A Comparative Evaluation of Bite Force as a Parameter for the Stability in Conventional and Three-dimensional Mini Plates

Gyan Chand Jain, Reeta Jain¹, Hemlata Dwivedi²
Departments of Oral and Maxillofacial Surgery and ¹Prosthodontics, Genesis Institute of Dental Sciences and Research, Ferozepur, Punjab, ²Department of Prosthodontics, Dental College Azamgarh, Uttar Pradesh, India

Abstract

Introduction: Maxillofacial skeleton fractures can be treated by open (surgical) and closed (non-surgical) techniques. Fracture sites are immobilized either with intermaxillary fixation or external or internal devices (i.e. plates and screws) to allow bone healing. Aim: The study was primarily aimed at investigating the comparison between three-dimensional (3D) mini plates versus conventional mini plates in mandibular fractures under functional load. Methodology: This study was carried out in twenty patients for treatment of mandibular fractures. Bite force readings were made using indigenous bite force recorder in kilograms. Bite forces were recorded at the operated site and contralateral site of the same region. Bite force recordings were done preoperatively before fixing Erich arch bar and postoperatively at each follow-up (7th, 14th, 21st, 28th, and 90th day). Observations: Data show postoperatively in operated sites of the molar that patients in Group A generate more biting force on day 28 and day 90 when compared to Group B. The difference in mean bite force over control group on fractured sites of molars and incisors when comparison was done between postoperative days interval was significant. Conclusion: It was concluded that the 3D mini plates in mandibular fractures are efficacious enough to bear masticatory loads during the osteosynthesis of fracture. It gives the advantage of reduced implant material and 3D stability with almost similar results as seen in two conventional mini plates osteosynthesis.

Keywords: Bite force, conventional mini plate, mandibular fracture, three-dimensional mini plate

Introduction

Rapid modern transportation has led to increased fatalities in road traffic accidents (RTAs). Mandibular fractures are most common among fractures in the maxillofacial region and their treatment is one of the most frequent forms of therapy provided by oral and maxillofacial service.[1] The variability in the pattern of fractures results from the different causes of injury such as RTAs, assault, falls, and sports injuries. The aim of maxillofacial trauma treatment is the restoration of anatomic form and function with particular care to reestablish the occlusion. Treatment modalities range from intermaxillary fixation to rigid internal fixation of bone fragments. Fixation with plates/screws system is now standard treatment modality for fractures, osteotomies, and reconstruction of defects of the craniomaxillofacial skeleton.

Various types of plating systems have been introduced for fixing fractures and continuity defects of the mandible. In conventional bone plate/screws system, the problem of loosening of one or more screws has been noticed resulting changes in occlusal relationship due to alteration in anatomically approximated fracture fragments. This problem has been overcome by development of a new plating system by Mustafa Farmand in 1992 which holds the fracture fragments in three dimensions known as three-dimensional (3D) plate.[2] The basic concept of 3D fixation is that a geometrically closed quadrangular plate secured with bone screws creates stability in 3Ds since it offers good resistance against torque forces. The plates are adapted to the bone according to Champy’s principles and are secured with monocortical self-cutting screws.[3] Easy use, good resistance against torque forces, and compact form of the plate are some of the advantages. Bite force generated by the patient was recorded preoperatively and postoperatively after fixation with these plates at different days.

Address for correspondence: Dr. Hemlata Dwivedi, Joy Dental Care and Implant Centre, Near Sharda Chauraha, Rahul Nagar Madaya, Azamgarh - 276 001, Uttar Pradesh, India. E-mail: dwivedihemlata@gmail.com

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in different patients but for the same type of fracture of the mandible. Comparative evaluation of bite force is undertaken to assess the efficacy of the two systems.

**Aims and objectives**
The aim of the present study is to compare the stability of fractured fragments of the mandible under functional load between conventional mini plate and 3D mini plates and substantiate the possible advantages offered by the 3D mini plates in mandibular fractures.

**Materials and Methods**
This study was carried out in twenty patients reporting to the Department of Oral and Maxillofacial Surgery for treatment of mandibular fractures.

Inclusion criteria – no sex predilection, normal healthy individuals with no debilitating systemic diseases, single, noncomminuted mandibular fractures excluding condyle and coronoid process. All patients treated either intraorally or extraorally are included in the study.

