Use of 3-D Plate in Displaced Angle Fracture of Mandible

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Abstract

Introduction Mandibular angle fractures can be treated by various methods, but even the most popular methods may not be able to give satisfactory results, as the pterygomasseteric sling and masticatory forces can result in displaced angle fracture. These displaced fragments cannot be satisfactorily retained by single miniplate fixation. The aim of this study is to assess treatment of displaced angle fracture with 3-D miniplate fixation. This study can also be considered as a therapeutic study with level V evidence.

Materials and Methods This study was designed to assess the feasibility of 3-D matrix miniplate fixation in displaced angle fractures. Eighteen patients with displaced angle fractures were included in this study. Matrix miniplate fixation was done transorally under general anesthesia.

Results All these cases were treated successfully, and common complications like infection (5.5% of patients), wound dehiscence (11%), paresthesia (16.7%), and malocclusion (11%) were observed in our study.

Conclusions Three-dimensional miniplate fixation in displaced angle fractures provides better stability and function.

Keywords

- osteosynthesis
- mandibular angle fracture
- matrix miniplate

Injuries to the facial skeleton are relatively common, and the incidence of mandibular fractures is higher compared with other facial fractures. Mandibular angle fractures make up 20 to 36% of all mandibular fractures.^{1,2} Heibel et al observed that mandibular angle fractures have a high frequency of complications, particularly in relation to the insufficient stability of the fixation system.³ Despite surgical advancements, angle fracture management still presents unpredictable results and difficulties in treatment in comparison with other mandibular fractures, leading to discussion about the ideal treatment. Various treatment modalities for angle fractures have been tried, ranging from a single noncompression miniplate, lag screws, two miniplates, one compression-type

locking miniplate, and a 3-D rectangular matrix fracture plate with varying levels of success.^{4–6}

The apex of the mandibular angle marks the junction of the body and vertical ramus. The average apical distance between the outer and inner cortex is constant, even in an edentulous jaw. Fractures located within these boundaries are by definition central angle fractures. In 1888, Schede first introduced open reduction and placement of a steel plate with four screws as a means of treatment by exposing the fractured fragments. Mandibular fractures can be treated by either rigid or semirigid fixation. The use of a stronger plate along lower border of the mandible, originally based on Association for Osteosynthesis/Association for the Study of Internal Fixation

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(AO/ASIF) principle, was introduced in 1970 in Switzerland, but had the disadvantage of external scarring and facial nerve damage through the external approach. Smaller bendable monocortical plates based on Champy's principle are placed at the juxta-alveolar junction (ideal line of osteosynthesis) to allow the natural muscular forces that exist on the jaw to stabilize the fractured bone ends to facilitate complete healing. This technique is simple, quicker, and still in practice. Maintaining a diet of soft foods is considered important by many for success. The modification of the original Champy's technique that involves the use of additional smaller plates and screws for added stability was introduced in the past decades. The stability of single miniplate fixation for angle fractures was challenged by several biomechanical studies based on 3-D models. The installation of a single miniplate on the buccal side of the fracture or along the external oblique line region was sufficient to withstand the masticatory forces, but this type of fixation did not resist buccolingual splaying or the opening of the inferior border due to bending of the plate.

Three-dimensional plates were introduced whose stability, unlike traditional plates, does not depend on the thickness of the plate, but on its format. The stabilization of the plate with monocortical screws forms a 3-D array that gives the system tridimensional stability.⁷ This stability is shown in biomechanical studies. This plate should be used in the neutral zone (between tension and compression areas) of the mandibular angle. The 3-D miniplate can be considered as two miniplates joined together by interconnecting cross struts, allowing virtually no torsional movements at the region of fracture, unlike what happens when only a single plate is installed at the tension area. At the superior border of the mandible, bending and torsional forces usually cause movement in the long axis of the plate, leading to an enlargement of the fracture gap at the inferior border of mandible and also buccolingual splaying of the mandible superiorly. The clinical studies with 3-D plates reported low complications rates.

Materials and Methods

This study included 18 patients (13 men and 5 women) with mandibular angle fractures who reported to the Department of Oral & Maxillofacial Surgery and Maxillofacial Unit of the King George's Medical University Trauma Center, in Lucknow. All the patients with displaced angle fractures (as visualized radiographically) were included in the study (► Figs. 1 and 2). Patients with comminuted angle fractures and suffering from any systemic diseases were not enrolled in the study. The patients' detailed history including age, sex, location of fractures, and time between trauma and surgery was recorded. The patients were operated on under general anesthesia and a 2.0-mm matrix plate was used for fixation (► Fig. 3). The maxillomandibular fixation (MMF) and sutures were removed 7 days postoperatively.

