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Three-dimensional v/s standard titanium miniplate fixation in the management of mandibular fractures – A randomized clinical study

Saumya Sehgal*, Lalitha Ramanujam, Kavitha Prasad, Ranganath Krishnappa

Oral & Maxillofacial Surgery (Head of Institution: Sreenivasa Murthy), M.S. Ramaiah Dental College & Hospital, M.S.R.I.T Post, Bangalore 560054, India

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ABSTRACT

Purpose: The aim of this study was to compare treatment outcomes using three-dimensional and standard titanium miniplates in the management of mandibular fractures.

Material and methods: A prospective study of 30 patients with mandibular fractures. Patients were randomly categorized into 2 groups with 15 patients in each group; patients in Group I were treated with 2.0 mm 3-dimensional titanium miniplate and screws and patients in Group II were treated with 2.0 mm standard plates and screws. Clinical parameters evaluated were: intra-operative assessment of reduction, intra-operative and post-operative assessment of stability of occlusion, mobility of fracture fragments and need for intermaxillary fixation. Radiographic parameters included pre-operative evaluation of displacement of fracture fragments and post-operative evaluation of bone union and plate fracture at different time intervals.

Results: In Group I, 3 patients (20%) and in Group II, 8 patients (53%) had gap between fracture fragments during reduction. Six patients (40%) in Group I and 8 patients (53%) in Group II had mildly deranged occlusion on the 7th post-operative day. Two patients (13%) in Group I and 6 patients (40%) in Group II needed IMF till the end of the 1st month. No patients showed tissue dehiscence at the end of 1st and 3rd month post-operatively. Infection was not observed in any patient post-operatively. Five patients (33%) from Group I had displaced fracture fragments and 10 patients (67%) had severely displaced fracture fragments pre-operatively. Seven (47%) patients from Group II had displaced fracture fragments and 8 (53%) had severely displaced fracture fragments pre-operatively. Nine patients (60%) in Group I and 6 patients (40%) in Group II showed radiographic evidence of bone union after the 3rd month post-operatively.

Conclusion: The use of 3D miniplate is a viable option for fixation of mandibular fractures routinely. 3D titanium miniplates showed comparable results compared to standard titanium miniplates.

1. Introduction

Fractures of the mandible cause both functional disabilities and social as well as cosmetic morbidities. The aim of treatment is the restoration of anatomical form and function, with particular care to re-establish the occlusion. The ideal method of treatment of mandibular fracture should have the objectives of perfect anatomical reduction, complete stable fixation and painless mobilization of the injured region around its articulation (Olson et al., 1982; Fonseca and Walker, 1997; Chacon and Larsen, 2004; Gerlach et al., 2007; Lee, 2008; Seemann et al., 2010).

Traditionally, the jaws were immobilized using various techniques. Currently open reduction and internal fixation (ORIF) is the mainstay of treatment and is achieved with different plating systems. It has eliminated the need for maxillomandibular fixation (MMF) and facilitates stable anatomic reduction while reducing the risk of post-operative displacement of fractured fragments, and allowing immediate return to the function.

Technical advantages of miniplate osteosynthesis include small and easily adapted plates, monocortical application, intraoral approach, functional stability and biomechanically favourability. Not only is the reduction anatomically acceptable, but the jaw function is also improved and there is decreased weight loss and improved pulmonary function. Other advantages are patient comfort, improved

* Corresponding author. C-692 New Friends Colony, New Delhi 110065, India. Tel./fax: +91 11 46501667.
E-mail addresses: saumyasehgal@gmail.com, saumyasehgal@yahoo.com (S. Sehgal).

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speech and oral hygiene, leading to enhanced social interaction, and a reduction in number of hospital visits (Snell and Dott, 1969; Champy et al., 1978; Rix et al., 1991; Hayter and Cawood, 1993; Saluja et al., 2012).

The three-dimensional (3D) titanium plating system for mandibular fracture treatment is relatively new and was introduced by Mostafa Farmand for maxillofacial fracture treatment in 1992. The 3D miniplate consists of two 4-hole miniplates joined by three or four interconnecting cross struts. In combination with the screws monocortically fixed to the outer cortex, the rectangular plate forms a cuboid that provides three-dimensional stability. The geometry of 3D strut plate conceptually allows for an increased number of screws, stability in three-dimension and resistance against torque forces while maintaining a low profile and malleability (Farmand, 1991; Farmand and Dupoirieux, 1992; Farmand, 1995, 1996).

Additional advantages of 3D miniplates over conventional miniplates include easy application, simplified adaptation to the bone without distortion or displacement of the fracture, simultaneous stabilization at both superior and inferior borders of the mandible, less operative time and improved biomechanical stability (Farmand, 1995).

The purpose of this prospective clinical study was to compare the treatment outcomes using three-dimensional and standard titanium miniplates in the management of mandibular fractures.

2. Materials and method

Thirty patients with mandibular fractures presenting to the Department of Oral and Maxillofacial Surgery, M.S. Ramaiah Dental College and Hospital, M.S. Ramaiah Medical Teaching Hospital and M.S. Ramaiah Memorial Hospital, Bangalore, from January 2011 to September 2012 requiring ORIF were selected for the study. Informed consent was taken prior to surgery and the source data was collected in the proforma.

