Original Article

Principle of Lag-Screw Fixation in Mandibular Trauma

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Abstract

Aims and Objectives: The aim of the study is to assess the effectiveness of lag screw fixation in mandibular fractures with respect to parameters such as stability of the occlusion, functional stability, infection rates, neurosensory deficit, ease of technique, and maximum interincisal opening.
Materials and Methods: Our study was carried out on 13 patients with mandibular fractures. Selected cases were treated with lag screw technique and 2.7 mm titanium screws were used. Postoperative complications such as wound dehiscence, infection, neurosensory disturbance, nonunion, malocclusion, postoperative mouth opening, and occlusal discrepancies were assessed.
Results: All the patients were male, aged between 17 and 50 years. The cause of the injury was road traffic accidents in all, except for two assaults. Our study of 13 cases of fractured mandible included five symphyses, five parasymphyses, two angle, and one body fracture cases. Our observation with open reduction and rigid internal fixation with 1–2 lag screws revealed close approximation of fractured fragments in all the cases, except in three patients who had mild discrepancy of occlusion.
Conclusion: Lag screw technique provides good interfragmentary compression and restoration of premorbid anatomic alignment of fracture fragments. In displaced mandibular fractures, especially in oblique fractures, the use of lag screw has proven to be ideal. The complications were found to be low. It was concluded that the lag screw provided excellent stability and occlusion.

Keywords: *Lag screw, mandibular angle, miniplates, parasymphysis, symphysis*

Introduction

The maxillofacial trauma has increased by many folds in recent times, due to an increase in road traffic accidents (RTAs). Incidence of particularly, mandibular fractures is high as it is the most prominent and mobile bone of the facial bones. Studies have shown that mandibular fracture is the most common fracture followed by zygomatic and maxillary fractures (6:2:1). Literature suggested that most of the mandibular fractures were reported in young males with a mean age of 23 years.[1,2]

RTA is the most common etiology, followed by assaults and sport-related injuries. These fractures can be single or multiple, with condyle being the most common site.[1,2] The therapeutic goal of any fracture management is to restore the original anatomic form and function, without causing any discomfort to the patient. The treatment modalities for maxillofacial fractures include closed reduction by means of wiring, arch bars, cap splints, gunning splints, and open reduction by transosseous wiring, miniplates, compression and noncompression plates. Open reduction and internal fixation are the widely accepted method of treatment. Lag screws when compared with plates, have an advantage of the requirement of minimum implant material and they also provide maximum stability.[3-5]

Brons and Boering in 1970, first introduced lag screw osteosynthesis to maxillofacial surgery to immobilize and compress the fracture fragments.[6] Lag screw

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is based on the concept of bone compression and is not used in comminuted fractures and fractures with gap defects. Lag screw is commonly employed in anterior mandibular fractures, oblique fractures of body mandible, and in the angle of the mandible. In some cases, lag screws are placed along with plates to secure fracture fragments.[5,6]

Lag screw technique requires an essential set of instruments and screws up to 40 mm in length and diameter of 2.7 mm. Niederdellmann *et al*. described this procedure in 1981 and reported uneventful healing of mandible angle fractures and described it as technique-sensitive procedure.[7] The lag screw does not need adaptation as in miniplates; where its fixation technique necessitates careful orientation to fracture line. Hence, lag screw placement is fairly straight forward method of rigid fixation. The selection of the lag screw technique depends on patient factors, type of fracture, site of fracture, and the skill of surgeon.[5-7]

Materials and Methods

A study was done to evaluate the effectiveness of the lag screw technique on patients with mandibular fractures who reported to the oral and maxillofacial surgery department. Our study was carried on 13 patients, and we used titanium cortical screws and applied the principle of lag screw technique for osteosynthesis. The cases were taken up for this study after obtaining Institutional Ethical Committee clearance and informed consent from the patients. The detailed case history was taken in a standard fashion. On intraoral examination, site of the fracture, sublingual ecchymosis, occlusal derangement, lacerations, subluxated teeth, missing teeth, and any preoperative infection were recorded. Basic hematologic and radiographic (orthopantomogram, posterior-anterior skull, and occlusal mandible) investigations were performed. Selected cases were treated with lag screw technique as per the principles and 2.7 mm titanium screws were used.

