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Original Research Article

Comparison of Locking Titanium Miniplates and Conventional Titanium Miniplates in Treatment of Mandibular Fractures

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Abstract: The goal of fracture management is to restore proper function by union of the fractured segments and restoring the strength, contour defects that might have happened at the time of injury, and controlling infection at the fracture site.[1]The present study were to evaluate and compare the treatment outcome between 2D locking titanium miniplates and conventional 2D miniplates for symphysis, parasymphysis and body fractures in the mandibular region. A total of 30 patients who sustained fracture in the symphysis, parasymphysis and body region were enrolled for this study. The patients were randomly and equally allocated into two groups. Group-A patient fractures were treated by locking titanium plates and Group-B Patient fractures were treated by conventional 2D mini plates. The patients were followed up at 1 month, 3 months and 6 months for occlusion, infection, hardware failure, stability of fracture segments, healing and paraesthesia .From the results one patient in Group-A had post-operative complication and none of the patients in Group -B had any complications. From this present study we would like to conclude locking titanium miniplates are an alternative mode of treatment for mandibular symphysis, parasymphysis and body fractures.
Keywords: Symphysis, parsymphysis and body fracture, Locking miniplates, 2-Dimensional miniplates

INTRODUCTION

Management of trauma is the area in which maxillofacial surgeons have excelled over the years [1]. The major health hazards of society is caused by road traffic accidents (RTA), violence, sports injuries, accidental falls and industrial trauma. Among the parts of the body, head is the most common site for injury [2]. The second most commonly affected site is the mandible because of the position and its prominence [1].

Open reduction and internal fixation (ORIF) of the mandible with bone plates were first described by Schede in 1888, who used steel plates and screws. Rigid fixation using compression plates has decreased the period of MMF and provided early return of mandibular function [3]. Miniplate osteosynthesis, first introduced by Michelet in 1973 [4], and further developed by Champy in 1976, which is the standard for the treatment of mandibular fractures at present . Champy introduced the ideal lines of osteosynthesis on which plates have to be applied to resist torsional forces.

Conventional plates and screws which were the choice for treatment of fractured mandible had several disadvantages which included the plate being perfectly and accurately adapted to the underlying bone to prevent alterations in the alignment of the segments and the changes in the occlusal relationship [5]. The conventional bone plating system achieved its stability when the head of screw compresses the fixation plate to the bone as the screw is tightened.

Locking plates and screw system which was introduced for the treatment of mandibular fractures has certain advantages over the conventional plating system. These plates achieve stability by locking the screw to the plates [2]. This is possible by having a screw with a double thread. One thread will engage the bone; another will engage a threaded area of the bone plate [6]. Theoretically advantages include; less chance of screw loosening, greater stability across the fracture site, less precision required in plate adaptation; and less

alteration in osseous or occlusal relationship upon screw tightening [2].

Recent studies have shown that locking miniplate have several advantages over the conventional miniplates. Considering the current concepts, the study was carried out in the Department of Oral and Maxillofacial Surgery, Yenepoya Dental College, to evaluate and compare the efficacy of locking titanium miniplates with conventional titanium miniplates in treatment of mandibular fractures.

AIM AND OBJECTIVES

The objectives of this present study were to evaluate and compare the treatment outcome between 2D locking titanium miniplates and conventional 2D miniplates for symphysis, parasymphysis and body fractures in the mandibular region

MATERIALS AND METHODS

A total of 30 patients who sustained fracture in the symphysis, parasymphysis and body region were enrolled for this study. The patients were randomly and equally allocated into two groups. Group A patient fractures were treated by locking titanium plates. Group B patients in which fracture were treated by conventional 2D plates.

All patients were treated under general anaesthesia. The patients were followed up at 1 month, 3 months and 6 months for occlusion, infection, hardware failure, stability of fracture segments, healing and paraesthesia. Statistical analysis was done using chi- square test.

RESULTS

In this present study 1 patient in Group-A had a post-operative complication and none of the patients in Group -B had any complications.

