

## Review Article

# Avoiding occlusal derangement in facial fractures: An evidence based approach

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## ABSTRACT

Facial fractures with occlusal derangement describe any fracture which directly or indirectly affects the occlusal relationship. Such fractures include dento-alveolar fractures in the maxilla and mandible, midface fractures – Le fort I, II, III and mandible fractures of the symphysis, parasymphysis, body, angle, and condyle. In some of these fractures, the fracture line runs through the dento-alveolar component whereas in others the fracture line is remote from the occlusal plane nevertheless altering the occlusion. The complications that could ensue from the management of maxillofacial fractures are predominantly iatrogenic, and therefore can be avoided if adequate care is exercised by the operating surgeon. This paper does not emphasize on complications arising from any particular technique in the management of maxillofacial fractures but rather discusses complications in general, irrespective of the technique used.

## KEY WORDS

Complication; fracture; malocclusion; mandible; midface fracture

## INTRODUCTION

Patients with maxillofacial fractures are frequently seen by specialists with varied academic and clinical background. This scenario makes it mandatory that surgeons involved in the care of these patients familiarize themselves with the complications that could arise out of treating such fractures. It also becomes important to identify the lapses in management that lead to these complications. This approach enables the surgeon to reduce the rate of complications and helps to rectify an unfavorable result.

There is a large amount of statistical data in the literature regarding the various complications that can arise from treating maxillofacial fractures.<sup>[1]</sup> Most of these studies evaluate particular techniques of fracture management and the relevant complications of these techniques.<sup>[1-4]</sup> With the changing concepts in the management of maxillofacial fractures and irrespective of the technique used, complications still arise.

### The post-trauma complications that are encountered are as follows

- Malocclusion
- Non vital teeth
- Neurological deficits
- Exposure of hardware
- Infection
- Nonunion and Malunion.

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In a series of 110 patients with mandible fractures, it was reported that malocclusion, exposure of metalwork, delayed union, and infection were observed in 3.6, 3.6, 1.8, and 1.0% of the patients, respectively.<sup>[1]</sup>

Complication rates vary with the etiology of the injury. The fractures that result from interpersonal violence are usually in the lower socio economic group who have poor oral hygiene and poor dentition whereas those fractures that result due to motor vehicle accidents are patients who are more concerned with their oral and general health.<sup>[2]</sup>

Another study indicates the association of poor oral hygiene, poor dentition, substance abuse, and a variety of other factors which may predispose this sample of patients to post-surgical complications.<sup>[3]</sup>

Most of the complications enlisted are iatrogenic and hence can be avoided if the operating surgeon is aware of the factors which contribute to these complications. Operator experience is an important factor in the outcome of treatment.<sup>[4-6]</sup> These studies suggest that improved results are not due to treatment methods but instead due to operator experience.

Literature review reveals many studies demonstrating the link between complication rate and the surgical approach and technique rather than the time elapsed between injury and operation.<sup>[7]</sup>

The possible causes of post trauma complications are

- Diagnostic errors
- Poor surgical technique
- Infection
- Healing disorders

### **Diagnostic errors**

Failure to recognize the morphology of a fracture may lead to selection of the wrong surgical approach and eventually the wrong method of fixation. For example, an extensive comminuted fracture of the mandible needs an extra-oral approach in order to ensure adequate visualization and fixation. Bony fragments due to micro fractures adjacent to the main fracture which were not identified and fixed may become unstable and potentially lead to infection or nonunion.

### **Poor surgical technique**

Irrespective of the technique of reduction and fixation used, inadequate establishment of the occlusion,

inadequate fracture reduction, inadequate fracture fixation, damage to the roots of teeth, damage to nerves, and failure to achieve primary closure amounts to poor surgical technique.

