ORTHOGNATHIC RECONSTRUCTION WITH TRUMATCH® CMF: Orthognathic reconstruction of a class III malocclusion and dental facial deformity utilizing an intraoral digital scan and DePuy Synthes ProPlan CMF®
PATIENT PROFILE

A 17-year-old female patient was referred from a local orthodontist for evaluation of a combined orthodontic surgical approach for correction of a malocclusion and dental facial deformity. When she presented to the office, her challenges included a significant vertical maxillary excess, severe mandibular hyperplasia, asymmetry of the mandible, maxillary cant, and an impacted second molar of the right maxilla.

The patient’s chief complaint was “my face is crooked and I cannot bring my lips together.” She complained about her difficulty eating due to a significant reverse overjet. This led to temporomandibular joint dysfunction where she experienced bilateral popping, bilateral reciprocal clicks, as well as pain and discomfort. Prior to referral from the orthodontist, her only treatment had been extraction of her third molars. In preparation for a one-piece LeFort 1 osteotomy, and mandibular setback, she returned to the orthodontist to be set up for surgery.

Her preoperative pictures showed that she had full incisor show at rest with a maxillary cant (Fig. 1). She furthermore had significant gingival tissue show of approximately 4 mm at full smile. A right lateral profile revealed the patient’s concave facial profile with a significant interlabial gap (Fig. 1). Intraoral examination reveals that she has a Class III occlusion bilaterally and a mandibular asymmetry with the midline approximately 3.5 mm to the left of the maxillary dental midline (Fig. 2).
A lateral cephalometric field reveals the patient has a concave facial profile with mandibular hyperplasia, and a large interlabial gap (Fig. 3). Panorex examination reveals that she does not have any bony lesions and confirms that she has no third molars in place, an impacted second molar of the right maxilla, and condyles that are within normal limits (Fig. 3).

Fig. 3. Lateral preoperative cephalogram showing concave profile with mandibular hyperplasia, impacted second molar, and labial gap. Preoperative panorex confirms absence of bony lesions, absence of third molars, and impacted second molar of the right maxilla.

TREATMENT PLAN

Following additional orthodontic leveling and aligning, the surgical plan included the following procedures: A one-piece Le Fort I osteotomy with impaction, advancement, and correction of maxillary cant. A bilateral sagittal split osteotomy with mandibular setback and correction of an asymmetry.
PREOPERATIVE PLANNING SESSION

Preoperative cone beam computed tomography (CBCT) scans were obtained and uploaded into DePuy Synthes ProPlan CMF Connect. To obtain a detailed occlusal view, an iTero** intraoral digital scan of the patient’s maxillary and mandibular dentition was performed and was then overlayed and merged with the CBCT scan to create a composite model of the patient’s skull (Fig. 4) by the ProPlan CMF clinical engineer to be utilized in the DePuy Synthes ProPlan CMF software for surgical planning and design of the intermediate and final splint.

During a web-based meeting with a ProPlan CMF clinical engineer, the surgical procedures were planned (Fig. 5-9). Specifically, a one-piece Le Fort I osteotomy with maxillary impaction and advancement with correction of a cant, and a bilateral sagittal ramus osteotomy with mandibular setback and correction of an asymmetry were planned. The virtual planning included setting the occlusal plane to 4° Frankfort horizontal (Fig. 8). The occlusion was then set using occlusal tables, including the one-piece Le Fort I osteotomy and mandibular setback (See supplemental figures—Setting the virtual occlusion). The final position of her maxilla and mandible were achieved and a case report showing the planned movements and measurements was created for surgeon review and approval after the web-based meeting. Upon approval of the case report, the intermediate and final splints were designed and 3D printed for use in surgery.

Fig. 4. Creation of the composite model from merging of the CBCT-based skull with the intraoral digital scan.

Fig. 5. Preoperative original position of maxilla and mandible.

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Fig. 6. Intermediate position with one-piece LeFort I osteotomy with maxillary impaction and advancement. Mandible in the original position.

Fig. 7. Final position with mandible set-back bilaterally and asymmetry partially corrected.

Fig. 8. Occlusal plane set to 4° Frankfort horizontal after repositioning of maxilla and mandible into final position.

Fig. 9. Simulated postoperative change of the facial width-to-height ratio from 87% to 90%.
SUPPLEMENTAL FIGURES—SETTING THE VIRTUAL OCCLUSION

Supp. 1 Countours overlayed with the CT show the segmentation lines from the 3D model.

Supp. 2 Setting the occlusion virtually involves manipulating the 3D model while the contours are monitored in the CT slices. The coronal, sagittal, and axial views are essential to aligning the jaws appropriately in 3D without the surgeon hand articulating the dental models prior to planning. Setting the midline is the first step. The overjet and overbite can then be adjusted using the sagittal view.

