Treatment of Mandibular Angle Fractures Using One Noncompression Miniplate

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Purpose: This study evaluated the results in patients treated for fractures of the mandibular angle with a single miniplate.

Patients and Methods: Eighty-one patients with fractures of the mandibular angle were treated by open reduction and internal fixation using one noncompression miniplate with 2.0-mm self-threading screws placed through a transoral incision. No patient was placed into postsurgical maxillomandibular fixation. They were prospectively studied for complications.

Results: Thirteen patients with angle fractures (16%) experienced complications requiring secondary surgical intervention. Most of the complications (n = 11), however, were minor and could be treated in the office. Most commonly, intraoral incision and drainage and later removal of the bone plate were required. All patients with minor complications had clinical union. Only two complications required hospitalization for intravenous antibiotics and further surgery. One of these patients had a fibrous union requiring a bone graft.

Conclusions: The use of a single miniplate for fractures of the angle of the mandible is a simple, reliable technique with a relatively small number of major complications.
Questions about the degree of stability provided by these miniplates have become a point of contention among surgeons. Ravel et al,26 Luh,27 and the AO/ASIF advocates28 do not think that the plates offer adequate stabilization of the fracture to eliminate the need for MMF. Mommaerts and Engelke reported that 76% of their patients treated with miniplates were placed into MMF for some period postsurgery.29 Although the controversy has not been resolved, this method of bone plating to stabilize fractures has become more popular in recent years owing to the ease with which the plates can be placed transorally. Some surgeons who routinely used the more rigid AO/ASIF plates also have begun to use miniplates.30,31

The purpose of this investigation was to prospectively evaluate the use of a single miniplate for stabilization of fractures of the mandibular angle.

**TECHNIQUE**

After placement of arch bars, the fracture was exposed using an intraoral incision. Only the amount of soft tissue stripping necessary to visualize, reduce, and stabilize the fracture was performed. Mobile teeth or teeth whose apices were exposed in the fracture were removed. If teeth in the fracture were to be extracted, the intraoral incision included the attached gingiva around the involved tooth. The fracture was then reduced and the jaws placed into MMF. A four-hole noncompression titanium miniplate (Walter Lorenz Surgical, Inc, Jacksonville, FL) was adapted along the medial side of the external oblique ridge and screwed to the bone using 2.0-mm self-threading screws (Fig 1). No transbuccal trochar was necessary for instrumentation. The three most anterior screws were inserted with the patient in MMF. The most posterior screw, which was on the medial surface of the mandibular ramus, in some cases was inserted after removing the MMF, allowing instrumentation between the upper and lower teeth from the opposite side. The anterior screws were 5 mm in length; those distal to the fracture were 7 mm in length. After the plate was placed, MMF wires were removed, and the occlusion was checked. Postsurgical MMF was not used in any patient. The incision was closed with resorbable suture, and no drains were placed. Postsurgical recommendations for soft diet were generally prescribed but, because of the noncompliant nature of our patients, rarely followed.

**Patients and Methods**

All dentate patients with noncomminuted fractures of the mandibular angle treated by this technique between July 1, 1993 and June 30, 1995, who had at least 6 weeks of follow-up, were included in this study. They were prospectively evaluated for the following information: 1) additional fractures; 2) presence of a tooth in the line of fracture; 3) extraction of tooth in line of fracture; 4) complications during surgery; 5) postsurgical occlusal relationship; and 6) postsurgical complications, which were defined as a need for further surgical intervention.

**Results**

Eighty-one consecutive patients treated by this method, 68 men or boys (85%) and 13 women or girls (M/F = 5.2:1), with 81 angle fractures (none were bilateral), had sufficient follow-up for inclusion in this study. They ranged in age from 12 to 52 years, with a mean of 27.2 years (SD = 8.0). Thirty-eight patients (47%) were African Americans, 32 were non-Hispanic Caucasians (39.5%), and 11 were of Hispanic origin (13.5%). The principal cause of the mandibular fracture was altercations (n = 73, 90.1%), followed by motor vehicle–related trauma (n = 5, 6.2%), falls (n = 2, 2.5%), and sporting accidents (n = 1 1.2%). The angle fracture was on the left side in 53 patients (65.4%) and on the right in 28 (34.6%). Forty-three patients (53.1%) had only a mandibular angle fracture. All other patients had a contralateral fracture in the body (n = 24), symphysis (n = 11), or condylar process (n = 1). One patient had contralateral fractures of both the condylar process and symphysis. All other fractures were treated by a variety of stable plate or screw fixation techniques. No patient was placed into postsurgical MMF; all were allowed immediate mobilization.

