

SURGIPLANNER: A NEW METHOD FOR ONE STEP ORAL REHABILITATION OF SEVERE ATROPHIC MAXILLA

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SUMMARY

The implant-prosthetic rehabilitation of edentulous upper jaws has always been complex for surgeons and dentists. The lack of bone in both vertical and horizontal dimension does not allow the correct insertion of dental implants. In addition, patients with edentulous upper and lower arch have a loss of vertical dimension of the face and an aged expression. Many surgical techniques have been proposed to increase the bone volume, height and thickness, such as the Le Fort I osteotomy, the bone grafts and the placement of dental implants. Planning these surgical procedures is difficult, because it is not possible to reproduce the movements of osteotomized bone segments in three planes of space. This article describes the treatment of severe atrophy maxilla with a new approach using a new instrument named "Surgi planner". Surgi planner is a method that, only using a computerized axial tomography (CAT), allows to obtain a totally predetermined therapeutic result from both an aesthetic and functional point of view, with surgery of severe resorbed jaws. Surgi planner allows repositioning of segment of the skeleton of the patient's face in a predetermined and controlled way for the best implant-supported oral rehabilitation.

Key words: atrophy of maxilla, severe resorbed maxilla, implant dentistry, cranio-facial surgery, bone.

Introduction

The implant-prosthetic rehabilitation of edentulous upper jaws has always been complex for surgeons and dentists (1-13). The lack of bone in both vertical and horizontal dimension does not allow the correct insertion of dental implants and oral rehabilitation (14-22). In addition, patients with edentulous upper and lower arch have a loss of vertical dimension of face with aged expression. Many surgical techniques have been proposed to increase the bone volume, height and thickness, such as Le Fort I osteotomy, bone grafts and insertion of dental implants (23-32). The project of these surgical procedures is complex, because it is not possible to reproduce

the displacements of osteotomized bone segments and condilar movements in three planes of space (7, 8). This article describes the treatment of severe atrophy maxilla with a new approach using a new instrument named "Surgi planner". Surgi planner is a method that, only using a computerized axial tomography (CAT), allows to obtain a totally predetermined therapeutic result from both an aesthetic and functional point of view, supporting surgery of severe resorbed jaws (Figure 1).

Surgi planner

We have designed and implemented a working



Figure 1
A patient before a) and after surgical treatment planned with Surgiplanner b).

method, the Surgiplanner, in order to achieve the best aesthetic and functional results after maxillo-facial surgery, only with the use of the computer assisted tomography (CAT) of the patient's skull. The Surgiplanner is a tool that allows to move the osteotomized maxilla segments in three planes of the space, maintaining the correct relationship between condyle and skull base into the glenoid cavity. It also allows to perform a 3D model of the temporomandibular joint, thus allowing to reproduce jaw movements in three planes of space. Reproduction of the condylar movements allows the reconstruction of functional occlusion in a fixed prosthesis. The Surgiplanner is a prototype developed to set the 3D model of the patient's facial skeleton in a functional way (Figure 2). The 3D facial skeleton model construction doesn't require the use of a facial arc transfer.

Pre-surgical procedures

The first step consists in performing a 3D model of maxilla and mandible, with the use of a CAT. The 3D model of cranial plane should be paral-

lel to the intra orbital line of the patient or to any other reference plane (Frankfurt plane, Bi-spinal plane etc.). After the mounting of the maxillary model on Surgiplanner, the mandible can be positioned by aligning the hinge axis with the axis of rotation of the articulator. The 3D model of the face skeleton allows to analyse the position of the future prosthetic crowns in relation to the morpho-functional characteristics of the face's patient. So a total upper denture is performed according to the correct occlusion (Figure 3).

With Surgiplanner it is possible to perform an upper total denture with a correct occlusion and analyse the anomalies of shape, size and position of the severely resorbed and dysmorphic edentulous maxilla, in relation to the future implant-prosthetic rehabilitation. A total denture is performed in order to replace the existing bone defect compared to prosthetic rehabilitation project, both from an aesthetic and functional point of view.

