In-House Hybrid Technique for Customization of Guides and Miniplates in Orthognathic Surgery

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Abstract: The use of customized plates in Orthognathic surgery offers precision in the repositioning of the jaws, according to the virtual planning performed, with the great advantage of avoiding the need for intermediate occlusal splints. However, the conventional customization process takes time to manufacture, present high cost and still involve legal issues with insurance companies. Moreover, a technical disadvantage is that the systems available for customized plates require large incisions, with large detachment of soft tissues for insertion of the guides and plates. The objective of this paper is to present the in-house hybrid technique for customization of guides and miniplates in orthognathic surgery using minimally invasive approaches.

Key Words: Computer-assisted osteotomy guides, minimally invasive surgery, orthognathic surgery

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The use of computed tomographic (CT) scan generated a major breakthrough in terms of diagnosis in all medical specialties. In the last decade, CT scan has achieved even more relevance due to the possibility of simulation of surgeries through specific planning software.[1,2]

In orthognathic surgery, virtual planning is already consolidated, including the manufacture of occlusal guides using 3-dimensional (3D) printers.[3,4] Recently, 3D technology has been used to manufacture custom titanium plates, designed from virtual planning.[5–8]

The use of customized plates in Orthognathic surgery offers precision in the repositioning of the jaws, according to the virtual planning performed, with the great advantage of avoiding the need for intermediate occlusal splints.[5–8] However, the conventional customization process takes time to manufacture, present high cost and still involve legal issues of authorization by insurances. Moreover, a technical disadvantage is that the systems available for customized plates require large incisions, with large detachment of soft tissues for insertion of the guides and plates.

The objective of this paper is to present the in-house hybrid technique for customization of guides and miniplates in orthognathic surgery using minimally invasive approaches. The following sequence illustrates a conventional case of bimaxillary advancement and genioplasty for aesthetical and respiratory improvements.

TECHNIQUE DESCRIPTION

First Step: Data Acquisition and Virtual Surgical Planning

Patient was first scanned with a cone beam computed tomography (CBCT) and DICOM files were generated. After tissue segmentation, the spatial repositioning of the scan was performed to obtain the natural position of the head. Secondly, the model casts were scanned isolated and at the planned final occlusion. The STL files generated from the occlusion were added to the DICOM files according to the proper dental position.

Maxillary movements were performed according to the treatment plan established based on the patient's examinations and main complaint. After the final decision of the type of surgery to be performed, the type of intermediate occlusal splint is defined, beginning surgery by the maxilla or mandible, in addition to the final splint.

The steps of data acquisition and planning can be accomplished with any 3D planning software according to the routine of each service.

Second Step: Generation of Guides

The determination of osteotomies does not matter when the main goal of virtual planning is only the preparation of occlusal splints (intermediate and final). In this case, it is very important to establish the osteotomies really according to where it is desired to perform in the operating room. Posteriorly, the adaptation of the repositioning guides and the customized miniplates depends strongly on the coincidence between the position of the osteotomies in the virtual planning and the patient at operating room.

Differently from the commercially customized guides, the intention of these guides is to allow the execution of the cuts according to the preference of the authors by small incisions and approaches. For this reason, the cutting guides do not contemplate the entire osteotomy, demarcate only the main region of interest, which is the region where the plates will be placed.

Third Step: Cutting and Repositioning Guides to the Maxilla

The maxillary cutting guide is supported only in the anterior nasal spine bone that has anatomy that allows passive stabilization of the guides (Fig. 1). The option of making the cutting guide supported by the teeth obliges the need to work with larger incisions.

In this hybrid technique, the main guide for jaw repositioning is the intermediate splint, if surgery starts with the maxilla, or the final splint, if surgery starts with the mandible.

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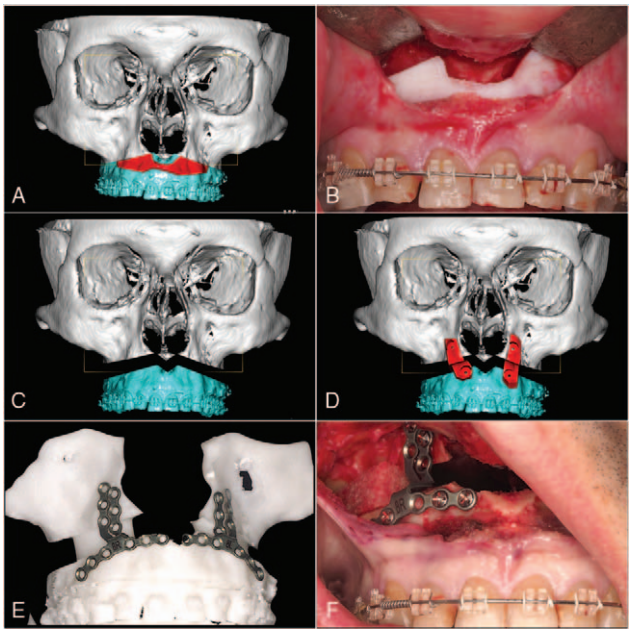