The time from the initial injury to surgical treatment ranged from <1 to 16 days, with a mean of 3.1 days (SD = 2.4). Five patients had surgery less than 24 hours from their time of injury (6.2%), 37 patients between 1 and 2 days (45.7%), 23 patients between 3 and 4 days (28.4%), and 16 patients longer than 4 days (19.7%). Sixty-five of the 81 angle fractures (85%) were associated with an impacted or erupted molar tooth. These were removed at the time of surgery in 39 (60%) of the fractures.

After application of the bone plate, all fractures appeared to be well reduced and stable. Postoperative radiographs taken within the first 2 days showed excellent reduction in all cases except four, where a 2- to 4-mm gap was noted at the inferior border. In spite of this finding on radiographs, immediate occlusal relationships were judged as normal in all but one of these patients, who had an slight posterior open bite on the side of the fracture that responded to light elastic traction for 10 days (Fig 2). Besides this case, two other patients had slight malocclusions that responded to the
wearing of elastics for 1 or 2 weeks. At the time of arch-bar removal, occlusal relationships were judged as normal in all cases. There was no clinical evidence of damage to the inferior alveolar neurovascular structures during placement of the fixation hardware. The follow-up of all patients ranged from 6 to 64 weeks, with a mean of 19.4.

Thirteen patients (16%) developed complications from their angle fracture that required further surgical intervention. The mean age (28.9 years), time between injury and treatment (3.2 ± 1.6 days), sex (11 male, 2 female; 5.5:1), and association with impacted/erupted molars (11 yes, 2 no) in these patients was not significantly different than the entire population. There was
a higher incidence of African Americans with complications (n = 8; 61.5%) when compared with the total sample (47%). The complications occurred from 1 to 38 weeks after surgery. They could be divided into major and minor complications. Minor complications occurred in 11 of the 13 patients (85%) and consisted of minor infections, swelling without discharge, or complaints of pain in the area of the bone plate. In all patients with minor complications, the fractures healed uneventfully without need for hospitalization or postsurgical MMF. Four patients had small amounts of purulent exudate in the area of the incision. Two of these occurred early, within 2 weeks of surgery. They were treated by introral incision and drainage, oral antibiotics, and removal of the bone plate under local anesthesia several weeks later, after the fracture had healed. The other two patients developed drainage after 6 weeks and required removal of the bone plate under a local anesthetic. The infections cleared in all cases after plate removal. Four patients had either a history of or obvious swelling over the angle of the mandible without noticeable drainage. They underwent elective removal of the bone plate under a local anesthetic. Three patients had complaints of either pain over the bone plate, pain in the molar associated with the fracture, or bleeding on brushing the teeth. They underwent elective removal of the bone plate or involved molar.

Two patients had major complications requiring hospitalization. One patient developed a postoperative infection 2 weeks after surgery. An incision and drainage was performed in the clinic, and she was hospitalized for intravenous antibiotics. She was taken back to surgery, where extraction of the impacted molar associated with the fracture was performed. The bone plate was still firmly attached to the mandible and was left in place. The infection rapidly cleared, and she underwent uneventful healing. The second patient developed infections in both of his mandibular fractures 1 week after surgery. He was treated as an outpatient with introral incision and drainage, oral antibiotics, and irrigations. The infection cleared, and the patient did not return for several weeks. At that time, he had an extraoral sinus tract at the angle. Radiographs showed dissolution of the bone around the plate and the angle fracture, as well as lack of healing in the contralateral fracture in the body of the mandible. Clinically, there were fibrous unions bilaterally. The patient was admitted to the hospital and taken to the operating room for bilateral hardware removal, sequestrectomy, extraction of the molar associated with the angle fracture, and bilateral bone grafting. Subsequent healing was uneventful.

Discussion

One of the greatest shortcomings of most studies on treatment of mandibular fractures is that the results for specific anatomic sites usually are not presented. This is also true of studies on miniplate fixation of mandibular fractures. It therefore becomes very confusing to compare complications of mandibular angle fractures when fractures in other areas of the mandible are included. In Champy et al's classic report of 183 cases of mandibular fracture, the 3.8% infection rate is for all fractures of the mandible. Unfortunately, it is impossible to determine whether angle fractures had a different incidence of complication from the others.

