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What is This?
Conventional versus 3-Dimensional Miniplate in Management of Mandibular Fracture: A Prospective Randomized Study

Virendra Singh, MDS¹, Puneet Puri, MDS¹, Sanjay Arya, MDS¹, Sunita Malik, MDS¹, and Amrish Bhagol, MDS¹

Abstract

Objective. The aim of this study was to compare conventional miniplate (Champy’s) and 3-dimensional miniplate fixation in the management of mandibular fracture.

Study Design. Prospective study.

Setting. The study was carried out in the Department of Oral and Maxillofacial Surgery, Govt. Dental College, Pt. B.D. Sharma University of Health Sciences, Rohtak, India.

Subjects and Methods. A prospective randomized clinical trial was carried out in 50 patients. Patients were randomly assigned to receive a 2.0-mm 3-dimensional miniplate (group A) or a 2.0-mm conventional miniplate (group B). All patients were followed up for 12 weeks postoperatively. Complications were analyzed according to the type of plate used and the site of fracture.

Results. Twenty-eight fracture sites were treated with the 3-dimensional miniplate and 28 with the conventional miniplate. Five complications occurred, representing 8.9% of the total. Two complications occurred in group A and 3 in group B, with complication rates equaling 7.14% and 10.71%, respectively. When comparing the overall complication rates according to plates used, the \( \chi^2 \) test showed no statistically significant difference between the 2 groups (\( P > .05 \)).

Conclusion. No major difference in terms of treatment outcome is observed in both systems, and both are equally effective in managing mandibular fracture.

Keywords

3-dimensional miniplate, conventional miniplate, mandibular fracture

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Rigid internal fixation was initially used in the oral and maxillofacial region in the late 1970s. Since the work of Michelet et al and later Champy et al, miniplate osteosynthesis has become an important fixation method in maxillofacial and craniofacial surgery.¹⁻³

Miniplate osteosynthesis is a standard method for the surgical treatment of mandibular fractures.⁴⁻⁵ Miniplates provide functionally stable fixation, unlike rigid fixation, which prevents micromotion of the bony fragments under function. Functionally stable fixation applies to internal fixators that allow bone alignment and permit healing during function.⁶ Miniplate osteosynthesis is accomplished by placement of a plate along the so-called ideal line of osteosynthesis, thereby counteracting distraction forces that occur along the fracture line during mandibular function.

Champy et al¹,² recommended a single miniplate on the superior border for mandibular angle fractures. However, experimental⁷⁻⁸ and clinical studies⁹ have shown that the stability of single-miniplate fixation for the repair of angle fractures is a continuing subject of debate. Within the symphyseal/parasymphyseal region, Champy et al stressed the need for 2 plates to counter increased torsional forces.

More recently, 3-dimensional (3D) titanium plates and screws have been developed by Farmand,¹⁰⁻¹¹ with a quadrangular design formed by joining 2 miniplates with interconnecting crossbars that allow easy adaptation of plate to bone without distortion. The free area between these connecting arms permits good blood supply to bone.¹² Unlike compression and reconstruction plates, their stability does not derive from the thickness of plates. In combination with screws monocortically fixed to the outer cortex, the rectangular plate forms a cuboid that possesses 3D stability. Because the screws are placed in a box configuration on both sides of the fracture rather than on a single line, broad platforms are created that may increase the resistance to torsional forces along the axis of the plate. This mechanical property makes them suitable for use in symphyseal fractures, which are under a greater degree of torsional strain.¹³
Although various experimental studies on biomechanics have confirmed sufficient stability of the 3D plating system, very few clinical trials have been performed to compare clinical experiences between conventional miniplates and 3D miniplates in the management of mandibular fractures. Keeping all these aspects of conventional and 3D miniplates in mind, a randomized prospective study was done in the Department of Oral and Maxillofacial Surgery, Post Graduate Institute of Dental Sciences, Pt. B.D. Sharma University of Health Sciences, Rohtak, Haryana, India, with the aim to evaluate the efficacy of a 2.0-mm 3D miniplate and screw system in comparison to a 2.0-mm conventional miniplate and screw system in symphyseal/parasymphyseal and angle fractures.

