ORIGINAL RESEARCH

Use of a 2.0 mm Three-dimensional Rectangular Grid Compression Miniplate in Treatment of Mandibular Angle Fracture: A Prospective Clinical Study

[1]Babu Parmar, [2]Mohit Agrawal, [3]Dixit Thakkar, [4]Ankita Midha, [5]Reedham Mehta

ABSTRACT

Background: The aim of this study was to determine the efficacy and stability of rectangular grid compression miniplate in displaced mandibular angle fracture.

Materials and methods: This prospective study was carried out in 10 patients using 2.0 mm three-dimensional (3D) rectangular grid compression miniplates and 8 mm multidirectional screws as a rigid internal fixation in 10 patients without postoperative intermaxillary fixation (IMF). Clinical evaluations were postoperatively performed at 15 and 30 days and 3 and 6 months, and the complications encountered were recorded and treated.

Results: All fractures were healed with an absolute stability in postoperative period. None of the patient complained of postoperative problem in occlusion.

Conclusion: Rectangular grid compression miniplate is rigid, reliable with low complication rates, easy handling, and easy adjustment, with a low cost and thus can be recommended for the treatment of mandibular angle fractures with sufficient interfragmentary contact.

Keywords: Three-dimensional miniplates, Mandibular angle fracture, Rectangular grid compression miniplate.

How to cite this article: Parmar B, Agrawal M, Thakkar D, Midha A, Mehta R. Use of a 2.0 mm Three-dimensional Rectangular Grid Compression Miniplate in Treatment of Mandibular Angle Fracture: A Prospective Clinical Study. J Orofac Res 2014;4(3):152-156.

Source of support: Nil

Conflict of interest: None

INTRODUCTION

The mandible is the largest and strongest facial bone; it is very commonly fractured, generally occurring 2 to 3 times as often as mid face fracture.[1] Mandible angle fractures generate the highest frequency of complications relative to other mandibular fracture, ranging from 0 to 32%.[2,3] Several methods of internal fixations have been studied with great variations in rate of complications.[3]

The original AO technique involved placement of superior and inferior border compression plate for angle fracture,[4,5] latter modifications used a non-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 use of variety of small plates with monocortical screws by intra/extraoral 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 Luhr technique. Champy later performed a series of experiments with miniplates that delineated 'ideal line of osteosynthesis' with in the mandible.[6,7] The short coming of rigid and semi rigid fixation lead to the development of three-dimensional (3D) 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 possess 3D stability.[8]

The grid plate as oppose to the conventional 3D plates is smaller and has only two vertical bars and four eccentric nonlocking 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 3D miniplates, the study was conducted in the

[1]Professor and Head, [2]Senior Lecturer
[3-5]Postgraduate Student

[1,3-5]Department of Oral and Maxillofacial Surgery, Government Dental College and Hospital, Ahmedabad, Gujarat, India

[2]Department of Oral and Maxillofacial Surgery, KD Dental College and Hospital, Mathura, Uttar Pradesh, India

Corresponding Author: Babu Parmar, Professor and Head Department of Oral and Maxillofacial Surgery, Government Dental College and Hospital, Ahmedabad, Gujarat, India Phone: 09426008749, e-mail: drbabusparmar@gmail.com

department of oral and maxillofacial surgery to evaluate the efficacy and stability of the 2.0 mm 3D rectangular grid compression miniplates with eccentric nonlocking monocortical screws for open reduction and internal fixation for noncomminuted and displaced 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 and 60 years was conducted having mandibular angle fracture at the oral and maxillofacial surgery department 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, pericoronal/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 mm rectangular grid compression miniplates and 8 mm multidirectional screws (Fig. 1). Preoperative occlusion was checked (Fig. 2). Radiographic examination was performed using either panoramic radiographs or computed tomography scan (Fig. 3). All patients were operated under general anesthesia by appropriate approach to the fracture site. An adequate reduction and approximation of fracture fragments was done. The monocortical perforations were performed, and fixation was done with the monocortical 2.0 mm system screws measuring 8 mm in length and 2 mm, 3D rectangular grid compression miniplates (Fig. 4). 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-month periods (Fig. 5). Patients were discharged on 7th postoperative day, liquid feeding was recommended for 7 days, and the diet was gradually being released.

During every follow-up occlusion, healing, paresthesia, oral hygiene, mouth opening, segmental mobility as well as other complications were evaluated (Fig. 6). Follow-up of the patients were maintained minimum up to 6 weeks.

