

## 3-D locking titanium miniplates in management of mandibular fracture: A prospective clinical study

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### ABSTRACT

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**Purpose:** The aim of this follow up clinical study was to evaluate the effectiveness of 2mm, 3-dimensional locking titanium miniplates.

**Patients and Method:** A prospective randomized clinical trial was carried out on 10 patients with mandibular fractures. The patients were evaluated for the operating time, clinical assessment of mobility after fixation, occlusion, adequacy of reduction on post-operative radiograph and any surgical complications. The statistical analysis was carried out in SPSS software.

**Results:** In 10 patients, 9(90%) were males and 1(10%) were females with a mean age of 28.75 years. Road traffic accident (RTA) was the etiological factor in 7(70%), interpersonal violence in 2 (20%) and fall in 1(10%) patient. The average intra-operative time was 40.10 min locking plates. This was found to be statistically significant when compared to the intra-operative time of non-locking plates in the literature. Bite force was measured in kilogram/cm<sup>2</sup> using indigenously designed bite force measurement device. All the measurements were compared to the control group who did not sustain mandible fracture. At third month it was found that there was no significant difference in the bite between locking plates and control group. On examination satisfactory postoperative functional occlusion was found to be 100% in locking plates.

**Conclusions:** The results obtained suggest that 3-D locking plate/screw system fulfill the treatment goals of adequate reduction, fixation and stabilization of fracture of mandible. 3-D locking plating system adequately reduces the fracture without much need for adaptation and hence reduces the intra-operative time.

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### INTRODUCTION

The modalities for the treatment of fractures of the mandible have been in a constant state of evolution. Over the years, the management of trauma has evolved from various forms of splinting circum mandibular wiring, extra oral pins, semi rigid fixation and trans-osseous wiring. This was followed by rigid fixation technique and more lately has given way to semi-rigid fixation with miniplates (Champy.M.et al). The currently used conventional miniplates technique requires maxillomandibular fixation for a short period and unable to render three dimensional stability at the fracture site. The three dimensional (3-D) miniplate system is one of the recent internal rigid fixations for the maxillomandibular surgery in years.<sup>1</sup>

Research continues to focus on size, shape, number and mechanics of plate/screw systems to improve surgical outcomes. Farmand developed 3-D plate with quadrangular design by joining two miniplates with interlocking crossbars. The basic concept of 3-D plate is the stability in three dimensions.

The stability is achieved by its configuration not by thickness or length. One of the advantage of 3-D plates is the simultaneous stabilization of the

tension & compression zones, making the 3-D plate a time saving alternative to conventional bone plate.<sup>2</sup> The locking plating system has been developed and popularized by AO/ASIF to obviate the main disadvantage of conventional plate system, which requires the plate to be perfectly adapted to the underlying bone to avoid gaping of the fracture and associated instability. This bone-plate system acts as an internal-external fixator, which results in better distribution of the load and prevents load concentration on a single screw, thus decreasing the risk of a screw's loosening and stripping. Moreover, because anatomic adaptation of the plate to the underlying bone contour is not crucial, there are theoretically a fewer interferences with the adjacent vascular supply.<sup>3</sup> The first biomechanical comparison of locking plates to appear in the maxillofacial surgical literature was made by Gutwald in 1999; he concluded that a higher stability was achieved with the locking plates.<sup>4</sup>

This study was designed to evaluate the treatment outcome of 3-D locking titanium plate in mandibular osteosynthesis.

### MATERIALS AND METHOD

The study was a randomized prospective study conducted on patients reporting to Department of Oral and Maxillofacial Surgery, I.T.S Dental College and Research centre, Muradnagar, Ghaziabad from November 2012 to April 2014 with definitive diagnosis of mandibular fractures. The patients were selected based on following inclusion criteria: (a) mandibular fractures in

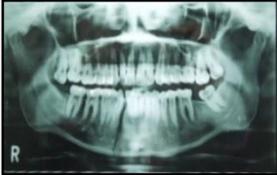
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patients between 15 – 65yrs (b) patients willing for open reduction and internal fixation of mandibular fracture and provided informed consent for the procedure (c) patients who are deemed fit for surgery in general anesthesia (G.A.) by anesthesiologist following pre anesthetic evaluation (d) isolated fracture. The exclusion criteria were: (a) mandibular fracture in patients below 15yrs and above 65yrs (b) mandibular fracture in edentulous patient (c) pregnant patients. The study was approved by local ethical committee, and informed consent was obtained from the patients before their inclusion in the study. The present study was conducted on 10 patients (9 male and 1 female) having fractured mandible. The patients were treated with open reduction and internal fixation (ORIF) using 3-D locking plates. The 3-D locking titanium miniplate used in the study were four hole square / six hole rectangular miniplate with 2.0 mm diameter hole and 1.0 mm thickness (Fig. 1-5).

