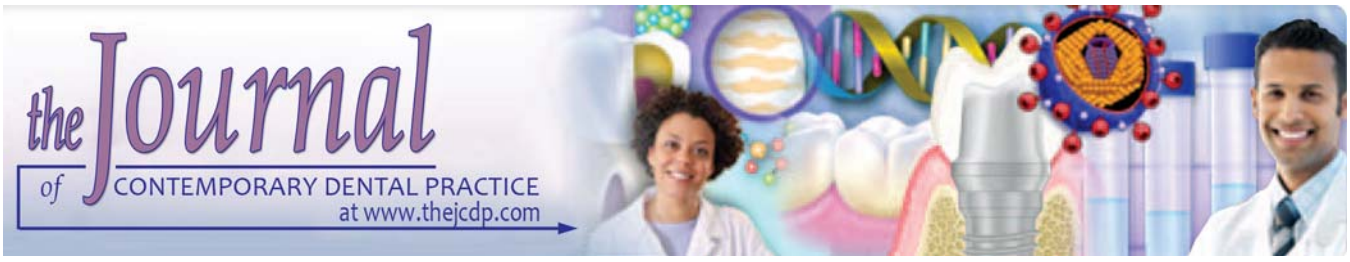
10.5005/jp-journals-10024-1303
ORIGINAL RESEARCH



Efficacy of Locking Plates/Screw System in Mandibular Fracture Surgery

Sunil S Nayak, C Pushpalatha, Praveen S Tammanavar, Sanjay L Naduwinmani, Muralee Mohan

ABSTRACT

Purpose: The purpose of this study was to determine the efficiency of locking plates and screw system in the treatment of mandibular fracture surgery, by comparing them with the conventional system.

Patients and methods: A protocol for selection of patients with mandibular fractures was developed. One hundred patients were treated by locking plates and screw system and another 100 patients were treated with the conventional system. The patients were prospectively evaluated for the duration of surgery, difficulties encountered during surgery, neurologic changes, postsurgical occlusal relationship, adequacy of reduction and postsurgical complications. Data were compared for statistical significance with Chi-square test and Z-test.

Results: There was statistically significant difference in postoperative infection, postoperative occlusal discrepancy, postoperative plate fracture and postoperative screw loosening and mobility of the fractured fragments and also the working time between the two systems.

Conclusion: The results of the present study are comparable with other published data and support the notion that the locking miniplate system is a valid alternative to conventional miniplates with several advantages, the only drawback being the additional working time required during adaptation of this hardware.

Keywords: Locking plates and screws, Conventional plates and screws, Mandibular fracture.

How to cite this article: Nayak SS, Pushpalatha C, Tammanavar PS, Naduwinmani SL, Mohan M. Efficacy of Locking Plates/Screw System in Mandibular Fracture Surgery. J Contemp Dent Pract 2013;14(2):222-226.

Source of support: Nil

Conflict of interest: None declared

INTRODUCTION

Techniques for treatment of mandibular fractures have evolved significantly in the past decade. These techniques have ranged from closed reduction with maxillomandibular fixation, to open reduction with wire osteosynthesis, to open reduction with either rigid internal fixation or adaptive miniplate fixation. Since, the development of osteosynthesis in maxillofacial surgery, various reconstruction plate designs have improved intraoperative handling as well as postsurgical results in the management of mandibular fractures. While the introduction of miniplates in the treatment of mandibular fracture surgery led to a notable decrease in surgical soft tissue trauma and improved ease of handling, loosening of screws due to transmission of pressure to the underlying bone leads to loss of fracture stability and fixation failure. A disadvantage of the conventional bone plate/screw system is that the plate must be perfectly adapted to the underlying bone to prevent alterations in the alignment of the segments and changes in the occlusal relationship.

Advantages of the locking system are the ease of plate adaptation and enhanced stability without transmitting excessive pressure to the underlying bone. These plates function as internal fixators, achieving stability by locking the screw to the plate. A unique advantage to locking plate/screw systems is that it becomes unnecessary for the plate to have intimate contact with the underlying bone, making plate adaptation easier. In the locking plate/screw system, the hole in the bone plate is so engineered so as to accept screws that lock to it by a second thread under the head of the screw. The purpose of this prospective study is to evaluate the efficacy of these locking plate/screw systems.

