



Original Research Article

Comparitive assessment of bite forces in subjects treated for anterior mandibular fractures with 3-dimensional plates and standard miniplates

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ABSTRACT

Background: Loss of masticatory function is one of the important effects of mandibular fractures. Therefore the therapeutic goal of management is to restore original anatomic form and function. Considering this, maximal bite force could be a major factor for evaluating the success of treatment.

Objective: The purpose of this study was to compare the efficiency of 2.0mm 3-Dimensional plates and two standard 2.0 mm Miniplates in the fixation of anterior mandibular fractures i.e, the parasymphysis and symphysis fractures on the basis of bite force and other clinical parameters.

Materials and Methods: The study was conducted on 30 patients with isolated fractures of anterior mandible region. The patients were categorized into two groups with 15 patients in each group. In group A patients were treated with 3-Dimensional miniplate and in group B patients were treated with two conventional Miniplates and these patients were evaluated pre-operatively, immediate post-op, 1st week, 4th week, 3rd month and 6th post-op months using bite force and other clinical parameters.

Results: The study results revealed no statistically significant difference between the study groups with respect to root damage and mal-union. There was occlusal discrepancy, mobility of fracture segments, and post-op infection observed in Conventional plate group which was absent in 3D plate group. One patient in Conventional plates group had to undergo implant retrieval due to persistent infection and experienced neurosensory deficit even after 6th post-op month. The bite force measurement between the study groups showed statistical significant increase of bite force in the right premolar and right molar regions at 4th post-op month, 3rd post-op month and 6th post-op month. In 3D plate group, patients showed increased bite force values in comparison to Conventional plates group throughout the follow up intervals.

Conclusion: This study concluded that the use of 3D miniplates in anterior mandibular fractures is efficacious enough to bear masticatory loads during the healing of fractures. It gives the advantage of greater stability, increased bite force, reduced implant material and 3D stability. It was also found that 3D miniplate was superior to two-dimensional miniplate with respect to stability, increased bite force, economy and surgical technique achieving early function with stable occlusion.

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1. Introduction

Maxillofacial trauma has upheaved in the past few decades as a consequence of increasing road traffic accidents, violence and sports injury.¹ Mandible is the largest and strongest bone in the facial skeleton & most commonly fractured (73%),² by the virtue of its position on the face. The after-effects of mandibular fractures include change in

the skeletal architecture, masticatory muscle tear and injury to neuromuscular components, which in turn lead to altered occlusal load during the healing phase. Surgical treatment aims at proper anatomical reduction, restoration of the pre-morbid occlusion, esthetics, and fixation for stable Osseo integration.³ During such process, the resultant soft tissue injury (stripping of masticatory muscles and iatrogenic neuromuscular injury) can further affect the function of masticatory apparatus. Although occlusal position can be restored surgically, it is unknown whether the patient might

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be able to reproduce the pre-morbid occlusal forces, as there will be changes in hard and soft tissue components of the masticatory apparatus either due to the fracture and/or its surgical treatment. Maximum occlusal forces are an important and a significant parameter of masticatory function and also are relatively easy to measure and analyze. These forces depend upon the occlusion, number of muscle fibers recruited for function, and the force created by these recruited masticatory muscle fibers. Thus, when used in patients treated surgically for mandibular fractures, records of maximum occlusal forces act as excellent assessment criteria for restoration of skeletal architecture and repair and healing of masticatory soft tissues.⁴

There is a paradigm shift in the treatment of mandibular fractures, from the historical maxillomandibular fixation to the recent internal fixation systems. Of these Miniplates and reconstruction plates are commonly used to treat simple and comminuted fractures of mandible. However, thick fixation plates are bulky and palpable through the thin skin and the gingiva.⁵ More recently, 3-dimensional (3D) titanium plates and screws have been developed by Farmand,⁶ with a quadrangular design formed by joining 2 miniplates with inter-connecting crossbars that allow easy adaptation of plate to bone without distortion. The free area between these connecting arms permits good blood supply to bone. 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 anterior mandibular fractures, which are under a greater degree of torsional strain.⁷

Thus, the purpose of this study was to compare the efficiency of 2.0mm 3-Dimensional plates and two standard 2.0 mm Miniplates in the fixation of mandibular fractures in the, parasymphysis and symphysis region on the basis of bite force and other clinical parameters.

