Evaluation of Titanium Lag Screw Osteosynthesis in the Management of Mandibular Fractures

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ABSTRACT

Introduction: The management of facial trauma is one of the most important and demanding aspects of maxillofacial surgery. Mandible is the most movable and prominent bone of facial skeleton. The management of the injuries to the maxillofacial complex remains a challenge for oral and maxillofacial surgeons. The aim of mandibular fracture treatment is the restoration of anatomical form and function with particular care to establish occlusion. The lag screw technique was first introduced to maxillofacial surgery by Brons and Boering in 1970, who cautioned that at least two lag screws are necessary to prevent rotational movement of the fragments in oblique fractures of mandible.

Aim: The aim of the study was to evaluate the outcome of lag screw osteosynthesis in the management of mandibular body, symphysis, and parasymphysis fractures.

Materials and methods: About 15 cases presenting with mandibular oblique, sagittally displaced mandibular fractures, and requiring open reduction and internal fixation (ORIF) were selected. Titanium lag screws were placed in such a way that their axes bisect the angle between a perpendicular drawn to the fracture line and perpendicular to the bone surface. About 3 months postoperatively, follow-up was done to evaluate the duration of surgery intraoperatively, stability of fracture segments, occlusion, biting efficiency postoperatively, and record any postoperative complications with lag screw fixation technique.

Results: The maximum intraoperative time was 120 minutes and minimum was 40 minutes. The average intraoperative time was 72 minutes. In postoperative complications, deranged occlusion was seen in two patients; in one patient, it was due to associated condylar fracture and technical error in the placement of lag screw in another patient; but, it was not significant statistically with a p-value of 0.483 and which was managed easily by placing guiding elastics for 2 weeks in both patients. All the patients in the study showed good stability of fixation and significant increase in biting efficiency over a period of time. No postoperative complications, such as lag screw exposure, neurosensory disturbance, and malunion/nonunion were seen in any of the patients.

Conclusion: Titanium lag screw fixation was found to have good stability, rigidity, was inexpensive, and less time consuming in some types of mandibular fractures, though there exist few contraindications regarding its usage. This technique is a

very sensitive procedure, requiring strict adherence to the lag screw placement principle and sufficient knowledge about the surgical anatomy of the mandible.

Clinical significance: Fixation of the anterior mandible fracture using this technique can achieve good stability and appropriate compression. The technique reduces the chances of infection due to less exposure and promotes the healing process by producing stress in the fracture lines. Lag screw showed faster improvement in terms of biting efficiency and a significant reduction in fracture gap, which is not seen in miniplate fixation.

Keywords: Lag screw, Maxillofacial trauma, Parasymphysis mandible fractures, Rigid fixation, Symphysis.

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INTRODUCTION

Maxilla and mandible are the keystones to bony architecture of the face, and the presence of teeth in the maxillofacial regions make the management of maxillofacial trauma unique compared with long bones.¹ The management of facial trauma is one of the most important and demanding aspects of maxillofacial surgery. The mandible is the most movable and prominent bone of facial skeleton. Mandible fracture is the most common than any other facial bone fracture.² The maxillofacial region occupies the most prominent position in the human body, making it highly vulnerable to injuries. The common etiologies of maxillofacial fractures, across the world, are road traffic accidents (RTAs), falls, assaults, firearm injury, sports, and industrial accidents; RTAs are reported to be the leading causes of maxillofacial fractures.³ In the past, intermaxillary fixation (IMF) had been the traditional method for treatment of mandibular fractures. The use of open reduction and internal fixation (ORIF) eliminated the need for maxillomandibular fixation, and facilitated stable anatomic reduction with reduction of the risk of postoperative displacement of fractured segment allowing immediate return to function.⁴ Stainless steel was one of the most corrosion resistant materials until titanium was introduced in the 1940s, which is not only biocompatible, but had a tendency for osseointegration

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and better corrosion resistance compared with stainless steel. Titanium also has excellent ductility and tensile strengths and is totally nontoxic.⁴

The lag screw technique was first introduced in maxillofacial surgery by Brons and Boering in 1970⁵; they cautioned that at least two lag screws are necessary to prevent the rotational movement of the fragments in oblique fractures of mandible.

The principle of lag screw is based on axial compression of the bone fragments. The screw glides through the fragments located near the screw head and seizes the fragments distant from the screw head. Lag screws should be placed in such a way that their axes bisect the angle between a perpendicular drawn to the fracture line and perpendicular to the bone surface.⁶

The major advantage of the lag screw is that it can be applied more rapidly without decreasing the rigidity, and it allows a more anatomically accurate reduction as displacement of bone fragments is high during placement of bone plate. The use of lag screws has several advantages over the use of bone plates:

- It uses less hardware making it more cost-effective.
- It also does not cause facial asymmetry due to large volume as plates sometimes may.
- When properly applied, lag screws provide a highly rigid method of internal fixation being functionally stable.¹⁴

AIM

- To evaluate the duration of surgery intraoperatively, stability of fracture segments, occlusion, and biting efficiency postoperatively. To record any postoperative complications with lag screw fixation technique.