The upper denture is performed according to the method by Professor Rudolf Slaviceck. The patient's initial models are mounted in the articulator to standard values (Sam 3 professional). The Surgiplanner may interface with any other artic-

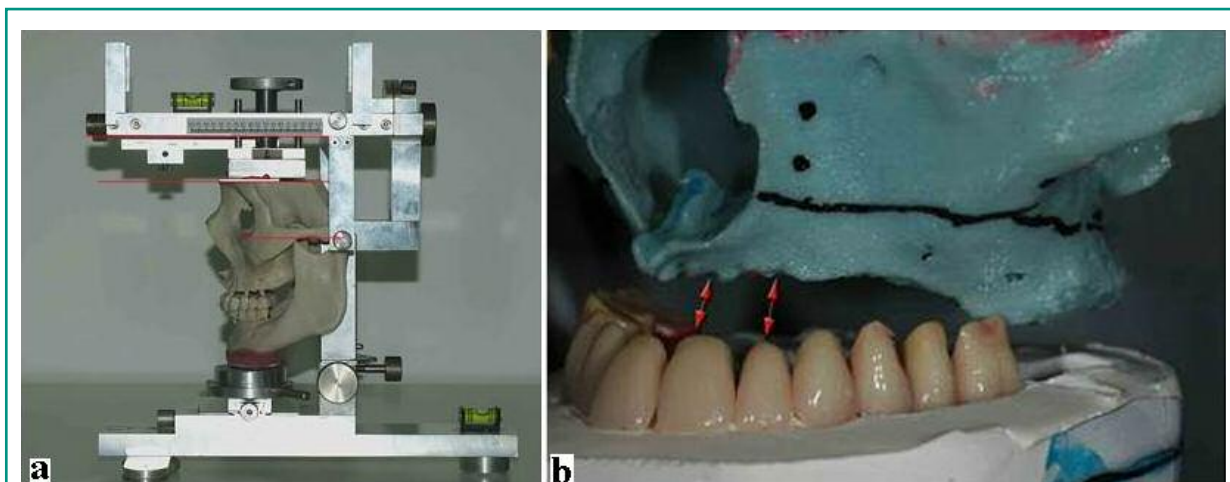


Figure 2
a) 3D model of a facial skeleton mounted on Surgiplanner; b) prosthetic crowns performed according to Surgiplanner analysis.

