

A Comparison of Anterior vs Posterior Isolated Mandible Fractures Treated With Intermaxillary Fixation Screws

Khalid Ansari, MD; David Hamlar, MD, DDS; Vu Ho, MD; Peter Hilger, MD; David Côté, MD, MPH; Tehnia Aziz, DDS

Objective: To compare complication rates after use of intermaxillary fixation (IMF) bone screws for anterior (ie, symphyseal/parasymphyseal) and posterior (ie, body and angle) mandible fractures.

Methods: A retrospective analysis of isolated mandible fractures treated with intraoperative IMF bone screws at 2 major level 1 trauma centers within the Department of Otolaryngology–Head and Neck Surgery at the University of Minnesota. From January 1, 2003, through January 31, 2006, we accrued 53 patients with 67 isolated mandible fractures treated with intraoperative IMF bone screws. These patients had at least 6 weeks of follow-up.

Results: Twenty-one patients had anterior mandible fractures and 32 had posterior mandible fractures. In the an-

terior group, there was 1 incident of wound dehiscence, resulting in a total complication rate of 5%. In the posterior fracture group, there was 1 infection (3%), 4 malunions/malocclusions (12%), and 1 nonunion (3%), for an overall complication rate of 19%. The difference between groups for malocclusion rates (12% vs 0%) was significant ($P < .001$).

Conclusions: The IMF bone screw system has a superior speed and safety profile. It produces better occlusion results in anterior mandible fractures and might have a lower overall complication rate compared with arch bars. Given this, IMF bone screws are the preferred modality of intermaxillary fixation in properly selected mandible fractures.

Arch Facial Plast Surg. 2011;13(4):266-270

TO FIXATE MANDIBLE FRAC- tures correctly, one must first obtain adequate reduction by aligning the maxillary and mandible dentition in centric occlusion, otherwise referred to as *maxillomandibular fixation* (MMF). Various methods have been championed by surgeons to achieve MMF, including manual reduction and stabilization, orthodontic brackets and wires, pyriform aperture and circummandibular wires, external fixators, Ernst ligatures, and the traditional criterion standard of Erich arch bars secured with circumdental wires.

For any fracture site in the mandible, arch bars (**Figure 1**) have played a vital role in the treatment algorithm. They may be the definitive treatment instituted in nondisplaced favorable fractures in the dentate mandible and also for fractures in the nondentate mandible (condylar, subcondylar, ramus, favorable angle, etc). Of course, this requires prolonged postoperative MMF with the attendant risks of temporomandibular joint ankylosis, poor dental hygiene, malnutrition, and possible aspiration with vom-

iting. Damage is also inflicted by the circumdental wires to the interdental papillae and surrounding periodontium. On the other hand, one cannot ignore the benefits of arch bars, such as providing a tension band effect in body fractures, ensuring dietary compliance with a nonchew diet, and resting the soft tissue enveloped for optimal healing. In pediatric mandible fractures, arch bars are contraindicated. Because deciduous teeth lack a cingulum, they are easily avulsed by the circumdental wires. Arch bars also cannot be used in individuals with extensive crown and bridge work or edentulous individuals. Arch bars function poorly in reducing anterior open bite deformities. The foremost disadvantages of arch bars include the prolonged operating room time and expense to apply the system and the risk of penetrating injury and transmission of lethal viruses (human immunodeficiency virus and hepatitis B and C viruses) to the operating room personnel.¹

Owing to the limitations of arch bars, there has been an impetus to develop faster and safer techniques to achieve MMF, in particular, the intermaxillary fixation (IMF) bone screw system. Smith and Du-

Author Affiliations: Division of Otolaryngology, University of Alberta, Edmonton, Alberta, Canada (Drs Ansari and Côté); and Department of Otolaryngology–Head and Neck Surgery, University of Minnesota, Minneapolis (Drs Hamlar, Ho, and Hilger). Dr Aziz is a graduate student in the Master's of Dentistry program in the Faculty of Medicine and Dentistry at the University of Alberta and is also in private practice in Edmonton.