Surgical procedure

General anesthesia was given in a supine/semi-supine position. Povidone-iodine scrubbing, mouth preparation, and draping with sterile towels were done. Maxillary and mandibular arch bars or eyelets were applied. Incisions were made from retromolar area to the mandibular canine for angle fractures, canine to the second molar region in case of body fractures, and from canine to canine in symphysis fractures. In all types of incisions, 4–5 mm of mucosa on the alveolar process was left to facilitate closure. Subperiosteal dissection of lateral and inferior borders of the mandible was done taking care of the mental nerve in the anterior region. Fracture was examined for mediolateral obliquity of cortices, fracture area was reduced, and intermaxillary fixation was done.

In angle fractures, at the premolar region, 3–4 mm stab incision was made extraorally through the skin at the inferior border ofthe mandible. Through this incision with the help of trocar, the blunt tunnel was made through the subcutaneous tissue in a posteromedial direction until the elevated periosteum was punctured. When seen through the intraoral incision, the trocar was beneath and posterior to the mental foramen. A cannula was then inserted through which 2.7 mm drill was used. For fractures of body and symphysis, trocar and cannula were not used as access was better, and instrumentation was easily used intraorally.

Selection of entry point was based on two requisites; one was that it should be anterior to the fracture sit so that sufficient amount of bone was present between the head of screw and fracture. The initial point of entry was 12–15 mm anterior to the fracture and drilling was done with an angle of 10°–20° parallel to buccal cortex, as countersinking the screw head required several millimeters of the bone resulting in head of the screw being more posterior to the point of entry of the drill. Second requisite to be considered was selecting superoinferior position as entry point of the initial drill. For this, a 2.7-mm drill was laid over the top of the mandible establishing proper mediolateral and superoinferior angulations.

Using the superoinferior angulations, the drilling hole was established. Entry to the bone was done above the canal. In the first and second molar region, due to the lingual position of the canal, injury to the nerve was avoided even if the canal was entered directly.

Path of screw insertion

It is predicted that securing the terminal screw threads in dense bone of lingual cortex is enough to provide rigid fixation, without endangering the contents of the mandibular canal. It was kept in mind that the angulations should be 10°–20° from the buccal cortex as if the angulation is parallel tothe buccal cortex, the inferior neurovascular bundle will be encountered. As there are no vital structures involved in case of symphysis region, screws were placed below the tooth apices above and parallel to lower border.

Drilling the near cortex

A 2.7-mm drill was used initially perpendicular to the buccal cortex at the entry point to prevent skidding and redirection [Figure 1]. The drill was withdrawn as well as trocar in cases of angle fractures.

Preparation of countersinking

For countersinking the hole, factor that was primarily considered was to keep the same angulation that was established by 2.7-mm drill hole, thus allowing seating of the screw head. As the head is 5 mm, the bone removal must be in perfect line with the direction of the drill hole or else; the screw may bind the bone medially on insertion resulting in fractured buccal cortex owing to undue forces [Figure 2].

Drilling the far segment

Later, a drill guide of 2 mm inner diameter and outer diameter of 2.7 mm was selected and inserted, so as to perfectly use it for centering and to snugly fit buccal cortex in the previously drilled 2.7-mm hole. Now, the reduction of fragments was done. With a 2-mm drill, drilling through the far segment was completed so as to perforate the lingual cortex of far segment.

Selection of screw length and preparation of tapping

Through the drilled hole of the near and far cortex, a long depth gauge was inserted and screw length was determined. The hole in the far segment was tapped with 2.7 mm tap. In angle fractures, to prevent tissue entanglement, the trocar was used through the stab incision through which tapping was done.

