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Original Article

Management of mandibular angle fractures using a 1.7 mm 3-dimensional strut plate

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ABSTRACT

Aim: We report our experience with the use of 1.7 mm 3-dimensional (3D) strut plate for the management of mandibular angle fractures.

Methods: This prospective study enrolled 15 patients in whom mandibular angle fractures were treated with 1.7 mm 3D plate using trans-buccal trochar. Patients were evaluated at 72 h, 2 weeks, 6 weeks and 12 weeks for fracture stability, occlusion, soft-tissue swelling, infection and post-operative inferior alveolar nerve damage. Other complications like wound dehiscence, non-union, mal-union and hardware failure were also assessed.

Results: In the immediate post-operative period, fracture instability was seen in 1 (6.7%) patient which resolved by 2 weeks. Mild occlusal discrepancy was also noted in 1 (6.7%) patient. Wound dehiscence was seen in 5 (33.3%) patients and all resolved by local measures. 1 (6.7%) patient developed post-operative nerve paraesthesia. Immediate post-operative radiographic evaluation demonstrated optimal reduction in all cases with no inferior border gaping. No case of infection, hardware failure, non-union and mal-union was noted.

Conclusion: Within the limitations of the study, 1.7 mm 3D strut plate was found to be effective for management of non-communitated mandibular angle fractures.

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1. Introduction

Management of mandibular angle fractures is one of the most widely discussed topics in maxillofacial literature. The aim of the treatment is to restore the anatomical form and

function as well as establishing the pre-operative occlusion. With ease of application and low complication rates, Champy's 2 mm miniplate is the widely used treatment modality for management of mandibular angle fractures.¹ This semi-rigid fixation utilizes a single miniplate placed along the superior border which acts as a tension zone. However,

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the superior border tension zone is seen only if load is applied along the incisal edge. Biomechanical studies have shown that ipsilateral molar loading causes lower border splaying with Champy's technique.^{2,3} Also, in vitro studies point out the greater stability of two point fixation (2 bone plates) in angle fractures as compared to one.⁴ However, clinical studies provide a different picture. Ellis noted that the application of 2 mini-plate is associated with significant complications (29%) as compared to a single one (2.5%).¹ Other studies have found no difference in the use of either treatment modality.^{5,6}

To overcome the disadvantages of 2 plate application and to provide additional stability with a use of a single plate, 3-dimensional (3D) plates were developed. It consists of two 4-hole miniplates joined by 4 interconnecting cross struts.⁷ This provides room for additional screw placement adding to torsional and 3D stability of the fracture.^{4,8} Studies have reported the use of 2 mm 3D strut plate in angle fractures and have compared it with Champy's technique. We report our experience with a 1.7 mm 3D strut plate in the management of mandibular angle fractures.

2. Materials and methods

This institutional review board approved prospective study enrolled 15 adult patients requiring open reduction and internal fixation of mandibular angle fractures, reporting to our unit between July 2011 and June 2012. Patients with additional fractures of the mandible were also included provided they were fixed with rigid fixation. Exclusion criteria included patients with: associated midface fractures, comminuted fractures, edentulous fractures, angle fracture in combination with condylar fracture, major systemic illness and pregnant or lactating females. Informed written consent was obtained from all patients prior to inclusion in the study.

Emergency care was provided to all patients prior to surgery. Demographic details, abusive habits, mode of trauma, fracture sites, inferior alveolar nerve paraesthesia and time duration from trauma to surgery were recorded. Pre-operative radiographs were obtained in two planes (orthopantomogram and postero-anterior [PA] mandible view) to evaluate the fracture site (Figs. 1 and 2).

Fig. 1 – Pre-operative orthopantomogram showing displaced left angle fracture.

Fig. 2 – Displaced left angle fracture on a PA mandible view.