Detailed case history of the patients was recorded and patients were evaluated on the basis of clinical and radiographic interpretation. Routine investigations were done. Preoperatively bite force recording was done on fractured site and contralateral site of same region before fixing Erich arch bar. Patients were randomly divided into two groups:

- **Group A** – Ten patients underwent osteosynthesis for fracture of the mandible using 3D stainless steel mini plate (2.0 mm system)
- **Group B** – Ten patients underwent osteosynthesis for mandibular fracture, using two 4 hole with/without gap stainless steel conventional mini plates (2.0 mm system)

Materials used for plating were as follows [Figure 1]:
1. Mini stainless steel plating surgical kit
2. 2.0-mm stainless steel 3D mini plates and 2.0-mm stainless steel 4 hole with/without gap conventional mini plates.

**Three-dimensional stainless steel mini plate 2 mm system**

- **Plates**
  - 2 × 2 holed-square plate
  - 2 × 2 holed-rectangular plates
  - 3 × 2 holed-continuous rectangle or double rectangle.

- **Profile height**
  - mm (standard plate).

- **Screws**
  - Diameter: 2 mm
  - Length: 5–10 mm.

- **Drill bit**
  - Diameter: 1.5 mm.

**Conventional stainless steel mini plates 2 mm system**

- **Plates**
  - Straight plate for 2 mm diameter screws
  - Profile height- 1.0 mm.

- **Screws**
  - Length: 5–10 mm.

- **Drill bit**
  - Diameter-1.5 mm.

**Methodology**

**Operative technique for three-dimensional mini plates**

Patients were operated either under general anesthesia or local anesthesia. Fracture sites were exposed. Reduction of the fragments and temporary intermaxillary fixation (IMF) were done. 3D miniplate was then positioned. Holding the plate, drilling was performed along with copious saline irrigation. Screws of suitable length were selected. Upper screws were tightened first, followed by the lower ones. Rotations were executed. IMF was released and occlusion was checked.

**Figure 1:** Armamentarium for Group A and Group B

**Figure 2:** Three-dimensional plate osteosynthesis
The site was closed layer wise using 3–0 vicryl and 3–0 silk [Figure 2].

**Operative technique for conventional mini plates**

Patients were operated either under G. A or L. A. fracture site was exposed followed by reduction of fracture fragments. Suitable mini plate was adapted at the lower border and another mini plate was fixed 4–5 mm above the lower plate. Screws were tightened in the drilled hole. IMF was released and the site was closed layer wise using 3–0 vicryl and 3–0 silk suture material [Figure 3].

Assessment of the patients was done under the following parameters:
1. Bite force recording
   a. Preoperative
   b. Postoperative – 7th, 14th, 21st, 28th, 90th day
2. Infection – present/absent
3. Paresthesia – present/absent
4. Hardware failure – present/absent
5. Mobility between fracture segment – present/absent

**Bite force recording**

Preoperatively, bite force recording was done on fractured and contralateral side before fixing Erich arch bar and postoperatively on 7th, 14th, 21st, 28th, and 90th day. Bite force readings were made using indigenous bite force recorder in kilograms [Figure 4]. Control group measurements were made in 50 normal healthy individuals in different age groups at different sites between incisor to the molar region. Mean values were calculated.

**RESULTS**

All the 20 patients treated were male. The youngest was 20 years old and the eldest was 44 years old [Table 1].

Etiology – 14 (70%) patients were of RTA, 3 (15%) assault, and 3 (15%) miscellaneous.

Time from injury to definitive management ranged within 14 days. 12 were treated between 1 and 6 days and 8 patients between 7 and 14 days. 13 (65%) patients had parasymphysis fracture, out of which 10 were on the right side and 3 on the left side, and 7 (35%) patients had body fractures out of which 4 were on the right side and 3 had on the left side.

Chief complaint of the patient’s were as follows: Pain in 6 (30%), pain and swelling in 3 (15%), pain and inability to open mouth in 7 (35%), inability to open mouth in 2 (10%), and inability to open mouth and swelling in 2 (10%).

Clinical examination – Displacement of fracture fragments with step and deformity in 10 (50%). Disturbed occlusion in 13 (65%) patients, existing soft-tissue injury in 15 (75%) patients, preoperatively infection – not noticed in any of the patients.

Comparative evaluation of bite force was performed among both the groups. All patients were evaluated for minor and major complications.

**Group A**

After application of 3D plates, all fractures appeared to be well reduced and stable in postoperative radiographs. One (10%) patient developed infection at the site of wound, which was drained and resolved by antibiotics. Major complications were not seen in any of the patients.

