

Efficacy of three dimensional titanium mini-plates in maxillofacial fractures- A prospective clinical study

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Type of Publication: Case Report

Conflicts of Interest: Nil

Abstract

Introduction: The purpose of this study is to know the efficacy of three dimensional titanium plates in the management of maxillofacial fractures.

Aim and Objective

- 1.The purpose of the study is to evaluate the clinical results of 3-dimensional mini-plates in stabilisation of fractured bone segments.
2. To assess the efficacy, stability and rigidity of 3-dimensional mini-plates for osteosynthesis.
3. To demonstrate its biocompatibility with surrounding soft tissue and bone.

Methodology: The study was conducted in 20 patients with maxillofacial fractures treated with open reduction and internal fixation using Three Dimensional Titanium mini-plates under general or local anaesthesia.

Results: All fractures had satisfactory stability in the postoperative period. A significant reduction and occlusal stability had been achieved in 63.2% cases. 5% of the patients had post-operative infection and soft tissue dehiscence which was treated. No evidence of nonunion or mal union was noted.

Conclusion: Three dimensional plates provide good stability of bone fragments due to closed quadrangular geometric shape, and the ease of contouring and adapting. Because of better inter fragmentary stability; supplemental fixation is not necessary or minimal time required, thereby enhancing the overall comfort, convenience and well being of the patient.

Keywords: 3-D Titanium miniplates, mid-face fractures, mandibular fractures, open reduction and internal fixation.

Introduction

Maxillofacial fractures include both the mid face and the mandibular fractures. main goal in the treatment of fracture is to restore pre injury anatomical form, with associated aesthetics and function⁽¹⁾. Miniplate osteosynthesis was first introduced by Michelet. et al in 1973 and later developed by Champy and Lodde in 1975. In Champy's method of semi rigid fixation monocortical miniplate is placed along the ideal osteosynthesis line. The preference to use titanium in the manufacture of 3D plates was obvious due to excellent properties like corrosion resistance, good biocompatibility, pliability and artefact free images in CT and MRI scan. Three dimensional mini plates are easy to adjust require minimal tissue dissection, thus least disturbing the blood supply and because of its design fixation points remain in the vicinity of fracture line. Its low profile design and space between mini plate holes permits excellent revascularization. The shortcomings of rigid and semi rigid fixation led to the development of 3 Dimensional (3D) consists of two 2-hole miniplate with gap which are interconnected by vertical cross struts. The quadrangular geometry of these plates provides three dimensional stability of the fracture segments against the mechanical forces. Based on the above bio mechanical and technical advantages of 3D miniplate system over the conventional miniplates promoted the current study to evaluate the efficacy of three dimensional titanium mini plates as treatment modality in the osteosynthesis of Maxillofacial fractures.

Methods of data collection

All the 20 patients had undergone Open reduction and internal fixation (ORIF) under general anesthesia or local anesthesia in the Department of Oral and Maxillofacial Surgery, D. A.Pandu Memorial R V Dental College, Bengaluru..Patients were evaluated pre-operatively, intra-operatively and post-operatively for various parameters.

The following clinical parameters were evaluated in the study are Duration of plate adaptation,Pre-operative occlusion,Post- operative occlusion,Supplemental fixation ,Duration Hardware complications,Inter fragment stability,Neurological deficit,Post-operative infection,Soft tissue dehiscence.

Plate design

We have used commercially available three dimensional titanium miniplates. It is made up of Titanium with a thickness of 2mm for mandibular fractures and 1.5mm for maxillary fractures and titanium screws of length 6mm and 8mm with 2mm diameter for mandible and maxilla we had used 6mm length and 1.5mm diameter screws

Methodology

Our study was conducted after approval by the Institutional Ethics Committee. The routine preoperative investigation comprised clinical examination and digital orthopantomogram and computed tomography scan. Complete haematological investigations were performed and all patients were started on intravenous antibiotics that were continued for 5 days postoperatively in all patients. Erich arch bars were applied to the maxillary and mandibular dentition a day prior to surgery if required. All patients were operated under general anaesthesia with nasotracheal intubation or local anesthesia following a standard surgical protocol by a single oral and maxillofacial surgeon.