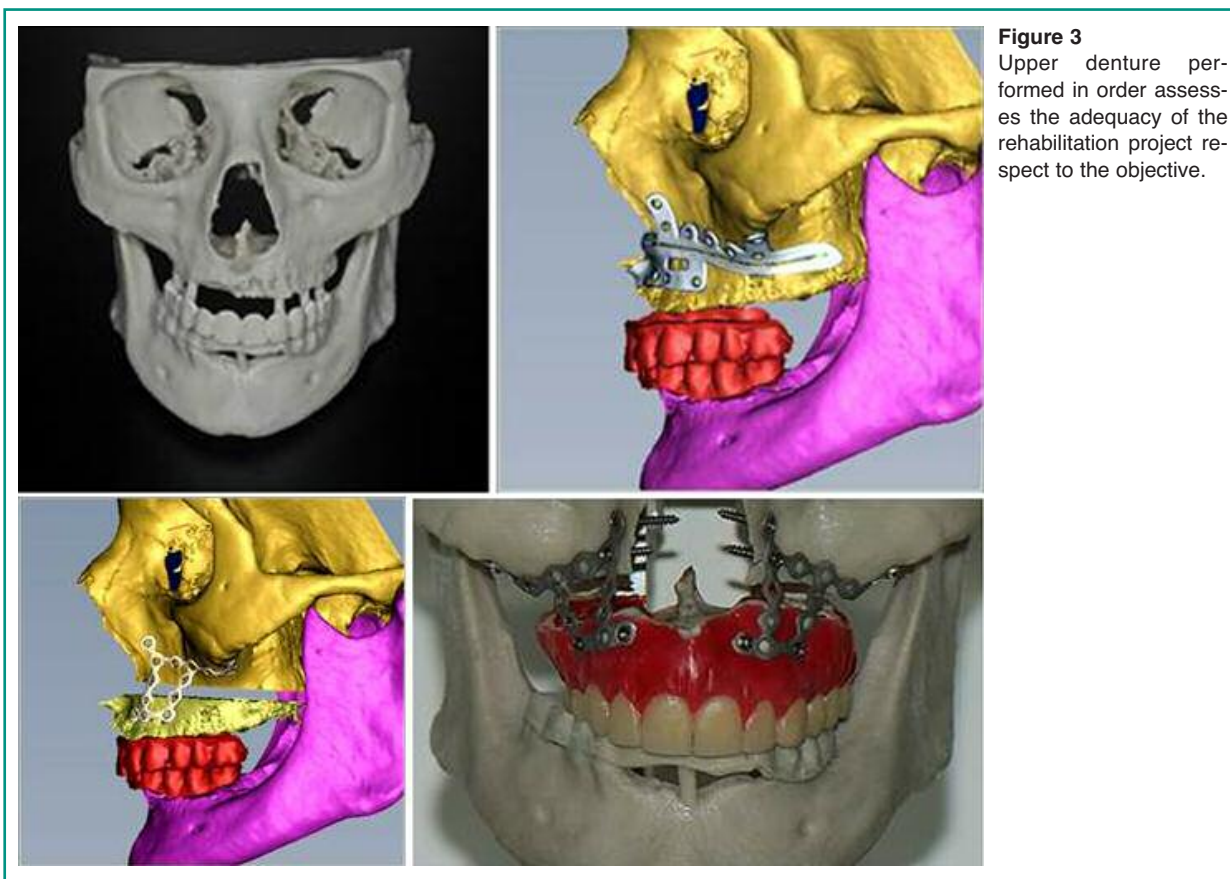


Figure 3
Upper denture performed in order to assess the adequacy of the rehabilitation project respect to the objective.

ulator. In the specific case it was interfaced with SAM articulators for occlusal analysis. Subsequently the patient, wearing the upper denture, is

submitted to another CAT in lateral view, after application of metal landmarks to the patient's skin. These landmarks allow the identification of

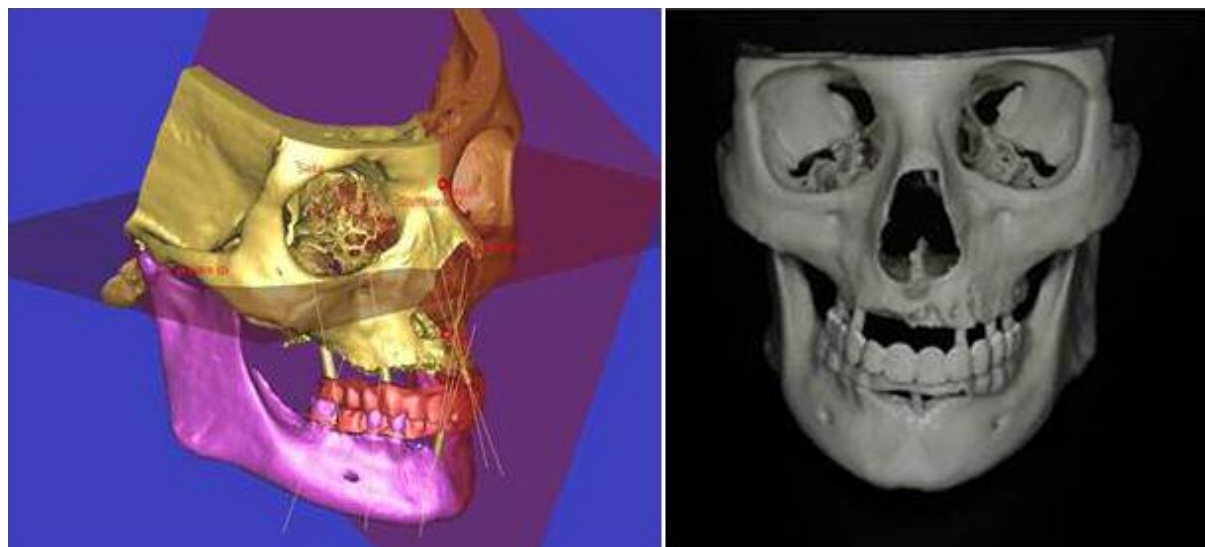


Figure 4

Cephalometric analysis in order to define the relationships between bone bases, vertical dimension of the patient's face, occlusal plane, position and orientation of the upper and lower incisors.

the x-axis orbital plane, of central low incisive, and of distal cusps of the two lower molars. It is then performed a cephalometric analysis in order to define the relationships between bone bases, vertical dimension of the patient's face, occlusal plane, and position and orientation of the upper and lower incisors (Figure 4).

The second cephalometric analysis is performed in order to evaluate the adequacy of the one-step oral rehabilitation project with articulated models. The upper denture should totally satisfy the aesthetic and functional expectations of the patient. The dental elements of this denture are made of radio-opaque material. The dental elements of the denture must also have the size and form of future prosthetic crowns. This denture is positioned in the patient's mouth to perform the CAT. The volume investigated includes the skeleton of the patient's face from the upper margin of the orbit to the entire mandible. A 3D model of the patient's skull is manufactured, so that the plane passing through the superior orbital margin is parallel to the assigned individual patient's orbital plane. In addition, the radio-opaque teeth are connected to the palate through appropriate connections.

The 3D models of facial skeleton are mounted in Surgiplanner as described above. Once removed the connections between the maxilla bone and maxillary teeth, the analysis of the distance between the teeth and bone residue, the quantity of bone loss, and the articular orientation relative to the axis-orbital plane are evaluated, in order to simulate the displacement of osteotomized maxilla segments. Instrumental analysis is also performed to evaluate the occlusion.

