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Osteosynthesis of Fractured Mandibular Angle by Titanium 3-Dimensional Miniplate

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Abstract: Background*: Osteosynthesis of fractured fragments at the mandibular angle region proves to be a controversial topic. Many studies have shown that no single approach to fixation is ideal. Champy's plate is vulnerable to torsional and bending forces along the long axis of the mandible leading to flaring of fragments, loss of friction lock and result in reduced primary stability. 3 Dimensional (3D) miniplate consisting of two miniplates joined by interconnecting struts that act as a single unit. The plate is strong enough yet malleable facilitating stabilization both at superior and inferior borders. This study was carried out to evaluate the efficacy of 3D titanium mini plate for fixation of mandibular angle fractures.*

Materials and Methods: *This randomized prospective study consisted of 10 patients who met the inclusion and exclusion criteria. The patients were selected irrespective of the age, sex and socioeconomic status, presenting with mandibular angle fracture with or without associated secondary fractures. 3D titanium miniplate was used for fixation of fracture and patients were followed up for 4 months postoperatively.*

Results: *The mean interval between initial trauma to definitive fixation (IT-DF) was 4.7 days and mean time interval for plate adaptation to definitive fixation (PA-DF) intraoperatively was 26 minutes. No patients sustained any infections or permanent complications postoperatively and functional return to normal was adequate.*

Conclusion: *3D titanium miniplate is an excellent choice for fast as well as reliably stable fixation of mandibular angle fractures.*

Keywords – *3-Dimensional, Angle Fracture, Mandible, Osteosynthesis, Titanium miniplate*

I. INTRODUCTION

The etiology of maxillofacial injuries varies vastly from country to country. Road traffic accidents are scaling new heights with increase in urbanization, high speed automobiles and poor road conditions. Maxillofacial

trauma can result from road traffic accidents (72.0%), accidental fall (16.0%), interpersonal violence (9.3%), sports (0.8%), industrial accidents (1.3%) and animal trauma (0.6%). Various sites of mandibular fracture are symphysis / parasymphysis (49.5%), angle (19.2%), condyle (14.4%), body (9.8%), dentoalveolar region (7.6%), ramus (0.7%) and coronoid.[1,2,3,4,5] Fracture of angle contributes largely because of the presence of 3rd molar, thinner cross-section area than the tooth bearing region and change in the direction of trajectories of bone.[3,6,7] The aim of treatment of mandibular fracture is the restoration of anatomic form and function, along with re-establishment of occlusion and facial esthetics. The management of trauma has evolved greatly over the years from supportive bandages, splints, circummandibular wiring, extra oral pins to rigid and semi rigid fixation. Internal fixation was born out of necessity, due to limitations imposed by closed reduction techniques.[8] "Osteosynthesis" - concept of functionally stable internal fixation of bone fractures, allowing the early recovery of function was developed in orthopaedic practice and adapted for use in the maxillofacial region, where recovery of jaw function is the prime consideration.[7,8,9] Eccentric dynamic compression plate was preferred over centric dynamic compression because there was gaping either at the superior or the inferior border. However, since the work of Michelet et al. (1972) and later Champy et al. (1975), mini plate osteosynthesis has become an important fixation method in maxillofacial and craniofacial surgery.[8,9] Bone plate fixation can produce three-dimensional (3D) stability – rigid promoting primary contact healing and the semi-rigid, primary gap healing. Mobility at the fracture site is one of the main causes of healing disturbances, hence preference should be given to a plate, which is not a compression plate but still gives enough rigidity to fractures.[10,11] Although many studies have shown more stable fixation of mandibular fractures with two miniplates rather than one, the use of one or two miniplates at the mandibular angle is debatable. These considerations led to the development of 3D miniplates. Increased stability is achieved by the geometric shape of the quadrangular plate rather than by its thickness or length.[11,12,13] The requirements of an ideal implant material used for osteosynthesis are biocompatibility and possibility of easy adaptation and stabilization of the osteotomized or fractured segments without dislocation of the fragments and impairment of blood supply. This study was thus carried out to evaluate the efficacy of 3D plate fixation in the management of mandibular angle fractures.

II. MATERIALS AND METHODS

The study consisted of 10 patients (8 male and 2 female) with mean age of 31 years (22-41 years), who reported to the Department of oral and maxillofacial surgery at College of dental science and research centre, with the fracture of angle of mandible between 2013 and 2019. The patients were selected irrespective of age, sex and socio-economic status. All patients underwent open reduction with internal fixation of the fractured segments using 3D titanium miniplates under general anesthesia for the same. Other maxillofacial fractures of the midface, if present, were plated with conventional miniplates systems.

