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Original Research Article

# Evaluation of the efficacy of Three-dimensional mini plates versus conventional mini plates used in the management of anterior mandibular fractures

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ABSTRACT

**Introduction:** The management of mandibular fractures has evolved from closed reduction to open reduction. Champy's miniplates have become highly popular and is a time-tested method of treatment of mandibular fractures. However, advances like 3D miniplate with claimed advantages like requires less armamentarium, providing better occlusal stability

**Materials and Methods:** Evaluative study conducted in 24 patients & randomly divided in 2 groups, use of 3D miniplate vs conventional miniplates in anterior mandibular fractures, age group 15-90, post-operative evaluation at day $1^{st}$, $7^{th}$ & $3^{rd}$ month, fracture stability, mobility of fracture fragment, complications & bite force.

**Result:** The level of significance was fixed at 5% and p ≤ 0.05 was considered statistically significant. 3D mini plating system (p value:- .001)have lesser operating time when compared to 2D conventional miniplating system, also 3D miniplate system have better intraoperative and lesser complications, significantly better bite force results (p value .002*(s)) with 3D miniplate compared to 2D conventional miniplating system.

**Conclusion:** 3D miniplate a novel form of plating system with better intraoperative and post operative results, better stability compared to conventional miniplating system.



## 1. Introduction

Themaxillofacial area serves various functions like vision, smell, chewing, talking and breathing; the most important functions due to trauma these functions may get affected which leads to poor quality of life, and social stigma.

In maxillofacial region mandible is most prominent bone. It has been noted that around 36-59% of mandibular fractures areas sociated with maxillofacial injuries. Depending on direction and force of trauma, mandibular fractures occurat different sites and can be classified according to its anatomy, locations and severity.

Due to mandible fractures, there are chances of airway compromise, occlusion gets disturbed and joint may get deranged. This may lead to pain, infection, transient or complete loss of sensation. Securing airway and to stop bleeding must be first priority before initiating any definitive management. The historical background of treatment for fractures of facial bone, matches the advancement in current oral and maxillofacial surgical procedure.

Trauma bring morbidity and primary concern of the maxillofacial surgeon is to treat the patients. The purpose of all forms of the therapy is restore the form, functional and rehabilitation of face and jaws to near normal. Treatment of jaw fractures have evolved since the time of Aristotle from the use of bandages to more recently in form of semirigid and biodegradable plate.[1,2] However, after $2^{nd}$ world war

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there was a major leap in management of jaw fractures from closed reduction to open reduction and direct fixation using bone plates and screws.[3,4]

Simultaneously, the idea of "osteosyn thesis" was created, which implies functionally stable internal fixation of bone fractures, permitting the early recuperation of capacity. Osteosyn thesis was initially developed by orthopedics practitioners but also underwent rapid development for use in maxillofacial region where early functional rehabilitation was required. Rigid fixation could be with/without dynamic compression. However, fixation within compression plates had many disadvantages. When centric dynamic compression was utilized for reduction of fractures in mandible there was gaping either at superior or inferior border, hence ECDP was preferred over centric dynamic compression plate.[5–8]

## 2. Objectives

To evaluate the post-operative outcomes of three-dimensional plates versus conventional mini plates in the management of anterior mandibular fracture, and to analyze the advantages of one over another.

Criteria of evaluation was:- of plating system, pain assessment using VRS, post op complications, time duration while plating of each system and assessment of bite force.[9–12]

### *2.1. Biomechanics of the symphysis (AO)*

The mandibular symphysis undergoes torsional forces (twisting) during function and therefore, this factor must be considered while deciding on fixation strategies. Either a reconstruction plate if not then two points of fixation as further apart as possible should be the treatment plan.

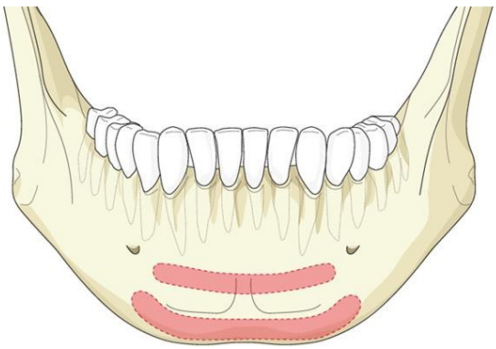
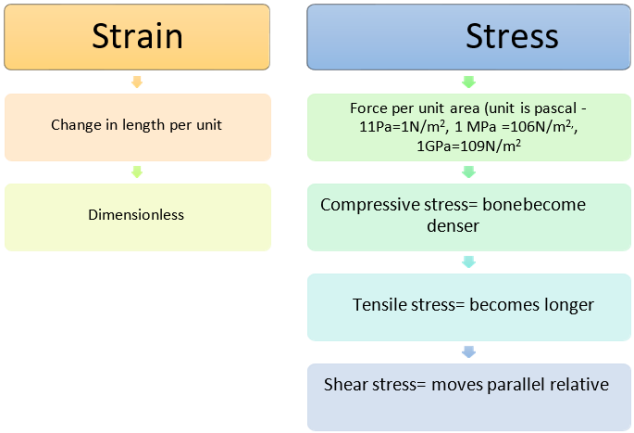


**Fig. 1:** Ideal lines of osteosynthesis according to champy's principle in symphyseal region**.**

C, center of curvature; R radius of curvature; NA, neutral axis; CM, center of mass[28].




