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Research Article

USE OF A MODIFIED 3-D TITANIUM PLATE FOR FIXATION OF FRACTURES INVOLVING OR IN CLOSE PROXIMITY TO THE MENTAL FORAMEN

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A B S T R A C T

Background: The fractures in the region of mental foramen pose a great challenge for the placement of 3D plates in order to avoid injury to the mental nerve and the dental root apices. Considering the varying anatomy of the mental foramen, course and anterior loop of the mental nerve and thickness of the buccal cortex in this region, the conventional 3D titanium plate was a modified for the preservation of the mental nerve.

Objective: To determine the efficacy of a modified 3D titanium plate for the fixation of mandibular fractures involving or in close proximity to; the mental foramen in order to prevent injury to the mental nerve and dental root apices.

Methodology: 16 patients with mandibular body fracture in close proximity to the mental foramen, reported to the department of Maxillofacial Surgery, were treated by open reduction and internal fixation using a modified 3D titanium plate. Post-operative evaluation of the subjects was carried out for occlusion, neuro-sensory disturbances, infection and plate stability with regular radiographic examination for 12 weeks.

Results: Majority of the patients were males (93.75%). Commonly observed etiology for fracture was road traffic accident. Occlusion and plate stability was satisfactory in 93.75 % of patients. One patient (6.25 %) showed infection and neuro-sensory disturbances at the end of 12 weeks postoperatively.

Conclusion: A modified 3D titanium plate was found to be effective in order to prevent injury to the mental nerve and dental root apices, in the fractures involving mental foramen region.

INTRODUCTION

Maxillofacial trauma is a cause of concern due to the increasing road traffic accidents, violence and sports injury. The unique position and prominence of mandible make it the second most commonly fractured bone of the maxillofacial skeleton. The treatment modalities for mandibular fractures have ranged from conservative measures such as splints or arch bar fixation to a more reliable and preferable open reduction with internal fixation.[1] The management of these fractures has evolved significantly in the past half century to restore original anatomic form and function at the earliest without least morbidity.[2]Various techniques using internal fixation have been introduced which allow immediate function not necessitating the need for additional maxillo-mandibular fixation.[3-5] These are based upon the precise alignment of the dentition along with the fractured segments and performing plate and / or screw osteosynthesis with or without compression. [3-5]

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Farmand and Dupoirieux demonstrated 3D plates in 1992. The plate has a quadrangular shape that is formed by joining two mini plates with interconnecting crossbars.[6] These 3-D plates have been used for fixation of the mandibular symphysis, parasymphysis and the angle fractures. The fractures in the region of mental foramen pose a great challenge for the placement of 3-D plates. The reason is to avoid injury to the mental nerve and the dental root apices in that region.[7,8]

Considering the varying anatomy of the mental foramen,[9] course and anterior loop of the mental nerve[10] and thickness of the buccal cortex in this region,[11] the conventional 3D titanium plate was a modified for the preservation of the mental nerve.

Objectives: To determine the efficacy of a modified 3-D titanium plate for the fixation of mandibular fractures involving or in close proximity to; the mental foramen.

MATERIALS AND METHODS

After obtaining ethics and research committee approval, a prospective randomized clinical study (experimental study) was carried out for a period of 24 months from May, 2016 to May, 2018 in the department of Oral and Maxillofacial Surgery.

Informed consent was obtained and 16 patients including both the genders within the age group of 20 to 50 years with isolated fractures of unilateral or bilateral mandibular body; involving or in close proximity to the mental foramen were included.

Preoperatively infected or medically compromised patients, those not willing to return for follow-up and those having paresthesia pre operatively were excluded. A standardized data sheet was formulated, and demographic variables and relevant clinical and radiological findings were noted. All patients were given prophylactic antibiotics and the procedure was carried out under general anesthesia. Following strict aseptic precautions, an appropriate intraoral incision based on the site was selected; a fracture site was identified, reduced, and after obtaining satisfactory occlusion, temporary maxilla-mandibular fixation was placed using Erich's arch bar and elastics. Fixation was done using a modified 3D titanium plate. Occlusion was recorded and the incision was closed watertight using 3-0 vicryl suture material

A 2mm thick, self-locking 3D titanium plate was designed for this study (Figure 1), keeping in mind the original design of a 3D plate. When an occlusal load is placed at the alveolar border near the premolar region, a tensile load is distributed along the upper border and simultaneously, there is compression at the lower border. Considering this principle, the plate was designed to have more surface area at the lower border to provide better support and the lower and the upper border of the plate were curved upwards. The inner slopes of the upper border of the plate were so designed as to counteract the tensile forces. The upper border of the plate slopes down at the centre into a 'V' shaped loop, which is incorporated to be fixed across the mental foramen.

