Virtual surgical planning (VSP) has revolutionized orthognathic surgery by increasing the efficiency and accuracy with which facial osteotomies are performed.1–4 This allows the use of customized cutting guides with intermediate and final splints for maxillomandibular fixation, both based upon a patient’s occlusal surface. Fixation of osteotomized segments with customized plates is a relatively new approach.5 The senior author has successfully utilized VSP and customized surgical plating for fixation in orthognathic surgery. Here, we present a case in which custom plates were essential in allowing a young patient with fibrous dysplasia of the nasal cavity and anterior skull base to avoid the scars and morbidity associated with tracheostomy during surgical resection.

**CLINICAL SCENARIO**

A 11-year-old girl presented to the hospital with a maxillary sinus infection. Routine imaging revealed a large mass consistent with fibrous dysplasia involving the nasal cavity, left medial orbital wall, and sphenoid sinus extending to the anterior cranial base (Fig. 1). Using VSP, a decision was made to approach the resection using supraorbital and Le Fort I osteotomies. The tumor prevented nasal intubation, and the necessity of maxillomandibular fixation to reduce the osteotomized maxilla with traditional fixation prevented oral intubation. Given the age of the patient and the desire to avoid a tracheostomy scar, a decision was made to utilize custom fixation plates. Virtual surgical planning was utilized to design custom cutting guides with splints for maxillomandibular fixation. These custom maxillary orthognathic plates ensured accurate reduction of the osteotomized maxillary segment and allowed for placement of an oral endotracheal tube. Despite the oral endotracheal tube preventing maxillomandibular fixation, use of custom plates established proper occlusion as determined immediately after extubation and at postoperative visits.

**SURGICAL PROCEDURE**

The patient was brought to the operating room, and induction of anesthesia and oral intubation proceeded without complication. A coronal incision was made, taking care to preserve an anteriorly based 10 × 12 cm pericranial flap. After a supraperiosteal plane was elevated, the maxillary sinus was entered, and the tumor was exposed. Using custom cutting guides, the supraorbital and Le Fort I osteotomies were performed, allowing the maxilla to be reduced and placed into proper occlusion. Despite the oral endotracheal tube preventing maxillomandibular fixation, use of custom plates established proper occlusion as determined immediately after extubation and at postoperative visits.

**Disclosure:** The authors have no financial interest to declare in relation to the content of this article.
A craniotomy was performed, and a supraorbital bar was removed to provide access to the cephalic portion of the lesion at the anterior cranial fossa. This was completely excised from the anterior skull base, medial orbital wall, and cephalic portions of the nasal cavity.

For the caudal portion of the mass, attention was turned to the Le Fort I osteotomy. The upper buccal flap. (See figure, Supplemental Digital Content 1, which displays an intraoperative view of a 10 × 12 cm pericranial flap, portions of which were used to envelop the nasal aspect of the medial orbital wall graft and to obliterate the nasofrontal duct. http://links.lww.com/PRSGO/B510.) A craniotomy was performed, and a supraorbital bar was removed to provide access to the cephalic portion of the lesion at the anterior cranial fossa. This was completely excised from the anterior skull base, medial orbital wall, and cephalic portions of the nasal cavity.

For the caudal portion of the mass, attention was turned to the Le Fort I osteotomy. The upper buccal flap. (See figure, Supplemental Digital Content 1, which displays an intraoperative view of a 10 × 12 cm pericranial flap, portions of which were used to envelop the nasal aspect of the medial orbital wall graft and to obliterate the nasofrontal duct. http://links.lww.com/PRSGO/B510.) A craniotomy was performed, and a supraorbital bar was removed to provide access to the cephalic portion of the lesion at the anterior cranial fossa. This was completely excised from the anterior skull base, medial orbital wall, and cephalic portions of the nasal cavity.

For the caudal portion of the mass, attention was turned to the Le Fort I osteotomy. The upper buccal flap. (See figure, Supplemental Digital Content 1, which displays an intraoperative view of a 10 × 12 cm pericranial flap, portions of which were used to envelop the nasal aspect of the medial orbital wall graft and to obliterate the nasofrontal duct. http://links.lww.com/PRSGO/B510.) A craniotomy was performed, and a supraorbital bar was removed to provide access to the cephalic portion of the lesion at the anterior cranial fossa. This was completely excised from the anterior skull base, medial orbital wall, and cephalic portions of the nasal cavity.

For the caudal portion of the mass, attention was turned to the Le Fort I osteotomy. The upper buccal flap. (See figure, Supplemental Digital Content 1, which displays an intraoperative view of a 10 × 12 cm pericranial flap, portions of which were used to envelop the nasal aspect of the medial orbital wall graft and to obliterate the nasofrontal duct. http://links.lww.com/PRSGO/B510.) A craniotomy was performed, and a supraorbital bar was removed to provide access to the cephalic portion of the lesion at the anterior cranial fossa. This was completely excised from the anterior skull base, medial orbital wall, and cephalic portions of the nasal cavity.

