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Research Article

Comparative Analysis of the Efficacy of Titanium 2-D Miniplates and Titanium Lag Screws in Treatment of Anterior Mandibular Fracture

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Abstract

Objective: To compare the efficacy of titanium 2-D miniplates and titanium lag screws in treatment of anterior mandibular fracture.

Materials and Methods: A total of 14 patients were treated in our institution with open reduction and internal fixation applying miniplates and lag screws for the anterior mandibular fracture. They were divided equally and randomly into two groups: Group 1 patients were treated with 2-D Titanium miniplates and Group 2 patients with Titanium lag screws. Duration of the surgery was measured from the time of incision placement to the suture placement. Postoperative pain was measured on Wong Baker's Scale and interfragmentary gaps were assessed using radiographs taken preoperatively and 24 hrs postoperatively. Postoperative complications such as infection, wound dehiscence, exposure, loss of teeth vitality, neurosensory deficit were also documented. Follow up was done at predefined intervals. Results were evaluated using Mann-Whitney test, chi square test, unpaired t-test.

Results: In this study, the mean duration of surgery in case of group 1 patients (2-D miniplates) was approximately 37.86 ± 16.03 min. and in group 2 (lag screws), it was approximately 25.71 ± 7.3 min. The gap difference between the fractured fragments were significantly greater in group 1 (miniplates) than group 2 (lag screws). Lag screw group showed minimal post operative pain and post operative complications.

Conclusion: In this study, lag screws fixation showed better results than miniplates for the fixation of anterior mandibular fractures as it offers advantages of rigid internal fixation apart from being cost effective. It not only reduces time and effort but also assists in primary healing without any major complications.

Keywords: Anterior Mandibular Fractures, Internal Fixation Techniques, Miniplates, Lag Screws, Rigid Internal Fixation.

Introduction

In the view of its position and prominence, the mandible is regarded as the second most commonly fractured bone of the maxillofacial skeleton [1]. Although great variation exists in the reported anterior mandibular fracture cases, average analysis shows that it approximately comprises 17% of the overall mandibular fractures [2].

Anterior mandibular fractures are defined as fractures involving the mandible, bounded bilaterally by vertical lines just distal to the canine teeth (the parasymphysis) or linear midline mandibular fracture (symphysis) [3]. Outnumbering the zygomatic and maxillary fracture by a ratio of 6:2:1[4] respectively, fracture of the mandible occurs more frequently than any other fractures of facial skeleton. The main therapeutic goal like any other fracture is first to restore original anatomic form and function at its earliest convenience with least morbidity. Ideally, this should be practiced instantaneously and with minimal patient discomfort [4].

The management of mandibular fractures has evolved greatly in recent times. The modern era of fracture treatment has provided the path to the use of more reliant rigid internal fixation to allow rapid return of function and significantly shorter recuperation [5]. The keys to the successful management for any fracture like accurate reduction, establishing the pretraumatic occlusion and early return to function is still necessary [6].

Osteosynthesis can be carried out with many forms: rigid, semi rigid, non rigid fixation. "Miniplates" comes under semi-rigid, while "Lag Screws" osteosynthesis comes under rigid forms of fixation [5].

The lag screw technique in maxillofacial surgery was first advocated by Brons and Boering in 1970 and was later reintroduced by Niederdellmenn., *et al.* [7], who stated that at least two screws were necessary to prevent rotational movement of the fragments in oblique fractures of the mandible. The concept of lag screw

osteosynthesis is based upon the principle of axial compression of bone fragments. The screw glides through the gliding hole (outer cortex) of one fragment and seizes the other fragment by threaded hole (inner cortex), thereby assisting the compression of both the bony fragments [8]. Spiessel and Schroll in 1972 presented a plate fixation system which was applied to the lower border of the mandible; 'biomechanically – the most unfavourable site', which resulted in the distraction at the upper border of the mandible along the alveolar ridge [4]. To overcome these limitations, Champy., *et al.* [9] in 1976 devised another plating system, (a modification of Michelet's technique, 1973) [10], and advised the use of 2 miniplates in the anterior region, one at the inferior border and the second 5mm above the lower plate. These modern systems provide higher stability of the fragments, better perioperative handling and minimal pressure on the bone [11].