Statistical analysis: Data was collected by using a structure proforma. Data entered in MS excel sheet and analysed by using SPSS 23.0 version IBM USA. Qualitative data was expressed in terms of percentages. Quantitative data was expressed in terms of Mean and Standard deviation. Association between two qualitative variables was seen by using Fischer's exact test. A p value of <0.05 was considered as statistically significant whereas a p value <0.001 was considered as highly significant.

Figure 1 A Modified 3D Titanium Plate

The plate was 25 mm in length, 7mm in width and 2mm in thickness.

It had a height of 3mm at the centre below the 'V'

RESULTS

Table 1 Distribution of subjects according to gender

Gender	No of patients	Percentage
Male	15	93.75
Female	1	6.25
Total	16	100.00

We included 16 eligible patients in our study. Majority were males i.e. 15(93.75%) whereas 1(6.25%) were female.

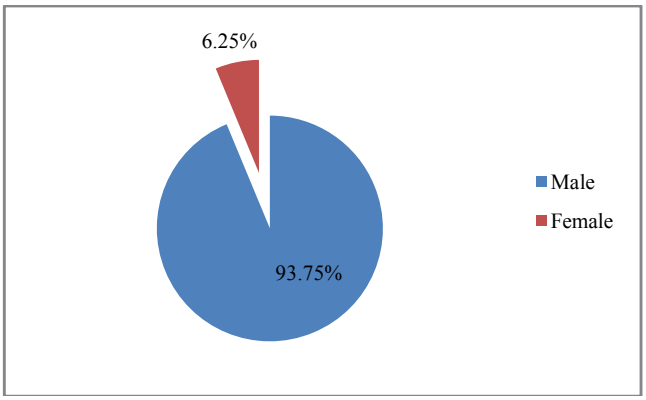

Fig 2 Pie diagram showing distribution of subjects according to gender

Table 2 Comparative evaluation of occlusion at different time intervals

Occlusion	Pre op	%	1week	%	8week	%	12week	%
Absent	12	75	1	6.25	1	6.25	1	6.25
Present	4	25	15	93.75	15	93.75	15	93.75
Total	16	100.00	16	100.00	16	100.00	16	100.00

Fischer's exact test - 15.67, p-0.00007 (<0.05), highly significant

Occlusion was satisfactory in all the patients at the end of 12 weeks postoperatively.

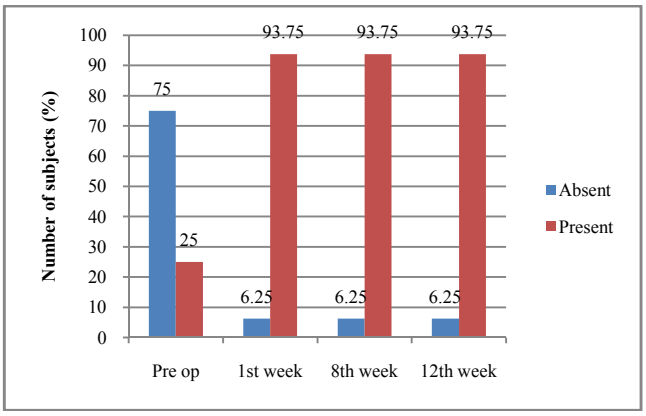

Fig 3 Bar diagram showing comparison of post-operative 1st week, 8th week and 12th week follow-ups with respect to occlusion evaluation.

All but 1 patient had satisfactory occlusion at 1st week, 8th week and 12th week post operatively.

Out of 16 patients, 1, 3 and 2 of the patients respectively showed the evidence of infection at the end of 1 week, 8 weeks and 12 weeks post operatively; which was controlled by the administration of antibiotics.