The parameters like operating time, clinical assessment of mobility after fixation, biting force, adequacy of reduction on postoperative radiograph, and any post-surgical complications were assessed. Following postoperative complications were evaluated; wound dehiscence, malocclusion, damage to roots by screws, post-operative neurosensory deficit, infection at the site, implant failure, implant palpability, nonunion and malunion.

All the patients were followed for 6months postoperatively. The evaluation was done at first week, first month, third month and sixth month. Bite force was measured in kilogram/cm<sup>2</sup> using indigenously designed bite force measurement device. The measurements were taken at second week, fourth week, third month and sixth month postoperatively. Bite forces were measured at the incisor and right and left molar region. All the measurements were compared to the control group who did not sustain mandible fracture.

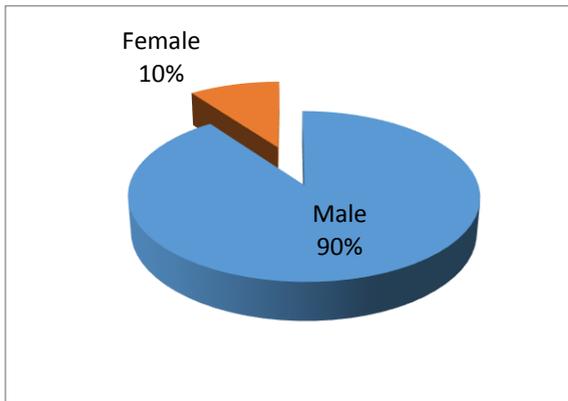
	<p>Fig: 1 Preoperative photograph of patient with right parasymphysis fracture showing deranged occlusion</p>
	<p>Fig: 2 Preoperative OPG show right parasymphysis fracture</p>
	<p>Fig: 3 Intraoperative photograph of patient showing reduction and fixation of right parasymphysis fracture site using 2.0-mm, 6-hole, 3-D locking plate via intraoral degolving incision</p>
	<p>Fig: 4 Postoperative photograph of patient with right parasymphysis fracture showing occlusion</p>
	<p>Fig: 5 Postoperative OPG showing reduction and fixation of right parasymphysis fracture with 2.0-mm, 6-hole, 3-D locking plate</p>

**RESULTS**

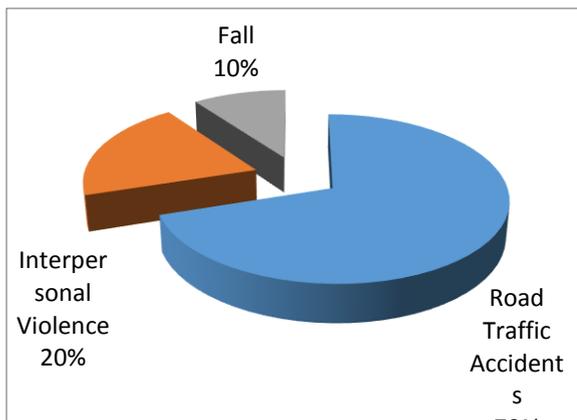
The mean age of the patient included in the present study was 28.75 years ranging from 18 to 58 years (Table 1). The main etiological factor of trauma was road traffic accident (RTA) in 7(70%), inter-personal violence in 2 (20%) and fall in

1(10%) of the patients (Pie chart 2). Duration of surgery was measured from the time of incision till the closure of wound. The average intra-operative time was 40.10 min locking plates. Adequacy of fracture fixation was checked immediately after fixation by clinical

manipulations in three dimensions. Functional occlusion was restored in all the cases. Minor occlusal discrepancy was seen in one patient which was managed by selective grinding. The bite force was improved significantly at sixth week and third month post-operative follow up period in all the sites. At third month it was found that there was no significant difference in bite force between locking plates and control group (Bar graph 1).