## 3. Materials and Methods

This study was held at Sri Aurobindo College of Dentistry, Indorein Department of Oral and Maxillofacial Surgery, treat anterior mandibular fractures and bite force assessment were done using Fuji film's prescale film from 0.05 to 300 MPa, using anoccluzer FPD705 (Fujifilm GC). It uses a color scale to capture pressure profile and reveals pressure distribution using an Occluzer FPD705 (FujifilmGC).

**Fig. 2:** Steps of measuring bite force

Figure Above- Epson V33 scanner machine; below- (left) dedicated cover to equalize pressure (middle) pre scale pressure sensitive sheet (right) calibration sheet to calibrate the scanner for pressure units

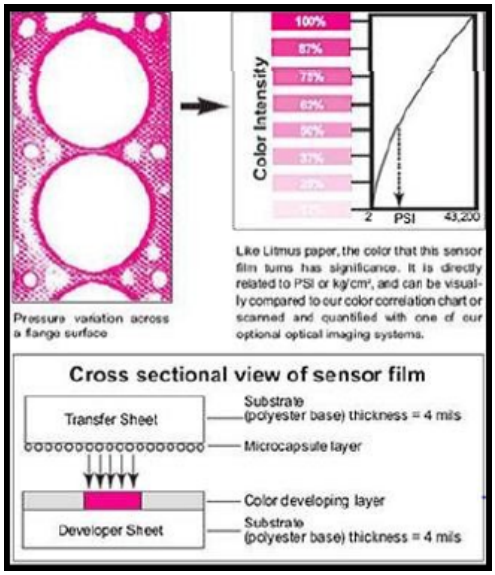



**Fig. 3:** Method of pressure calculation

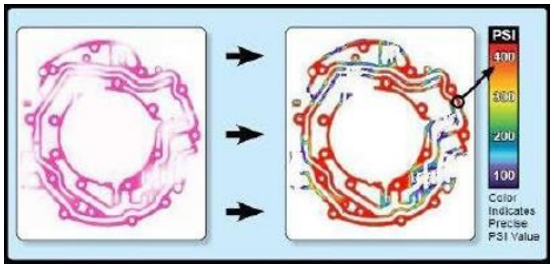



**Fig. 4:** Pressure map revealing pressure measurement evaluation. Left: colour change on pressure sensitive sheet; right: computerized analysis of pressure in PSI/MPA

### *3.1. Preoperative assessment*

1. Assessment of pre-operative occlusion (stability/derangement)
2. Assessment of pre-operative displacement of fracture fragment radio graphically (favorable/unfavorable)

### *3.2. Intraoperative assessment*

1. Operating time for fixation of 3D mini plates and conventional miniplates. From plate adaptation till final screw tightening. (In minutes).

### *3.3. Postoperative assessment*

1. Need for any supplemental method of fixation or cuspal grinding.
2. Evaluation post operatively on $1^{st}$ day, $7^{th}$ day & $3^{rd}$ month will include the assessment of: -

   (a) Stability of occlusion: stability of occlusion was checked according to molar relation class I (present/absent)
   (b) Complications {infection, pain (0 –no pain, 1-mild pain, 2-moderate pain, 3-severe pain), neurosensory deficit)}
   (c) Mobility of fracture fragments: mobility of fracture fragment was tested using bimanual palpation method and the mobility (present/absent) was checked in both the horizontal and vertical directions
   (d) Bite force assessment: bite force was assessed using presacle (Fujifilm) right and left side, units will be measured in megapascals.

