

# Locking v/s non-locking reconstruction plates in mandibular reconstruction

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## ABSTRACT

**Purpose:** To compare the efficacy of locking plates to non-locking plates in the osteosynthesis of mandibular fractures on the basis of clinical parameters. **Materials and Methods:** A prospective randomized clinical trial was conducted at the Faculty of Dental Science, CSMMU (formerly King Georges Medical College), Lucknow, to treat consecutive mandible fractures. The patients were randomly divided into two groups. The patients underwent osteosynthesis—group 1 with 2.4-mm locking titanium plates and group 2 with 2.7 mm non-locking titanium plates. The cause of trauma, the number of days from injury to surgery, average age, gender, and site distribution were all reviewed. The assessment of the patients was done at 1, 3, and 6 weeks and 3 months using the clinical parameters. **Results:** A total of 12 patients with mandibular fractures met the inclusion criteria. In our study, a statistically significant difference was not found in the clinical parameters such as infection, paraesthesia, hardware failure, and mobility between the fracture segments. A statistically significant difference was found between pain and swelling from the previous follow-up visit in groups 1 and 2. In locking group, pain decreases significantly at 3<sup>rd</sup> week, 6<sup>th</sup> week, 12<sup>th</sup> week from 1<sup>st</sup> week and pain was absent after 3 week. In non-locking group, pain decreases significantly at 3<sup>rd</sup> week, 6<sup>th</sup> week and 12<sup>th</sup> week from 1<sup>st</sup> week but pain was present till 12<sup>th</sup> week. Pre-operative swelling was present only in case of non-locking group. Swelling was present in 66.7% of non-locking group and 0% in locking group. After one week swelling was absent in 100% patients at 3<sup>rd</sup>, 6<sup>th</sup> and 12<sup>th</sup> week. Swelling was considerably decreased in locking group as compared to the non-locking group. **Conclusion:** These findings show that the use of locking plates in mandibular fracture was efficacious enough to bear the masticatory loads during osteosynthesis of the fracture. The locking plates provide the advantage of a greater stability, with clinical results almost similar to those seen with non-locking plate osteosynthesis.

**Key words:** Locking, mandibular reconstruction, non-locking

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## INTRODUCTION

Mandibular fractures are common facial injuries accounting for 36 to 59% of all maxillofacial fractures

and their treatment is one of the most frequent forms of therapy provided by maxillofacial surgeons. The leading causes of mandibular fractures were motor vehicle accidents and assaults.<sup>[1,2]</sup> It is recommended that, to achieve the low rates of wound dehiscence and infection, miniplate osteosynthesis must be performed soon after injury.<sup>[3,4]</sup> Champy *et al.* recommended fixation within 12 h, whereas Cawood extended this period to 24 h after injury. However it was reported that the complication rates with delayed miniplate osteosynthesis were comparable with miniplate osteosynthesis performed within 24 h.<sup>[5]</sup>

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With the development of osteosynthesis in maxillofacial surgery, different systems have been designed. They have become smaller, more simple to handle and extraoral incisions can be avoided. Surgeons have attempted to achieve four main goals when repairing the mandibular fractures: anatomical restitution, immobilization, prevention of infection and rehabilitation of function. Achieving these goals is essential for successful bone healing and correct postoperative function of the stomatognathic system.<sup>[6]</sup> Different techniques for the treatment of mandibular fractures have evolved in the past decade. These techniques have ranged from closed reduction with maxillomandibular fixation (MMF) to open reduction with wire osteosynthesis, to open reduction with either rigid internal fixation or adaptive miniplate fixation.<sup>[7]</sup> Rigid fixation using compression plates has decreased the period of MMF and provided early return of mandibular function.<sup>[8]</sup> Transoral placement of non-compressive miniplate fixation has recently gained popularity using the principles of Champy *et al.*<sup>[3]</sup>