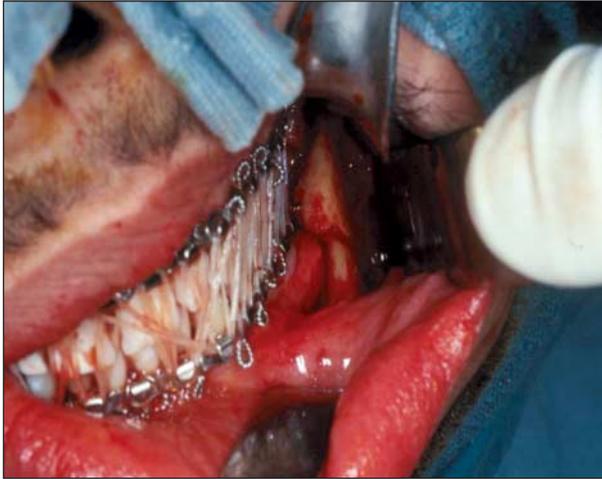


Figure 1. Traditional arch bars with elastics.

cic² formally described placing regular fixation screws in mandible fracture segments and wiring them together to assist in fracture reduction. In 1981, Otten³ and, in 1988, Ito et al⁴ inserted fixation screws into the mandible and maxilla and wired them together to achieve MMF. However, their method was complicated with frequent wire slippage, resulting in unreliable MMF. In 1998, Rhinehart⁵ introduced the microlug technique for pediatric mandible fractures. He used a 0.8-mm monocortical screw to secure a 2-hole vitallium mesh to create a microlug in the each quadrant of the mandible and the maxilla. The MMF was obtained when these microlugs were linked by polyglactin 910 (Vicryl; Ethicon, Somerville, NJ) and elastics. Although elaborate and stable, the technique was still too cumbersome to garnish popularity. Karlis and Glickman⁶ in 1997 were the first team to devise a cortical bone screw with a hole milled in the center of the screw head. This eliminated the possibility of wire slippage and significantly improved the stability of the system. This system was further refined by Jones⁷ in 1999, resulting in the creation of the modern IMF cortical bone screw.

The modern IMF cortical bone screw has unique design characteristics (**Figure 2**); it has a 4-mm capstan-style head to hold the wire away from the mucosa and a circumferential groove on the surface of the head to accommodate elastics. Two cross holes in the head allow for easy passage of the wire. The thread diameter is 2 mm and the thread length ranges from 10 to 16 mm. In addition, the threads are self-drilling and self-tapping.

To achieve correct intermaxillary screw fixation, one must insert an IMF screw between each canine and first premolar (**Figure 3**). The screw is placed just beyond the junction where the attached gingiva reflects to become the labial mucosa. The screws are inserted in a self-drilling and self-tapping manner until enough monocortical bone has been engaged for stable insertion. This is performed in all 4 quadrants. Because the screws are inserted beyond the tooth roots and are mesial to the mental foramen, tooth root damage and inferior alveolar nerve injury are avoided. A 24-gauge wire is passed through the holes in the screw heads on each side and twisted to achieve intermaxillary fixation. When open reduction and internal fixation is completed, the IMF screw system is



Figure 2. The modern intermaxillary fixation cortical bone screw system.



Figure 3. Recommended intermaxillary fixation screw placement and maxillomandibular fixation with 25-gauge wire.

removed. The IMF screws may also be inserted further distally along the zygomatic buttress of the maxilla and along the posterior mandible.⁸ Posterior screw placement in the mandible is not recommended without a preoperative panoramic radiograph (panorex). The panorex helps to plan strategic placement of the screws to avoid tooth root or inferior alveolar nerve injury.⁹

Intermaxillary fixation screws can be used for most mandible fracture sites except for condylar and subcondylar fractures with malocclusion, for which stable postoperative MMF with arch bars is still the mainstay of treatment. Intermaxillary fixation screws are also useful for edentulous mandible fractures, taking advantage of the

