

Comparative Study of 3 Dimensional and Standard Miniplate in Management of Anterior Mandibular Fractures

Revati Singh¹, Ajoy Kumar Shahi², V.K. Prajapati³, Swati Sharma⁴, Subhash Chandra⁵, Sandeep Kumar⁶

ABSTRACT

Introduction: The aim of mandibular fracture treatment is to restore the pre-injury anatomic form and function, with particular care to establish the occlusion. Of the various treatment modalities available, Champys miniplate fixation has become the most widely used technique. The 3-dimensional (3D) plating for mandibular fracture treatment is relatively new. This study was conducted to compare efficacy, stability and rigidity of 3-dimensional plates with that of 2mm titanium miniplates in the surgical management of anterior mandibular fractures.

Material and Methods: The study was conducted on 70 patients with anterior mandibular fractures (Symphysis and Parasymphysis region). Patients were randomly divided into two groups, Group I (n=35) in which the patients underwent fixation by miniplates (2 nos) while in Group II (n=35), 3D plates were used for fixation. The patients preoperative, intra operative and post-operative clinical and radiological findings were recorded in a proforma and were subjected to statistical analysis. Fisher's Exact Test was used to compare the data obtained from group I and group II patients.

Results: Out of 70 patients, 77.14% corresponded to the age group of 15-30 years and 82.85% were males. Road traffic accident (80) % was the leading cause of fracture. The time required to adapt and fix the miniplates was slightly more than 3-D plates and results were statistically significant. Skeletal and occlusal stability was maintained in both group.

Conclusion: There is no major difference in terms of treatment outcome in both systems, and both are equally effective in mandibular fracture treatment.

Keywords: Anterior Mandibular Fractures, Champys Miniplate, 3D Plate

INTRODUCTION

Traffic accidents - road, or rail, violence- personal or otherwise, sport accidents etc, have increased alarmingly in the past few decades. Maxillofacial trauma is very common in all these unforeseen events and the unique position of the mandible on the face makes it vulnerable. It is therefore, one of the most commonly fractured facial bones.¹ Fractures through the mandible at the level of the symphysis and/or parasymphysis are relatively common and account for approximately 20% of mandibular fractures.²

The main goal in the treatment of fracture is to predictably restore preinjury anatomical form and occlusion, with associated aesthetics and function and immobilization of reduced fractured ends. The goal must be accomplished by means that will produce the least disability, risk, and the shortest recovery period for the patient.³

The treatment of mandible fractures has evolved from closed reduction to rigid or semi-rigid internal fixation to three dimensional plate fixation.⁴ Historically, mandibular fractures were treated with closed reduction and a course of prolonged maxillomandibular fixation. The next phase of mandibular fracture management involved open reduction and wire osteosynthesis. Wire osteosynthesis was subsequently supplanted as the preferred treatment of fractures by open reduction and internal fixation with titanium hardware including lag screws and plates. The approach to rigid plate fixation has likewise been modified with progressively smaller plates and less reliance on compression in the treatment of these fractures.⁵

Rigid internal fixation was initially used in the oral and maxillofacial region in the late 1970s. Since the work of Michelet et al and later Champy et al, miniplate osteosynthesis has become an important fixation method in maxillofacial and craniofacial surgery.⁶⁻⁸ Miniplate osteosynthesis is accomplished by placement of a plate along the so-called ideal line of osteosynthesis, thereby counteracting distraction forces that occur along the fracture line during mandibular function. Miniplates provide functionally stable fixation, unlike rigid fixation, which prevents micromotion of the

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bony fragments under function. Functionally stable fixation applies to internal fixators that allow bone alignment and permit healing during function.⁹

Three-dimensional titanium plates and screws were developed and were reported first by Farmand.^{4,10} The 3D plating system is based upon the principle of obtaining support through geometrically stable configuration. The quadrangle geometry of plates assures a good stability in three dimensions of the fracture site since it offers good resistance against torque forces.¹ As the screws are placed in a box configuration on both sides of the fracture rather than on a single line, broad platforms are created that may increase the resistance to torsional forces along the axis of the plate. This mechanical property makes them suitable for use in symphyseal fractures, which are under a greater degree of torsional strain.¹¹

The 3-dimensional (3D) plating for mandibular fracture treatment is relatively new. Although experimental studies on biomechanics have confirmed sufficient stability of 3D plating system, only a few clinical studies are reported in the literature.^{12,13}

Also very few clinical trials have been performed to compare clinical experiences between conventional miniplates and 3D miniplates in the management of mandibular fractures. Based on these concerns, the present study was undertaken for comparative evaluation of stability and rigidity of titanium 3-D plates and titanium 2 mm miniplates as a viable treatment modality in the osteosynthesis of anterior mandibular fractures.

