

Treatment of mandibular angle fracture with a 2mm, 3 dimensional rectangular grid compression miniplates: A prospective clinical study

Samir Mansuri¹, Abdul Mujeeb Abdulkhayum², Giath Gazal¹, Mohammed Abid Zahir Hussain³

¹Assistant Professor, Department of Maxillofacial Surgery, College of Dentistry, Taibah University, Al-Madina Al-Munawwarah, Kingdom of Saudi Arabia; ²Associate Professor, College of Dentistry, Taibah University, Al-Madina Al-Munawwarah, Kingdom of Saudi Arabia; ³Professor, College of Dentistry, Taibah University, Al-Madina Al-Munawwarah, Kingdom of Saudi Arabia.

ABSTRACT

Background: Surgical treatment of fracture mandible using an internal fixation has changed in the last decades to achieve the required rigidity, stability and immediate restoration of function. The aim of the study was to do a Prospective study of 10 patients to determine the efficacy of rectangular grid compression miniplates in mandibular fractures.

Materials & Methods: This study was carried out using 2.0 rectangular grid compression miniplates and 8 mm multidirectional screws as a rigid internal fixation in 10 patients without post operative intermaxillary fixation (IMF). Follow up was done for period of 6 months.

Results: All fractures were healed with an absolute stability in post operative period. None of the patient complained of post operative difficulty in occlusion.

Conclusion: Within the limits of this study, it can be concluded that rectangular grid compression miniplates was rigid, reliable and thus can be recommended for the treatment of mandibular angle fractures.

Key Words: 3-dimensional miniplates, mandibular angle fracture, Rectangular grid compression miniplates.

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Address for Correspondence: Dr. Samir Mansuri. Department of Maxillofacial Surgery, College of Dentistry, Taibah University, Al-Madina Al-Munawwarah, Kingdom of Saudi Arabia. Phone: + 966 – 535635419.

Email: samirmansuri78@yahoo.co.in

Introduction

Facial bones are the one of the most important and complex portion of skeleton and injuries of the facial bone can result in devastating emotional sequale as well as functional disturbance. The mandible is the largest and strongest facial bone; it is very commonly fractured, generally occurring 2 to 3 times as often as midface fracture.¹ Mandible angle fractures generate the highest frequency of complications relative to other mandibular fracture, ranging from 0% to 32%.^{2,3}

The optimum treatment of mandibular angle fractures

remains debatable. The treatment of these fractures has evolved over a period of time from old method of bandaging, splitting, pin fixation and prolong maxillomandibular fixation, which is a part of closed reduction to avoid methods of open reduction and internal fixation (ORIF). The advantages of ORIF include early mobilization and restoration of jaw functions, nutritional status, better oral hygiene, patient comfort and earlier return to the work. Several methods of internal fixations have been studied with great variations in rate of complications.³

The philosophy of AO initially stressed the need for absolute stability to prevent fragments mobility and

generate primary bone healing. The original AO technique involved placement of superior and inferior border compression plate for angle fracture^{4,5}, latter modification used anon compression tension band plate on the superior border and compression plate on the inferior border. The possible disadvantages of the AO/ASIF philosophy for the treatment of mandibular angle fracture were the need for larger plates and greater difficulty for plate adaptation.⁴ Due to these disadvantages, authors turned their attention to the used of variety of small plates with monocortical screws by intra oral approaches.

In 1973, Michelet et al describe the treatment of mandibular fractures using small, easily bendable, non compression miniplates placed transorally and anchored with monocortical screws. This technique contradicted the AO and Luh'r technique. Champy later performed a series of experiments with miniplates that delineated "ideal line of osteosynthesis" with in the mandible.^{6,7} Champy's method of semi rigid fixation used one easily bendable monocortical miniplates along an ideal osteosynthesis line. Plates placed along these lines were thought to provide optimum fixation and stability but still many maxillofacial surgeon feel that miniplates also does not provide adequate stability and required maxillomandibular fixations for additional stability.