The basic concept for rigid fixation is absolute stability and there are a variety of techniques advocated to achieve this goal. Champy suggest that engaging a single cortex is sufficient for rigid osteosynthesis. While the introduction of miniplates in the treatment of mandibular fractures led to a notable decrease in surgical soft tissue trauma and improved ease of handling, with sufficient stability and fixation of mandibular fractures, loosening of screws due to transmission of pressure to the underlying bone leads to loss of fracture stability and fixation failure.<sup>[9,10]</sup> Advantages of the locking system are the ease of plate adaptation, enhanced stability without transmitting excessive pressure to the underlying bone, leading to less impairment of blood supply.<sup>[9,11]</sup> The minilocking-system (UniLock 2.0, Synthes, Oberndorf, Switzerland) developed by the Albert-Ludwigs University of Freiburg in cooperation with the AO/ASIF Institute (Davos, Switzerland) was evaluated in an *in-vitro* study by Gutwald and co-workers and was shown to provide superior accuracy in bone reduction and stability when compared to conventional miniplates.<sup>[9]</sup>

Two fundamental principles are required to obtain adequate rigid internal fixation for comminuted mandibular fractures. First, the fixation needs to support the full functional loads (load-bearing osteosynthesis). Second, absolute stability of the fracture construct must be achieved.<sup>[8,12]</sup> This is the prerequisite for sound bone healing and a low rate of infection. These principles can be applied to mandibular osteosynthesis reconstruction or universal plates. However, technically in comminuted fractures, the bone fragments cannot take part in the functional load, and therefore load-

sharing osteosynthesis between implant and bone is not possible. Advantage of bone plate osteosynthesis is that the patient does not need to undergo inter-maxillary fixation for weeks.

## MATERIALS AND METHODS

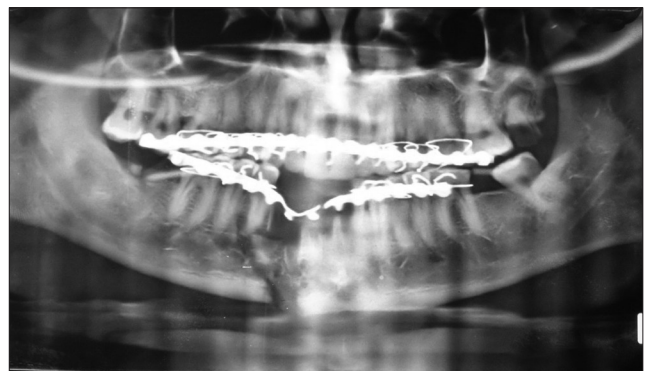
This study comprised of 12 patients having mandibular fractures attending outpatient department of OMFS. They were randomly selected irrespective of cast, creed, age and sex. Patient having mandibular fractures with comminuting, infection, pathological fracture, continuity defect and trauma were taken. Informed consent was taken to participate in the study. The patients were divided in two groups consisting of 6 patients in each group. Surgery was performed under general anesthesia in all but 1 patient who underwent surgery under local anesthesia [Table 1, Figures 1–9].

**Table 1: No. of patient**

No. of patients	Osteosynthesis
Group A 6	2.4 mm Uni-lock system
Group B 6	2.7 mm non-locking system



**Figure 1: Preoperative occlusion (locking group)**



**Figure 2: Preoperative OPG (locking group)**



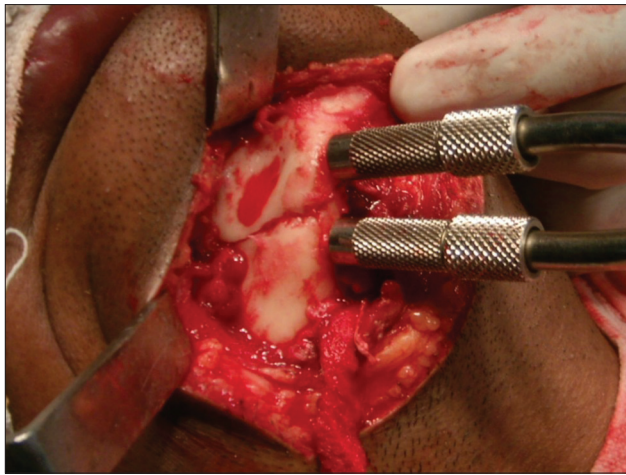


Figure 3: Reduction of fracture segments (locking group)