Screw insertion

The screw was now inserted into the screw hole. In the case of angle fractures, it was inserted through the stab incision on a screwdriver. Attention to the fracture sites was considered as important to confirm that the fracture segments were reduced perfectly along the entire length [Figures 3 and 4]. We carefully looked for signs of crazing around the head of the screw during the last few turns. Microfractures around the screw head were avoided to obtain the best stability. Postoperative radiographs were taken to confirm the reduction of fractured segments [Figures 5-8].

Intermaxillary fixation was release, and rigidity of the fracture was tested by various movements of the mandible that were performed manually. Fracture site was thoroughly irrigated and intraoral incision was closed in one layer with resorbable suture material, and stab incisions were closed with monofilament sutures.

Postoperative care and follow-up

Immediate care

Antibiotics, i.e., augmentin 625 mg (amoxicillin with clavulanic acid) was given to all the patients twice daily for 1 week, and the patients were advised to take liquid diet for 2 days, and normal diet thereafter. To maintain oral hygiene, the patients were advised warm saline rinses. Extraoral sutures were removed on the 7th postoperative day.

Figure 1: Drilling the near cortex

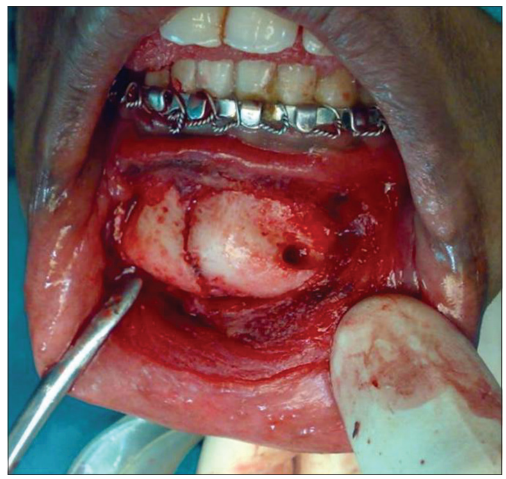

Figure 2: Prepared countersink

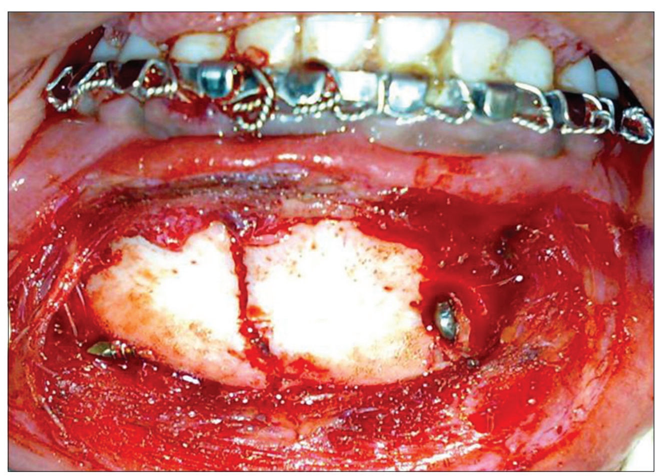

Figure 3: Intraoperative picture showing lag screw fixed for fracture right parasymphysis

Long-term follow-up

Patients were called weekly for 6 weeks and monthly thereafter. Follow-up was done for a period of 3 months. Postoperative complications such as wound dehiscence,

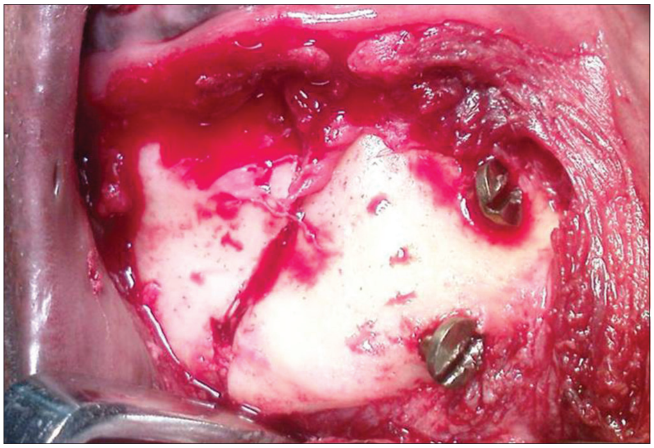

Figure 4: Intraoperative picture showing two screws used in fracture symphysis and left condyle