For the caudal portion of the mass, attention was turned to the Le Fort I osteotomy. The upper buccal flap. (See figure, Supplemental Digital Content 1, which displays an intraoperative view of a 10 × 12 cm pericranial flap, portions of which were used to envelop the nasal aspect of the medial orbital wall graft and to obliterate the nasofrontal duct. http://links.lww.com/PRSGO/B510.) A craniotomy was performed, and a supraorbital bar was removed to provide access to the cephalic portion of the lesion at the anterior cranial fossa. This was completely excised from the anterior skull base, medial orbital wall, and cephalic portions of the nasal cavity.

For the caudal portion of the mass, attention was turned to the Le Fort I osteotomy. The upper buccal flap. (See figure, Supplemental Digital Content 1, which displays an intraoperative view of a 10 × 12 cm pericranial flap, portions of which were used to envelop the nasal aspect of the medial orbital wall graft and to obliterate the nasofrontal duct. http://links.lww.com/PRSGO/B510.) A craniotomy was performed, and a supraorbital bar was removed to provide access to the cephalic portion of the lesion at the anterior cranial fossa. This was completely excised from the anterior skull base, medial orbital wall, and cephalic portions of the nasal cavity.
mucosa was incised and subperiosteal dissection exposed the anterior maxillae. At this point, the custom-fabricated cutting guides were placed onto the maxilla and maxillary occlusal surface and secured into place. The osteotomy sites and screw locations were marked with methylene blue dye. The screw sites were drilled. The maxillary osteotomies were made with a reciprocating saw and the pterygoids were fractured with an osteotome. The downfracture was completed, providing wide access to the caudal portion of the mass. The excision of a 3 × 3 × 4 cm mass from the nasal cavity was completed by using this approach.

Here, the maxilla would ordinarily need to be fixated to the mandible with custom splinting and titanium plates bent to secure the inferior maxilla to the stable facial bones. Using the custom plates and the pre-drilled screw locations, maxillomandibular fixation was unnecessary, and the maxilla was secured into place while an oral endotracheal tube secured the airway (Fig. 3).

Attention was then directed back to the supraorbital region. The frontal sinus mucosa was meticulously removed from the bone to prevent mucocele development. Split calvarial grafts were harvested to reconstruct the orbital roof and medial orbital wall. The medial canthus had not been involved in the excision and did not require reconstruction. A resorbable fixation system was used to secure these grafts to avoid titanium-associated artifact in post-operative surveillance imaging.

A portion of the pericranial flap was used to envelop the nasal aspect of the medial orbital wall graft. The remaining pericranial flap was used in conjunction with bone graft obtained during the craniotomy to obliterate the nasofrontal duct before securing the supraorbital bar. As such, the pericranial flap provided a vascular barrier between the dura and the nasofrontal duct while the frontal sinus was cranialized. Titanium plating was used to secure the frontal bone and supraorbital bar in a good position. The patient was uneventfully extubated, and the patient’s occlusion was verified as matching the preoperative occlusion.

**DISCUSSION**

VSP has been implemented in orthognathic surgery and mandibular reconstruction for over a decade, but the introduction of custom platting for orthognathic surgery is relatively new. In this particular case, every effort was made to remove this mass with minimal visible impact on the patient (Fig. 4). The Le Fort I osteotomy was chosen to enable appropriate access to the lesion, as determined preoperatively with VSP. Unfortunately, traditional orthognathic techniques would have required maxillomandibular fixation to ensure proper occlusion when fixating the osteotomized components. Given that this particular lesion obstructed the nasal cavity and prevented nasal intubation, a surgical airway would typically have been indicated via a tracheostomy or submental access. Either of these approaches would have resulted in visible stigmata of a surgical airway.

Although the use of VSP and customized plating in orthognathic surgery can add to the initial cost of the procedure, we believe this approach offers several benefits. In addition to increasing efficiency and ensuring accuracy of the procedure, VSP and customized platting in select cases can help avoid the risks and stigmata associated with surgical airways in orthognathic surgery. The senior author has since then adopted the use of custom platting in his orthognathic practice (including routine Le Fort I osteotomies), as it obviates the need for maxillomandibular fixation.

**CONCLUSIONS**

The applications and utility of VSP continue to grow. In this instance, we present a case in which VSP was used both to verify our planned approach to resection and to allow for the development of a set of customized maxillary plates for fixation after resection. This helped our patient to avoid scars and morbidity associated with a surgical airway while also ensuring appropriate postoperative occlusion after orthognathic surgery.

**REFERENCES**

1. Farrell BB, Franco PB, Tucker MR. Virtual surgical planning in orthognathic surgery. Oral Maxillofac Surg Clin North Am. 2014;26:459–473.
2. Steinbacher DM. Three-dimensional analysis and surgical planning in craniofacial surgery. J Oral Maxillofac Surg. 2015;73(12 suppl):S40–S56.
3. Naran S, Steinbacher DM, Taylor JA. Current concepts in orthognathic surgery. Plast Reconstr Surg. 2018;141:925e–936e.
4. Iorio ML, Masden D, Blake CA, et al. Presurgical planning and time efficiency in orthognathic surgery: the use of computer-assisted surgical simulation. Plast Reconstr Surg. 2011;128:179e–181e.
5. Mazzoni S, Bianchi A, Schiariti G, et al. Computer-aided design and computer-aided manufacturing cutting guides and customized titanium plates are useful in upper maxilla waferless repositioning. J Oral Maxillofac Surg. 2015;73:701–707.