Table 4 Distribution of subjects according to presence of infection at week 1, 8 and 12

Presence of Infection	1week	%	8week	%	12week	%
Absent	15	93.75	12	75	14	87.5
Present	1	6.25	3	25	2	12.5
Total	16	100.00	16	100.00	16	100.00

Fischer's exact test- 1.31, p-0.51, Not significant

Comparison of post-operative 1st week, 8th week and 12th week follow-ups with respect to the evidence of infection showed that 1 patient i.e. 6.25%, 3 patients i.e. 25% and 2 patients i.e. 12.5% had infection at the end of 1st week, 8th week and 12th weeks post operatively respectively which was controlled by the administration of antibiotics.

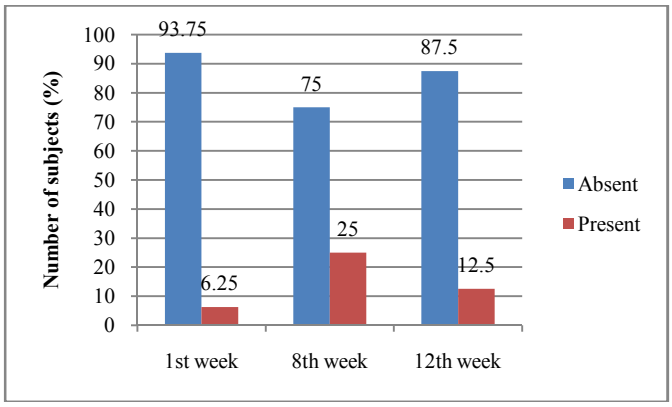

Fig 4 Bar diagram showing presence of infection at week 1, 8 and 12

Table 4 Distribution according to neuro-sensory disturbances

Neuro-sensory disturbance	1week	%	8week	%	12week	%
Absent	14	87.5	15	93.75	15	93.75
Present	2	12.5	1	6.25	1	6.25
Total	16	100.00	16	100.00	16	100.00

Fischer's exact test -0.36, p-0.54 (>0.05), Not significant

Out of 16 patients, 2 (12.5%) had neuro-sensory disturbances on pin prick test, on post-operative 1st week and 1(6.25%) each on 8th week and 12th week respectively.

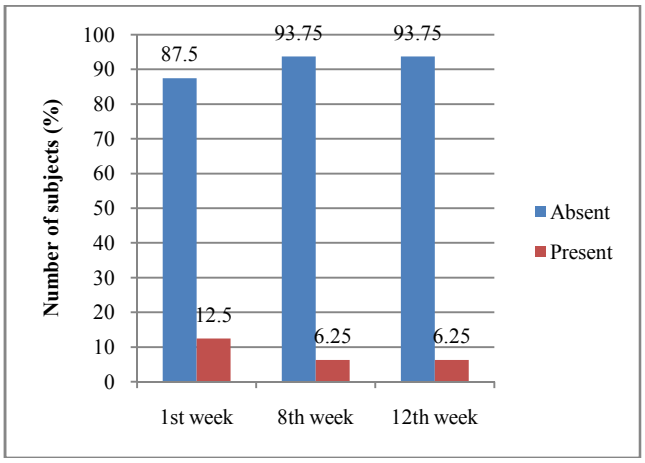

Fig 5 Bar diagram showing comparison of post-operative 1st week, 8th week and 12th week follow-ups with respect to the neurosensory disturbance on the pin prick test

Only one patient had neuro-sensory disturbances at the end of 12th weeks post operatively.

Table 5 Distribution according to stability of plate

Plate stability	1week	%	8week	%	12week	%
Absent	1	6.25	1	6.25	1	6.25
Present	15	93.75	15	93.75	15	93.75
Total	16	100.00	16	100.00	16	100.00

Fischer's exact test-0.00, p-1.0 (>0.05), Not significant

Out of 16 patients, plate stability was not found in 1 patient (6.25%) at the end of 12 weeks post operatively.

