

## Management of Panfacial Fracture

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### Abstract

Traumatic panfacial fracture repair is one of the most complex and challenging reconstructive procedures to perform. Several principles permeate throughout literature regarding the repair of panfacial injuries in a stepwise fashion. The primary goal of management in most of these approaches is to restore the occlusal relationship at the beginning of sequential repair so that other structures can fall into alignment. Through proper positioning of the occlusion and the mandibular-maxillary unit with the skull base, the spatial relationships and stability of midface buttresses and pillars can then be re-established. Here, the authors outline the sequencing of panfacial fracture repair for the restoration of anatomical relationships and the optimization of functional and structural outcomes.

**Keywords:** panfacial fracture, facial trauma, sequencing repair, occlusion restoration, spatial relationships of midface and mandible.

### EPIDEMIOLOGY OF PANFACIAL BONE FRACTURE

Panfacial fractures are usually caused by high-energy injuries (e.g., motor vehicle or gunshot injuries). Panfacial fractures account for 4%–10% of all facial fractures. In Korea, the incidence was reported to account for 6.59% of all facial bone fractures. The most common site of mandibular fracture is the symphysis (33.5%), followed by the condyle (31.1%) and body (17.1%) .

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### HISTORY OF THE MANAGEMENT OF PANFACIAL FRACTURES

In the 1980s and early 1990s, craniofacial surgeons established the principles of wide exposure and direct visualization of fracture alignment for accurate craniofacial bone reduction. When these principles were applied, the sequence of alignment restoration was influenced<sup>(1)</sup>. The concept of facial buttresses was emphasized as the key to restoration of skeletal framework, and panfacial reconstructions began with the reduction of the frontal bone and proceeded with the midfacial bone alignment. Using the reconstructed maxillary framework as a template, the lower face was reconstructed last (top-to-bottom sequence)<sup>(2)</sup>.

Following the advent of rigid internal fixation, surgeons started reduction of facial fractures with the mandibular condyle<sup>(3)</sup>. The condyles determine the facial posterior height, and restoration of this height allows the mandible, which is the strongest bone of the facial skeleton, to be used as a template for panfacial bone reduction. Because of this, the bottom-to-top sequence is widely used in craniofacial surgery today.

## **Principles of Approach to Panfacial Fracture**

One of the primary concerns with regards to the repair of panfacial fractures is airway management. There are four established mechanisms for the airway: oral intubation, nasal intubation, submental intubation, and a tracheostomy. The latter three of these intubations allows for mandibular–maxillary fixation with full dentition. Oral intubation is possible when there is an absence of occlusion or absent teeth that allows the oral tube to be placed posteriorly in the mouth. Nasal intubation is often possible; however, with complex nasal and naso-orbito-ethmoid fractures, in addition to mandibular and palatal fractures, there is concern for postoperative management of the airway. There can be significant edema or packing within the nose in combination with mandibular–maxillary fixation that also leads to concern about maintaining airway patency. Submental intubation has been shown to be a safe approach with the tube out of the way, but the postoperative issues in regards to nasal packing and mandibular–maxillary fixation still exist. A tracheostomy allows the tube to be away from the structures being repaired and also has postoperative control of the airway. Of course, there are concerns about postoperative tracheostomy-related complications; however, the risk of tracheostomy is relatively low when compared with the risk of airway management postoperatively. The inside-out thought process is reconstructing the maxillary–mandibular unit as the first major step and then focusing on the midface structures. This would allow the occlusal relationship to be restored and then “built out” from that process. The outside-in, or top-down, mentality would be reconstructing the outer facial frame and the bony pillars, such as the zygomatic arch and the frontal areas, and then addressing the interfacial frame.<sup>(4)</sup> These two thought processes have permeated the literature and teaching for decades. In actuality, the best course of action is to follow a combined process. The primary goal would be to restore the occlusal relationship and then the spatial relationship between the occlusal structures and the skull base.