2. Materials and Methods

Patients with isolated mandibular fracture at interforaminal regions reporting to the Department of Facio-maxillary Surgery, from October 2019 to December 2020 requiring open reduction and internal fixation were selected for the study. Informed consent was taken prior to surgery and the data was collected in an enclosed Performa. Pre operatively either an OPG (orthopantomogram), and CT if necessary were taken to assess the type/site of mandibular fracture.

The patients were categorized into two groups as Group A and Group B each receiving 15 patients. In Group A: Fractures were fixed with 2.0mm 3 Dimensional

plate and in Group B: Fractures were fixed with two 2.0mm conventional Miniplates and screws placed according to Champy's principle. Bite forces was measured preoperatively, immediate post-op, 1st week post op, 4th week post-op, 3 months post-op and 6 months post-op.

2.1. Exclusion criteria

Medically compromised patients, patients with mixed or primary dentition, patients with associated mid face, malunited and infected fractures, completely edentulous patients, compromised dentition, patients with associated preexisting bone pathology, patients with previous history of major reconstruction maxillofacial surgeries (grafting, partial resection), patients with coronoid and condylar fractures were excluded, as it would not support this study.

Preoperative bite force measurements were recorded, using a bite force device consisting of a stainless steel bite force sensor of strain gage type, capable of measuring up to 800N, requiring 5VDC power supply and a load cell indicator with 124x64 LCD display, which displayed the force exerted in Newton(Figure 1). All measurements were made with the subject seated upright, looking forward and in an unsupported natural head position. The bite force instrument (transducer) could be conveniently positioned between the antagonizing cusps in the region of Left First Molar, Left first premolar, Central Incisor, Right first premolar and Right First Molar. Peri-operative antibiotic prophylaxis and analgesics were started as per our trauma protocol.

Patients were treated under General anesthesia. Eyelets/Erich arch bars were placed in both the arches as per the case requirement. 2% Lignocaine with 1:80000 Adrenaline was used for local infiltration. Intraoral lower vestibular incision was made in the labio-buccal sulcus and a full thickness mucoperiosteal flap was raised to expose the fracture site till the lower border of the mandible. Open reduction of fracture fragments was done and Occlusion was established with maxillomandibular fixation. For Group A: A 2.0mm stainless steel 3 Dimensional plate placed adapted and secured with monocortical 2.0mm X 8 mm stainless steel screws. For Group B: Two 2.0mm X 4 holed conventional stainless steel Miniplate were used sub apically and at the inferior border of mandible and secured with monocortical 2 X 8 mm stainless steel screws respectively, according to Champy's ideal line of osteosynthesis. A gap of 4-5 mm and parallelism were maintained between the two plates. The lower plate was adapted first and then the upper plate. Great care was taken not to damage the mental nerve. Occlusion was checked for all the patients before closing the surgical site. Operative site was closed in layers with 3-0 Vicryl suture. An extra oral pressure dressing was applied.

Patients were maintained under antibiotic coverage for 5-7 days and they were advised to take semi-solid diet

for 2 days and thereafter on a soft diet for 2 weeks. Betadine mouth rinse was advised. Sutures were removed on the 7th postoperative day. All patients were followed up on post-operative day 1, 1st week, 1st month, 3rd month and 6th month. Clinical parameters evaluated at the aforesaid intervals were bite force, damage to root by screw, Implant failure, malunion/nonunion, infection at site, neurosensory deficit, occlusal discrepancy, postoperative mobility at fracture site. During each follow up maximum bite forces at the of Left First Molar, Left first premolar, Central Incisor, Right first premolar and Right First Molar were measured. The transducer was cleaned with 70% alcohol and protected with disposable polyethene coverings, positioned on the bite device between each process. For patients on post-operative maxillomandibular fixation, the first week bite force measurement was done by retrieving the IMF and later redoing it after the measurement of bite force. The patients were advised to bite as forcefully as possible and the values were recorded in the preformed data sheet.



