Standard 3D Titanium Miniplate Versus Locking 3D Miniplate in Fracture of Mandible: A Prospective Comparative Study

Arjun Singh¹ · K. V. Arunkumar¹

Received: 19 December 2014 / Accepted: 7 July 2015 / Published online: 29 July 2015
© The Association of Oral and Maxillofacial Surgeons of India 2015

Abstract

Introduction The purpose/aim of the study conducted was to compare the efficiency between two principles of plating system, 3D non locking mini plates versus 3D locking mini plates.

Materials and Methods A total of 20 adult patients were selected according to the inclusion criteria and divided into two groups of locking plates/screws and non-locking plates/screws of ten each. All patients were treated with 2.0 mm 3D locking and non locking mini plates and screw system. Comparison of ease of use, functional stability, operator's comfort were tabulated.

Results A total of 27 fractures in 20 patients were treated. Each group contained ten patients. Fracture reduction was good in all the cases. At the follow up of 3 months, all fractures had healed, only one patient had a occlusal discrepancy.

Conclusion There was no difference in the stability in both the groups. Intra operatively locking group consumed more time in fixation as it demands precision in making a hole exactly in the centre of plate necessitating the use of drill guide. Clinical and radiographic healing was good in both the groups.

Keywords 3D non locking miniplates · Miniplates · Locking miniplates · 3D locking miniplates

Introduction

The management of mandibular fracture aims to restore an anatomical form and function. Traditional indirect wiring techniques for closed reduction achieve satisfactory occlusion with bone healing but may not restore anatomical reduction. In past few decades many different techniques of open reduction and internal fixation (ORIF) have emerged showing varying success rates. Michelet et al. in 1973, developed small plates and monocortical screws to fix mandibular fractures through transoral incisions.

The Champy's technique, as it later became known, uses intraoral incisions, mini plates, and monocortical screws. The plates are placed along ideal lines of osteosynthesis. The advantages of this technique are the avoidance of cutaneous incisions, reduced facial and inferior alveolar nerve injury, and reduced operating time. The critics of the Champy's technique cite the lack of absolute rigidity with the smaller plates and the apparent requirement for patient compliance with a liquid to soft diet during healing as a major limitation of this technique [1].

The shortcomings of rigid and semi-rigid fixation led to the development of 3 dimensional (3D) miniplates, consisting of two 2-hole miniplates with gap which are interconnected by vertical cross struts. The concept of 3D titanium plates were developed and were reported first by Farmand and Dupoirieux. Unlike compression and reconstruction plates, their stability does not derive from the thickness of the plate [2].

In 1913, Lambotte had found that, if the anatomic reduction of fracture fragments had been done, then this specially designed plate offered sufficient stability without further immobilization, and that this system was superior to that in use at the time using wiring osteosynthesis. However this method did not gain popularity; this might be

✉ K. V. Arunkumar
arunkumarkv@yahoo.com

Arjun Singh
arjunbrat@gmail.com

¹ Department of Oral and Maxillofacial Surgery, Subharti Dental College and Hospital, NH-58, Subhartipuram, Meerut, U.P., India

attributed to the lower biocompatibility of the material and because treatment methods using closed reduction were preferred.

The shape of three-dimensional titanium plates is based on the principle of the quadrangle as a geometrically stable configuration for support. Because 3D stability is achieved by the geometric shape that forms a cuboid, compared with standard miniplates and reconstruction plates, the thickness of these plates is reduced to 1 mm. The basic form is a quadrangular 2×2 hole square plate; square or rectangular 3×2 or 4×2 hole plates are also available. Few experimental studies on biomechanics have confirmed sufficient stability of the 3D plating system; only a few clinical studies are reported in the literature [3]. Studies [2–4] quote comparison made between miniplates and 3D miniplates. At the beginning of this study to our knowledge there were no studies published in the literature comparing 3D locking versus 3D non-locking miniplates. Hence, this study was conducted to understand the ease and efficacy between these two designs of plates and screws.