### ***Inadequate establishment of the occlusion***

Occlusal discrepancy is one of the most frequently encountered complications of fracture management. The discrepancy which is evident postoperatively is a result of intra-operative disregard for the pre-trauma occlusion. The intra-operative inter-maxillary fixation (IMF) should reproduce the occlusion as was prior to the trauma and this IMF should be held stable throughout the fixation procedure. It is important to ensure that preexisting wear facets on the teeth are visualized and IMF done in the correct occlusal relationship. In case of gross displacement of fracture fragments, the fracture sites need to be first exposed and reduced and thereafter the teeth should be brought into occlusion and IMF done. This avoids forcible IMF which can present as deranged occlusion once the IMF is released post fracture fixation.

### ***Inadequate fracture reduction***

This could be the case in symphyseal fractures where reduction at the lingual cortex is not taken into consideration or in multiple mandible fractures, where it is important to reduce all the fractures before application of fixation. Poorly reduced fractures have deficient bone contact and hence leading to mobility between fragments. Fragments that are not properly reduced may lead to non-union, malunion/malocclusion, or facial asymmetry. A useful maneuver is to use a bone hook and disimpact the fracture. This allows for mobility and subsequent accurate reduction of the fracture along with adequate irrigation of the fracture hematoma. If the fracture ends are not stable, a bone reducing clamp can be used to reduce and stabilize the fracture, while fixation is being executed.

### ***Inadequate fracture fixation***

Fracture stability is essential for bone healing. Biomechanical principles are paramount while executing the necessary fixation. Common violation of rigid fixation principles include a plate that is too small, one plate instead of two, placement of a screw into the line of fracture, too few screws per side of fracture and inadequate plate bending.<sup>[8]</sup> Typically, a 1.5/1.7 mm plating system is used for the maxilla and a 2 mm system is used for the mandible. Avoid overheating of bone during application of hardware which could lead

to bone necrosis and hardware failure. While drilling, the drill should enter the bone in a perpendicular fashion, drill the hole and immediately be withdrawn, with the bur still rotating. Prolonged drilling inside the bone will lead to inadequate purchase by the screws and result in loosening. Some plating systems have an emergency screw which can be used in such a situation. Secure fixation should be obtained with at least 2 stable screws on either side of the fracture. In case of a comminuted fracture where the bone pieces are too small, a useful tip is to place the plate on the loose bone and secure it under the plate without actually placing a screw into it. A reconstruction plate would be a good option for such a fracture in the mandible. Holding the plate in position using a plate stabilisation forceps by the assistant, ensures that the predetermined position of the plate is maintained throughout the procedure of fixation. Inadequate fixation is the most common cause of subsequent infection during the healing period.<sup>[9]</sup> Such a situation warrants the removal of the hardware and placing the patient on IMF and antibiotics. Awareness of the importance of facial buttresses in the midface should be used in planning fixation. Typically, a long L or Y plate is placed on the naso-maxillary buttress and a L-plate placed on the zygomatico-maxillary buttress.

Internal fixation in the mandible should follow the theoretic principles of osteosynthesis which take into consideration the tensile, compressive, and torsional forces.<sup>[10-13]</sup>

In a study comparing three techniques of mandibular fracture osteosynthesis (trans osseous wiring, mini-plating following Champy's principles and mini-plating which did not use Champy's principles), morbidity was reduced in the group following Champy's principles. The postoperative variables (duration of admission, duration of inter-maxillary fixation (IMF), malocclusion, infection, dehiscence, union, removal of fixation, and nerve function were assessed and compared.<sup>[14]</sup>

Schierle *et al.* indicates that biomechanics are only one factor to be considered when treating fractures.<sup>[15]</sup> Improved maintenance of blood supply to the bone with limited dissection is an important consideration when treating facial fractures.<sup>[16-20]</sup> Application of hardware in growing children leads to restriction of growth and therefore all hardware in growing children is to be removed once fracture healing is complete.