Subsequently a segment of the skeleton of the patient's face is repositioned in a predetermined and controlled way thus leading to a new skeletal structure. The analysis with Surgiplanner allows to qualitatively and quantitatively define the movements of bone segments to achieve a specific goal (the new skeletal structure) and to assess the adequacy of the rehabilitation project respect to the objective.

At this point, with Surgiplanner, it is possible to move the mandible in the three directions of space, and use the temporo-mandibular joints for reproducing the mandible movements.

Subsequently, we can perform the necessary movements so that the upper jaw is oriented properly with respect to the position of implant-

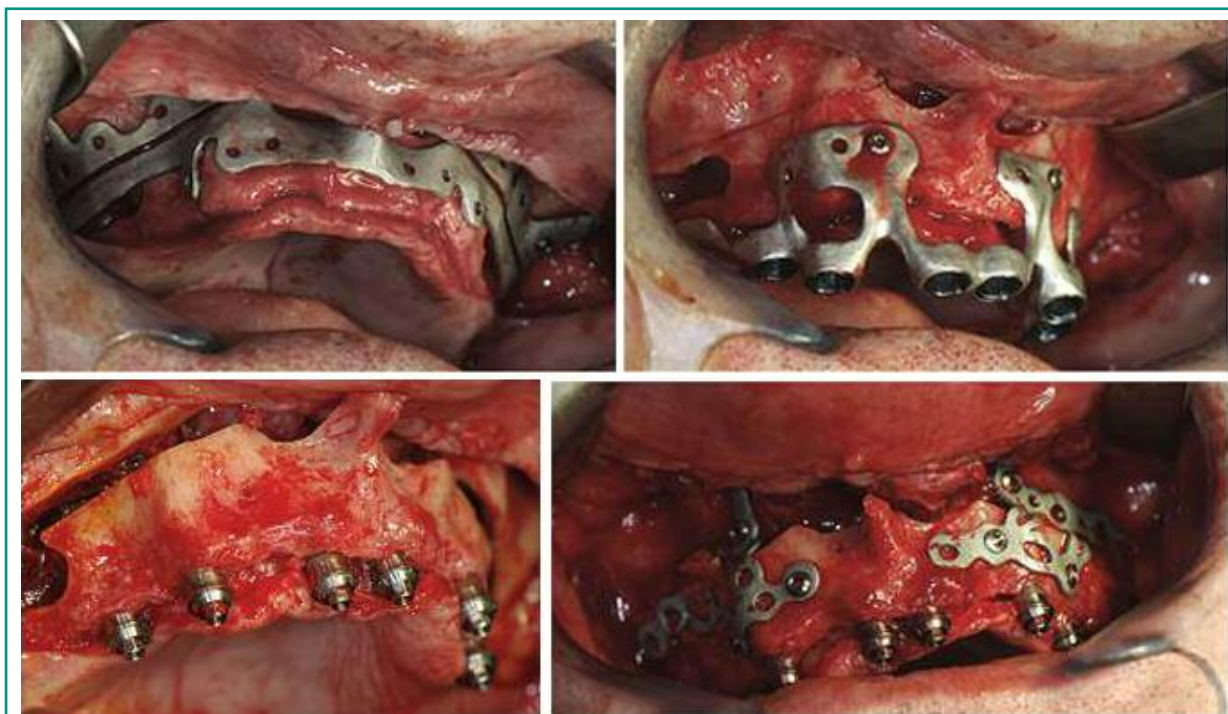


Figure 5

Surgiplanner additional tools (drilling templates for osteotomy, template for implantology, orientation grids custom-made osteosynthesis) offering the surgeon the possibility to orient the skeletal segments exactly in the position that will allow to insert implants for a better prosthesis.

supported prosthetic crowns. All the movements are measured by suitable indicators (millimetres or degrees). The soft tissues of the edentulous maxilla are reproduced, taking into account the thickness of the mucous membrane in orienting the upper jaw.

Surgiplanner allows evaluation of the appropriateness of the prosthetic rehabilitation respect to the objective achieved with the surgery. Surgical tools for controlling the mobilization and orientation of the skeletal segments during the maxillo-facial surgery can be performed with Surgiplanner.

Surgiplanner additional tools (drilling templates for osteotomy, orientation grids) are then performed, offering the surgeon the possibility to orient the skeletal segments exactly in the position for insertion of implants in order to obtain a better result in prosthesis (Figure 5).