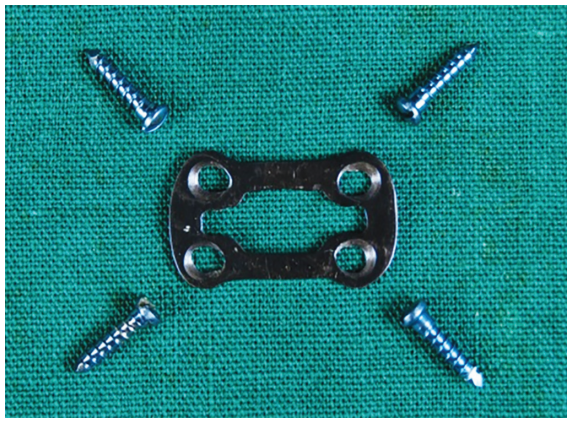

Fig. 1: 2.0 mm 3D rectangular grid compression plate

Fig. 2: Preoperative occlusion

Fig. 3: Preoperative OPG

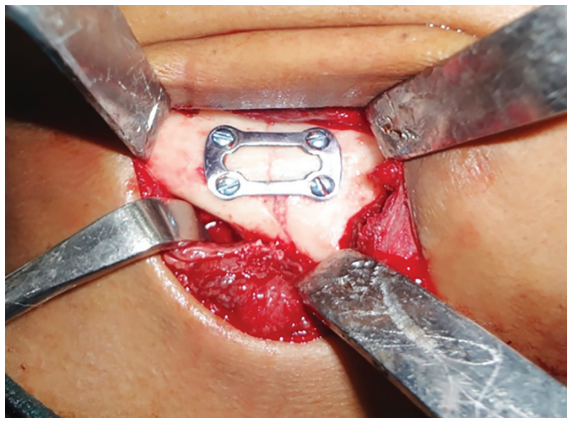

Fig. 4: Fracture fixation with grid compression plate

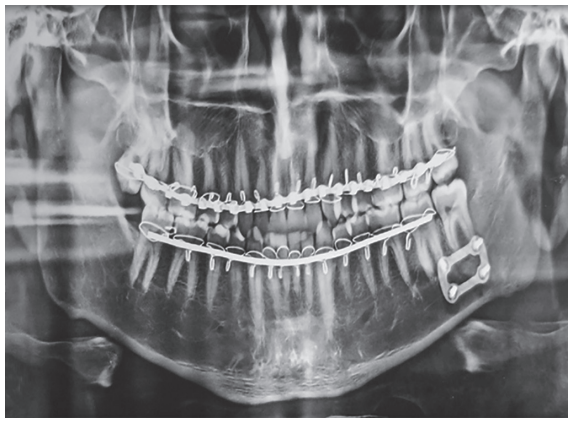

Fig. 5: Postoperative OPG

Fig. 6: Postoperative occlusion

RESULTS

Patients with mandibular angle fractures treated over period of 2 years with a 2.0 mm rectangular grid compression miniplates by appropriate approach with monocortical screws. The fractures at angle of mandible were approached via Risdon incision and those at parasymphysis and body were approached by intraoral or with existing laceration.

The age group of the patients at the time of reporting to the hospital was ranged from 16 to 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 to 30 years (Table 1). It was also noted that in 90% of cases male patients were affected as compare to female having ratio of 9:1. According to many statistic studies, male genders are the more prone in 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. 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. In most of the cases, postoperative healing was uneventful encouraging the efficacy and biocompatibility of the fixation system used. In one 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.

In all cases, 1st postoperative day OPG, PA mandible open mouth radiographs showed adequate reduction of the fracture fragments with fixation of the 2.0 mm rectangular grid compression miniplates and 4 hole monocortical screws. At 1 month, postoperative OPG showed primary sign of bone healing and formation of osseous callus although signs were more prominent in younger age group, yet all fracture showed adequates bone healing. At 3 months, postoperative OPG showed continuation of bone healing by indicating deposition of lamellar bone parallel to the fracture line, while on the 6 months follow-up period showed total radiopacity at the

Table 1: Age-wise distribution of fractures

Age group (years)	*No. of patients*	*Percentage*	*Sex*	*No. of patients*	*Percentage*
11-20	2	20	Male	9	90
21-30	5	50			
31-40	2	20	Female	1	10
41-50	1	10			
Total	10	100	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			
Interpersonal violence	2	20	Unilateral	7	70
Miscellaneous	3	30	Bilateral	3	30
Total	10	100	Total	10	100

fracture site. There was no sign of resorption, nonunion, or infection related to the tooth present in fracture line.

DISCUSSION

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 fixation have been studied with great variation in rates of complications.[11] Farmand developed the concept of 3D 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 slandered miniplates, the thickness can be reduces to 1 mm.[12]

The use of 3D plates with monocortical screw for the treatment of mandibular angle fracture is not yet widespread.[8] The clinical studies with 3D plates reported low complication rates and concluded that the 3D plates used are the alternatives to conventional manipulates for the treatment of mandibular fracture.[8,11,13,14] The advantages of the 3D rectangular grid compression miniplates was easy manipulation, snugging 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, the outcome of the treatment compared in terms of pre- and postsurgical occlusal relationship, adequacy of reduction on postoperative radiograph, immediate postoperative stability and any postsurgical 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 to 30 years (50%). This is supported by study of Allan and Daly[15] and Hosein.[16]

Screws were 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 tread toward increasing the complications rates with increasing rigidity of fixations.[6] In this study, small plate size requires less periosteal stripping and reduced treatment time thereby reducing blood supply disruption. This was one of the reasons for fewer complications in our study. In our study, fractures were approached via extraoral submandibular incision, this may represent a critical perioperative factors for adequate reduction of fracture with optimum screw purchase.[18,19]

Lack of adequate stabilization leads to chronic inflammation which impair the normal healing process and can result in delayed union, nonunion 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. Hence, number of patient treated in our study was very small; the infection rate of 0% is extremely encouraging. However, the asepsis protocol followed ion intraoperative procedure as well as postoperative 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 al,[8] showing that the 3D 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 is 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 suggests that although the bars are the point of strain, the plate was stable for the treatment of mandibular fracture.[22]

In this study, we did not encounter any complications related to the tooth in fracture line. According to 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] The 2.0 mm 3D 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 3D 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 multicenter study with large number of patients and correlations among these studies to authenticate our clam.

