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A comparative evaluation of fixation techniques in anterior mandibular fractures using 2.5mm titanium lag screws,2.0mm 2 dimensional titanium miniplates and 2.0mm dimensional titanium miniplates

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Abstract

Various treatment modalities for mandibular fractures have been documented. [15.] The techniques being lag screw fixation,fixation with 2 dimensional or 3 dimensional miniplates . this prospective clinical study was designed to compare and evaluate the efficacy and surgical outcome of open reduction and internal fixation on thirty patients with anterior mandibular fractures using 2.5mm Titanium Lag Screws, 2.0mm 2 Dimensional Titanium Miniplates And 2.0mm Patients were randomly divided into 3 groups and treated based on either of these 3 techniques.

The three techniques fulfilled goals of immobilization, fixation, and stabilization of mandibular fractures. Lag screws and 3D plates showed comparable results and were superior to two dimensional plates.

When compared based upon the ease of fixation according to surgeons' evaluation, fixation of 3D plates

was observed to be comparatively easier followed by 2D plates and lag screws respectively highlighting the technique sensitivity of lag screws and their usage in peculiar patterns of fracture. In this study, patients were also evaluated for and compared based upon compliance and cost effectiveness, stability of implant,presence of neurosensory disturbances. As lag screws offered best possible reduction and fixation with use of least possible implants, they were observed to be more cost effective as compared to 3D plates followed by 2D plates. As patients treated using lag screws were also observed to have early reduction in pain and early functional recovery, patient compliance was observed more for lag screws followed by 3D plates and 2D plates respectively.

Keywords: Lag Screws, 3 Dimensional Plates, 2 Dimensional Plates, Anterior Mandibular Fixation, Mandibular Fractures.

Introduction

Maxillofacial trauma; now a days, has become a cause of grave concern because of the increased motor vehicle accidents, interpersonal violence and sports injuries.[1,2]

Mandible, despite being the largest and strongest facial bone, is commonly fractured when maxillofacial trauma is sustained because of its position on the face and its prominence.

Considering their incidence, mandibular fractures are the second most commonly occurring fractures next to nasal bone fractures when considering facial fractures

The anatomy of the mandible and vector of forces exerted by the temporalis and the masseter muscles make symphysis and parasymphysis fractures particularly problematic.

The management of mandibular fractures has evolved significantly in the past half century to restore original anatomic form and function at the earliest with least morbidity.[12]

Various techniques using internal fixation have been introduced which allow immediate function not necessitating the need for additional maxillo-mandibular fixation.[13-15] These techniques are based upon precise alignment of the dentition along with the fractured segments and performing plate and / or screw osteosynthesis with or without compression.[13-15.]

Michelet; in 1973, first introduced internal fixation of mandibular fractures with miniplates in conformity with the tension band principle; which was later modified by Champy et al in 1978.[17,18] Farmand and Dupoirieux; in 1992, presented 3 dimensional plates with quadrangular shape formed by joining two miniplates with interconnecting crossbars.[19,32]

Although each of these techniques of fixation of mandibular fracture offer unique advantages and disadvantages, a side by side comparison of all 3 of them for repair of anterior mandibular fractures does not exist in the surgical literature. The use of lag screw technique for internal fixation was first described by Brons and Boering in 1970, who postulated that the screw not only immobilizes the fracture fragments but also produces a constant compression of the fracture area. Others have similarly illustrated the versatility of lag screws for mandibular fractures.[16 31] Locking 2.0 miniplates utilize double threaded screws which lock to the bone and the plate, creating a mini-internal fixator. This results in a more rigid construction with less distortion of the fracture or osteotomy, less screw loosening and less interference with bone circulation since the plate is not too tightly pressed against the bone.[32]

Hence, this prospective clinical study was designed to compare and evaluate the efficacy and surgical

outcome of open reduction and internal fixation using 2.5mm Titanium Lag Screws, 2.0mm 2 Dimensional Titanium Miniplates And 2.0mm 3 Dimensional Titanium Miniplates for the treatment of anterior mandibular fractures.

Material and method

Thirty patients of age group between 16 to 45 years reported to the Department of Oral and Maxillofacial surgery Bagalkot; for a period of 3 years diagnosed with isolated fractures of mandibular midsymphysis and / or unilateral or bilateral parasymphysis were selected for the study, the primary variables being any other mandibular fractures other than parasymphysis fractures i.e angle fractures, condylar fractures, body fractures etc, and the secondary variables being pathologic fractures or medically compromised patients. After obtaining the informed consents, the patients were randomly divided into three groups namely, Group I: Patients treated using 2.5mm titanium lag screw, Group II: Patients treated using 2.0mm 2 dimensional titanium miniplate, Group III: Patients treated using 2.0mm 3 dimensional titanium miniplate. The operative time, pain, ease of fixation of implants, functional occlusion, clinical implant stability, neurosensory deficits, postoperative complications, cost effectiveness and compliance of patients were noted to evaluate the efficacy and the surgical outcome of internal fixation using these three techniques.