Surgical procedures

In order to control the mobilization of the maxilla, a drilling template for osteotomy is built. According to the surgeon's instructions, the maxillary osteotomy lines are anchored to the grids. The 3D model is scanned and a prototyper realizes the drilling and osteotomy template, which allow the surgeon to perform holes and osteotomy lines where exactly planned. The osteotomy template is then used to perform the 3D model for surgery. The upper jaw is then detached and oriented in an appropriate position for a correct implant supported prosthetic rehabilitation. The maxilla is then fixed with the resin in the new position. The 3D model is scanned and built with a prototyper for the orientation of grids that allow the surgeon to displace the osteotomized maxilla exactly in the correct position. The 3D jaw is fixed using two

grids of orientation. At this point, the analogues of implants are inserted in the template.

Discussion

Surgiplanner shows the advantages described below:

1. analysis of the anomalies of shape, size and position of the severely resorbed and dysmorphic edentulous upper jaw, in relation to the functional and aesthetical implant supported fixed prosthesis;
2. reposition of face skeleton segments in a predetermined and controlled way, in order to obtain a new skeletal structure, simulating the final result of the maxillo-facial surgery on three dimensional (3D) models;
3. assessment of prosthetic rehabilitation in relation to the intervention of maxilla-facial surgery;
4. construction of surgical template for controlling the predetermined mobilization and orientation of skeletal segments during surgery. The surgical templates (osteotomy and drilling templates, grids for orienting the skeletal segments) must offer the surgeon the possibility to orient in the space the osteotomized skeletal segments exactly in the

position that will allow the prosthetic guided insertion of implants. The implants loading can be immediate (33-35) or delayed;

5. development of an alternative method of analysis of maxillo-facial surgery (one step oral rehabilitation) that can be developed without the use of a personal computer (computer free implantology). The details of surgery procedures are available on Surgiplanner website (www.surgiplanner.com). The limits of Surgiplanner are represented by the high costs for the pre-surgical planning. The costs of 3D models and the necessary time for planning of the surgical and prosthetic procedures requires a great commitment to the surgeon and dentist.

Case report

A 49-year-old Caucasian woman with partial edentulous maxilla requires a fixed prosthetic rehabilitation (Figure 1). She had no history of pathologies that could contraindicate surgery. Panoramic radiography and CAT were examined to evaluate the bone volume of the maxilla and to eliminate the risk of undiagnosed pathologies (Figure 6).

The surgery procedures were performed under general anesthesia with endotracheal intubation



Figure 6
A 49-year-old Caucasian woman with partial edentulous maxilla. The CAT evidences severe bone loss.

reinforced with local infiltration of anesthesia with vasoconstrictor.

After an analysis with Surgiplanner a discrepancy between the atrophic maxilla and prosthetic crowns was detected. In order to orient the osteotomized maxilla in a favorable position for a correct implant supported prosthetic rehabilitation, the maxilla should be moved forward on the sagittal plane of 6 mm and down to 8 mm. The maxilla has been rotated in the

sagittal plane of 6 degrees and in horizontal plane of 5 degrees. Landmarks points have been mapped before performing the 3D model with a CAT. In order to allow the surgeon to replicate *in vivo* the pre planning simulation, surgical tools (osteotomy and drilling template, orientation grids and template implant) were performed with the use of Surgiplanner (Figure 7). The final result was satisfactory for the patient (Figure 8).





Figure 8
The final result of one-step oral rehabilitation.

Conclusion

Surgi planner is a method of analysis, planning and execution of surgery (one-stage oral rehabilitation) that can be used without any kind of software (computer free implantology). The dentist can use only a 3D model of the skeleton of the patient's face, a CAT, and a tool for the as-

sembly of 3D models (Surgi planner). Dental laboratories carried out the 3D scans of the 3D models. Two service providers have employed technologies for the production of 3D models and surgical tools (drilling and osteotomy templates and guidance grids). Surgi planner allows in a single time osteotomy of the maxilla, the predetermined orientation of the maxilla, the insertion of implants and immediate loading (one-step oral rehabilitation). The one step oral rehabilitation allows patients with totally edentulous atrophic and dysmorphic maxilla to leave the operating room with a new skeletal structure obtained with the osteotomy, the repositioning, the reconstruction of the maxilla and eight implants ready to be loaded immediately. Surgical tools (drilling and osteotomy template, implant template and guidance grids) enable the surgeon, with no chance of errors, to properly orient the maxillary giving the patient's face the aspect previously agreed, and to place the osteotomized skeletal segment exactly where the prosthetic crowns are connected to the implants. In conclusion, Surgi planner is an innovative instrument supporting the surgeon and the dentist' work in their daily practise.

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