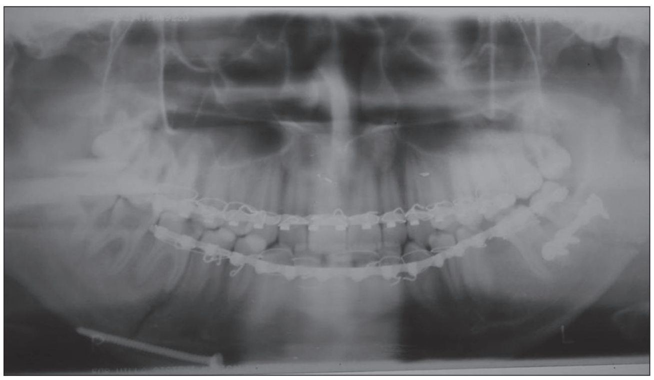

Figure 6: Postoperative orthopantomogram showing lag screw fixed for body and plate for left angle fracture

infection, neurosensory disturbance, nonunion, malocclusion, postoperative mouth opening, and occlusal discrepancies were assessed.

Results

In our study, all patients were males, aged between 17 and 50 years (average age of 28 years). Cause of injury was RTA in all, except for two assaults. Patients reported to our hospital within 2–10 days after the injury. Our study of 13 cases of fracture mandible included five symphyses, five parasymphyses, two angles, and one body fracture [Table 1]. Three cases had associated condylar fractures that were managed by trapezoidal condylar plate along with lag screws for the other fractures of the mandible.

Of the five cases of symphysis fracture, one had mild instability of fragments; a two hole 2.5-mm plate was used in conjunction. In another case, the screw length was longer than required as the healing was good; it was suggested for removal.

Of the five cases treated for parasymphysis, one case had instability and was advised the International Monetary

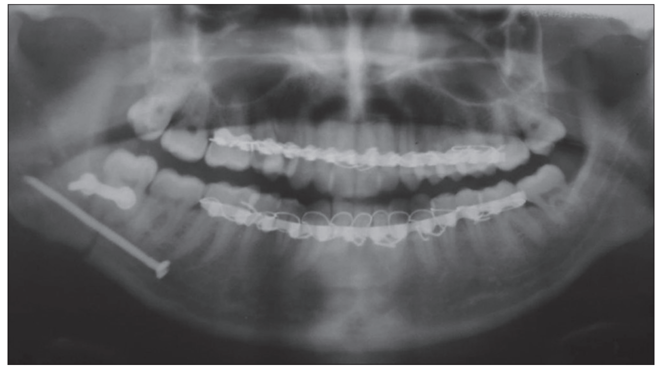

Figure 5: Postoperative orthopantomogram showing lag screw in conjunction with miniplate in fracture right angle

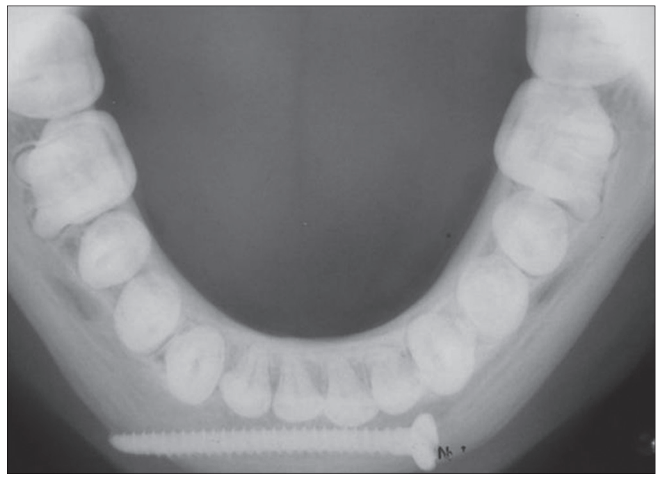

Figure 7: Postoperative occlusal radiograph showing lag screw fixed for fracture right parasymphysis