MATERIALS AND METHODS

Source of the Data

The study was set up in two districts, Mangalore in Karnataka state, and Sangli in Maharashtra state, both in India, both of which have a high incidence of road traffic accidents. The study group comprised of 200 individuals

with mandibular fractures treated over a period of 3 years (2009-2012).

METHODOLOGY

Noncorrosive heat resistant locking plate/screw system (Fig. 1) and conventional plate/screw system ensuring good flexibility were used in this study. Four-hole with gap and two-hole with gap miniplates were used in this study. These plates had screw holes with diameter of 2 mm. Screw lengths were 8 or 6 mm depending on the thickness of the underlying bone. In most of the cases, preoperative intermaxillary fixation was done using Erich's arch bar or eyelet wiring to achieve maximum possible occlusion. Either intraoral or extraoral approaches were used depending on the access, location and type of mandibular fracture. Following reduction, miniplates were applied along the osteosynthesis lines as per Champy's principles. The technique for application of the locking plates/screw system is not different than the application of any other noncompression type of miniplate. The only exception is that one should use a drill guide to 'center' the drill hole with that of the bone plate to facilitate screw locking with the plate. Hemostasis was achieved and closure was done.

The sutures were removed and the patients were discharged on the 7th postoperative day. Arch bars were removed before discharge. Subsequent follow-up was done at 1 and 6 months postoperatively.

During each follow-up, occlusion, wound healing, oral hygiene, mouth opening, as well as other complications were looked for. The plates were not routinely removed and their efficacy was judged after the follow-up period. Patients were evaluated for the presence of infection preoperatively, at the end of the first week, at 1 and 6 months postoperatively. Any signs of screw loosening or plate fracture were also noted. Occlusion was checked preoperatively (Fig. 2), on the first day, at 1 and at 6 months postoperatively (Fig. 3). Preoperative radiographs (Fig. 4) and postoperative radiographs (Fig. 5) were taken and assessed.

The fracture site was also examined for signs of mobility of the fractured segments preoperatively and postoperatively for the same time period. The intraoperative working time for the surgical procedure was noted and the mean working time was assessed.