## 4. Case-1 Open reduction & Internal Fixation using 3D Miniplate

### *4.1. Pre-Operative photographs*

**Fig. 5:** Pre-operative- front profile & occlusion

**Fig. 6:** Pre-operative orthopantomogram revealing symphysis fracture

**Fig. 7:** Reduction and final position of 3D plate

### 4.2. Post-operative

**Fig. 8:** Post-operative photograph- front profile & occlusion

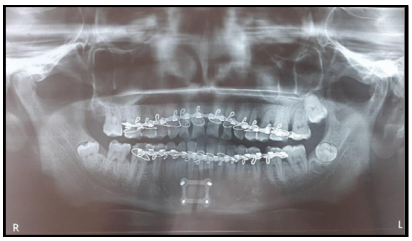


**Fig. 9:** Post-operative orthopantomogram revealing position of 3D plate

### 4.3. Bite force measurment

**Fig. 10:** Bite force measurment of patien using prescale fujifilm

## 5. Case-2 using 2D Conventional M iniplates

### 5.1. Preoperative photos graphs

**Fig. 11:** Pre-operative- front profile & occlusion

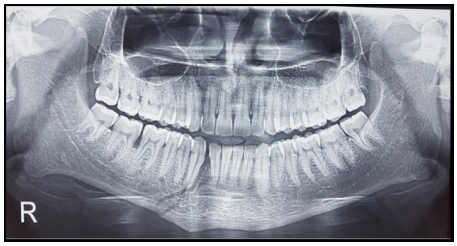



**Fig. 12:** Pre-operative orthopantomogram revealing right parasymphysis fracture

### 5.2. Intraoperative photograph

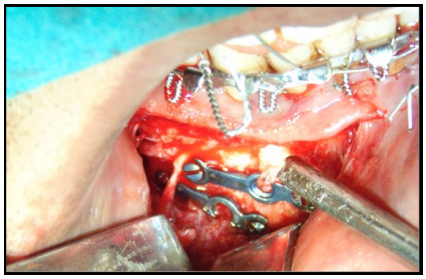


**Fig. 13:** Intra-operative photograph showing final placement of 2d conventional miniplates

### 5.3. Postoperative photographs

**Fig. 14:** Post-operative- front profile & occlusion

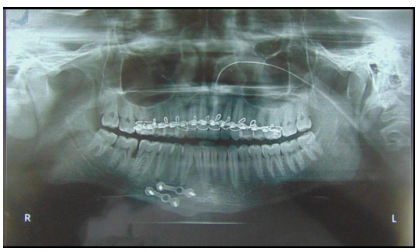


**Fig. 15:** Post-operative orthopantomogram revealing final placement of 2D conventional miniplates

**Fig. 16:** Bite force measurment of patien using prescale fujifilm Statistical analysis

### *5.4. Bite force measurment*

The data obtained from this study was entered in predetermined master chart format. The level of significance was fixed at 5% and $p \leq 0.05$ was considered statistically significant. Normality of data was checked and Chi square test was for non-parametric data and Student t test & Analysis of Variance for parametric data

## 6. Results

The present study was carried out to evaluate the efficacy of 3D miniplate versus conventional miniplates in the management of anterior mandibular fractures. The results are based on analysis of 24 patients, all of whom were male, for determining the efficacy of three-dimensional mini plates versus conventional miniplates.

Table 1 Shows the descriptive characteristics of the participants in the present study. The participants in group I had higher mean age than group II. All the participants in the present study underwent open reduction and internal fixation. Symphysis fracture was reported as diagnosis in greater proportion in patients belonging to conventional group and right parasymphysis in patients belonging to the study group.

S Shows the preoperative characteristics of the participants in the present study. A comparative evaluation revealed no significant differences between study and conventional group for any of the preoperative parameters assessed.

Table 3 Evaluation and comparison of the mean procedure time in the present study revealed significant differences between the two groups with significantly lower mean procedure time in study group 3D plate when compared to the conventional group.

Table 4 Shows the evaluation of the post-operative parameters in patients receiving study group 3D plate. Post-operative occlusion was found to be stable at day 7. No horizontal or vertical mobility of fracture fragments were seen and no neurosensory deficit or infection was reported after 3 months; however, mild pain was reported in only one patient after the $3^{rd}$ month. No significant differences at different time intervals were reported for the assessed parameters in the 3D group.

Table 5 Shows the evaluation of the post-operative parameters in control group patients receiving conventional group 2D plates. Post-operative occlusion was found to be stable at day 7. No horizontal or vertical mobility of fracture fragments were seen; however, neurosensory deficit was reported in two patients even after the third month. No infection or pain was seen in patients after 3 months. No significant differences at different time intervals were reported for the assessed parameters in the 2D group.

Table 6 Comparison of post-operative parameters in patients receiving 3D plate – study group and 2D conventional plates- control group revealed no significant difference between the two groups for any of the post-operative parameter assessed.

Table 7 Shows the comparison of bite force in patients receiving study group 3D plate and conventional group 2D plates at different time intervals on right and left sides. A comparative evaluation revealed no significant differences at Day 1 and 7 for both right and left sides; however, significant differences at $3^{rd}$ month time interval was seen with greater bite force in patients with study group 3D plate when compared to conventional group 2 D plates for both right and left sides.

## 7. Discussion

The management of mandibular fractures has evolved from closed reduction to open reduction. Champy's miniplates have become highly popular and is a time-tested method of treatment of mandibular fractures. However, advances like 3D miniplate with claimed advantages like requires less armamentarium, providing better occlusal stability, reduction of post-operative complication, intra operative time have been developed to further simplify the surgical technique.

In the current study, total 24 patients were included, demonstrated male predilection and most common site affected was right parasymphysis (55%), left parasymphysis (25%) and symphysis (20%). Barde et al. (2014) in study of total 40 patients reported higher ratio of male patient 34(85%) and female of 5(15%) with most common site affected to be parasymphysis (85%) and symphysis (15%). Kumar et al. (2012) reported (90%) parasymphysis and (10%) symphysis in study of 20 patients with a higher male predilection. Above both findings are in accordance to our study. On contradictory Goyal et al. (2011) found most common site to be angle (46.7%) followed by body (31.1%) and parasymphysis (20%) at last in total 30 patients.[13–15]

In present study, plating was done in group I with (3D miniplate) and group II (2D conventional miniplate) with a mean age of patients was 29.04 years with range of 17-56 years out of which Group I had mean age of 32.33±14.51

