A Systematic Approach for Splint Fabrication in Orthognathic Surgery: Case Series

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Orthognathic surgery involves the surgical manipulation of the facial skeleton to correct anatomical and functional deformities. Model surgery is an integral part of orthognathic surgery. It gives the three-dimensional understanding of the post-operative relationship of the jaws. Orthognathic model surgery has been used to assist the surgeon in repositioning the upper and lower jaws into a predicted position. Model surgery planning has generally been carried out using one of two techniques - The lock wood key spacer technique or Eastman Dental Hospital anatomically orientated model surgery technique. This work presents our experiences in model surgery using modified Eastman's technique.

Keywords: Articulators, Occlusal splint, Orthognathic surgery

INTRODUCTION

Dentofacial deformity is a condition primarily affecting jaw and dentition. Problems associated with dentofacial deformity include the inability to incise or chew, speech impairment, unacceptable esthetics, temporomandibular joint disorders, and psychological issues. There are two modalities for the correction of dentofacial deformities, i.e., orthodontic treatment and orthognathic surgery. Orthodontic treatment offers limited scope in severe dentofacial deformity. Orthognathic surgery attempts to establish normal esthetic and functional anatomy for patients suffering from dentofacial disharmony. It is the task of the surgeon to first define the original position of the dentofacial skeleton, and then to estimate the desired final position, and finally to develop a three-dimensional (3D) representation of the movements necessary to accomplish the intended goal.¹

The planned surgical procedure is performed on a plaster cast of the patient’s jaws and teeth. Splints thus fabricated after model surgery are used as a surgical guide for repositioning maxillary and/or mandibular osteotomized segments.² Recent advancement in the field of orthognathic surgery is the use of computer-aided design/computer-aided manufacturing (CAD/CAM) in development of surgical planning for the treatment of complex craniofacial deformities.⁴⁻⁶

Model surgery is a pre-surgical laboratory procedure done on anatomically mounted jaw models to ensure that the jaws have been positioned into the prescribed relationship.

Steps in model surgery:
1. Impression making
2. Model preparation
3. Facebow transfer
4. Articulation and model surgery
5. Splint fabrication.

CASE REPORTS

Case Report 1
A 23-year-old female reported with the complaint of upper teeth being too much visible and large lower jaw. Based on various facial and radiographic measurements the treatment plan proposed was Le-fort I superior impaction (for correction of increased upper facial height) and bilateral sagittal split osteotomy (BSSO), set back (for correction of mandibular prognathism). After completion of 4 months of pre-surgical orthodontic treatment phase model surgery was performed.
Impression Making
Two sets of irreversible hydrocolloid (Neocolloid, Zhermack) impression were made. One was kept to analyze and document the pre-operative situation, and other was used to perform mock surgery. Orthodontic brackets were blocked out with wax to prevent tearing and distortion of the impression during removal.

Model Preparation
Impressions were poured with Type IV dental stone (Kalrock, Kalabhai). Precaution was taken to avoid bubbles/voids in pour-up because it may lead to an inaccurate fit of intra-operative occlusal splints due to altered occlusal relationship, particularly with segmental procedures.

FaceBow Transfer
The models were oriented in a semi-adjustable Hanau H2 articulator after facebow transfer (Figure 1). A facebow transfer is essential because significant differences between planned and surgical jaw movements can result from the difference between the true and simulated centers of mandibular rotation, as well as from the erroneous transfer of reference lines and points, between model surgery and operation.

Articulation and Model Surgery
The mandibular cast is mounted on the articulator using a centric wax record. Reference lines were drawn in order to make all movements visible in a three dimension. Horizontal reference line drawn at 10 mm and 20 mm from the articulating ring and parallel to the occlusal plane (Figure 2). The upper assembly is removed. The cast is segmentalized with a sharp saw and moved to reproduce the movement prescribed by the surgeon (10 mm of superior impaction). The maxilla is repositioned 10 mm upward in accordance with vertical reference lines. The segmented parts are sealed together using sticky wax (Figure 3).