Preoperative

Table 1: Occlusion

		mild	moderate	severe	Total
Group	A	3	3	9	15
		20.0%	20.0%	60.0%	100.0%
	B	6	4	5	15
		40.0%	26.7%	33.3%	100.0%

Table 2: Infection

		absent	present	Total
Group	A	12	3	15
		80.0%	20.0%	100.0%
	B	13	2	15
		83.3%	16.7%	100.0%

Table 3: Stability

		mobility	no mobility	Total
Group	A	12	3	15
		80.0%	20.0%	100.0%
	B	8	7	15
		53.3%	46.7%	100.0%

Table 4: Parasthesia

		absent	present	Total
Group	A	8	7	15
		53.3%	46.7%	100.0%
	B	8	7	15
		53.3%	46.7%	100.0%

Post Operative

Table 5: Occlusion

		mild	normal	Total
Group	A	1	14	15
		6.7%	93.3%	100.0%
	B	2	13	15
		13.3%	86.7%	100.0%

Table 6:Infection

		absent	Total
Group	A	15	15
		100.0%	100.0%
	B	15	15
		100.0%	100.0%

Table 7: Stability

		no mobility	Total
Group	A	15	15
		100.0%	100.0%
	B	15	15
		100.0%	100.0%

Table 8: Healing

		satisfactory	Total
Group	A	15	15
		100.0%	100.0%
	B	15	15
		100.0%	100.0%

Table 9: Hardware failure

		absent	Total
Group	A	15	15
		100.0%	100.0%
	B	15	15
		100.0%	100.0%

Table 10: Parasthesia

		absent	present	Total
Group	A	13	2	15
		86.7%	13.3%	100.0%
	B	12	3	15
		80.0%	20.0%	100.0%

