multi-unit abutments from teeth #35 to 45 was veneered completely, including gingival regions, using VITA titanium ceramic (Fig. 20). As before,

Figs. 21 & 22_The framework was veneered with a gingiva-coloured ceramic material and opaquer was attached in the region of the stumps.
Fig. 23_Model with Procera alumina single crowns.

Fig. 24_Situation *in situ* with multi-unit abutments.
Fig. 25_Procera Implant Bridge *in situ* before crown cementation.
Fig. 26_Aesthetic appearance at the red–white transition.



it was feasible to implement the screw retentions exactly according to plan such that no adverse aesthetic effects arose. The far-reaching bridge was fabricated at the Nobel Biocare milling centre and was prepared for the veneering steps with only little time required for minor details of post-production processing. Thanks to CAD/CAM technology, it is possible to generate frameworks that are truly free of tension. In this context, Nobel Biocare guarantees a precision of fit of less than 25 µm.



Fig. 27

Fig. 27_Panoramic X-ray.

For aesthetic reasons, an elaborate form of restoration was selected for the upper jaw. A Procera Implant Bridge Titanium on multi-unit abutments was produced. The bridge was designed to allow all-ceramic NobelProcera Crowns Alumina to be cemented to them. For this purpose, the framework was veneered with a gingiva-coloured ceramic material and opaquer was attached in the region of the stumps by firing (Figs. 21 & 22). In the next step, the single crowns were prepared (Fig. 23). After completion of the entire restoration, the basic framework was screw-retained in the mouth (Fig. 24) and the aesthetic Procera alumina single crowns were cemented in the mouth using conventional cement (Durelon, 3M ESPE; Fig. 25). Accordingly, the patient's restoration was still conditionally removable in the dental office, since the crowns covering the screw channels remained removable. This is advantageous for the patient in that the aesthetic appearance of the upper jaw can be improved even further, while no screw channels are visible. This resulted in an excellent aesthetic appearance at the red-white transition (Figs. 26 & 27).

Conclusion

In this article we have demonstrated a dental team being able to offer treatment based on a one-provider concept that starts with a 3-D diagnostic work-up, allows for template-guided navigated implant placement, keeps in stock all implant and prosthetic components (as typifies the concept of

Nobel Biocare), and offers numerous advantages, including:

- _ application of a broad range of different techniques from a single supplier;
- _ only a single supplier needs to be contacted;
- _ implant and prosthetic components match;
- _ interfaces match;
- _ materials match;
- _ final result has a high precision of fit;
- _ generous solutions if difficulties are encountered; and
- _ custom-made designs for special needs.

Approaching the planning and implementation of an implant-borne restoration from the patient's perspective and his or her needs will always cause the treatment team to place safety very high up on the list of its priorities. Based on the reliable NobelGuide concept, the success of the team becomes a matter of planning. To have but a single supplier to contact for all necessary components saves time and the attending team can rely on the perfect match of all components. Another aspect that should not be underestimated is the increasing number of litigations after unsuccessful outcomes. Products that have been tested in numerous scientific studies provide the needed validity. 3-D planned and template-guided implant placement, aesthetically pleasing forms of restoration, and a long service life of the restorations also appeal to the patients.

The dental office of Drs Grebe periodically organises courses in 3-D implantology and CAD/CAM prosthetics for dentists and dental technicians. If you are interested, please enquire about the dates of upcoming events by e-mail.

We would like to thank our dental technicians Michaela Schenker, Frank Rödel and Jörg Parsaksen for their support.

Editorial note: A list of references is available from the authors.

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