**Table 1: Age distribution**

| Age (years) | Number of cases treated with 3D plates (Group A) | Number of cases treated with conventional mini plates (Group B) | Total |
|-------------|--------------------------------------------------|---------------------------------------------------------------|-------|
| 16<20       | 1                                                | 1                                                             | 2     |
| 21<25       | 3                                                | 1                                                             | 4     |
| 26<30       | 2                                                | 4                                                             | 6     |
| 31<35       | 0                                                | 3                                                             | 3     |
| 36<40       | 3                                                | 1                                                             | 4     |
| 41<45       | 1                                                | 0                                                             | 1     |
| Total       | 10                                               | 10                                                            | 20    |

3D: Three-dimensional

**Figure 3:** Conventional miniplate osteosynthesis  

**Figure 4:** Technique of recording bite force in premolar–molar region
**Group B**

All the fractures appeared to be well reduced and stable in postoperative radiographs. Two (20%) patients developed infection at the site of the wound, which was drained and got resolved on administration of antibiotics. Major complications such as infection requiring plate removal, malunion, or nonunion were not noticed.

**Comparative evaluation of bite force**

1. The difference in mean bite forces when comparison was done between fractured and nonfractured sites in all 20 patients over control group preoperatively was 5.86 kg (14.15%) and postoperatively at day 7, it was 4.91 kg (11.74%); day 14, it was 4.21 kg (9.98%); day 21, it was 3.42 kg (8.02%); day 28, it was 3.02 kg (6.98%); and day 90, it was 2.28 kg (5.09%) [Table 2]

2. The difference in mean bite force when comparison was done in Group A with that of Group B on fractured sites of molars over control group preoperatively was 1.65 kg (−0.31%) and postoperatively at day 7, it was 0.03 kg (−3.23%); day 14, it was − 1.99 kg (−7.54%); day 21, it was − 0.38 kg (−3.09%); day 28, it was 1.81 kg (2.90%); and day 90, it was 1.00 kg (1.58%) Data show postoperatively in operated sites of the molar that patients in Group A generate more biting force on day 28 and day 90 when compared to Group B [Table 3]

3. The difference in mean bite force preoperatively between Group A and Group B on incisors over control group was 3.26 kg (6.59%) and postoperatively at day 7, it was 1.99 kg (1.02%); day 14, it was 0.20 kg (−7.65%); day 21, it was − 0.77 kg (−11.93%); day 28, it was 0.64 kg (−0.98%); and day 90, it was 0.39 kg (1.28%). Data show postoperatively when incisors are compared that patient in Group A can generate more biting force when compared to Group B [Table 4]

4. The difference in mean bite force over control group on fractured sites of molars when comparison was done between postoperative days interval was significant. Patient was able to generate 13.18% more of biting force from 29th to 90th day, 13.55% from 22nd to 28th day, 10.51% from 15th to 21st day, 12.96% from 8th to 14th day, and 21.43% from preoperative recordings to 7th day [Table 5]

5. The difference in mean bite force over control group on incisors when comparisons were done between postoperative days interval was significant. Patient was able to generate 24.42% more of biting force from 29th to 90th day, 12.29% from 22nd to 28th day, 12.02% from 15th to 21st day, 17.34% from 8th to 14th day, and 15.80% from preoperative recording to 7th day [Table 6].

**Discussion**

The use of 3D mini plates has not yet become established. In a recently published survey of 104 North American and European AO/ASIF surgeons, only 6% stated that they use this type of plate. Moreover, only a few follow-up series are presented in the literature, with few studies emphasizing the hardware-related advantages over conventional mini plates. These advantages include easy application, simplified adaptation to the bone without distortion or displacement of the fracture, improved biomechanical stability, simultaneous stabilization at superior and inferior borders, and hence less operative time. 3D titanium mini plates exhibit excellent biocompatibility as experienced by Julio Acero and Javier Calderon et al. Similarly, our study is in agreement with these authors. The present study had compared the bite forces generated by the patient after fixation with conventional mini plates and 3D mini plates as a parameter to compare the stability offered by these two plating systems under functional load. In this study, all the 20 patients treated for mandibular fracture

