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Clinical Paper
Trauma

The use of three-dimensional strut plates for the management of mandibular angle fractures: a retrospective analysis of 222 patients

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Abstract. This study was performed to evaluate the use of three-dimensional (3D) strut plates for the surgical management of mandibular angle fractures and to determine the subsequent postoperative complication rate. Two hundred and twenty-two patients met the inclusion criteria for mandible angle fracture at the university hospital in Miami between 2009 and 2013 and were included in this study. The treatment protocol for mandibular angle fractures included open reduction and internal fixation with the utilization of a 3D strut plate. Patients were not placed in postoperative intermaxillary fixation. An evaluation of the cases revealed a complication rate of 15.3%, of which 6.8% were considered major complications requiring a surgical intervention. The 3D strut plate has been found to have many advantages over single miniplate techniques with respect to the stability of the fracture and the rate of complications. Based on the current data, 3D strut plates provide a predictable result in the treatment of mandibular angle fractures.

Key words: 3D strut plate; mandibular angle fracture; box plate.

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Facial bone fractures are a common occurrence following assaults, motor vehicle accidents, and falls. Between 19% and 40% of all facial fractures involve the mandible. Furthermore, 30–40% of all documented mandibular fractures are located at the angle.[1–3] Despite advances in fixation techniques, angle fractures continue to generate complication rates as high as 32% and remain a management challenge.[4–6] Well-established treatment protocols for the mandibular angle fracture remain controversial (Fig. 1).[7]

Champy and others have described the ideal line of osteosynthesis, which is now well known and accepted, forming the basis of internal fixation using miniplates and screws. Historically, the treatment of mandibular angle fractures has involved rigid fixation techniques allowing for absolute stability and primary bone union.[8] Recently, the miniplate monocortical fixation approach has gained popularity, and studies have described low complication

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Fig. 1. Displaced left angle of mandible fracture.

Fig. 2. Utilization of Champy's technique for ORIF of a left angle of mandible fracture.

Fig. 3. Utilization of a 3D strut plate for ORIF of a left angle of mandible fracture.

rates of 12–16%, especially with the use of Champy's technique (Fig. 2).[9] However, the stability of single miniplate fixation at the angle has been challenged in more recent biomechanical studies.[9]

Newer three-dimensional (3D) techniques allow oral surgeons to fixate angle fractures using a combination of transorally placed plates and screws.[10–13] Furthermore, the use of the 3D strut plate has been shown to result in a decrease in morbidity and simplification of the surgical procedure in comparison to rigid reconstruction plates (Fig. 3).[14,15]

Farmand and Dupoirieux first described the 3D quadrangular strut plate, which is formed by joining two miniplates with interconnecting crossbars.[10] The geometry of the plate's design allows for increased stability and resistance against torsion while maintaining malleability and a low profile.[16] This simultaneously stabilizes both the tension and compression zones at the injury site, thus reducing surgical times when compared to the conventional two-plate technique.[1] Regarding the mandibular angle, the best site for plating is along the superior aspect of the mandible, particularly at the flat osseous section approximating the third molar.[17]

This study was performed to evaluate the surgical management of patients treated with 3D strut plates for mandibular angle fractures, occurring either alone or in combination with other mandibular fractures, and to determine the subsequent postoperative complication rate. Outcome parameters evaluated included infection, wound dehiscence, plate fracture, and malocclusion; these were further classified into major and minor complications. Information about the type of fracture, presence of the third molar, degree of displacement, mechanism of injury, medical comorbidities, use of intermaxillary fixation (IMF), and time taken to perform the procedure were also recorded.

Patients and methods

This was a retrospective study of 263 patients with mandibular angle fractures treated with 3D strut plates at a university hospital in Miami, Florida, USA; the study was approved by the institutional review board. The hospital database and records were reviewed for the period 2009–2013. The following data were collected: patient demographics, fracture type and characteristics, presence of teeth in the line of fracture, timing of the procedure, duration of the procedure, medical comorbidities, patient medications, presence of nerve damage, post-surgical complications, perioperative course, and follow-up. Patient age ranged from 16 to 63 years, with a mean age of 30 years.

All patients with mandibular angle fractures treated with the 3D strut plate were initially included in this study. Exclusion criteria included the following: bilateral angle fractures, condylar and subcondylar fractures requiring IMF, severely comminuted mandibular angle fractures requiring extraoral approaches, and patients with inadequate perioperative and follow-up information. Severely comminuted angle fractures were defined as any shattered angle fractures or fractures with fragmentation so severe that the individual fracture segments could not be fixated, could not be used to provide support for the fixation of the mandible, or the fractures would extend beyond the internal fixation screw holes of the strut plate.

Out of the 263 patient charts reviewed, 222 were included in the study. Eight patients were excluded due to the involvement of a condylar/subcondylar fracture, 19 patients presented with a severely comminuted angle fracture, three had bilateral angle fractures, and 11 patients had inadequate follow-up documentation (never returned for any postoperative visits).

The quantification of fracture displacement was assessed by direct measurement using the calibrated measurement tool on axial and coronal computed tomography (CT) scans. The surgical operative time was recorded from incision to wound closure. The operative time excluded the duration of IMF application. All plates were placed via an intraoral approach and fixated with eight monocortical screws, four on the proximal segment and four on the distal segment. A transbuccal trocar technique was used to aid in the drilling of bone and placement of the self-tapping screws. No drains were placed and all patients received one preoperative dose of 3 g ampicillin/sulbactam 1 h before the surgery and then received one postoperative week of oral amoxicillin.

Complications were divided into two groups: major and minor. Major complications were defined as those undesirable postoperative sequelae requiring a surgical intervention, while minor complications were defined as postoperative sequelae that were resolved without a surgical intervention. Finally, a review of documented nerve injury was also conducted.

Results

Based on the review of the 222 patients, the most common cause of the angle fracture was assault and interpersonal violence. This was followed by motor vehicle collision and falls (Table 1). Thirteen patients presented with comminuted fractures (5.9%) and 134 (60.4%) presented with two or more fractures of the mandible, as shown in Tables 1 and 2. The overall rate of major complications requiring a surgical intervention was 6.8%. The combined complication rate including minor complications was 15.3% for all patients.

Fifteen patients had major complications (Table 2). Three of the patients developed a postoperative malocclusion involving a posterior apertognathia. These patients returned to the operating room for removal of the 3D strut plate, manipulation of the mandibular segments, and placement of IMF. One of these patient required additional plate removal in the parasymphysis area and a new osteotomy to restore occlusion. A reassessment of the three patients at the 2-week postoperative visit revealed a reestablishment of the preoperative occlusion.

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