MATERIAL AND METHODS

Subjects for the study were selected among the patients reporting to the Department of Oral and Maxillofacial Surgery in Buddha Institute of Dental Sciences and Hospital, Patna from November 2012 to June 2014 for the treatment of the mandibular bone fractures. Prior approval was taken from ethics and research committee of our hospital.

The preoperative evaluation was done on the basis of history, clinical and imaging techniques. A total of 70 patients underwent surgery (open reduction and rigid internal fixation) for fracture anterior mandible (symphysis and parasymphysis). Patients in the age group 15-50 years with adequate permanent dentition to apply Ehrlich's arch bar or eyelet wiring were included in the study. Patients with any other associated fractures of facial skeleton other than mentioned above were excluded from the study as the surgical procedure was carried out under local anaesthesia.

Procedures were carried out under local anaesthesia (inferior alveolar nerve block) and local infiltration of lignocaine 2% with adrenaline for hemostasis. A standard intraoral surgical technique was followed to expose and reduce the fractures and in case of pre existing extraoral laceration the fracture site was exposed through the extraoral approach.

In the anterior region, the lower lip was everted and a B.P. blade no. 15 was used to incise the mucosa. The incision was curvilinear, extending anteriorly out into the lip, leaving 10-15mm of attached mucosa. The mentalis muscle was stripped

in a subperiosteal plane. Retraction of the facial tissues was facilitated by stripping them off the inferior border of the symphysis. In parasymphysis region to avoid mental nerve, the incision was made superiorly in the canine and premolar region. The controlled dissection and reflection of the mental neurovascular bundle facilitated retraction of the soft tissues away from the mandible. The fracture fragments were then reduced and proper occlusion was obtained.

Following reduction, the patients were randomly (simple randomisation) divided into two groups. In Group I (n=35) fixation was done with 2mm titanium miniplates and screws. Group II (n=35) patients underwent fixation with 3-D titanium plates and screws.

In group I patients fixation was done using 2-mm titanium miniplates (four holes with gap) using Champy's principle of osteosynthesis. 2x10 mm titanium screws were used to stabilize the plates.

In group II patients the titanium 3-D plate was adapted and held with plate holding forceps. Drill bits of 1.5 mm were used to make holes for the screws at the fracture site. Fixation with titanium three dimensional plates was achieved by using one 8 holed three dimensional plate and monocortical screws. The plate was placed in such a way that the horizontal crossbars were perpendicular and the vertical crossbars were parallel to the fracture. The screws were placed away from the roots of the teeth above and inferior alveolar canal below. The screws were threaded into position till the proper depth and tightness was reached under constant irrigation.