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**Table 2: Mean bite force on fractured and nonfractured site of both premolar and molar regions**

| Category               | Number   | Bite force mean (kg) | SD (kg) | Bite force mean (%) |
|------------------------|----------|----------------------|---------|---------------------|
| Preoperative           |          |                      |         |                     |
| Nonoperated site       | 20       | 10.19                | 4.90    | 24.70               |
| Operated site          | 20       | 4.33                 | 2.25    | 10.56               |
| Postoperative (day 7th)|          |                      |         |                     |
| Nonoperated site       | 20       | 18.03                | 6.63    | 43.72               |
| Operated site          | 20       | 13.12                | 4.86    | 31.99               |
| Postoperative (day 14th)|         |                      |         |                     |
| Nonoperated site       | 20       | 22.65                | 6.28    | 54.92               |
| Operated site          | 20       | 18.44                | 5.39    | 44.95               |
| Postoperative (day 21st)|         |                      |         |                     |
| Nonoperated site       | 20       | 26.17                | 6.23    | 63.47               |
| Operated site          | 20       | 22.75                | 6.62    | 55.45               |
| Postoperative (day 28th)|         |                      |         |                     |
| Nonoperated site       | 20       | 31.33                | 4.17    | 75.98               |
| Operated site          | 20       | 28.31                | 4.70    | 69.01               |
| Postoperative (day 90th)|         |                      |         |                     |
| Nonoperated site       | 20       | 35.99                | 3.64    | 87.28               |
| Operated site          | 20       | 33.71                | 4.80    | 82.19               |

SD: Standard deviation

**Table 3: Mean bite force on fractured sites of premolars and molars in Group A and Group B**

| Group      | Number of fractured sites | Bite force mean (kg) | SD (kg) | Bite force mean (%) |
|------------|---------------------------|----------------------|---------|---------------------|
| Preoperative |                            |                      |         |                     |
| A          | 10                        | 4.16                 | 2.07    | 10.40               |
| B          | 10                        | 4.50                 | 2.53    | 10.71               |
| Postoperative (day 7th) |           |                      |         |                     |
| A          | 10                        | 12.14                | 4.62    | 30.33               |
| B          | 10                        | 14.10                | 5.13    | 33.56               |
| Postoperative (day 14th) |          |                      |         |                     |
| A          | 10                        | 16.44                | 4.93    | 41.09               |
| B          | 10                        | 20.43                | 5.31    | 48.62               |
| Postoperative (day 21st) |         |                      |         |                     |
| A          | 10                        | 21.56                | 7.83    | 53.87               |
| B          | 10                        | 23.93                | 5.29    | 56.96               |
| Postoperative (day 28th) |          |                      |         |                     |
| A          | 10                        | 28.22                | 4.65    | 70.49               |
| B          | 10                        | 28.40                | 4.99    | 67.59               |
| Postoperative (day 90th) |         |                      |         |                     |
| A          | 10                        | 33.22                | 3.25    | 83.00               |
| B          | 10                        | 34.21                | 6.13    | 81.42               |

SD: Standard deviation
were male. This is in accordance with Guimond et al.\textsuperscript{[4]} who observed that out of 37 patients treated 86% were male. This difference may be because of the difference in the sample size/ inclusion criteria. The time interval from the onset of injury to surgical treatment in the present study ranged within 14 days and after plate fixation in both the groups; all fractures appeared to be well reduced and stable. Postoperative radiograph confirmed the adequacy of reduction. We have achieved similar objectives as found in the study done by Ellis and Walker that the time interval from the initial injury to surgical treatment ranged from 1 to 16 days and after application of bone plate, all fractures appeared to be well reduced and stable. Postoperative radiograph taken showed excellent reduction in all cases.\textsuperscript{[7]} Regalo et al. compared maximum bite force in molar and incisor regions of young Brazilian indigenous individuals with that of white Brazilian individuals and revealed mean maximum bite forces of indigenous individuals in right molar 421N, left molar 429N, and incisor region 117N. For white individuals recordings was right molar 410N, left molar 422N and incisor region 117N. It was observed that incisor region showed statistical significance ($P < 0.0005$), but no significance was observed in the molar region.\textsuperscript{[8]}

In an another study conducted by Gerlach and Schwarz\textsuperscript{[9]} which evaluated maximal biting forces in 22 mandibular angle fracture patients treated with mini plate osteosynthesis as advocated by Champy. The authors found postoperatively (after 1 week) only 31% of the maximal vertical loading as compared to controls was registered. These values increased to 58% at the 6th week postoperatively.

In this study, on the operated sites of premolar–molar region in Group A, patients generated a bite force of 30.33% on day 7, 41.09% on day 14, 53.87% on day 21, 70.49% on day 28, and 83% on day 90 over control group. Similarly, bite force generated postoperatively by Group B patients on operated sites of premolar–molar region was 33.56% on day 7, 48.62% on day 14th, 56.96% on day 21st, 67.59% on day 28th, 81.42% on day 90th over control group.