2.1. Surgical procedure

Surgical procedure was carried out under local or general anaesthesia depending upon patient compliance. Pre-operative antibiotic in the form of injection amoxicillin + clavulanic acid 1.2 g IV was given 1 h prior to the procedure after antibiotic sensitivity testing. Chlorhexidine 0.2% was used to prepare the oral cavity pre-operatively. Standard intra-oral vestibular incision with full thickness muco-periosteal flap was used in most cases to expose the fracture site. In few cases, an extended third molar crevicular incision was used wherever third molars were to be extracted. Third molars with gross caries, periodontal involvement, crown/root fracture, excessive mobility and those interfering with reduction of the fracture segments were extracted. Temporary maxillo-mandibular fixation (MMF) was done with tie-wires after obtaining satisfactory occlusion. Fixation of additional mandibular fracture was done with a load bearing locking plate with bicortical locking screws or with two miniplates; the plate at the lower border was fixed with bicortical screws to provide rigid fixation.

After proper reduction of angle fracture, fixation was carried out using a 1.7 mm × 10-hole titanium straight 3D strut plate (Stryker-Leibenger, Freiburg, Germany). It was positioned on the lateral surface of the mandible with the struts paralleling the fracture line. A trans-buccal trochar system was used to fix mono-cortical screws with 4 screws on either side of the fracture line. MMF was released and occlusion was checked. The operated site was closed with 3-0 vicryl and an extra-oral pressure dressing was applied. Post-operatively, the same antibiotic was continued for 3 days (2 dosages in a day). Analgesics and chlorhexidine 0.2% mouthwash were also prescribed. Strict oral hygiene instructions

Fig. 3 – Post-operative orthopantomogram after 3D plate fixation of the angle fracture.

were given and patients were kept on semi-solid diet for 2 weeks in both the groups.

Patients were evaluated after 72 h, 2 weeks, 6 weeks and 12 weeks post-operatively for the following parameters by a single investigator: (1) fracture stability – mobility of the fracture site was evaluated in two planes; (2) occlusion – was deemed satisfactory or deranged; (3) soft-tissue swelling – was recorded as mild [perceivable on palpation only], moderate [evident on inspection] and severe [gross swelling]; (4) infection – any erythema, oedema and purulent discharge at the fracture site was noted; (5) post-operative inferior alveolar nerve damage – any hypoesthesia/paraesthesia arising post-operatively was noted. Other complications like wound dehiscence, non-union, mal-union and hardware failure were also assessed.

Orthopantomogram and PA view mandible was obtained at 72 h, 4 weeks and 12 weeks post-operatively to check for reduction of the fracture segments (Figs. 3 and 4). Any change in the alignment of the fracture segments was also noted.

Fig. 4 – Post-operative PA mandible after 3D plate fixation of angle fracture.

Table 1 – Details of patients included in the study.

Variables	N = 15
Age (years) ^a	29.6 ± 7.9
Gender	
Male	14 (93%)
Female	1 (7%)
Abusive habits	
Alcoholic	3 (20%)
Tobacco (chewing/smoking)	5 (33%)
Mode of trauma	
RTA	9 (60%)
Assault	1 (7%)
Fall	5 (33%)
Side of angle fracture	
Right	6 (40%)
Left	9 (60%)
Associated fracture	
Present	8 (53%)
Absent	7 (47%)
Presence of tooth in fracture line	15 (100%)
Time between injury and presentation (days) ^a	4.4 ± 4.3
RTA, road traffic accident.	
^a Mean ± standard deviation.	

3. Results

The mean age of patients included in the study was 29.6 (SD 7.9 years) with 14 males and 1 female (Table 1). 8 (53%) patients had some kind of abusive habit (alcoholic, tobacco chewer or smoker). Road traffic accident (60%) was the most common aetiology of trauma. Additional symphysis or parasymphysis fracture was seen in 8 (53%) patients. It took a mean of 4.4 (SD 4.3 days) for patients to report for treatment following injury. All the angle fractures had 3rd molar within the fracture line (100%) and it was extracted intra-operatively in 4 (26.6%) patients.