2.1 INCLUSION CRITERIA:

- Age group between 18-60 years.
- Single noncomminuted fracture of the angle of mandible requiring open reduction with internal fixation for treatment (Fig-1(a,b,c)).
- Subject willingness.

2.2 EXCLUSION CRITERIA:

- Patients with systemic disease contraindicating general anesthesia.
- Patients with history of uncontrolled diabetes mellitus, prolonged steroid therapy, compromised immunity and associated bone pathology.
- Patients with fracture communition and mandibular condylar fracture.
- Patients with history of previous mandibular fractures or osteotomies.

A standard proforma was used to collect necessary information regarding each case after inclusion. The patients were informed about the study and necessary consent was obtained from the concerned personnel. All necessary preoperative, intraoperative and postoperative photographic records were maintained for these patients. All patients were given prophylactic antibiotics intravenously half an hour before procedure. Procedures were performed by same surgeon under general anesthesia using nasal endo-tracheal intubation. Following strict aseptic precautions, an appropriate intraoral or extraoral incision based on the site was selected. The fracture site was identified, reduced and after obtaining satisfactory occlusion, temporary maxilla-mandibular fixation was placed using Erich's or custom made arch bar or ivy eyelet loop wiring. At the angle region, a plate was bent over the oblique line so the vertical crossbars were aligned perpendicular to the external oblique ridge. Fixation was done using 3D titanium miniplate. Fixation of 3D plate was done in such a way that a horizontal bar was perpendicular and vertical bar was parallel to the fracture line.

Monocortical and bicortical screws were used. Postoperative intermaxillary fixation was maintained for 5-7 days (Fig-1(d,e)). A water tight wound closure was performed.

Duration of the procedure was noted. Soft diet was recommended for 6 weeks postoperatively. Patients were followed for a period of 4 months at the interval of 1 week (Fig-1(g,h)), 6 weeks, 3 months and 4 months (Fig-1(i)) by blinded senior oral surgeon for wound dehiscence, infection, segmental mobility, postoperative occlusion, significant post-operative complications, postoperative anesthesia / parasthesia and radiological evaluation of reduction, and fixation. All data were collected on proforma and subjected to suitable statistical analysis, and a conclusion was drawn.

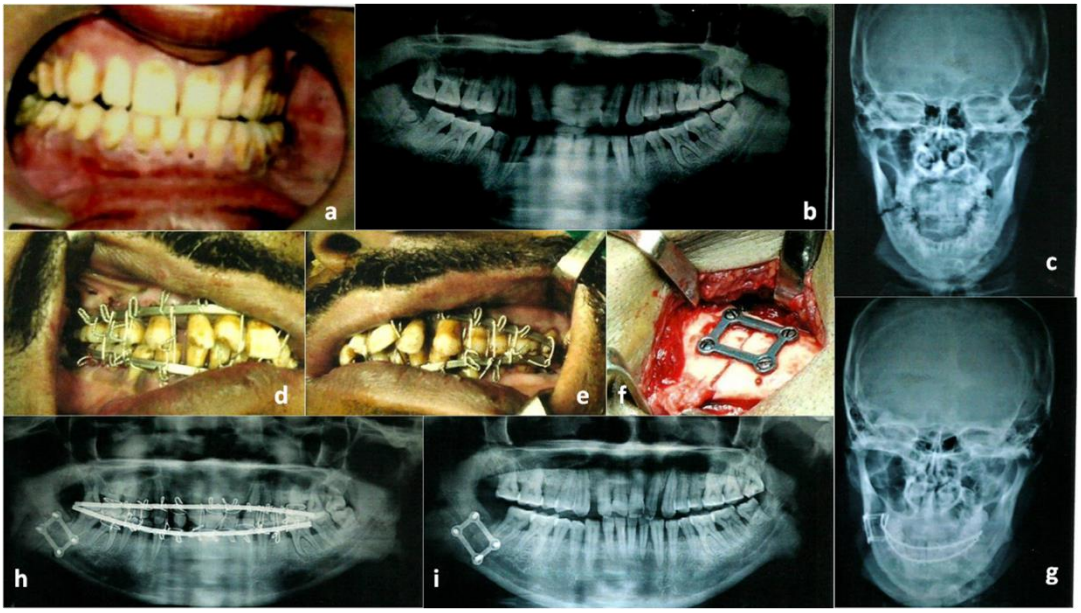

Fig-1 (a) Preoperative occlusion, (b) Preoperative orthopentomogram, (c) Preoperative PA skull, (d) Intermaxillary fixation and postoperative occlusion on right side, (e) Intermaxillary fixation and postoperative occlusion on left side, (f) Fixation of fracture site with titanium 3D plate, (g) 1 week postoperative PA skull, (h) 1 week postoperative orthopentomogram, (i) 4 months postoperative orthopentomogram.

