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Original Article

Comparison of Fixation of Mandibular Angle Fractures Using Single Miniplate versus Curved Angle Rectangular Strut Plate - A Prospective Randomized Clinical Study

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Abstract

Aim: To compare and evaluate the treatment outcome and post-operative complications in mandibular angle fractures using single miniplate versus curved angle strut plates.

Materials and Methods: This study consisted of a sample of 20 patients divided randomly but equally (single-blind control trial study) into two groups. Each group contains 10 patients. Group I was treated with open reduction and internal fixation using curved angle rectangular strut plate. Group II was treated using single 2-mm miniplates.

Results: The results of this study suggested that there is no statistically significant difference in terms of infection, occlusal discrepancy, and union. The mean duration of rectangular plating in our study was 83.9 ± standard deviation (SD) 27.299 min while as in single miniplate, it was 47.6 ± SD 6.552 min with $P < 0.001$ which is statistically highly significant. It proves that single miniplate can be accomplished quicker than rectangular plating. Swelling increased after the 2nd day of procedure and then after decreased up to the 7th day of the procedure in each group with statistically insignificant difference in both the groups. Visual analog score increased after the 2nd day of the procedure and then after decreased up to 7th day of the procedure in each group with statistically insignificant difference in both the groups. Occlusion at 1st week, 6 weeks, 3rd month, and at 6 months were compared and it is found statistically insignificant with P value of 1. Paresthesia at 1st week, 6 weeks, 3rd month, and at 6 months were compared, and it is found statistically insignificant with P value of 1. Post-operative infection at 1st week, 6 weeks, 3rd month and at 6 months were compared, and it is found statistically insignificant with $P = 1$. In both the groups, none of the patient developed wound dehiscence. Radiographic evaluations for reductions and fixation were confirmed at 1st week which was satisfactory in all patients in both the groups. Radiographic evaluation for union or non-union was confirmed at 20th week after the procedure in both the groups, and it was found that there is the statistically insignificant difference. In both the groups all patients return to their normal activity such as speech, mastication, and social interaction in 10-14 days with no statistical difference.

Conclusion: Till now no philosophy of treatment of mandibular fractures has proved superior over Champys except in cases of comminution defect or atrophic mandible.

Key words: Conventional 2.0-mm miniplates, Mandible angle fracture, Rectangular strut miniplates

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INTRODUCTION

Despite many advances in internal fixation, angle fracture remains among the most difficult and unpredictable fracture to treat compared to those of other areas of the mandible. Large number of studies on mandibular angle fracture treatment attests to the fact that no single

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approach has been shown to be ideal, and that treatment of mandibular angle fractures remains conceptually controversial, with a bothersome complication rate. During the last decade, significant attention has been paid on a variety of plate fixations for mandibular angle fractures.[1-12] Fixation using miniplates has been shown to simplify surgery and reduce surgical morbidity but failed to surpass the predictability of rigid fixation.[13-24] Although there have been number of studies on linear and curvilinear plates for mandibular fixation, only a few reports on the use of low profile three-dimensional (3-D) strut or mesh plates are reported in literature.[1-6] In fact, majority of studies on rectangular strut plates were *in vitro* biomechanical studies. The geometry of rectangular strut conceptually allows for an increased number of screws, stability in 3-D, and resistance against torque forces while maintaining a low profile and malleability.[25-34]

The 2.0 mm titanium 3-D curved angle strut plate allows for almost no movement at the superior and inferior borders with manual torsional and bending forces, as opposed to when a single linear plate is applied to the superior border area.[35-57] When only one linear plate is placed on the superior border, torsional and bending forces usually cause movement along the axis of the plate with buccal-lingual splaying and gap formation at the inferior border, respectively. Because the screws are placed in box configuration of 2.0 mm titanium 3-D curved angle strut plate on both sides of fracture rather than on a single line, broad plate forms are created that may increase the resistance to torsional forces along the axis of the plate.[58-72]

Because the design of 2.0 mm titanium 3-D curved angle strut plate is essentially that of 2.0 mm plates connected by reinforcing vertical struts, they may, therefore, provide greater resistance against gap opening at the inferior border with biting forces compared with when a single plate is applied at the external oblique ridge or superolateral border. The use of 3-D plates in mandibular fractures has not yet become established. Only few follow-up studies are presented in literature with few studies emphasizing easy application, simplified adaptation to bone without distortion or displacement of fracture,[6] simultaneous adaptation at both superior and inferior borders hence less operating time.[58]

Aims and Objectives of the Study

The patients were evaluated and compared for:

1. Stability of fractured segments clinically and radiographically.
2. Post-operative occlusion.
3. Post-operative complication such as infection, wound dehiscence, neurosensory deficits (paresthesia of the area involved), non-union, malunion, and delayed union.