Cawood, in one of the best studies, compared 50 consecutive patients with miniplate fixation to 50 with wire fixation plus 6 weeks of MMF. Overall, the patients who had miniplate fixation regained the ability to open their mouths much sooner. There was a slightly higher incidence of malocclusion (8% vs 4%), infection (6% vs 4%), and dehiscence (12% vs 6%) in the miniplate group than in the wire fixation group. The infections all responded to plate removal. The miniplate group had a much faster rate of recovery of mandibular mobility. At 4 weeks, the miniplate group achieved an average of 42 mm of interincisal opening, compared with 34 mm after 15 weeks in the wire fixation group. In Cawood's study, 27 patients in the miniplate group were treated for fractures of the angle; 21 patients in the wire fixation group had fractures of the angle. Although there was no direct comparison of complications in the patients who were treated for fractures of the angle, some information was reported for the miniplate group. Three patients with miniplate fixation of angle fractures developed dehiscence of the incision (11%), one patient had a malocclusion (3.7%), and one patient developed an infection (3.7%). The plates were electively removed at approximately 3 months postsurgery.

After studying many alternate treatments for fractures of the angle of the mandible in our patient population, an AO reconstruction bone plate was placed through an extraoral approach offered the lowest rate of major postsurgical complications (7.5%). However, there are several disadvantages to this method of open reduction and internal fixation. The transfacial approach requires increased operating time and risks damage to the facial nerve, and hypertrophic scar formation may occur. Therefore, this technique is less desirable in noncomminuted dentate mandibular angle fractures.

Of the intraoral techniques studied by us, the single miniplate was associated with the fewest major complications. Most complications in the current study were minor and easily treated on an outpatient basis. Only two patients had complications requiring hospitalization; one required bone grafting for fibrous union. There was no case of malocclusion requiring surgical intervention in spite of the finding in some
patients of a gap along the inferior border in the immediate postoperative radiograph. By the 6-week radiograph, the gap had completely closed in all cases.

The apparent success of this modality of treatment for fractures of the mandibular angle may seem incongruous with traditional principles of rigid internal fixation. Proponents of rigid internal fixation believe that prevention of interfragmentary mobility is the key to success and should be sought when treating fractures. Clearly, a single miniplate does not satisfy the requirements of a truly rigid system. This seeming dichotomy highlights the limitations of relying on the results of biomechanical bench testing for clinical treatment recommendations.

**BIOMECHANICAL TESTS FOR DETERMINING FIXATION REQUIREMENTS**

Karasz et al compared the stability of an AO/ASIF 2.7-mm eccentric dynamic compression plate placed along the inferior border with that of a four-hole miniplate placed along the superior border in a simulated Araldit fracture model using simple beam mechanics. They concluded that the single miniplate offers more resistance to vertical bending forces and therefore satisfied the clinical requirements for functionally stable osteosynthesis. Based on this study, and similar ones by Champy et al, one might assume that the single miniplate is biomechanically stable under all situations, and superior to the use of a more rigid bone plate applied along the inferior border. However, the fallacy of this assumption is that the model used only one loading condition (vertical), using simple beam mechanics.

A more realistic model was used by Kroon et al. They examined the stability of miniplate fixation of simulated fractures of the mandibular angle using polyurethane mandibles. In contrast to previous studies, they loaded the mandible in various functional positions and found quite different results from those obtained in the simple models of Champy et al or Karasz et al. Neither bending nor torsional forces were sufficiently controlled by single miniplate fixation in Kroon’s study. Furthermore, when the ipsilateral molar was loaded, the zones of tension and compression reversed, causing a gap to form at the inferior border of the mandible, where no fixation device was placed. Similar results were obtained in an elegant study comparing the dynamic stability of six internal fixation schemes for angle fractures by Shetty et al. They showed that a single miniplate for fractures of the mandibular angle applied according to the principles of Champy offered the least resistance to displacement of the six methods tested.

Based on the studies of Kroon et al and Shetty et al, one might recommend the use of a second miniplate applied further inferiorly on the lateral surface of the mandible to control torsional forces and prevent separation of the inferior border under some loading conditions. Choi et al showed that two miniplates provide much greater stability than a single miniplate in a biomechanical analysis using cadaveric mandibles under loading conditions using a testing apparatus similar to Kroon et al’s. Significantly greater displacement of mandibular fragments was found when only one miniplate was applied ($P < .05$).

