



Original Research Article

Evaluation of the treatment outcome of fixation of mandibular fractures with eccentric dynamic compression plates

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ABSTRACT

Background: The introduction of bone plates as the implants for osteosynthesis has changed this facet of oral and maxillofacial surgery. The objective of this study was to evaluate the treatment outcome of fixation of mandibular fractures with Eccentric Dynamic Compression Plates (EDCP) with a follow up interval of 1 week, 3 weeks, 6 weeks and 3 months.

Materials and Methods: Ten patients will be randomly selected and subjects underwent Open Reduction and Internal Fixation under General anesthesia/ Local anesthesia. Fixation will be done using 2.5 mm Titanium Eccentric Dynamic Compression Plates 2.5x 8.0mm Titanium screws through Intraoral/ Extraoral approach.

Results: In our study the 2.5mm EDC plates had low morbidity and significantly lower infection rates. It was proved to be comparable to other plating systems. It was also easy to use alternative to the conventionally used miniplates, in that it provided absolute rigidity to the fractured segments.

Conclusion: 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.

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1. Introduction

Facial injury is a devastating psychological as well as functional disturbance. Being the largest, strongest and the lowest, yet one of the most prominent bones of the facial skeleton, the mandible is the second most commonly fractured bone of the facial skeleton. Basic principles of orthopaedic surgery also apply to the mandibular fractures including reduction, fixation, stabilization and supportive therapies. It is well known that the union of the fracture occur only in the absence of mobility.¹ The association for the study of internal fixation (ASIF), under its German name "ARBEITSGEMEINSCHAFT FÜR OSTEOSYNTHESEFREGEN (AO), stipulated the four

principles which remain relevant even today in the treatment of all skeletal fractures:

2. Rigid internal fixation 2 Anatomical reduction 3 Atraumatic technique 4 Early mobilization

Based on these principles they advocated the use of compression as an elegant method to exclude inter-fragmentary motion. Compression fixation consists in pressing together two surfaces, either bone to bone or implant to bone. The effect of compression is two-fold: it produces preload in the fracture plane and it acts by increasing inter-fragmentary friction (Figure 2). Thus the fracture remains immobilized for a long as the axial pre load is higher than the tensile loads produced by function, and as long as the inter-fragmentary friction prevents displacement

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by shear forces. Compression is no absolute precondition for undisturbed healing, but in specific applications it means more safety and includes a biological and mechanical advantage. Biologically, compression means undisturbed healing because it guarantees absolute stability even under the conditions of function. Mechanically it allows load sharing between bone and implant. Based on these findings the dynamic compression plate was developed which further led to the development of the eccentric dynamic compression plate.^{2,3}

3. Materials and Methods

Patients referred to the Department of Oral and Maxillofacial Surgery, P.M.N.M. Dental College and Hospital, Bagalkot with mandibular fractures that require open reduction and internal fixation.

3.1. Methods of collection of data

The study consisted of a sample of 10 patients with fractures in any region of the mandible; which were treated from November 2012 to May 2014. The procedure to be performed was explained, followed by informed written consent. Ethical committee clearance was obtained duly signed by head of the institution. A detail clinical history with special regard to medical history was recorded in a specially prepared case history Performa. Patients with systemic disease contraindicating general anesthesia and patients not willing to participate in the study and also comminuted fractures of mandible and mid- facial fractures were excluded from the study.

All the patients underwent open reduction with internal fixation of the fractured segments using 2.5mm, 4 holes with gap Titanium Eccentric Dynamic Compression Plates and 2.5x8 mm titanium screws under general anesthesia or local anesthesia. Fractures of the associated condyle were treated with rigid fixation which was placed for 2-3 weeks. The patients were evaluated preoperatively, intra-operatively and postoperatively for various parameters. Postoperative clinical evaluation was done at the 1st week, 3rd week, 6th week & 3rd month.

Evaluation was done for the operative time, ease of fixation of plate (access, reduction and fixation of fractured segments, stability (hardware failure), postoperative occlusion, neurosensory deficits (paraesthesia of the area involved), radiographic evaluation of fracture site at 1 week, 3 weeks, 6 weeks and 3 months and postoperative complications (infection, non-union, mal-union, delayed union).