Fig. 1: Bite force recording device – transducer with digital disp

3. Results

A prospective study was conducted on 30 patients with isolated anterior mandibular fractures, requiring open reduction and internal fixation with 3-dimensional miniplates and standard miniplates. Bite forces were recorded in right and left molar, premolar, and incisor regions at various intervals of time in both the groups and were compared with independent student t test. According to the patients demographic data collected, the age ranged from 18 – 60 years. In Group A, the mean age was 31.47 years (SD=12.02) and in Group B, the mean age was 29.4 years (SD=11.08) respectively. The distribution of gender among study population included showed 14 (93.4%) male and 1 (6.7%) female patient in Group A and 13(86.7%) male and 2(13.3%) female patients in Group B. There was male predominance in both the groups. The assessment of incidence of aetiology showed increased incidence of road traffic accidents with 80.0% (n = 12) in Group A and 93.3% (n = 14) in Group B, self-fall in 13.3% (n=2) in Group A and 6.7% (n = 1) in Group B, followed by occupational injury in 6.7% (n = 1) in Group A.

No root damage was observed in both the groups. In Group B, 1 (6.7%) patient had implant failure and the implant had to be retrieved. In our study, mal-union/non-union of the fracture fragments were not observed. Infection of the surgical site was experienced in 1 (6.7%) patient in Group B at post-operative weeks 1 and 4. In Group A, 1 (6.7%) patient had neurosensory deficit, which recovered by 1st post-operative month. In Group B, 2 (13.3%) patients had neurosensory deficit. Out of which recover was seen in 1 (6.7%) patient by the 1st post-operative month, whereas the other failed to recover even after 6 post-operative months. Occlusal discrepancy was seen in 1 (6.7%) patient in Group B which was corrected by 1st post-operative month by the placement of IMF with elastics. Mobility of fracture fragments was not observed in any of the groups. Post-operative IMF was paced in 2 (13.3%) patients for a period of 2 weeks in Group B. Wound dehiscence was seen in 1 (6.7%) patient in both the groups which healed by 1st post-operative month.

In the left molar region, (Table 1) the pre-op mean bite force value was 104.18N for 3D plate group and 73.70N for Conventional plate group, which was statistically significant (p value= 0.05) as measured by independent t test. It increased gradually over a period of 6 months and reached a mean of 353.72N for 3D plate group and 325.7N for Conventional plate group. In the left premolar region, the mean pre-op bite force for 3D plate group was 60.36N which increased to 222.09N in the 6th post-op month. In Conventional plate group the mean pre-op bite force was 48.77N which increased to 205.78N by 6th post-op month. There was gradual increase of bite force values to normal by the end of 6 months. During the follow up periods, no significant difference was observed in change in incisor bite force between 3D plate group and Conventional plate group, but the change in bite force was greater in 3D plate group than Conventional plate by the end of 6 months. There was no significant gain in bite force after 3 months post-op. The bite force values in the right premolar region increased significantly at progressive follow-ups compared to that recorded preoperatively (Table 2). In both the groups, a statistically significant increase in bite force was found at 4th week, 3rd month and 6th postoperative months when compared to pre-op. The pre-op bite force was only 60.67N (in 3D plate group) and 45.61N (in Conventional plate group) compared with 237.14N (in 3D plate group) and 196.76N (in Conventional plate group) in the 6th month follow up after surgery. In the right molar region (Table 3), there was a progressive increase in the bite force readings in both the groups from a pre-op value of 118.37N (3D plate group) and 90.90N (conventional plate group) to 3378.23N (3D plate group) and 314.02N (conventional plate group) at 6th month post-op. There was statistical significant difference in the bite force values in both the groups at 4th week, 3rd month and 6th post-op month with p-values of