Materials and Methods

Patients who reported to the Department of Oral and Maxillofacial surgery with trauma were selected according to the following inclusion criteria:

1. Adolescents and adults
2. Completely dentulous
3. Mandibular fractures only—simple and compound
4. Trauma less than 3 weeks
5. Non infected

Exclusion criteria

1. Less than 12 years
2. Complete/partially edentulous patients
3. Comminuted/complex fracture/condylar fractures
4. Trauma more than 4 weeks
5. Infected/malunited

Fig. 1 3D locking miniplate pre op OPT

Fig. 2 3D locking miniplate post op OPT

6. High condylar fracture/panfacial trauma

Patients with mandibular fracture were included in the study. Twenty patients were selected and divided into two equal groups of ten each for the study.

Group A: 10 Patients/Non-locking Group

Patients underwent osteosynthesis using three-dimensional 2.0 mm titanium miniplates and self tapping $6 \text{ mm} \times 2.0 \text{ mm}$ screws.

Group B: 10 Patients/Locking Group

Patients underwent osteosynthesis using three-dimensional locking 2.0 mm titanium miniplates and pre-tapped $6 \text{ mm} \times 2 \text{ mm}$ screws (Figs. 1, 2).

Armamentarium:

	Non-Locking	Locking
Plating kit	✓	✓
Transbuccal system	✓	✓
Drill guide	×	✓
Self tapping screws	✓	×
Pre tapped screws	X	✓

Technique

Non locking plates and screws After achieving the anatomic reduction, vertical arm of the plate was placed parallel to the fracture line, screws were placed perpendicularly (Figs. 3, 4).

Locking plates and screws After achieving the anatomic reduction, vertical arm of the plate was placed parallel to the fracture line, drilling was done perpendicular to plate with help of drill guide, screws were placed perpendicularly to achieve proper head fit into the plate threads.

Fig. 3 3D non locking miniplate pre op OPT

Fig. 4 3D non locking miniplate post op OPT

- Anatomic reduction.
- Plate positioning 5 mm below the alveolar crest, avoiding the teeth roots and parallel to the fracture line.
- Screws placed perpendicularly in a diagonal pattern.
- Checked manually for stability of fracture.

Statistics

The results of the study were subjected to statistical analysis by applying the following tests:

1. Mean
2. Standard deviation (SD)
3. Standard error of mean (SEM)
4. Paired student's *t* test

Results

A total of 20 patients (18 males, 2 females) met the inclusion criteria and were included in the study. They were divided equally into two groups of 10 patients each. Locking plate group consisted of 2 females and 8 males. In non-locking plate group all patients were males. The average age in locking group was 25.5 ± 7.79 and average

age in non-locking group was 27.2 ± 11.35 . The cause of trauma was road traffic accident (RTA) in 15 patients, assault in 3 and fall in 2.

Total number of days for reporting after trauma, locking group mean was 5.0 ± 5 and mean for non-locking was 3.0 ± 2 . A series of pre-operative parameters recorded included, pain, swelling, mouth opening, neurosensory deficits, occlusion, sites of fractures, requirement for maxilla-mandibular fixation (MMF), teeth in line of fractures and inferior alveolar canal continuity. A total of 27 fractures were treated in 20 patients. Single fractures occurred in 13 patients and double fractures occurred in 7 patients (Table 1).

The patients who got the treatment done under general anesthesia, three from locking plate group and five from non-locking group, rest of the patients were treated under local anesthesia. Intra operatively MMF was done in four patients and manual reduction in six patients in locking group. In non-locking group MMF was done in seven patients.

Intraoperative Records

A total of 12 3D plates were used (square/rectangular) in locking group and 15 3D plates (square/rectangular) were used in non-locking group (Table 2).

The teeth in fracture line were extracted only if they were grade III mobile/carious/fractured/pathologically involved. Therefore, in Locking group, in 3 patients teeth in fracture line were extracted and in non-locking group, 5 patients teeth in fracture line were extracted.