**Table 1:** Descriptive characteristics of the participants in the present study

| Variable | Study Group with 3D plate Mean + S.D. | | Control group with Conventional 2D plates Mean + S.D. | |
|---|---|---|---|---|
| Age | 32.33+14.51 | | 25.72+9.33 | |
| Diagnosis | Symphysis | 2(16.7) | Symphysis | 3(25) |
| | Rt. Parasymphysis | 7(58.3) | Rt. Parasymphysis | 6(50) |
| | Lt. Parasymphysis | 3(25.0) | Lt. Parasymphysis | 3(25) |
| Procedure Performed | Open reduction and internal fixation | 12(100) | Open reduction and internal fixation | 12(100) |

**Table 2:** Pre-operative characteristics of the study participants

| Characteristics | Categories | Study group - 3D miniplate N (%) | Conventional group -2D plates N (%) | p value |
|---|---|---|---|---|
| Pre-operative Occlusion | Stable | 5 | 7 | .921 |
| | Deranged | 7 | 5 | |
| Pre-operative Pain | Mild | 6 | 8 | .415 |
| | Moderate | 4 | 3 | |
| | Severe | 1 | | |
| Pre-operative fracture favorability – Horizontal | Favorable | 5 | 7 | .921 |
| | Unfavorable | 7 | 5 | |
| Pre-operative fracture favorability – Vertical | Favorable | 8 | 11 | .140 |
| | Unfavorable | 4 | 1 | |

**Table 3:** Shows the preoperative characteristics of the participants in the present study. A comparative evaluation revealed no significant differences between study and conventional group for any of the preoperative parameters assessed.

| Variable | Study Group 3D plate Mean + S.D. | Control Group conventional 2D plates Mean + S.D. | p value |
|---|---|---|---|
| Mean | 8.00+1.12 | 14.08+1.88 | .001*(s) |

**Table 4:** Evaluation of the post-operative parameters in patients – study group with 3D plate

| Group | Categories | Day 1 | Day 7 | $3^{rd}$ month |
|---|---|---|---|---|
| Stability of occlusion acc. To molar relation | Stable | 11 | 12 | 12 |
| | Deranged | 1 | - | - |
| Mobility of fracture fragment-horizontal | Present | - | - | - |
| | Absent | 12 | 12 | 12 |
| Mobility of fracture fragment-Vertical | Present | - | - | - |
| | Absent | 12 | 12 | 12 |
| Neurosensory deficit | Present | 2 | 2 | - |
| | Absent | 10 | 10 | 12 |
| Infection | Present | - | 2 | - |
| | Absent | 12 | 10 | 12 |
| Pain | No pain | 1 | 10 | 11 |
| | Mild pain | 11 | 2 | 1 |
| | Moderate pain | | | |
| | Severe pain | | | |

and group II had mean age of 25.75±9.33. Khalifa et al. (2012) reported mean group between 15-50 years and mean age of 32.5 which is akin to our study. Barde et al. (2014) reported age ranged between 20-50 years with mean age of 35 years which also nearly similar to our study age group. Sadhwani et al. (2013) reported age group between 18-60 years. Kumar et al. (2012) reported age group between 19-63 years and the mean age being 33.3 years. All the above studies show age profile of patients similar to the present study.

In present study, the operating time was considered from plate adaptation till final tightening of screw in group I 8.0±1.12 minutes and in group II 14.0±1.88 minutes, the difference between groups was found to be statistically significant. ($p<0.001$). In other similar studies Kumar et al. (2012) reported average time for 3D plate to be 6.3 minutes and for conventional plates to be 10.2 minutes and difference was statistically significant between two groups.

**Table 5:** Evaluation of the post-operative parameters in patients - control group with conventional 2D plates

| Group | Categories | Day 1 | Day 7 | $3^{rd}$ month |
|---|---|---|---|---|
| Stability of occlusion | Stable | 5 | 12 | 12 |
| | Deranged | 7 | - | - |
| Mobility of fracture fragment-horizontal | Present | - | - | - |
| | Absent | 12 | 12 | 12 |
| Mobility of fracture fragment- Vertical | Present | - | - | - |
| | Absent | 12 | 12 | 12 |
| Neurosensory deficit | Present | 7 | 8 | 2 |
| | Absent | 5 | 4 | 10 |
| Infection | Present | 2 | 3 | - |
| | Absent | 10 | 9 | 12 |
| Pain | No pain | | 1 | 12 |
| | Mild pain | 11 | 11 | |
| | Moderate pain | 1 | | |
| | Severe pain | | | |

**Table 6:** hows the evaluation of thepost-operative parameters in control group patients receiving conventional group 2D plates. Post-operative occlusion was found to be stable at day 7. No horizontal or vertical mobility of fracture fragments were seen; however, neurosensory deficit was reported in two patients even after the third month. No infection or pain was seen in patients after 3 months. No significant differences at different time intervals were reported for the assessed parameters in the 2D group.

| Parameter | Comparison - Study group 3D and Conventional miniplates group | | |
|---|---|---|---|
| | Day 1 p value | Day 7 p value | $3^{rd}$ month p value |
| Stability of occlusion | .377 | - | - |
| Mobility of fracture fragment-horizontal | - | - | - |
| Mobility of fracture fragment- Vertical | - | - | - |
| Neurosensory deficit | .190 | .273 | - |
| Infection | - | .371 | - |
| Pain | .753 | .640 | - |