CONCLUSION

The 2.0 mm rectangular grid compression miniplate employs the benefits of an excellent combination of a reliable osteosynthesis protocol, a stable fixation technique, a low profile plate and an ideal implant biomaterial. Moreover, the 2.0 mm grid plate placed at the neutral zone of the mandible angle seems capable of neutralizing compression and tensile forces, thus, making unnecessary the use of a second plate in case of mandibular angle fracture. It provides 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.

REFERENCES

1. Haug RH, Prather J, Indresano AT. An epidemiological survey of facial fractures and concomitant injuries. J Oral Maxillofac Surg 1990;48(9):926-932.
2. Lizuka T, Lindqvist C. Rigid internal fixation of fractures in the angular region of the mandible: An analysis of factors contributing to different complications. Plat Reconstr Surg 1993;91(2):265-271.
3. Ellis E. Treatment method of fractures of the mandibular angle. Int J Oral Maxillofac Surg 1999;28(4):243-252.
4. Schierle HP, Schmelzeisen R, Rahn B. One or two plate fixation of mandibular angle fractures? J Craniomaxillofac Surg 1997;25(3):162-168.
5. Potter J, Ellis E. Treatment of mandibular angle fractures with malleable non compression miniplates. Oral Maxillofac Surg 1999;57(3):288-292.
6. Ellis E, Karas N. Treatment of mandibular angle fracture using two dynamic compression miniplates. J Oral Maxillofac Surg 1994;52(10):1032-1036.
7. Champy M, Lodde JP. Mandibular synthesis. Placement of synthesis as a function of mandibular stress. Rev Stomatol Chir Maxillofac 1976;77(8):971-976.
8. Zix J, Olivier L, Tateyuki L. Use of straight and curved 3 Dimensional titanium miniplates for the fracture fixations at the mandibular angle. Oral Maxillofac Surg 2007;65(9): 1758-1763.
9. Hochuli-Vieira E, Ha TK, Pereira-Filho VA, Landes CA. Use of rectangular grid miniplates for the fracture fixations at the mandibular angle. J Oral Maxillofac Surg 2011;69(5):1436-1441.
10. Gray H. Anatomy of the human body. Philadelphia: Lea & Febiger; 1918;1.
11. Guimond C, Johnson JV, Marchena JM. Fixation of mandibular angle fractures with a 2 mm 3-dimensional curved angle strut plate. Oral Maxillofac Surg 2005;63(2):209-214.
12. Farmand M. Experiences with the 3D miniplates osteosynthesis in mandibular angle fractures. Fortschr Kiefer Gesichtschir 1996;41(3):85-87.
13. Feledy J, Caterson EJ, Steger S. Treatment of mandibular angle fractures with a matrix miniplates: a preliminary report. Plast Reconstr Surg 2004;114(7):1711-1716.
14. Bui P, Demian N, Beetar P. Infection rate in mandibular angle fracture treated with a 2.00 mm, 8 hole curved strut plate. Oral Maxillofac Surg 2009;67(4):804-808.
15. Allan BP, Daly CG. Fracture of the mandible. A 35 years retrospective study. Int J Oral Maxillofac Surg 1990;19(5): 268-271.
16. Hosein M. An assessment of maxillofacial fracture: A 5 years study of 237 patients. J Oral Maxillofac Surg 2003;61(1):61-64.
17. Choi BH, Kim KN, Kang HS. Clinical and in vitro evaluation of mandibular angle fracture fixation with the two miniplates system. Oral Surg Oral Med Oral Path 1995;79(6):692-695.
18. Mehra P, Murad H. Internal fixation of mandibular angle fractures: comparisons of 2 technique's. Oral Maxillofac Surg 2008;66(11):2254-2260.
19. Passeri LA, Ellis E, Sinn DP. Complications of nonrigid fixations of mandibular fractures. J Oral Maxillofac Surg 1993;51(4):382-384.
20. Hung W, Li Z. Does traumatic brain injuries result in accelerated mandibular fracture healing? J Oral Maxillofac Surg 2012;70(9):2135-2142.
21. Lamphier J, Ziccardi V, Ruvo A. Complications of mandibular fractures in an Urban teaching center. Oral Maxillofac Surg 2003;61(7):749-750.
22. Tate G, Knommen M. A novel bite force recorder and maximal isometric bite force values for healthy young adult. Scand J Dent Res 1993;101(3):171-175.
23. Ellis E 3rd. Outcome of the patients with teeth in the line of mandibular angle fractures treated with stable internal fixations. Oral Maxillofac Surg 2002;60(8):863-865.