Table 1: Bite force recordings in left molar region

Left Molar Region		Minimum	Maximum	Mean	Std. Deviation	t value	p value
Pre-op bite force	Group A	17.46	196.13	104.18	43.83	2.022	0.05*
	Group B	20.15	136.40	73.70	38.52		
Immediate post-op	Group A	28.19	186.32	109.42	40.31	1.87	0.07
	Group B	14.40	138.10	81.45	41.27		
1 week	Group A	50.61	269.57	180.52	57.35	1.00	0.32
	Group B	44.51	287.60	157.41	68.26		
4 weeks	Group A	78.31	389.63	235.97	62.80	1.05	0.30
	Group B	75.43	315.12	211.24	65.73		
3 months	Group A	184.21	390.16	299.97	55.14	1.44	0.16
	Group B	160.62	355.87	270.36	57.37		
6 months	Group A	240.00	456.20	353.72	59.39	1.21	0.23
	Group B	250.41	496.20	325.70	66.30		

Table 2: Bite force recordings in right pre-molar region

Right Premolar Region		Minimum	Maximum	Mean	Std. Deviation	t value	p value
Pre-op bite force	Group A	19.15	107.83	60.675	30.84	1.41	0.16
	Group B	11.25	93.11	45.61	27.32		
Immediate post-op	Group A	13.28	122.16	67.50	35.54	1.35	0.18
	Group B	10.20	96.60	51.05	30.79		
1 week	Group A	32.30	172.15	126.34	47.04	1.72	0.09
	Group B	26.18	191.62	96.42	47.94		
4 weeks	Group A	90.33	234.03	178.15	40.46	2.38	0.02*
	Group B	44.88	234.03	138.54	49.87		
3 months	Group A	125.16	270.61	211.71	37.97	2.9	0.007*
	Group B	114.25	240.61	167.89	44.34		
6 months	Group A	185.45	295.62	237.74	31.28	3.34	0.002*
	Group B	133.18	246.18	196.76	35.67		

Table 3: Bite force recordings in right molar region

Right Molar Region		Minimum	Maximum	Mean	Std. Deviation	t value	p value
Pre-op bite force	Group A	23.09	193.98	118.37	53.94	1.88	0.07
	Group B	20.15	160.25	90.90	45.36		
Immediate post-op	Group A	23.09	193.98	118.37	53.94	1.50	0.14
	Group B	20.15	160.25	90.90	45.36		
1 week	Group A	70.71	338.66	223.52	79.34	1.93	0.06
	Group B	32.15	312.31	170.44	70.51		
4 weeks	Group A	103.12	389.63	283.12	71.02	2.23	0.03*
	Group B	40.04	389.63	221.25	80.17		
3 months	Group A	224.80	390.16	336.44	42.43	2.73	0.01*
	Group B	156.18	426.30	276.94	72.87		
6 months	Group A	332.18	498.10	378.23	38.78	3.27	0.003*
	Group B	210.18	458.10	314.02	65.16		

0.03, 0.01 and 0.003 respectively.

4. Discussion

Mandibular fractures, are of great cause of concern for the patient as these have a significant effect on mastication which is a unique function of the craniofacial musculoskeletal system. It is imperative to consider the anatomic, physiologic and biomechanical principles associated with the management of these injuries. Bite

force is considered as one of the indicator, of the functional restoration of the masticatory system that results from the action of jaw elevator muscles modified by the craniomandibular biomechanics.⁸ These forces depend upon the occlusion, number of muscle fibers recruited for function, and the force created by these recruited masticatory muscle fibers.⁹ Thus, when used in patients treated surgically for mandibular fractures, records of maximum occlusal forces act as excellent assessment criteria for restoration of skeletal architecture and repair and