MATERIALS AND METHODS

Source of Data

Twenty patients with mandibular angle fracture reporting to the Department of Oral and Maxillofacial Surgery were selected for this study and were divided into two groups.

- Group 1: 2 mm titanium 3-D curved angle strut plate.
- Group 2: 2 mm titanium 4 hole miniplates.

Methods

Twenty patients aged more than 18 years were randomly selected for open reduction and internal fixation. Fixation was done using 2 mm titanium rectangular curved angle strut plate and 2×6 mm titanium screws in 10 patients in Group A and single miniplate on the superior border in 10 patients in Group B patients (Figures 1-14).

Inclusion Criteria

1. Adult patients.
2. Single or multiple fractures of mandible requiring open reduction with internal fixation for treatment with angle fracture.
3. Subject willingness.

Exclusion Criteria

Following patients were excluded.

Patients with systemic disease are contraindicating general anesthesia.

Patients with a history of uncontrolled diabetes mellitus, prolonged steroid therapy, compromised immunity and associated bone pathology Patients with fracture comminution.

EVALUATION

Pre-operative and post-operative evaluations were done by clinical and radiographic means. It includes:

- Orthopantomogram.
- PA view.

All patients will be followed for a minimum of 6 months postoperatively.

Clinical assessment will be done on the 7th day, 3 weeks, 12 weeks, 3 months, and 6 months postoperatively.

RESULTS

In our study, in 3-D plating group of patients most common cause was renal tubular acidosis, 8 out of 10 (80%) and two-dimensional (2-D) plating group the most common

Figure 1: Incision

Figure 2: Fracture

Figure 3: fixation by 3 D strtu plate

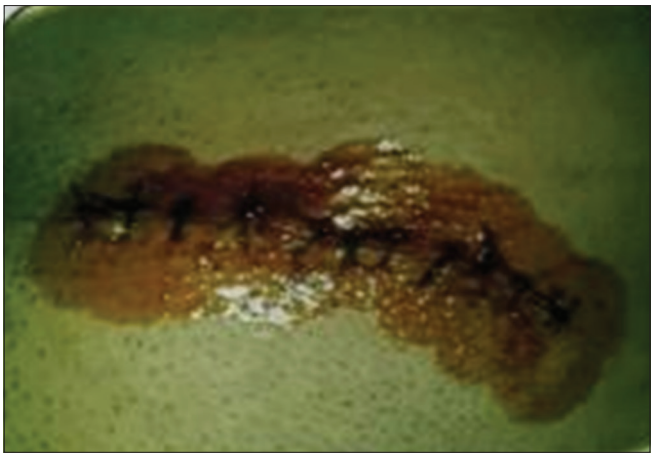

Figure 4: Closure

Figure 5: Post-operative occlusion

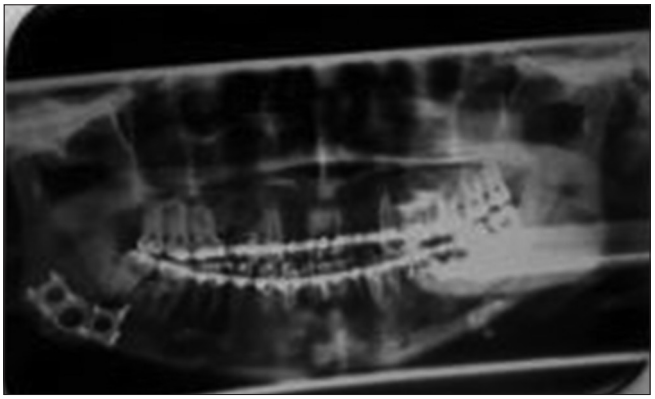

Figure 6: Post-operative orthopantomogram

cause was same 9 out of 10 (90%) (Figure 17). In both the groups of patients the most common fracture site was angle, 80% in each group (Figure 18). The mean duration of 3-D plating in our study was 83.9 ± SD 27.299 min while as in 2-D plating 47.6 ± SD 6.552 min with $P < 0.001$ which is statistically highly significant. It proves that 2-D plating can be accomplished quicker than 3-D plating (Figure 19). Swelling increased after the 2nd day of the procedure and then after decreased up to the 7th day of the procedure in each group with the statistically insignificant difference in both the groups (Figure 20). Visual analog score increased after the 2nd day of the procedure and then after decreased up to the 7th day of the procedure in each group with the statistically insignificant difference in both the groups (Figure 21).