Results

The male and female patients were a mean age of 29 and 26 years respectively. Of 18 patients, two had isolated angle

Table 1 Location of fracture site along fracture angle

Anatomical location of fracture	n	%
Isolated angle fracture	2	11.1
Angle fracture plus contralateral body fracture	12	66.6
Angle fracture plus contralateral condylar fracture	4	22.3

fractures and 16 had angle fractures combined with contralateral body/condylar fractures (► Table 1). Fifteen patients (83%) had high mobility, and 3 patients (17%) had slightly mobile fracture fragments. Mouth opening was restricted in 13 cases (72%), and in 5 patients (28%) mouth opening was adequate (► Table 2). Postoperatively, one patient reported persistent swelling and pain at the operation site. Antibiotic course was given for 7 days and no surgical intervention was required to control infection or to remove the plate. In two patients, wound dehiscence was noted after a week, which might be due to fragment manipulation during placement of the matrix plate at the angle region. Wound dehiscence was observed in initial cases, which may be due to excessive retraction of soft tissue flap during screw placement. Three patients also reported paresthesia following the surgery, but regained normal sensation (► Table 3). Relevant data related to the clinical follow-up of wound healing, postoperative occlusion, any paresthesia, and radiological observations were recorded at regular intervals for up to 3 months (► Figs. 4 and 5).

Table 2 Presurgical fracture displacement, fracture mobility, and impaired mouth opening

Parameter	n	%
Dislocation of fragments		1
Yes	18	00
No	–	
Mobility of fragments		
High	15	83
Slight	3	17
None	0	
Preoperative mouth opening		
Impaired	13	72
Nonimpaired	5	28

Table 3 Complications

Complications	n	%
Infection	1	5.5
Wound dehiscence	2	11
Paresthesia	3	16.7
Malocclusion	2	11

Figure 1 Preoperative orthopantomogram showing displaced fracture fragments.

Discussion

Fracture of the mandibular angle is the commonest fracture and is difficult to treat, as there is no universal standard protocol to treat angle fractures. Various types of implants (plates) have been designed for various implant systems claiming to be superior to other types of implants in terms of stability and complications.

Mastication-like movements, mainly in the molar region, result in displacement of the mandibular base region that was not neutralized with one plate fixation in the region of tension, which can lead to clinical failure of osteosynthesis. Choi et al observed a bony gap along the inferior border of the fracture, and this fracture movement was thought to contrib-

Figure 2 Preoperative posteroanterior view showing displaced fracture fragments.

Figure 3 Intraoperative picture showing plate placement.

ute to subsequent complications including infection.⁸ A second plate was suggested to reduce anterior-posterior separation of the fracture line as well as lateral displacement, which was frequently observed on postoperative radiograph. Levy et al indicated that miniplate fixation of angle fractures may not be efficient and recommended fixation be augmented by a second plate at the lower border of the mandible.⁹ Fracture reduced by Champy's plate was vulnerable to torsional and bending movements along the long axis of the mandible, particularly when loaded close to the fracture site. These torsional forces may lead to a loss of friction lock and result in reduced primary stability. The friction between the screw head and plate is the main weak point of the entire fixation. Another factor is inaccurate adaptation of

Figure 4 Postoperative orthopantomogram showing matrix miniplate fixation.

Figure 5 Postoperative posteroanterior view showing matrix miniplate fixation.

conventional plates that causes displacement of the mobile bony fragments when the screws are tightened and can decrease primary stability. The presence of a pterygomasseteric sling transmits dynamic force to this anatomical (angle region) localization. Occlusal load applied near the fracture (second molar) and to the contralateral second molar produced a rotational separation of segments, whereas a bicortical system resisted displacing forces better when the load was applied closer to the fracture line in the second molar area.

Jain et al reported a study on 20 patients and concluded that Champy's miniplate system is a better and easier method than a 3-D miniplate system for fixation of mandibular fractures, but also stated that a 3-D system provides good stability due to excessive implant material because of extra vertical bars incorporated in the implant to counteract torquing forces.¹⁰ Presence of paresthesia was reported in three patients in our study, which could be explained due to fracture displacement, which also causes displacement of canal or nerve diameter. Zix et al also explained that the displacement of fragments might cause traumatic injury to the nerve, which should normally recover in due course of time.¹¹ In two patients, postoperative malocclusion was detected, which was relieved by selective grinding of teeth. Wittenberg et al studied the biomechanical evaluation of mandibular angle fracture by stabilizing by a Leibinger eight-hole 3-D miniplate (Leibinger-Fischer, Irving, TX), a Synthes eight-hole mesh plate, and a Synthes six-hole reconstruction plate (S-Mesh, Synthes, Paoli, PA) with 2-mm and 2.4-mm mono- and bicortical screws.¹² These results indicated that 3-D or mesh plates can be used for fixation of mandibular angle fractures.

Zix et al studied 20 noncomminuted mandibular angle fractures treated with a 2-mm 3-D miniplate system in transoral approach and reported it as suitable for simple mandibular angle fractures, easy to use, and possibly contraindicated in insufficient interfragmentary bone contact, which causes minor stability of the fracture.¹¹

In this study, 5.5% of patients reported infection postoperatively that did not require removal of plate and were treated with antibiotic therapy only. Guimond et al reported a low infection rate¹³ and Hochuli Vieira et al reported a 4.44% infection rate when compared with studies using conventional plates and miniplates, where the infection rate ranged from 3 to 32%.¹⁴

Conclusions

Three-dimensional miniplate fixation in displaced angle fractures provides better stability in terms of form and function. This plate also retains the displaced fragments in reduced position during the healing period with minimum side effects. The main advantage that we found from our study is simultaneous stabilization of the tension and compression zones leading into better stability as supported by literature.

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