**Table 7:** Comparison ofpost-operative parameters in patients receiving 3D plate – study group and 2D conventional plates- control group revealed no significant difference between the two groups for any of the post-operative parameter assessed.

| Time duration | Sides | Conventional Group 2D platesMean + S.D. | Study Group 3D plateMean + S.D. | p value |
|---|---|---|---|---|
| Day 1 | Right Side | 2.12+62 | 2.24+.73 | .679 |
| | Left Side | 2.22+47 | 2.4+.82 | .533 |
| Day 7 | Right Side | 6.45+1.50 | 5.68+1.48 | .218 |
| | Left Side | 6.58+1.46 | 5.80+1.40 | .200 |
| $3^{rd}$ month | Right Side | 35.75+4.55 | 40.83+2.20 | .002*(s) |
| | Left Side | 36.58+4.31 | 41.66+2.34 | .002*(s) |

Vivek (2016) reported average operating time to be 8.3 minutes for 3D plates and 14 minutes for conventional plates and statistically significant differences was found between two groups. Khalifa et al. (2012) also found statistically significant difference in terms of operating time between the patients operated using 3D plate was 10 minutes and using conventional miniplates 19 minutes. Barde et al (2014) in his study considered operating from incision to closure though the difference of operating time was higher from present study for 3D plate 50.60 minutes and for conventional plate 59.60 minutes. Which was statistically significant but higher than present study.[16–19]

All above studies shows statistically significant differences in operating which is in concordance with present study. On the contrary Sadhwani et al (2013) found operating time (incision to closure) was significantly higher using 3D plate then 2D conventional miniplates. According to this study it took 20 minutes extra time at symphysis and parasymphysis when 3D plate was used.

Operating time is an important parameter as higher time leads higher time to general anesthesia as well as financial burden on patients. Less operating time leads to less fatigue for surgeon and operation theatre staff and also physiologically and financially beneficial for the patients.

Mittal et al. (2012) stated that use of 3D plate in fracture reduction leads to less operating time than the conventional miniplates, which he considered was due to their geometric design and ease of contouring and adaptability, also it can be adapted using minimal exposure and no need to bend the plate as well.

In present study, the ability of plate for fracture fixation was evaluated by clinical examination for the presence or absence of mobility of fractured fragments. In this study, no statistical difference was noted as no mobility between fracture fragments was found postoperatively with 3D plate and 2D conventional miniplates in any of the 24 patients evaluated. Doshi et al. (2018) found mobility of fracture site in 2 out of 20 patients between follow-up from 1st week till 6th week, 1 in 3D plate and 1 in 2D conventional miniplates which was resolved within 3rd month. Sadhwani et al. (2013) in a study of 28 patients and reported no mobility in postoperative fracture site which was plated with 3D plate system at all and 2 patients had postoperative mobility which were plated using 2D conventional miniplates. Kumar et al (2012) among 20 patients found no statistically significant differences in between 3D plate and 2D conventional miniplates in terms of post-operative mobility of fractured segments. 2 patients of both groups had postoperative mobility at 2nd week recorded on follow-up but resolved within 6th week.

Barde et al (2014) stated; 12 out of 19 patients plated with 3D plate had mobility of fracture fragment and 4 out of 16 patients had fracture fragment mobility plated with 2D conventional miniplates at 2nd week follow-up which resolved at 4th week follow-up and the difference however, was not statistically significant. Goyal et al (2011) in study of 30 patients reported statistically no difference in both group in which one was plated using 3D miniplate and other using 2D conventional miniplates in that group one patient had minor changes in alignment of fracture fragment on 3rd month when it was compared to immediate post-operative. Above studies parameters were found to be non-significant. Mobility of fracture fragment after fixation shows poor efficacy of fixation system used and thus is an important parameter to evaluate the efficacy of plating system to provide rigid fixation.[20–24]

Primary aim of mandibular fracture reduction and fixation is to establish early and good functional occlusion hence post-operative occlusal stability is an important parameter to evaluate the success of surgery and the techniques used for fixation. In present study, occlusal stability was assessed on basis of molar relationship. Total 8 patients had mild occlusal discrepancies. In group I, only 1 out of 12 patients had mild occlusion derangement on post-operative day 1 in group I which was restored on post-operative day 7, minimal selective cuspal griding was done and there was no occlusal discrepancy noted at post-operative 7th day and 3rd month. In group II, 7 out of 12 patients had mild occlusion derangement on post-operative day 1, 4 patients had post gag and 3 had 1.0 mm open bite in which 4 patients were managed with inter maxillary fixation using elastics and 3 were managed by coronoplasty. At post-operative day $1^{st}$ 11 out 12 patients in group I had stable occlusion but in group II only 5 out of 12 patients had stable occlusion, difference can be noted at day $1^{st}$, but from 7th day and 3rd month all patients had perfect class 1 molar relations and data turn out to non-significant as all patients had stable occlusion. Goyal et al. (2011) in study of 30 patients, two patients (one in each group) had minor occlusal discrepancies which were managed by selective grinding, in one patient with comminuted fracture kept on inter maxillary fixation post-operatively and released next day and no discrepancy was noted later on follow-up at 3rd,15th and 30th day. Which is statistically non-significant. Doshi et al. (2018) found that only one 1 out of 10 patients had post-operative occlusion derangement at $1^{st}$ week and 2nd weeks of follow-up in group A (3D plate group) & group B (conventional 2-D miniplates group). At 3rd week of follow-up, four patients in 3D plate group and two patients in 2D conventional miniplates group had occlusion derangement. 6th week of follow-up 3 patients in Group A and one patient in Group B had occlusal derangement. At the end of 3rd month one patient had occlusal derangement in both the Groups. There was no difference between two groups at all the follow-ups ($p>0.05$). Both these studies though showed some incidence of occlusion derangement in both the groups at some point of time but there was no significant difference between groups which confirms to the findings of the present study.