Figure 7: Pre-operative

Figure 8: Pre-operative occlusion

Figure 9: Pre-operative orthopantomogram

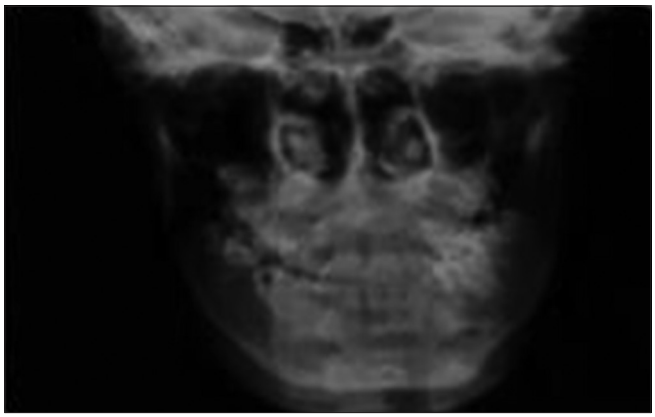

Figure 10: Pre-operative PA

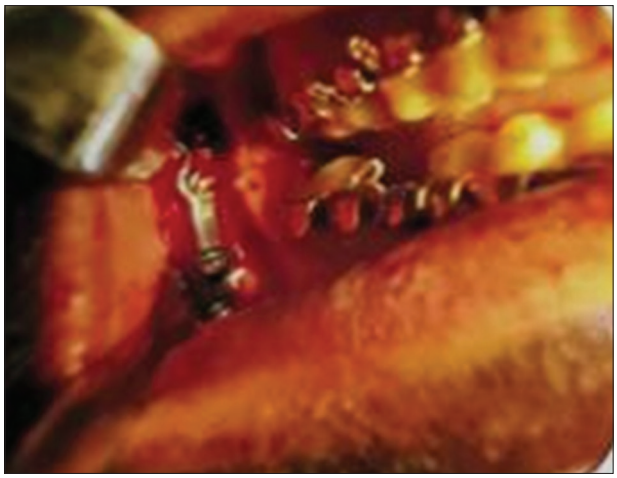

Figure 11: Fixation by single plate

Figure 12: Post-operative occlusion

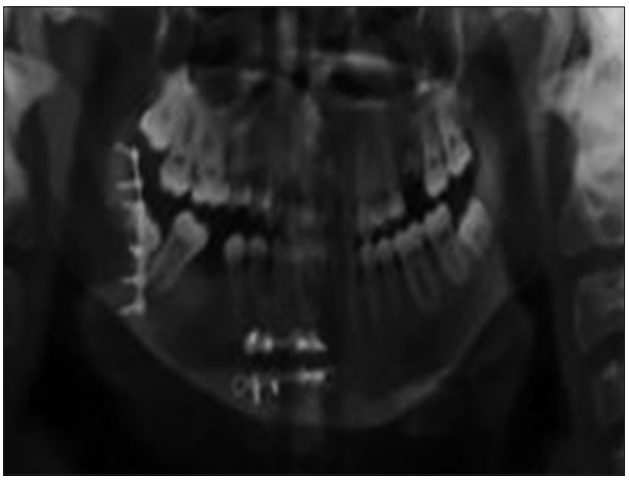

Figure 13: 6 months orthopantomogram

Occlusion at 1st week, 6 weeks, 3rd month, and at 6 months were compared in 3-D plating and 2-D plating groups, and it is found statistically insignificant with $P = 1$ (Figure 22). Paresthesia at 1st week, 6 weeks, 3rd month, and at 6 months were compared in 3-D plating and 2-D