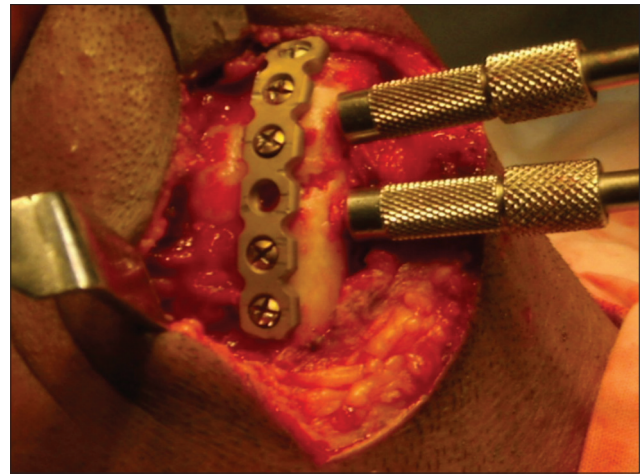


Figure 4: 2.4-mm Unilock plate secured with locking screw (locking group)



Figure 5: Postoperative occlusion (locking group)

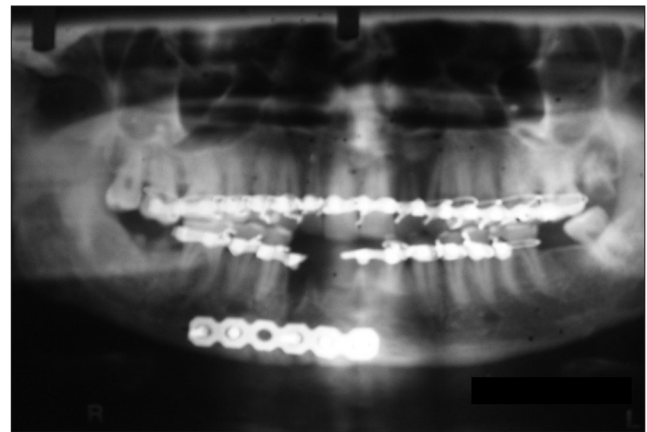


Figure 6: Postoperative OPG (locking group)



Figure 7: Preoperative OPG (gunshot injury) (non-locking group)

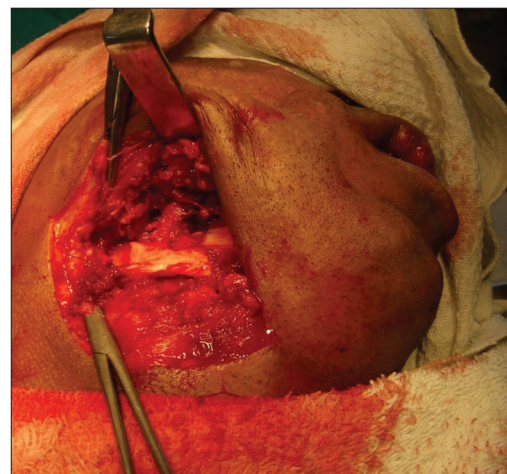


Figure 8: Intraoperative fracture site exposed (non-locking group)

Standard instruments were used for maxillofacial surgery and bone plating [Figures 10–17]. Basic operative technique for operating in both group were the same [Table 2].

## RESULTS

Postoperative assessment of the patients was done

on the basis of pain, swelling, paraesthesia, esthetic, function, infection/hardware failure, mobility between fracture fragments. Follow-up at 1<sup>st</sup> week, 3<sup>rd</sup> week, 6<sup>th</sup> week, and 12<sup>th</sup> weeks intervals [Table 3].

