

Efficacy of Three-Dimensional Titanium Miniplate in Management of Maxillofacial Trauma - An Original Study

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Abstract

Background: This study was to evaluate the efficacy of three-dimensional (3D) titanium miniplates in the management of maxillofacial trauma. **Materials and Methods:** Ten patients who were diagnosed with maxillofacial fractures were selected for this study. The fractured fragments were fixed with 3D titanium miniplates. Postoperatively, cases were assessed clinically and radiographically at immediate post-operative, 1 month and 3 months. **Results:** The results of this study suggest that fixation of maxillofacial fractures with 3D titanium plates provides three-dimensional stability and carries low morbidity and infection rates. The only probable limitation of these plates may be excessive implant material due to the extra vertical bars incorporated for countering the torque forces and in cases where the fracture line passing through the mental foramina region. **Conclusion:** During the course of the present study, the 3D titanium plate was found to be standard in profile, strong yet malleable, facilitating reduction, and stabilization at both the superior and inferior borders giving three-dimensional stability at fracture site. They seem to be an easy to use alternative to conventional miniplates. However, the small sample size and limited follow-up could be considered as the limitations of our study.

Keywords: 3D plating system, maxillofacial fractures, titanium mini plates

INTRODUCTION

Trauma may be defined as “a physical force that results in injury.” Injuries to the maxillofacial region are clinically highly significant as they affect both function and esthetics.^[1]

Modern traumatology started with the development of osteosynthesis. In general, mandibular fractures are treated surgically, either by rigid or semirigid fixation. These two techniques reflect almost opposite concept of mandibular osteosynthesis. Rigid fixation is promoted by the Arbeitsgemeinschaft für Osteosynthesefragen/Association for the Study of Internal Fixation (AO/ASIF). In this concept, compression, tension, torsion, and shearing forces, which develop under functional loading, are neutralized by thick solid plates fixed by bicortical screws. Dynamic compression plates (DCP) and eccentric DCP plates were used in this concept.^[2]

The shortcomings of rigid and semi rigid fixation led to the development of three-dimensional (3D) miniplates, consisting of two 2-hole mini plates with gap which is interconnected by vertical cross struts. Three-dimensional titanium plates

and screws were developed and reported by Farmand.^[3] Unlike compression and reconstruction plates, their stability is not derived from the thickness of the plate. In combination with screws mono cortically fixed to outer cortical plate, the rectangular plate form cuboid which possesses 3D stability. The 3D plating system is based on the principle of obtaining support through geometrically stable configuration. The quadrangle geometry of plates assures a good stability in three dimensions of the fracture site since it offers good resistance against torque forces.

The biomechanical and technical constraints of the conventional rigid internal fixation devices have prompted the present study

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to evaluate the efficacy of the three-dimensional titanium miniplates as a viable treatment modality.

MATERIALS AND METHODS

The study was conducted in the Department of Oral and Maxillofacial Surgery at St. Joseph Dental College and Hospital at Duggirala, Eluru. Ten patients who sustained maxillofacial fractures irrespective of sex were randomly selected for open reduction and rigid internal fixation with 3D titanium plates and screws.

1. 3D titanium miniplates (Figure 1)
2. 2×6 mm, 2×8 mm, and 2×10 mm titanium screws (Figure 1)
3. Surgical plating kit (Figure 2).

Detailed clinical examination was carried out for all ten patients and following parameters were noted. (1) Facial asymmetry, occlusion, and mouth opening. (2) Radiographic evaluation of the fractured site. (3) Routine hematological investigations. (4) Medical assessment of the patient by physician and anesthesiologist was done. (5) Informed consent obtained from patient before surgery. After the routine clinical and radiological examination protocol, the fracture sites were exposed either by intraoral or extraoral approaches, maxillofacial fractures were fixed with 3D titanium miniplates and screws. Closure was done with 3-0 vicryl and 3-0 chromic gut sutures (Figures 3a-e and 4a-g).



Figure 1: 3D titanium plates with mini screws



Figure 2: Surgical plating kit

RESULTS

A sample size of ten patients with maxillofacial fractures. Patients had undergone ORIF with 3D titanium miniplates/screws intraorally.

After fixation of the fracture with 3D titanium miniplates and screws, routine post-operative OPG and PNS were taken 1 day after the procedure to evaluate the reduction of the fracture. Follow-up OPG'S were taken after 1st month and 3rd month.