Based on such biomechanical studies and clinical results, some investigators have advocated the use of two miniplates for fractures of the mandibular angle. Levy et al compared a small sample of patients who had fractures of the angle treated with either one or two miniplates without postsurgical MMF. There were no complications in the 18 patients who had double miniplates, but two complications in the 10 patients (20%) who had a single miniplate. Interestingly, another sample of 14 patients with two miniplates plus postsurgical MMF had a greater rate of complication (7.1%) than when no MMF was used.

Our clinical results do not corroborate the results of the more elaborate biomechanical tests showing the benefit of a second miniplate, or the study by Levy et al. We found a very high rate of major complications in our patient population (29%), mostly infections, when angle fractures were treated by two miniplates. However, using a single miniplate as advocated by Champy et al was found to be very successful in our patient population. The number of major complications was minimal (2 of 81), and only one patient had a fibrous union requiring bone grafting. Many minor complications occurred but were simply treated in the office. The results of our studies indicate that biomechanics are only one factor to be considered when treating fractures. Many others may be more important. Perhaps improved maintenance of the blood supply to the bone because of limited dissection is one such factor. We therefore agree with Ewers and Härlle, who questioned the need for absolute rigidity for treatment of fractures. In fact, Champy and Kahn related that Lodde has reduced the thickness of miniplates by half, and there has been no increased incidence of complication over what was obtained with standard miniplates. From the foregoing, it is obvious that fractures of the mandibular angle do not require the amount of stability determined in biomechanical tests. This should not be surprising in light of bite force studies by Gerlach et al and Tate et al, which showed that bite forces are subnormal for many weeks after fracture of the mandible.

Another question one might ask is, should a four-hole or six-hole miniplate be applied? Haug studied
the ability of various screw lengths and number of screws per fragment to resist displacement when used as tension bands in a simple beam model with bovine ribs. He found that the length of the screws was inconsequential. 4 mm screws were as effective as longer lengths in resisting bone displacement in the model. There was a slight increase in rigidity of the system when three screws were used on each fragment as opposed to two, but there was no additional benefit with four screws. We used four-hole miniplates with 5-mm screws anteriorly and 7-mm screws posteriorly. Whether we would have had fewer complications with 5-mm screws anteriorly and 7-mm screws posteriorly.

The Need for Postsurgical Maxillomandibular Fixation

Many clinicians who use a single miniplate for fractures of the mandibular angle apply MMF for some duration postoperatively. It is not always clear why these surgeons use MMF. Immobilization of the mandible until the soft tissue incision has healed is often cited as the reason. Other clinicians use postsurgical MMF to “settle” the occlusal relationship after application of the bone plate. However, we did not use postsurgical MMF in any patient and had no case of permanent malocclusion. We left the arch bars in place to use for postsurgical elastic traction, if necessary, but had to use them in only a few cases for a week or two. We continue to leave arch bars on in every dentate case for many reasons, especially to encourage the patient to return for follow-up. The arch bars are not removed until the patient’s mandibular function is rehabilitated, generally a minimum of 6 weeks after surgery.

Time Between Fracture and Surgery

Champy et al and Cawood recommended that miniplate osteosynthesis must be performed soon after injury to minimize the incidence of dehiscence and infection. Champy et al, using no preoperative antibiotics, recommended fixation within 12 hours of injury. Cawood extended this period to 24 hours after injury. Unfortunately, many of our patients did not present for treatment until days after their injury. Even when they did present early, it was not always possible to perform immediate surgery for a host of logistical reasons. Because of this, our patients were treated an average of 3.1 days after injury. We could detect no difference in complication rate for those fractures treated early or late. Lack of such a relationship has also been found by Smith, Barnard and Hook, and Tuovinen et al.

Use of Miniplates in Infected Fractures

Champy et al originally recommended that miniplates not be used to treat fractures in the presence of infection. However, the successful treatment of infected mandibular fractures with internal fixation devices has been reported by Becker, Tu and Tenthulzen, Johansson et al, Koury and Ellis, and Koury et al.