Lag screws also play a vital role in maxillofacial osteosynthesis [4]. It is also considered as one of the useful methods to provide rigid fixation in the anterior mandible [12]. If compared to compression osteosynthesis with bone plates, it has an advantage of easy application, less cost and requirement of minimal implanted material [13].

There's always been a conflict as to which method is superior to the other for the management of anterior mandibular fractures. Taking both pros and cons of the lag screws and miniplates respectively, the purpose of this study is to compare the fixation techniques in anterior mandibular fractures using miniplates and lag screws.

Materials and Methods

Fourteen patients of mandibular fracture involving symphysis or parasymphysis were selected irrespective of caste, creed, gender and religion from the OPD and Emergency of Department of Oral and Maxillofacial Surgery, Himachal Institute of Dental Sciences, Paonta Sahib, H.P. They were divided randomly into two groups: Open reduction and internal fixation of Group 1 (7 patients) were performed with miniplates and Group 2 (7 patients) with lag screws. All participants have read and signed informed consent form.

Inclusion criteria

Patients within the age group of 18-50 yrs of age with fairly good general health (ASA-I and II) without any contraindication for oral and maxillofacial surgery or anaesthesia (General), indicated for rigid and semi rigid internal fixation for mandibular fractures and mandible with permanent dentition.

Exclusion criteria

Patients with head injury affecting the motor and / or sensory response, pre-existing motor paralytic disease, edentulous patients in whom occlusion was not assessable, multiple mandibular fractures, comminuted fractures and patients of mandibular fractures having mixed dentition to avoid damage to developing permanent tooth germs were excluded.

Procedure

Patients, irrespective of poor verbal communication, extreme anxiety, or otherwise uncooperative in nature, were elected to be treated under general anaesthesia. After following the normal protocol for exposure and debridement of the fracture site, for group 1 patients, 2 titanium miniplates(2mm/2.5mm 4 hole with gap) were contoured, applied and fixed along the line of osteosynthesis using monocortical screws (2x8mm/2x10mm/2.5x 8mm/2.5x10mm), in accordance with Champy's principles (Figure 1). For group 2 patients, titanium lag screws (2x20mm/2x24mm) were placed using "lag screw principle". At least 2 lag screws were placed for the fixation of anterior mandibular fracture (Figure 2). On completion of the procedure, MMF was released to check the primary stability of the fixation by bimanual manipulation and then MMF was reapplied for at least 1 week after the procedure. The patients were followed up clinically after 24hrs, weekly intervals for 2 weeks and then monthly intervals for 6 months. For radiographic evaluation OPG was taken 24hrs after surgery in the postoperative period. Surgical time was recorded from the time of incision till the time of suture placement. Postoperative recovery as assessed by evaluating pain (measured on Wong Baker's Scale) and postoperative complications such as infection, wound dehiscence, loss of vitality of teeth, neurosensory deficit were recorded. Follow up was done at the predefined intervals. Interfragmentary gaps were assessed with the help of the radiographs taken preoperatively and 24 hrs postoperatively.

Figure 1: A. Preoperative occlusion. B. Preoperative OPG. C. 2-D titanium miniplates placement. D. Postoperative OPG. E. Postoperative occlusion.

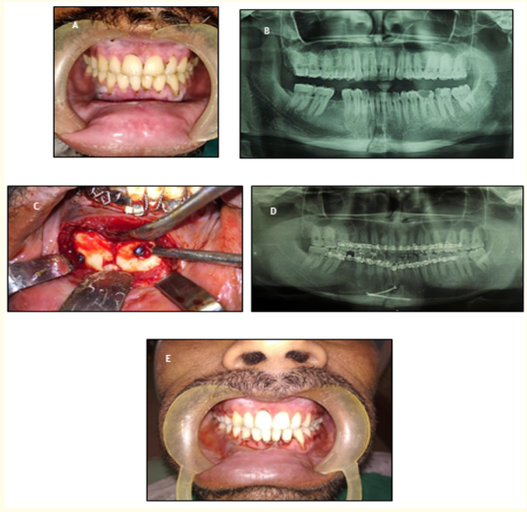


Figure 2: A. Preoperative occlusion. B. Preoperative OPG. C. Titanium lag screws placement. D. Postoperative OPG. E. Postoperative occlusion.