Operating time in minutes was recorded for both the groups from fracture exposure till the last screw placement. In locking plates group (Fig. 5) the average time recorded for different sites were as follows; symphysis 18 ± 9.89 , parasymphysis 13.6 ± 7.02 , body 20 ± 7.07 , angle 27.33 ± 3.05 . For non-locking group (Fig. 6), parasymphysis was 13.33 ± 3.72 , body 17 ± 4.24 and angle 23.66 ± 12.22 .

MMF was required in four patients from locking group and seven patients from non-locking group who had two mandibular fractures; rest of the patients (six from locking and three from non-locking group) with single fractures were fixed using manual reduction.

The difference in time taken to fix the symphysis and parasymphysis fractures in both groups was negligible, i.e., <1 min. In case of body and angle fractures, the locking group took 3–4 min additionally in comparison to non-locking group.

Operator comfort was recorded on a 1–10 scale. The locking group comfort were noted as; angle 5.6 ± 2.08 , parasymphysis 3 ± 1.41 , symphysis 2.5 ± 0.70 , body 3 ± 1.41 . In non-locking group; angle 4.4 ± 0.54 , parasymphysis $1.8 \pm .44$, body $1.5 \pm .70$.

Table 1 Pre operative record of group A and group B

S. no.	Parameters	Locking	Non-locking
1	Age	25.5 ± 7.79	27.2 ± 11.35
2	Gender	M = 8, F = 2	M = 10, F = 0
3	Nature of injury	Assault = 2 Fall = 2 RTA = 6	Assault = 1 Fall = 0 RTA = 9
4	No. of days	4.8 ± 5.22	3 ± 2.4
5	Pain	6.1 ± 2	4.5 ± 2.1
6	Mouth opening	27 ± 8.4	26.8 ± 5.8
7	Neuro-sensory deficit	No = 9 Yes = 1	No = 9 Yes = 1
8	Occlusion	Deranged = 6 Normal = 4	Derranged = 8 Normal = 2
9	Fracture displacement	No = 3 Moderate = 6 Severe = 1	No = 4 Moderate = 1 Severe = 5
10	Pre operative MMF	Yes = 4 No = 6	Yes = 7 No = 3
11	No. of fractures	12	15
12	Site of fracture	Angle = 3 Symphysis = 2 Parasymphysis = 5 Body = 2	Angle = 6 Symphysis = 6 Parasymphysis = 0 Body = 2
13	IAC continuity	Yes = 7 No = 3	Yes = 7 No = 3
14	Pathology	No	No
15	Swelling		
	1		
	Right	11.6 ± 0.69	11.32 ± 1.19
	Left	11.74 ± 0.74	11.17 ± 0.89
	2		
	Right	12 ± 0.75	11.86 ± 0.58
	Left	12.04 ± 0.48	12.03 ± 0.71
	3		
	Right	16.4 ± 1.2	15.75 ± 1.09
	Left	16 ± 1.31	15.92 ± 1.14

Transbuccal system was utilized to fix the fractures in three cases of locking group and six cases of non-locking group.

Postoperative radiographs were taken subsequently and satisfactory reduction was seen in all the cases.

Postoperatively (Tables 3, 4, 5, 6, 7, 8) mean pain for locking group at 1 week was 3.2 ± 1.22 , at 1 month 2 ± 1.56 , at 3 months was 1 ± 0 . For non-locking group at 1 week was 3.4 ± 1.26 , at 1 month $1.9 \pm .567$, at 3 months was 1 ± 0 .

The swelling was not found be a major statistically significant factor in both the groups. At the end of 1 week the values recorded for both the groups had marginal difference from pre-operative swelling. At the end of 2 weeks swelling had regressed considerably to near normal values.

Neurosensory deficit for locking group at 1 week was present in two patients, at 1 and 3 months none of the patients had neurosensory deficiency. For non-locking group at 1 week neurosensory deficit was present in one patient, at 1 and 3 months none of the patients had neurosensory deficiency.