Fund (IMF) for 2 weeks. Of the two cases of angle fractures, one case had a mild occlusal discrepancy that was corrected by selective grinding. In another case, lag screw became unstable and hence was removed, and the fracture area was finally fixed with one four hole 2.5-mm plate. The two angles and the only body fracture were treated with a single lag screw. Parasymphysis and symphysis cases were treated with either 1 or 2 lag screws and in combination with miniplate in one case. All cases operated by lag screws were evaluated for 3–4 months radiographically and clinically [Table 1].

Ease of technique

The study showed that lag screw fixation is extremely technique-sensitive one. All cases showed an excellent reduction of fragments, except one case with moderate reduction.

Occlusal stability

Occlusal stability was seen in a majority of the patients. An excellent reduction was seen in the radiographs that were taken within 1–2 days postoperatively. Long-term stability of occlusion was maintained. However, three

Table 1: Demographics, etiology, treatment, and complications of all the study cases

Case number	Age	Sex	Etiology	Fracture site	Treatment	Mouth opening (mm)				Complications
						Preoperative	Postoperative (1 week)	Postoperative (4 weeks)	Postoperative (3 months)	
1	35	Male	RTA	Symphysis and left condyle	ORIF with two 25-mm lag screws for symphysis and TCP for left condyle	20	22	28	42	Nil
2	17	Male	RTA	Symphysis	ORIF with one 30-mm lag screw	25	27	26	36	Nil
3	20	Male	Assault	Symphysis	ORIF with 1 lag screws	30	31	33	35	Nil
4	28	Male	RTA	Symphysis	ORIF with one 30-mm lag and one 2.5-mm miniplates	25	28	34	40	Nil
5	50	Male	RTA	Symphysis	ORIF with 2.25-mm lag screws	30	32	33	34	Nil
6	38	Male	RTA	Left parasymphysis and left condyle	ORIF with two lag screws of 35 mm for parasymphysis and one TCP for left condyle	20	24	36	40	Nil
7	30	Male	Assault	Right parasymphysis	ORIF with one 25-mm lag screw	25	27	31	35	Nil
8	26	Male	RTA	Left parasymphysis	ORIF with one 30-mm lag screw and TCP for left condyle	20	24	29	42	Nil
9	17	Male	RTA	Right parasymphysis	ORIF with one lag screw of 30 mm	22	26	31	40	Nil
10	32	Male	RTA	Right parasymphysis	ORIF with two 25-mm lag screws	15	17	25	35	Nil
11	24	Male	RTA	Right body and left angle	ORIF with 1, 30-mm lag for body and 4 hole miniplates for angle	20	24	31	40	Nil
12	25	Male	RTA	Right angle	ORIF with one 40-mm lag screw and with one two 2.5-mm hole plate	10	13	32	40	Nil
13	22	Male	RTA	Right body and left angle	ORIF with one 40-mm lag screw for angle and one four hole 2.5-mm plate for right body	15	18	26	35	Nil

RTA=Road traffic accident, ORIF=Open reduction and internal fixation, TCP=Trapezoidal condylar plate

cases had a minimal occlusal discrepancy. IMF was done later and was corrected.

Interincisal opening width

A gradual increase in inter incisal mouth opening was seen, with an average of 10 mm to 45 mm in angle cases and from 20 to 45 mm in other cases.

Infection rate

Patients were given antibiotics and healing in all cases was uneventful.

Neurosensory deficit

There was no neurosensory deficit observed in any of the cases.