Radiographical parameters for the study were evaluated after taking orthopantomogram (OPG) one preoperatively and one 24hrs postoperatively. The difference in gap between the fractured fragments pre and postoperatively was the main parameter for this evaluation. On the radiographs, a line was drawn along the fracture and was divided into 3 equal parts. Perpendicular lines were projected onto the fracture line for reproducible measure points. Measurements of the fracture gap were conducted on these 4 points (starting from inferior border to superior border of the fracture line) by using a precision caliper as described by Schaaf., *et al* [8]. (Figure 3) Results were evaluated using unpaired t-test.

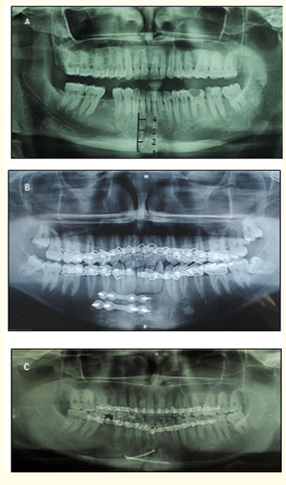


Figure 3: A. On the OPG, fracture lines was traced onto a tracing sheet and divided into 3 parts by 4 measuring points generated by a perpendicular line projected onto the fracture line. B. Fracture treated with miniplates(Group I), C. Fracture treated with lag screws (Group II).

Results

14 patients of anterior mandibular fracture were included in this study. Most of the patients included in this study were male, with 1 female ranging in the age group of 20-50 years. Road traffic accident was the main cause for the fracture in most of the patients in this study, except for one inter personal violence and one included accidental fall. This is in correlation with the study conducted by Ranton and Wiesenfeld (1996) [14]. Symphysis and parasymphysis fractures of the mandible have been reported to occur with a frequency of 9% to 57% [15,16]. In this study there were total of 14 fractured sites in anterior mandibular region in 14 patients. Of these, 2 were symphysis, 5 were right parasymphysis and 7 were left parasymphysis. Duration of surgery was measured from the time taken from the start of incision to the closure of the wound. In case of group 1 patients (2-D miniplates) it was approximately 37.86 ± 16.03 min. and in group 2 (lag screws), it was approximately 25.71 ± 7.3 min. The difference was statistically significant (p value < 0.05). (Table1). Postoperative pain was assessed by Wong baker's scale [15] in both the groups. Statistical analysis was carried out by Mann-Whitney test and the difference was statistically significant ($p < 0.05$).

Radiographical evaluation was done by measuring the gaps between the fracture fragments at 4 predefined points along the fracture line in panoramic view. T-test statistics was carried out and the differences at all four points were statistically significant (p value < 0.05) at Point 1 - 0.004, point 2 - 0.001, point 3 - 0.013, point 4 - 0.016. It is evident that the mean post operative radiographic distance between all measuring points was considerably more in case of miniplates as compared to lag screws.

In group 1(miniplates) 1 patient had non vital teeth in the fractured segment and 1 patient had derranged occlusion because of displacement of fragments while fixation. Additional IMF for next 4 weeks was carried out in this patient. In group 2 (lag screw) no such complications were seen.

Discussion

Osteosynthesis in oral and maxillofacial surgery has evolved substantially since its first introduction. From extraoral fixations to less bulkier and miniatured fixation techniques, different systems have been designed to make patients and the surgeons, more comfortable.

After Brons and Boering introduced the lag screw technique in 1970, many other researchers illustrated its versatility. One of the most important advantages of lag screw has, it delivers the merits of rigid internal fixation inspite of being less bulky, cheaper, easier and faster to apply [13].

Hansmann (1886), considered as the inventor of plate osteosynthesis; was the first one to develop and present a procedure for subcutaneous fixation of bone fragments with a plate- screw system. He is also the first one to perform a plate osteosynthesis on the mandible [11], but it was Michelet., *et al*. (1976) who introduced miniaturized osteosynthesis in maxillofacial surgery [10].

Anterior mandible, described as the area between two mental foraminas is best for placing any method of osteosynthesis, but is best suited for the placement of lag screws for following reasons: curvature, thickness of bony cortices and no anatomic hazards[4]. Where on the one hand the miniplate uses the tension-banding principle as described by Champy., *et al.* [9]; the principle behind the placement of lag screws is based on axial compression of the bone fragments. The screw glides through the fragment located near the screw head (gliding hole) and seizes the fragment distant from screw head (threaded hole) [8].