Historically, the lines of weakness were first described by LeFort in 1901<sup>(5)</sup>. This was followed by descriptions of the buttresses in 1916 by Cryer, and by illustrations of the vertical pillars and horizontal buttresses. Epstein and Dingman described the palatine and maxillary fractures as important for structural stability of the midface; finalized the importance of this relationship to the cranial base. This led to our understanding of the anatomy and physiology of the bony structural components of the midface in relation to the skull base and the mandible

## **Anatomical Relationships**

The components of panfacial fractures are outlined in. The definition of panfacial fracture incorporates the lower-third, middle-third, and upper-third facial components usually in a combination of fractures. There are multiple buttresses within the midface that need to be approached to restore the midface height, midface projection, and midface width, in addition to restoring the occlusal relationship<sup>(6)</sup>. The medial buttresses are along the nasal frontal bone to the anterior maxillary alveolus. The lateral zygomatic maxillary buttresses extend along the zygoma and malar bone to the lateral maxillary alveolus. The pterygomaxillary buttress has a medial component that extends from the posterior alveolus and palate to the cranial base, and a lateral component that extends from the lateral pterygoid plate to the greater wing and lateral wall of the sphenoid. There is a central sphenovomerine buttress,

which is along the central posterior palate to the floor of the sphenoid sinus.<sup>(7)</sup> With disruption of all of the buttresses and the occlusal relationship, there is a tendency for facial widening, flattening, and rotation of the maxilla. Consequently, there will be an appearance of an obtuse nasolabial angle with impaction of the midface, which will seem like an open-bite deformity. The loss of bony relationships along the sphenoid bone or the lateral walls of the orbit with fractures along the zygomatic arch will result in apparent facial widening.<sup>(8)</sup> With condylar fractures or ramus fractures, there is also a collapse of the mandibular relationship at the skull base. Therefore, the primary treatment goal is to approach these fractures in a stepwise fashion with proper sequencing of repairs by restoring the occlusal relationship and extending out to the repair of all of the buttresses.<sup>(9)</sup>

## **Sequencing**

The key to sequencing in panfacial fracture management is to understand both the principles of buttress reconstruction and the need for restoring the spatial relationship of the occlusion in the skull base.<sup>(10)</sup> With panfacial fractures, there is a compromise of the mandibular–maxillary unit and the relationship between these two structures and the skull base. The midface is also violated with the loss of key components necessary for anatomical alignment. For example, the repair of mandibular–maxillary fractures often will rely on the stable structure of the upper face and vice-versa. With panfacial fractures, there is a loss of the customary structures for anatomical alignment.

The sequencing that will be described assumes that all of the structures have been violated with the loss of anatomical stability. If there are any components that are minimally injured or not fractured, those can be assumed as “repaired” in the sequencing structure.

The first fracture to be repaired would be the palate. There is often a split within the midline or parasagittal component of the palate that needs to be realigned. Perfect structural alignment of the palate is somewhat difficult, so the goal would be to close the fracture and have this structure fixed in position. The options would be either to open up the mucosa and place a plate over the fracture site or to close the fracture and place transmucosal screws, utilizing a locking system.<sup>(11)</sup> Once the fracture has been closed, the fragments of the maxilla will be able to toggle, but not distract.

## **Two options for sequencing**

There are two options for sequencing:

- Re-establish the maxillo-mandibular unit as the first major step of the sequencing (bottom-up).
- Starting with the reduction and fixation at the level of the calvarium and working in a caudal direction (top-down).

### ***1) Re-establish the maxillo-mandibular unit as the first major step of the sequencing (bottom-up).***

Once the maxillomandibular unit is established, most surgeons start from the calvarium and proceed in a caudal direction with reduction and fixation.