In locking group, pain decreases significantly at 3<sup>rd</sup> week, 6<sup>th</sup> week, 12<sup>th</sup> week from 1<sup>st</sup> week and pain was absent



**Figure 9:** Postoperative OPG 2.7-mm non-locking plate in place (non-locking group)



**Figure 10:** Non-locking screws



**Figure 11:** Locking screws



**Figure 12:** Plate cutting instruments



**Figure 13:** Plate bending instruments



**Figure 14:** Plate bending plier

after 3<sup>rd</sup> weeks. In non-locking group, pain decreases significantly at 3<sup>rd</sup> week, 6<sup>th</sup> week and 12<sup>th</sup> week from 1<sup>st</sup> week but pain was present till the 12<sup>th</sup> week [Table 4, Graph A].

Preoperative swelling was present only in case of non-locking group. Swelling was present in 66.7% of non-locking group and 0% in locking group. After one week swelling was absent in 100% patients at 3<sup>rd</sup>, 6<sup>th</sup>

**Table 2: Plate profile**

Plate profile	Thickness	Width	Hole spacing	Shape
Locking	2.5 mm	8.0 mm	8.0 mm	Straight angle
Non-locking	2.7 mm	8.0 mm	8.0 mm	Straight angle

Screws: 2.4 mm, 3.0 mm self-tapping

and 12<sup>th</sup> week. Swelling was considerably decreased in locking group as compared to the non-locking group [Tables 5 and 6, Graphs B and C].



The locking and non-locking group occlusion was achieved in 100% patient at different follow-up.

## DISCUSSION

According to Arbeitsgemeinschaft für Osteosynthesefragen (AO)/Association for the Study



Figure 15: Screw driver

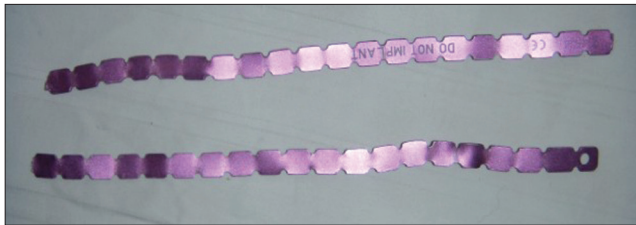


Figure 16: Surgical template

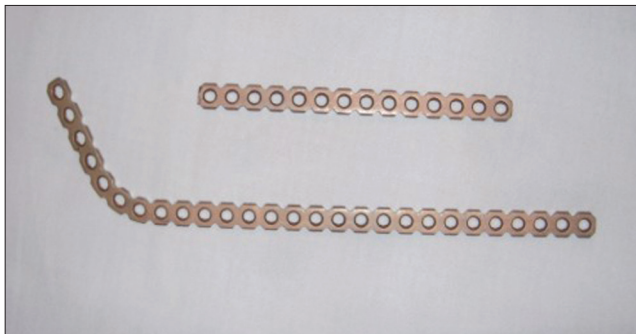


Figure 17: Reconstruction plates

of Internal Fixation (ASIF) principles, the main aim of open reduction and rigid internal fixation in the management of mandibular fractures is to achieve undisturbed healing and immediate restoration of form and function without the adjunctive use of MMF. This approach has become increasingly popular during the past 20 years for all types of mandibular fractures, and diverse plating systems have been developed to meet this fundamental requirement.<sup>[13-16]</sup> The locking plating system has been developed and popularized by AO/ASIF to obviate the main disadvantage of conventional plate system, which requires the plate to be perfectly adapted to the underlying bone to avoid gapping of the fracture and associated instability. This bone-plate system acts as an internal-external fixator, which results in better distribution of the load and prevents load concentration on a single screw, thus decreasing the risk of a screw's loosening and stripping. Moreover, because anatomic adaptation of the plate to the underlying bone contour is not crucial, there are theoretically a fewer interferences with the adjacent vascular supply.<sup>[17,18]</sup>

The dimensions of the UniLock 2.0 system correspond to conventional 2.0-mm miniplate systems. The plates are available in three different sizes, 'Mini', 'Intermediate' and 'Large' and in straight or angled forms with or without a bar (for the sizes 'Intermediate' and 'Large'). All plate sizes are fixed with self-tapping 2.0 mm locking screws with a characteristic twin thread on the rim of the screw head. The screw thread fits exactly into the threaded plate holes and locks the screw into the plate during fixation. These plates were developed in order to improve miniplate osteosynthesis and reduce complications when surgically treating mandibular fractures.