Irrespective of the method of osteosynthesis used for anterior mandibular fracture, the goals should remain the same and include the establishment of pretrauma occlusion and uncompromised mandibular function. Semi rigid or non rigid fixation methods may result in unstable fracture fragments that necessitates IMF for extended period of time therefore, rigid internal fixation allowing early mobilization has increased in popularity during the last decade [14].

As the management techniques are still evolving for mandibular fractures, there is always a dispute for best type of osteosynthesis. This study is undertaken to compare the efficacy of titanium 2 D miniplates and titanium lag screws in treatment of anterior mandibular fracture.

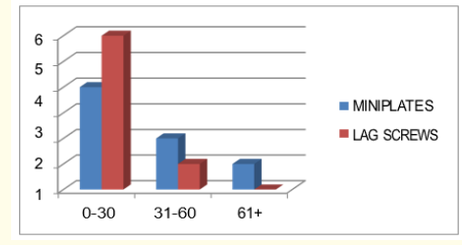
In this study, duration of surgery was measured from the time taken from the start of incision to the closure of the wound. The mean duration of surgery in case of group 1 patients (2D miniplates) was approximately 37.86 min, with standard deviation of 16.03 min. Whereas in patients of group 2 (lag screw), it took approximately 25.71 min with standard deviation of min. The difference was found to be statistically significant (p value < 0.05) (Table 1, Graph 1). This showed that lag screw fixation is relatively quicker as compared to the miniplates fixation techniques. Similar results were achieved previously by Peter and Edward (1992) [16].

Wong baker's scale (0 - 5) [15] was used to evaluate pain at the site of fixation throughout the duration of treatment and follow up visits. In group 1 (2-D miniplates) maximum mean score after 24 hrs of miniplate fixation was reported to be 2.57 and that of group 2 (Lag screws) was 2.14. At the end of 1 month post op, in group 1 (miniplates) patients, the overall mean score decreased to 0.57 and in that of group 2 (lag screws), it decreased to 0.28. After that, the pain score was 0 in both the groups in subsequent follow up periods. Statistical analysis was carried out with Mann Whitney Test and the difference came out to be significant (p < 0.05), (Table 2, Graph 2). No study was conducted previously involving Wong Baker's Scale for pain assessment.

Radiographical evaluation was done by measuring the gaps between the fracture fragments at 4 predefined points along the fracture line in panoramic view. In group 1 (2-D miniplates), the mean post operative distances were; point 1 – 2.07mm, point 2 – 1.57mm, point 3 - 0.64mm, point 4 - 0.85mm. Among the group 2 (lag screws), the mean post operative distances were as follows: point 1 – 1.21mm, point 2 – 0.78mm, point 3 – 0.57mm, and point 4 – 0.57mm. T-test statistics was carried out and the differences at all four points were statistically significant (p value <0.05), (Table

	Group	N	Mean	Std. Deviation	Std. Error Mean
Time for Fixation Min.)	Miniplates	7	37.86	16.036	6.061
	Lag Screws	7	25.71	7.319	2.766

Table 1: Surgical Time.



Graph 1: Surgical Time.

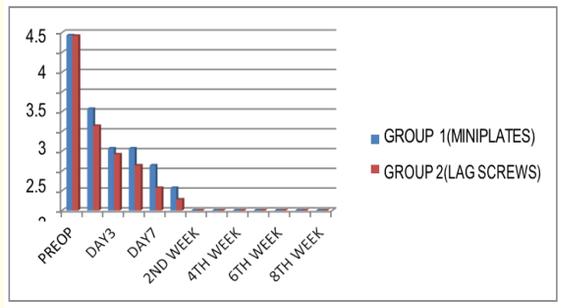
Chi-square Test

P-Value	Inference
0.0093	P<0.05 (Highly Significant)

Difference in time taken is highly significant between the two groups.

Group	Preop	Immediate Post Op	1st Week	2nd Week	1st Month	2nd Month	3rd Month	6th Month
2d Miniplates	16.4	18.28	18.71	24.14	28.42	33.57	37	40.57
Lagscrews	17.57	20.42	20.7	26.42	32.14	36.85	39.14	43.14

Table 2: Pain at Site.