The following observations were made in the study:

There was no presence of wound dehiscence in all the patients; Anatomical reduction of the fractured segments was good in all the patients; mobility of the fractured fragments was negligible with 3D titanium plating system; adequate occlusal stability was achieved; temporary paresthesia was noticed in one case; post-operative plate exposure was not seen in any case; none of the cases had either delayed healing or non-union; and this study shows favorable results on use of 3D titanium miniplates and in maxillofacial fractures.

DISCUSSION

The treatment of the facial fractures has evolved over a period of time from methods such as splinting and bandaging which resemble the closed reduction of recent times. Open reduction and rigid internal fixation over the past 30years and its increasing popularity has brought numerous advances in the management of fractures of the mandibular region.^[2]

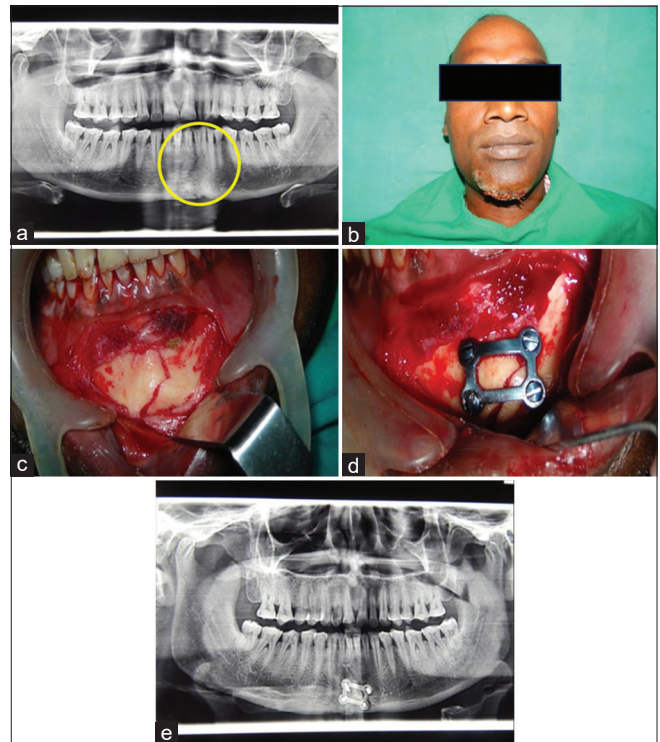


Figure 3: (a) Pre-operative profile of symphysis fracture with laceration on chin. (b) Pre-operative radiograph shows mandibular symphysis fracture. (c) Fracture site exposed. (d) Fracture fixation done with 3D titanium plate. (e) Post-operative radiograph

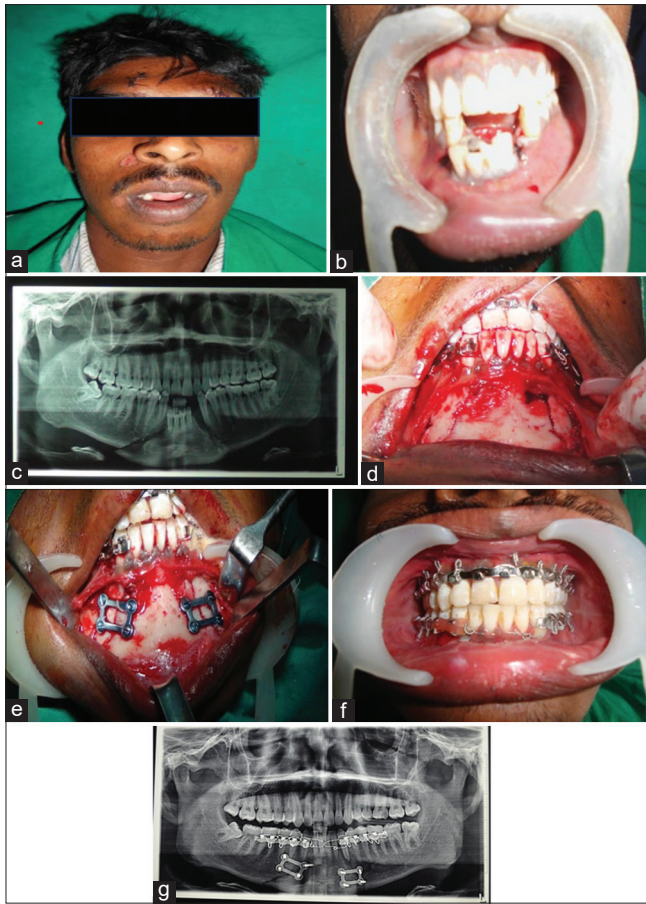


Figure 4: (a) Pre-operative profile of bilateral symphysis fracture. (b) Pre-operative occlusion. (c) Pre-operative radiograph bilateral parasymphysis fracture. (d) Fracture site exposed. (e) Fracture fixation with 3D titanium plates. (f) Post-operative profile and occlusion. (g) Post-operative radiograph