The short coming of rigid and semi rigid fixation lead to the development of 3-Dimensional miniplates. Unlike compression and reconstruction plates, their stability is not derived from thickness of the plates. In combination with the screws monocortically fixed to the outer cortex, the rectangular plate forms a cubid, which posses 3-Dimensional stability.⁸

The continuation with the development in 3-Dimensional plating system lead to the evaluation of the grid compression miniplates to overcome the shortcoming of the 3-Dimensional plates with additional advantages of the its inheretent design. The grid plate as oppose to the conventional 3-Dimensional plates is smaller and has only two vertical bars and four eccentric non locking screws, one at each corner of the plate. The grid plate allow for almost no movement at the superior and inferior border with Manual tensional and bending forces as opposed to when single linear plate is applied to the superior border

area, when tensional and bending forces usually cause movement along the axis of the plate with buccal lingual splaying and gap formation at the inferior border respectively.⁹

To overcome the drawbacks associated with the use of previous modalities for the treatment of mandibular angle fracture and considering the current concept of the 3-Dimensional miniplates, the study was conducted in the department of Oral & Maxillofacial surgery to evaluate the efficacy, stability of the 2mm 3-Dimensional rectangular grid compression miniplates with eccentric non locking monocortical screws for open reduction and internal fixation for non comminuted mandibular angle fracture and analyze the indications and limitations of the treatment modalities.

Materials and Methods

A prospective randomized clinical study of 10 cases between the ages of 16-60 years was conducted having mandibular angle fracture at the Oral & Maxillofacial Surgery Dept., Govt Dental College & Hospital, Ahmadabad after ethical committee approval for the trail. Patients with concomitant condylar fracture, complex fracture of maxilla, medically compromised patients and patients having fracture with bone loss, which needed bone graft were excluded from the study. The criteria for removal of a tooth in the line of fracture at the time of surgery was fracture teeth, loose teeth, pericoronar / periodontal infection, inability to reduce the fracture without removal. Infection was defined as having purulent discharge from the incision or through a sinus tract to the skin or having closed swelling that required incision and drainage of purulent material in the said study.⁵

All patients were treated by 2.0 rectangular grid compression miniplates and 8 mm multidirectional screws. Radiographic examination was performed using either panoramic radiographs or computed tomography scan (Figure 1). Preoperative occlusion was checked (Figure 2). All patients were operated under general anesthesia by appropriate approach to the fracture site (Figure 3). A adequate reduction of fracture fragments was done (Figure 4). The monocortical perforations were performed, and fixation was done.

With the monocortical 2.0 mm system screws measuring 8 mm in length and 2mm, 3-Dimensional rectangular grid compression miniplates. After fixation

liquid feeding was recommended for 7 days, and the diet was gradually being released.

During every follow up occlusion, paraesthesia, oral

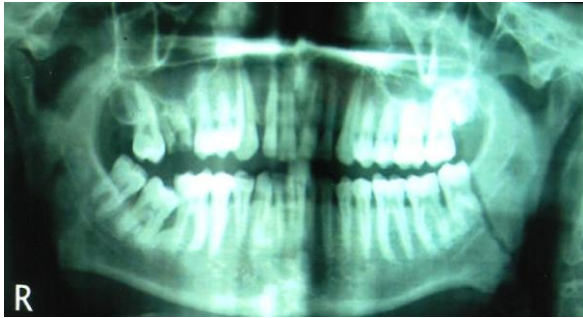


Figure 1: Preoperative OPG.



Figure 2: Preoperative occlusion.



Figure 3: Fracture fragment.

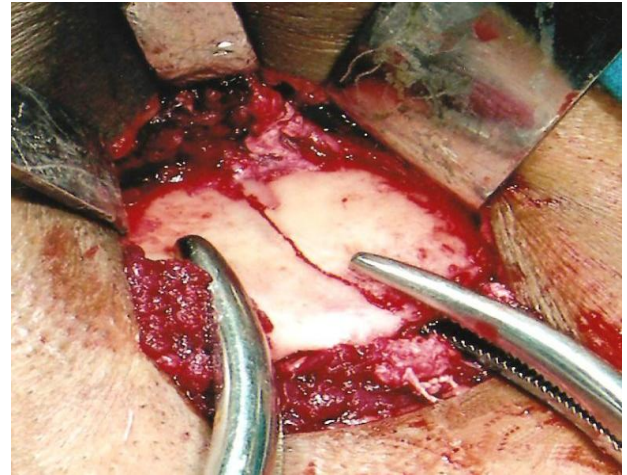


Figure 4: Reduction of fracture fragments.