Graph 2: At the end of 1 week there is significant difference in pain reduction between the two groups.

Mann Whitney Test

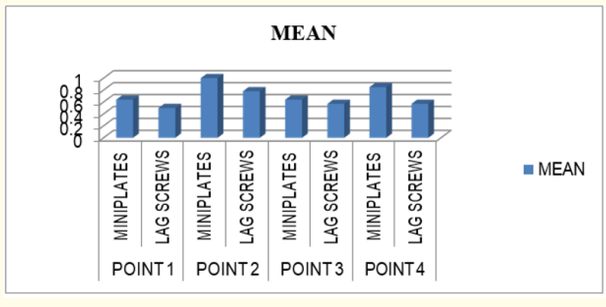
p-value	Inference
0.01	Significant

3, Graph 3). Point 1 - 0.004, point 2 - 0.001, point 3 - 0.013, point 4 - 0.016. It is evident that the mean post operative radiographic distance between all measuring points was considerably more in case of miniplates as compared to lag screws. This is in accordance with the study conducted by Schaaf., *et al.* (2011) [8] and Goyal M., *et al*. (2012) [4].

Disturbance of occlusion was checked at predesigned intervals i.e. 7th day post op and then weekly intervals for next 2 months. Occlusion was unstable in 1 patient from Group 1(miniplates), mostly because of the minor displacement of fractured fragments. MMF was extended for next 4 weeks in this patient after which a stable occlusion was achieved. All the patients in group 2 (Lag screws) achieved stable occlusion till the end of follow up period. The malocclusion recorded in this study was functionally

Radiographic Evaluation At 4 Different Points.	Implant Used	Total No. Of Patients	Mean		Std. Dev.	
			Preop	Post Op	Preop	Post Op
Distance Between Fracture Fragments In Mm - Point 1	Miniplates	7	2.64	2.07	0.37	0.53
	Lag Screws	7	2.07	1.21	0.60	0.48
Distance Between Fracture Fragments In Mm - Point 2	Miniplates	7	2.35	1.57	0.56	0.45
	Lag Screws	7	1.57	0.78	0.53	0.27
Distance Between Fracture Fragments In Mm - Point 3	Miniplates	7	1.35	0.64	0.38	0.39
	Lag Screws	7	1.28	0.57	0.39	0.19
Distance Between Fracture Fragments In Mm - Point 4	Miniplates	7	1.71	0.85	0.49	0.34
	Lag Screws	7	0.92	0.57	0.34	0.19

Table 3: Radiographical Evaluation.



Graph 3: All 4 points showing statistically significant reduction in the fractured fragments ($p < 0.05$).

T-Test Analysis

Points	Point 1	Point2	Point3	Point 4
P-Value	0.004	0.001	0.013	0.016

insignificant (1 case). This result is in accordance with Kallela., *et al.* [17] and Ellis and Ghali [12] who reported no post operative malocclusion after lag screw fixation.

In post operative complications, we encountered only one case of non vital tooth related to the site of fixation. This is in accordance with the study conducted by Lee T (2013) [18] who reported tooth root injuries in 0.9% of the cases, occurring from superior positioning of miniplates and Ellis (2011) [19] where incidence of tooth root injuries were reported to be around 1.5%. No other complications related to neurosensory deficit, plate exposure, implants breakage or wound dehiscence were reported. This is supported by the study of Cadwood JI (1985) [20] as he studied 50 patients with mandibular fractures and none of the patients reported with any permanent complications. This is in accordance with the study conducted by Bhatnagar A, Bansal V, Kumar S and Mowar A (2013) [21].

Conclusion

There are studies carried out previously that describe the potential advantages of lag screws over miniplates for fractures of mandible. Lag screws not only are easy to place, but also offers the advantages of rigid fixation. Thus, we can conclude from this clinical study that lag screw fixation of anterior mandibular fracture is a simple and successful method of rigid fixation across fracture fragments. Still, to conclude it in a better way, a study with larger sample size is advocated.

Acknowledgement

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Patient Consent

Patient consent was taken from every patient included in the study.

Conflicts of Interest

There was no conflict of interest between the authors of this study.

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