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3D Stainless Steel versus 3D Titanium Plate System for Osteosynthesis of Mandibular Fracture: Cost Effectiveness and Clinical Outcome? A Prospective Clinical Study

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Abstract

Purpose: Several metals have been tried since 1920's like gold, silver, copper & its alloys, lead and aluminum were used and tested. Stainless steel and titanium emerged through the era as the new corrosion resistant material. Titanium metal introduced with claims of lots of advantages over the classic stainless steel. These observations prompt us to do a study to compare the efficacy of 3D stainless steel plate system and 3D titanium plate system for osteosynthesis of mandibular fractures (oral functions, duration of plate adaptation to definite fixation (PA-DF interval), cost effectiveness and complications).

Patients and methods: A 20 patients with non comminuted mandibular fractures were divided into two Groups (Group A titanium 3D and Group B stainless steel 3D plate system) randomly. Among 20 patients, 8 had symphysis fractures, 8 parasymphysis fractures and 4 angle fractures. All patients underwent open reduction and internal fixation. Postoperatively patients were analyzed at the 1st week, 6th week, 3rd month and 4th month according to Uglesic V scoring system, 1993.

Results: Significant results were observed in duration of Plate Adaptation to Definite Fixation (PA-DF interval) more in 3D stainless steel plate system. Difficulty was encountered with 3D stainless steel plate adaptation on curved bony contours in symphysis region. No significant difference was observed in clinical outcome (Oral functions, occlusion & stability of fracture fragments) of 3D stainless steel plate system and 3D titanium plate system.

Conclusion: 3D titanium plates has better adaptability at curved bony contours, less operating time, and have less postoperative complications. The 3D stainless steel plate has advantage of cost effectiveness.

Keywords: 3D Titanium; 3D Stainless Steel; Osteosynthesis; Mandibule Fractures

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Introduction

Cosmetic and functional disabilities bring morbidity to the trauma patient and are of primary concern to the maxillofacial surgeon. The aim of all therapies is to restore the aesthetic and function of the face as well as jaws to near normal at affordable cost even to rural population in the underdeveloped or developing countries.

Zix J *et al.,* [1] mentioned rigid or semi rigid fixation reflects almost opposite concepts of craniomaxillofacial osteosynthesis. Rigid fixation has the disadvantages of increased operating time, risk of damage to branches of facial nerve and technique sensitivity. In some cases of semi-rigid fixation it becomes hard to believe that a single miniplate will be sufficient to stabilize the fracture or not Farmand M, led to the development of three dimensional (3D) plates due to these shortcomings. A 3D plate is formed by joining two miniplates with interconnecting vertical cross-bars. The fundamental idea of the three-dimensional bone plate is based on the principle of a quadrangle as a geometrically stable configuration for support. Increased stability is achieved by the geometric shape of the quadrangular plate rather than by its thickness or length [2]. Wittenberg J.M *et al.,* [3] explained the advantage of 3D miniplate that it can be easily placed at angle fracture by an intraoral approach. Deepak S and Manjula S, said in their study, several metals have been tried since 1920's. Although gold, silver, copper and its alloys, lead and aluminum were used and tested, stainless steel emerged through the era as the new corrosion resistant material [4]. At about the same time or later

Table 1.1: Preoperative Details OF Group A Patients (Titanium Group).
The table shows Age, Sex distribution, Aetiology, Chief Complaint, Type of fracture, Displacement, Soft Tissue Injury, Duration between initial trauma & definitive fixation (IT-DF Interval), Occlusion, Trimus Index and Site of fracture in the Group A patients.