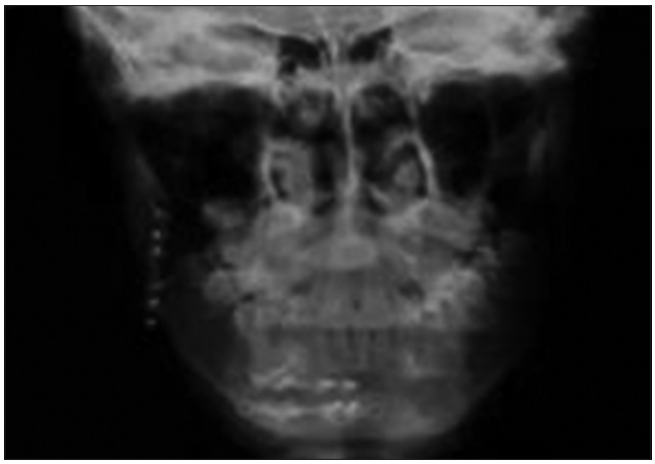

Figure 14: 6 months PA

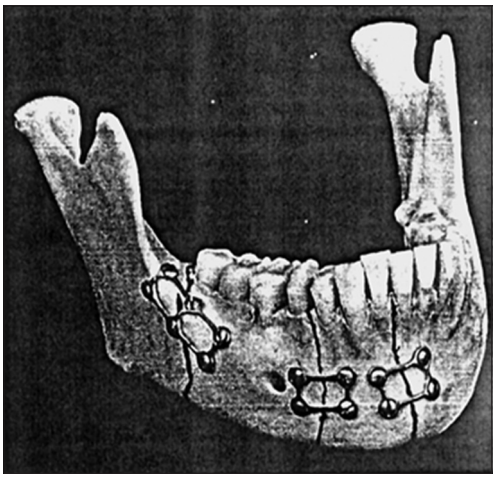

Figure 15: 3 D plate over angle region

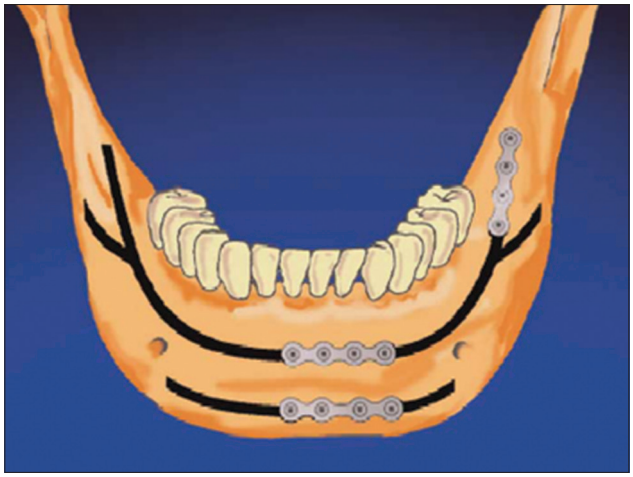

Figure 16: 2 D plate over external oblique ridge

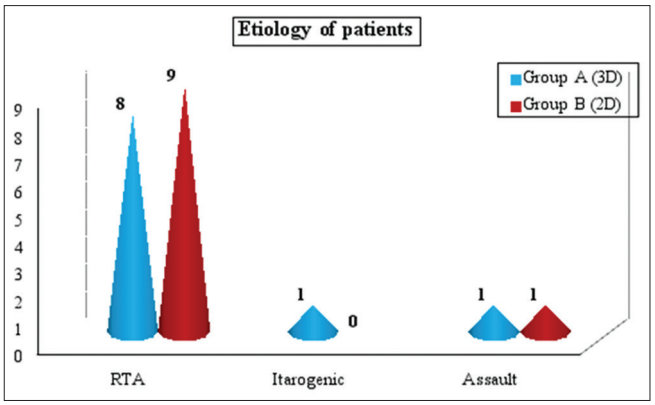

Figure 17: 2 D plate over external oblique ridge

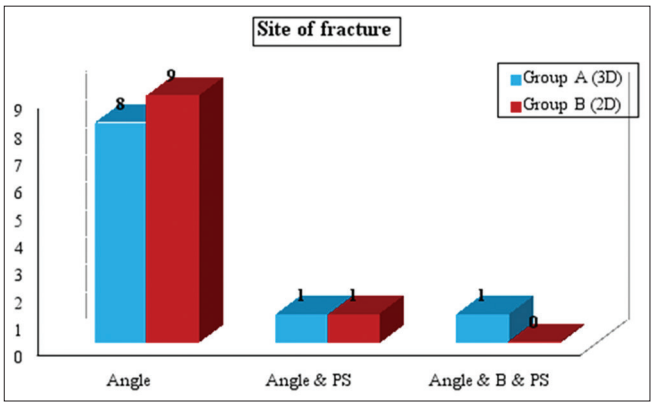

Figure: 18: Site of fracture

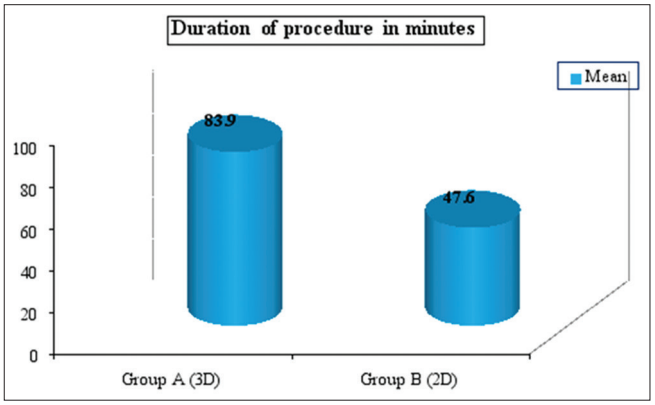

Figure 19: duration of procedure in minutes

plating groups, and it is found statistically insignificant with $P = 1$. Post-operative infection (Figures 23 and 24) at 1st week, 6 weeks, 3rd month, and at 6 months were compared in 3-D plating and 2-D plating groups, and it is found statistically insignificant with $P = 1$. In both the groups, none of the patient developed wound dehiscence (Figures 25-27).