MATERIALS AND METHODS

The prospective study was conducted in the Department of Oral and Maxillofacial Surgery at ITS Centre for Dental Studies and Research, Muradnagar, Ghaziabad, Uttar Pradesh, India, after obtaining ethical committee approval. The study was undertaken for a period of 1 year and 7 months, i.e., from November 2013 to May 2015 on 15 patients with mandibular symphysis, parasymphysis, and body fracture.

Informed consent was obtained from the patients before their inclusion in the study. Detailed case history was obtained. Routine investigations were done which included hemoglobin percentage, bleeding time, clotting time, random blood sugar, total leukocyte count, differential leukocyte count, erythrocyte sedimentation rate, electrocardiogram, chest X-ray, human immunodeficiency virus, hepatitis B and C viruses (surface antigen of the hepatitis B virus), and urine examination. Erich arch bar/IMF screws/eyelets were applied.

Fig. 1: Lag screw kit

- Lag screw kit (Fig. 1).
- Inclusion criteria were mandibular body, symphysis, and parasymphysis fractures in patients between 15 and 55 years. Patients willing for ORIF of mandibular fracture and were willing to provide informed consent for the procedure were included. Patients who are deemed fit for surgery by anesthesiologist following pre anesthetic evaluation. Linear and oblique fracture in mandibular symphysis, parasymphysis, and body region were managed by ORIF using 2 and 2.5 mm lag screws. A routine follow-up at 1 day, 1 week, 1 month, and 3 months was done for all the patients included in the study.

Exclusion criteria include mandibular fracture in patients below 15 years and above 55 years. Patients with uncontrolled systemic disease, pregnant patients, those who were unable to provide informed consent for the procedure, and long oblique comminuted fractures were excluded.

- All the parameters, such as stability of fixation, occlusion biting efficiency, and postoperative complications, like infection and lag screw exposure wound dehiscence, were recorded at recall visits as mentioned above.
- Orthopantomogram (OPG) and occlusal radiograph were taken in all the cases preoperatively at 1-day postoperatively and later at a period of 1 month and 3 months (Figs 2 and 3).
- The study had been independently reviewed and approved by an ethical board. All participants have read and signed informed consent form.
- All patients were operated under general anesthesia (GA). Nasotracheal intubation was done. Surgical site was prepared and isolated with surgical drapes. The surgical site was infiltrated with 2% lignocaine with 1:200,000 adrenaline. Intraoral vestibular incision was given with BP Blade No. 15. The mucoperiosteal flap was raised and fracture site was exposed, reduced,

Figs 2A and B: Preoperative radiograph: (A) OPG; and (B) occlusal radiograph

and stabilized. The fracture fragments were reduced to normal anatomical position, and occlusion was achieved with the help of IMF. Once the proper angulation and point of entry had been established, the 1.5 mm drill bit for 2 mm lag screw and 2 mm drill bit for 2.5 mm lag screw were initially placed almost perpendicular to the selected point of entry to prevent skidding of the drill bit and a hole was begun in the buccal cortex until the lingual cortex was reached.

- The drill bit was withdrawn and larger diameter drill bits, i.e., 1.7 mm for 2 mm lag screw and 2.3 mm for 2.5 mm lag screw were used only in the buccal cortex; after that, a countersink tool was used at slow speed

Figs 3A and B: (A) Postoperative OPG showing lag screws; and (B) postoperative occlusal view

to provide a smooth platform for screw-head seating. A depth gauge was then inserted through the drill hole and the screw length was determined. The hole in the proximal segment was tapped using a long tap. After selection of the appropriate length screw; it was loaded on a screw driver and inserted into the screw hole. The screw slips through the outer hole, which was free of threads and engages the threads in the far segment. Thus, when tightened, the screw compressed the two segments of bone together. If more than one screw were used, they were placed at a distance of 4 to 5 mm from first screw (Fig. 4).

Figs 4A and B: Intraoperative picture showing lag screw placement

- After the lag screw fixation, the IMF was released and occlusion checked. Hemostasis was achieved and closure was done using 3-0 Vicryl sutures. Parenteral drugs were given for 72 hours followed by oral drugs (injection Monocef 1 gm, injection Metrogyl 500 mg, injection Voveran 75 mg, injection Aciloc 50 mg, injection Ondem 4 mg, tablet Taxim-O 200 mg, tablet Metrogyl 400 mg, and tablet Voveran 100 mg). Oral hygiene maintenance using 0.2% Chlorhexidine mouthwash was advised to all the patients on discharge. The patients were followed up for a period of 3 months, and initially at day 1, 1 week, 1 month, and 3 months.