Fracture site was stable in all, except for 1 (6.7%) patient where instability was seen in on the 3rd post-operative day which resolved by the end of 2 weeks. Mild occlusal discrepancy was seen in 1 (6.7%) patient on the 3rd post-operative day. The patient was successfully managed by placing guiding elastics for 10 days. At the end of 2 weeks, occlusion was satisfactory in all the cases. All of our patients developed severe post-surgical oedema on the 3rd post-operative day. It resolved by the end of 2 weeks except for mild soft tissue swelling in 1 which was persistent at the end of 2 months. 5 (33.3%) patients had wound dehiscence, 3 cases were of mucosal dehiscence while 2 were of complete dehiscence with exposure of bone and/or plate. All of these cases were managed by local measures and oral antibiotics. None required surgical intervention. 8 (53.3%) patients had post-injury (pre-operative) inferior alveolar nerve paraesthesia. 1 (6.7%) patient developed post-operative nerve paraesthesia. None of our patients had infection of the surgical site. No case of hardware failure, non-union and mal-union was noted.

On radiographs, angle fracture was found displaced in 14 (70%) patients pre-operatively (based on the discontinuity of inferior alveolar canal). Post-operative radiographic evaluation demonstrated optimal reduction in all cases.

Table 2 – Comparison of present study with previous studies reporting the use of 3D plates for mandibular angle fracture.

Author	Year	No of fractures	Plate used	Infection	Dehiscence	New paraesthesia	Malocclusion	Hardware failure	Non-union	Mal-union
Guimond et al. ¹²	2005	37	2 mm 8-hole curved 3D plate (Synthes, Paoli, PA)	2 (5.4%) ^a	1 (2.7%)	3 (8.1%)	–	–	–	–
Zix et al. ¹³	2007	20	2 mm 8-hole curved or straight 3D plate (Stryker-Leibenger, Freiburg, Germany)	–	2 (10%)	2 (10%)	–	1 (5%)	–	–
Bui et al. ¹⁴	2009	49	2 mm 8-hole curved 3D plate (Synthes, Paoli, PA)	4 (8.2%)	–	–	–	–	–	–
Höfer et al. ¹⁵	2012	30	2 mm 4-hole rectangular grid plate (Medartis, Switzerland)	–	–	–	–	–	–	–
Wolfswinkel et al. ¹⁶	2012	34	2 mm 8-hole 3D plate (Synthes, Paoli, PA)	3 (8.8%) ^b	–	–	–	–	1 (2.9%)	–
Singh et al. ¹⁷	2012	10	2 mm 6-hole 3D plate	2 (20%)	–	4 (40%)	–	–	–	–
Moore et al. ¹⁸	2013	73	2 mm 8-hole curved 3D plate (Synthes, West Chester, PA)	2 (2.7%)	1 (1.4%)	–	–	2 (2.7%)	–	–
Pal et al. ¹⁹	2013	18	2 mm matrix 4-hole 3D plate	1 (5.5%)	2 (11%)	3 (16.7%)	2 (11%)	–	–	–
Vineeth et al. ²⁰	2013	10	2 mm 6 or 8-hole 3D plate	–	–	–	–	–	–	–
Xue et al. ²¹	2013	6	2 mm 10-hole delta 3D plate (Stryker, Kalamazoo, MI)	–	1 (20%)	–	–	–	–	–
Guy et al. ²²	2013	68	2 mm curved 3D plate	3 (4%)	4 (6%)	1 (1%)	2 (3%)	1 (1%)	3 (4%)	1 (1%)
Chhabaria et al. ²³	2014	21	2 mm 8-hole curved 3D plate	–	2 (10%)	3 (15%)	–	–	–	–
Present study	2014	15	1.7 mm 10-hole straight 3D plate (Stryker-Leibenger, Freiburg, Germany)	–	5 (33.3%)	1 (6.7%)	–	–	–	–

^a Hardware removal done in both cases.^b Hardware removal done in 2 of 3 cases.

4. Discussion

3D plates have an advantage over conventional miniplates and reconstruction plates in terms of ease of application, simplified adaptation to bone without distortion or displacement of the fracture, and simultaneous stabilization at both superior and inferior borders.⁹ Biomechanical studies also support the better stability of 3D plates. However, it is still not widely used for fixation of mandibular angle fractures.¹⁰ With only a few studies in literature using this treatment modality, all using a 2 mm 3D strut plate with a profile of 1 mm,¹¹ we report our results with a thinner 1.7 mm 3D plate with a profile of 0.6 mm for managing such patients. Table 2 compares the results of present study with previous studies utilizing a variety of 3D plates for fixation of angle fractures.