Procedure followed are local infiltration of the intra oral site with 2% lignocaine with 1:80,000 adrenaline, an incision was planned based on the site of fracture. Intra oral approach followed in all cases in the study. Sub periosteal dissection done .Fracture segments identified and reduced under direct vision, satisfactory occlusion was achieved and held in place.Fractured segments are stabilised using 2mm 3-D rectangular mini plate for mandible and 1.5mm 3-D rectangular plate for

maxilla. Plates are secured using mono cortical screws of 2mm diameter in mandible and 1.5mm diameter in the maxilla of varying lengths. If inter maxillary fixation was done it was released and checked for occlusion. Copious irrigation was performed with betadine and saline. The intraoral wound was closed with 3-0 vicryl sutures and the throat pack was removed (general anesthesia patients only). General anesthesia was reversed and the patient was extubated and shifted to the recovery room. All patients were hospitalized for 5 days and were placed on a liquid diet for 2 weeks, followed by a soft diet for another 4 weeks. Pre and post-operative radiographs were taken for all the patients. After proper history taking pre-operative occlusion was noted and case pictures were taken. Intra-operatively after reduction of fracture segments, the time taken for the plate adaptation was recorded. If preoperative occlusion is not there and arch bar was placed, release the arch bar post-operatively and post operative occlusion was checked. Occlusion was evaluated on the post-operative day one and if required elastics or intermaxillary fixation was done and the duration of fixation was also noted. During the surgery any hardware complications like plate breakage or difficulty in fixation of screws was also noted. Immediately after the fixation interfragment stability was checked followed by evaluation at regular intervals of 6 weeks and 6th month post-operatively. If the stability is achieved it represented as present, if not it is recorded as absent. Neurological deficits like paresthesia was recorded both preoperatively and post-operatively. This was evaluated during the follow-up and recorded at regular intervals. Post-operative infection was evaluated at regular intervals with any pus discharge from the site of surgery and the treatment given if any was recorded accordingly. Soft tissue dehiscence with wound breakdown, plate exposure and the wound healing in the

operative site was evaluated at the intervals of immediate, 6 weeks and 6th month post operatively.

Results

Twenty patients included in the study were in the range of 20 to 64 years with mean age and standard deviation of 31.9 and 10.7 respectively. Study included 19 male patients (90%) and 1 female patient (10%).

Fracture characteristics elicited from the study participants

Etiology of fractures was RTA in 14 patients (70%) and the assault or the self fall (15%) each were the other common causes for the fractures. Para symphysis stands the most common site of fracture with 11 patients (55%) in the study group. The second most common fracture in the study group was anterior wall of maxilla fracture and symphysis with 3 patients (15%) in each respectively. In our study we had 2 patients (10%) with both parasymphysis and body fracture.

Time taken for the adaptation of the plate intra-operatively among the study group

Intra operatively duration of the time taken to adopt the plate to the fractured jaw including the plate bending was noted. The average time taken to adopt the plate ranges from 1 to 4min with a mean and standard deviation (SD) of 2.19 and 0.72 respectively. (Table-1)

Distribution of Duration of time taken for 3D Plate Adoption among study subjects			
Variable	Category	Mean	SD
Time (in mins)	Mean & SD	2.19	0.72
	Range	01 - 04	

Comparison of occlusion pre and postoperatively among the study group

Occlusion was evaluated preoperatively during the initial assessment before the procedure. Patients who had

deranged occlusion had been treated with intermaxillary fixation using elastics at different intervals of time. 13 patients(65%) had occlusion in which they don't need any supplemental fixation. 20% of the patients required fixation for 1 week after which they could achieve satisfactory occlusion. 2 weeks of elastics was required for 10% of the patients followed by 5% of the patients needed the fixation for 3 weeks. (Table-5.5) and (Graph-5.5). Comparison of occlusal status among study subjects between different time intervals was statistically evaluated using Cochran's Q test. P- Value <0.001* which is statistical significant(Table-2)