### ***Damage to the roots of teeth***

Faulty placement of the screws results in the teeth becoming non-vital. Literature review revealed the report of a case where a screw was inserted into the root of a second premolar during fixation of a Le Fort I fracture.<sup>[21]</sup> Care should be exercised to avoid the roots of teeth by following the Champy's lines of osteosynthesis in the mandible.<sup>[10,11]</sup> If the plate is over the tooth root, it needs to be repositioned such that the screw is placed a minimum of 5mm above the root apices. Similar care should be taken in fixation of Le Fort I fracture to avoid roots of the maxillary teeth, especially the canines.

### ***Damage to nerves***

This complication manifests as neurological deficits of the relevant sensory and motor nerves. The damage can occur during the dissection procedure or during the application of hardware. Care should be taken to avoid the mental nerve by taking into consideration the anterior loop of the nerve during fixation of mandibular body fractures. Typically, the nerve is isolated and a thin malleable retractor or periosteal elevator is used to protect it during the plating process. It is not uncommon to place screws on either side of the nerve as it exits the mental foramen and great care should be taken while drilling to prevent the nerve from being caught in the spinning drill. The inferior alveolar nerve which runs in the mandibular canal should be avoided in fixation of body and angle fractures.<sup>[10,11]</sup> In the midface, the infra-orbital nerve which emerges from the infra-orbital foramen on the facial aspect of the maxillary bone, below the infra-orbital rim can be jeopardized during the fixation of the infra-orbital rim in Lefort II fractures. A common mistake is to place the plate below the infraorbital margin where the nerve actually emerges onto the anterior surface of the maxilla via the infraorbital foramen. The plate needs to be fixed onto the infraorbital margin, to avoid any damage to the nerve which can result in neuralgic pain in the distribution of the terminal branches of the infraorbital nerve. Ensure that the nerve is totally free from entrapment within the fracture fragments before fixation is instituted.

### ***Failure to achieve primary closure***

This may lead to infection of the fixation device. Soft tissue loss from trauma may leave the fixation device exposed in the oral cavity. Small areas of exposure get spontaneously covered but larger exposures may need to be covered by local flaps. If this is not possible then a change in the treatment plan should be considered, for example external fixation. A useful tip is to preserve

a gap of about 10 mm from the gingival margin when making the mucosal incision and preserve an adequate cuff of mucosa for closure. Closure is secure with a two layer closure with absorbable sutures.

### Infection

Causes of postoperative infections are multi-factorial which include instability, failed hardware, teeth in the line of fracture, medically compromised patients, delay in treatment and non-compliant patients have been described in the literature.<sup>[22]</sup> Controversy exists with the treatment of teeth in the line of fracture,<sup>[23]</sup> delay of treatment,<sup>[23]</sup> and prophylactic antibiotic coverage.<sup>[24]</sup> A recent study investigated 68 patients having 90 mandibular fracture sites with a tooth in the line of fracture who were treated using miniplates for fixation, the incidence of complications when the tooth was extracted was higher (3/12) than when it was left in place (8/78).<sup>[25]</sup>

Kyzas<sup>[26]</sup> suggests that the evidence to support the prophylactic use of antibiotics in the treatment of mandible fractures is rather limited and of doubtful quality. Management of an infected fracture post-fixation should take into consideration the timing that has lapsed post-fixation, stage of fracture union, presence of a tooth in the line of fracture, and the presence of necrotic bone.<sup>[27]</sup> However, this study was done in a population that is completely different to an Indian setting.

Post-fixation osteomyelitis is generally seen when there is an underlying systemic disease<sup>[28]</sup> and surgical treatment for the same includes debridement, sequestrectomy, mandibular resection, and immobilization of the fragments.<sup>[29]</sup> In a study on 110 patients with mandible fractures, complication rates were within acceptable limits even when treatment was performed later than 24 h after injury. The healing conditions and the surrounding tissues did not show any serious problems.<sup>[30]</sup>

Typically, all patients should be encouraged to brush their teeth even with the IMF in place and have regular chlorhexidine mouth washes.