FIGURE 1. Maxillary cutting guide using DDS-Pro software: (A) virtual surgical planning and (B) during surgery with a small incision and minimal exposure. (C) Downward maxillary movement and (D) repositioning guide to assist vertical position and maintenance. (E) Miniplates selection and customization using the printed maxilla. (F) Miniplate fixation on the right-side during surgery with minimal exposure.

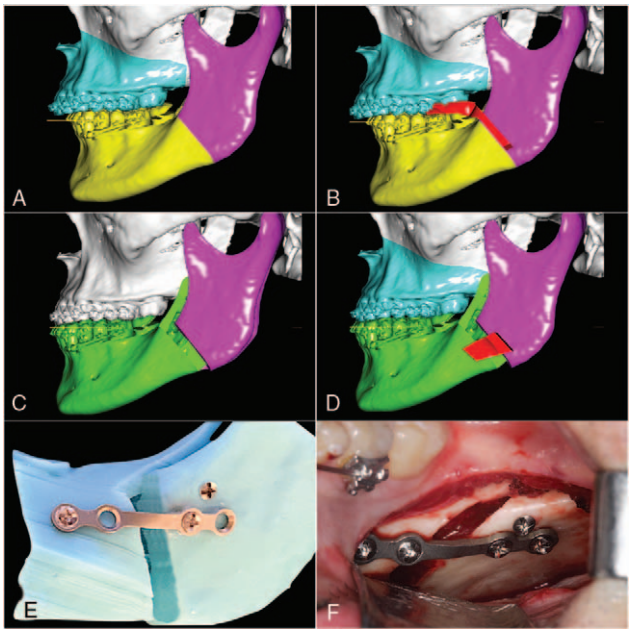

FIGURE 2. Virtual surgical planning for mandibular repositioning: (A) sagittal split osteotomy definition; (B) cutting guide teeth-supported; (C) mandibular advancement after final occlusion and (D) repositioning guide to assist proximal segment maintenance. (E) Miniplate selection and customization using the printed mandible. (F) Miniplate fixation on the left side during surgery similar to the virtual planning and printed model.

However, for the maxillary repositioning, a guide can be adapted on 1 or 2 sides of the jaw to ensure vertical maxillary repositioning according to the planning (Fig. 1), without relying on vertical references taken with the caliper until the custom plates are placed.

Fourth Step: Cutting and Repositioning Guides to the Mandible

The anatomy of the mandibular body is very flat and does not allow passive stabilization of a guide supported only in the bone. In addition, the proximity of the osteotomy and the teeth allows the cutting guide for sagittal osteotomy to be done with support in 2 posterior teeth, guaranteeing the stability of the guide without requiring an increase in the incision (Fig. 2).

In the same way as in the maxilla, the main guide to repositioning the mandible are the occlusal splints. However, there is concern for repositioning the proximal segment (condylar), especially for mandibular advancements. If the osteotomy is performed in the same position as in the planning, a maintenance guide can be used in the osteotomy gap to guide the position of the proximal segment during the rigid fixation of the mandible (Fig. 2).

Fifth Step: Cutting and Repositioning Guides to the Chin

The anatomy of the chin is also flat and does not allow the passive stabilization of a guide supported only in the bone, so the recommendation is to make the guide supported on 4 to 6 anterior teeth. It is important that the guide extension is small to allow its insertion even in small incisions (Fig. 3).

The repositioning of the chin is traditionally done hands-free, without the application of the occlusal splints. Therefore, repositioning guides are extremely valid, especially for cases of asymmetric movements. Other possibility is to perform midline mandibular segmentation with the same guide for genioplasty with the vertical orientation for the osteotomy (Fig. 4).