Patients were randomly allotted, using computer randomization, to Group I or Group II, with 15 patients in each group. After obtaining the consent, ORIF was done either under general anaesthesia or local anaesthesia. Fractures in Group I patients were fixed with three-dimensional titanium miniplates and screws, whereas fractures in Group II were fixed with 2.0 mm standard titanium miniplates and screws (Fig. 1).

Emergency care was provided immediately for all the patients at the time of admission. All patients were placed on the triple I.V. antibiotic regimen with Ceftrioxone, Amikacin and Metronidazole pre-operatively and this was continued as per the trauma protocol of M.S. Ramaiah Hospitals for a total period of 7 days. Diclofenac Sodium, Ketorolac or Tramadol were administered as analgesics as per requirement.

Twenty-nine patients were treated under general anaesthesia and one patient was treated under local anaesthesia. Submental intubation was done for 2 patients as they had concomitant fractures involving the midface. The surgical field and the oral cavity were prepared with povidone-iodine. The operating area was isolated with towels and drapes.

Upper and lower arch bars were placed in case of any other associated fractures of the mandible and eyelet wires were placed in both the arches in case of isolated mandibular angle fracture. 2% lidocaine with 1:200,000 adrenaline was used as the local anaesthetic solution. Depending on the location of fracture, the fracture site was exposed either through intraoral lower vestibular incision/extraoral sub-mandibular incision or an existing extraoral laceration. Occlusion was verified and MMF was done before fixation of the fracture.

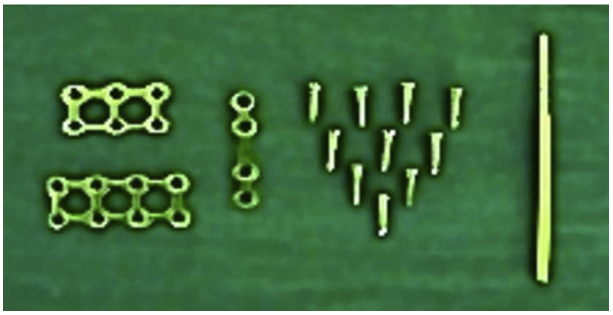

Fig. 1. 2.0 mm 3-D miniplates, 2.0 mm conventional miniplate and screws, 1.8 mm drill.

After obtaining adequate exposure of the fractured segments, occlusion was established with the help of temporary MMF. In Group I, 3D miniplates were used for the fixation of fractures. This plate was adapted to the bone in such a way that the horizontal bars were perpendicular to fracture line and vertical bars (cross struts) were parallel to it. Diagonally opposite screws were placed first, followed by the remaining two screws. At the mandibular angle region, the 3D plate was bent over the oblique line so that the vertical bars were aligned perpendicular to the external oblique ridge and secured with 2 mm × 8 mm monocortical titanium screws over tension band zone according to Champy's line of osteosynthesis (Fig. 2a–d).

In Group II, 2 miniplates were used for fixation of fractures in the inter-foraminal region. A single plate was used for fixation of fractures in the body region. In the region of the angle of mandible, a single miniplate was selected and bent to contour the underlying bone. It was secured with monocortical screws (2 mm × 6 mm or 2 mm × 8 mm) over the superior border (tension band zone) according to Champy's technique (Fig. 3a–d).

Adequacy of fixation and occlusion were verified after placement of the miniplates. The area was irrigated with betadine and saline and after adequate haemostasis was achieved, the incision or wound was closed in layers with 3-0 vicryl and 4-0 nylon. MMF was released and an adhesive pressure bandage was given.

As per the previously described trauma protocol of the hospital, post-operatively, all patients were maintained under antibiotic coverage. The patients were also given Injection Dexamethasone 8 mg eight hourly I.V. and the dosage was tapered down in the subsequent 3–4 days to decrease oedema and inflammation in the surgical site. Patients were advised to take a liquid diet for the initial 2 days and thereafter were put on a soft diet for 2 weeks. In addition, they were advised to use chlorhexidine gluconate mouth rinse frequently to maintain oral hygiene. Sutures were removed on the 7th post-operative day. All patients were evaluated on the 1st post-operative day, 7th post-operative day, 1st month and 3rd month for certain clinical and radiographic parameters.

The following clinical parameters were evaluated: (1) Intra-operative assessment of reduction of fracture – assessed by placing an appropriate gauge stainless steel wire between the fracture fragments; (2) Intra-operative and post-operative assessment for (a) Stability of occlusion - assessed according to the following criteria: (i) Satisfactory – No gap between upper and lower first molars, (ii) Mildly deranged – Gap of 1 – 2 mm between upper and lower first molars, (iii) Deranged – Gap more than 2 mm between upper and lower first molars, (b) Mobility of fracture fragments – checked by a single operator by digital palpation with the help of thumb and index finger of both the hands. Applying pressure alternatively assessed the stability; (i) Stable – no movement of fragments, (ii) Unstable – movement present. (c) Need for

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