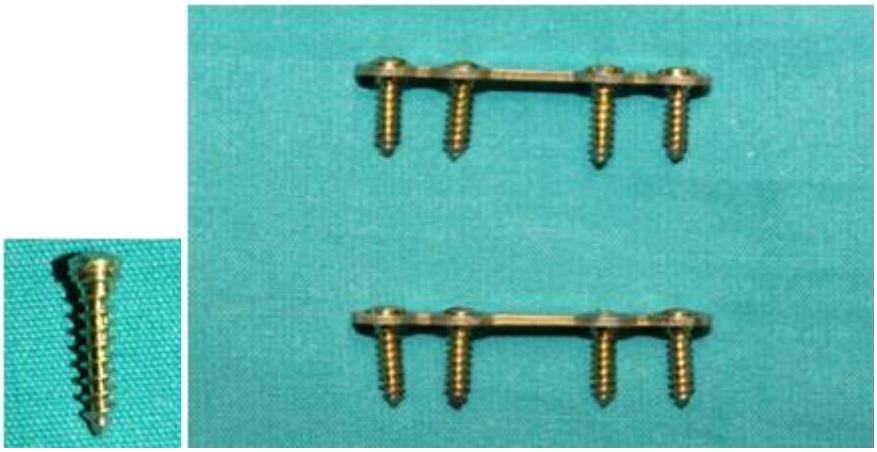

Fig 1: 2-DIMENSIONAL LOCKING TITANIUM MINIPLATES AND SCREWS

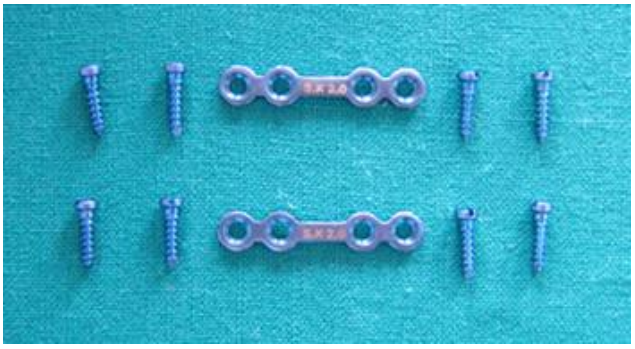

Fig 2: 2-DIMENSIONAL TITANIUM MINIPLATES AND SCREWS

GROUP A

Fig 3: **PREOPERATIVE**

Fig 4: **INTRA OPERATIVE**

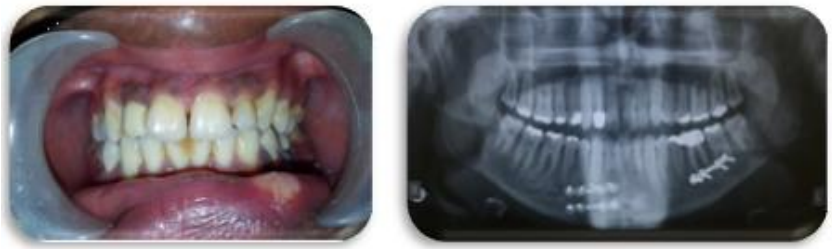

Fig 5: **POST OPERATIVE**

GROUP B

Fig 6:**PRE OPERATIVE**

Fig 7: **INTRA OPERATIVE**

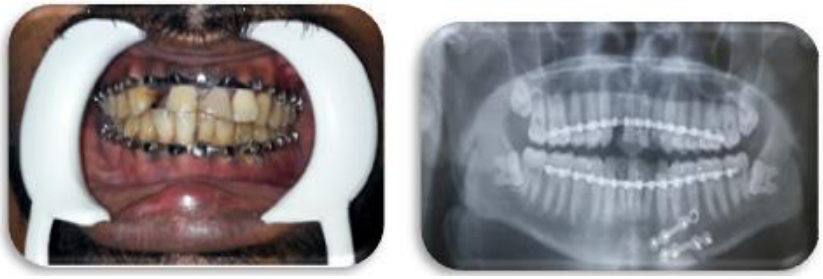

Fig 8: **POST OPERATIVE**

DISCUSSION

The treatment for mandibular fracture has evolved from an age old wiring technique to the most recent plating system. Conventional wiring technique showed to be less efficient with the progression of time. Introduction of rigid plating fixation allows early mobilisation for the patient.

Michelet *et al* in 1960 developed the concept miniplate osteosynthesis. They published a report in 1973 authenticating the successful use of a small plate and monocortical screws for the treatment of mandibular fractures. The original goal of miniplate osteosynthesis was to provide stable mandibular fracture reduction without requiring inter fragmentary compression or maxillomandibular fixation. Initial studies performed in 1970s at the Group d'Etude en Biomecanique Osseuseet Articularie de Strasbourg confirmed that the miniplate achieves this goal by counteracting undesirable tensile forces while retaining favourable compressive forces during function [7].

The miniplate system which is smaller in size offers several advantages over the larger mandibular plates. Plating can be done with a Smaller incision and less soft tissue dissection. It can often be placed intraorally, which avoids an external scar. They are less palpalpable because of its smaller size. Pates may be placed in the areas of mandible adjacent to tooth roots with minimal risk of dental injury. The justification of using monocortical plate in mandibular fracture is that the plate fixed on to the outer cortical plate is durable enough to support the occlusal forces developed by masticatory muscles [8].

Conventional miniplates which are loaded axially in tension translate the force applied to shear stress at the plate–bone interface. Axial forces are opposed by frictional force between the plate and bone. The normal force to the plate is equal to the axial force produced by the torque applied to the screws which is used to fix the plate to the bone.

Advancing screw threads produce shear forces, the osteoporotic and comminuted bone may not able to endure. This situation makes it impossible for the screws to attain sufficient torque which is required for the proper adaptation of the plates to reduce the fracture. This creates a gap strain and can cause failure of the system.