Serial No.	Age	Sex	Aetiology	Chief complaint	Type of mandibular fracture	Degree of Displacement	Soft Tissue Injury	IT-DF Interval	Occlusion	Trismus Index(mm)	Site of Fracture
T1	32	M	RTA	Pain in jaw and difficulty to open mouth	CI	Severe	Moderate	2 days	Deranged	21	Left angle #
T2	43	M	RTA	Pain in jaw and difficulty to chew	CI	Moderate	Minimal	1 day	Normal	30	Right parasymphysis#
T3	40	M	Fall	Pain in jaw and difficulty to chew	CI	Minimal	Minimal	2 days	Normal	32	Symphysis #
T4	18	M	RTA	Pain in jaw and difficulty to chew	CI	Minimal	Minimal	1 day	Deranged	30	Left parasymphysis #
T5	38	M	RTA	Pain in jaw and difficulty to chew	CI	Moderate	Minimal	2 days	Deranged	31	Symphysis #
T6	26	F	RTA	Pain in jaw	CI	Severe	Moderate	4 days	Deranged	22	Right angle #
T7	28	M	RTA	Pain in jaw and difficulty to open mouth	CE	Moderate	Moderate	2 days	Deranged	30	Left parasymphysis # + maxillary dentoalveolar #
T8	32	M	Fall	Pain in jaw	CI	Moderate	Moderate	3 days	Deranged	30	Symphysis #
T9	22	F	RTA	Pain in jaw and front loose teeth	CI	Moderate	Minimal	1 day	Deranged	32	Symphsis #
T10	26	M	Assault	Pain in jaw and bleeding from mouth	CI	Minimal	Minimal	2 days	Normal	33	Left parasymphysis #

*CI: Compound Intra orally; *IT: Initial Trauma; CE: Compound Extra orally; DF: Definitive Fixation

Table 1.2: Preoperative Details OF Group B Patients (Stainless Steel Group).
The table shows Age, Sex distribution, Aetiology, Chief Complaint, Type of fracture, Displacement, Soft Tissue Injury, Duration between initial trauma & definitive fixation (IT-DF Interval), Occlusion, Trimus Index and Site of fracture in the Group B patients.

Serial No.	Age	Sex	Aetiology	Chief complaint	Type of mandibular fracture	Degree of Displacement	Soft Tissue Injury	IT-DF Interval	Occlusion	Trismus Index(mm)	Site of Fracture
S1	21	F	Fall	Pain in jaw and difficulty to open mouth	CI	Moderate	Minimal	1 day	Normal	26	Right angle #
S2	25	M	RTA	Pain in jaws and difficulty to chew	CE	Moderate	Moderate	3 days	Deranged	32	Left parasymphysis# + Maxillary Dentoalveolar #
S3	38	M	RTA	Pain in jaw and bleeding from mouth	CI	Minimal	Minimal	1 day	Normal	30	Left Parasymphysis #
S4	39	M	RTA	Pain in jaws and difficulty to chew	CI	Moderate	Minimal	2 days	Deranged	30	Symphysis #
S5	25	M	RTA	Pain in jaws and difficulty to chew	CI	Moderate	Minimal	3 days	Deranged	32	Left Parasymphysis # + Maxillary Dentoalveolar #
S6	38	M	Assault	Pain in jaws and difficulty to chew	CI	Severe	Minimal	2 days	Deranged	20	Right angle #
S7	36	M	Assault	Pain in jaw and front loose teeth	CI	Moderate	Moderate	4 days	Deranged	32	Symphysis # + maxillary dentoalveolar #
S8	35	M	Fall	Pain in jaw and difficulty to chew	CI	Moderate	Minimal	2 days	Deranged	33	Right Parasymphysis #
S9	25	M	RTA	Pain in jaw and bleeding from mouth	CI	Minimal	Moderate	4 days	Normal	35	Symphsis #
S10	37	M	RTA	Pain in jaws and difficulty to chew	CE	Moderate	Severe	1 day	Deranged	33	Symphysis #

*CI: Compound Intra orally; CE: Compound Extra orally; *IT: Initial Trauma; DF: Definitive Fixation

on other metals or alloys like titanium were introduced with claims of lots of advantages over the classic stainless steel.

These observations prompt us to do a study to compare the use of 3D stainless steel versus 3D titanium plates for osteosynthesis of mandibular fractures keeping in mind the following objectives.

- Ease of fixation by the respective 3D plating system.
- Adequacy and stability of fracture fixation achieved by the respective 3D plating system.
- Postoperative incidence of complication like infection, plate fracture, mobility of fracture segments and trismus.
- Ability of the treated patient to resume pre-trauma occlusion and oral functions like chewing and unhindered speech.

Patients and Methods

The study protocol structure was reviewed and approved by the institutional research, review board and institutional ethical committee. A total of 20 patients were selected and divided into two Groups (Group A titanium 3D plate system and Group B stainless steel plate system) randomly as listed in Table 1.1 and 1.2 respectively. Among 20 patients, 8 had symphysis fractures, 8 parasymphysis fractures and 4 angle fractures. All the patients underwent open reduction and internal fixation using 3D titanium or 3D stainless steel plate of 2mm thickness with 2 mm × 8 mm screws following standard surgical protocols under general anesthesia.