Materials and Methods
A prospective randomized clinical trial was conducted for 14 months, from August 2010 to September 2011. A total of 50 patients with isolated mandibular fractures involving symphysis/parasymphysis and angle fractures without preexisting infection and comminution were selected. Patients were randomly divided according to a computer-generated randomizer into 2 equal groups of 25 patients each. Group A patients underwent osteosynthesis using 2.0-mm 3D miniplates, whereas group B patients underwent osteosynthesis using 2.0-mm conventional miniplates. They were informed of the need for a 3-month follow-up (Figure 1). The patients had to give informed consent or refusal regarding participation in the study. The patient information was documented in a consent form. Before beginning the study, design had been approved by the institutional review board (Post Graduate Institute of Dental Sciences).

All patients underwent general anesthesia via nasoendotracheal intubation. To get preinjury occlusion, maxillomandibular fixation (MMF) was done either by arch bar or eyelet wiring. The approach to the fracture site was gained via the intraoral or transbuccal approach depending on the site of fracture and accessibility. Extraction of teeth in the line of fracture, including impacted third molars, was performed if indicated. Maxillomandibular fixation was maintained intraoperatively using a 26-gauge wire. Once proper occlusion was achieved, fractures were fixed with either a 2.0-mm titanium 3D miniplate or a 2.0-mm titanium conventional miniplate (Figures 2 and 3) along Champy’s line of ideal osteosynthesis using monocortical screws. These monocortical screws have the advantage of not causing any damage to the tooth root because of involvement of the outer cortex only. The 3D plates were placed in such a way that horizontal bars were perpendicular to the fracture line and vertical ones parallel to it. In symphysis/parasymphysis, 1 plate was fixed with the upper bar in the subapical position (Figure 4). An angle region plate was placed over the external oblique line or on the lateral cortex. This technique follows the principle of 3D fixation given by Farmand.

After confirming the preinjury occlusion and achieving proper hemostasis, the incision site was closed layer-wise using 3-0 vicryl and 3-0 silk. Duration of surgery (measured from the beginning of incision to the surgical closure) was noted in both groups. Associated condylar or subcondylar fractures were treated closed. All patients received intravenous antibiotics from the time of admission until discharge. Following this, patients were prescribed a 3-day course of oral antibiotics.

Postoperatively, no MMF was done for 24 hours. After that, the status of the occlusion was checked, and if there was any occlusal discrepancy, MMF was done for 5 days in both group A and group B. Patients were instructed to continue a soft diet for 4 weeks.

Assessment of the patients was done under the following parameters: pain, infection, paresthesia, hardware failure (plate fracture), mobility between fracture fragments, occlusion, need for MMF, and radiological evaluation of reduction and fixation.
All the patients were followed for 12 weeks postoperatively. The evaluation was done at the first week, fourth week, eighth week, and third month. Each complication was recorded according to plates used and fracture sites. The data results of the clinical and radiological examination were recorded on a specifically designed evaluation form. Parametric data were evaluated with an independent samples t test. Nonparametric data were analyzed with a $\chi^2$ analysis. A $P$ value less than .05 was considered statistically significant (by using SPSS version 17; SPSS, Inc, an IBM Company, Chicago, Illinois).

**Results**

The average age of the 50 patients was $30.42 \pm 8.23$ years, with a range of 17 to 46 years (Table 1). There were 46 males and 4 females. The cause of trauma was road traffic accident in 31 patients, assault in 11, and fall/sports injury in 8 (Table 2). The time from injury to the treatment ranged from 2 to 15 days, with a mean $\pm$ SD of $6.90 \pm 3.35$ days. Twenty-eight fracture sites were treated with 2.0-mm titanium 3D plates and 28 with 2.0-mm titanium conventional miniplates.

After application of the bone plates, all fractures appeared to be well reduced and stable. Postoperative radiographs (Figures 5 and 6) showed excellent reduction in all cases, with alignment of the osseous borders of the mandible and inferior alveolar canal, when crossed by the fracture.

In group A, average operating time was 37.25 minutes and 57.37 minutes for symphysis/parasymphysis and angle fractures, respectively. In group B, average operating time was 53.62 minutes and 44.16 minutes for symphysis/parasymphysis and angle fractures, respectively. Overall average operating time was 43 minutes in group A and 49.57 minutes in group B (Table 3).