healing of masticatory soft tissues.⁴ Farmand et al in 1992 developed the concept of 3D miniplates.⁶ Their shape is based on the principle of the quadrangle as a geometrically stable configuration for support. Since the stability achieved by the geometric shape of these plates surpasses the standard miniplates, the thickness can be reduced to 1 mm. He undertook a biomechanical investigation of these plates in 1996, where he studied the performance of a plate in the shape of the four sides of a square open in the middle. In his view, the device, which was fixed by screws, would foster stability in three dimensions, and its biomechanical characteristics were comparable to those of conventional miniplates.¹⁰ One of the advantages of this technique is the simultaneous stabilization of the tension and compression zones, making the 3D plates a time-saving alternative to conventional miniplates.⁶ Square and rectangular miniplates do have a disadvantage of molding to the bone surface, as they have to be bent in three dimensions, whereas the linear plates only have to be bent in two. It is more difficult to get a perfect adaptation with the 3D plates than with the linear ones because they are objects in the form of a plane that need to be adapted to a curved surface and not just an object in the form of a straight line.¹¹ Therefore, we undertook a study to compare the efficiency of 3 D miniplates and conventional Miniplates in the management of mandibular fractures in the interangular region on the basis of bite force and other clinical parameters.

The age distribution of the patients in our study was between 18-60 years with a mean age of 31.47 years in 3D plate group and 29.4 years in Conventional plate group. Majority of the individuals in this age group have complete permanent dentition, which is a necessity for the measurement of bite force and that their bite force remains relatively constant during this period. A review by Koc et al. states that normal aging process causes change in masticatory muscle force, and it stays fairly constant from about 20 years to 50 years of age and then declines.⁹ The gender wise distribution of the patients in our study groups were, 14 Males and 1 Female in 3D plate group and 13 Males and 2 Females in Conventional plate group. The majority of the patients were male in both the groups. In a retrospective study of 1,521 patients over a period of 20 years, it was found that the majority of the fractures occurred between the ages of 20 to 29 years and commonly in young men and the main etiological factor in their study were road traffic accidents.¹² In the present study, the relation of incidence of fracture occurrences and age distribution of the patients in both the groups had similar correlation with the study done earlier. In our study, the distribution of patients according to etiology was road traffic accidents in 80.0% (n = 12) in 3D plate group and 93.3% (n = 14) in Conventional plate group, self-fall in 13.3% (n=2) in 3D plate group and 6.7% (n = 1) in Conventional plate group, followed by occupational injury in 6.7% (n = 1) in 3D

plate group which was similar to the study done earlier with respect to etiology and gender distribution.¹² In our study, of the 30 patients, 3D plate group had, 9 patients (60%) with left parasymphysis fracture, 4 (26.7%) right parasymphysis fracture, and 2 (13.3%) fracture in the symphyseal region respectively. In Conventional plate group, 1 (6.7%) patient had bilateral body of the mandible fracture, 1 (6.7%) patient with bilateral parasymphysis fracture, 3(20.0%) patients with left body of the mandible fracture, 1(6.7%) patient with left parasymphysis fracture, 1 (6.7%) patient with left parasymphysis and right body of mandible fracture, 3 (20.0%) patients with right body of mandible fracture, 3 (20.0%) patients with right parasymphysis fracture and 2 (13.3%) patients with symphysis fracture respectively. Most of the patients had undisplaced linear fractures, oblique fracture was present in one patient in the 3D plate group. In a retrospective epidemiological study of 2137 mandibular fracture patients,¹³ it was found that majority of the fractures (45%) were in the symphyseal and parasymphyseal region as seen in our study (69%). The study included 30 patients who were categorized into two groups with 15 patients in each group based on inclusion and exclusion criteria. In Group A, the fractures were fixed with 3D miniplates and Group B, they were fixed with two conventional Miniplates placed according to Champy's principle under Local/General anesthesia. The clinical parameters evaluated were bite force, damage to root by screw, Implant failure, malunion/nonunion, post-op infection, neurosensory deficit, occlusal discrepancy, postoperative mobility at fracture site. In an analysis done by Ellis of 2,137 mandibular fracture patients, 10.5% patients sustained trauma to non-maxillofacial areas. In our study 20.3% patients in Conventional plate group had sustained trauma to non-maxillofacial areas.¹³ In our study, damage to tooth roots was not observed in any of the cases in both the groups. Post-op maxillo-mandibular fixation was placed in 2 patients in Conventional plate group. Out of the 2 cases, one patient was a young adult with bilateral parasymphysis fracture, for whom one side was treated with open reduction and internal fixation and the other was treated with MMF for a period of 2 weeks. This was done to compare the bite forces in fractures treated with open and closed reduction methods. A decision of 2 weeks of MMF for close reduction of fracture was done based on the results of Adeyemi et al.¹⁴ who suggested that a short period (2 weeks) of IMF in the management of minimally displaced mandibular fractures of the tooth-bearing area in young adults is a suitable alternative to the conventional method in terms of the healing outcome. The 1st week post-op bite force measurements were recorded by retrieving the MMF and redoing it after bite force measurements. The rate of post-op infection was 3.3% in Conventional plate group and 0% in 3D plate group by the end of 1st post-operative week. Guimond et al reported an infection