Mean masticatory efficiency in locking group at 1 week was 6.7 ± 2.16 , at 1 month 3.4 ± 2.17 , at 3 months 1 ± 0 . For non-locking group at 1 week it was 7.7 ± 1.05 , at 1 month 4.5 ± 2.06 , at 3 months 1.2 ± 0.421 .

Mean mouth opening for locking group at 1 week was 26.5 ± 13.335 , at 1 month 33.3 ± 9.7188 , at 3 months 34.5 ± 8.29 . For non-locking group at 1 week it was

Table 2 Intra operative records

S. no.	Parameters	Locking	Non-locking	Difference
1	MMF/manual	MMF = 4 Manual = 6	MMF = 7 Manual = 3	
2	Operator's comfort	Angle 5.6 ± 2.08 Parasymphysis 3 ± 1.41 Body 3 ± 1.41 Symphysis $2.5 \pm .7071$	Angle 4.4 ± 0.547 Parasymphysis 1.8 ± 0.45 Body 1.5 ± 0.70 Symphysis 0 ± 0	Angle-1.2 Parasymphysis-1.2 Body-1.5
3	Operating time	Angle 27.3 ± 3.0 Parasymphysis 13.6 ± 7.0 Body 20 ± 7.0 Symphysis 18 ± 9.8	Angle 23.66 ± 12.22 Parasymphysis 13.33 ± 3.72 Body 17 ± 4.242641 Symphysis 0 ± 0	Angle-4.3 Parasymphysis-0.3 Body-3
4	Occlusion on table	Good = 10	Good = 10	
5	Stability after fixation	Good	Good	
6	Transbuccal	Yes = 3	Yes = 6

Fig. 5 Locking plate and screws

25.8 ± 6.32 , at 1 month 36.7 ± 8.641 , at 3 months 39.5 ± 8.475 .

None of the patients had any dehiscence, infection, screw loosening and exposure post operatively.

Maxillo-mandibular fixation in locking group was done in one patient for 1 week only. In non-locking group none of the patients had to undergo maxilla-mandibular fixation.

In our study one patient each in both locking and non-locking groups had to be put on elastics for a brief period of 1 week to correct minor occlusal discrepancy.

In locking group occlusion was good at 1 week, 1 and 3 months. In non-locking group at 1 week occlusion was

Fig. 6 Non-locking plate and screws

good in nine patients and poor in 1 at 1 month good in nine patients and poor in one patient, at 3 months good in nine patients and satisfactory in one patient.

Radiographic healing was not present at 1 week, at 1 month was satisfactory and good at 3 months in both the groups.

Discussion

This study aimed to evaluate the ease and efficacy between the 3D locking versus non-locking plate and screws in mandibular fractures. The study group consisted of 20 patients, 10 patients each in group A (non-locking plates and self-tapping screws) and group B (locking plates and pre tapped screws). Locking group consisted of 8 males

Table 3 Post operative comparative records for locking

	Pre-op	Post-OP		
		1 week	1 month	3 months
Pain	6.1 ± 2.078995	3.1 ± 1.37	1.9 ± 1.59	1 ± 0
Mouth opening	27 ± 8.44	26.5 ± 13.33	33.3 ± 9.71	34.5 ± 8.28
Neurosensory deficit	Yes-1	Yes-2	No	No
Occlusion	Derranged-6	Good	Good	Good
Sites of fracture	Angle = 3 Symphysis = 2 Parasymphysis = 5 Body = 2			
MMF	Yes = 4	Yes-1	No	No
Inferior alveolar canal continuity	No-3	Yes	Yes	Yes

Table 4 Swelling pre operatively

1	Right	11.6 ± 0.69	11.32 ± 1.19
	Left	11.74 ± 0.74	11.17 ± 0.89
2	Right	12 ± 0.75	11.86 ± 0.58
	Left	12.04 ± 0.48	12.03 ± 0.71
3	Right	16.4 ± 1.2	15.75 ± 1.09
	Left	16 ± 1.31	15.92 ± 1.14