Discussion

In fracture healing, the degree of mobility of fracture area plays an important role in amount of periosteal callus, with mobility of fragments causing more voluminous callus. Mandible forms one of the important esthetic and functional portions of the face and therefore demands proper planning of its fracture to minimize the occurrence of deformities such as asymmetry, improper occlusion, nonunion, malunion, and infection. Intermaxillary fixation delays functional rehabilitation in the management of fracture mandible.[5,6]

Niederdellmann *et al*. described the lag screw osteosynthesis conception as the stable union of bony fragments under pressure with the help of screws, which in turn are under tension.[7] These screws can be used alone or in combination with compression plate for fracture stability. Screws that have a constant thread diameter along their entire length were considered as the best ones.[5-7]

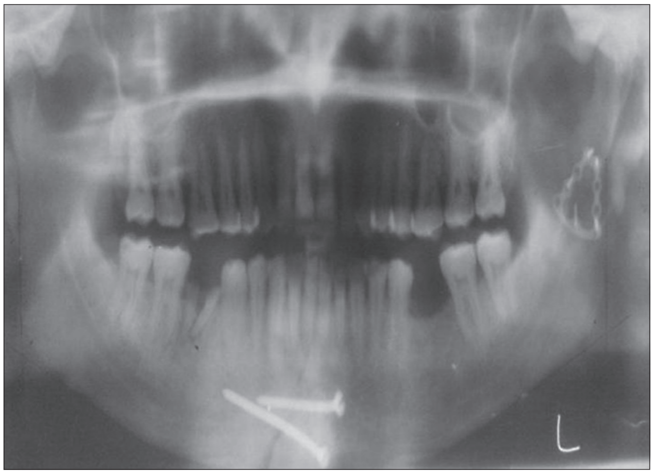

Figure 8: Postoperative orthopantomogram showing screws in fracture symphysis and left condyle

Lag screws can be used to fix fractures of the mandible, rarely maxilla, zygoma, and also for fixing grafts. Champy advised the use of small plates in most regions of mandible and for symphysis alone advised two plates.[8] Brons and Boering in 1970 advised the use of at least two screws to prevent rotational movements of the fragments in oblique fractures of mandible due to shear forces that act around the screw.[6]

With regard to access, the use of lag screw in angle is cumbersome and has to be performed through trocar when compared to symphysis and body. In symphysis, curvature allows to place the lag screw across the region easily as there are no anatomic hazards in the symphysis region, whereas in the body, the presence of mental foramen with its contents near to the point of entry makes it difficult to access body region, and it is more sensitive in its use in condyles due to vital structures around and difficult access.

Technique and principle

Spiessel in his study evaluated that interfragmentary compression can be done with lag screws. It is based on the principle that they engage fragments together and compresses them when tightened.[9] Lag screw technique involves drilling the screw at an angle that bisects the angle between the line of fracture and outer cortex, but in case of linear fractures of symphysis due to curvature, this not applicable. To be effective in achieving a secure and rigid stabilization of fractured fragments, the screw should be placed perpendicular to the line of fracture, thereby preventing displacement of fragments upon tightening. Lag screw achieves 1000–4000N of compression compared to 600N with prebent compression plates. Lag screw when properly used offers the most rigidity of all rigid fixation techniques.[7-9]

Rationale for using cortical screw

The cortical screws are preferred over lag screws in the lag screw technique as in the presence of reverse cutting threads the removal of true lag screws is difficult, as the bone grows around the narrower smoother part of the shaft creating an obstruction. Spiessel indicated lag screw osteosynthesis in situations such as wide lamellar fractures of mandible, short lamellar fracture of mandible in combination with neutralization plate, fracture of angle mandible, edentulous jaw fractures, bone graft fixations, rigid internal fixation after orthognathic surgeries, rigid internal fixation of zygomatic maxillary fractures, and in comminuted fractures to simplify fracture situation along with plates.[8,9]

Studies have shown that the mandibular fracture management is guided by various dental and orthopedic rules such as restoration of premorbid occlusion, reduction of fracture to its original anatomical position, rigid immobilization to aid healing, early restoration of function, prevention of infection, nonunion, and malunion. Lag screw fulfills all these principles. Intermaxillary fixation has certain disadvantages such as loss of weight, social inconvenience, physical discomfort, poor oral hygiene, respiratory complication, and communication difficulties.[10,11]

Advantages of lag screw osteosynthesis, when compared with plates, are that it is a simple technique, needs less implant material, limited surgical exposure, reduced time, and result in fewer postoperative infections.[11-13]

Evaluation of operative procedure

Titanium screws were used in our study for better osseointegration where bone-metal bond was observed during healing, whereas with stainless steel, a layer of connective tissue is seen between bone and metal reducing the mechanical advantage.