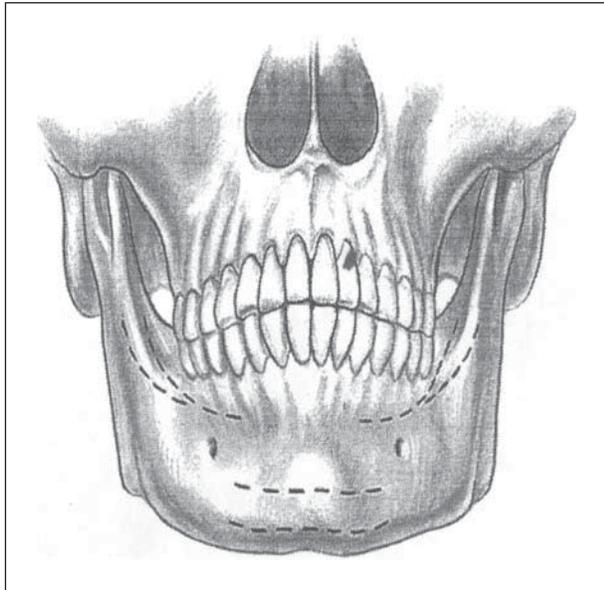


Figure 4. Champy line: the ideal line of load-sharing osteosynthesis along which miniplates are applied.

patient's dentures or Gunning splints to achieve MMF. Intermaxillary fixation screws may provide superior management of anterior open bite deformities because the IMF screw system brings the anterior dentition into better occlusion than do arch bars.

Compared with arch bars, the IMF bone screw system has been extolled by trauma surgeons because of its favorable speed and safety profile. Vartanian and Alvi¹ discovered that the average time of IMF screw application was 15 minutes compared with the 45 to 100 minutes required to secure arch bars. This saves a significant amount of operating room time and cost. Furthermore, they found no incidence of penetrating injury, making this one of the safest methods of achieving IMF.

Although there is a growing proclivity toward IMF screws, they possess certain limitations.¹⁰ Intermaxillary fixation bone screws may be unstable in severely osteoporotic bone. Even with monocortical placement, there is a significant risk of damaging unerupted permanent teeth in the pediatric dental arch. The IMF bone screw system fails to provide stable MMF in the event of comminuted fractures or alveolar fractures. Unlike arch bars, the screws cannot be used alone as definitive treatment for mandible fractures, and they do not serve the purpose of a tension band.

Although IMF screws have been popularized in the literature, there are only cursory references to the complications associated with IMF screws, and most of these relate only to tooth root and mental nerve injury.¹¹ The issue of malocclusion produced by treating displaced posterior fracture segments with IMF screws only in the anterior mandible is completely ignored.

Because the IMF bone screw system reduces anterior mandible fractures into proper occlusion better than it does posterior fractures, we hypothesized that IMF bone screws used for anterior (ie, symphyseal/parasymphyseal) mandible fractures have reduced complications when compared with their use for posterior (ie, body and angle)

mandible fractures. Therefore, we performed a retrospective analysis of isolated mandible fractures treated with intraoperative IMF bone screws, comparing the complication rates of anterior vs posterior mandible fractures.

METHODS

Within the Department of Otolaryngology–Head and Neck Surgery at the University of Minnesota, we used the level 1 trauma centers of Region's Hospital in St Paul and Hennepin County Medical Center in Minneapolis. Four otolaryngology staff personnel provided care with resident involvement.

PATIENTS

From January 1, 2003, through January 31, 2006, 53 patients with 67 isolated mandible fractures were treated with intraoperative IMF bone screws. The patients' ages ranged from 16 to 81 years; 43 patients were male and 10 female. There were no edentulous patients. The exclusion criteria for the patients were prior maxillomandibular fractures, other concurrent craniofacial fractures, and less than 6 weeks of follow-up. Furthermore, patients with comminuted mandible or alveolar fractures, patients younger than 14 years, or those requiring postoperative MMF to treat their fractures were also excluded.

All patients included in the study met the inclusion and exclusion criteria. All patient data collected was deidentified to ensure confidentiality, and no patients were contacted. Appropriate institutional review board approval was obtained.