Inclusion criteria were the patients with clinical and radiological evidence of non-comminuted symphysis, parasymphysis and angle fracture of mandible and their age ranged from 15 years to 45 years.

Table 2.1: Intraoperative Details of Group A Where ORIF was done using 3D Titanium Plate.
The table shows the Surgical Approach, Associated Fractures, Duration between 3D miniplate adaptation & complete fixation (PA- DF Interval) and Hardware Complications in Group A patients.

Serial No.	Surgical Approach	Other Associated Fractures	PA-DF Interval	Hardware Complications
T1	Risdon's submandibular incision	Nil	22 mins	None
T2	Lower Vestibular Degloving incision	Nil	16 mins	None
T3	Lower Vestibular Degloving incision	Nil	18 mins	None
T4	Lower Vestibular Degloving incision	Nil	19 mins	None
T5	Lower Vestibular Degloving incision	Nil	22 mins	None
T6	Risdon's submandibular incision	Nil	20 mins	None
T7	Through the cut Lacerated Wound	Maxillary Dentoalveolar # treated by arch bar fixation for 4 weeks	23 mins	None
T8	Lower Vestibular Degloving incision	Nil	20 mins	None
T9	Lower Vestibular Degloving incision	Nil	25 mins	None
T10	Lower Vestibular Degloving incision	Nil	15 mins	None

*PA: Plate Adaptation; *DF: Definitive Fixation

Table 2.2: Intraoperative Details of Group B where ORIF was done using 3D Stainless Steel Plate.
The table shows the Surgical Approach, Associated Fractures, Duration between 3D miniplate adaptation & complete fixation (PA-DF Interval) and Hardware Complications in Group B patients.

Serial No.	Surgical Approach	Other Associated Fractures	PA-DF Interval	Hardware Complications
S1	Risdon's submandibular incision	Nil	22 mins	None
S2	Through the cut Lacerated Wound	Maxillary Dentoalveolar # treated by arch bar fixation for 4 weeks	23 mins	None
S3	Lower Vestibular Degloving incision	Nil	22 mins	None
S4	Lower Vestibular Degloving incision	Nil	26 mins	Difficulty in plate bending
S5	Lower Vestibular Degloving incision	Maxillary Dentoalveolar # treated by arch bar fixation for 4 weeks	25 mins	None
S6	Risdon's submandibular incision	Nil	28 mins	None
S7	Lower Vestibular Degloving incision	Maxillary Dentoalveolar # treated by arch bar fixation for 4 weeks	24 mins	Difficulty in plate bending
S8	Lower Vestibular Degloving incision	Nil	21 mins	None
S9	Lower Vestibular Degloving incision	Nil	23 mins	None
S10	Through the cut Lacerated Wound	Nil	26 mins	Difficulty in plate bending

*PA: Plate Adaptation; *DF: Definitive Fixation

Patients with comminuted, associated condylar fractures, completely edentulous and medically compromised were excluded.

The patients were evaluated preoperatively, intraoperatively and postoperatively for various parameters. Postoperative clinical evaluation was done at the 1st week, 6th week, 3rd month and 4th month respectively.

Preoperative assessment: (Table 1.1: Group A Titanium) and (Table 1.2: Group B Stainless steel)

1. Location and number of fractures in the mandible.

2. Associated Soft Tissue Injuries (STI) were evaluated as follows -

a. Single Abrasion = Minimal STI

b. Multiple Abrasions +/- Single Cut Lacerated Wound = Moderate STI

c. Multiple Cut Lacerated Wound = Severe STI

3. Preoperative occlusion.

4. Maximal interincisal opening (calibrated between incisal edge of central incisor of upper jaw and lower jaw with divider and transferred on scale in mm observed).

5. Any parasthesia or anesthesia of involved area (with the help of cotton wool, pin prick and an assessment of patient's objective feedback).

6. Presence or absence of displacement of the fractured segments. Displacement was seen at the inferior border with caliper scale on radiograph.

7. The displacement present was classified as -

a. 0 mm to 2 mm = Mild Displacement

b. 2 mm to 5 mm = Moderate Displacement

c. More than 5 mm = Severe Displacement.

8. Presence of teeth in the fracture line was assessed radiographically.

9. Duration between trauma and definitive treatment (IT-DF) noted.

Intraoperative assessment: (Table 2.1: Group A Titanium) and (Table 2.2: Group B Stainless steel)

1) Reduction approach (intraoral or extraoral)

2) Implant material used (Titanium or Stainless steel).