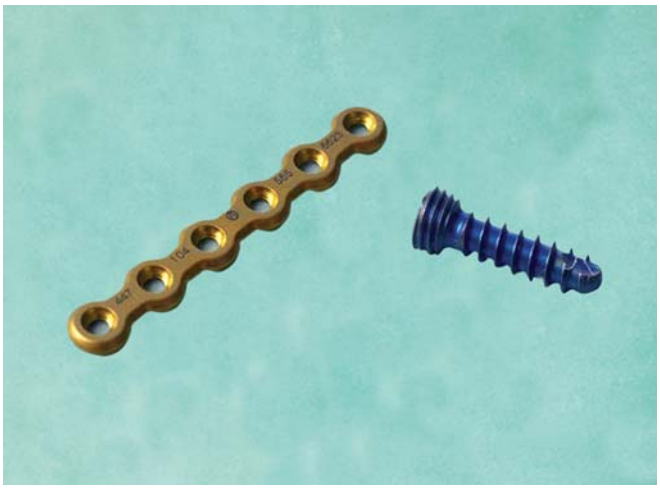


Fig. 1: Locking plate and screw

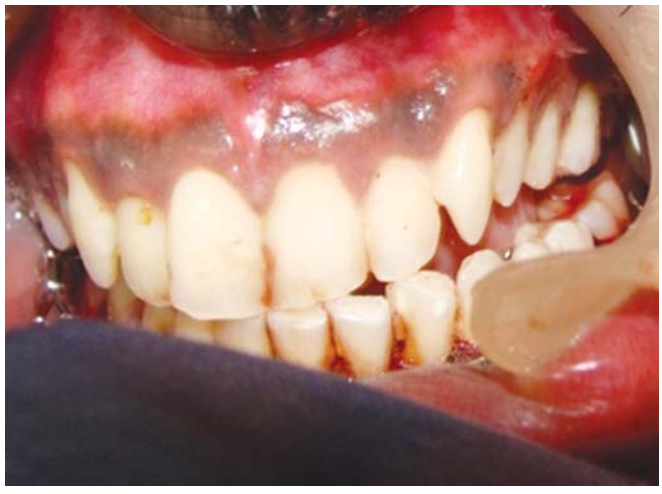


Fig. 2: Preoperative occlusion

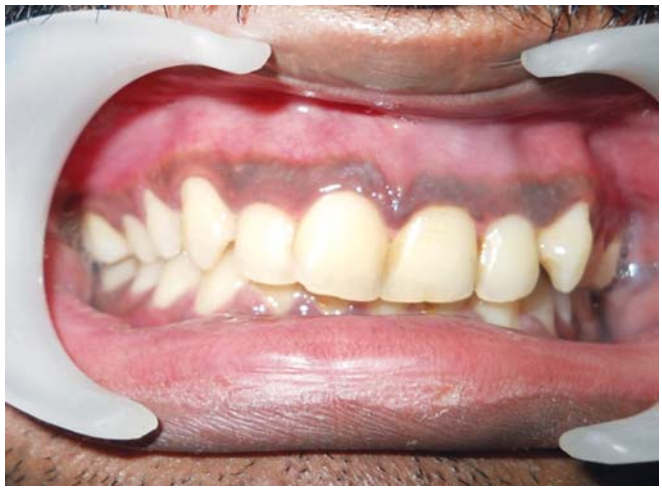


Fig. 3: Postoperative occlusion

Fig. 4: Preoperative radiograph

Fig. 5: Postoperative radiograph

Inclusion Criteria

Patients between 16 and 70 years with at least 6 weeks of follow-up after surgery and patients consenting to participate in the study.

Exclusion Criteria

Medically compromised patients and patients with gross infection at the site of fracture.

STATISTICAL ANALYSIS

The statistical significance of these parameters was assessed by Chi-square test and Z-test.

RESULTS

The present study was conducted in 200 patients having mandibular fractures. One hundred patients were treated with locking miniplates and screws and another 100 were treated with conventional miniplates plates and screws. Two hundred and eighty mandibular fractures were treated in all.

There were no intraoperative difficulties associated with the application of plates and screws. Fracture reductions were considered to be excellent in all cases. The age of the patients included in the study, ranges from 11 to 70 years. Twenty patients (10%) were in the age group of 11 to 20 years, 100 were in the age group of 21 to 40 years (50%), 50 were in the age group of 41 to 60 years (25%), 30 were in the age group of 60 plus years (15%). Maximum number of patients involved in study belonged to the age group of 21 to 40 years (50%). Twenty patients were operated under local anesthesia.

All the operated patients were kept on a follow-up and examined at 1 and 6 months intervals. Out of 100 patients treated using conventional miniplates and screws, 10 patients developed subsequent infection, which was treated by removal of the plate and heavy antibiotics. Only one of the patients treated by locking miniplates and screws developed postoperative infection. This was statistically significant ($p < 0.05$) (Table 1).

Twenty-eight patients treated by conventional miniplates developed postoperative occlusal discrepancy. Out of 100 patients treated by locking miniplates and screws, eight patients developed mild occlusal discrepancy (Table 2). This was found to be statistically highly significant ($p < 0.01$). One incidence of plate fracture was reported in patients having locking plates. Twelve patients out of the 100 treated with conventional plates reported with a plate fracture. This was found to be statistically highly significant ($p < 0.01$) (Table 3).

Out of the 100 patients treated by locking miniplates and screws, only four developed screw loosening and postoperative mobility of the fractured segments. In case of the conventional miniplates and screw system, out of the 100 patients treated, 28 cases reported with screw loosening and postoperative mobility of the fractured segments (Table 4). This was found to be statistically highly significant ($p < 0.01$).