Loosening of screws and plates are considered to be the main risk factors for increased rates of infection and complications.<sup>[11,19,20]</sup> The present study showed good results from the UniLock 2.4 mm plate, Provided the UniLock 2.4 mm plates are inserted correctly, the risk of screw loosening is minimal. In conventional systems with similar dimensions, fixation is achieved

Table 3: Comparison of pain in locking and non-locking group

Time duration →	1 <sup>st</sup> week		3 <sup>rd</sup> weeks		6 <sup>th</sup> weeks		12 <sup>th</sup> weeks	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Locking group	2.50	0.84	0.67	0.52	0	0	0	0
Non-locking group	5.17	1.94	2.17	1.60	0.83	0.76	0.67	0.63

Table 4: Comparison of swelling in locking and non-locking group

Swelling	Pre-operative				1 <sup>st</sup> week				3 <sup>rd</sup> weeks				6 <sup>th</sup> weeks				12 <sup>th</sup> weeks			
	L		NL		L		NL		L		NL		L		NL		L		NL	
Present	-	-	1	11.6	-	-	4	66.7	-	-	-	-	-	-	-	-	-	-	-	-
Absent	6	100	5	88.4	6	100	2	33.7	6	100	6	100	6	100	6	100	6	100	6	100
Total	6	100	6	100	6	100	6	100	6	100	6	100	6	100	6	100	6	100	6	100

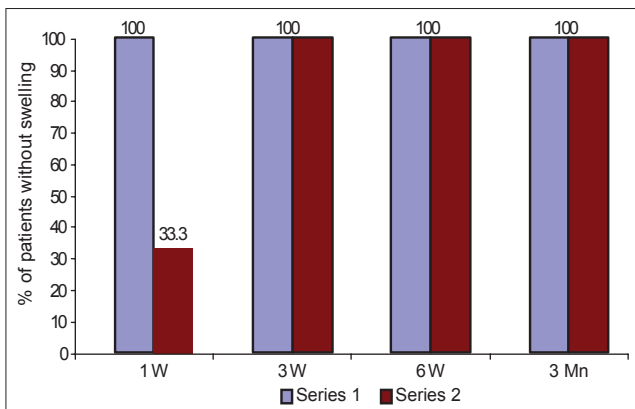
**Table 5: Comparison of functional occlusion in two groups**

Follow up Group	Preoperative		1 <sup>st</sup> week		3 <sup>rd</sup> weeks		6 <sup>th</sup> weeks		12 <sup>th</sup> weeks											
	L	NL	L	NL	L	NL	L	NL	L	NL										
Malocclusion	6	100	5	88.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Functional occlusion	-	-	1	11.6	6	100	6	100	6	100	6	100	6	100	6	100	6	100	6	100
Total	6	100	6	100	6	100	6	100	6	100	6	100	6	100	6	100	6	100	6	100

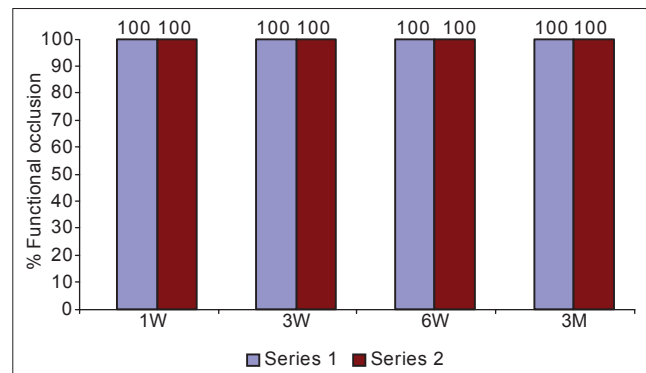
**Table 6: Comparison of esthetic in locking and non-locking group**