Locking mini plates began from the failure of conventional plate and screw constructs to meet the demands of minimally invasive and indirect fixation, as well as a failure of compression plating techniques to provide an environment favourable to secondary bone healing. Conventional plates and screws cannot achieve proper fixation in osteopenic or pathologic bone, leading to necrosis induced bone loss which is a potential nidus for infections, which weakens bone and increases the chance for refracture after device removal; and creates asituation where lack of stability will result in delayed or nonunion.

Locking plates control the axial alignment of the screw to the plate, thereby improving screw–plate–bone stability by creating a single-beam construct. A single locked screw–plate act as single devices. Functioning as a single device, locked plates can improve fracture fixation in circumstances where fracture alignment or bone quality do not provide sufficient screw securing to achieve the plate–bone compression necessary to reducegap strain with conventional plate screw system. Locking plates change

shear stress to compressive stress at the screw–bone interface; fixation is improved because bone has much higher resistance to compressive stress than shear stress. In locked plates, the strength of fixation equals the sum of all screw–bone interfaces rather than that of the single screw's axial stiffness or pullout resistance as seen in conventional plates.

Locking plates do not function on frictional force between the plate and bone to achieve compression and absolute stability, which allows the local blood supply under the plate to be well-maintained. This preserved periosteal blood supply permits for more rapid bone healing and reduced occurrence of infection, bone resorption, delayed union, nonunion, and secondary loss of reduction. Animal studies and cadaver injection studies have confirmed the decrease in vascular insult with locking miniplates. Another theoretical advantage in the locking miniplate/screw system is that these plates do not disrupt the underlying cortical bone perfusion as much as the conventional miniplates which compress the under surface of the bone plate to the cortical bone. It also projected that this system provides greater stability than that provided by the standard conventional miniplate [5].

The screws in locking plate system are unlikely to loosen from the plate, which gives the flexibility of placing the screw into the fracture line and loosening of screw will not occur. The possible advantage to this property of the locking plate and screw system is reduced inflammatory complications from loosening of hardware.

Other advantages of the locking system:

1. Not allowing the stripping of screws.
2. Prevent movement and loosening of screws.
3. Plate do not have to be as precisely adapted to the underlying bone.
4. Do not have to be compressed against the bone for stability.
5. The bending of the plates is simplified.
6. Dislocation following osteosynthesis is minimized or eliminated.
7. Less interference with underlying vascular supply and the fixator principle provides increased primary stability [9].

It is observed that the degree of plate adaptation affected the mechanical behavior of conventional plates but did not affect the locking plate and screw system. Brain Alpert, Rolf Gutwald, and Rainer Schmelzeisen in 2003 stated that the only exception is that a drill guide has to be used to "center" the drill holein the center of bone plate to enable proper screw locking to the plate [2]. The locking plate and bone forms a single solid framework with higher stability than the conventional miniplate system. It has been demonstrated that it has higher stability across a fracture compared with the conventional nonlocking 2.0 mm miniplate in vitro.

In our study a total of 30 patients who were divided into two groups, A&B with 15 patients in each group. Group A was treated with locking titanium miniplates and group B with 2D titanium miniplates. Among the 30 patients there were 27 males and 3 females. The age of the patients ranged from 12-54 years. As recorded there was 80% parasymphysis fracture and 20%/ of symphysis fracture in group A. In group B there was 67% of parasymphysis fracture, 26% of mandibular body fracture and & 7% of symphysis fracture.

RTA was the most common cause of trauma as observed in both the groups with 93% of occurrence. The remaining 7% of cases reported were of self-sustained injuries.

Pre operatively the patient was assessed for occlusion, infection, stability of fracture segments and paraesthesia. The preoperative occlusion was divided mild moderate and severe according to the occlusal discrepancy observed. Severe occlusal discrepancy was observed in 60%, moderate in 20% and mild in 20% of patients of group A were as there was 33% with severe discrepancy,26.7% with moderate and 40% with mild discrepancy in group B(Table 1).

