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Review Article

Digital Flow to obtain Surgical Guides and Customized Plates in Minimally Invasive (MIS) procedures for Facial Orthognathic Surgery

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ABSTRACT

This article aims to present a personal experience in the digital flow for facial orthognathic surgery, combining different technologies to get surgical orthognathic guides to perform osteotomies and a manual customization of titanium plates for maxilla, jaw, and chin throughout precise stereolithographic models, using Mimics Materialize Software.

Starting with virtual planning in a helical computed tomography or 3D cone-beam to segment and reconstruct the osteotomies projections, using CAD-CAM in conjunction with the occlusal scanner to obtain the intermediate and final occlusal splints to give more possibilities and benefits with low cost to the surgeon who does minimally invasive orthognathic facial surgery approaches.

Keywords

Digital flow, Minimally invasive orthognathic surgery.

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Introduction

The Mimics Materialize software is used to manage high-resolution clinical images on a computer; this integration software can reconstruct models simultaneously with raw data in 2D, which leads to the generation of software packages for segmentation and 3D reconstruction. The visible Korean research team used the Mimics software for the segmentation and subsequent rebuilding of the surface from the cardiac structure, where it was possible to segment the images and classify the different parts in colors and reconstruct the organ with high-precision images, detecting errors presented by another type of software in delineating of a structure, for visible human projects, computeraided imaging, processing, three-dimensional imaging, and user computer interface [1].

This is how the Mimics software allows the surgeon to preview 3D images of the osteotomies area, separating specific bone structures, hiding or moving them, allowing performing the virtual surgical movements from a planned surgery before any physical incision. Using the Mimics, MedCAD, and Simulation modules is possible to study all the topography details and the accurate positioning of the bone segments.

This virtual procedure for surgical planning gives a direct and precise reference with the patient's data in 3D visualization that allows different customizations of the case in almost all surgical procedures; the use of advanced finite element analysis software enables profound mechanical studies on stereolithographic structures [2]. That is why performing a highly effective workflow requires a strict protocol, starting with virtual surgical planning, which consists in getting a computerized axial tomography, either helical (CT) or cone-beam, an intraoral and/or models digital scanning for obtaining virtual files (STL) also; Subsequently, these files must be combined in a 3D surgical planning software, determining the accurate patient position of the jaws and the occlusion with a precise record to obtain a virtual model of the patient [3].

Planning in orthognathic surgery has evolved in recent decades in a systematic data check-up to evaluate the accuracy and benefits of computer-aided planning in CADCAM orthognathic surgery, compared to conventional studies in the diagnosis of facial deformities, which began with 'classic' surgical planning using film X-ray cephalogram, cephalometric analysis of the lateral film, facial analysis, and patient's plaster casts of dental arches mounted on an articulator and acrylic resin surgical splints. Then, planning began using two-dimensional (2D) computer programs for cephalometric analysis of lateral radiographs and the most modern computer-aided planning technique. Clinical facial analysis of patients supported with Computer-assisted planning and virtual surgical intervention for orthognathic surgery through software integrates a three-dimensional cephalometric analysis (3D), achieving the ideal study to create dento-skeletal harmony [4,5].

The customization systems offered by companies involve, high cost and a prolonged time; in addition, those are performed mainly through systems engineers with limited medical-surgical knowledge, and as a result, working with these plates needs to make significant incisions approach. The hybrid technique to customize guides and mini plates allows the surgeon to increase precision and reduce incisions, processing, and surgical times, which conduces to minimum, cost [6].

The minimally invasive techniques are currently applied in maxillofacial surgical procedures [2], including facial orthognathic surgery. The author and collaborators reviewed 403 articles, and orthognathic surgery was included in the minimally invasive surgical approach. Orthognathic techniques assisted by endoscopy, distraction osteogenic, and with piezoelectric as essential tools in minimally invasive, the evidence that marks these studies is that patients have less mobility and recovery is faster. Minimally invasive surgery by Swann presents a novel surgical algorithm to increase surgical efficiency in orthognathic surgery with small incisions and minimal dissections; in addition, it develops MI algorithms for the five main surgical procedures in facial orthognathic surgery. MIS minimizes bleeding, edema, and injuries, improving the speed and quality of patients' recovery.