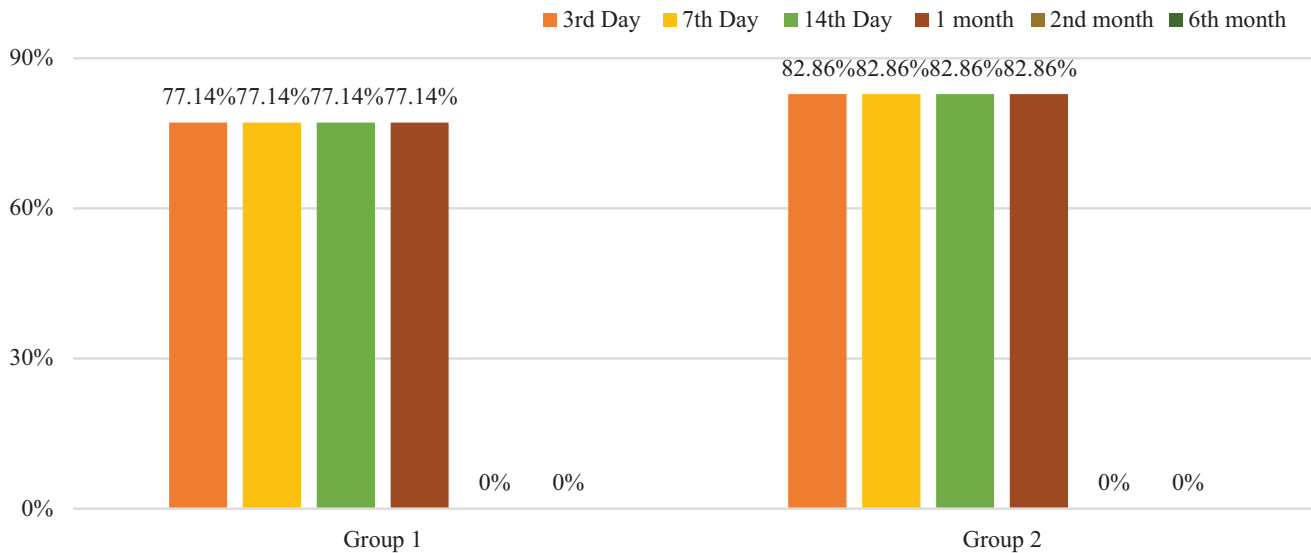
Once adequate fixation was achieved the area was irrigated with normal saline solution and hemostasis achieved. The incision was closed with 3-0 silk suture. An intraoral wet gauze pack was placed and a pressure bandage was applied over the operated site.

Peroperative time taken in titanium 3-D plates and titanium 2mm miniplates were evaluated. The patients clinical findings were recorded on the 3rd day, 1 week, 2 weeks, 1 month, 2 months and 6 months postoperatively. Post-operative clinical evaluation included assessment of both the groups on requirement of post operative MMF, occlusion, mouth opening, mobility of the fractured fragments, pain, infection, wound dehiscence, neurological defect, malocclusion, non union, fibrous union, screw loosening, plate fracture and lower border continuity. Radiological evaluation was done first, second and sixth month post operatively. All the observations for different parameters were recorded on the master chart based on the proforma prepared.

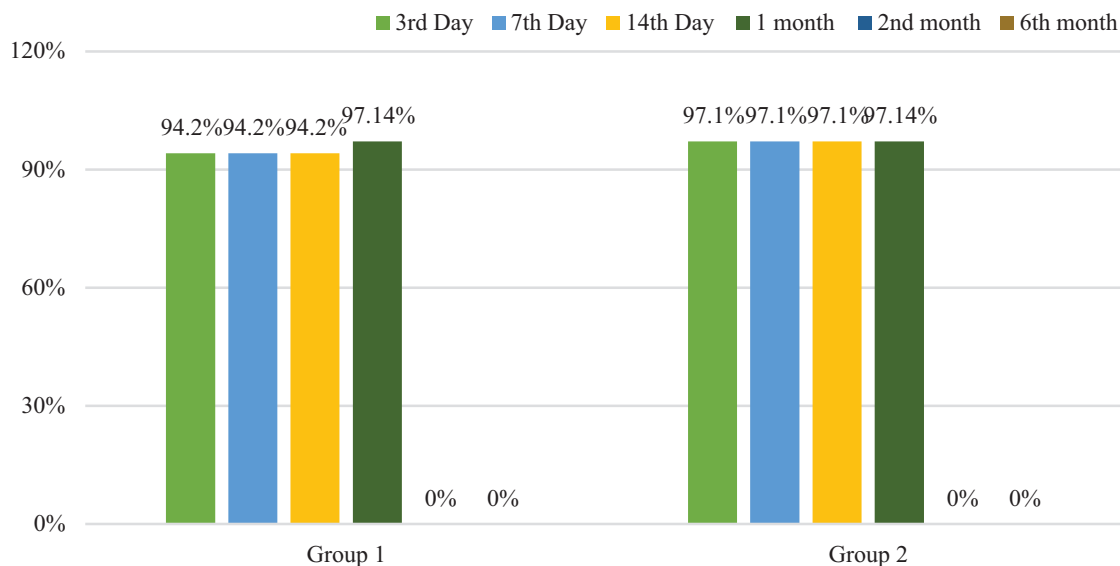
Data was entered in Microsoft excel and analyzed using SPSS (version 16). Fisher's Exact Test was used to compare the data obtained from group I and group II patients.