Supp. 3 The coronal view can be helpful in understanding how the cusps of the teeth come together, where there is contact or where the collision will be if a tighter occlusion is needed. In this way, scrolling through the CT and adjusting the contours provides a way to virtually set the occlusion in 3D.
Supp. 4 Example view of a collision between the palatal cusp of the second bicuspid and the buccal cusp of the mandibular bicuspid (shown in the coronal and sagittal views).

Supp. 5 Example view demonstrating no collision, yet cusp-to-cusp contact at the second molars (shown in the coronal and sagittal views).
INTRAOPERATIVE SURGICAL DETAILS

Under general anesthesia via nasal endotracheal intubation, a maxillary vestibular approach was used to gain access for the one-piece Le Fort I osteotomy. Upon completion of the osteotomy, the maxilla was rigidly fixed to the stable mandible using the intermediate splint. At this time, the bilateral sagittal ramus osteotomy was performed. The mandible was set back in correcting an asymmetry by coinciding the maxillary and mandibular dental midlines. In addition, a maxillary cant was corrected by removing the excess bone in the left maxillary Le Fort I osteotomy cuts. Her right mandibular inferior border was reduced to complete correction of her mandibular asymmetry (Fig. 10).

RESULTS

The patient did well postoperatively and was de-banded and had her brackets removed after 5 months of postoperative orthodontics. At 5-months postoperatively the patient has a Class I occlusion with coincidental midlines and no transverse deficiency or cant (Fig. 11-13). As revealed in Figure 12, she now has a Class I facial profile with good chin projection and interlabial gap and less than 1 mm gingival show at full smile. She has full sensation along the V2 and V3 distribution of the trigeminal nerve five months postoperatively.

Fig. 10. Final correction of mandibular asymmetry.

Fig. 11. Frontal and lateral view of the patient pre- (left images) and 5-months postoperatively (right images) demonstrating the changes to her facial profile.
Fig. 12. Lateral and frontal view 5-months postoperatively showing her Class 1 occlusion.

Fig. 13. Cephalogram and panorex 5-months postoperatively showing her Class 1 occlusion and coincidental midlines.

Fig. 14. Areas of dental collision that require burring during surgery.
DISCUSSION

Virtual surgical planning for orthognathic surgery has become very predictable. The principles are identical to traditional model surgery and template surgery. The virtual planning appears to be at least as precise as the traditional methods. It allows the surgeon to plan cases with a good understanding of the three-dimensional changes that are occurring in the maxilla and the mandible. In addition, the digital impressions that can be merged with the CBCT 3D scan have the potential to replace impressions and setting of the final occlusion with traditional models. A final occlusion can be set using the existing occlusal tables that can be generated using the DePuy Synthes ProPlan CMF software. This includes any high occlusal stops that can be adjusted intraoperatively using a round diamond bur (Fig. 14). This approach saves pre-operative time and eliminates the need to physically mail any materials to the ProPlan CMF clinical engineer, streamlining the time from planning to surgery. Overall, the efficiency in the work-flow requires a minimal lead-time. Once electronic materials are uploaded, the preoperative planning session can be held and the splints and planning materials received within days.

Following the principle of setting the occlusal plane at 4–7°, setting the maxilla with tooth-to-lip show at 2 to 3 mm using a modified Holdaway with a ratio of 1:1, and assuring that the maxilla and mandible are symmetrical using Frankfort horizontal and infraorbital horizontal plane can achieve a Class I facial profile. The next step, setting the occlusion virtually, can be achieved using occlusal digital scanning and merging it with the CBCT 3D scan. We see this as the future of traditional orthognathic model surgery; setting the occlusion and performing model surgery with a stone model will most likely be limited to oral maxillofacial training programs for the surgical residents to understand the concepts of orthognathic surgery and the comprehensive planning that is required prior to taking the patient to the operating room. As the residents grasp these concepts they can then graduate to surgical digital planning, which includes setting the occlusion digitally. This can benefit patients through more precise, predictable postsurgical facial and occlusal outcomes.
ORTHOGNATHIC SPLINTS

SD900.008  Patient-specific instruments and Planning Kit – Orthognathic Kit, 2 splints

Intermediate splint

Final splint

IMPLANTS USED

04.511.212.01  (6x) 1.85 mm Self-tapping screws, 12 mm

04.511.224.01  (16x) 1.85 mm Self-drilling screws, 4 mm

04.511.302  (4x) 90°L-Plate 2x2 holes, reversible, medium, 0.5 mm
SURGEON PROFILE

T.J. Tejera, D.M.D., M.D.
Southwest Florida Oral & Facial Surgery, P.A.
8267 College Parkway
Fort Myers, FL 33919