Vineeth et al.²⁰ in their prospective randomized trial found greater fracture instability (40%) with miniplates as compared to 2 mm 3D plates (10%) in the immediate post-operative period. Though not statistically significant, the initial better stability with 3D plate was suggested to be associated with its geometrical shape. While assessing for fracture stability, only 1 patient of the current series had mild mobility on the 3rd post-operative day. It could have been due to extraction of the deeply placed mobile 3rd molar in this case which reduced the bony buttress at the fracture site. This however resolved without the need of additional fixation and all cases had good stability by 2 weeks.

Infection rates of mandibular angle fractures are significantly higher than those for other fracture sites.¹² Presence of third molars and fracture instability are significant factors influencing infection rate in angle fractures. Ellis and Walker²⁴ have reported an overall infection rate of 15% with Champy's miniplate, while the infection rate with 3D plate has been 0–20%.^{12,14,15,20} In the present study, all our patients had surgical site oedema in the immediate post-operative period. None of them reported with local rise in temperature, erythema with pus discharge which required incision and drainage or plate removal. Mild swelling however persisted in 1 patient which could be due to greater dissection required for placing 3D plates. This may also be the reason why a higher incidence of wound dehiscence was in our patients [33.3% (n = 5)]. This is significantly higher than 0–20% reported in literature.^{11,21} However, a decrease in the incidence of mucosal dehiscence was seen in the latter cases which points out the learning curve associated with this new technique.

The incidence of post-injury paraesthesia has been linked to degree of displacement of the fracture site.¹² Fracture displacement was seen in 70% of our cases with 53.3% of patients reporting with post-injury/pre-treatment inferior alveolar nerve paraesthesia. Thurmüller et al.²⁵ in their review reported a wide incidence (5.7–58%) of post-injury/pre-treatment paraesthesia while the incidence of persistence sensory deficit was between 0.9 and 66.7%. Post-operative inferior alveolar nerve paraesthesia was found in 1 patient (6.7%). A range of 0–40% post-operative sensory deficit has been reported with the use of 3D plate.^{11,17} Important to note is that though it has a larger dimension requiring greater number of screws, a higher incidence of nerve paraesthesia has not been seen with this technique.

Opening up of the fracture at the lower border with some displacement of the fragments has been a case against Champy's miniplate osteosynthesis. This feature though not significant clinically, supports the fact that these plates are not as efficient biomechanically. A single miniplate does not bear the torsional forces and act as a fulcrum for rotation along the long axis of the mandible. This inferior border gaping however is seen to resolve by the end of 6 weeks.²⁴ Following fixation with 3D plate, no evidence of inferior border gaping and medio-lateral flaring was present in any case. Biomechanical in vitro studies have supported that 3D plates by and large withstand all types of forces the fractured mandible is subjected to, due to their optimal design.⁸ Their properties are similar to that of 2 miniplates and hence are highly recommended over the standard Champy's miniplate modality. However, in the actual clinical scenario, good recovery and fracture healing are also seen with single miniplate application.¹ Reduced bite forces in the recovery phase can be one of the reasons. Also, the fracture gap is not straight as in the in vitro studies. Fracture lines in the actual clinical situations have small interdentations that reduce the stress on the osteosynthesis material. Thus, it may be assumed that the load on the plate is lower than that computed by in vitro studies for the most-unfavourable situation.¹

A recent meta-analysis of the use of 3D plates in angle fractures has suggested that 3D plates are associated with lower complication rates as compared to standard miniplate fixation. With only a few studies in literature, it has been found that 3D plates might reduce patient morbidity while easing technical difficulties in the management of mandibular angle fractures.¹¹ Our experience, within the limits of small sample size and lack of comparison, also suggests 3D plates to be an equally suitable technique with low complication rates and good initial stability after open reduction and internal fixation of non-communited angle fractures.

There are some disadvantages associated with 3D plates. The use of transbuccal trocar system is required for placing these plates.^{15,20} The disadvantage of the trocar system lies in the need for small but extra-oral stab incisions which can be completely avoided while placing a single miniplate. Höfer et al.¹⁵ have suggested the use of right angled screw driver for this purpose, but it requires some training for routine practice.

Conflicts of interest

The authors have none to declare.

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