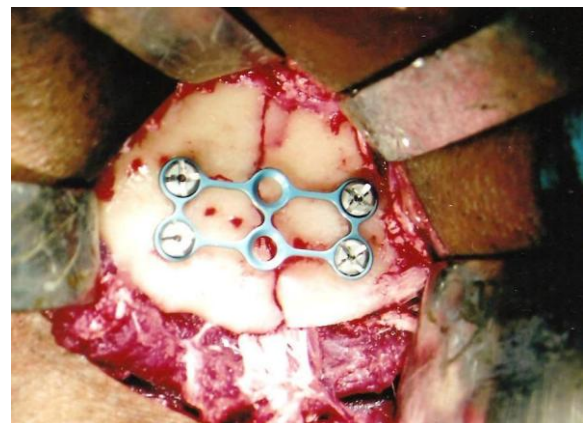


Figure 5: Fracture fixation with grid compression plate.



Figure 6: Post operative OPG.

of the fracture (Figure 5), intermaxillary fixation was removed, and no intermaxillary block was used in the postoperative period. Radiographs were obtained on day 1 postoperatively to verify the reduction and plate positioning, as well as 3 and 6 months periods (Figure 6). Patients were discharge on 7th post operative days,

hygiene, mouth opening, segmental mobility, as well as other complications were evaluated (Figure 7). Follow up of the patients were maintained minimum up to 6 weeks.



Figure 7: Postoperative Occlusion.

Results

Patients with mandibular angle fractures treated over period of 2 years with a 2 mm rectangular grid compression miniplates by appropriate approach with monocortical screws. The fracture at angle of mandible were approached via risdon incision and those at parasymphysis and body were approached by intraorally or with existing laceration.

The age group of the patients at the time of reporting

maxillofacial trauma. Road traffic accidents were so responsible for majority of cases In 20% patients, fracture occurred because use of interpersonal violence and in 30%, the fracture resulted due to fall. Road traffic accident (50%) was the major factor behind the mandibular angle fracture in our study It was observed that 7 patients had unilateral single fracture while 3 had associated fracture (symphysis / mandibular body). Out of 10 patients 7 cases involved the left side of the mandibular angle and other 3 cases showed involvement of right side. The 70% of the cases belong to unilateral cases (Table 2). There was 1 fracture of the symphysis and 2 of the mandibular body associated with angle fracture. It was noticed that in 30% of the cases opposite side of the mandibular body was associated with mandibular angle fracture (Table 3). Overall in 7 cases out of 10 cases tooth was present in fracture line. Tooth was retained in all cases except in one in which tooth was vertically fractured (Table 4). In the most of the cases postoperative healing was uneventful encouraging the efficacy and biocompatibility of the fixation system used. In one

Table 1: Age wise distribution of Fractures.

Age group	No. of patients	percentage	Sex	No. of patients	percentage
11-20 years	2	20%	Male	9	90%
21-30 years	5	50%			
31-40 years	2	20%			
41-50 years	1	10%	Female	1	10%
Total	10	100%			

Table 2: Etiological Distribution of Fractures.

Etiology	No. of patients	percentage	Type of fracture	No. of patients	percentage
Road traffic accident	5	50%	Unilateral	7	70%
Interpersonal violence	2	20%			
Miscellaneous	3	30%	Bilateral Total	3	30%
Total	10	100%	Unilateral	10	100%

to the hospital was ranged from 16-50 years with the mean age of 28.1 years. Maximum occurrence of mandibular angle fracture (50%) was seen in the age group of 21-30 years (Table 1). It was also noted that in 90% of cases male patients were affected as compare to female having ration of 9:1. According to many statistic studies male gender are the more prone in

case there was postoperative paresthesia present which was due to the severe displacement of the mandibular angle fracture leading to trauma to the mandibular nerve (Table 5).

In all cases 1st post operative day OPG, PA mandible open mouth radiographs showed adequate reduction of the fracture fragments with fixation of the 2.00 mm

Table 3: Distribution of the associated fractures.

Site of fracture	No. of fracture	Percentage
Symphysis	1	10%
Parasymphysis	0	0.0%
body	2	20%
ZMC	0	0.0%
Maxilla	0	0.0%
Total	3	30%

Table 4: Teeth in fracture line.