RESULTS

The sample size was 15 including male patients with the minimum age of 17 years and maximum age of 55 years, with a mean age of 27 years. The main etiological factor of trauma was RTA (40%), assault (27%), fall (20%), and interpersonal violence (13%) of the patients. In 15 patients, 9 patients were found with parasymphysis fracture (60%), 5 patients with symphysis (33%), and 1 patient with body fracture (7%). The maximum intraoperative time was 120 minutes and minimum was 40 minutes. The average intraoperative time was 72 minutes. Out of 15 patients, 5 patients had concomitant fractures in which 3 patients had angle fracture, which was treated by miniplate fixation; 1 patient had condylar fracture, which was treated by closed reduction; and 1 patient had subcondylar fracture, which was treated by miniplate fixation.

Parameters Evaluated

Clinical stable fixation by manual testing was obtained in all 15 patients. In 2 patients, occlusions were found to be deranged only on the first postoperative day evaluation. Fisher's exact test was applied and the p-values of 0.483 which showed these two patients with deranged occlusion are not statistically significant.

Trend of Biting Efficiency over a Period of Time

If the patient can chew normal food properly, it is considered as good biting efficiency.

Scoring

- Patient on liquid diet – 0
- Patient can chew semisolid food – 1
- Patient can chew soft food – 2
- Patient can chew normal food – 3

Table 1 shows the overall p-value of 0.001 by Friedman test, which showed significant increase in biting efficiency. Since overall change is significant, *post hoc* comparison revealed that there are significant differences at all pairs of time comparisons as shown in Table 2.

Table 1: The overall p-value of 0.001 by Friedman test

Time	1–7 days	7th days	1 month	3 months	p-value
Median (min/max)	0 (0–1)	1 (0–2)	2 (1–3)	3 (1–3)	<0.001

Table 2: Overall change is significant so *post hoc* comparison revealed that there is a significant difference at all pair of time comparison as shown

Time	p-value
1 day–1 week	0.001
1 day–1 month	<0.001
1 day–3 months	<0.001
1 week–1 month	0.001
1 week–3 months	<0.001
1 month–3months	0.002

Wilcoxon signed rank test was applied and the p-value of 0.002 showed a significant increase in biting efficiency from the 1 month to 3 months (Table 2).

Postoperative Complications

These were assessed with the help of clinical observation and postoperative radiographs. In case of infections, the case to be considered infected had discharge with positive culture test. A lag screw failure was when there was any breakage of implant. One patient showed partial wound dehiscence 1 week postoperatively, which healed uneventfully, with satisfactory results at 3-month follow-up. Except this, no other postoperative complications were found (Table 3).

Fisher's exact test was applied, and the p-value of 1.0, which showed one patient with wound dehiscence, is not statistically significant.

Radiological Evaluation

All the patients showed adequate reduction of fracture. None of the patients out of 15 showed displacement of fixed fracture segment and invasion of lag screw in relation to root apices/mental foramen as shown in Table 4.

Table 3: Postoperative complication: One patient showed partial wound dehiscence 1 week postoperatively which healed uneventfully with satisfactory result at 3 month follow-up. Except this no other postoperative complication were found

Complications	Total no of patients	No of patients			
		1 day	1 week	1 month	3 months
Infection	15	0	0	0	0
Wound dehiscence	15	0	1	0	0
Lag screw exposure	15	0	0	0	0
Neurosensory disturbance	15	0	0	0	0
Malunion/nonunion	15	0	0	0	0
Lag screw failure	15	0	0	0	0

Table 4: Radiographic evaluation-All the patients show adequate reduction of fracture. None of the patients out of 15 showed displacement of fixed fracture segment and invasion of lag screw in relation to root apices/mental foramen

Clinical evaluation	Total no of patients	Adequacy of reduction		Displacement of fixed fractured segments		Invasion of lag screw in relation to root apices/mental foramen	
		Adequate	Inadequate	Not displaced	Displaced	Present	Absent
Evaluation criteria							
No of patients	15	15	0	15	0	0	15

DISCUSSION

Fracture of the mandible occurs more frequently than any other fracture of facial skeleton and they outnumber zygomatic and maxillary fractures by a ratio of 6:2:1 respectively. The etiology of mandibular fractures mainly includes assaults, RTAs, falls, and sports injuries. The ORIF of mandibular fractures, using plates, has become a widely accepted method during the past three decades. In contrast to orthopedic surgery, lag screws played a vital role in maxillofacial osteosynthesis.⁷