The MIS has developed essential techniques for pterygomaxillary disjunction and the twist technique, which handles a substantially smaller incision and therefore achieves an effective and immediate separation of the maxilla that allows adequate visibility of the palatine neurovascular bundle, based on the experience of the author's in 1297 patients, demonstrates the safety and efficacy of the technique. MIS has reached important levels to perform an intraoral condilectomy with a 3D printed cutting guide, achieving precision in the treatment of condylar hyperplasia [7-11]. olymeric materials are currently used in several areas of medicine, which can be sterilized with wet or dry heat [12].

Description of the Technique

The patient is instructed to take studies such as Facial cone beam or helical CT scan and intraoral occlusal scanner.

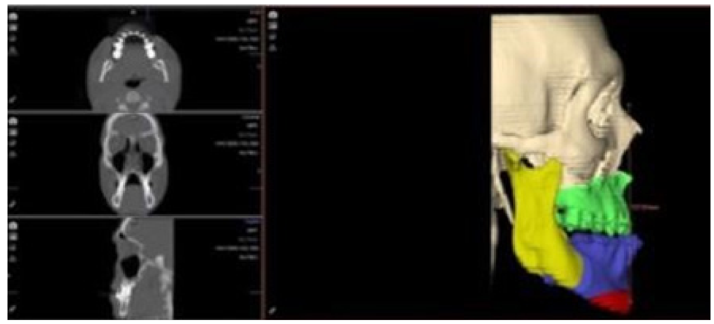

Figure 1: Import CT to DICOM format to Nemo studio, in addition the intraoral occlusal scanner in STL files.

CT is prepared by segmenting maxilla, jaw, chin, teeth, occlusion and head position are established according to the reference lines such as the bipupillary axis and Frankfurt Plane.

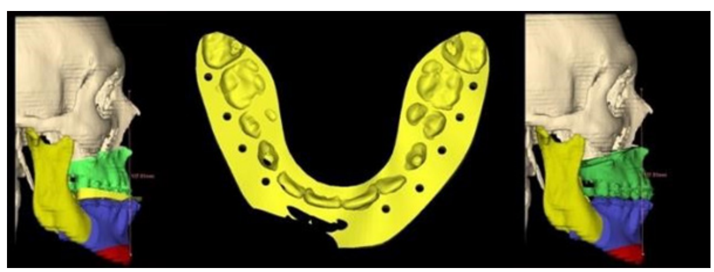

Figure 2: In Nemo ceph, cephalometry is performed with virtual points.

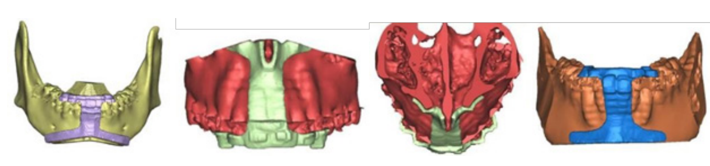

Figure 3: Virtual osteotomies are performed for mobilization of segments according to the surgical diagnostic plan, and then the intermediate mandibular positioning guide is performed.

It is cleaned with isopropylic alchohol to remove excess resin without polymerizing, it is then photocured and tags are removed.

Figure 4: STL file is downloded to MIMICS software and osteotomy marking guides are performed.

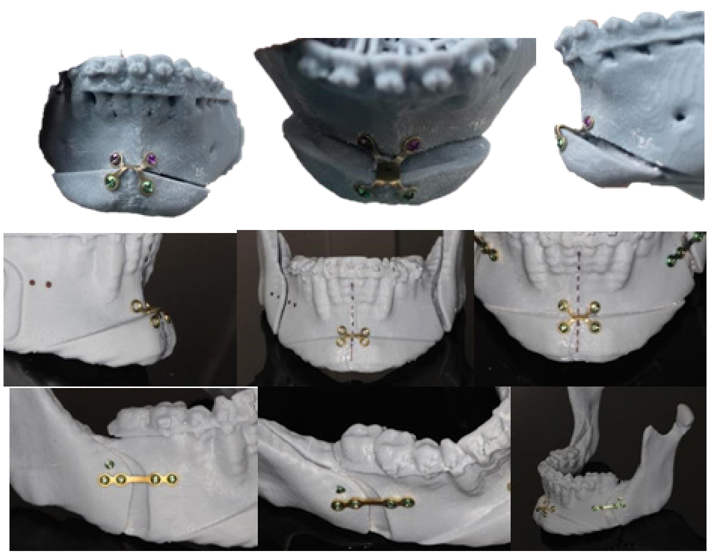

Figure 5: Anatomix printed in resin to obtain steriolithographic models.