Table 3.1: Postoperative Details OF Group A Patients (Titanium Group).
This table shows the postoperative IMF/ELASTICS duration, Trismus Index, scores of Complications, Occlusion (surgeon & self evaluation) at 3rd and 4th months and Chewing (self evaluation only) at the 3rd and 4th months for Group A patients.

Serial No.	Postoperative IMF/ Elastics	Trismus index (mm)	Complication Scores				Occlusion (at 3 months)		Occlusion (at 4 months)		Chewing (at 3 months)	Chewing (at 4 months)
			1st week	6th week	3rd month	4th month	Surgeon Evaluation	Self Evaluation	Surgeon Evaluation	Self Evaluation	Self Evaluation	
T1	Elastics given for 7 days	28	0	0	0	0	5	-3	5	5	3	5
T2	Not given	35	0	0	0	0	5	5	5	5	5	5
T3	Not given	38	0	0	0	0	5	5	5	5	5	5
T4	Not given	35	0	0	0	0	5	5	5	5	5	5
T5	Not given	34	0	0	0	0	5	5	5	5	5	5
T6	Elastics given for 7 days	29	0	0	0	0	5	-3	5	5	3	5
T7	Not given	38	0	0	0	0	5	5	5	5	5	5
T8	Not given	32	0	0	0	0	5	5	5	5	5	5
T9	Not given	37	0	0	0	0	5	5	5	5	5	5
T10	Not given	38	0	0	0	0	5	5	5	5	5	5

Table 3.2: Postoperative Details of Group B Patients (Stainless Steel Group).
This table shows the postoperative IMF/ELASTICS duration, Trismus Index, scores of Complications, Occlusion (Surgeon & self evaluation) at 3rd and 4th months and Chewing (self evaluation only) at the 3rd and 4th months for Group B patients.

Serial No.	Postoperative IMF/ Elastics	Trismus index (mm)	Complication Scores				Occlusion (at 3 months)		Occlusion (at 4 months)		Chewing (at 3 months)	Chewing (at 4 months)
			1st week	6th week	3rd month	4th month	Surgeon Evaluation	Self Evaluation	Surgeon Evaluation	Self Evaluation	Self Evaluation	
S1	Not given	33	0	0	0	0	5	-3	5	5	3	5
S2	Not given	36	-1	0	0	0	3	-3	5	5	3	5
S3	Not given	34	0	0	0	0	5	5	5	5	5	5
S4	Not given	34	0	0	0	0	5	5	5	5	5	5
S5	Not given	35	0	0	0	0	3	-3	5	5	3	5
S6	Elastics given for 7 days	26	0	0	0	0	5	-3	5	5	3	5
S7	Not given	35	0	0	0	0	3	-3	5	5	3	5
S8	Not given	35	0	0	0	0	5	5	5	5	5	5
S9	Not given	37	0	0	0	0	5	5	5	5	5	5
S10	Not given	35	0	0	0	0	5	5	5	5	5	5

3) Hardware complications (difficulty in plate bending/ breakage of plates)

4) Time duration for fixation of 3D bone plates from plate adaptation to last screw fixation (PA-DF)

Postoperative Assessment: (Table 3.1: Group A Titanium) and (Table 3.2: Group B Stainless steel)

1. Need for any supplemental method of fixation (IMF/ Elastics).

2. Maximal interincisal opening (calibrated between incisal edge of central incisor of upper jaw and lower jaw with divider and transferred on scale in mm observed distance in mm).

3. Any parasthesia or anesthesia of the involved area (with the help of cotton wool, pin prick and an assessment of patient's objective feedback). According to Treatment Scoring System developed by Uglesic V [5].

4. Occlusion and chewing in the 3rd and 4th month postoperatively (by Surgeon's evaluation and self evaluation).

5. Complications (Soft tissue infection, trismus, mobile fracture fragments, and bone infection) at the interval of 1st week, 6th week, 3rd month and 4th month postoperatively were observed.

The criteria and scoring parameters given in the system are described below.

Evaluation of occlusion (Only after 2 months of fracture treatment)

Surgeon's evaluation

-5 points: occlusion altered bilaterally. Reoperation required.

-3 points: occlusion altered on one side: Reoperation required

1 point: occlusion altered on one side. The other side has to be adjusted.