Preoperatively it was found that 20% of patients in group A and 16.7 % in group B had infection at the fractured site(Table 2). Regarding the stability of the fracture segments mobility was present in 80% of patients in group A and 53% of patients in group B(Table 3). In both the groups 46.7% of patients had paraesthesia in the fracture site(Table 4).

The post-operative period was assessed under the parameters of occlusion, infection, stability of fracture segments, healing, hardware failure and paraesthesia of the fracture site. The evaluation was done at the intervals of 1month, 3month and 6month postoperatively.

1st month follow up showed mild occlusal discrepancy in 3 patients (20.0%) in group A and 2 patients (13.3%) in group B. In group A 1 patient (6.7%) presented with infection and none of patient in group B had infection. There were no mobility of fracture segments in both groups. In group A 1 patient (6.7%) healing was unsatisfactory. Hardware failure was not seen in both groups. In group A 2 patients (13.3%) and group B 5 patients (33.3%) had paraesthesia in the fractured site.

3rd month follow up showed mild occlusal discrepancy in 1 patients (6.7%) in group A and 2 patients (13.3%) in group B. None of patient in group A & B had infection. There were no mobility of fracture

segments in both groups. Healing was satisfactory in all the patients of group A and B. Hardware failure was not seen in both groups. In group A 2 patients (13.3%) and group B 5 patients (33.3%) had paraesthesia in the fractured site.

6th month follow up showed mild occlusal discrepancy in 1 patients (6.7%) in group A and 2 patients (13.3%) in group B (Table 5). None of patient in group A & B had infection (Table 6). There were no mobility of fracture segments in both groups (Table 7). Healing was satisfactory in all the patients of group A and B (Table 8). Hardware failure was not seen in both groups (Table 9). In group A 2 patients (13.3%) and group B 5 patients (33.3%) had paraesthesia in the fractured site (Table 10).

The mild occlusal discrepancy remained the same for 1 patient in group A and 2 patient in group B at 3rd month and 6th month follow up. Infection in one patient was evident from group A during 1st month follow up, which was managed with higher antibiotics for a week. In 3rd month and 6th month none of the plates in both the groups reported with any infections. Fracture segments was stable in both the groups in 1st, 3rd and 6th month follow up. Except for the 1st month 1 patient in group A which showed unsatisfactory healing which was due to the infection, all the other patients were free of infection for 3rd and 6th month. No Hardware failure was reported in in both groups A and B at the end of 6th month follow up. Paraesthesia was present in 13.3% of patients in group A and 33.3% of patients in group B, these problems were present in patients pre-operatively which remained the same till 6th month follow up. The paraesthesia in some cases got resolved only after a period of 6 month to 1 year post operatively.

Occlusal discrepancy at 6th month shows a ‘p’ value of 0.543, post-operative infection & healing at 1st month follow up shows a ‘p’ value of 0.309, and paraesthesia at 6th month follow up shows a ‘p’ value of 0.624, which were all statistically insignificant.

In our study the locking plate showed less number of patients with occlusal discrepancy and less number of case with paraesthesia of the fractured site. Certain disadvantages were noticed in the locking plates system, bending of plates for adaptation led to improper fitting of the screws in the grooves of the plate, the working time taken for the fixation of the locking plate and screws are considerably more than the conventional plate and screws. The adaptation of the locking screws should be perpendicular to the plate holes [2], and maximum angulation possible was 13^0, which turned out to be difficult in many cases. One patient who got infected in the first month of follow up in group A, may be due to the improper care taken by the patient post operatively.

CONCLUSION

The following inferences can be drawn from this study:

Patients treated by locking miniplates showed less post-operative complications in terms of occlusion, nerve damage, and stability of fracture segments. Only one patient reported with infection in the first post-operative month which was subsequently resolved and the plate was not removed. All patients in present study appreciated early recovery of normal jaw function, primary healing and good union at fracture site with minimal weight loss due to early functional rehabilitation. During the course of present study the plate was found to be effective in managing mandibular symphysis, parasymphysis and body fractures. They seem to be an easy to use alternative to conventional 2D miniplates.

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