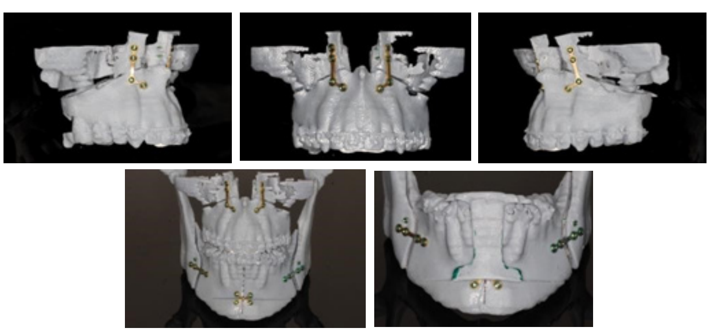

Figure 6: According to surgical plan plates are molded to the performed osteotomies then the fixing screws are placed (example's in dommies models).

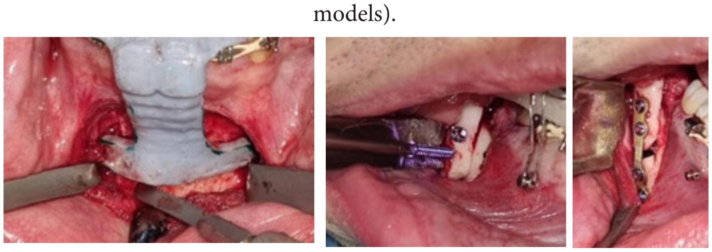

Figure 7: Sterilization of models and plates.

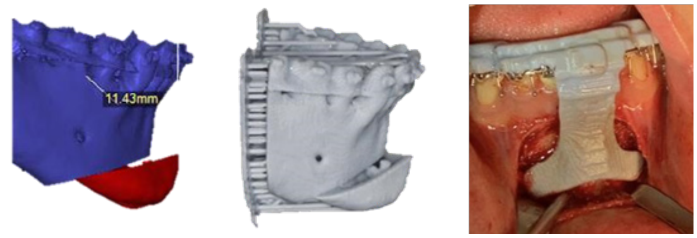

Figure 8: Placing of surgical guide for mental osteotomy.

At this level of evolution in facial orthognathic surgery, where personalized customization has given many advantages to maxillofacial surgeons, this depending on whether they use minimally invasive surgery or not, on the other hand it is a fact that in different countries medical insurance expenses are not cover for orthognathic surgical procedures which makes this kind of surgeries it very expensive.

We believe that depending on the individuality of the patient and the surgeon, this technique can help facilitating the diagnosis, surgical guides manufacturing and giving the chance to modifying details plate wise prior the surgery or in case of any nondesired fracture or incorrect disposition of the planned osteotomy be able to have continuity with the handling or bending of the plates. Another great advantage of the use of this combination of software's is the sharpness of the printing; this is proved since some commercial houses use the same software for personalized customization.

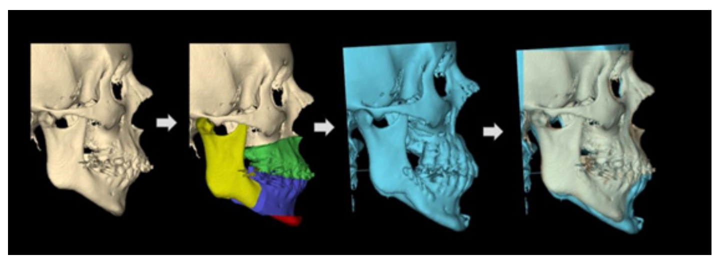

Figure 9: Pre-Surgical tomographic image of (a), Virtual surgical planning 3D (b), Postsurgical (c), pre and postoperative overlaying (d).

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