Sixth Step: Miniplates Selection and Customization

After the completion of the planning, a STL file with the operated skull was created. The file is handled to select only the

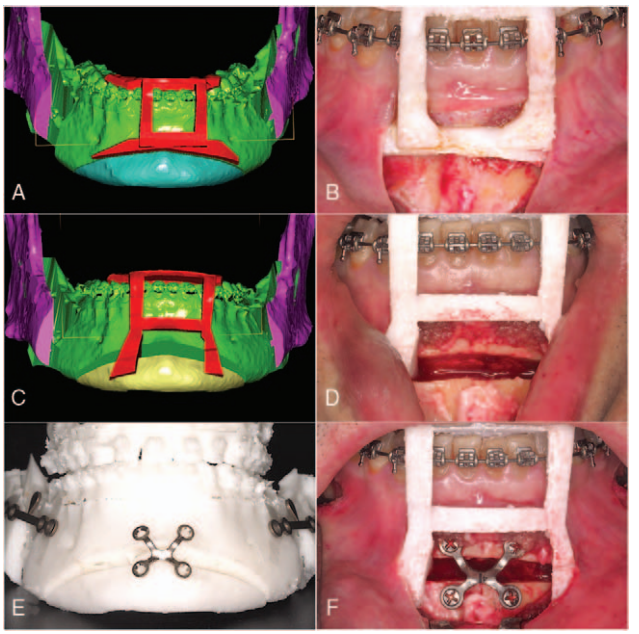

FIGURE 3. Genioplasty cutting guide during: (A) virtual surgical planning and (B) during surgery with a small incision and minimal exposure. (C) Repositioning chin guide teeth-supported design and (D) during surgery maintaining the vertical repositioning of the chin. (E) Miniplate selection and customization using the printed mandible. (F) Miniplate fixation with minimal exposure.

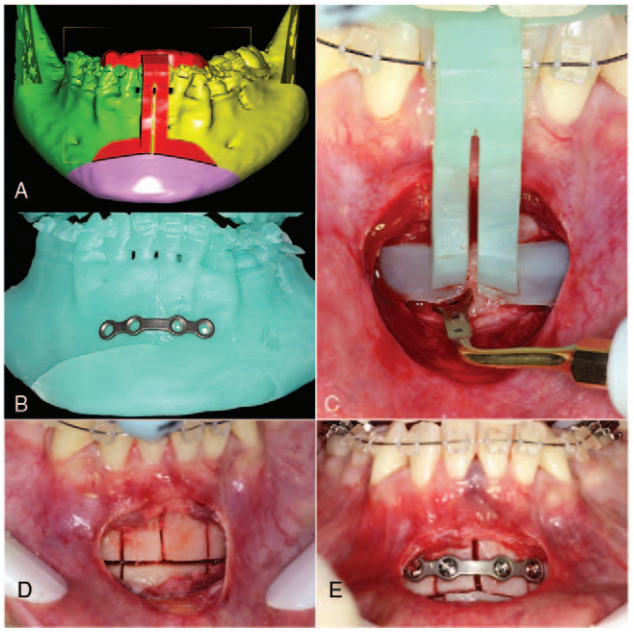

FIGURE 4. (A) Genioplasty cutting guide with the vertical extension for midline mandibular segmentation. (B) Miniplate selection and customization using the printed mandible. (C) Teeth-supported guide adaptation with a small incision and minimal exposure. (D) During surgery after osteotomies. (E) Miniplate fixation after mandibular repositioning.

areas of interest to decrease the size of the skull. These areas were taken to print separately to decrease printing time.

In this step there is no need for sophisticated printers. The fidelity of the anatomy in the operated skull will depend much more on the quality of the tomography and the tissue segmentation process.

The selection of the design and size of the miniplates is much easier on the printed models than in the operating room with the presence of soft tissues. The bends and cuts in the plates (customization) should be made considering small variations that may occur in the trans-operative (bad splits, friable bone, included teeth, etc). Since these plates are not customized from their manufacture, care must be taken not to handle them too much and to lose the mechanical stability of the hardware.

DISCUSSION

Recent reports have demonstrated the use of customized miniplates for orthognathic surgeries with promising results allowing the oral and maxillofacial surgeons to perform bimaxillary surgeries without the need for intermediate splints (waferless surgery). However, the evidence remains unclear and the technology too new to recommend use on a daily basis.[5,8]

Most of the customization systems described in the literature for orthognathic surgeries are a company-made process, in association with engineers. These processes involve high costs and is time consuming. Also, most of these publications used large incisions to allow the introduction of cutting guides and customized plates. The authors of this paper strongly prefer to work with small incisions according to these new concepts of minimally invasive orthognathic surgery.[9,10]

Further studies are necessary to evaluate the overall impact. In our experience, the hybrid technique for customization of guides and miniplates is a feasible method for orthognathic surgeries that allows surgeons to decrease incisions, increase precision and reduce operating time with a low-cost process.

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