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

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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 anterior 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.

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To fixate mandible fractures 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 vomiting. 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.

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-
cic\textsuperscript{2} formally described placing regular fixation screws in mandible fracture segments and wiring them together to assist in fracture reduction. In 1981, Otten\textsuperscript{3} and, in 1988, Ito et al\textsuperscript{4} 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, Rhinehart\textsuperscript{5} 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 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 garner popularity. Karlis and Glickman\textsuperscript{6} 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 Jones\textsuperscript{7} 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 removed. The IMF screws may also be inserted further distally along the zygomatic buttress of the maxilla and along the posterior mandible.\textsuperscript{8} Posterior screw placement in the mandible is not recommended without a pre-operative panoramic radiograph (panorex). The panorex helps to plan strategic placement of the screws to avoid tooth root or inferior alveolar nerve injury.\textsuperscript{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
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. Nasotracheal 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.

Figure 4. Champy line: the ideal line of load-sharing osteosynthesis along which miniplates are applied.
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 nonchew 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 cocontralateral angle fracture, as detailed in the following tabulation:

<table>
<thead>
<tr>
<th>Site</th>
<th>No. of Patients (N=53)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Posterior fracture</td>
<td></td>
</tr>
<tr>
<td>Angle</td>
<td>21</td>
</tr>
<tr>
<td>Body</td>
<td>8</td>
</tr>
<tr>
<td>Body and angle</td>
<td>3</td>
</tr>
<tr>
<td>Condylar, subcondylar, and ramus</td>
<td>0</td>
</tr>
<tr>
<td>Anterior fracture</td>
<td></td>
</tr>
<tr>
<td>Parasymphseal/symphseal</td>
<td>10</td>
</tr>
<tr>
<td>Parasymphseal/symphseal and angle</td>
<td>11</td>
</tr>
<tr>
<td>Parasymphseal/symphseal</td>
<td>10</td>
</tr>
</tbody>
</table>

Eleven patients with parasymphseal/symphseal 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. No infections/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 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.

### Table 1. Anterior vs Posterior Mandibular Fracture Complications

<table>
<thead>
<tr>
<th>Fracture Complication</th>
<th>Anterior Fracture Group (n=21)</th>
<th>Posterior Fracture Group (n=32)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infection</td>
<td>0</td>
<td>1 (3)</td>
</tr>
<tr>
<td>Wound dehiscence</td>
<td>1 (5)</td>
<td>0</td>
</tr>
<tr>
<td>Malunion/malocclusion (^a)</td>
<td>0</td>
<td>4 (12)</td>
</tr>
<tr>
<td>Nonunion</td>
<td>0</td>
<td>1 (3)</td>
</tr>
<tr>
<td>Damaged teeth</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Postoperative anesthesia</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>All</td>
<td>1 (5)</td>
<td>6 (19)</td>
</tr>
</tbody>
</table>

\(^a\) \(P<.001\).

**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 parasympysis, 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 symphseal 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 cocontralateral angle fracture. According to Fox and Kellman\(^{12}\) and Ellis and Walker\(^{13}\), angle fractures have one of the highest com-
complication 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 Marentette14 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.

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

<table>
<thead>
<tr>
<th>Fracture Type</th>
<th>Arch Bars (%)</th>
<th>IMF Screws (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior</td>
<td>58/242 (24)</td>
<td>21/1 (5)</td>
</tr>
<tr>
<td>Posterior (excluding ramus, condylar, and subcondylar)</td>
<td>77/242 (32)</td>
<td>6/32 (19)</td>
</tr>
</tbody>
</table>

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

1. There 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.

2. Data are from Valentino and Marentette.14

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**REFERENCES**


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