RESULTS

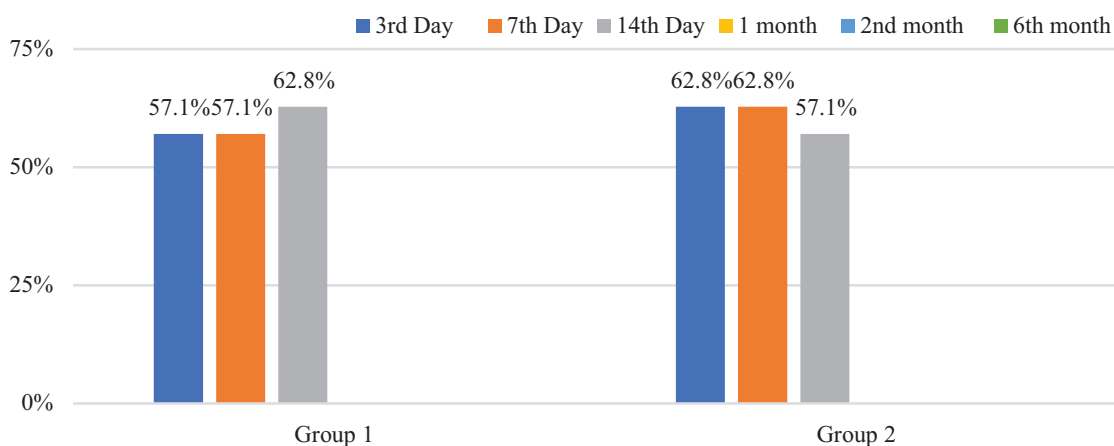
Table I shows the demographic and clinical findings. Out of 70 patients, 77.14% corresponded to the age group of 15-30 years. Out of 70 patients 82.85% were males. Road traffic accident, 58.57% was the leading cause of fracture followed by fall 28.57% and interpersonal violence 12.85%. The operative delay i.e. the time interval between trauma and



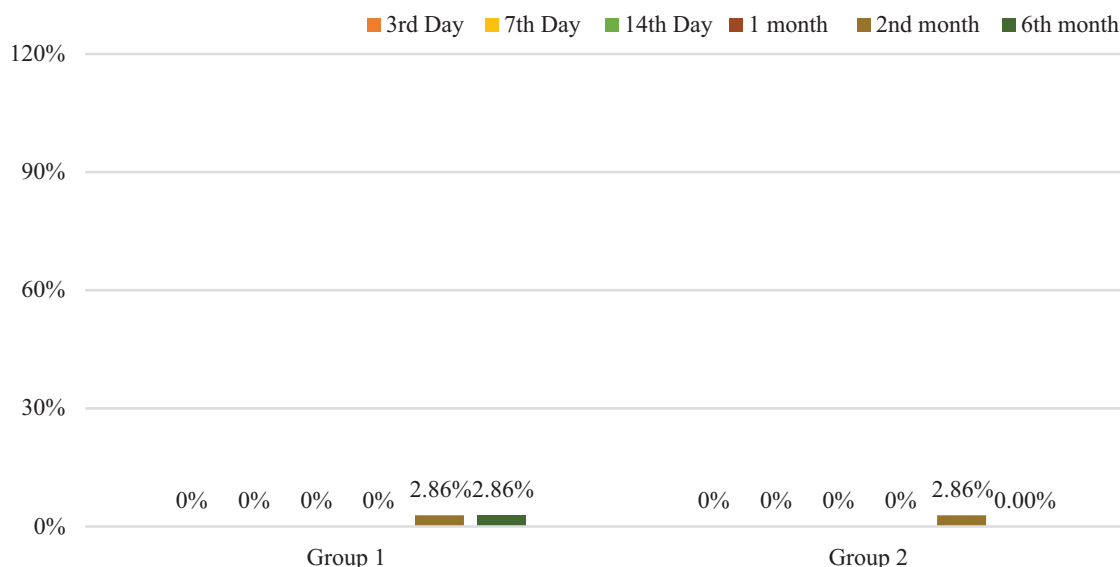
Graph-1: shows comparison among both the group with respect to maxillomandibular fixation at 3rd day, 7th day, 14th day, 1st month, 2nd month and 6th month.