When incisors were taken into consideration, patients in Group A generated bite force of 26.75% on day 7th, 39.41% on day 14th, 49.13% on day 21st, 67.32% on day 28th, and 92.96% on day 90th over control group. Similarly, bite force generated by Group B patients was 25.73% on day 7th, 47.07% on day 14th, 61.06% on day 21st, 68.31% on day 28th, and 91.66% on day 90th over control group.\textsuperscript{[9]} This difference in bite force which was generated by patients in Group A in comparison to Group B over control group is statistically inconclusive, because the size of sample was limited. However, statistically significant differences were achieved when comparison was done in bite forces generated by patients on different postoperative days.

When operated sites of premolar–molar region were taken into consideration, patient was able to generate 13.18% more of biting force from 29th to 90th day, 13.55% from 22nd to 28th day, 10.51% from 15th to 21st day, 12.96% from 8th to 14th day, and 21.43% from preoperative recordings to 7th day.

### Table 4: Mean bite force of incisors in Group A and Group B

| Group       | Number of fractured sites | Bite force mean (kg) | SD (kg) | Bite force mean (%) |
|-------------|---------------------------|----------------------|---------|---------------------|
| Preoperative A | 10                       | 2.03                 | 1.54    | 13.95               |
| Preoperative B | 10                       | 1.26                 | 0.91    | 7.36                |
| Postoperative A (day 7th) | 10           | 3.90                 | 1.98    | 26.57               |
| Postoperative A (day 14th) | 10          | 4.39                 | 2.07    | 25.73               |
| Postoperative A (day 21st) | 10         | 5.75                 | 2.49    | 39.41               |
| Postoperative A (day 28th) | 10         | 8.03                 | 1.25    | 47.07               |
| Postoperative A (day 90th) | 10        | 7.16                 | 2.77    | 49.13               |
| Postoperative B (day 7th) | 10         | 10.42                | 2.32    | 61.06               |
| Postoperative B (day 14th) | 10        | 11.66                | 2.40    | 68.31               |
| Postoperative B (day 21st) | 10        | 13.55                | 2.56    | 92.96               |
| Postoperative B (day 28th) | 10        | 15.64                | 3.41    | 91.68               |

A: Fixation with 3D plate, B: Fixation with miniplate, 3D: Three-dimensional, SD: Standard deviation

### Table 5: Mean bite force difference on fractured site of premolars and molars at postoperative days interval

| Number of fractured sites | Mean percentage (kg) | SD |
|---------------------------|----------------------|----|
| Control group bite force  | 20                   | 41.02 | 7.10 |
| Preoperative bite force   | 20                   | 4.33  | 2.25 |
| Increase in bite force from 1st to 7th day | 20 | 21.43 | 4.86 |
| Increase in bite force from 8th to 14th day | 20 | 12.96 | 5.39 |
| Increase in bite force from 15th to 21st day | 20 | 10.51 | 6.62 |
| Increase in bite force from 22nd to 28th day | 20 | 13.55 | 4.70 |
| Increase in bite force from 29th to 90th day | 20 | 13.18 | 4.80 |

SD: Standard deviation

### Table 6: Mean bite force difference of incisors at postoperative days interval

| Number of fractured sites | Mean percentage (kg) | SD |
|---------------------------|----------------------|----|
| Control group bite force  | 20                   | 15.82 | 3.69 |
| Preoperative bite force   | 20                   | 1.65  | 1.29 |
| Increase in bite force from 1st to 7th day | 20 | 15.80 | 1.98 |
| Increase in bite force from 8th to 14th day | 20 | 17.34 | 2.25 |
| Increase in bite force from 15th to 21st day | 20 | 12.02 | 3.00 |
| Increase in bite force from 22nd to 28th day | 20 | 12.29 | 2.92 |
| Increase in bite force from 29th to 90th day | 20 | 24.42 | 3.13 |

SD: Standard deviation
When incisors were taken into consideration, patient was able to generate 24.42% more of biting force from 29th to 90th day, 12.29% from 22nd to 28th day, 12.02% from 15th to 21st day, 17.34% from 8th to 14th day, and 15.80% from preoperative recordings to 7th day. Our findings are in accordance to the study conducted by Cecillio, Moreto et al., and Gerlach and Schwarz. [8,9] Moreno et al. [10] analyzed 245 patients with 386 fractures and compared the complication rate with different types of mandibular fracture treatment. There were no differences in the complication rates for the different types of treatment. The occurrence of postoperative complications in treatment of mandibular fracture is fundamentally related to the severity of the fracture rather than to the type of treatment used.