Comparison of Occlusion status among study subjects between different time intervals using Cochran's Q Test									
Occlusion	Pre Rx		Day 1		6 Weeks		6 Months		P-Value
	n	%	n	%	n	%	n	%	
Intact	7	36.8%	12	63.2%	19	100.0%	19	100.0%	<0.001*
Deranged	12	63.2%	7	36.8%	0	0.0%	0	0.0%	

(Table-2)

Multiple comparison of occlusal status among study subjects between different time intervals was evaluated using Mc Nemar's test. (Table-3)

Different P- values compared at different intervals was mentioned in the table.

Multiple comparison of Occlusal Status among study subjects between different time intervals using McNamara's Test						
Time Intervals	T0 vs T1	T0 vs T2	T0 vs T3	T1 vs T2	T1 vs T3	T2 vs T3
P-Value	0.04*	<0.001*	<0.001*	0.01*	0.01*	..

* - Statistically Significant

Note: T0 - Pre Rx, T1 - Day 1 Post-op, T2 - After 6 Weeks, T3 - After 6 Months

(Table-3)

Hard ware complications like plate breakage, broken screws and screw heads were evaluated and none of these were elicited in the study group (Table-4).

Distribution of Supplemental Fixation and Hardware Complications among study subjects			
Variables	Category	n	%
Supplemental Fixation / duration	1 Wk Elastics	4	20%
	2 Wk Elastics	2	10%
	3 Wk Elastics	1	5%
	None	13	65%
Hardware complication	None	20	100%

(Table-4).

Interfragment stability was evaluated immediately after the surgery and at the follow-up intervals of 6 weeks and 6 months. 70% of the patients achieved the stability immediately after the open reduction and fixation with the plate. By 6 weeks 100% patients had achieved the stability between the fractured segments. This was evaluated at different time intervals using Cochran's Q test. P- Value is 0.002* which is statistically significant.(Table-5).

Comparison of Inter Fragment Stability among study subjects between different time intervals using Cochran's Q Test								
Inter Fragment Stability	Day 1		6 Weeks		6 Months		P-Value	
	n	%	n	%	n	%		
Present	14	70%	20	100%	20	100%	0.002*	
Absent	6	30%	0	0%	0	0%		

Multiple comparison of Inter Fragment Stability b/w different time intervals using McNemar's Test			
Time Intervals	T1 vs T2	T1 vs T3	T2 vs T3
P-Value	0.01*	0.01*	..

* - Statistically Significant

Note: T1 - Day 1 Post-op, T2 - After 6 Weeks, T3 - After 6 Months

(Table-5)

Post-operative infection was the important parameter evaluated among the study groups. The data collected was analyzed using Cochran's Q Test. All the patients had been treated with antibiotic coverage, so none of the patients had infection on the immediate post-op day. 5% of the patients were noticed with post-operative infection

when evaluated at 6 weeks and 6 months.(Table-6)

Comparison of Post-op Infection among study subjects between different time intervals using Cochran's Q Test							
Post-op Infection	Day 1		6 Weeks		6 Months		P-Value
	n	%	n	%	n	%	
Present	0	0%	1	5%	1	5%	0.61
Absent	20	100%	19	95%	19	95%	

(Table-6)

Soft tissue dehiscence near the incision sites was evaluated and data was collected at the intervals of immediate post-op, 6 weeks and 6 months post operatively. The data was analyzed using Cochran's Q test where 15% of the patients were having the wound dehiscence at the immediate post op day. None of the patients had the problem during the further follow-ups(Table-7)

Comparison of Soft Tissue Dehiscence among study subjects between different time intervals using Cochran's Q Test							
Soft Tissue Dehiscence	Day 1		6 Weeks		6 Months		P-Value
	n	%	n	%	n	%	
Present	3	15%	0	0%	0	0%	0.06
Absent	17	85%	20	100%	20	100%	