Significant was the fact that the average working time was considerably more in the locking plate system when compared to the conventional type. The mean duration of the operative surgery in case of locking system was 53.5 minutes whereas in case of the conventional system it was 46.0 minutes (Table 5). There was a significant difference between the two groups ($p < 0.01$).

Table 1: Postoperative infection

	Locking plates	*Conventional plates*
No infection		
Count (%)	99	90
Presence of infection		
Count (%)	1	10

Chi-square = 6.157 with 1 degree of freedom; $p < 0.05$ (significant)

Table 2: Postoperative occlusal discrepancy

	Locking plates	*Conventional plates*
Absence of occlusal discrepancy		
Count	92	72
%	90	72
Presence of occlusal discrepancy		
Count	8	28
%	8	28

Chi-square = 12.229 with 1 degree of freedom; $p < 0.01$ (highly significant)

Table 3: Postoperative plate fracture

	Locking plates	*Conventional plates*
Count	99	88
Absent (%)	99%	88%
Count	1	12
Present (%)	1%	12%

Chi-square = 8.227 with 1 degree of freedom; $p < 0.01$ (highly significant)

Table 4: Postoperative screw loosening/mobility of fracture segments

		Locking plates	*Conventional plates*
Absence of screw loosening/mobility of fractured segments	Count	96	72
	%	96%	72%
Presence of screw loosening/mobility of fractured segments	Count	4	28
	%	4%	28%

Chi-square = 19.680 with 1 degree of freedom; $p < 0.01$ (highly significant)

Table 5: Working time (minutes)

Group		*Mean*	*SD*
Locking plates	100	53.50	3.46
Conventional plates	100	46.00	3.60

Z-test: Z-value = 15.025, $p < 0.01$; There is highly significant difference in means of working time in conventional and locking plates

DISCUSSION

An *in vitro* evaluation by Ribeiro et al[1] came to a conclusion that locking plate/screw systems provided significantly greater resistance to displacement than conventional miniplates. Another study conducted by Ribeiro et al,[2] showed that in sagittal split osteotomy, the locking sagittal miniplate showed higher resistance to displacement than the regular four- and six-hole standard miniplates.

According to Ellis and Graham,[3] a theoretical advantage to the use of locking bone plate/screw systems is that the screws are unlikely to loosen from the bone plate. This means that even if a screw is inserted into a fracture gap, loosening of the screw will not occur. The possible advantage to this property of a locking plate/screw system is a decreased incidence of inflammatory complications from loosening of the hardware. It is known that loose hardware propagates an inflammatory response and promotes infection. For the hardware or a locking plate/screw system to loosen, loosening of a screw from the plate or loosening of all the screws from their bony insertions would have to occur. Both of these are unlikely events. As the human mandible shows an uneven surface, adapting conventional miniplates to the contours of the bone can compensate for such incongruities. Repeated bending may cause material fatigue and create predetermined breaking points. Moreover, inaccurate adaptation of conventional plates causes displacement of the mobile bony fragments when the screws are tightened and can decrease primary stability. In contrast the locking plate principle allows the mobile fragments of the bone to stay in the reduced position when tightening the screws, even if the plate is not precisely adapted. Therefore, exact plate adaptation is no longer necessary. In our study, the incidence of screw loosening or postoperative mobility of fractured fragments reported in the locking plate/screw system, is significantly less when compared to the conventional system.

Sauerbier et al[4] showed good results from the UniLock 2.0 system with only 1.9% of major complications and loosening of only one screw, discovered during plate removal. Fifty-six mandibular fractures in 53 patients were treated with the UniLock 2.0 system. Provided the UniLock 2.0 plates are inserted correctly, risk of screw loosening is minimal. In conventional systems with similar dimensions, fixation is provided by the screw thread inserted into the bone, creating a friction lock between the plate and the bone which is essential to achieve stability after the reduction. Torsional forces between the bony fragments may lead to a loss of this friction lock and result in reduced primary stability. Cordey et al[5] stated that the friction between the screw head and plate is the main weak point of the entire fixation. In the locking plate/screw system, the thread on the screw head locks into the congruent thread of the plate, transforming the screws and plate into a unit, creating a rigid splint with higher mechanical stability. The results bear similarity to our study results.