Fabrication of Splints
Used intra-operatively to position a mobile osteotomized jaw against the other stable jaw. If a single jaw is being repositioned, one surgical splint is used to guide the occlusion of the jaw, or a segment being moved relative to the remaining jaw and is then wired or screwed in place. If both maxillary and mandibular repositioning osteotomies are planned, two surgical splints are made. A primary or intermediate splint is used to guide the movement of one jaw relative to the other jaw. Then, the secondary or final surgical splint is used to reposition the remaining jaw. Splints were fabricated with auto polymerizing resin (Rapid Repair, Pyrex) and color coded to avoid confusion. The upper and lower cast were coated with a layer of separating medium (cold mold seal, pyrex) and allowed to dry. A combination of salt and pepper and dough method was used. The occlusal surface wetted with monomer and sprinkled with a thin layer of polymer onto the monomer. Acrylic is rolled into a cylindrical shape at dough stage, adapted to the lower teeth, and the upper cast is rotated into occlusion. Excess acrylic is trimmed with scissors and left for curing (Figure 4). Undercuts and the buccal surfaces trimmed to permit visual verifications of proper seating at the time of surgery. All the external surfaces were sandpapered, pumiced, and polished.

The mandibular cast was dearticulated and again rearticulated by moving 5 mm backward at a stable occlusion (to mimic BSSO set back), final splint fabricated in this position by the same method (Figure 5). These splints are used during surgery for repositioning of osteotomized segments of the jaw (Figures 6-8).
Case Report 2
A 22-year-old female reported with a chief complaint of upper front teeth placed too forward. Based on various facial and radiographic measurements, the treatment plan proposed was Le-Fort I superior impaction and anterior maxillary osteotomy (AMO) based on Le-Fort I fracture line (backward positioning of anterior maxilla). After completion of 4 months of pre-surgical orthodontic treatment phase model surgery was performed.

Two sets of impression were made and cast poured, out of which one set was mounted on semi-adjustable Hanau Wide Vue articulator using a facebow record. Horizontal reference line marked on maxillary cast 10 mm from the articulating ring and vertical lines marked in canine, second premolar and first molar region (Figure 9). A customized incisal pin was fabricated to calculate the amount of setback achieved (Figure 10). AMO fracture line marked, and model segmentalized with a sharp saw along the line. First premolars of both sides were removed along a “V” shape cut. The remaining segment fused with sticky wax and articulated back with the help of reference lines (Figure 11). Repositioning splint is made in this position and used to reposition osteotomized maxilla with the stable mandible.

Case Report 3
A 28-year-old male reported with a chief complaint of tilted upper half of face (Figure 12). Based on various facial and
radiographic measurements, the treatment plan proposed was Le-Fort I superior impaction with correction of right side canting. Two sets of impression were made, and cast poured, out of which one set was mounted on semi-adjustable Hanau H2 articulator using a facebow record. Asymmetrical horizontal cutting was required in maxilla to compensate for canting in the occlusal plane. Selective superior repositioning of 7 mm on right side and 2 mm on left side is performed to achieve a horizontal occlusal plane (Figure 13). Segments were rearticulated and repositioning splint fabricated with auto polymerizing resin in this position (Figure 14). This splint is used to reposition the osteotomized maxilla with respect to mandible during surgery.

DISCUSSION

Planning orthognathic model surgery on semi-adjustable articulator offers various advantages. The significant anteroposterior error inherent in the simple hinge articulator creates inaccurate interocclusal splints and should therefore not be used for this purpose. Canted occlusal planes and edentulous spaces require full 3D control during planning and surgery, hence there is a need for a facebow and semi-adjustable articulator with models oriented to the Frankfort plane or true postural horizontal plane.\(^{13}\) Semi-adjustable articulator with its arbitrary facebow can even reproduce an anesthetized patient’s hinge axis movements.\(^ {14}\)

Modern technologies including navigation surgery have been used in orthognathic surgery to increase the precision of surgical movements of bone segments. The virtual orthognathic 3D planning software is an excellent tool, which assists in diagnosis, planning of virtual treatment, and post-operative evaluation of craniomaxillofacial deformities. However, the surgical transfer of virtual surgical plans remain unpredictable.\(^ {15}\) Various approaches that use internal and external references and positioning devices have been attempted, but could not be established in practice. Orthognathic surgical planning therefore still relies on the use of maxillomandibular-interocclusal splints, which are required to position the maxilla or mandible.\(^ {16}\)

CONCLUSION

In this modern era of evidence-based dentistry, presurgical planning is essential for the predictable result of orthognathic surgery. A systematically performed model surgery aids the oral and maxillofacial surgeon to decide the exact surgical movement necessary to obtain desired occlusion and esthetics. Latest computerized, and rapid
prototyping technologies let us fully imagine, design, and control orthognathic procedures without information loss among the surgeons, orthodontists, and prosthodontist. With the use of these modern techniques error sources inherent in conventional model, surgery procedures may be eliminated. Still, a major paradigm shift from routine planning to 3D virtual planning will take time till these techniques become easily accessible, user-friendly, and available at relatively low cost.