Table 5 Swelling post operatively

Sides	Mean ± SD (difference)	
	1W-1M	1M-3M
Right side	0.544 ± 0.995447	0 ± 0
Left side	0.15 ± 0.190029	0 ± 0
Right side	0.15 ± 0.217307	0 ± 0
Left side	0.07 ± 0.176698	0 ± 0
Right side	0.51 ± 0.578216	0 ± 0
Left side	0.42 ± 0.603324	0 ± 0

and 2 females whereas in the non-locking group all 10 patients were males. Males dominated (90 %) in our list of study group as comparable with Jain et al. (87.5 %) [3], and Collins et al. (91 %) [5].

In our study the etiology of trauma was predominated by RTA (75 %), assault (15 %) and fall (10 %) which was found similar to Gandhi and Kattimani [6] study [RTA (75 %), assault (15 %), others (20 %)]. The etiology varied greatly when compared to the studies conducted in developed countries. Guimond et al. [7] study showed different etiology for trauma dominated by assault (81.1 %), fall (10.8 %) and RTA (8.1 %).

The patients reporting after trauma varied from 1 to 17 days. More than 3 weeks of trauma, infected or malunited fractures were not included in the study. The study did not find any difference in managing late reporting fractures

except for time consumed in debriding fracture site off callus to see the fracture edges clearly before anatomical reduction. Lucca et al. [8] compared fracture management difference in early (less than 48 h) with late treatment (more than 48 h). The authors stated that there no statistically significant finding evident but the late operated fractures had the tendency for infection, malocclusion, wound dehiscence and malunion compared to early treatment.

A total of 27 fractures were treated in 20 patients. Single fractures occurred in 13 patients and double fractures occurred in 7 patients. The fractures included symphysis (2, 7.4 %), parasymphysis (11, 40 %), body (4, 14 %), angle (9, 33 %) and ramus (1, 3.7 %). Lucca et al. [8] in their study found the following order of fracture in mandible: condyle, subcondyle, angle, body and parasymphysis fractures. Kumar et al. [9] in their study found more of angle fractures followed by parasymphysis, body and ramus fractures. The patients who got the treatment done under general anesthesia, 4 from locking plate group and 5 from non-locking group, rest of the patients were treated under local anesthesia.

Intra operatively MMF (Ivy loop eyelet or Erichs arch bars) was done in four patients and manual reduction in six patients in locking group. In non-locking group MMF was done in seven patients and rest three patients were reduced manually. MMF was done in cases that had double fracture and older fracture for better control during fixation. In cases of single and fresh fractures the anatomical reduction was achieved manually followed by plating as supported in the study by Fordyce et al. [10]. Kumar et al. [2] routinely placed the patients on MMF during intra operative procedure and continued guiding elastics for a period of 1 week post operatively.

The intra-oral approaches included translabial, trapezoidal or extended wards incisions. In transbuccal approach a stab incision was made taking care of vital structures and normal crease over the skin. Wan et al. [11] explained that the relative risk of complications using the transoral

Table 6 Post operative comparative records for non locking

	Pre-op	Post-op		
		1 week	1 month	3 months
Pain	4.5 ± 2.1	3.3 ± 1.41	1.6 ± 0.69	1 ± 0
Mouth opening	26.8 ± 5.8	25.8 ± 6.32	36.7 ± 8.64	39.5 ± 8.47
Neurosensory deficit	Yes-1	Yes-1	No	No
Occlusion	Derranged-8	Derranged-1	Derranged-1	Good
Sites of fracture	Angle = 6			
	Symphysis = 6			
	Parasymphysis = 5			
	Body = 2			
MMF	Yes = 7	No	No	No
Inferior alveolar canal continuity	No-3	Yes	Yes	Yes

Table 7 Swelling pre operatively

1	Right	11.32 ± 1.19
	Left	11.17 ± 0.89
2	Right	11.86 ± 0.58
	Left	12.03 ± 0.71
3	Right	15.75 ± 1.09
	Left	15.92 ± 1.14

technique was 1.59 times that of the transbuccal technique. The rate of complications was 1.71 times greater with the transoral technique than with the transbuccal technique. A total of 12 3D plates were used (square/rectangular) in locking group and 13 3D plates (square/rectangular) were used in non-locking group.