2.3 PREOPERATIVE ASSESSMENT:

1. Associated soft tissue injuries (STI) were evaluated as follows —
- Single abrasion = Minimal STI
- Multiple abrasions +/- single cut lacerated wound = Moderate STI
- Multiple cut lacerated wounds = Severe STI
2. Location and number of fractures in the mandible.
3. Presence or absence of displacement of the fractured segments.

Displacement which was seen at the inferior border, was assessed by routine clinical and radiographic examination.[8]

The displacement present was classified as:
- 0 - 2 mm = Mild displacement
- 2 - 5 mm = Moderate displacement
- More than 5 mm = Severe displacement

4. Preoperative occlusion.
5. Presence of teeth in the fracture line.
6. Any parasthesia or anaesthesia of involved area.
7. Duration between injury and definitive fixation.

2.4 INTRAOPERATIVE ASSESSMENT:

1. Reduction approach (intraoral or extraoral)
2. Implant material used.
3. Length of screw used in fixing the either plate.
4. Hardware complications (difficulty in plate bending / breakage of plates)
5. Time taken for fixation of either bone plates.

2.5 POSTOPERATIVE ASSESSMENT:

1. Need for any supplemental method of fixation.
2. Maximal interincisal opening.
3. Occlusion and chewing (in the 3rd and 4th month postoperatively) according to Treatment Scoring System developed by V. Uglesic in 1993.
4. Complications (Soft tissue infection, trismus, mobile fracture fragments, bone infection) according to Treatment Scoring System developed by V. Uglesic in 1993.
5. Any parasthesia or anesthesia of the involved area.

III.RESULTS

3.1 PREOPERATIVE DATA EVALUATION

The mean age of patients in our study was 31 years (22-41 years) out of which 80% were male and 20% female. The aetiology of injury of the study sample was 70% (n=7) being road traffic accidents, 20% (n=2) being self fall and 10 % (n=1) being industrial injury victims. The mean duration from initial trauma to definitive fixation (IT - DF interval) in the mandibular angle fracture patients was 4.7 days. In the study sample 80% (n=8) of the trauma patients had minimal soft tissue injury, 20% (n=2) were with moderate soft tissue injury; 50% (n=5) of the mandibular fractures were having minimal displacement, 40% (n=4) were with moderate displacement and 10% (n=1) were having severe displacement.

3.2 INTRAOPERATIVE DATA EVALUATION

In all patients, fixation was done using either a 2x2 or a 3x2 hole titanium 3D miniplate of 1mm thickness with holes of 2mm diameter with titanium self tapping screws (Fig-1(f)). 7 patients had right mandibular angle fractures and remaining 3 patients had left side angle fractures. The mean duration of plate adaptation to definitive fixation (PA - DF interval) of the mandibular angle fracture was 26 minutes.

3.3 POSTOPERATIVE DATA EVALUATION

Postoperatively none of the patients developed soft tissue infection. Three patients had trismus (mouth opening less than 35mm) till 3rd month postoperatively, however all achieved adequate mouth opening by the 4th month. The mean score of complication was 0.05. The mean interincisal opening was 35.4mm. Postoperative mean score for occlusion (surgeon's evaluation) at 3rd and 4th month were 5.0 and 4.2 and Mean scores for occlusion (self evaluation) at 3rd and 4th month were 4.2 and 4.6 respectively. Postoperative mean score for chewing at 3rd and 4th month were 3.1 and 4.2 respectively.

