COMPUTER-ASSISTED VIRTUAL TREATMENT PLANNING COMBINED WITH FLAPLESS SURGERY AND IMMEDIATE LOADING IN THE REHABILITATION OF PARTIAL EDENTULIES

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SUMMARY

It has been suggested that for success with immediate loaded dental implants it is necessary that, prior to their placement, bone quality and quantity as well as the biomechanical environment in which the implants are to function be evaluated.

However, conventional techniques currently used for immediate implant placement lack sufficient precision and are usually accomplished by opening flap procedures. Nowadays computer-guided flapless surgery for implant placement using stereolithographic templates is gaining popularity among clinicians and patients. The advantages of this surgical protocol are its minimally invasive nature, accuracy of implant placement, predictability, less post-surgical disconfort and reduced time required for definitive rehabilitation. The introduction of digital planning programs has made it possible to place dental implants in preplanned positions and being immediately functionally loaded by using prefabricated prostheses. The surgical guide is used, infact, to develop a master model and fabricate the provisional bridge that will be secured to the implants immediately after their placement using the guided surgery template. In this way patients are able to achieve, in the same day of the surgery, a comfortable fixed rehabilitation needing only minor occlusal adjustments. Job S. et al during the three-month period, have demonstrated that the average reduction of crestal bone height around the implants placed with flapless surgery (0.06 mm) is not statistically significant, while the average reduction of crestal bone height around the implants placed using flap surgery (0.4 mm) is statistically significant, concluding that the use of stereolithographic appliances in accordance with flapless surgery makes immediate placement of the implants more predictable. However, the documentation of this technique in partial rehabilitations is limited. PURPOSE of this paper is to report the benefit of sophisticated pre-operative diagnostic implant planning and a flapless surgical approach with immediate loading in the rehabilitation of partial edentulies.

Key words: dental implants, computer guided flapless implant placement, immediate loading, partial rehabilitation.

Introduction

In implant dentistry today, precise preoperative planning of both the implant placement and the restoration is a critical prerequisite to succeeding in the oral rehabilitation of patients with dental implants. Modern three-dimensional imaging techniques such as digital volume tomography allow the acquisition of radiologic data with very low levels of radiation and excellent image accuracy, and also allow the processing of these data with various types of software applications. Thanks to these technologies it is now possible to predetermine the precise three-dimensional position of the planned implant before the actual implant insertion, and to transfer this position to the surgical site. Thus, the restoration can be fabricated before surgery and can be placed into the patient's mouth immediately after surgery. Treatment planned in this way is fast, minimally invasive, and most importantly, predictable. This increases the quality of both the sur-

gical procedure and the restoration (1-2-3). The introduction of digital systems into the diagnostic routine, and their application using three dimensional data sets of the bone topography, have made it possible to reconcile the two central aspects of planning an ideal prosthetic solution with the given anatomic situation prior to implant surgery. Three-dimensional data from a computerized tomography (CT) scan or from digital volume tomography (DVT) scan in DICOM format (Digital Imaging and Communications in Medicine) can be represented, analyzed, and used for the subsequent fabrication of a surgical template with the help of special software applications. Such surgical guides are produced in a stereolithographic process using digital data (NOBEL GUIDE, Nobel Biocare) and integrate the appropriate sleeves for the implant positioning. This offers considerable advantages for both the patient and the clinician. The available bone can be used optimally and bone grafting can be avoided, or planned in advance in the best possible way if a bone graft is necessary. By combining the digital information of the bone with the planned restorative solution, the implant position can be adjusted to the best possible angulations, position, and depth. In addition, it is possible to accurately prepare a provisional or permanent restoration on the cast prior to the surgical procedure and to use it as an immediate provisionalization. This results in a predictable surgical outcome, and subsequently, a restorative treatment outcome (4). The aim of this clinical report is to document the protocol of sophisticated pre-operative diagnostic implant planning and a flapless surgical approach with immediate loading in the rehabilitation of partial edentulies (5-6).