rate of 5.4% (2 out of 37 patients) with the use of 3D plates, Feledy et al reported 9% infection rate (2 out of 22 patients)¹ and Zix et al reported 0% (0 out of 20) infection rate in their study.¹⁵ There was one case in each group which showed wound dehiscence in the 1st post-operative week. In Conventional plate group the wound dehiscence was due to the presence of infection. Patients were advised antibiotics, continuous follow up for intraoral irrigations and strict oral hygiene maintenance which led to satisfactory healing in 3D plate group. Due to persistent infection implant had to be retrieved in Conventional plate group. The occlusion was checked preoperatively and during the follow up intervals after surgery. In the present study, 13 patients of 3D plate osteosynthesis and 10 patients of Champy's miniplate osteosynthesis had normal pre-op occlusion and no post-op discrepancy was observed. All the 15 patients of 3D plate osteosynthesis had normal pre-morbid occlusion postoperatively. On the other hand, 13 patients of Champy's miniplate osteosynthesis had normal postoperative occlusion and 2 patients had postoperative occlusal discrepancy which had to undergo inter-maxillary fixation with elastics for 2 weeks. 3D plates and miniplates are semi rigid methods of fixation which have reported less occlusal disturbances as these plates are self-adaptable and non-compressive, they do not fix the fragments rigidly hence self-correction due to action of oro- facial musculature can take place.¹ Fracture stability was assessed by simple digital palpation on either side of the fracture line and checked for the mobility of the fracture. Preoperative assessment of fracture fragments in both the study groups showed unstable fracture whereas postoperative assessment from day 1 to 6 months showed stability of fracture fragments in 3D plate group. One patient in Conventional plate group had mobility of fracture fragments by the 1st post-op month due to persistent infection which led to implant failure and retrieval.

Our study results showed that one patient in Conventional plate group developed infection, during 1st follow up week and none in 3D plate group. The infection was managed with local conservative therapy such as wound debridement with antibiotic irrigation followed by oral antibiotics, analgesics and chlorhexidine mouth rinse from the day of presentation but as there was no improvement in the condition, the implant had to be retrieved by the 1st post-op month. In no cases nonunion/malunion was observed in both the groups. In 3D plate group, 1 (6.7%) patient had neurosensory deficit, as the fracture line was passing through the mental foramen and nerve entrapment was relieved intra-operately, which recovered by 1st post-operative month. In Conventional plate group, 2 (13.3%) patients had neurosensory deficit. Out of which recover was seen in 1 (6.7%) patient by the 1st post-operative month, whereas the other failed to recover even after 6 post-operative months. This persistent