3.2. Surgical technique

3.2.1. Plate

A 2.5mm 4 hole with gap titanium EDC plate (Figure 3) for mandible fracture was custom made and used in this study,

the plates were so designed that they had 2.5mm screw hole diameter, the plates had holes whose geometry was based on the “Spherical Gliding Principle”(Figure 1) which transforms a vertical force into a horizontal one. The gliding hole had a bend of 135°, this is where the force changed. The length of the plate was 3.1cms. The distance between two central dynamic compression holes was 8.6mm and the distance between the dynamic and the outer eccentric holes was 7.5mm on either side; the eccentric holes being at 45°. The width of the plate was 8.0 mm. Increase in stability was achieved by the thickness of the plate which was approximately 1.0 mm.

When the mandible was in function the primary forces of concern on the plate included bending, vertical displacement and shear. In the EDCP since the two horizontally placed holes bring the inferior border into anatomic position with compression and the eccentric holes i.e. the vertical set rotates each alveolus into position around the axis of the first screw resulting in production of rigidity. The plates were carefully adapted. Rigidity also increased because of the thickness and the design of the plate.

3.3. Screws

Titanium screws, 2.5mm (thickness) x 8mm (length) were used the screws were so designed so as to glide on the hole of the plating system. The diameter of head of screw was 2.5mm.

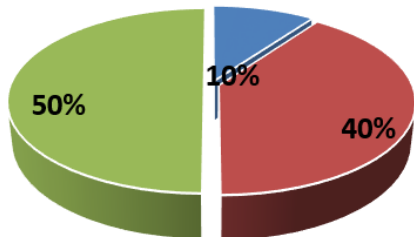
ORIF was done under under local anaesthesia or general anaesthesia, either through extraoral approach by pre-existing laceration or intraoral approach by degloving incision to the fracture site. The EDC plates were adapted parallel to the lower border of the mandible. The drilling was performed with a 2.0mm drill bit, at an angulation which was maintained perpendicular to the surface of bone. The holes in the vertical set were drilled near the inferior border of the mandible, creating rotational forces in the superior direction that brings the alveolus into dynamic compression; whilst the inner holes were drilled laterally so that the screws glide and compress the fracture fragments against each other horizontally. The eccentric screws after drilling were tightened by slightly loosening the horizontally directed screws so as to produce dynamic compression at the alveolus. A force of 150 N was applied to the plates. The patient (Figures 4 and 5) was instructed for a semi solid diet for one week. Subsequent follow up was done at 6 weeks and 3 months, during every follow up the patient was evaluated for occlusion, infection and plate stability radiographically.

4. Results

Among the study population, majority of the population were in the age group of 25-30 years. There were 9 (90%) male and 1 (10%) female patients. With road traffic accident

(RTA) 8 patients (80%) being the most common aetiology followed by 2 patients with (20%) work related or self-fall.

The Fracture distribution consisted of the following, mid- symphysis fracture of mandible 2 (20%) patients, left parasymphysis fracture of mandible 3 (30%) patients, right parasymphysis fracture of mandible 5 (50%) patients, along with associated fracture of the condyle accounting for 5 (50%) of patients.



- ORIF under GA through EXTRA- oral approach using compression plates
- ORIF under GA through Intra-oral approach using compression plates
- ORIF under LA through Intra-oral approach using compression plates

Fig. 1:

Table 1: Operative time wise distribution

Operative time	Percentage	P value
<80 minutes	50%	1.0
>80 minutes	50%	

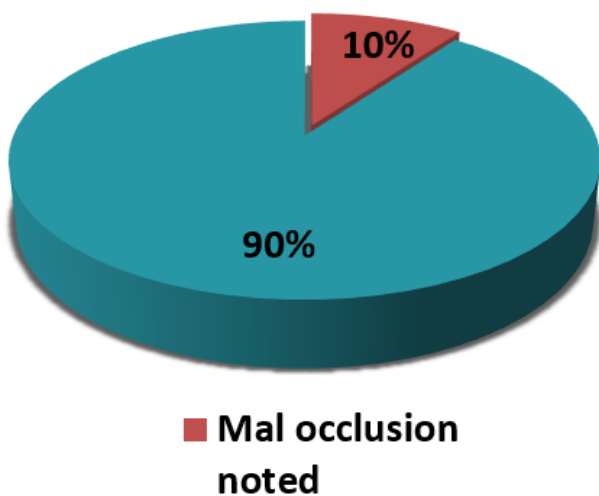


Fig. 2: Post op occlusion wise distribution

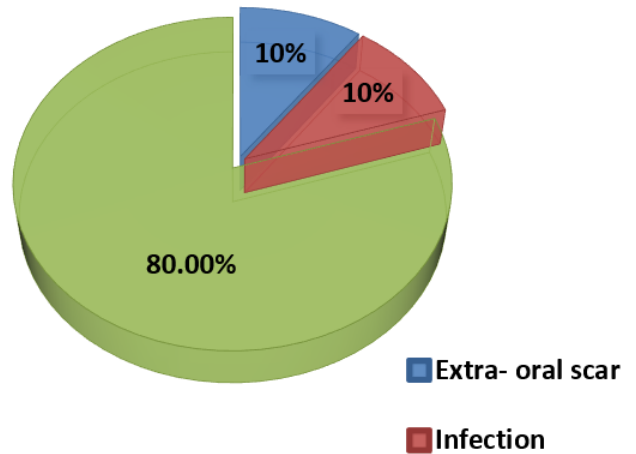


Fig. 3: Post- operative complications wise distribution

5. Discussion

Open reduction and internal fixation (ORIF) of the mandible with bone plates was first described by Schede (1888). General acceptance of open osteosynthesis did not appear in maxillofacial literature until an organised research by AO in 1950. Luhr, Spiessl, and others derived inspiration from orthopaedic biomechanical studies performed by Schenk. Who suggested accelerated bone healing through compression, Rigid fixation using dynamic compression plate which has its own disadvantages such as requirement of a wide incision, bulky nature of the plates and the procedure which are technique sensitive according to findings given by Iizuka et al. (1991).⁴

The EDCP permits application of compression by taking advantage of a specially designed screw hole. This hole has an inclined surface, which means that the plate compresses the fracture when the screws are inserted in a somewhat eccentric position. Furthermore the spherical geometry of the EDCP permits insertion of the plate screws at an angle in order to avoid fracture lines and improve their function as lag screws.³

Bouloux et al. reported slightly higher operating time of 150 minutes for mandibular fractures treated using dynamic compression plates using AO principles.⁵ In our study we reported an operative time of 80 min (mean) with a standard deviation of 9.35. The maximum operative time noted was 90 minutes. No significant time difference was noted between extra- oral and intra- oral approaches probably due to the fact that in our study, the only case in which we used an extra- oral approach, was done through a pre-existing cut lacerated wound.

One of the disadvantages of EDCP is the bulk of the plate, which might lead to pain in the region of plate fixation due to cold sensitivity in patients who live in severe winter temperatures.⁶ But we did not face this problem as the study

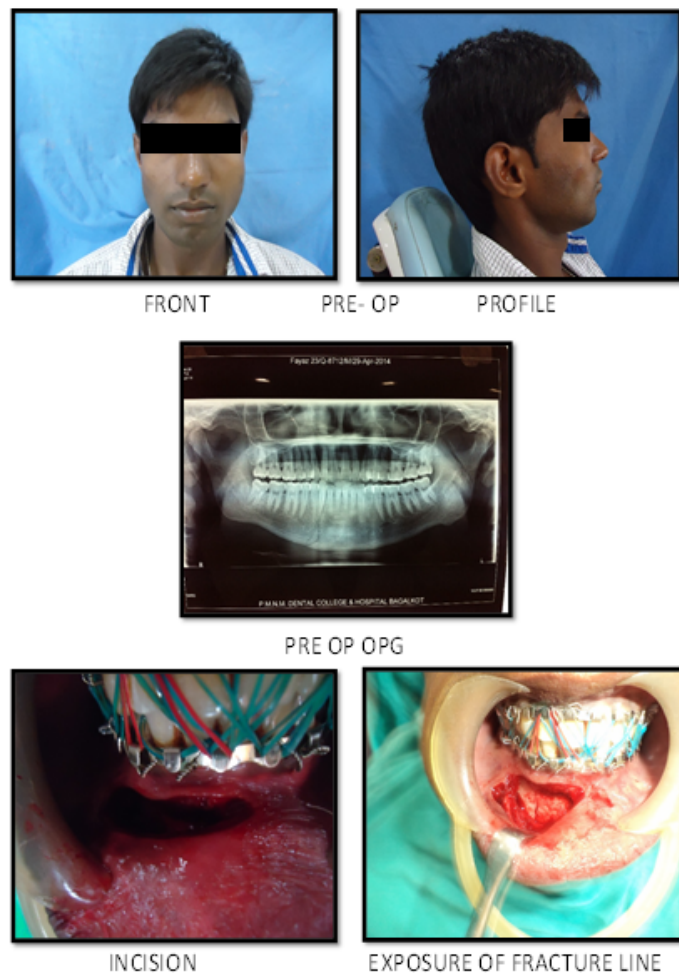


Fig. 4: Pre-operative photographs of case 1

was carried out in Karnataka, which has tropical climate.