Sadhwani et al. (2013) found significant difference p value of <0.05 at 95% confidence interval between two groups in study of total 28 patients. 2 patients plated with conventional miniplate had occlusal discrepancy and was corrected with inter maxillary fixation for weeks none of patients plated with 3D plate had discrepancy. Mohd. Ali Patel et al. (2016) statistically significant p value of 0.0001 among both groups in which plated conventional miniplate had occlusal discrepancy in 3 patients and group plated with 3D plated had only 1 patient had occlusal discrepancy which were restored using inter maxillary fixation. Both above mentioned studies are contrary with our studies.

In our study, bite force data was different between two groups (p value of 0.002) which was statistically significant. Bite force has been found significantly increasing for patients in whom 3D plate was used with maximum force observed at post-operative $3^{rd}$ month. For group I plated with (3D plate) the avg. bite force efficiency on $1^{st}$ day was- left side 2.4+.82 and right side 2.24+.73 Mpa, on day $7^{th}$ avg. left side 5.80+1.40 and right side 5.68+1.48 Mpa, significantly increasing up to value of avg. left side 41.66+2.34Mpa and right side 40.83+2.20Mpa at post-operative 3rd month and in the group II (2D conventional

miniplates) the avg. bite force efficiency on $1^{st}$ day was left side 2.22+47 and right side 2.12+62 Mpa, on $7^{th}$ day avg. left side 6.58+1.46 and right side 6.45+1.50 Mpa and at $3^{rd}$ month it was found to be on left side 36.58+4.31 and right side 35.75+4.55 Mpa . Gyanchand et al[115]. (2018) in total 20 patients found significant increase in bite force on post-operative day 7th,14th,21st,28th and 90th. Group A in which 3D plate was used found to generating more forces than group B in which 2D conventional plate was used. In 3D plate group the bite force generated was 30.33% on $7^{th}$ post-operative day, 41.09% on $14^{th}$ post-operative day.53.87% on $21^{st}$ day, 70.49% on $28^{th}$ post-operative day and 83% at $3^{rd}$ month post-operatively. The bite force values were found to be 33.56% on day 7th, 48.62% on day $14^{th}$, 56.96% on day 21st, 67.59% on day 28th, 81.42% at $3^{rd}$ month in 2D conventional miniplates group.

Denny George et al. (2016) at 3rd month follow-up found significant differences in both groups in terms of bite force. Group I which was plated with 2D conventional plate had significant difference on 7th day, 3rd week, 6th week and 3rd month in whom incisor bite force was 0.35, 1.01, 1.73 and 3.86 kg, respectively and for group II in which 3D plate was used values on $7^{th}$ day, $3^{rd}$ week, $6^{th}$ week and $3^{rd}$ month post-operatively, incisor bite force were 0.41, 1.63, 4.31 and 10.03 kg, respectively. In early post-operative follow-up, no difference in terms of bite force was noted. Significant data was found in terms of bite force was noted in later follow-up from $6^{th}$ week to $3^{rd}$ month in incisor area. 3D plate group had better bite force in incisor area in comparison to 2D conventional miniplates. Above mentioned both studies shown significant improvement in both groups and more with 3D plate thus 3D plating system is more efficient in bite force recovery and matches to present study.

El Nakeeb et al. (2016) in a comparative study, bite force found no significant differences between two groups of total 20 patients (Using pressure indicating film (Pressurex®, Sensor Products INC, New Jersey, USA). At 3rd month bite force for group I had mean of 315.28±124 .18 N and for group II had mean of 333.79±119.46 N. ($p>0.450$) which was statistically non-significant. Krishna Kishor et al. (2019) found non-significant differences in bite force data of 30 patients as measured By using digital bite force recorder. Mean bite force for Group A 3D plate was 7.96 ± 1.23 and group B standard conventional miniplates was 7.84 ± 1.28 after one month. After 1 month between two groups data was found to be statistically insignificant ($P>0.213$). Above mentioned both studies are contrary and doesn't match with our present study. The primary motive of any innovation in surgical technique is to improve the outcome and minimize the complications.