FARMAND in 1992 developed the concept of 3D miniplates. Their shape is based on the principle of the quadrangle as a geometrically stable configuration for support. When the mandible is in function, primary forces of concern include bending, vertical displacement, and shearing. In the 3D miniplate since the two horizontally placed miniplates are further joined using vertical struts, they further minimize bending. Since the entire plate acts as one single unit, due to its interconnections and quadrangular shape, the vertical displacement and shearing of bone is also reduced to minimal, thus holding the bone fragment in three dimensions. Since the stability achieved by the geometric shape of these plates surpasses the standard miniplates, the thickness can be reduced to 1 mm. The basic form is quadrangular with 2×2 hole square plate and 3×2 or 4×2 hole rectangular plate. Unlike compression and reconstruction plates, their stability is not derived from the thickness of the plate. In the combination with the screws monocortically fixed to outer cortical plate, the rectangular plates form a cuboid, which possesses 3D stability. The 3D plating system is based on the principle of obtaining support through geometrically stable configuration.^[4]

In recently published survey by Gear *et al.*, among 104 AO/ASIF surgeons, only 6% use this type of plate.^[5] Zix *et al.*^[6] reported reduced operating time because 3D plate is geometric configured plate which consists of two horizontal bars interconnected with two vertical bars. Hence, single 3D plate stabilized the fracture both at superior and inferior border at a time; hence, time is saved in plate fixation.

In our study, patients were checked for wound dehiscence preoperatively and postoperatively at the site of fracture, on the immediate post-operative day, after 1 week, 1 month, 2 months, and 3 months. None of the patients in our study showed wound dehiscence.

It has been claimed that mobility of fragments is a causative factor in post-operative infections improvement of plate stability which might be a way to minimize this problem.^[7] 3D plating system has compact design and is easy to use. The 1.0 mm thick 3D plate is as stable as the much thicker 2.0 mm mini plate. This offers better bending stability and more resistance to out of plane movement or torque.^[8] In our study, we found that the mobility of fragments with three-dimensional plating system is negligible.

3D plates are easier for placement intra orally compared to other plating systems. Due to closed quadrangular geometric shape and ease of contouring and adapting to bony fragments, it provides good stabilization in three dimensions. 3D plating seems to be an easy-to-use alternative to conventional miniplates; however, its application should be limited to cases where the fracture site has sufficient interfragmentary stability.

In our study, assessment of the involved nerve for paresthesia was done at 1 month and 3 months postoperatively by subjective and objective testing. Postoperatively, one of the patients had temporary paresthesia. Neurosensory alterations were noted through objective testing and were more frequently related with fracture of the parasymphysis region. The main cause of sensory deficit for mandibular angle fractures was trauma itself.^[6]

In our study, plate exposure was not observed in any of the cases, Nakamura *et al.* noticed post-operative complications such as malocclusion (3.6%), exposure of miniplate (3.6%), delayed union (1.8%), and infection (1.0%) in 110 patients with mandibular fractures. Post-operative complications may be due to inadequate reduction and stabilization, delay in treatment, teeth in fracture line, failure to provide antibiotics, and alcohol or drug abuse.^[9]

Radiographic examination at the 1st month postoperatively revealed that no changes in the position of fractured segments and fracture lines are hardly detected and at the end of the follow-up period none of the patients showed any signs of non-union.^[10]

The only probable limitation may be excessive implant material due to extra vertical bars for countering the torque forces^[11] and in case where the fracture line passing through the mental foramina. This finding was true even in our study and there is

a difficulty in adaptation of 3D plate at the mental foramina area with intact nerve bundle.

3D plate adaptation was good at symphysis region where as at angle region 3D plate adaptation was found to be difficult through intraoral incision. In such cases, Claude Guimond *et al.* suggested to percutaneously fixation mandibular angle fractures with a 2mm 3D curved angle strut plate may be an alternative.^[12]

CONCLUSION

3D plates were indeed easy and simple to use. Significant reduction in operating time could be achieved with the use of 3D plates which make it a time-saving alternative to other plating systems. During the course of our study, the 3D titanium plate was found to be standard in profile, strong yet malleable, facilitating reduction, and stabilization giving three-dimensional stability at fracture site. 3D titanium plate found to be advantageous. The small sample size and limited follow-up could be considered as the limitations of our study. Hence, it is recommended to have a further study with large number of patients and correlation among these studies to authenticate our claims.

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