The teeth in fracture line were extracted only if they were grade III mobile/carious/fractured/pathologically involved. Therefore, locking group, in three patients tooth in fracture line were extracted and in non-locking group, five patients teeth in fracture line were extracted. All teeth that were extracted were third molars in the angle fracture site. None of the teeth in the symphysis, parasymphysis, body region were extracted. Only one case, the anterior tooth was extruded from socket due to trauma which was removed at the time of surgery. Zix et al. [4] in their study found molars in line of fractures but were not removed.

Kambooza and Moorthy [12] suggested to retain the teeth in line of fracture as extraction may lead to exposure of fractured site directly to oral contamination. A clinical and radiological observation to be made till 1 year and consider endodontic treatment if required.

Operating time in minutes was recorded for both the groups from fracture exposure till the last screw placement. The operating time was not found to be significantly different (0.3 s) in both the groups for symphysis, parasymphysis fractures. Whereas, in locking group angle fractures took 3–4 min more than the non-locking group. This is because the drill guide had to be used in cases of locking plates to achieve near perpendicular drill to position the screw heads accurately into the threaded plate holes. In both the groups transbuccal system was used, the advantage with non-locking plate was that it accommodated a 10° angulation of screw placement. The increased time consumed while plating is similar to the study done by Goyal et al. [13]. The authors reason for additional time at angle are due to bigger sized plates with more number of holes and transbuccal system use. Mittal et al. [14] quoted the reason for reduced time to fix 3D plates as less surgical exposure, minimal soft tissue retraction and no need to bend the plates. Khalifa et al. [15] compared miniplate and 3D plates and opined that the reduced time for fixing 3D plate was due to non-bending of plates when

Table 8 Swelling post operatively

Sides	Mean ± SD (difference)		
	1W-1M	1M-3M	1W-3M
Right side	0.01 ± 0.585852	0.01 ± 0.031623	0.02 ± 0.584618
Left side	0.2 ± 0.176383	0.02 ± 0.042164	0.22 ± 0.198886
Right side	0.26 ± 0.275681	−0.03 ± 0.067495	0.23 ± 0.275076
Left side	0.1 ± 0.182574	−0.01 ± 0.119722	0.09 ± 0.152388
Right side	0.23 ± 0.240601	0.02 ± 0.147573	0.25 ± 0.287711
Left side	0.29 ± 0.331495	0.03 ± 0.176698	0.32 ± 0.364539

compared with miniplates which require near surface adaptation.

Requirement of MMF Ebenzer et al. [16] at the time of surgery has been helpful to control the fractured jaws in pan facial trauma. In case of mandibular single, undisplaced and fresh fractures MMF may not be required routinely. But in more than one, unfavourable fracture and less assisting hands MMF plays an important role. In our study a total of 11 patients were operated with MMF and 9 patients with manual reduction. The MMF was done in those patients with more than one fracture and who delayed getting treated for various reasons.

Fordyce et al. [10] quoted reasons against MMF for mandibular fracture management due to the following reasons: it took nearly 40 min to place upper and lower arch bars, risk of pricks for assistant and operator, poor oral hygiene, discomfort during removal, increase in cost if performed under general anaesthesia. Ellis and Graham [17] in their study stated that MMF was mandatory before and during surgery; none of the patients were on MMF post operatively.

Operator technical comfort was calculated on a 1–10 scale. 1–3 easy, 4–7 moderately difficult and 8–10 difficult. Operators found it easy in cases of symphysis and parasymphysis fracture fixation in both the groups. Moderately difficult for body and difficult at angle plating in locking group [13]. The reason being accessibility, visibility, securing drill guide and orientation of the drill bit, which was similar to the experience in the study by Gandhi and Kattimani [6].