In present study, the post-operative complications in form of infection, pain and neurosensory deficit, were evaluated. In group I (3D plate) at 7th post-operative day 12 patients had neurosensory deficit for which medication was prescribed and the symptoms resolved within 3rd month follow-up. Infection was noted in 2 patients who had poor oral hygiene in which 1 patient had pre-existing laceration of lower labial mucosa which was already repaired after debridement under aseptic conditions preoperatively and intra operatively after plating. In other patient plate exposure was noted at lower labial vestibule region near lower central incisor which was conservatively managed with local debridement and irrigation and with coe pack, and healing occurred within 15th day and no infection noted at 3rd month follow-up. Patient also had complained of pain at chin region till post-operative 7th and 15th day follow-up after that it resolved and no medications were prescribed for it. Patient gave history of similar experience of delayed wound healing when he underwent extraction about 3 years back. In group II (2D conventional plates) 3 out of 12 patients had infection at post-operative day 7th and no signs of infections noted at 3rd month post-operative follow-up. All 3 patients had very poor oral hygiene. 1 patient had pre-existing laceration with his lower labial vestibule which communicating extra-orally it was managed conservatively with debridement and irrigations. Goyal et al. (2011) found no statistically significant data in terms of complications between both groups with infection rate of 1 out of 15 patients in each group. Sadhwani et al. (2013) in study of 28 patients found significant difference between two groups in view of complications in which no complications were found in group I (3D plate) and in group II (2D conventional miniplates) had 1 plate exposure and led to removal of plate after 3rd month. Which is contrary to our present study.[20–24]

In out study post-operative pain was evaluated in both groups on day 1st, 7th and 3rd month using verbal rating scale with range of 0,1,2,3. In Group I (3D plate) on post-operative day 1st, 11 patients had mild pain and 1 patient had no pain at all which significantly improved and on 7th day post only 2 patients experienced mild pain whereas on 3rd month post-operative only 1 patient had mild pain who also had plate exposure. In group II, 11 patients had mild pain and 1 patient had moderate pain on $1^{st}$ post-operative day. On post-operative day 7th 11 patients had mild pain and on post-operative 3rd month no pain was experienced. Barde et al. (2014) found statistically non-significant data between both groups in terms of pain. For group I (3D plate) avg vas score 2.93 and for group II avg vas score 3.00 with greatest pain at 2nd week post-operative and resolved within 4th week post-operative. Doshi et al. (2016) no significant statistical difference between both groups found in his study. Neurosensory deficit was evaluated by verbal response of patient for the presence or absence of numbness. In group I (3D plate) 2 out of 12 patients had paresthesia on post-operative day 7th which resolved after prescribing medication within 3rd month post-operative follow-up. In group II (2D conventional miniplates) 8 out of

12 patients had paresthesia on post-operative 7th day out of which 2 patients persisted paresthesia of lower lip left side (mental nerve region) even after 3rd month despite taking medications and which was finally resolved at about 4and 1/2 month. Doshi et al. (2016) in study of total 20 patients found statistical non-significant data. 2 out 20 patients in both groups had mental nerve paresthesia which resolved within 3rd month. Mohd. Ali patel et al. (2016) in 6 out of 40 patients had complications which had a value of (0.0001) and data was statistically significant in terms of complications. In our study, regarding complications no significant data was noted for both groups.

In the present study, we found that though that 3D plate cost is slightly higher than the 2D conventional miniplates but in the anterior mandibular fractures as only one plate is used than the 2D conventional miniplates and less numbers of screws are used. The higher cost is obsolete by this fact. Cost is further reduced in terms of operating time by using 3D plate.

The present study planned to include 20 patients each in both the groups but due to unforeseen circumstances of epidemic/pandemic of COVID-19 the flow of patients reduced due to the restriction imposed by govt. thus the patient included in groups were reduced by numbers.

## 8. Conclusion

Maxillofacial trauma is very common in India. Timely & effective intervention is pertinent for successful results with significant minimal post-operative risk of complications.

3D miniplate is a novel form of internal fixation system which promises for better intraoperative and post-operative results, when compared to standard 2D conventional miniplates; In recently published literatures.

The findings of our study infer that 3D miniplate fixation not only reduced intra operative time therefore effectively allows the surgeons to utilize his/her efforts for taking care of other surgical considerations which translates to better surgical outcome, but also provides better stability with lesser or no complications in management of anterior mandibular fracture; when compared to conventional 2D miniplates fixation. However, larger scale study including more subjects with blinded/non-blinded controls required to be done to conclusively prove the above.

## 9. Summary

In the present study, the center was Sri Aurobindo College of dentistry, Indore. The study was done to evaluate the efficacy of 3D miniplate vs 2D. conventional miniplates in anterior mandibular fracture. A total 24 patients were divided in two groups, out of which 12 patients treated using 3D miniplate and the remaining 12 treated with 2D conventional miniplates. The study was done to evaluate both intraoperative (difference in operating time) and post-operative (occlusal stability, complications, and bite force) factors important for successful treatment

On summarizing the results, operating time was found to be certainly less for 3D plate when compared to conventional miniplates and significant difference was noted. When compared for post-operative occlusal stability mild differences were noted with 3D plate in early post-operative phase in comparison to conventional miniplates. No difference was noted in terms of complications in both groups as complications subsided in late post-operative follow-up. Bite force was found to be significantly better with 3D plate group post-operatively in our study.