Radiographic evaluations for reductions and fixation were confirmed at 1st week which was satisfactory in all patients in both the groups. Radiographic evaluation for osteogenic changes was confirmed at 9th week after the procedure in both the groups, and it was found that there is the statistically insignificant difference. Radiographic evaluation for union or non-union was confirmed at 20th week after

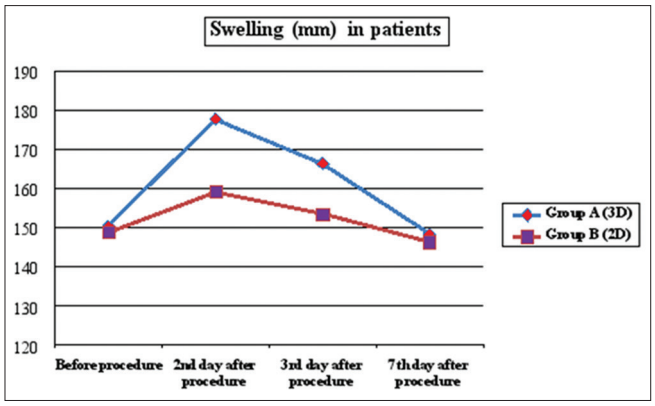

Figure 20: Swelling in patients

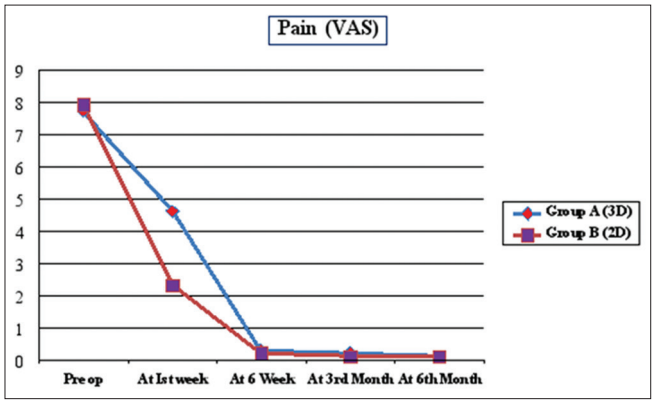

Figure: 21: Pain

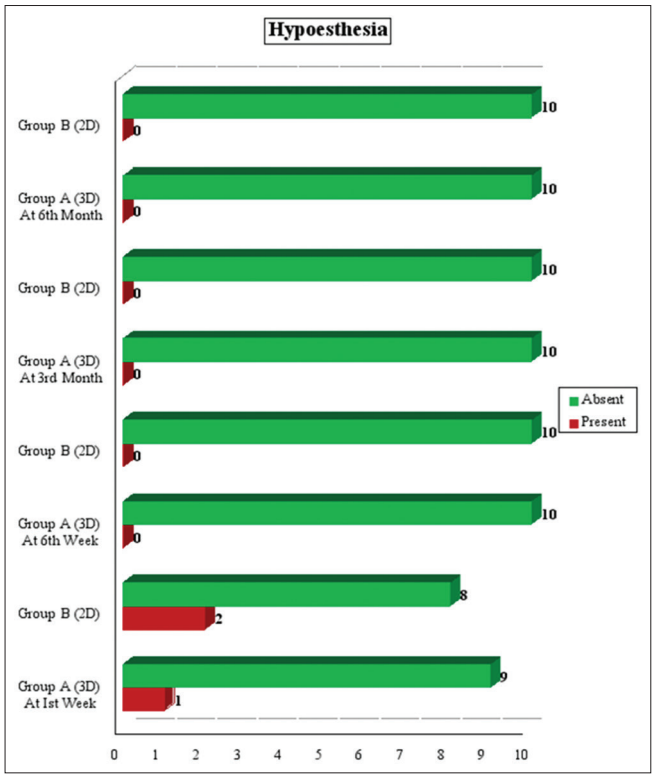

Figure 22: Hypoesthesia

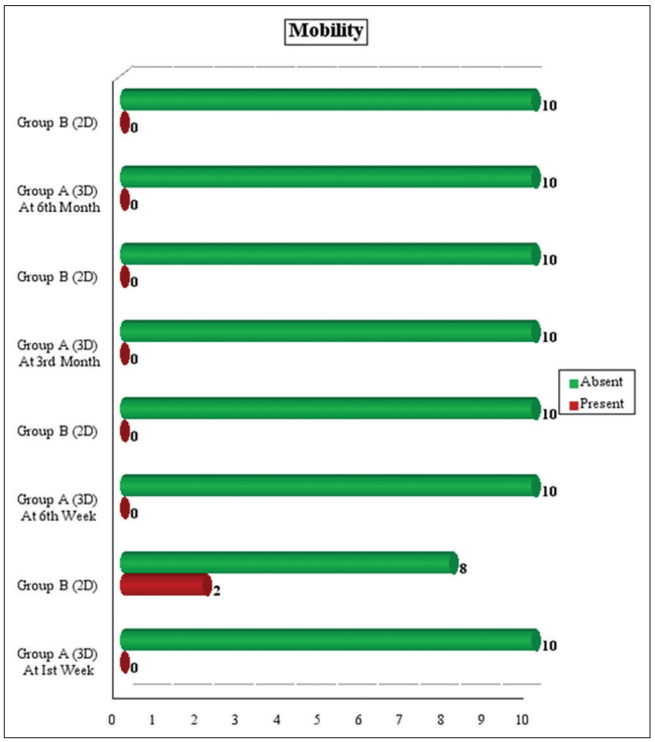

Figure 23: Mobility

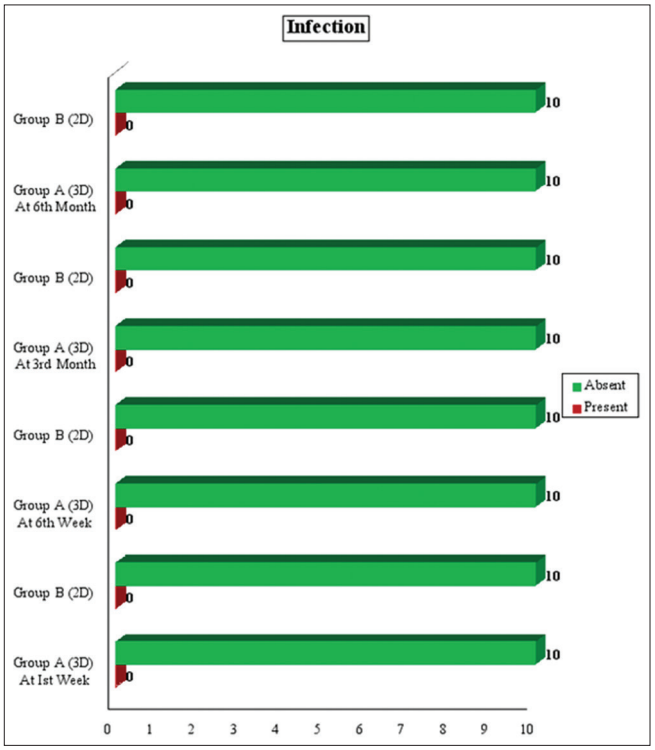

Figure 24: Infection

the procedure in both the groups, and it was found that there is statistically insignificant difference (Figure 28).

In both the groups all patients return to their normal activity such as speech, mastication, social interaction