TREATMENT METHOD

Treatment was delivered within at least 72 hours of injury. Preoperative radiographs included one of the following: panorex, computed tomography, or 3-dimensional computed tomography reconstruction. Intravenous antibiotics and corticosteroids were administered 30 minutes before the procedure. Nasoendotracheal intubation with general anesthesia was initiated. Appropriate dental extractions were performed on grossly carious or decayed teeth in the fracture line, devitalized teeth with root fractures, and subtotally avulsed teeth. Stable teeth within the fracture line were preserved. The teeth were scrubbed with chlorhexidine solution, 0.1%. Intraoral incision sites were infiltrated with lidocaine hydrochloride, 1%, with 1:100 000 epinephrine. An IMF bone screw system was applied using the recommended technique.

Open reduction and internal fixation was then performed on the mandible fractures (**Figure 4**). Symphyseal, parasymphyseal, and body fractures were treated with a 1.5-mm miniplate with monocortical screws (Synthes, West Chester, Pennsylvania) as a tension band along the Champy line and a 2.0-mm mandible locking plate (Synthes) with bicortical screws secured at the inferior mandible border. Angle fractures were plated with a 2.0-mm, 6-hole mandible plate (Synthes) with 6-mm-long screws along the Champy line. Fracture segments located posterior to the IMF screws were manually held in reduction before plating. Ramus, subcondylar, and condylar fractures were deliberately not selected by the staff surgeons for treatment with the IMF bone screw system and therefore were excluded from this study.

The fracture sites were then copiously irrigated with saline solution, and a 2-layer closure was performed. The IMF bone screw system was removed and occlusion was rechecked. A supportive jaw strap was applied for 24 hours postoperatively.

The patients received another dose of intravenous antibiotics and corticosteroids 12 hours later. After a postoperative period of 24 to 72 hours, the patients were discharged home. All the patients received postoperative instructions detailing a 6-week non-chew soft diet and meticulous oral hygiene. They also received a 1-week course of oral analgesics, oral antibiotics, and chlorhexidine mouth rinse. A postoperative panorex was obtained as an inpatient before discharge or during an outpatient follow-up visit.

Follow-up visits were scheduled 1 week after surgery, and then every 2 weeks. All the patients included in the study required at least 6 weeks of follow-up. During their follow-up, the patients underwent evaluation for complications such as mental nerve anesthesia, malunion/malocclusion, wound dehiscence, infection, nonunion, and evidence of screw-damaged tooth roots on the postoperative panorex.

RESULTS

Twenty-one patients had anterior mandible fractures and 32 had posterior mandible fractures. Eleven patients in the anterior mandible fracture group also had a contralateral angle fracture, as detailed in the following tabulation:

Site	No. of Patients (N=53)
Posterior fracture	
Angle	21
Body	8
Body and angle	3
Condylar, subcondylar, and ramus	0
Anterior fracture ^a	
Parasymphiseal/symphiseal	10
Parasymphiseal/symphiseal and angle	11

^aEleven patients with parasymphiseal/symphiseal fractures with a concurrent contralateral angle fracture are included in the anterior fracture group.

In the anterior group, there was 1 incidence of wound dehiscence, resulting in a total complication rate of 4.8% in this group. In the posterior fracture group, there was 1 infection (3.1%), 4 malunion/malocclusions (12.5%), and 1 nonunion (3.1%), for an overall complication rate of 18.8% (**Table 1**).

The wound dehiscence and local infections were all successfully treated with oral antibiotics, meticulous oral hygiene, and chlorhexidine rinses. No infections proceeded to frank osteomyelitis. The malunions/malocclusions were treated with a course of arch bars with guiding elastics and occlusal equilibration by the dentist. No orthognathic surgical procedure was required, and all patients went on to develop normal occlusion. The 1 incident of nonunion at the angle required reoperation with debridement, extraction of an infected and impacted third molar, and replacement of the 2.0-mm Champy plate with a 2.4 mandible reconstruction plate at the inferior border and a 2.0-mm tension band at the superior border. The patient also received 2 weeks of postoperative MMF with arch bars. Fortunately, this proceeded to heal with solid union.

There were no incidents of iatrogenic inferior alveolar nerve injury on 2-point discrimination testing. In addition, no tooth root injuries were noted on the follow-up panorex images.