Diagnostic, prosthetic and surgical protocol

Before any treatment all patients are clinical examinated. In addition to general health requirements for conventional implant treatments, patients have to be able to open the mouth at least 5 cm (prerequisite to accomodate the surgical drills). However in case of limited mouth opening is sufficient give to the patient, for three mounth before surgery, a neuro-muscolar decontizioning therapy and plan the implants maximum until the first molar (7). After this important valutation we can start the computer guided implant protocol that can be divided in six stages: radiographic guide preparation; CT scan; computer planning; provisional restoration fabrication; surgical procedure; and provisional restoration adjustment. The preparation of the radiographic guide for partial rehabilitation follows the same rules used for full arch rehabilitation with some little differents. It starts with the articolation of the stone model using a silicone bite registration index, and making an ideal wax-up of the missing teeth. After that the laboratory technician realize the radiographic guide covering with resin material (with a thickness between 2 and 3 mm) buccal, occlusal and palatal sides of the remaining teeth (Fig. 1). A full palatal recovering is important to achieve an optimal retention of both radiographic and surgical template (that will be realized on the basis of the radiographic guide). In addition we suggest to make some inspection windows through the occlusal surface of the existing teeth so that they are visible

Figure 1
Radiographic guide.

while occluding. These inspection windows will be finally automatically transferred from the radiographic guide to the surgical template allowing us to confirm the proper seating of surgical guide during clinical procedure. Finally before proceding with CT scan, in order to correlate the radiographic guide with the bone structures in the software, some gutta-percha ball markers (minumum of six with 1,5 mm diameter and 1 mm deep) must be integrated into the thickness of the radiographic template, placed at different levels both in buccal and palatal plane. When the radiographic guide is ready, the double Ct scan is performed. The procedure begin with the patient scan. The patient, wearing the radiographic guide stabilized with a silicone index (that ensures the correct patient's bite) is scanned with the occlusal plane parallel to the axial slices. Immediately after, a second scan of the radiographic template itself is performed using the same CT scanner settings. The software will correlate this second scan with the images of the bone on the basis of the radiopaque gutta-percha markers. This double scan procedure allows better visualization during implant planning and control of the precision of the image. Only at this time the treatment planning can be performed by the clinician using the Procera® Software Planning Program (Nobel Guide, Nobel Biocare AB). The virtual scene with the patient's CT data is inspected with a three-dimensional viewer, presenting a general overview of the scene. To visualize the cross-sectional reslices, the clinician interactively manipulates a curve in the three-dimensional viewer that guides these reslices along the maxillary crest. With the zoom, rotate, and translate tools, every detail can be inspected. The virtual three-dimensional scene of the planning environment is interactively composed. By a simple click of the mouse, the prosthesis (radiographic template) can thus be introduced or removed from the image. The software is fully three-dimensional, allowing the clinician to visualize concomitantly three planar views of the object (the bone and/or prosthesis) in one image. Placing an implant is done intuitively by indicating a point on top of the bone crest and another more apically, mimicking the use of a drill. When the implant is thus apparent (Figs. 2-5), the clinician can change the lenght, width, inclination or position (a safety margin of 1.5

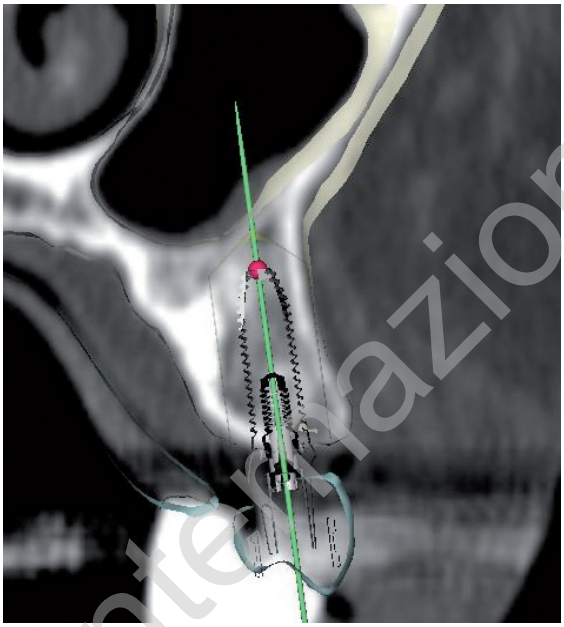

Figure 2
Virtual treatment planning.

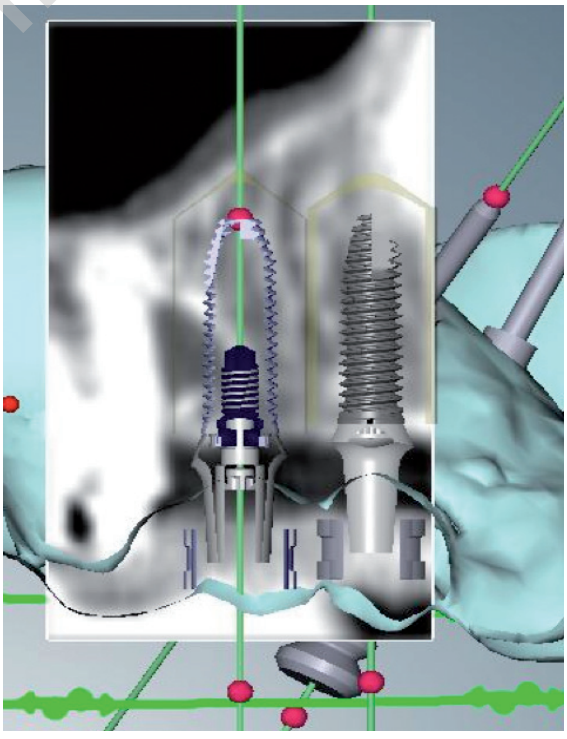

Figure 3
The virtual scene with the patient's CT data is inspected with a three-dimensional viewer, presenting a general overview of the scene.