The postoperative radiographs showed all fractures were in the proper reduction and fixation. All the patients showed good occlusion. None had any paraesthesia. Lag screw gave rigid fixation without any requirement of immobilization of fractured mandible after the treatment. In ten cases, intermaxillary fixations were removed after operation. In two cases, intermaxillary fixation was advised for 2 weeks, as they had condylar fracture fixed with a trapezoidal condylar plate with mild occlusal discrepancy along with slight mobility. In another case of symphyseal fracture, intermaxillary fixation for 2 weeks was advised due to minimal occlusal discrepancy and mild mobility. These problems may be attributed to the improper angulation of the screws and also due to inadequate fracture reduction while drilling.

Complications

In our study of 13 cases, none of the cases had infections and the healing had been uneventful. All the patients received standard regimens of antibiotics. The minor occlusal discrepancy in the immediate postoperative period was corrected by intermaxillary fixation for 3 weeks in three cases. None of the cases had paraesthesia. There was no breakage of the drill bits intraoperatively.

Removal of lag screw

No screws were removed in our study, but in one case of well-healed oblique symphysis fracture where the screw length exceeded than required from buccal to lingual cortex, a decision was made to remove.

According to Spiessel,[9] even though true lag screw has a reverse cutting edge on the screw thread, it is difficult to remove, when attempted with excessive torque the screw may break. Lag screw removal in a regular counterclock-wise direction causes fracture of the shaft between the screw threads further complicates removal. This was the reason that fully threaded cortical screw was used in our study so that it can be easily removed after healing occurs.

Our findings of stable fixation in a minimum operative time with lag screws are similar to that of study by Kozakiewicz and Swiniarski. They confirmed the findings by computerized tomography and magnetic resonance imaging. According to them, the major advantage with lag screw application is the reduction of fracture fragments, ease of removal than plates, owing to the lack of requirement of a wide surgical approach, and reduced articular scarification.[4]

The study sample of Betharia and Dolas included 28 males and 2 females. The age of patients ranged from 14 to 52 years with a mean of 28 years.[3] However, we found all 13 cases to be males, and the average age was 28 years (17–50 years).

Kallela *et al*. found that 8 (68%) patients had neurosensory disturbances which might be due to stretching of the mental nerve and soft tissues during surgery.[14] We did not notice any such complications in our study.

Balasubramanian *et al*. carried a similar prospective clinical study to assess the effectiveness of "solitary lag-screw fixation" in the management of mandibular angle fractures. All the five patients were evaluated postoperatively for 6 months. There was a long-term occlusal stability, 35–45 mm of interincisal opening, without any signs of infection or neurosensory disturbance. They concluded that solitary lag screw fixation is an effective and simple procedure in achieving good treatment results for angle fractures of the mandible.[15]

A more detailed study on a larger sample may give better inference. The limited series of cases in our study had shown that lag screw osteosynthesis when used judiciously with proper planning can provide excellent results.

Limitations

The limitations of this study were as follows:

1. Smaller sample size
2. A comparative study with other treatment modalities such as miniplates would have given us a better opportunity to evaluate the effectiveness of the lag screw technique on patients with mandibular fractures
3. Apart from interincisal opening, follow-up of all parameters after the 1st day, 1st week, 4th week, and 36th week would have given us knowledge about correct outcome of treatments rendered.

Conclusion

A rigid fixation with lag screws was evaluated for functional, anatomical, and occlusal stability. Our observation with open reduction and rigid internal fixation with 1–2 lag screws revealed close approximation of fractured fragments in all, except in three patients who had a mild discrepancy of occlusion. The use of lag screws in mandibular trauma needs only minimum material and time with an experienced surgeon and also decreases hospital stay.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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