The screw length was chosen as 6 mm in order to avoid vital structural injury in the mandible. The buccal cortical plate thickness was 1.78–2.01 mm at canine/premolar region, 2.6–3.18 mm at molar region as studied by Al-Jandan et al. [18] who also suggested the safest length of screw to be 3 mm at canine and 4 mm at molars. In our study none of the patients had injury either to the teeth root or the inferior alveolar nerve. Whereas, Mittal et al. [14] used 9 mm screws in the mandible with no significant injury to the inferior alveolar nerve.

Post operatively there was no statistically significant difference found between both the groups for pain, swelling, mouth opening, neurosensory deficits. Pain and swelling was same in both the groups and reduced at the end of 1 week. Mouth opening increased gradually after 1 week and was normal at the end of 1 month in both the groups. Two patients who experienced neurosensory deficits post operatively had pre-existing altered sensation due to trauma.

MMF was required post operatively for a period of 2 weeks (1 week of rigid MMF and 1 week of elastics) in one patient in non-locking group as patient experienced inadequate intercuspation post operatively. This patient also had undisplaced ramus fracture which was not fixed.

Masticatory efficacy was checked based on early resumption of patients normal chewing habits scored on 1–10 scale. Patients in locking group found more comfort during chewing 1 week later when compared to non-locking group. At the end of 1 month there was no difference evident in chewing comfort in both the groups.

Richard et al. [19] in their comparative study on mechanical behaviour of locking versus non locking plate and screw system, found that the non-locking system had significant yield load, displacement and stiffness when compared with locking system. They also concluded that the degree of adaptation affected the mechanical behaviour in non-locking system. Therefore supporting our study of the reason for better masticatory comfort in locking group compared with non-locking.

Gutwald et al. [20] and Pektas et al. [21] in a cadaveric study comparing mini-locking system with conventional miniplates, subjected to mechanical loading simulating muscle forces showed the lowest gaps and torsion, best stability at the caudal border in case of mini locking plates. Authors stated that the locking principle prevents stripping, movement and loosening of screws. Fixation technique simplifies plate bending and decreases torsion or opening at the fracture site.

None of the patients had any intra oral wound dehiscence, infection, screw loosening and plate exposure post operatively. Kumar et al. [2] and Jain et al. [3] in their study encountered 2/10 patients with infection in 3D plating system which was treated with antibiotics; 2 patients out of 20 had wound dehiscence requiring re-suturing. None of the patients had to undergo plate removal due to the above mentioned reasons. Zix et al. [4] had one plate fractured at 6th week followup period. Ellis and Graham [17] in their study stated that infection rate, plate and screw loosening with other minor complications in 3D plates are at par with miniplate system. They concluded that the possible advantage of locking plate/screw fixation system are theoretical, whether clinical results can be improved could not be measured. Gutwald et al. [20] experienced complications in the region of angle followed by parasymphysis and body. Minor infections required hardware removal, and occlusal discrepancy was treated with elastics and enameloplasty. The main disadvantage they reported was cost and locking system demands precision to achieve proper plate and screw head interface lock requiring a locking drill guide.

Clinical and radiographic assessment for healing was same in both the groups at the end of 1 week. At the end of 3 months both groups had completely satisfactory bone healing. A similar healing period was evident on radiographic assessment criteria mentioned by Bouloux et al. [1] and Malhotra et al. [22] in their comparative study on 3D plates versus miniplates.