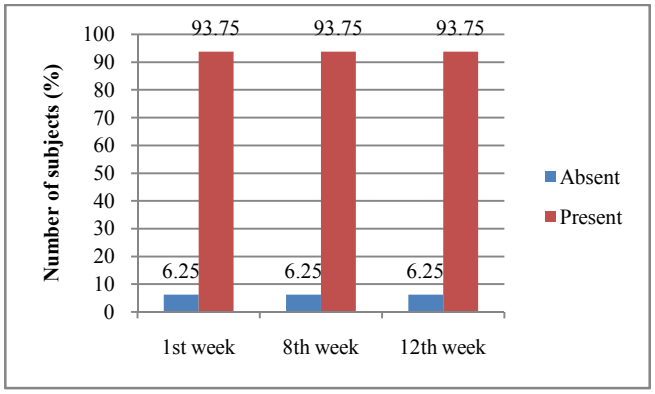

Fig 6 Bar diagram showing Comparison of post-operative 1st week, 8th week and 12th week follow-ups with respect to the plate stability.

One patient was observed to have non stability at the end of 12th weeks post operatively.

DISCUSSION

Past half centuy has witnessed the dramatic change in the management of mandibular fractures that evolved significantly. This not only helped to restore original anatomy and function but also reduced the morbidity.[2] The treatment modalities have ranged from conservative measures such as splints or arch bar fixation to a more reliable and preferable open reduction with internal fixation.[1] Various techniques using internal fixation have been introduced which allow immediate function not necessitating the need for additional maxillo-mandibular fixation.[3,4,5]

These techniques are based upon the precise alignment of the dentition along with the fractured segments and performing plate and / or screw osteosynthesis with or without compression.[3-5] In 1973, Michelet first introduced internal fixation of mandibular fractures with miniplates in conformity with the tension band principle.[12] It was later a modified by Champy et al[13] in 1978. Subsequently in 1992, Farmand and Dupoirieux presented 3-dimensional plates with a quadrangular shape formed by joining two miniplates with interconnecting crossbars.[6]

Though 3-D plates have been used for fixation of the mandibular symphysis, parasymphysis and the angle fractures, the region of the mental foramen limits the use of these plates in the ideal line of osteosynthesis. The buccal cortex in this area is very thin Also the screws in the neutral zone carry the risk of damaging the root apices.[7,8] To overcome these short comings and considering the varying anatomy of the mental foramen,[9] course and anterior loop of the mental nerve[10] and thickness of the buccal cortex in this region,[11] the conventional 3-D plate was a modified and used in this study for the preservation of the mental nerve.

A 2 mm thick titanium 3-D self-locking plate was designed for this study, keeping in mind the original design of a 3-dimensional plate. When an occlusal load is placed at the alveolar border near the premolar region, a tensile load is distributed along the upper border and simultaneously, there is compression at the lower border. Considering this principle, the plate was designed to have more surface area at the lower border to provide better support and the lower and the upper border of the plate were curved upwards. The inner slopes of the upper border of the plate were so designed as to counteract the tensile forces. The upper border of the plate slopes down at the centre into a 'V' shaped loop, which is incorporated to be fixed across the mental foramen.

pre op opg

Exposure of fracture site

Post Op OPG

Fixation using a modified 3-D titanium plate

In our clinical experience, this modified 3-D plate allows almost no movements at the superior and inferior borders with manual torsional and bending forces. The screws were placed on both sides of the fracture along the line of osteosynthesis in 2 planes rather than on a single plane as in cases of miniplates. This created broad platform that increases the resistance to torsional force along the axis of the plate therefore providing greater resistance against gap opening at the inferior border with biting forces. This locking system further adds to the stability of the plate screw system.

CONCLUSION

In our study, the modified 3-dimensional plates carried low morbidity and infection rates. Incidence of malocclusion, hardware failure and neuro-sensory disturbances were also found to be minimal. The plates also provided a good stability at the fracture site. Thus post-operative inter maxillary fixation could be avoided. Patients treated by these plates showed a lesser incidence of occlusal discrepancy. All the patients present in the study appreciated early recovery of normal jaw function, primary healing and good union at the fracture site with minimal weight loss due to early functional rehabilitation. Though we cannot comment on the rigidity and malleability of the a modified 3- dimensional plates compared to other systems without a control group or comparative study with other plating systems our statement is thoroughly based only on our clinical experience and the results seen in literatures. Further comparative studies are necessary to set gold standards for these plating systems with a control group.

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