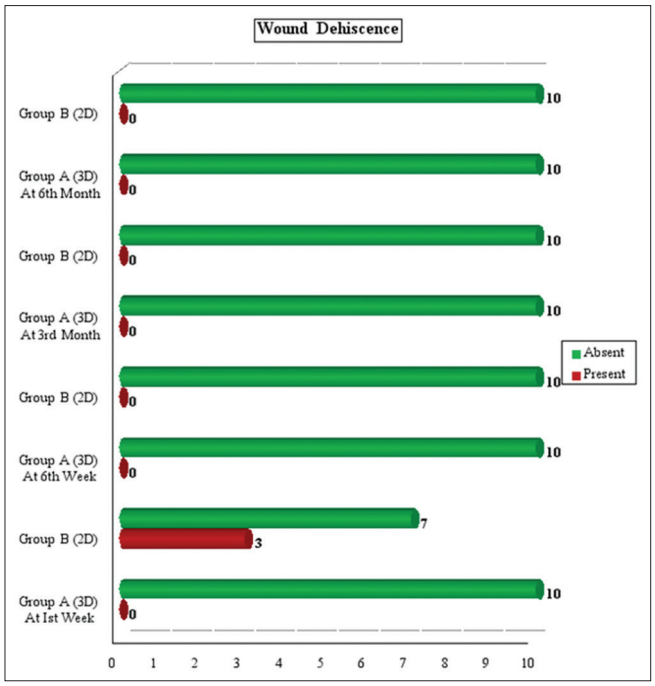

Figure 25: Wound dehiscence

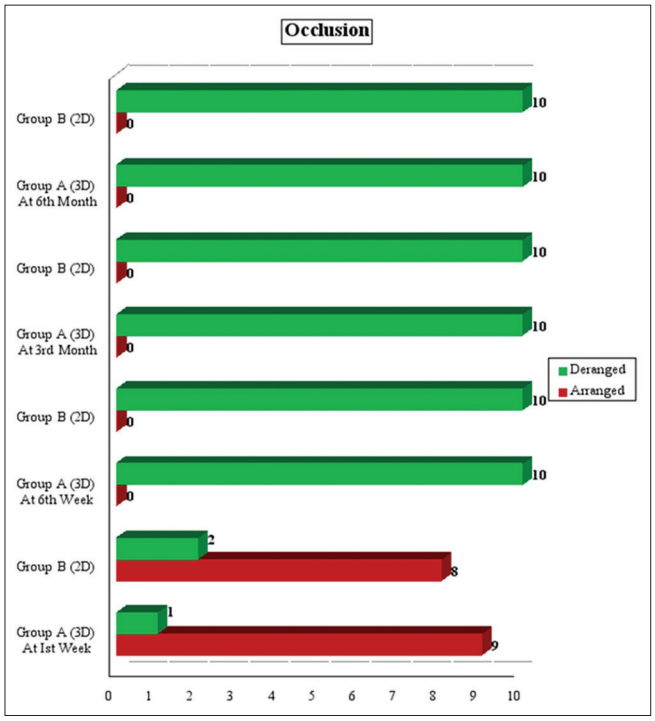

Figure 26: Occlusion

in 10-14 days with no statistical difference. There is no major difference in terms of treatment outcome in both systems, and both are equally effective in mandibular angle fracture treatment. However, in the symphysis/para symphysis region, 3-D miniplate fixation is an easy-to-use alternative to conventional miniplates in terms of less surgical time and simultaneous stabilization at both the

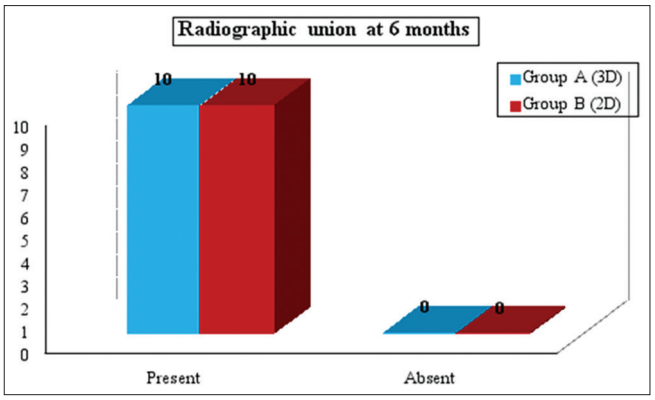

Figure 27: Radiographic union at 6 months

superior and inferior border by one plate; in the angle region, a single conventional miniplate fixed according to Champy's technique is easy to place intraorally with less surgical time and less surgical trauma and has similar clinical results. Due to the superior design of 3-D maximum number of screws lie near the fracture site thus providing better stability and thus open up doors for its satisfactory use in the management of displaced fractures. Although this study is promising, small sample size is limitation of this study. A more comprehensive conclusion can only be drawn when a larger sample size is taken.

DISCUSSION

Restoration of function and appearance with particular care to re-establish the occlusion is the basic aim of the treatment of mandibular fractures. For a long period of time, intermaxillary fixation was the only method of treatment. With the introduction of modern anesthesia, antibiotics and blood transfusion, open reduction with fixation of fragments have become routine in the treatment of fractures with gross displacement, comminution and the edentulous mandible. Through decades various plate and screw osteosynthesis have been introduced such as AO plating system, miniplating system, resorbable plates, and screws and 3-D titanium plates.

3-D titanium plates have been used sporadically by few surgeons for fixation of the mandibular angle fractures.[6,12] Its use in the maxilla has remained skeptical, with Farmand[6] being the only surgeon to have used them for the maxillary fracture osteosynthesis.

The principle of 3-D plate osteosynthesis is:

1. Tissue dissection only in vicinity of planned osteotomy or fracture line.
2. The 3-D plates are positioned parallel to the osteotomy or fracture line.

3. The connecting arms of the plate should be positioned rectangular to the osteotomy or fracture line (Ananad Sanker, Thangavelu 2004).

The use of 3-D plates in mandibular fractures has not yet become established. Only few follow-up studies are presented in literature with few studies emphasizing easy application, simplified adaptation to bone without distortion or displacement of fracture,[6] simultaneous adaptation at both superior and inferior borders hence less operating time.[58]

Guimond[53] and Jeurgen[56] found the fixation with 3-D plates predictable, the plate strong yet malleable facilitating stabilization both at superior and inferior borders. They concluded that 3-D titanium plates are easy to use alternative to conventional miniplates but contraindicated its use in fractures with less inter fragmentary bone contact.