If the initial treatment is delayed for more than 3 days, any infection at the compound fracture site(s) should first be resolved by IMF and intravenous antibiotics before performing an open reduction. This is done to ensure adequate perfusion of blood at the fracture site when the open reduction is performed.<sup>[30]</sup>

### Healing impairment

Underlying systemic diseases, chronic deficiency states, chronic use of steroids, or bisphosphonates are linked with impaired healing after fracture treatment.<sup>[22,28,31]</sup> Increased risk of complications in patients who abused alcohol and drugs has also been identified in the literature.<sup>[3,31-33]</sup> A study involving 352 patients with 589 mandibular fractures were reviewed to analyze the relationship between complications and substance abuse following mandibular fractures. Positive associations between complications and chronic abuse of alcohol and non-intravenous and intravenous drugs were found.<sup>[3]</sup>

Post-trauma complications that may require reoperation for their correction include

- Non-union
- Malunion/malocclusion

### Non-union

In a mandible fracture non-union is that which exhibits mobility after 4 weeks without treatment and after 8 weeks with surgical management as described by Haug and Schwimmer.<sup>[32]</sup> Causes of non-union are soft tissue infection, osteomyelitis, fracture mobility, inaccurate reduction, delay in treatment, teeth in the line of fracture, substance abuse, inexperienced surgeon, poor patient compliance,<sup>[32,34,35]</sup> early mobility after fixation,<sup>[36]</sup> large gaps, comminuted fractures, soft tissue entrapment, and poor bone contact. These situations require a more aggressive approach by debridement, decortication, and possibly bone grafting the gap between the fracture fragments along with stable fixation using a reconstruction plate.

### Malunion

Malocclusion is the most common sign and symptom of malunion.<sup>[7]</sup> It is a result of inadequate establishment of occlusion, lack of accurate anatomic reduction, and poor adaptation of fixation plate. Rigid internal fixation is more often associated with malunion and malocclusion than closed techniques since the rigidity obtained prevents correction of technical errors without reoperation.<sup>[27]</sup> Minor occlusal disparities are corrected using orthodontic therapy, crown and bridge, or occlusal adjustments. Malunion when detected early manifests as malocclusion and should be immediately rectified. The common approach would be to remove the hardware, achieve correct occlusion, perform good reduction, and rigid fixation. Malunion when detected after fracture healing involves osteotomies of the bone, establishing the occlusion using a surgical splint and



application of rigid fixation [Figures 1-6]. Pre-operative planning using dental models is invaluable in achieving a good acceptable outcome.

Facial deformity as a result of malunion due to inadequate reduction or due to loss of bone along the facial buttresses as a result of trauma needs secondary surgeries involving osteotomies, bone grafting procedures, or soft tissue correction.



**Figure 1:** Soft tissue effect following malunion of the mandible fracture. Note deviation of chin to the left and fullness of the right cheek due to buccal rotation of the inferior border of right mandible



**Figure 3:** Preosteotomy orthopantomogram of the patient



**Figure 5:** Postoperative occlusion

## STRATEGIES TO AVOID THE UNFAVOURABLE RESULT

- Thorough evaluation and analysis of fracture lines
- Use of dental models if necessary



**Figure 2:** Malocclusion following inaccurate fixation of mandibular symphysis fracture. The right mandibular segment is lingually rotated



**Figure 4:** Postoperative picture showing corrected facial deformity



**Figure 6:** Postoperative orthopantomogram demonstrating the result of osteotomy and de-rotation of right mandible segment with accurate internal fixation. Note the alignment at the inferior border of mandible

- Pre-operative and post-operative antibiotics, especially in the setting of poor dental hygiene
- Pre-operative planning of incisions
- Good dissection technique with preservation of mucosal cuff
- Secure accurate IMF before fixation of fractures
- Anatomical reduction and rigid internal fixation
- Check occlusion before closure
- Soft tissue resuspension and double layer closure
- Early follow-up to detect any occlusal abnormalities.

## CONCLUSION

Factors leading to an unfavorable result with occlusal derangement in facial fractures are outlined. An unfavorable result can be anticipated in certain clinical situations. A surgical strategy has been proposed to reduce the incidence of complications.

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