We compared the various complication rates between the 2 cohorts treated with intraoperative IMF screws

Table 1. Anterior vs Posterior Mandibular Fracture Complications

	No. (%) of Patients	
	Anterior Fracture Group (n=21)	Posterior Fracture Group (n=32)
Infection	0	1 (3)
Wound dehiscence	1 (5)	0
Malunion/malocclusion ^a	0	4 (12)
Nonunion	0	1 (3)
Damaged teeth	0	0
Postoperative anesthesia	0	0
All	1 (5)	6 (19)

^a $P < .001$.

using a log-likelihood ratio test. The anterior fracture group had a statistically significant lower malocclusion rate (0%) compared with the posterior fracture group (12.5%) ($P < .001$). Otherwise, there was no statistically significant difference in the other complications between the 2 cohorts.

COMMENT

The superior speed and safety profile of the IMF screw system compared with arch bars has been established. However, in the current literature, there are only cursory references to the complications of IMF screws, and most of these relate only to tooth root and mental nerve injuries. In particular, the issue of malocclusion with IMF screws is completely ignored. Because the IMF screw system essentially provides a point of stabilization on each side of the parasymphysis, the system provides excellent reduction for anterior mandible fractures (Figure 3). More posterior fracture segments that are distal to the IMF screws are free floating and are not brought into proper reduction and occlusion without some additional intervention. This intervention usually entails a reliable and attentive assistant to manually reduce the posterior fragment with exacting precision before plating. Although surgical errors in fracture reduction can be minimized, they cannot be eliminated altogether, suggesting that posterior mandible fractures treated with intraoperative IMF screws are more prone to poor reduction and subsequent malocclusion. Another possible explanation for the worse occlusion outcomes for posterior fractures is that there is less bone stock and surface area of contact between the posterior fragments (ie, for angle fractures compared with symphyseal fractures). Also, one must be cognizant of the possible distracting forces of the muscle sling on posterior fractures. Taking these factors into account, accurate reductions in more posterior mandible fractures are difficult to maintain, resulting in higher malocclusion rates.

In addition, there is another pertinent finding that lends support to our result. In our study, 11 patients in the anterior fracture group (52%) had a contralateral angle fracture. According to Fox and Kellman¹² and Ellis and Walker,¹³ angle fractures have one of the highest com-

Table 2. Total Complication Rates of Arch Bars vs IMF Screws in Anterior and Posterior Mandible Fractures^a

	No. (%)	
	MMF Arch Bars ^b	IMF Screws
Anterior fractures	58/242 (24)	1/21 (5)
Posterior fractures (excluding ramus, condylar, and subcondylar)	77/242 (32)	6/32 (19)

Abbreviations: IMF, intermaxillary fixation; MMF, maxillomandibular fixation.

^aThere is a trend for posterior fractures to have a higher complication rate than anterior fractures, regardless of whether arch bars or screws are used (ie, 32% vs 24% and 19% vs 5%). There is also a trend for IMF screws to have a lower complication rate compared with arch bars, irrespective of the fracture location. These comparisons are not statistically verified.

^bData are from Valentino and Marentette.¹⁴

plication rates of all the mandible fracture sites. Therefore, one would expect that this significant proportion of angle cofractures in our anterior fracture group would adversely amplify the complications for this cohort. Despite the negative impact of including these high-risk angle fractures, there was still a lower malocclusion rate in the anterior fracture group treated with IMF screws ($P < .001$).

On the other hand, one could debate that anterior fractures have a lower complication rate than posterior fractures regardless of the type of temporary MMF used. Valentino and Marentette¹⁴ in 1995 retrospectively reviewed 499 mandible fractures treated with intraoperative arch bars in 287 patients at the University of Minnesota. After comparing our study with the 1995 study (**Table 2**), we confirmed that posterior fractures tend to have a higher complication rate than do anterior fractures, regardless of whether arch bars or screws are used. However, we also discovered that the IMF screw system had a lower total complication rate compared with arch bars, irrespective of the fracture site being treated. Nonetheless, this observation may be a reflection of the surgeon's bias in selecting more favorable fractures to be treated with IMF screws and reserving fractures more prone to complications (ie, comminuted fractures) to be treated with arch bars.