Teeth in line of fracture	No. of patients
Retained	6
extracted	1
Total	7

rectangular grid compression miniplates and 4 hole monocortical screws. At one month, post operative OPG showed primary sign of bone healing and formation of osseous callous although sign were more prominent in younger age group, yet all fracture showed adequate bone healing. At 3 month post operative OPG showed continuation of bone healing by indicating deposition of lamellar bone parallel to the fracture line, while on the 6 month follow up period showed total radio opacity at the fracture site. There was no sign of resorption, non union, or infection related to the tooth present in fracture line.

Discussion

The treatment of mandibular angle fractures has evolved over a period of time from old methods of bandaging and splinting which are forms of closed reduction to the more recent method of open reduction. General acceptance of open osteosynthesis did not appear in maxillofacial literature until an organized research was done by AO group in 1950. Even in open osteosynthesis technique there has been change in trends from rigid fixation in 1968 to semirigid in 1973. The importance of treating a mandibular fracture in the best possible way cannot be overstressed. The strategic position of the mandible on the facial skeleton and its unique role compels the clinician to give immediate attention.¹⁰

Several methods of open reduction and internal

Table 5: Complications

Complications	Fracture involved
Infection	0
Dehiscence	0
Malocclusion	0
Delayed union	0
Anesthesia/Paresthesia	1
Screw loosening/ Plate fracture	0
Total	1

fixation have been studied with great variation in rates of complications.¹¹ According to the AO/ASIF philosophy for the treatment of fracture of the mandibular fracture are the need for extra oral approaches when larger plate being used, more periosteal stripping; and greater difficulty in plate adaptation and chances of compression necrosis of underlying bone. The Champy's philosophy, showing that some of these plates have simplified the surgery and decreases morbidity failed to overcome the predictability of rigid fixation with a compression and reconstruction plates, especially in fracture that cannot adequately reduced.⁷

These inconvenience lead to the development of three dimensional plates, whose stability, unlike traditional plates, not depend on the thickness of the plates but depend on its format. Farmand M developed the concept of three dimensional miniplates. Their shape is based on the principle of the quadrangle as geometrically stable configuration for support. Since the stability achieved by the geometric shape of these plates surpasses the slendered miniplates, the thickness can be reduces to 1 mm.¹²

The use of 3-Dimensional plates with monocortical screw for the treatment of mandibular angle fracture is not yet widespread.⁸ The clinical studies with three dimensional plates reported low complication rates and concluded that the 3-Dimensional plates used are the alternatives to conventional manipulates for the treatment of mandibular fracture.^{8,11,13,14} The advantages of the 3-Dimensional rectangular grid compression miniplates was easy manipulation, snug adaptation over the bone, without distortion or displacement of the fracture as well as simultaneous

stabilization of the tension and compression zones and compression of fracture fragments.

In this study, 2.00 mm 3-Dimensional rectangular grid compression manipulates were used to treat displaced mandibular fracture in 10 patients through submandibular incision with 9 (90%) males and 1 (10%) female. The outcome of the treatment compared in terms of pre and post surgical occlusal relationship, adequacy of reduction on post operative radiograph, immediate post operative stability and any post surgical complications requiring a secondary surgery intervention. The highest number of mandibular trauma due to road traffic accident was observed in the age group of 21-30 years (50%). This is supported by study of Allan and Daly¹⁵ and Mohammad Hosein.¹⁶

In this study, the grid compression miniplates having three dimensional designs showed no movement at the superior and inferior borders with manual torsional and bending forces, as opposed to when a single linear plate was applied to the superior border area. When only 1 linear plate applied to the superior border, torsional and bending forces cause movement along the long axis of the plate with buccal lingual splaying and gap formation at the inferior border. Screws was placed in box configuration on both sides of the fracture lines than on a single line, broad platforms was created that may increase the resistance to tensional forces along the long axis of the plate.¹⁷ Our results are supported by the studies by Kroon et al and Choi et al which showed that the placement at the superior border was not stable enough for the treatment of mandibular fracture.

Ellis in numerous publications about the open reduction of mandibular fracture found a trend towards increasing the complications rates with increasing rigidity of fixations.¹⁸ This appear counterintuitive to the concept of "more plates and screw = greater rigidity and stability. In this study small plate size require less periosteal stripping and reduced treatment time there by reducing blood supply disruption. This was one of the reasons for fewer complications in our study.