According to Soderholmet et al,[6] one of the potential advantage in locking bone plate/screw systems is that they do not disrupt the underlying cortical bone perfusion as much as conventional plates, which compress the undersurface of the bone plate to the cortical bone leading to disruption of cortical blood supply directly beneath the bone plate, with resultant bone resorption. The locking plate/screw system does not need a friction lock between plate and bone for stability,[7-9] resulting in decreased pressure transmitted to the underlying bone. Less disturbance of perfusion of underlying bone with decreased bone necrosis is the result, which might lead to increased bony healing and regeneration.

In the locking miniplate/screws system, a drill guide is necessary to both 'center' the drill hole and to ensure a perpendicular placement of the screw. Locking screws that are not placed at 90° to the plate will not properly engage the threaded plate hole and therefore will not lock. In our study, significant was the fact that the average working time was considerably more in locking plate system when

compared to the conventional type. This was because of the time taken to 'center' the drill hole with the center of the bone plate to facilitate screw locking with the plate.

REFERENCES

1. Ribeiro-Junior PD, Magro-Filho O, Shastri KA, Papageorge MB. In vitro evaluation of conventional and locking miniplate/screw systems for the treatment of mandibular angle fractures. Int J Oral Maxillofac Surg 2010;39:1109-14.
2. Ribeiro-Junior PD, Magro-Filho O, Shastri KA, Papageorge MB. Which kind of miniplate to use in mandibular sagittal split osteotomy? An in vitro study. Int J Oral Maxillofac Surg 2012;41:1369-73.
3. Ellis E, Graham J. Use of a 2.0 mm locking plate/screw system for mandibular fracture surgery. J Oral Maxillofac Surg 2002;60:642-45.
4. Sauerbier S, Kuenz J, Hauptmann S, Frederik C. Clinical aspects of a 2.0 mm locking plate system for mandibular fracture surgery. J Craniomaxillofac Surg 2010;38:501-04.
5. Cordey J, Borgeaud M, Perren SM. Force transfer between the plate and the bone: Relative importance of the bending stiffness of the screws friction between plate and bone. Injury 2000;31: 21-28.
6. Soderholm A, Lindqvist C, Skutnabb K. Bridging of mandibular defects with two different reconstruction systems. J Oral Maxillofac Surg 1991;49:1098-105.
7. Gutwald R, Buscher P, Schramm A, Schmelzeisen R. Biomechanical stability of an internal minifixation system in maxillofacial osteosynthesis. Med Biol Eng Comp 1999;37: 280-81.
8. Herford A, Ellis E. Use of a locking reconstruction bone plate/ screw system for mandibular surgery. J Oral Maxillofac Surg 1998;56:1261-65.
9. Haug R, Street C, Goltz M. Does plate adaptation affect stability? A biomechanical comparison of locking and nonlocking Plates. J Oral Maxillofac Surg 2002;60:1319-26.

ABOUT THE AUTHORS

Sunil S Nayak (Corresponding Author)

Assistant Professor, Department of Oral and Maxillofacial Surgery Bharati Vidyapeeth Deemed University Dental College and Hospital Sangli, Maharashtra, India, Phone: +91 7350555740, e-mail: sunilmaxfac@yahoo.com

C Pushpalatha

Assistant Professor, Department of Pedodontics and Preventive Dentistry, Bharati Vidyapeeth Deemed University Dental College and Hospital, Sangli, Maharashtra, India

Praveen S Tammanavar

Assistant Professor, Department of Orthodontics, Bharati Vidyapeeth Deemed University Dental College and Hospital, Sangli, Maharashtra India

Sanjay L Naduwinmani

Professor, Department of Orthodontics, Maratha Mandal Dental College, Belgaum, Karnataka, India

Muralee Mohan

Professor, Department of Oral and Maxillofacial Surgery, AB Shetty Memorial Institute of Dental Sciences, Mangalore, Karnataka, India