The infection rate in our study was found to be 10%, which was less as compared to the 16% infection rate found by Lindquist et al. in 1986.⁷ One patient had a wound infection by 10th day which can be due to communication of the extra and intra-oral lacerated wounds or due to his tobacco chewing habit. The patient was put on antibiotic coverage, the infection subsided and plate removal was not deemed necessary.

In a study done by Renton et al. in 1996 the incidence of malocclusion was noted to be around 17% which was treated with occlusal adjustment and the remainder resolved at a later review. We found the incidence of malocclusion to be ten percent in our study which was due to intra-capsular condylar fracture supposed to be treated with IMF but the patient was non-compliant for the same. At later review dates the minor mal-occlusion was corrected with selective occlusal grinding.

One of the advantages offered by EDCP is that there is no or lessened need to place IMF.^{8,9} Results in our study

were concurrent with these findings in that the need to place the patient in IMF was obviated in 50% of patients and that the IMF which was done prior to ORIF was removed immediately after surgery and patient was put on a soft diet for a month. In the remainder of cases (50%) because of the involvement of the condyle patient was placed on MMF for a period of 2-3 weeks and the patients placed on liquid diet. The weight loss factor was eliminated in patients in whom IMF was not carried out.¹⁰

Radiologic evaluation was carried out for 3 months post-operative and the bony union noted. It was found out that complete bony union was seen radiographically between 6 weeks and 3 months. In the study carried out by Mishra et al. in 1998 radiologic union was seen at 6-8 weeks.¹⁰

6. Conclusion

Authors found that EDC titanium plates were technique sensitive to use. Placing these plates was found to be comfortable to the operator and the patient, as the surgical

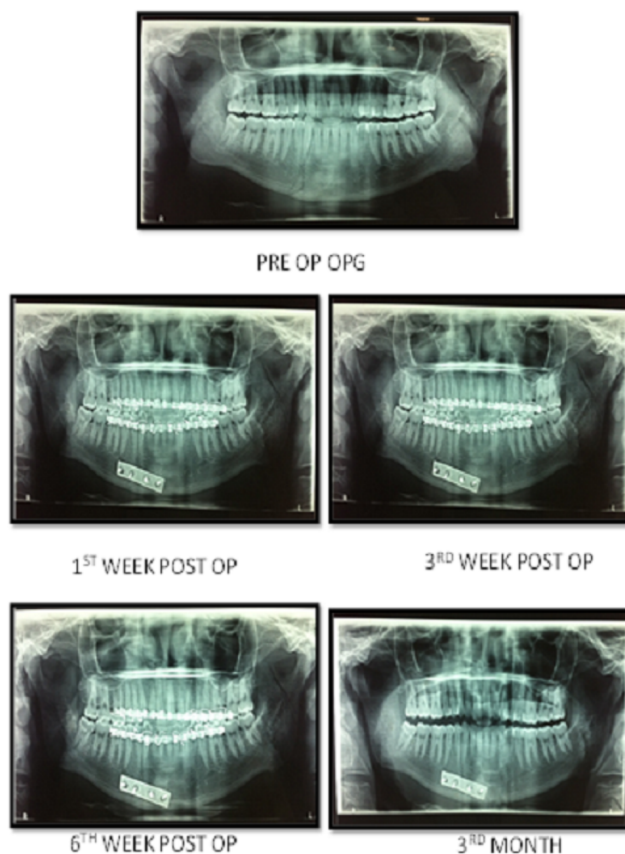


Fig. 5: Post-operative photographs of case 1

time required was less. The EDC titanium plates were quite difficult to adapt to the bone but had greater resistance to compression load. Patients treated by these EDC plates showed a lesser incidence of occlusal discrepancy. Fixation of mandibular fractures with EDC titanium plates facilitates reduction and stabilization at both the superior and inferior borders. It is difficult to adapt these plates at the parasymphysis region as the mental nerve lies in close proximity. 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. The EDC plate was found to be standard in profile, strong yet malleable, facilitating reduction and stabilization at both the superior and inferior borders giving three dimensional stability at the fracture site. Although this method may not be the panacea for mandibular fractures, it is an important technique that skilful maxillofacial surgeons should maintain in their armamentarium and can be used whenever / wherever it is necessary.

7. Source of Funding

None.

8. Conflict of Interest

None.

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