The number of patients who required postoperative maxillomandibular fixation varied in both groups. In group A, 8 of 25 patients (32%) required MMF postoperatively, whereas the number of patients requiring MMF in group B was 17 (68%). The difference between 2 groups was statistically significant ($P < .05$).

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**Table 1. Age Distribution**

<table>
<thead>
<tr>
<th>Age Group, y</th>
<th>Patients with 3D Miniplate (Group A), No.</th>
<th>%</th>
<th>Patients with Conventional Miniplate (Group B), No.</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-20</td>
<td>2</td>
<td>8</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>21-40</td>
<td>20</td>
<td>80</td>
<td>19</td>
<td>76</td>
</tr>
<tr>
<td>41-60</td>
<td>3</td>
<td>12</td>
<td>4</td>
<td>16</td>
</tr>
<tr>
<td>Total</td>
<td>25</td>
<td>100</td>
<td>25</td>
<td>100</td>
</tr>
</tbody>
</table>

**Table 2. Etiology and Sex Distribution**

<table>
<thead>
<tr>
<th>Etiology</th>
<th>Total No. of Patients (Male/Female)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road traffic accident</td>
<td>31 (30/1)</td>
<td>62</td>
</tr>
<tr>
<td>Assault</td>
<td>11 (10/1)</td>
<td>22</td>
</tr>
<tr>
<td>Others (fall, sports injury)</td>
<td>8 (6/2)</td>
<td>16</td>
</tr>
<tr>
<td>Total</td>
<td>50 (46/4)</td>
<td>100</td>
</tr>
</tbody>
</table>

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**Figure 3.** Fixation done with a conventional miniplate over the angle region.

**Figure 4.** A 3-dimensional plate fixed over the parasymphysis region.
There was significant decrease in pain (visual analog scale [VAS]) on progressive follow-ups in both groups. No significant difference in pain (VAS) was noted in group A or group B at any of the follow-ups.

Four patients in group A and 5 patients in group B had a complaint of paresthesia postoperatively, which was confirmed by pinprick test and cotton wool test. None of the patients had complete paresthesia but had altered sensations. In all patients, paresthesia disappeared at the 3-month follow-up.

Five patients (2 in group A and 3 in group B) developed postoperative infection. They were treated in the outpatient setting with wound debridement, incision and drainage, and oral antibiotics. Hardware had to be removed in 1 patient in group A (after 3 months) because infection did not resolve after the local maneuver and antibiotic therapy. The patient had good occlusion and healed fracture at the time of hardware removal. Infection seen in all 5 patients could be attributed to their poor oral hygiene and surgical technique instead of the hardware used.

A total of 5 complications occurred, for a total complication rate of 8.9%. Two complications occurred in angle and 3 in parasymphysis fractures. Two complications occurred in group A and 3 in group B, with complication rates equaling 7.14% and 10.71%, respectively (Table 4).

When comparing the overall complication rates according to plates used, the χ² test showed no statistically significant difference between the 3D and conventional miniplates ($P > .05$).

**Discussion**

The aim of mandibular fracture treatment is to restore anatomic form and function, with particular care to establish the occlusion. Even though these objectives often can be achieved by closed reduction and intermaxillary fixation (IMF), recently there has been a shift toward open reduction and internal fixation (ORIF). Methods of ORIF have changed and diversified enormously in the past few years. They have become smaller and simpler to handle, and extraoral incisions can be avoided. However, there is still controversy regarding the optimal treatment. For example, when selecting a fixation scheme for a fracture, one has to consider many things such as size, number of fixation devices, their location, ease of adaptation and fixation, biomechanical stability, surgical approach, and amount of soft tissue disruption necessary to expose the fracture and place the fixation devices.13,16

Most mandibular fractures are treated by using standard Champy miniplate fixation.13,16 The 3D plating system for mandibular fracture treatment is relatively new.17

The use of 3D miniplates in mandibular fracture has not yet become established. In a recently published survey13 of 104 North American and European AO (Arbeitsgemeinschaft für Osteosynthesefragen)/Association of the Study of Internal Fixation (ASIF) surgeons, only 6% stated that they use this type of plate. Moreover, only a few follow-up series have been presented in the literature, with few studies11,15,18,19 emphasizing the hardware-related advantages over conventional miniplates and reconstruction plates. These advantages include easy application, simplified adaptation to the bone without distortion or displacement of the fracture, simultaneous stabilization at both superior and inferior borders, and hence less operative time.