Johansson et al treated 37 patients with 42 infected mandibular fractures with miniplate fixation. The delay between fracture and surgery ranged from 1 day to 10 months. Postsurgical MMF, if used, was terminated after 1 or 2 days. No drains were inserted, and all patients were given antibiotics for at least 10 days after surgery. Approximately 10 of these fractures were in the region of the mandibular angle. Uncomplicated healing occurred in 28 patients (76%). In 9 patients (24%), the preoperative infection persisted, and additional treatment was necessary. Six of these patients healed after incision and drainage, insertion of an intraoral drain, prolonged treatment with systemic antibiotics, and extraction or endodontic treatment of devitalized teeth. In the remaining three cases, the fixation became unstable, necessitating removal of the bone plates and application of MMF for 6 to 8 weeks. Two of these patients had uncomplicated healing; one required a bone graft. Unfortunately, this article did not report on the location of the fracture complications.

Our study included too few patients whose fractures were initially infected to determine the utility of miniplates in such fractures. In the four patients we treated for infected fractures of the mandibular angle, two had postsurgical complications requiring removal of the bone plate later. Both of these patients were listed as minor complications and were treated in the clinic. In both cases, the plate was maintaining stability and was left in position long enough for healing to occur. The plate was then removed.

The finding in this study showed that the use of a single miniplate for treating noncomminuted fractures of the mandibular angle in our patient population was associated with minimal major complications. However, minor complications occurred with some prevalence, requiring intervention. Fortunately, most of these problems were easily treated in the outpatient setting.

References


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Treatment of Mandibular Angle Fractures
Using One Noncompression Miniplate

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Treatment of mandibular angle fractures continues to be an enigma for surgeons. A variety of treatment options with a broad range of advantages and disadvantages are available. In the past 20 years, rigid internal fixation (RIF) without maxillomandibular fixation (MMF) has become a popular method of treatment. However, this method is not without controversy.

Since the introduction of RIF to stabilize mandibular fractures, two different treatment philosophies have evolved. Advocates of the AO/ASIF principles promote absolute rigidity of the angle fracture to obtain primary bone healing.3 To achieve that goal, an extraoral incision using two plates (inferior border plate and a superior border tension band plate) or one large reconstruction plate is required.4 Attempts to obtain absolute rigidity through an intraoral incision have been fraught with a high complication rate.2 In contrast, Champy and others have advocated semirigid fixation using a single noncompression miniplate placed along the mandibular superior border through an intraoral incision.5-7

In this article, Drs Ellis and Walker have prospectively evaluated the use of a single noncompression miniplate without the use of MMF to treat mandibular angle fractures. This study is unique in that it was conducted in a patient population that is often noncompliant and has a variety of medical problems. In the past, many felt that this population is best served with absolute rigidity because of potential complications. In addition, Ellis has previously evaluated other fixation techniques in this same population, thus allowing for comparative analysis.4,6,9 The authors’ findings in this study indicate that semirigid fixation in this population has a complication rate that is comparable to that of the AO/ASIF rigid fixation technique or wire-osteosynthesis stabilized with MMF.3

The authors have attempted to qualify complications and have divided them into minor and major based on the need for rehospitalization. All the minor complications were successfully treated in an outpatient setting. Based on this parameter, the authors found that 85% of the complications were minor. This is significant as we attempt to provide cost-effective treatment without MMF to patients with mandibular fractures.

Infection and swelling were the most commonly occurring complications. This is not surprising, because it appears that there is an inherent risk of infection when using an intraoral incision to treat mandibular angle fractures regardless of the fixation method.6,10 However, minor complications occurred as late as 6 weeks after treatment. When using RIF to treat mandibular fractures, most minor soft tissue infections occur within the first 2 weeks after the operation. Major complications such as osteomyelitis or nonunions usually do not occur until 4 to 6 weeks after the operation. Because there was a small number of late minor infections (n = 2) that occurred, a larger population study size is needed to determine the true occurrence rate. This may be important, because it is unknown if the patient with an late minor infection who does not return for follow-up may progress to a major complication. Therefore, careful postoperative monitoring may be important when using this technique.

Another unique aspect of this study was that no patient was placed into MMF after plate placement. In other studies, the use of miniplates was done in conjunction with a short period of MMF.11 It is a fair assumption that this population did not maintain a soft diet immediately after treatment. However, there was not an increased incidence of malunions, nonunions, or osteomyelitis when compared with other techniques of stabilization. This is an important finding when treating the potential noncompliant patient who may never return for a follow-up.

This leads into the question of rigidity and function. The authors describe biomechanical studies that address displacement forces at the mandibular angle fracture site and the use of RIF to counter these forces. The findings of this study do not corroborate the need for absolute rigidity at the angle...