References

1. Bouloux GF, Chen S, Threadgill JMC (2012) Small and large titanium plates are equally effective for treating mandible fractures. *JOMS* 70:1613–1621
2. Kumar BP, Kumar J, Mohan AP, Venkatesh V (2012) A comparative study of three dimensional stainless steel plate versus stainless steel miniplate in the management of mandibular parasymphysis fracture. *J Bio Innov* 1(2):19–32
3. Jain MK, Manjunath KS, Bhagwan BK, Dipit K (2010) Comparison of 3-dimensional and standard miniplate fixation in the management of mandibular fractures. *JOMS* 68:1568–1572
4. Zix J, Lieger O, Iizuka T (2007) Use of straight and curved 3-dimensional titanium miniplates for fracture fixation at the mandibular angle. *JOMS* 65:1758–1763
5. Collins CP, Leonard PG, Tolas A (2004) A prospective randomized clinical trial comparing 2.0-mm locking plates to 2.0-mm standard plates in treatment of mandible fractures. *JOMS* 62:1392–1395
6. Gandhi L, Kattimani VS (2012) Three dimensional bone plating system in the management of mandibular fractures—a clinical study. *AED* 4(2):42–52
7. Guimond C, Johnson JV, Marchena JM (2005) Fixation of mandibular angle fractures with a 2.0-mm 3-dimensional curved angle strut plate. *JOMS* 63:209–214
8. Lucca M, Mckenzie KSW, Kraus J, Finkelman M, Wein R (2010) Comparison of treatment outcomes associated with early versus late treatment of mandible fractures: a retrospective chart review and analysis. *JMOS* 68:2484–2488
9. Kumar N, Malhan S, Mahajan S, Asi KS (2012) Titanium miniplate osteosynthesis of mandibular fractures. *IJDS* 1(4):21–24
10. Fordyce AM, Lalani Z, Songra AK, Hildreth AJ, Carton ATM, Hawkesford JE (1999) Intermaxillary fixation is not usually necessary to reduce mandibular fractures. *BJOMS* 37:52–57
11. Wan K, Williamson RA, Gebauer D (2012) Open reduction and internal fixation of mandibular angle fractures: does the transbuccal technique produce fewer complications after treatment than the transoral technique? *JOMS* 70:2620–2628
12. Kamboozia HA, Moorthy PA (1993) The fate of teeth in mandibular fracture lines. *IJOMS* 22:97–101
13. Goyal M, Marya K, Chawla S, Pandey R (2010) Mandibular: a comparative evaluation of two different fixation systems using 2.0 mm titanium miniplates and 3D locking plates. *JMOS* 10(1):32–37
14. Mittal G, Dubbudu RM, Cariappa MK (2011) Three dimensional titanium mini plates in oral and maxillofacial surgery: a prospective clinical trial. *JMOS* 11:24–28
15. Khalifa EM, Hawary HE, Hussein MM (2012) Titanium three dimensional miniplate versus conventional titanium miniplate in fixation of anterior mandibular fractures. *LSJ* 9(2):1006–1010
16. Ebenzer V, Ramalingam B (2011) Three-dimensional miniplate fixation in mandibular angle fractures. *IJMD* 1(2):89–93
17. Ellis E, Graham J (2002) Use of a 2.0-mm locking plate/screw system for mandibular fracture surgery. *JOMS* 60:642–645
18. Al-Jandan BA, Al-Sulaiman AA, Marei HF, Syed FA, Almana M (2012) Thickness of buccal bone in the mandible and its clinical significance in mono-cortical screws placement. A CBCT analysis. *IJOMS*. doi:[10.1016/j.ijom.06.009](https://doi.org/10.1016/j.ijom.06.009)
19. Richard HH, Street CC, Goltz M (2002) Does plate adaptation affect stability? A biomechanical comparison of locking and nonlocking plates. *JOMS* 60:1319–1326
20. Gutwald R, Alpert B, Schmelzeisen R (2003) Principle and stability of locking plates. *Keio J Med* 52(1):21–24
21. Pektas ZO, Bayram B, Balcik C, Develi T (2011) Effects of different mandibular fracture patterns on the stability of miniplate screw fixation in angle mandibular fractures. *IJOMS* 41:339–343
22. Malhotra K, Sharma A, Giraddi G (2012) Versatility of titanium 3D plate in comparison with conventional miniplate fixation for the management of mandibular fracture. *JMOS* 11(3):284–290