3 points: occlusion adequate on both sides but not the same as before injury.

5 points: occlusion the same as before injury.

Self-evaluation

-5 points: Occlusion is not the same as before injury. Chewing essentially altered.

-3 points: Occlusion is not the same as before injury. Chewing mildly altered.

3 points: Occlusion is not the same as before injury. Chewing not altered.

5 points: Occlusion is same as before injury

Self evaluation of chewing (Only after 2 months of fracture treatment)

-5 points: not able to chew.

0 points: on soft diet

3 points: on normal diet, but can chew only on one side.

5 points: on normal diet

Evaluation of complications by the surgeon.

- 0 points: without complications

-1 points: soft tissue infection

-2 points: trismus 3 months after treatment

-3 points: mobile fracture fragments 6 weeks after treatment

-5 points: bone infection

Significant Results

Intra-operative: (Table 2.1 and 2.2)

The mean duration of plate adaptation to definitive fixation (PA-DF Interval) in Group A was 20 minutes and in Group B was 24 minutes. Titanium plates were easy to adapt and less time consuming, may be due to high malleability.

In Group A no hardware difficulty in plate adaptation was encountered where as in Group B, 3 patients (30%) had difficulty of adaptation at symphysis region probably because of prominent bony ridge and deranged occlusion.

Post-operative (Table 3.1 and 3.2)

There was need of supplemental elastic MMF for 7 days in 2 patients of Group A and in 1 patient of Group B. This can be explained by the fact that all the three patients had unfavorable fractures at the angle.

No patient reported any postoperative parasthesia/anesthesia.

Surgeon's evaluations for occlusion: At 3rd month, occlusion was maintained in Group A, but in 3 patients of Group B occlusion was adequate on both sides but not the same as before injury. Slight alteration in occlusion postoperatively in Group B may be attributed to the associated fracture of maxilla. All patients were re-evaluated at 4th month and occlusion rehabilitation was done by selective grinding. The patients were recalled again after 2 days for re-evaluation of occlusion.

Self evaluations for occlusion: At 3rd month, 2 patients in Group A were not satisfied, because occlusion was not same as before injury. 5 patients of Group B were not satisfied at 3rd month. These finding were based on patient's perception only and on clinical correlation with surgeon's evaluation it was found to be true only in 3 patients of Group B. Patients of Group A and Group B in which surgeon's evaluation revealed that occlusion was satisfactory, were psychologically assured that, the occlusion was normal clinically and the feeling of altered occlusion was patient's faulty perception. All the patients of Group A and B were re-evaluated at 4th month. All the patients of Group A found occlusion to be satisfactory now. Out of 5 patients of Group B, 2 patients who were psychologically assured recovered and in remaining 3 patients occlusal rehabilitation was done. All the patients exhibited improvement in occlusion.

Self evaluations for chewing: In Group A, 2 patients out of 10 were able to chew normal diet but from one side of jaw at 3rd month. Later on all patients regained full chewing efficiency at 4th month. In Group B, 5 patients were able to chew food from one side of jaw at 3rd month. But at 4th month 2 patients regained full chewing efficiency whereas, in remaining 3 patients improvement occurred after occlusion rehabilitation.

There were no incidence of postoperative complications in Group A. whereas, only 1 patient of Group B developed soft tissue infection at 1st week and was managed with intravenous antibiotics and surgical drainage.

Discussion

Matthew I.R *et al.*, [6] concluded in their study no significant changes occurred in the surface characteristics of both stainless steel as well as titanium miniplates retrieved up to 24 weeks after implantation. But titanium plates are very costly as compared to stainless steel miniplates. There has been no documented study so far to compare the effectiveness of stainless steel 3D plate with 3-D titanium plates in mandibular fracture osteosynthesis as per author's knowledge.

Gear AJ *et al.,* [7] told in a recently published survey of 104 North American and European AO/ASIF surgeons, only 6% stated that they use 3D miniplates. Farmand M, experienced good stability of the 3-D-plates in the osteosynthesis of mandibular fractures without major complications. The thin 1.0 mm connecting arms of the plate allow easy adaptation to the bone without distortion. The free areas between the arms permit good blood supply to the bone. 3D titanium plates have been used sporadically by few surgeons predominantly for fixation of the mandibular angle region [2]. Hughes extended its use to the anterior mandible [8]. Its use in the maxilla has remained skeptical, with Farmand M, being the only surgeon to have used them for the maxillary fracture osteosynthesis [1]. Thereby, we also intended to use 3D plates for fixation in the mandible, each group constituted of two cases of mandibular angle fracture, four cases of symphysial fracture and four cases of parasymphysial fractures.