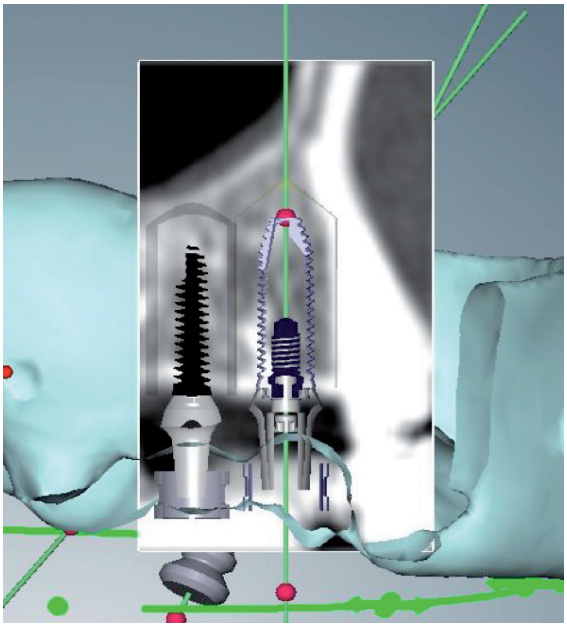

Figure 4
When the implant is thus apparent the clinician can change the lenght, width, inclination or position (a safety margin of 1.5 to 2 mm is therefore recommended for all systems).

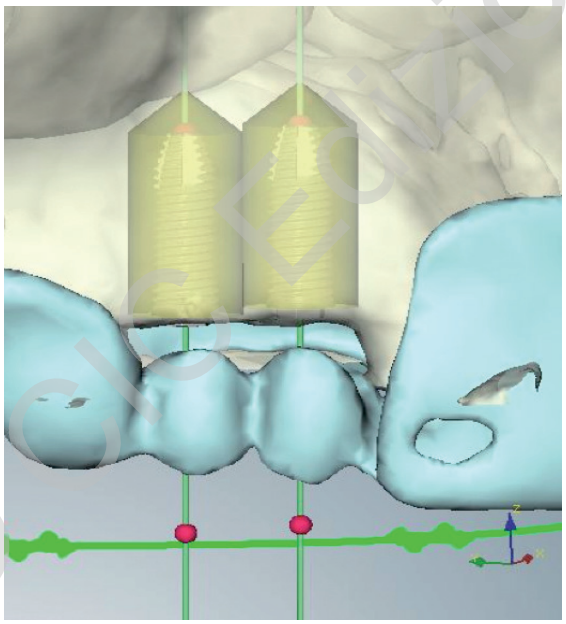

Figure 5
Once the treatment planning has been approved by the clinicians team, it is digitally sent to the Procera® workstation for further manufacturing of surgical template.

to 2 mm is therefore recommended for all systems) (8). The clinician also plans three or four stabilizing pins for the surgical template between the implant sites. Once the treatment planning has been approved by the clinicians team, it is digitally sent to the Procera® workstation (Nobel Biocare AB) for further manufacturing of a stereolithographic model. Starting from this model the surgical template is produced in acrylic material on the basis of the radiographic guide, and containing metallic sleeves (corresponding to the location and inclination of the planned implants) in which removable stainless drill guides with varying inner diameters (corresponding precisely to the diameters of the drills) can be fitted (Fig. 6). In addition the surgical template provide all necessary information (implant position, soft-tissue and teeth geometry) to make the final stone model. The laboratory procedures include marking the implant approximate positions on the initial stone model, cutting this section away and checking the correct position of the surgical template over the model via the inspection windows. Nobelguide specific laboratory components and implant replicas are attached, silicone gingiva applied and the removed section of the stone model filled with stone cast. The new stone model is articolated with the radiographic guide and the radiographic index in place. Then the radiographic guide is replaced by the surgical template,