IV. DISCUSSION

Mandible may be compared to an archery bow which is strongest anteriorly in the midline and progressively weaker toward the condyles, hence, more prone to fracture. Next to the condyle, angle is the most common site of fracture. It is caused due to an impact over the same side of mandible between the canine and second molar region or an impact to chin point on opposite side. Fracture at the angle is influenced by masseter and medial pterygoid muscles which causes displacement of fracture segment in upward, inward and forward direction.[1,2,5,11,14] Fracture of the mandibular angle is difficult to treat, as there is no standard protocol. Various types of plates have been designed, claiming to be superior one to other types in terms of stability and complications.[11] The large number of studies on mandibular angle fracture treatment depicts to the fact that no single approach is ideal; hence the treatment of mandibular angle fractures remains a conceptually controversial aspects of management. During the last decade significant attention has been focused on fixation using a variety and combination of transorally placed small plates secured with monocortical screws. Fixation using such plates has been shown to simplify surgery and reduce surgical morbidity but failed to surpass the predictability of rigid fixation.[1-14] The use of a single miniplate for fixation of mandibular angle fracture has been debated over years. The conventional rigid fixation technique employs thick compression plate along the lower border of the mandible but results in flaring of the fractured site at the alveolar bone level, hence, requiring second plate (Tension plate) with monocortical screws.[2,8] Levy et al. indicated that miniplate fixation at angle fractures may not be efficient and hence, recommended fixation be augmented by a second plate at the lower border of the mandible.[15] Fracture fixed with Champy's plate is vulnerable to torsional and bending forces along the long axis of the mandible, particularly when plate is placed close to the fracture site. These torsional forces may lead to 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 apparatus.[8] 3D plate is predictable - the plate is strong enough yet malleable facilitating stabilization both at superior and inferior borders.[13] 3D titanium plates are easy to adapt and are good alternative to conventional miniplates. A study done on biomechanical experiment found that

entire 3D 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. Interconnections of the plate reduced the vertical displacement and shearing of bone to a minimal level. It also prevents flaring at alveolar region.[6] The fixation of 3D miniplate can be done by using monocortical screws at upper level in distal tooth bearing segment to prevent the root damage and bicortical screws in proximal segment which provide the better stability against the torsional and shearing forces. After proper adaptation of plate, first screw should be fixed in proximal segment at upper hole to stabilize the plate followed by fixation at lower hole at distal segment which will stabilize the both distal and proximal segments in close proximity. Third screw should be fixed in lower of proximal segment followed by upper hole in distal segment. If plate is 3x2 holes than remaining middle holes should be fixed at last. In our study we have evaluated the efficacy of 3D titanium miniplate fixation in the management of mandibular angle fracture. The time elapsed between initial trauma and definitive fixation is referred as the IT-DF interval. The various surgeons implementing the use of 3D plate reported IT-DF intervals ranging from 2.3 days to 4.5 days.[6,13] In our study the mean IT-DF Interval was 4.7 days. Hence, the management pattern approximately appears concurrent with the western setups. After comparing the preoperative data, it was found that incidence of mandibular angle fracture was higher in third decade and in male as compared to female with main causative factor being RTA. Various surgeons have experienced reduced operative time with usage of 3D plates. Juergen[6] and Wittenberg[12] reported a mean operative time (from initial incision to closure) of 65 to 105 minutes in mandibular angle fracture fixation with 3D plate where in our study mean time was 79.7 minutes. The time taken for fixation of the 3D plate has been referred as the PA - DF interval which, in our study was approximately 26 minutes. The studies show complication rates of mini plate osteosynthesis for mandibular fractures treatment ranges approximately from 3.8% to 28% over the last three decades.[2,9,14] But in contrast with 3D plate fixation at mandibular angle fracture was as low 0% - 10%.[6,12,13] In our study we found that bone and soft tissue infection rate were 0%. The incidence of non union, malunion, breakage of plate and malocclusion were 0%. In this study two reasons have been considered for the low complication rates seen with 3D plates. Firstly, their placement required dissection only in the vicinity of the fracture line, hence, lesser periosteal stripping. Secondly, due to their design, lesser implant material or foreign material was required to stabilise the fracture fragments. Studies reported satisfactory occlusion postoperatively in all patients treated with 3D plates.[6,12,13] In our study the postoperative mean score for occlusion and chewing viewed by both the surgeon and the patient for both the groups had minimal variations. It can be concluded that titanium 3D plates are equally successful in providing a functionally stable occlusion. However, because of the smaller study sample, a more extensive clinical study is recommended for better understanding the full spectrum of its application in maxillofacial surgery.

V. CONCLUSION

Our experience in using the 3D titanium plate was based on the observations drawn from 10 patients, leading us to a variety of conclusions. The 3D plate offered an advantage of reduced operative time, was easy to adapt and can be place at angle fracture sites in the mandible. It provides good post operative stability of fractured components and also prevents flaring at alveolar bone, whilst providing good functional movements like occlusion, chewing and mouth opening. 3D titanium plate showed minimal complication rates. The usage of 3D plate for mandibular angle fractures is ideal with only contraindication in fractures with less inter fragmentary bone contact. Henceforth, we conclude that the titanium 3D plate was successful in providing satisfactory osteosynthesis of mandibular angle fractures.

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