Guimond *et al.*, and Jeurgen *et al.*, [9,1] found the fixation with 3D curved angle strut plates predictable, the plate strong yet malleable facilitating stabilization both at superior and inferior borders. They concluded that 3D titanium plates are an easy to use alternative to conventional mini plates but contraindicated its use in fractures with less inter fragmentary bone contact [9,1]. In the present study, we found better stability with 3D titanium plate as compare to 3D stainless steel plate.

Loukota and Shelton had directly compared the mechanical strength of various types of titanium and stainless steel mini plates with each other. They very significantly concluded that the stainless steel and titanium plates of the same Champy's design showed similar bending stiffness in flat wise and edgewise direction [10,11]. In the present study, the mechanical strength of both 3D titanium and 3D stainless was compared with each other, and found difficulty in 3D

stainless steel plate bending and adaptation especially on curved bony contours.

In Hughes, study mean age of their study subjects was to be around 15 years to 62 years done on the 3D plates [8]. The mean age of our sample ranged from 30 years to 32 years.

Assault is the most common etiology 40% to 88% in the majority of the studies done in American and European trauma centres using 3D plates. Guimond *et al.* reported the most common etiology was interpersonal violence (81.1%). In contrast road traffic accidents accounted for 65% of the fractures in our study. This variation can be attributed to the over-populated cities, bad road conditions and poor traffic discipline among masses.

None of the previous studies on 3D Titanium Plates reported difficulty in bending the 3D Plate at the symphysis region. However in our study; we experienced difficulty in plate bending in three patients of Group B (stainless steel group) during plate adaptation at the symphysis region. The absence of any such hardware related problems in group A i.e. the titanium group can be attributed to its increased malleability.

Juergen *et al*., [1] reported mean operating time (from initial incision to closure) was 65 minutes with mandibular angle fracture fixation using 3D titanium plates.

In the present study a mean operating time (from 3D plate adaptation to definitive fixation) was approximately 20 minutes for 3D titanium plates and 24 minutes for 3D stainless steel plates. Feledy in their clinical study stated, that the easier application of 3D titanium plates was reflected in a reduced average operating time [12]. The ease in the adaptability of 3D titanium plates is probably the reason for reduced operating time in titanium Group.

According to the Treatment Scoring System, the success of mandibular fracture osteosynthesis depends on the incidence of complications (infection, plate fracture, mobility of fracture fragments) and the ability of the fractured jaw to resume normal oral functions (occlusion, chewing and interincisal opening) postoperatively [5]. We found this assumption satisfactory, Henceforth, evaluate and compare the osteosynthesis ability of titanium and stainless steel 3D plates using this scoring system.

For 3D plate fixation in mandibular fractures the complication rates reported so far range from 0% to 10% [9]. In the present study the effective complication rate for the Group B was 10% (1 in 10) and for Group A was 0% (0 in 10). Henceforth, the complication rate in our study is concurrent with the current standards of care in managing mandibular fractures.

Guimond reported satisfactory occlusion postoperatively in all patients treated with 3D plates [9]. However, in our study the postoperative mean score for occlusion and chewing by both the surgeon and the patient for both the groups had minimal variations. Henceforth, we can conclude that both the titanium and stainless steel 3D plates were equally successful in providing a functionally stable occlusion to the fractured mandible.

Conclusion

Previously, 3D titanium plates were used extensively for osteosynthesis of mandibular fractures. Our study has shown that the end result achieved by both the 3D plate systems was equally successful in providing satisfactory osteosynthesis of mandibular fractures. However, stainless steel 3D plate has a little difficulty to adapt over curved bony contours (symphysis region) but at the same time has an advantage of cost effectiveness.

Hence, as both the titanium and stainless steel groups achieved similar success in restoration of oral functions for the fractured jaw, we recommend the usage of 3D stainless steel plates for fixation of non comminuted mandibular fractures, with a definite advantage of cost effectiveness. It is also recommended to reduce the width of the struts in the stainless steel 3D plates to enhance its malleability and application to wider regions in the maxillofacial skeleton. A more extensive clinical study is recommended for better understanding the full spectrum of its application in maxillofacial surgery.

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