Graph-2: shows the comparison among both the group with respect to occlusion at 3rd day, 7th day, 14th day, 1st month, 2nd month and 6th month.



Graph-3: shows the comparison among both the group with respect to Mobility of the fractured segment at 3rd day, 7th day, 14th day, 1st month, 2nd month and 6th month.



Graph-4: shows the comparison among both the group with respect to infection at 3rd day, 7th day, 14th day, 1st month, 2nd month and 6th month.

General Information (n=70)		N (%)
Age	15-30 years	54 (77.14)
	31-40 years	12 (17.14)
	41-50 years	4 (5.72)
Gender	Male	58 (82.85)
	female	12 (17.15)
Etiology	RTA	41 (58.57)
	Fall	20 (28.57)
	Interpersonal violence	9(12.85)
	Sporting injury	0 (0)
	Industrial trauma	0 (0)
Operative delay	1st 24 hrs	0 (0)
	Within 3 days	18 (25.71)
	1 week	34 (48.57)
	2 weeks	14 (20)
	None of the above	4 (5.72)
Site of Fracture	Symphysis	11 (15.72)
	Parasymphysis	59 (84.28)
Edema	Mild	11 (15.72)
	Moderate	49 (70)
	Severe	8 (11.42)
	None of the above	2 (2.86)
Sensory deficit	Present	0 (0)
	Absent	70 (100)
Side of fracture	Right Side	18 (25.71)
	Left Side	52 (74.29)

Table-1: Sample distribution and clinical findings

surgery ranged from 48.57% in 1 week, 20% within 2 weeks and only 25.71% within 3 days.

Parasymphysis of mandible (84.28%) was the most commonly involved site. 70% of the mandibular fracture patients had moderate oedema preoperatively. None of the patients had any sensory deficit.

Table II illustrates the preoperative clinical findings of the study group. Out of 70 patients 97.14% (n=68) had deranged occlusion and in 2.86% (n=2) the preoperative occlusion was

General Information (n=70)		N (%)
Interincisal distance	10-20 mm	44 (62.85)
	21-35 mm	23 (32.87)
	>35 mm	3 (4.28)
Occlusion	Maintained	2 (2.86)
	Deranged	68 (97.14)
Pain	Absent	0 (0)
	Mild	11 (15.72)
	Moderate	47 (67.14)
	Severe	12 (17.14)
Step defect	Present	69 (98.57)
	Absent	1 (1.43)
Hematoma	Present	65 (92.86)
	Absent	5 (7.14)

Table-2: Preoperative clinical findings

Group	N=70	Operation time ± SD (min)
Group I	35	15.33 ± 5.91
Group II	35	15.12 ± 5.20
t-value		8.11
P-value		0.02
S		

S: p<0.05- statistically significant

Table-3: Comparison of time required to adapt and fix the plate in Group I and Group II patients.

maintained. 62.85% of the patients had interincisal distance (mouth opening) between 10-20mm followed by 32.87% of the patients with interincisal distance between 21-35mm and only 4.28% had interincisal distance more than 35 mm. Out of 70 patients 98.57% had step defect present and 92.86% had sublingual hematoma present. 67.14% of the patients had moderate pain, 17.14% had severe pain and only 15.72%

S. no	Groups	3 rd day		7 th day		14 th day		1 month		2 months		6 months	
		Present n (%)	Absent n (%)	Present n (%)	Absent n (%)	Present n (%)	Absent n (%)	Present n (%)	Absent n (%)	Present n (%)	Absent n (%)	Present n (%)	Absent n (%)
1.	Group I	0 (0)	35 (100)	2 (5.72)	33 (94.2)	2 (5.72)	33 (94.2)	0 (0)	35 (100)	0 (0)	35 (100)	0 (0)	35 (100)
2.	Group 2	3 (8.57)	32 (91.4)	4 (11.43)	31 (88.5)	4 (11.43)	31 (88.5)	0 (0)	35 (100)	0 (0)	35 (100)	0 (0)	35 (100)
	Total (n=70)	3 (4.28)	67 (95.7)	6 (8.58)	64 (91.4)	6 (8.58)	64 (91.4)	0 (0)	70 (100)	0 (0)	70 (100)	0 (0)	70 (100)
	p-value	<0.001 S		0.05 S		0.05 S		-		-		-	
Fisher's exact test, S: p<0.05- statistically significant													

Table-4: Comparison among both the group with respect to wound dehiscence at 3rd day, 7th day, 14th day, 1st month, 2nd month and 6th month.

had mild pain while.