Followup postoperatively	1 <sup>st</sup> week		3 <sup>rd</sup> weeks		6 <sup>th</sup> weeks		12 <sup>th</sup> weeks	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Locking group	0	0	0.67	0.52	2.0	0.0	3.0	0.0
Non-locking group	0	0	2.80	0.45	1.83	0.75	3.0	0.0

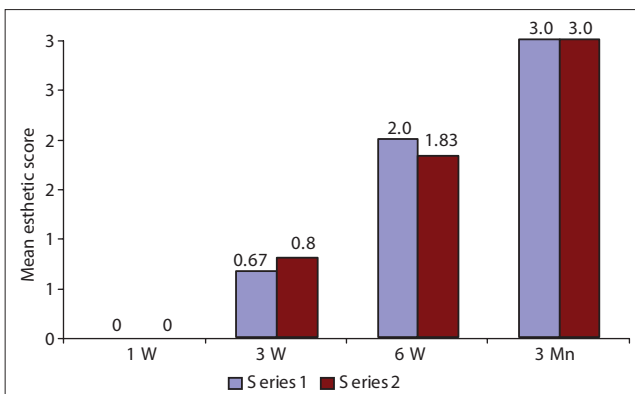
There is no significant difference in esthetic score in two groups at different follow-up



**Graph A:** Blue bar (non locking) brick red bar (locking) percentage patient without swelling at follow up weeks (W) months (M)



**Graph B:** Blue bar (non locking) brick red bar (locking) Functional occlusion in two groups



**Graph C:** Blue bar (non locking) brick red bar (locking) Esthetics score

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 bony fragments may lead to a loss of this friction lock, which result in reduced primary stability. Cordey *et al.* state that the friction between the screw head and plate is the main weak point of the entire fixation.<sup>[21]</sup> In the UniLock 2.4 mm 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.

In our study, in locking group, pain decreases significantly at 3<sup>rd</sup> week, 6<sup>th</sup> week, 12<sup>th</sup> week from 1<sup>st</sup> week and pain was absent after 3<sup>rd</sup> week. In non-locking group, pain decreases significantly at 3<sup>rd</sup> week, 6<sup>th</sup> week and 12<sup>th</sup> week from 1<sup>st</sup> week but pain was present till 12<sup>th</sup> week. Pain was decreased significantly in locking system. Also swelling was decreased significantly in locking group.

The absence of major complications found in this study corroborates the two main biological and mechanical advantages reported by experimental studies on locking plates, which allow for more rapid and undisturbed bone healing and decreased risk of delayed union, nonunion, or infection.<sup>[17,18]</sup> First, the absence of pressure under the plate prevents the cortical blood supply from being disrupted and allows periosteum growth under the plate.<sup>[17,18]</sup> Second, stress shielding below the plate is eliminated, which prevents chronic inflammation and subsequent bone necrosis.<sup>[22]</sup> Moreover, AO 2.4-mm locking reconstruction plates offer the advantages resulting from buttress plates, which can support a full functional load by acting as load bearing devices and can counter and convert shear forces to compressive axial forces at the fracture site.<sup>[23-25]</sup> This improves the stability of the construct, which decreases the gap strain and the mechanical susceptibility to infection that occurs when adequate stabilization is no longer guaranteed.

Thus far, to the best of our knowledge, Ellis and Graham<sup>[11]</sup> were the only investigators to report on the clinical use of AO 2.0-mm lock reconstruction plates for mandibular fractures. In a series of 59 patients with 80 mandibular fractures, these researchers reported the use of 102 AO 2.0-mm locking plates, of which only 12 were reconstruction plates. The researchers did not separately analyze the fractures treated with reconstruction plates, but they found sound bone healing radiographically in all patients and a 10% infection rate.

## CONCLUSION

In conclusion, the present study has demonstrated that treating mandibular fractures with a AO 2.4-mm locking reconstruction plate allows sound bone healing and is not associated with major complications. Moreover, this study showed that the 2.7-mm unlocking reconstruction plates used is also having comparable results. Although this report is promising, it should be interpreted with caution because only a prospective study comparing the conventional plating with the locking plating would allow definitive conclusions to be drawn.

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