Inadequate screw seating resulted in decline in fracture stability. Screw stability is an importance as the plate configuration for minimizing motions across the fracture site. Clinically, over drilled holes may

represent incorrect drill sizing or selection, or shifting or angulations of drill bit during the procedure. In our study fracture were approach via extra oral Submandibular incision, this may represent a critical Perioperative factors for adequate reduction of fracture with optimum screw purchase.¹⁹

For the assessment of bone healing x-ray OPG taken at interval of 1 month, 3 month and 6 month. According to Wei Huang et al defining the exact time when bony union changes visible on a radiograph is difficult to predict because multiple factors influence one healing.²⁰ In this study normal bone healing was observed in all cases. On 1st month x-ray there is a direct apposition of the cortical bone in the region of viable bone. 3rd month follow up x-ray OPG shows continuation of the bone depositions parallel to fracture line and perpendicular to the long axis of the bone. The 6th month follow-up x-ray shows complete remodeling of bony trabeculae. The direction of bony trabeculae changes to 90 degree and become parallel to long axis of the bone leading to complete radio opacity of the fracture site. There were no sign of resorption at fracture margins, necrosis or nonunion. The low incidence of major complications in this study corroborates with one of the most important principles of the AO/ASIF group, which is susceptibility to the infection is related to ability of bone fragments. Lack of adequate stabilization lead to chronic inflammations, which impair the normal healing process and can result in delayed union, non union, or infection.²⁰

Infection is the most common complications in mandibular fracture. The improvement of plate stability is the way to minimize this problem.²¹ The reported incidence of infection ranges from 3% to 32% when open reduction and internal fixation was used. Infection rates in clinical studies of 3-Dimensional plates were 5.4% (2 out of 37) and 9% (2 out of 22) respectively in studies of Guimond et al and Feledy et al. Hence number of patient treated in our study was very small, the infection rate of 0% is extremely encouraging. However-- the asepsis protocol followed intra operative procedure as well as post operative wound care also a significant factor for such results.

In this study one patient with severely displaced mandibular angle fracture had sensory alteration in preoperative area, which was gradually recovered.

This is consistence with findings in the literature showing that the main cause of sensitive alteration in mandibular fracture is the degree of displacement of the fracture fragments.^{2,8,12}

In this study there was no fracture of any plates, which is coincide with the study of Eduardo et al and Zix et al⁸, showing that the 3-Dimensional plates, despite having only 4 hole and being 1.0 mm thick, had adequate strength. Wittenberg et al performed a biomechanical study with a plate similar to that used in the study of Zix et al and found that deformation of the plate with 230 N, enough to support the masticatory forces after fracture of the mandibular angle during the bone repair process, which lies between 25 and 66 N. This suggest that although the bar are the point of strain, the plate were stable for the treatment of mandibular fracture.²²

Tooth in fracture line was presented in 7 cases among the 10 patients. Tooth were retained in 6 cases (85.7%) cases and extracted in 1 (14.3%) cases. Tooth was extracted because it was vertically fractured. In this study we did not encounter any complications related to the tooth in fracture line. According to Ed Ellis III (2002) the risk of infection and need for hardware increase when there is a tooth present in the fracture line, but the increase in risk is not statistically significant.²³ This is also influence with type of treatment, oral hygiene, surgical technique used and personal; habits of the patients.

The 2 mm, 3-Dimensional rectangular grid plate used in the study was stable for the treatment of mandibular angle fractures with low complications rates, easy handling and adjustment and low cost. These not only provide 3-dimensional stability but also carry low morbidity and infection rates. These were no incidence of a surgically created sensory deficit with this plate because monocortical screws were used.

The small sample size could be considered as the limitation of the study. It is recommended to have multicentre study with large number of patients and correlations among these studies to authenticate our clam.

Conclusion

At the end of study reviewing result from all the aspect and keeping in mind limitation and variables of this

study, it can be concluded that treating mandibular angle fracture with a 2.00 mm 3-Dimensional rectangular grid compression miniplates provide excellent stability at the fracture site which is turn lead to uneventful bone healing and early functional rehabilitations.

Although this study is promising but small sample size is limitation of this study. A more comprehensive conclusion can only be drawn after long term follow up and large number of cases.

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