Table III represents time required for the adaptation and fixation of the plate at the fracture site for both the groups. In group I the average time required was 15.33 minutes and in group II time required was 15.12 minutes. The t-value was found to be 8.11 and the P-value was <0.05 which was statistically significant value. This result clearly suggested that fixation time was slightly more with titanium miniplates.

Graph 1 shows the requirement of maxillomandibular fixation (MMF) in both the groups on 3rd day, 7th day, 14th day and 1 month postoperatively. In group I out of 35 patients 22.86% (n=8) did not require MMF whereas in group II 17.14% (n=7) did not require MMF. After 1 month 100% in both Group I and Group II did not require MMF. In comparison among both the groups with respect to requirement of MMF at 3rd day, 7th day, 14th day, 1st month, 2nd month and 6th month postoperative period, the results were found to be statistically not significant.

Graph 2 illustrates the comparison of occlusion in Group I and Group II postoperatively. On 3rd day, 7th day and 14th day post operatively in group I, occlusion was maintained in 94.2% (n=33) and in group II occlusion was maintained in 97.14% (n=34) of the patients. On 1st month postoperatively the occlusion was maintained in 97.14% of the patients in both the groups. On 2nd month and 6th month postoperatively occlusion was maintained in 100% of the patients in group I as well as in group II. In comparison among both the groups with respect to occlusion on 3rd day, 7th day, 14th day, 1st month, 2nd month and 6th month postoperatively, the results were statistically not significant.

Graph 3 illustrates the comparison between the two groups with respect to fracture mobility. On 3rd day and 7th day post operatively fracture mobility in Group I and Group II was 57.1% (n=20) and 62.8% (n=22) respectively. On 14th day postoperatively fracture mobility in Group I patients were 62.8% (n=22) and in Group II patients it was 57.1% (n=20). On 1st month, 2nd month and 6th month postoperatively in both group I and group II, 100% (n=35) patients had no fracture mobility. In comparison among both the groups with respect to fracture stability on

3rd day, 7th day, 1st month, 2nd month and 6th month postoperatively, the results were not found to be statistically significant.

Graph 4 illustrates the comparison among both the group with respect to infection. No sign of infection in either of the group was seen till the 1st month post operatively. In the 2nd month post operatively 2.86% (n=1) of the patients in both the groups had signs of infection. 6th month post operatively only 2.86% patient in Group I had shown signs of infection and none in Group II. In comparison among both the groups with respect to infection on 3rd day, 7th day, 14th day, 1st month, 2nd month and 6th month postoperatively the results were not found to be statistically significant.

Table IV represents the comparison among both the groups with respect to wound dehiscence. On the 3rd day post operatively, wound dehiscence was present in 8.57% (n=3) of the patients in Group II and none in Group I. On 7th day and 14th day post operatively in 5.72% in Group I and 11.43% in Group II patients wound dehiscence was present. On the 1st month, 2nd month and 6th month post operatively none of the patients in either of the group reported with wound dehiscence. In comparison among both the groups with respect to wound dehiscence on 3rd day, 1st month, 2nd month and 6th month postoperatively the results were not found to be statistically significant while the same on 7th day and 14th day were found to be significant with more wound dehiscence in Group II.

None of these parameter i.e. malunion, non-union, screw loosening, plate fracture and fibrous union were seen in either group. Lower border continuity was maintained in both the groups in all the post operative reviews.