The goal of treatment of mandible fractures should be to restore the patient to a preinjury state of function and esthetics, restore proper function by ensuring union of the fractured segments, and reestablishing preinjury strength, restore any contour defect that might arise as a result of the injury, and prevent infection at the fracture site.⁸

The previously used methods of rigid fixation were dynamic compression plates and eccentric compression plates, whereas presently we use rigid and semirigid fixations, such as lag screw, reconstruction plates, and miniplates. Over a period of time, many studies have been conducted comparing lag screw with miniplate in various areas of mandibular fractures and have found that lag screw is better than miniplates in various aspects.^{2,7,9-11} Lag screws also have biomechanical advantages over miniplate fixation. Miniplates fractured under functional loads and adequate stability could not be obtained with single miniplate.¹⁰ A study done by Anwar¹² concluded rigid internal fixation with lag screws was a reliable, efficient, and cost-effective technique for anterior mandibular fractures as compared with miniplates.

In our study, we used two titanium lag screws (Orthomax Surgical, Gujarat) in each patient, of 2/2.5 mm diameter and of 18 to 24 mm length. Kallela et al¹³ in their study used screws of 2.7 mm diameter and 30 to 40 mm length in 17 parasymphiseal fractures. Clinical stable fixation by manual testing was obtained in all 15 patients in our study. Similar result was found in a study done by Agnihotri.² Similar study was done by Kallela et al¹³ and Balasubramanian et al¹⁴; one patient showed instability of fixation.

Slight occlusal derangement was observed in two patients on the first postoperative day. But, it is not significant statistically. In one patient, occlusal derangement could be attributed to the associated subcondylar fracture, for the correction of which guiding elastics were

placed for a period of 2 weeks with satisfactory intercuspation on both sides subsequent to release. None of the other patients in our study required postoperative IMF. Similarly, in a study done by Niederdellmann et al,¹⁵ they supplemented lag screw osteosynthesis of mandibular angle fracture with postoperative IMF for a period of 2 weeks in one patient with associated subcondylar fracture. A significant increase was found in biting efficiency in all patients with time, which was statistically significant over a period of time.

Out of 15 patients, no patient in our study developed postoperative infection, whereas in a study done by Eckelt and Hlawitschka¹⁶ on 230 patients with mandibular condylar fractures, they found wound infection in 3 patients, resulting in reduced mouth opening followed by lag screw fixation. Similarly, Niederdellmann et al¹⁵ observed 4 cases of wound infection in 18 cases treated for mandibular angle and parasymphiseal fractures with lag screw osteosynthesis, which were managed by opening incision and inserting an iodoform gauze.

We found one patient with partial wound dehiscence at the end of 1 week postoperatively, which is not statistically significant. The dehiscence was managed by suturing and dressings, which led to satisfactory wound healing with no complication within 1 week. In a study done by Agnihotri,² four patients had wound dehiscence, which was managed by external support using adhesive elastic bandage on the chin.

In our study, we found no postoperative neurosensory disturbance in any of the patients. In a study done by Kallela et al,¹⁷ eight patients showed neurosensory deficits in the form of slight paresthesia in lower lip and chin. None of the patients in our study showed invasion of lag screw to the root apices of teeth or close proximity to the mental foramen or neurovascular bundle. None of the patients in our study showed malunion/nonunion. In our study, the postoperative radiograph assessment confirmed that all fractures were adequately reduced and well stabilized with no displacement of either screw or fractured segments. Balasubramanian et al¹⁴ noticed slight mobility of fractured segment in one patient after lag screw fixation. Hence, the patients were kept under IMF for 2 weeks.

In the current era of increasing costs of medical treatment of trauma patients, our study on a limited number of patients supports the concepts of lag screw osteosynthesis for the treatment of mandibular body, parasymphysis, and

symphysis fractures. In comparison with other methods, lag screws, though technique-sensitive, are simpler, easier to use, provide good stability, restore function early, and are cost effective. Besides applying compression between the fragments to support faster healing, fracture stabilization is firm and tissue exposure required is minimal. Despite several advantages, lag screws have some disadvantages like chances of invasion of root apices of tooth; the method is technically sensitive and cannot be used in comminuted fractures.

CONCLUSION

Fixation of anterior mandibular fractures using lag screws can achieve good stability and appropriate compression, thereby, aiding in achieving better masticatory forces. Lag screw fixation of mandibular body, symphysis, and parasymphysis fractures is a practical and effective way of intraoral fixation. Though lag screw technique is technically sensitive and requires operator skill and competency, advantages of lag screws include a shorter operative time, economic saving, decreased patient morbidity, good bone healing, and faster improvement in functional rehabilitation. Though the sample size is less to reach to any conclusion, the results of our study suggest that the use of lag screws in the fixation of mandibular fractures can be very demanding procedures.

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