Inclusion Criteria

- Patients with isolated fractures of symphysis and / or unilateral or bilateral parasymphysis region of the mandible
- Patients medically fit for surgery under general anesthesia or local anesthesia
- Patients willing to participate in the study

Exclusion Criteria

- Patients with comminute mandibular fractures and / or pathologic fractures
- Medically compromised patients unfit for surgery

Method

The method basically consisted of 4 steps:

a. Pre-operative evaluation and preparation

b. Surgical procedure

c. Postoperative management

d. Rehabilitation and follow up

Results

The patients in all the three groups were evaluated and compared for,

1. Clinical implant stability
2. Neurosensory deficits
3. Ease of fixation of implants (access, reduction and fixation of fractured segments)
4. Cost effectiveness of the techniques
5. Occlusion
6. On comparing the clinical stability of the implants, Group I and Group II showed clinical stability in 90% of the patients whereas it was a 100% in Group III at 12^{th} week post-operative. (table 1)
7. Neurosensory disturbances were observed in 20% of the patients from each group at post-operative week 1, whereas20% of patients from Group I and Group III and only 10% of the patients from Group II showed neurosensory disturbances at the 4^{th} post-operative week. Whereas 10% of the patients from Group II showed the evidence of neurosensory disturbances even after 8^{th} week, which was not observed in Group I and Group III(table 2)
8. In this study, the three groups when compared based upon the ease of fixation of implants, 3D plates were found to be the most easily placed implants with the

p value of 0.0001(table 3)

9. On comparison of the three groups based upon the cost effectiveness, fixation of the fractures with lag screws was observed to be better technique than the 3D and 2D plates.(table 4)
10. However, when the preoperative status of the occlusion was compared with the status of occlusion at post-operative week 1, week 4, week 8 and week 12; statistically significant differences were observed in Group I and Group III with the p value of 0.0277 and 0.0180 respectively.(table 5)

Table 1: Comparison of three groups based upon the cost effectiveness

Cost Effectiveness	Lag screw	%	2D Plate	%	3D Plate	%	Total	%
Good	0	0.00	10	100.00	1	10.00	11	36.67
Best	10	100.00	0	0.00	0	0.00	10	33.33
Better	0	0.00	0	0.00	9	90.00	9	30.00
Total	10	100.00	10	100.00	10	100.00	30	100.00
Chi-square= 54.5454 p=0.0001*								

*p<0.05

Table 2: Comparison of the presence of neurosensory disturbances at different points of time in three groups by Kruskal Wallis ANOVA

Time points	Lag screw		2D Plate		3D Plate	
	Effect in %	P-value	Effect in %	P-value	Effect in %	P-value
Cochran Q test (among all times)	Q = 6.0000	0.1116	Q = 4.0000	0.2614	Q = 6.0000	0.1116
1 week to 4 weeks	0.00	1.0000	10.00	1.0000	0.00	1.0000
1 week to 8 weeks	20.00	1.0000	10.00	1.0000	20.00	1.0000
1 week to 12 weeks	20.00	1.0000	20.00	1.0000	20.00	1.0000

Table 3: Comparison of three groups based upon clinical implant stability at different time points by Kruskal Wallis ANOVA

Time points	Lag screw				2D Plate				3D Plate				Total	H-value	P-value
	Stable	%	Un stable	%	Stable	%	Un stable	%	Stable	%	Un stable	%			
1 week	10	100.0	0	0.00	10	100.0	0	0.00	10	100.0	0	0.00	30	0.0000	1.0000
4 weeks	9	90.00	1	10.00	9	90.00	1	10.00	10	100.0	0	0.00	28	1.0360	0.5960
8weeks	9	90.00	1	10.00	9	90.0	1	10.00	10	100.0	0	0.00	28	1.0360	0.5960
12weeks	9	90.00	1	10.00	9	90.00	1	10.00	10	100.0	0	0.00	28	1.0360	0.5960

Table 4: Comparison of three groups by ease of fixation

Ease of fixation	Lag Screw	%	2D Plate	%	3D Plate	%	Total	%
Good	10	100.00	0	0.00	0	0.00	10	33.33
Best	0	0.00	0	0.00	9	90.00	9	30.00
Better	0	0.00	10	100.00	1	10.00	11	36.67
Total	10	100.00	10	100.00	10	100.00	30	100.00
Chi-square= 54.5454 p=0.0001*								

*p<0.05

Table5: Comparison of the status of occlusion at different points of the time in three groups

Time points	Lag screw		2D Plate		3D Plate	
	Effect in %	P-value	Effect in %	P-value	Effect in %	P-value
Cochran Q test (among all times)	Q = 24.0000	0.0001*	Q = 12.0000	0.01733*	Q=28.0000	0.0001*
Postoperative to 1 week	60.00	0.0277*	30.00	0.1088	70.00	0.0180*
Postoperative to 4 weeks	60.00	0.0277*	30.00	0.1088	70.00	0.0180*
Postoperative to 8 weeks	60.00	0.0277*	30.00	0.1088	70.00	0.0180*
Postoperative to 12 weeks	60.00	0.0277*	30.00	0.1088	70.00	0.0180*

*p<0.05

Discussion

Open reduction and internal fixation of the mandible with bone plates was first described by Schede in 1888**.** Luhr, Spiessl and others derived inspiration from orthopaedic biomechanical studies performed by Schenk, who suggested accelerated bone healing through compression rigid fixation using dynamic compression plate which has its own disadvantages such as requirement of a wide incision, bulky nature of the plates and the procedure which are technique sensitive**.**[5-6,39]

In 1973 Michelet[17] and later in 1978 Champy[18] and co-workers introduced non-compression miniplates in the treatment of mandibular fractures to overcome the disadvantages of the bulkier and technique demanding compression plating systems.