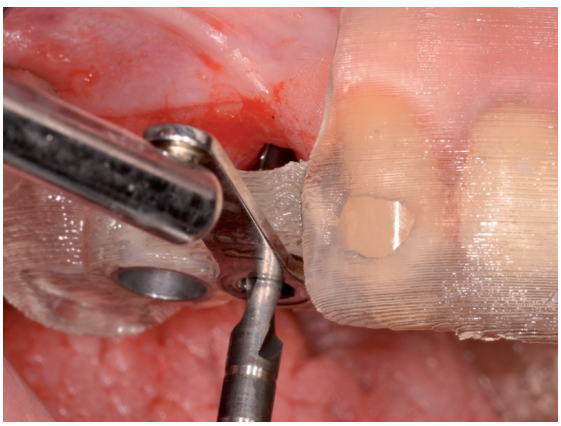

Figure 6
The surgical template contains metallic sleeves in which removable stainless drill guides with varying inner diameters can be fitted.

and a surgical silicone index is made. This will be used to stabilize the surgical template in the patient's mouth in the beginning of the surgery. This is finally performed under local anesthesia with articaine chlorhydrate with epinephrine 1:100000. The patient is prepared with antibiotic therapy and analgesic therapy. Prednisone is also administrated daily in a regression mode from the day of surgery until 4 days. Antiacid medication is given for all the time of antibiotic therapy (6 days). The surgical template itself is preparated (aseptic procedure) by keeping it for 2 minutes in ipoclorito di sodio solution and then washed. Finally the surgical template stabilized with the silicone index is placed in the patient's mouth and his proper fitting is verified through the inspection windows. Nevertheless the surgical template with this design is often already well stabilized, we suggest to anchor it always to the bone by means the planned horizontal pins, to ensure the best stability of the guide during the implant surgery that is performed, following the manifacturer's instructions, using a drilling protocol (Nobel Guide, Nobel Biocare AB). After implant placement (Figs. 7,8), the surgical template is removed and when a good primary implant stability is achieved (more than 40 N/cm)(9) the abutments are screwed with a torque of 30 N/cm and the temporary crowns (cemented or screw-retained) are delivered (Figs. 9-11) after occlusal adjustment where needed. Completed the osteointegration period the case is finalized with conventional prosthetic procedure (Figs. 12-17). In the rehabilitation of partial edentulies, in some cases is possible to prepare directely Procera® CAD-CAM customized zirconia or titanium abutments and the relative frameworks. So in these cases we finalize the re-

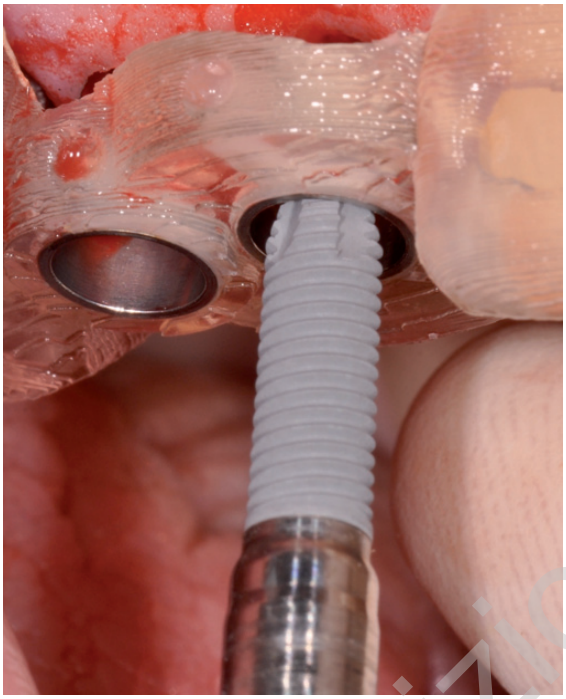

Figure 7
Implant placement.

Figure 8
Implant insertion torque.

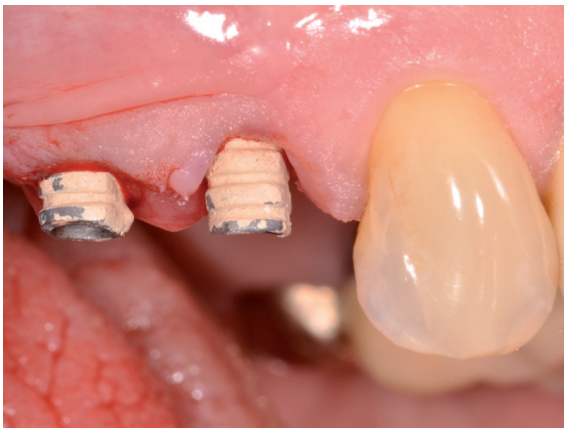

Figure 9
Temporary abutment for immediate loading.