Monocortical miniplate osteosynthesis has been used successfully for the management of facial fractures. Michelet *et al*.[20] developed the concept of miniplate osteosynthesis in the late 1960s. In 1973, they published a report documenting the successful use of a small plate and monocortical screws for the treatment of mandibular fractures. The original goal of miniplate osteosynthesis was to provide stable mandibular fracture reduction without requiring interfragmentary compression or maxilla mandibular fixation. Studies performed in the early 1970s at the Groupe d'Etudes en Biomecanique Osseuse et Articulaire de Strasbourg demonstrated that the miniplate achieves this goal by neutralizing undesirable tensile forces while retaining favorable compressive forces during function. Champy *et al*.[22] elaborated on Michelet's work with the intraoral application of the monocortical miniplate for the treatment of mandibular angle fractures.

The reduced size of the miniplate system offers several advantages over the larger mandibular plates. Smaller incisions and less soft tissue dissection are required for their placement. In addition, miniplates can often be placed intraorally, thereby avoiding an external scar. Due to the smaller size and thinner profile of the miniplates, they are less likely to be palpable, possibly reducing the need for subsequent plate removal. The smaller size of the miniplates may decrease the degree of stress shielding seen following rigid fixation; however, this remains to be demonstrated. Finally, because the screws are monocortical, the plates may be placed in areas of the mandible adjacent to tooth roots with minimal risk of dental injury.

The rationale of using monocortical plate in the mandibular fracture is that osteosynthesis by plate screwed on the outer cortical plate is solid enough to support the strain developed by masticatory muscle. On the horizontal ramus, the masticatory forces create elongation strain along the alveolar border and compressive strain along the lower border within the mandible. Only the traction strain is injurious and has to be neutralized. The study of moments with regard to the mathematical model of the mandible[21] showed that at the level of horizontal ramus, there are almost only flexion moments, the value of which increases from the front backward. In the anterior part of the mandible, anterior to 1st premolar, there are mainly moments of torsion. They are higher, the nearer they are to the mandibular symphysis. Therefore, the principle of osteosynthesis is to re-establish, the mechanical qualities of the mandible, taking into account the anatomical conditions.

The clinical effectiveness of 3-D plate needs to be verified or substantiated by biomechanical studies. Wittenberg[9] in his biomechanical experiment found that entire 3-D titanium plate was formed by joining two miniplates with interconnecting vertical cross bars which reinforced each other, thereby the plate acting as a single unit and interconnections of the plate reduced the vertical displacement and shearing of bone to minimal (Figure 15).

The 3-D miniplate is positioned in such a way that the horizontal cross bars are perpendicular to the fracture line and the vertical ones are parallel to it. At the angle, the plate can be bent over the oblique line so that the vertical crossbars are aligned perpendicular to the external oblique ridge. This technique follows the principle of 3-D fixation given by Farmand.[5]

As for as 2-D plates are concerned posterior to mental foramen, one plate is sufficient, while anterior to the mental foramen, one should place two miniplates separated by 4-5 mm to neutralize torsional force. In case of angle, fracture plating is done over the external oblique ridge (Figure 16).

Our study consisted of 20 patients with 10 patients in Group A with 3-D plating and Group B 1 patients with 2-D plating with no underlying medical compromising condition.

Champy *et al*.,[21] Cawood,[24] Smith,[29] and Kuriakose *et al*.[35] used miniplate for patients with mandibular fracture and found uneventful healing. The same finding was reported in our study.

Intermaxillary fixation was done preoperatively only when needed to achieve the optimum habitual occlusion and

post-operative intermaxillary fixation for 1-2 weeks which is in accordance with the many authors.[29,33,56,59,60]

CONCLUSION

There is no major difference in terms of treatment outcome in both systems, and both are equally effective in mandibular angle fracture treatment. However, in the symphysis/parasymphysis region, 3-D miniplate fixation is an easy-to-use alternative to conventional miniplates in terms of less surgical time and simultaneous stabilization at both the superior and inferior border by one plate; in the angle region, a single conventional miniplate fixed according to Champy's technique is easy to place intraorally with less surgical time and less surgical trauma and has similar clinical results. Due to the superior design of 3-D maximum number of screws lie near the fracture site thus providing better stability and thus open up doors for its satisfactory use in the management of displaced fractures.

Although this study is promising, small sample size is a limitation of this study. A more comprehensive conclusion can only be drawn when a larger sample size is taken.

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