In Group a postoperatively, mobility of fracture fragments and occlusal discrepancy was not noticed in any of the patient. One (10%) patient developed infection at the site of wound, which was drained and got resolved on administration of antibiotics. Major complications such as infection requiring plate removal, malunion, or nonunion were not noticed.

In Group B postoperatively mobility of fracture fragments, occlusal discrepancy was not noticed. Two (20%) patients developed infection at the site of the wound, which were drained and got resolved on administration of antibiotics. Major complications such as infection requiring plate removal, malunion, or nonunion were not noticed. [10]

The results obtained from this study shows that the mean difference of biting force in patients treated using 3D mini plates/screw system and patients treated using conventional mini plates/screw system over control group was statistically insignificant. However, evaluation of biting force generated by patient on various postoperative days was statistically significant. When comparison was done regarding the outcome of treatment and complications noticed between patients treated with 3D mini plates/screw system and patients treated with conventional mini plates/screw system statistically insignificant results were obtained. Studies with larger sample size are necessary to corroborate the findings of the present study for their wider use in clinical practice.

**Conclusion**

3D mini plates can be used satisfactorily in cases of unstable fractures of the mandible. Use of 3D mini plates is comparatively more cost-effective than two conventional mini plates as lesser number of plates and screws are needed for fixation. With the 3D mini plate osteosynthesis technique, lesser surgical exposure of the underlying fracture site is needed, with a minimal traction of the surrounding soft tissue. Because of the closed quadrangular geometric shape, and the ease with which it can be contoured and adapted to the bony fragments, the 3D mini plates provide better stabilization of fractured fragments in 3Ds. No hardware failure was noticed in either group. Bite force recording showed significant increase in values at various follow-ups in either group. Group A patients generate more bite force on subsequent follow-ups as compared to Group B. Bite force values reached near control group at day 90th. It was concluded that the 3D mini plates in mandibular fracture are efficacious enough to bear masticatory loads during the osteosynthesis of fracture. It gives the advantage of reduced implant material and 3D stability with almost similar results as seen in two conventional mini plates osteosynthesis.

**Informed consent**

Informed consent was obtained from all individual participants included in the study.

**Declaration of patient consent**

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patients have given their consent for their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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**Conflicts of interest**

There are no conflicts of interest.

**References**

1. Bochlogvros PN. A retrospective study of 1,521 mandibular fractures. J Oral Maxillofac Surg 1985;43:597-9.
2. Farmand M, Dupoirieux L. The value of 3-dimensional plates in maxillofacial surgery. Rev Stomatol Chir Maxillofac 1992;93:353-7.
3. Munish K, Ravi N, Bhavna GM. 3 Dimensional titanium mini plate fixation in the management of mandibular fractures – A Prospective study. Univ J Dent Sci 2016;1:37-410.
4. Jain MK, Manjunath KS, Bhagwan BK, Shah DK. Comparison of 3-dimensional and standard miniplate fixation in the management of mandibular fractures. J Oral Maxillofac Surg 2010;68:1568-72.
5. Zix J, Lierer O, Iizuka T. Use of straight and curved 3-dimensional titanium miniplates for fracture fixation at the mandibular angle. J Oral Maxillofac Surg 2007;65:1758-63.
6. Güimond C, Johnson JV, Marchena JM. Fixation of mandibular angle fractures with a 2.0-mm 3-dimensional curved angle strut plate. J Oral Maxillofac Surg 2005;63:209-14.
7. Ellis E 3rd, Walker LR. Treatment of mandibular angle fractures using one noncompression miniplate. J Oral Maxillofac Surg 1996;54:864-71.
8. Regalo SC, Santos CM, Vitti M, Regalo CA, de Vasconcelos PB, Mestriner W Jr, et al. Evaluation of molar and incisor bite force in indigenous compared with white population in brazil. Arch Oral Biol 2008;53:282-6.
9. Gerlach KL, Schwarz A. Bite forces in patients after treatment of mandibular angle fractures with miniplate osteosynthesis according to champy. Int J Oral Maxillofac Surg 2002;31:345-8.
10. Moreno JC, Fernández A, Ortiz JA, Montalvo JJ. Complication rates associated with different treatments for mandibular fractures. J Oral Maxillofac Surg 2000;58:273-80.