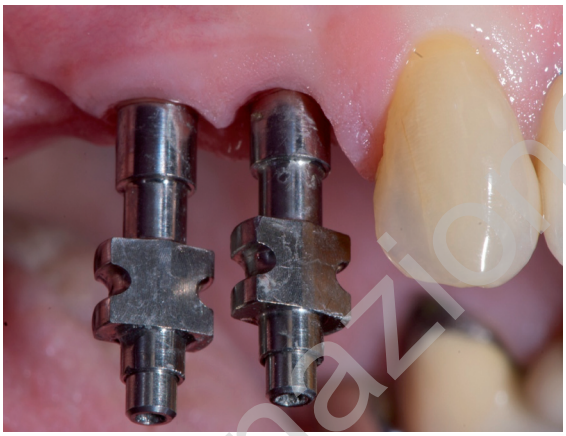

Figure 12
Impression transfert.

Figure 10
Immediate provisionalization.

Figure 13
Definitive CAD-CAM titanium abutments.

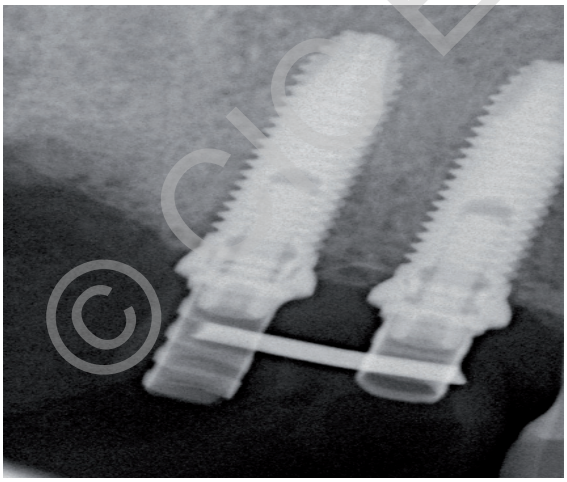

Figure 11
After surgery Rx.

Figure 14
Initial Rx.

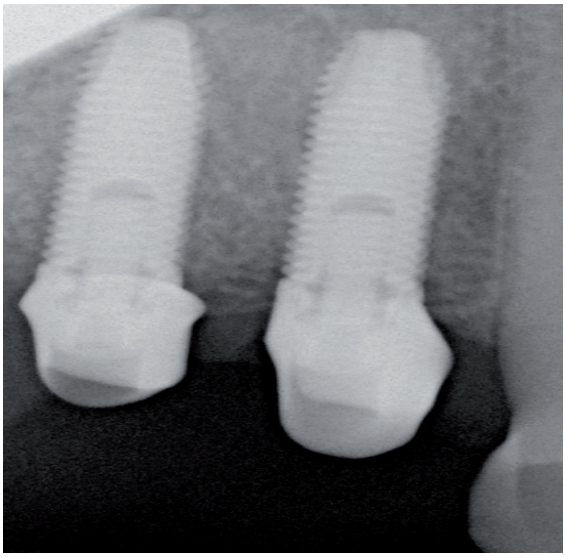

Figure15
Final RX.

Figure 16
Initial clinical situation.

Figure 17
Final clinical situation.

habilitation simply taking an impression of their position. In those unfortunately cases in which the margin of abutments preparations at the end of bone and tissue healing is not in esthetic zone is possible to decide between two strategies. We can choose to prepare more apically the margin of the abutments preparation directly in patient's mouth (10) and take a new impression like with natural teeth or take away the abutments from the fixture, put temporary healing abutments and modify the margin preparation on a new stone model.

Conclusion

Three-dimensional guided implant surgery improves the quality of both the surgical procedure and the restorative results, enabling a very safe and predictable rehabilitation compared with conventional surgery. Moreover elderly or medically compromised patients, and people suffering from fear or anxiety of surgical treatment may benefit greatly from the use of these protocol. However, the documentation of this technique in partial rehabilitations is limited nevertheless the benefits are evident. These involve minimally invasive nature, accuracy of implant placement, predictability, less post-surgical disconfort and reduced time required for both definitive rehabilitation and surgical procedure (less than 10 minutes for the placement of two implants). Moreover the possibility of placing the final abutments in the day of the surgery has the great biologic advantage to minimize every future disgregation of the bone-implant-abutment giunction with a better behavior (prognosis) of the implant rehabilitation in the long time. Finally the digital planning allowing an ideal implant position (depth and mesio-distal distance between natural teeth or other implants)(11), guarantees the best esthetic results in all clinical situations.

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