In our study, average operating time was less with the 3D plating system (37.25 minutes) as compared with conventional miniplates (53.62 minutes) in the symphysis/parasymphysis region. In the angle region, the 3D plate took more time (57.37 minutes) as compared with conventional miniplates (44.16 minutes). Overall operating time was less with the 3D plating system (43 minutes) as compared with conventional miniplates (49.57 minutes). This is consistent with another study20 that also found that the 3D plating system took less operating time in the symphysis/parasymphysis region and more time in the angle region as compared with conventional miniplates.

**Table 3. Duration of Surgery (Average Operating Time)**

<table>
<thead>
<tr>
<th>Fracture Site</th>
<th>3D Miniplate (Group A), min</th>
<th>Conventional Miniplate (Group B), min</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symphysis/parasymphysis</td>
<td>37.25</td>
<td>53.62</td>
</tr>
<tr>
<td>Angle</td>
<td>57.37</td>
<td>44.16</td>
</tr>
<tr>
<td>Overall</td>
<td>43.00</td>
<td>49.57</td>
</tr>
</tbody>
</table>
There is less operating time with the 3D plating system in the symphysis/parasymphysis region because the surgeon needs to place only 1 plate instead of 2 separate conventional miniplates. Because of the broad size of the plate and more screws (6 hole) are needed, fixation of 3D plates in the angle region takes more time. Intraoral placement of the 6-hole 3D plate is also more difficult.

It has been advised by a number of authors to supplement miniplate fixation with MMF to allow stabilization of the occlusion. One of the interesting findings in our study was that postoperative MMF was required in fewer cases if osteosynthesis was done with the 3D plating system. Although this finding is statistically significant ($P < .05$), it alone cannot prove the higher stability of the 3D plating system.

In our study, we found satisfactory results with postoperative MMF for 5 days, which correlates with the study conducted by Singh et al. We recommend no postoperative MMF or, if required, MMF for a period of 5 days can be used in both groups.

It has been claimed that mobility of fragments is a causative factor in postoperative infections. Because infection is the most common complication in mandibular fractures, the improvement of plate stability might be a way to minimize this problem. With the use of open reduction and internal fixation, the reported incidence of infection ranges from 3% to 32%.

Infection rates with 3D plating in other studies have been 8.2% and 5.5% for angle fractures and 6.6% and 10% for mandibular fractures. The infection rate with 3D plating in our study was 7.14%.

Farmand and Dupoirieux also treated 95 fractures of the mandibular body using 3D plates; among the complications, only 1 late infection and 1 plate fracture were recorded. Plate fracture was again a most important complication in the study by Zix et al., in which the reduced interfragmentary cross-sectional bone surface at the fracture site was cited as the most likely reason. In another study, the vertical strut of the 3D plate broke intraoperatively in 1 case because the plate was bent repeatedly to adapt it precisely according to the contour of the angle. Two cases of infection but no plate fracture occurred in our study.

The overall complication rate in our study was 8.9%, with 7.14% in the 3D plating group and 10.71% in the conventional miniplate group, which is consistent with the study by Goyal et al., who found an overall complication rate of 11.1%, with 13.6% in the 3D plating group and 8.6% in the conventional miniplate group in their study. When complication rates of both groups were compared, there was no statistically significant difference ($P > .05$).

**Conclusion**

There is no major difference in terms of treatment outcome in both systems, and both are equally effective in mandibular fracture treatment. However, in the symphysis/parasymphysis region, 3D 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.

**Author Contributions**

Virendra Singh, substantial contribution to conception and design and final approval of the version to be published; Puneet Puri, acquisition of data and drafting the article; Sanjay Arya, revised the article critically for important intellectual content; Sunita Malik, revised the article critically for important intellectual content; Amrish Bhagol, revised the article critically for important intellectual content.

**Disclosures**

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**References**