paresthesia could be attributed to permanent damage to the nerve due to severe displacement of the fracture fragments. The patient was counseled about the condition and advised multivitamin supplements and recalled for regular follow ups. In the present study, bite force was measured both preoperatively and post operatively in the region of Central Incisor, Right First Molar, Left First Molar, Left premolar and Right premolar region at the intervals of post-operative day 1, 1st week, 1st month, 3rd month and 6th month post-op. A preliminary study was conducted to measure the mean maximum bite force (MMBF) in healthy Indian individuals in the age group of 18-47 years with piezoelectric transducer device. It was found that the MMBF in Indian individuals to be 372.39 ± 175.93 N in the First Molar region and slightly higher in males (448.47 ± 191.82 N) as compared to females (296.31 ± 116.79).⁹ In another study, the measurement of voluntary bite force in 18-60 years individuals, it was found that the bite forces ranged from 22 to 50 kg in the Molar region and 3 to 27 kg in the Incisor region and the mean adult healthy value (male and female) in the molar region was 36kg and in the incisor region was 15kg.¹⁶ In the left molar region, the increase in post-operative bite force was more in 3D plate group when compared to the conventional group which was statistically significant. These findings correlate with that of Kinra et al.¹⁷ who undertook a comparative study to evaluate the bite forces in anterior mandibular fractures treated with 3Dimensional and conventional miniplate osteosynthesis. No significant difference was observed in change in incisor bite force between 3D plate group and Conventional plate group, but the change in bite force was greater in 3D plate group than Conventional plate by the end of 6 months. These findings correlated with the findings reported by Agarwal et al. 2011. There was no significant gain in bite force after 3 months post-op. This finding is in correlation to the findings of Kshirsagar et al. from his study of Bite Forces in Mandibular Parasymphysal Fractures.¹⁸ In the right premolar region and in right molar region, In both the groups, a statistically significant increase in bite force was found at 4th week, 3rd month and 6th postoperative months when compared to pre-op. Gerlach and Schwarz in 2002 stated that maximum bite force in a patient with mandibular fracture treated with miniplate osteosynthesis reaches only 31% at 1 week postoperatively and these values increase to 58% at the 6th week postoperatively.¹⁹ In our study, the bite force measurements in a bilateral parasymphysis fracture patient, who was treated with open reduction and internal fixation on one side and closed reduction with IMF for 2 weeks on the other, showed lesser bite force values on the closed reduction side at all the follow up intervals. This finding is in correlation with the findings of Pal et al. who compared post-operative bite force in mandible fractures treated with open and closed reduction.²⁰ Hence

emphasizing that open reduction and internal fixation of fractures result in early normalization of bite forces and early return to function.

In the present study, the bite force measurement was recorded between the study groups and at different regions at different time intervals. It showed increase in the bite force values, from post-operative day 1 to 3rd and 6th post-op month in both the groups which was significant in the right premolar and right molar region. Bite force is the cumulative effect of number of factors such as number of residual teeth, tactile impulses, and pressure and pain perception in periodontal ligament. There is a reduction in bite force with age due to age-dependent deterioration of dentition. The above finding shows that the use of 3D miniplates in mandibular fracture was efficient enough to withstand masticatory forces during the healing of the fracture. Although results obtained in the present study do not show a major difference in clinical outcome between the two techniques, yet 3D miniplates could be considered better of the two as its low profile design provides larger space between the plate holes thus permitting excellent revascularization. 3D miniplate utilizes optimal instruments and implant design to avoid complications during handling. Technically too, the use of 3D miniplate could be considered better as it requires minimal tissue dissection near the fracture site. Due to its superior design, maximum number of screws lie near the fracture site thus providing better stability, increased bite force, it could be used satisfactory even in the management of displaced fractures. On the economic point of view too, 3D miniplate could be adjudged better due to its low cost owing to the fewer number of plates and screws used in the technique.

5. Conclusion

This study results infer that fractures of the interangular region could be treated successfully with 3-Dimensional miniplates, as its specially designed geometric shape fulfilled the treatment goals of adequate immobilization, fixation and stabilization of fractures, with reduced post-op complications and early functional rehabilitation as indicated by the early return of bite forces to normal in comparison to the conventional plating system.

The merits of this study is that isolated, non-communited mandibular fractures were considered which aided in the appropriate measurements of bite forces and long follow-up period.

To conclude, the use of 3D miniplates in mandibular fractures is efficacious enough to bear masticatory loads during the healing of fractures. It gives the advantage of greater stability, increased bite force, reduced implant material and 3D stability. It was also found that 3D miniplate was superior to two-dimensional miniplate with respect to stability, increased bite force, economy and surgical technique achieving early function with stable

occlusion.

Further prospective randomized control studies with a large sample size are essential to evaluate this system for suitability in regular use.

6. Source of Funding

None.

7. Conflict of Interest

None.

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