In the study by Valentino and Marentette,¹⁴ fractures fixed with arch bars had an overall malocclusion rate of 4%. Comparatively, IMF screws produced better occlusion results in anterior fractures (0%) and worse occlusion results in posterior fractures (12.5%). Therefore, great care and caution must be exercised when treating posterior mandible fractures with IMF screws alone to avoid poor occlusion outcomes. If the reduction of the posterior segment is precarious when manually held in place, we suggest that one use an arch bar in this area to gain greater stability before plate fixation.

Although these are interesting comparisons between arch bars and IMF screws, they are not statistically verified. In the future, we plan a prospective randomized controlled study to compare arch bars and IMF screws.

In conclusion, the IMF bone screw system has a superior speed and safety profile. It produces better occlusion results in anterior mandible fractures and possibly has a lower overall complication rate compared with arch bars. Given these findings, IMF bone screws are the preferred modality of IMF in properly selected mandible fractures.

Accepted for Publication: January 20, 2011.

Correspondence: Khalid Ansari, MD, Division of Otolaryngology, University of Alberta, 4031-1100 Youville Dr West NW, Edmonton, AB T6L 5X8, Canada (dr.kalansari@gmail.com).

Author Contributions: Study concept and design: Ansari, Ho, and Hilger. Acquisition of data: Ansari, Hamlar, Ho, and Aziz. Analysis and interpretation of data: Ansari. Drafting of the manuscript: Ansari, Hamlar, Ho, and Aziz. Critical revision of the manuscript for important intellectual content: Ansari, Hilger, Côté, and Aziz. Administrative, technical, and material support: Ansari, Hamlar, Ho, Hilger, Côté, and Aziz.

Financial Disclosure: None reported.

REFERENCES

- Vartanian AJ, Alvi A. Bone-screw mandible fixation: an intraoperative alternative to arch bars. *Otolaryngol Head Neck Surg*. 2000;123(6):718-721.
- Smith JE, Ducic Y. Interim fixation of mandible fractures. *J Otolaryngol*. 2002;31(4):227-230.
- Otten JE. Modifizierte Methode zur intermaxillaren Immobilisation [Modified methods for intermaxillary immobilization]. *Dtsch Zahnarztl Z*. 1981;36(2):91-92.
- Ito M, Handa Y, Okutomi T, et al. Application of von Otten interaxillary immobilization for infant condylar fracture. *J Jpn Stomatol Soc*. 1988;37:773.
- Rinehart GC. Mandibulomaxillary fixation with bone anchors and quick-release ligatures. *J Craniofac Surg*. 1998;9(3):215-221.
- Karlis V, Glickman R. An alternative to arch-bar maxillomandibular fixation. *Plast Reconstr Surg*. 1997;99(6):1758-1759.
- Jones DC. The intermaxillary screw: a dedicated bicortical bone screw for temporary intermaxillary fixation. *Br J Oral Maxillofac Surg*. 1999;37(2):115-116.
- Busch RF. Maxillomandibular fixation with intraoral cortical bone screws: a 2-year experience. *Laryngoscope*. 1994;104(8, pt 1):1048-1050.
- Coburn DG, Kennedy DW, Hodder SC. Complications with intermaxillary fixation screws in the management of fractured mandibles. *Br J Oral Maxillofac Surg*. 2002;40(3):241-243.
- Schneider AM, David LR, DeFranzo AJ, Marks MW, Molnar JA, Argenta LC. Use of specialized bone screws for intermaxillary fixation. *Ann Plast Surg*. 2000;44(2):154-157.
- Holmes S, Hutchison I. Caution in use of bicortical intermaxillary fixation screws. *Br J Oral Maxillofac Surg*. 2000;38(5):574. doi:10.1054/bjom.2000.0514.
- Fox AJ, Kellman RM. Mandibular angle fractures: two-miniplate fixation and complications. *Arch Facial Plast Surg*. 2003;5(6):464-469.
- Ellis E, Walker L. Treatment of mandibular angle fractures using two noncompression miniplates. *J Oral Maxillofac Surg*. 1994;52(10):1032-1037.
- Valentino J, Marentette LJ. Supplemental maxillomandibular fixation with miniplate osteosynthesis. *Otolaryngol Head Neck Surg*. 1995;112(2):215-220.