(Table-7)

Neurosensory deficit like paresthesia of infra orbital or inferior alveolar or mental nerve had been evaluated during the study. Patients were evaluated for the same at the intervals of 6 weeks and 6 months follow-up. Cochran,s Q test was used to evaluate the results. 20% of the patients from the study group were found to be with deficits and it was resolved over a period of time (Table-8)

Comparison of Neurosensory Deficit among study subjects between different time intervals using Cochran's Q Test							
Neurosensory Deficit	Day 1		6 Weeks		6 Months		P-Value
	n	%	n	%	n	%	
Present	4	20%	4	20%	0	0%	0.02*
Absent	16	80%	16	80%	20	100%	

(Table-8)

Conclusion

Here from our study titled “Efficacy of the three dimensional titanium mini-plates in the maxillofacial fractures- a prospective clinical study” we can conclude that:Road Traffic Accidents is the most common cause of mandibular fractures in most age groups, especially in males. Due to the stability of the fractured segments most of the patients achieved satisfactory occlusion after the treatment.Present study showed that the 3-D titanium mini plate allows no movement at the superior and inferior border with minimum torsional and bending forces as opposed to a single linear plate applied to superior border area. Adaptation of the plate to the fractured jaw is easy and care should be taken while operating in the para symphysis region when adopting a plate near premolar region because of mental nerve.Post operative infection and wound dehiscence, seen in very less number of patients in the study group. The above two happened in the patients who had the habit of smoking. Patients habits should be noted and should be encouraged to stop the habit after the surgery will avoid the above complications.None of the patients reported with any hard ware complications and the 3-D plates are bio compatible.In conclusion, our results suggest that 3-D plating system is the suitable method for the fixation of the maxillofacial fractures. They are easy to use and good alternative to the conventional mini plates.

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Legend Figure

3-D Rectangle Plate Fixation In Left Anterior Wall Of Maxilla Fracture.



Figure 1: Pre-Operative Profile



Figure 2: CT-Scan Pictures



Figure 3: Stabilization With 3-D 1.5mm Rectangular Plate



Figure 4: Post-Operative Pictures



Figure 5: Pre-Operative Profile

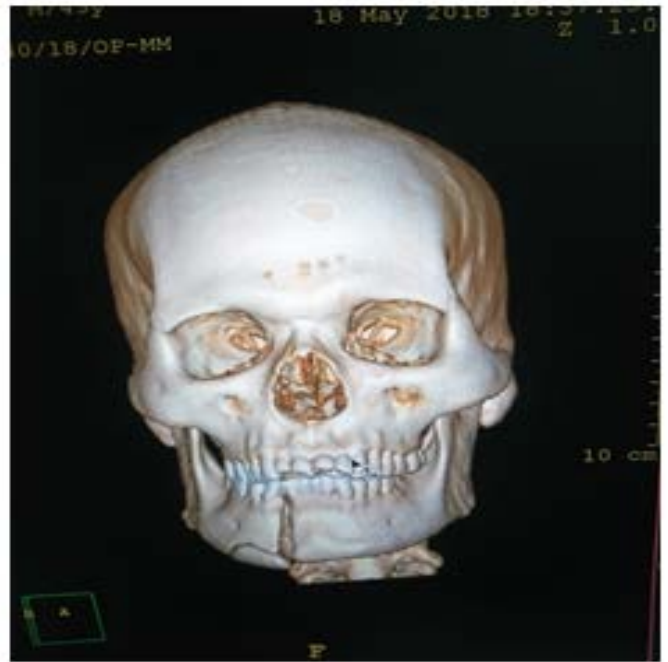


Figure 6: CT-Scan Pictures



Figure 7: Fracture Fixation Using 3-D Plate



Figure 8: Post-Operative Pictures



Figure 9: Pre-Operative Profile



Figure 12: Postoperative Follow-Up Pictures



Figure 10: C Scan Picture



Figure 11: Fixation with 3-D Miniplate