Thus, it can be summarized that 3D miniplate fixation reduced intraoperative time and also provided better post-operative results in terms of stability of occlusion with less/no complications which allows the patients for a more comfortable recovery, thereby enhancing the quality of life of the patient after the episode of trauma and its surgical intervention.

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None.

## 11. Conflict of Interest

None.

## References

1. Raymond FJ, Walter RV. Oral and Maxillofacial Trauma. vol. 1. 2nd ed. Pennsylvania: W.B. Saunders Company; 1997. p. 474–8.
2. Clark HB, Hayes PA. A study of the comparative effects of" rigid" and" semirigid" fixation on the healing of fractures of the mandible in dogs. *JBJS*. 1963;45(4):731–41.
3. Becker R. Stable compression plate fixation of mandibular fractures. *Br J Oral Surg*. 1974;12(1):13–23.
4. Krüger E, Schilli W. Oral and maxillofacial traumatology. Quintessence Pub Co; 1985.
5. Champy M, Lodde JP, Schmitt R, Jaeger JH, Muster D. Mandibular osteosynthesis by miniature screwed plates via a buccal approach. *J Maxillofac Surg*. 1978;6(1):14–21. doi:10.1016/s0301-0503(78)80062-9.
6. Ikemura K, Kouno Y, Shibata H, Yamasaki K. Biomechanical study on monocortical osteosynthesis for the fracture of the mandible. *Int J Oral Surg*. 1984;13(4):307–12.
7. Shira R. Open reduction of mandibular fractures. *J Oral Surg*. 1954;12(2):95–111.
8. Lindqvist C, Kontio R, Pihakari A, Santavirta S. Rigid internal fixation of mandibular fractures–an analysis of 45 patients treated according to the ASIF method. *Int J Oral Maxillofac Surg*. 1986;15(6):657–64. doi:10.1016/s0300-9785(86)80105-3.
9. Pogrel MA. Compression osteosynthesis in mandibular fractures. *Int J Oral Maxillofac Surg*. 1986;15(5):521–4. doi:10.1016/s0300-9785(86)80053-9.
10. Iizuka T, Lindqvist C, Hallikainen D, Paukku P. Infection after rigid internal fixation of mandibular fractures: a clinical and radiologic study. *J Oral Maxillofac Surg*. 1991;49(6):585–93. doi:10.1016/0278-2391(91)90340-r.
11. Michelet A, Deymes J. Osteosynthesis with screwed plates in maxillofacial surgery. Experience with 500 satellite plates. *J Maxillofac Surg*. 1973;58(4):249–53.
12. Reitzik M, Leyden WS. Bone repair in the mandible: a histologic and biometric comparison between rigid and semirigid fixation. *J Oral*

*Maxillofacial Surg*. 1983;41(4):215–8.
13. Rhinelander FW, Baragry RA. Microangiography in bone healing: I. Undisplaced closed fractures. *JBJS*. 1962;44(7):1273–98.
14. Roaf R. Non union and delayed union. In: Modern Trends in Orthopaedics – Science of Fractures – IV. London: Buttersworth; 1964.
15. Kárász I, Köröndi L, Szabó G. Photoelastic stress analysis on mandibular osteosynthesis. *Int J Oral Maxillofacial Surg*. 1986;15(3):259–62.
16. 3rd EE, Walker LR. Treatment of mandibular angle fractures using one noncompression miniplate. *J Oral Maxillofac Surg*. 1996;54(7):864–71. doi:10.1016/s0278-2391(96)90538-8.
17. Farmand M. The 3-D plating system in maxillofacial surgery. *J Oral Maxillofac Surg*. 1993;51(3):166–7.
18. Wittenberg JM, Mukherjee DP, Smith BR, Kruse RN. Biomechanical evaluation of new fixation devices for mandibular angle fractures. *Int J Oral Maxillofacial Surg*. 1997;26(1):68–73.
19. Dupre A, Touron P, Daste J, Lassere J, Bonafe JL, Viraben R, et al. Titanium pigmentation. An electron probe microanalysis study. *Arch Dermatol*. 1985;121(5):656–8. doi:10.1001/archderm.121.5.656.
20. Moran C, Mullick FG, Ishak KG, Johnson FB, Hummer WB. Identification of titanium in human tissues. *Human Pathol*. 1991;22(5):452–4. doi:10.1016/0046-8177(91)90130-h.
21. Morrow BT, Samson TD, Schubert W, Mackay DR. Evidence-based medicine: Mandible fractures. *Plast Reconstr Surg*. 2014;134(6):1381–90.
22. Gupta M, Iyer N, Das D, Nagaraj J. Analysis of different treatment protocols for fractures of condylar process of mandible. *J Oral Maxillofac Surg*. 2012;70:83–91. doi:10.1016/j.joms.2011.02.009.
23. Dingman RO, Natvig P. Surgery of facial fractures. *Br J Surg*. 1964;51(7):560. doi:10.1002/bjs.1800510741.
24. Richardson M, Hayes J, Jordan JR, Puckett A, Fort M. Biomechanical Evaluation of a Mandibular Spanning Plate Technique Compared to Standard Plating Techniques to Treat Mandibular Symphyseal Fractures. *Surg Res Pract*. 2015;p. 569030. doi:10.1155/2015/569030.

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