DISCUSSION

Over the years the methods to treat mandibular fractures have undergone many refinements. Newer methods have been tried and older ones had improvements. Despite encouraging results the use of 3D miniplates in mandibular fracture 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.¹¹ Moreover, only a few follow-up series are presented in the literature, with few studies emphasizing the hardware-related

advantages over conventional miniplates and reconstruction plates.^{4,14}

Statistics Associated With Mandibular Fractures

Teenage and middle aged males are most prone to fractures in maxillofacial region due to socially active life led by this age group. Other studies have also reported that more men than female were involved in maxillofacial injuries with the highest occurrence among those in the 20–29 age group.^{15,16} In this study majority of patients received trauma due to road traffic accidents (58.57%), followed by fall (28.57%) and interpersonal violence (12.85%). The results are consistent with other studies where road traffic accidents (64%) was reported as the main etiological factor in mandibular fracture.^{15,17} Oikarinen et al reported that the main etiological factor of mandibular fracture varied from place to place. He reported that road traffic accidents was main cause of mandibular fracture in Kuwait but in Toronto and Oulu (Finland) assault was the most common cause.¹⁸

Operating time

In this study the time required for the adaptation and fixation of the plate at the fracture site in the mandible was recorded for both the groups. The operating time for adaptation and fixation for 3D plating was less as compared with conventional mini-plates and the results were statistically significant. Jain et al in contrary reported that the 3D plate system is unfavorable for use in cases of oblique fractures and those involving the mental nerve, and is also difficult to adapt because geometric plate is much broader and has to be bent in 3 dimensions, whereas a linear plate has to be bent only in 2 dimensions and so it is trying to adapt a “plane” rather than a “line” to a curved surface.¹² Our findings are similar to the results of other studies who have reported that 3D plates were easily adaptable which reduces the average operating time.^{12,19,20}

Occlusion

Postoperatively two patients in Group I and one patient in Group II had slight occlusal discrepancy which was successfully corrected by guiding elastics with selective grinding in one case. This incidence of occlusal discrepancy was compared between the two groups and the results showed no statistically significant difference. Similar results were obtained by Barde et al in their study. They concluded that 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.¹³

Infection

Post operative infection following treatment of mandibular fracture depends on several factors like patients systemic condition, treatment modality (open vs closed reduction), surgical contamination, lack of skeletal instability, delay in treatment, tooth in the line of fracture, oral hygiene etc. Infection rates following mandibular treatment is also debatable with rates varying from 0 to 24.7%.²¹ In our study 2.86% (n=1) of the patients in both the groups had signs of infection. Majority of patients (48.57%) were given definitive management within the time lapse of 1week

and (20%) in 2 weeks after the injury. These results are consistent with Czerwinski et al who reported that delay of mandibular fracture treatment greater than 72 hours does not significantly increase infection risk.²²

Mobility of fractured segment

Mobility at the fractured site was examined in Group I and Group II patients preoperatively and during various follow up stages. Fracture mobility was assessed with the help of digital manipulation of the fracture site with the help of thumb and index finger of both the hands. Preoperatively all patients of Group I and Group II had mobility of fracture fragment. In our study, it was observed that twenty cases (57.1%) out of 35 cases of Group I had mobility after 7 days which later decreased over a period of 2 weeks, and by the 1st month postoperatively none of the patients showed any mobility in fractured segments. In Group II, twenty two cases (62.8%) out of 35 patients had mobility 2 weeks postoperative mobility at the fracture site and by the 1st month postoperatively none of the patients showed any mobility in fractured segments. No statistically significant difference was found among the two groups. The results are consistent with results of Barde et al who concluded that rigidity of fractured segments produces a stable foundation for soft tissue growth and improved vascularity to the area improves and allows better healing of wound.¹³

Wound Dehiscence

In our study the patients were also checked for wound dehiscence, on the 3rd day, 1 week, 2 weeks, 1 month, 2 months and 6 months post operatively. Wound dehiscence was slightly more in Group II as compared to Group I though the results were not statistically significant. Some studies have reported low incidence of wound dehiscence and plate exposure with 3D plate in comparison to conventional miniplate.³

Extensive laceration of buccal gingiva and infection were the most common cause of wound dehiscence. All the patients with wound dehiscence were kept on antibiotics and continuous follow up in the OPD for normal saline and betadine irrigations, which led to satisfactory secondary healing.

CONCLUSION

The choice of a suitable osteosynthesis material is an integral part of a treatment plan. In our study there was no major difference in terms of treatment outcome in both systems, and both were equally effective in mandibular fracture treatment. However, in the symphysis/parasymphysis region, 3D plates fixation is less time consuming as compared to miniplate fixation. Another limitation of 3D plates was excessive implant material resulting from extra vertical bars incorporated in its design which is also very difficult to adapt in mental foramen area. A larger sample size however may be required to substantiate our results.

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