Though clinically successful, many surgeons like Raveh, Luhr, AO/ASIF advocates felt that these mini plates do not offer sufficient resistance to fracture fragment displacement. Hence they used supplemental Maxillomandibular fixation for several weeks following fixation with miniplates.[8,31,32.] .this can be attributed to micro movements within the fractured fragments thus causing clinical implant instability. our study also showed 10% of patients had absence of functional occlusion.

B.H Choi advocated the use of two Miniplate fixation technique for atrophic edentulous mandibular fractures as a single plating technique was less stable.[25-26]

The lag screw technique was first introduced to Maxillofacial Surgery by Brons and Boering in 1970, who cautioned that at least two screws are necessary to prevent rotational movements of the fragments in mandibular body fractures.[12,30]

The anterior mandible is uniquely suited to the application of lag screws for three reasons.[12,28]

1) Curvature of the mandible.

This allows placement of lag screws across the symphysis, from one side to the other side, for sagittal fractures and from anterior to posterior for oblique fractures and those of anterior body region.

2) Thickness of bony cortices.

Thick bony cortices provide extremely secure fixation when the screws are properly inserted.

3) Absence of anatomic hindrances.

Safer to place it below the apex of tooth,care to be taken in proximity of mental foramen.

Mustafa Farmand in 1990 developed a new miniplate system made up of Titanium that takes advantage of bio geometry to provide stable fixation and he called it as 3D plating system. The Concept behind these plates is that, a geometrically closed quadrangular plate secured with bone screws creates stability in all three dimensions.[7,29]

Although each of these techniques of fixation of mandibular fracture offer unique advantages and disadvantages, a side by side comparison of all 3 of them for repair of anterior mandibular fractures does not exist in the surgical literature. Hence, this prospective clinical study was designed to compare and evaluate the efficacy and surgical outcome of open reduction and internal fixation using 2.5mm Titanium Lag Screws, 2.0mm 2 Dimensional Titanium Miniplates And 2.0mm 3 Dimensional Titanium Miniplates for the treatment of anterior mandibular fractures.

In our study, the incidence of mandibular fracture was observed to be more in males and 83.33% of the patients operated were males; which is similar to the studies done by various authors.[10,38]

The present study included patients within the age group of 16 to 45 years and commonly affected age group in our study was observed to be 16 to 25 years as 40% of the patients operated were less than 25 years of the age. The foremost cause of mandibular fracture was observed to be RTA (90%) followed by self-fall (6.67%) and violence (3.33%) which was similar to other studies conducted by Madan et al,[20] and Goyal M et al.[28]

When compared based upon the ease of fixation according to surgeons' evaluation, fixation of 3D plates was observed to be comparatively easier followed by 2D plates and lag screws respectively highlighting the technique sensitivity of lag screws in accordance with the studies conducted by Sadhwani BS and Anchlia S,[17] Barde DH et al,[19] Goyal M et al[*] and Bhatnagar A et al.[28]

In our study all the patients in the three groups were evaluated and compared based upon the presence or absence of neurosensory disturbances in post-operative week 1, week 4, week 8 and week 12. On post-operative week 1, 20% of the patients from all the three groups were observed to have neurosensory disturbances based upon the findings of pin prick test and light touch test. At the end of post-operative week 8, 10% of the patients from Group II were observed to have neurosensory disturbances which were absent in Group I and Group III. At the end of 12 weeks post operatively, all the patients were observed to be satisfactorily recovered from these sensory deficits. The differences observed in these three groups were not found to be statistically significant which is in accordance to study done by Goyal M et al,[28] and Sadhwani BS and Anchlia S.[17]

In this study, the patients from all the three groups were also evaluated for and compared based upon the compliance and the cost effectiveness of the individual technique. As the lag screws offered best possible reduction and fixation with the use of least possible

implants, they were observed to be more cost effective as compared to 3D plates followed by 2D plates.[22,30]

As the patients treated using lag screws were also observed to have early reduction in the pain and early functional recovery the patient compliance was observed more for the lag screws followed by 3D plates and 2D plates respectively.

Conclusion

From the above study we have concluded that fixation of 3D plates was observed to be comparatively easier followed by 2D plates and lag screws respectively. Lag screws offered best possible reduction and fixation with use of least possible implants, they were observed to be more cost effective as compared to 3D plates followed by 2D plates. As patients treated using lag screws were also observed to have early reduction in pain and early functional recovery, patient compliance was observed more for lag screws followed by 3D plates and 2D plates respectively.

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