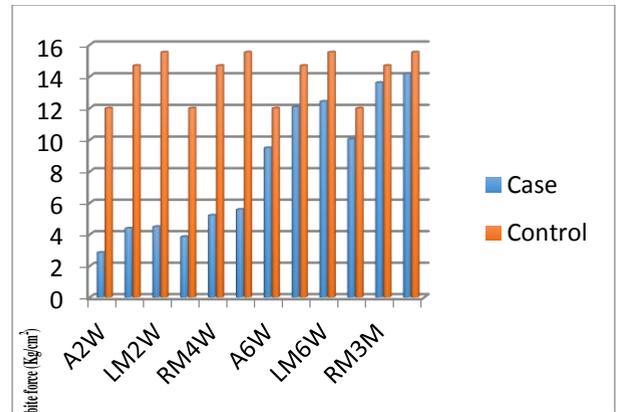
**Pie chart 1:** Gender Distribution



**Pie chart 2:** Etiological Distribution

**Table 1:** Age distribution of fracture patients

Age range (years)	Number of patients	Percentage
<20	1	10%
21-30	5	50%
31-40	2	20%
41-50	1	10%
>50	1	10%
Total	10	100%



**Bar graph 1:** showing comparison of bite force (Kg/cm<sup>2</sup>) between both the case and control group at 2 week, 4 week 6 week and 6 months postoperative interval

**DISCUSSION**

Farmand et al 1992, developed the concept of 3-D miniplate. The advantage of 3-D plate is the simultaneous stabilization of both superior & inferior borders makes a time saving alternative to conventional miniplate. The main disadvantage of the 3-D plate system is that precise adaptation to the underlying bone, interference with the perfusion of bone underlying the plate. The locking plate/screw system was initially developed by Raveh et al. In the mid-1980s, the principles of external fixation devices were incorporated into a bone plate. These plates achieve stability by locking the screw into the plate and have been shown to enhance fixation stability.<sup>5</sup>

Locking plate/screw systems do have certain advantages over conventional plates and screw. Theoretical advantages proposed include: less screw loosening, greater stability across the fracture site, less precision required in plate adaptation because of the internal-external fixator, less alteration in osseous or occlusal relationship upon screw tightening and no need for a friction lock between plate and bone for stability, resulting in decreased pressure transmitted to the underlying bone.<sup>6,7</sup> Michlet & Champy study was based on two dimensional models which took only bending & torsional forces into account and sometimes necessitate placement of two plates at angle/symphyseal region. Another study reveals that at a given point in fracture site three forces acting on mandible namely bending, torsional and shear.<sup>8</sup> Thus three dimensional miniplate was evolved by joining two miniplates with interconnecting vertical crossbars.<sup>9</sup> In symphysis and parasymphysis regions, 3-D plating system uses lesser foreign material than the conventional miniplates using Champy's principle. Thus our study suggest that 3-D plating system offers advantages over conventional miniplates as it uses lesser foreign

material, reduces the operation time and overall cost of the treatment.<sup>10</sup>

The absence of major complications found in this study corroborates the two main biological and mechanical advantages reported by experimental studies on locking plates, which allow for more rapid and undisturbed bone healing and decreased risk of delayed union, nonunion, or infection. First, the absence of pressure under the plate prevents the cortical blood supply from being disrupted and allows periosteum growth under the plate. Second, stress shielding below the plate is eliminated, which prevents chronic inflammation and subsequent bone necrosis.<sup>3,11</sup> In the present study we experienced that for fixation of fractures of mandible 3-D locking titanium miniplate has advantages, as precise adaptation of plate is not required thus reducing the operative time and chances of screw loosening. The only disadvantage of the locking system is cost and minor addition to instrument armamentarium. Drill guide is required for central and perpendicular placement of hole.<sup>2</sup>

## CONCLUSIONS

To achieve early functional mobility with assured stability in case of mandibular fractures, our findings recommend the use of 3-D locking plate as precise adaptation of 3-D locking plates is not required and does not affect their mechanical behavior. Therefore plate placement becomes easier and less time consuming, though a more extensive study with more number of patients and longer period of follow up is required.

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