**2) Starting with the reduction and fixation at the level of the calvarium and proceed in a caudal direction with reduction and fixation (top-down).**

It should be noted that with this second option of sequencing, reestablishment of the proper maxillomandibular unit is still very important, but may be achieved later in the case.<sup>(12)</sup>

**VARIOUS SEQUENCES OF PANFACIAL BONE REDUCTION**

As no clear classification of panfacial bone fractures is available, various sequences of reduction (bottom-to-top, top-to-bottom, inside-out, and outside-in) are used in combination to restore facial contour. Numerous studies have compared combinations of these reduction sequences. However, the efficacy of inside-out or outside-in sequences have not been assessed independently of bottom-to-top or top-to-bottom sequences. The “bottom-to-top and outside-in” approach is the most widely used method in the panfacial bone reduction. Gruss and Phillips<sup>(12)</sup> advised starting panfacial reconstructions with reduction of the zygomatic arch and malar projection to establish the outer facial frame and to provide upper facial width and projection before NEO, maxillary, and mandibular reconstruction. Merville suggest the frontozygomatic suture line should be reduced first in panfacial bone fractures because this important structure determines facial width and projection. As NEO fracture fragments are fragile, it is difficult to find a stable fixation point in naso-ethmoid-orbital area. Therefore, experts often recommend the outside-in sequence for reconstruction of panfacial bone fractures.

**Sequencing from the calvarium down**

- The first priority is to address any significant calvarial, frontal sinus, and orbital roof fractures. Using the calvarium as the foundation for the remainder of the midface reconstruction, the surgeon progresses from this level down to the Le Fort I level. The fractures at the Le Fort I level are the second to last fractures to be plated.
- The zygoma is positioned into its proper three-dimensional position taking care to properly line up the lateral wall of the orbit with the greater wing of the sphenoid.
- The proper alignment of the zygomatic arch and the infraorbital rim must be taken into consideration during the reduction of the various fractures<sup>(13)</sup>.
- The completion of the reconstruction of the periorbital areas is performed by addressing the NOE and nasal fractures.
- Any condylar fractures may be treated open or closed depending on the wish of the surgeon.

**Closure and Recovery**

At this point, the face should be completely reconstructed. The mandibular–maxillary fixation will need to be released to assess the occlusion and make sure there is central occlusion with maximum intercuspation. The forced duction test will also need to be performed to verify freely moving orbital cone contents. This will all need to be done in anticipation of closure. The closure of the midface is a very important aspect of panfacial trauma management, so even part of the opening has to do with the

anticipation of the closure. The intraoral incisions are closed in the usual fashion with reapproximating the muscle and then the mucosa. This could either be with running sutures or with multiple interrupted sutures, depending on the nature of the tissue that is left. The lateral midface will need to be closed by reapproximating the deep temporal fascia. The malar eminences will be completely degloved, thereby causing a risk of ptosis and the need for resuspension. Although there are techniques to suture the periosteum, there is really no periosteum available with extensive deglovings and panfacial fractures<sup>(14)</sup>. The deep tissue is grasped on either side of the infraorbital nerve with a suture placed through this tissue and then resuspended to the inferior rim; this is equivalent to the malar midface lift. With the resuspension of the malar tissue, the inferior rim hardware is covered, which may assist with preventing cicatricle retraction of the lower eyelids postoperatively. The scalp is enclosed with multiple interrupted buried sutures. Staples can be used; however, staples are often difficult to place because of their thickness. Thinner scalps allow staples to be placed with eversion. Staples placed in a thick scalp tend to have overlapping edges without eversion or coaptation of the skin edges. A safe closure would be suturing of the skin with the running locking suture or multiple simple sutures.

## **Conclusion**

In summary, the sequencing of panfacial fracture repair should be in a stepwise fashion. The restoration of the occlusion is considered the primary goal in the beginning of the sequencing process. The LeFort I level of the maxilla will need to be restored in its width with mandibular–maxillary fixation. This mandibular–maxillary unit is then restored to its vertical height and position in relation to the skull base. The remainder of the midface is subsequently reconstructed by full exposure and reduction with the key elements of repair involving restoration of the lateral wall of the orbit at the zygomaticosphenoid junction and the projection of the zygomatic process of the temporal bone. The naso-orbito-ethmoid fractures are reduced at this point as well. After all of these fractures are addressed, then the LeFort I level can be plated because this is the area that is the most forgiving. Ultimately, panfacial fractures are managed through systematic sequencing steps focusing on the occlusion as the foundation for proper alignment.

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