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Comparative evaluation of 2.3 mm locking plate system vs conventional 2.0 mm non locking plate system for mandibular condyle fracture fixation: a seven year retrospective study

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Abstract. – OBJECTIVE: This retrospective study evaluated the efficacy of a 2.3 mm locking plate/screw system compared with a 2.0-mm non-locking plate/screw system in fixation of isolated non comminuted mandibular condyle fractures.

PATIENTS AND METHODS: Surgical records of 101 patients who received either a 2.3 mm locking plate (group A, n = 51) or 2.0 mm non locking plate (group B, n = 50) were analyzed. All patients were followed up to a minimum of 6 months postoperatively and evaluated for hardware related complications, occlusal stability, need for and duration of MMF and mandibular functional results.

RESULTS: Four complications occurred in the locking group and eighteen in the non locking group with complication rates equalling 8% and 36% respectively. When comparing the overall results according to plates used, the χ^2 test showed a statistically significant difference between the locking and non locking plates ($p < 0.001$). Fewer patients required postoperative MMF in group A.

CONCLUSIONS: Mandibular condyle fractures treated with a 2.3 mm locking plate exhibited stable osteosynthesis, were associated with minimal complications and resulted in acceptable mandibular range of motion compared with a 2.0 mm non locking plate.

Key Words:
Condylar fracture, Rigid fixation, Open reduction, Locking miniplates.

Introduction

Mandibular condyle fractures frequently result from scuffles, sports and traffic accidents, with definite geographic differences[1]. It is reported that 9 to 45% of mandibular fractures are observed at the condylar process[1]. When it comes to treating fractures of the mandible, the condyle is the surgically most demanding location. Although the conservative versus the operative approach in treating mandibular condyle fractures is still controversial, in general, the operative treatment proves to be the superior option[2,3].

Surgical approaches to the mandibular condyle that have been reported in literature are the intraoral endoscopic approach[4] and the extra oral approaches[5] including postauricular, preauricular, submandibular and retromandibular approaches. The open reduction and rigid internal fixation of displaced or dislocated mandibular condylar fractures became more prevalent because it provides better reduction, gives adequate stability to the fracture, facilitates rapid fracture healing, allows early restoration of function, and avoids prolonged intermaxillary fixation. Studies have shown that open reduction and rigid internal fixation of isolated unilateral condylar fractures provides similar or better functional outcome when compared with closed treatment[6].

Miniplate osteosynthesis can be classified into two groups: non locking and locking systems. The stability of conventional bone plating systems is achieved when the head of the screw compresses the fixation plate to the bone as the screw is tightened. Over time, the cortex of bone adjacent to the plate resorbs[7]. If the plate is not contoured precisely and is not in intimate contact with the bone or if the host is compromised (medically or nutritionally), the result will be unstable fixation[7]. To overcome this shortcoming, a screw which locks not only to the bone but to the bone plate was developed. The result is a locking plate system which in effect acts as a mini-internal fixator. Since the plate locks to the screw

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rather than gaining its rigidity by being compressed against the bone, it also avoids the cortical necrosis which is sometimes seen under a plate which is compressed against the bone [8] A critical theoretical advantage of locking screws is the decreased potential of screw loosening which can promote infection[8].

The purpose of this study was to compare results after open reduction and internal fixation of isolated unilateral condylar fractures with a single 2.3 mm locking miniplate/screws or 2.0 mm standard miniplate/screws with regards to occlusal stability, hardware related complications and mandibular functional results.

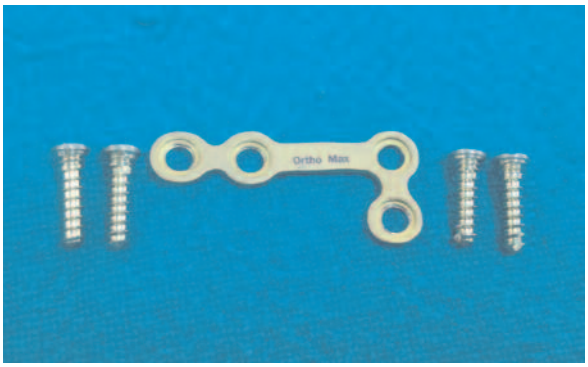

Figure 1. 2.3 mm locking miniplate and screw.s

Patients and Methods

An Internal Review Board (IRB) approved the study. All patients had signed written informed consent. A retrospective study of the period from January 2007 to December 2013 was designed. Inclusion criteria were patients with isolated unilateral condyle fractures, patients aged between 18 to 60 years, no concomitant mandible or midface fracture, a dentition complete enough to apply stable Erich arch bars and a follow up period of at least 6 months. Exclusion criteria were pregnancy, other facial fractures (especially Le Fort), comminuted fractures, coma, poly trauma, mental incapacity, impossibility of follow-up and age less than 18 years. A total of 110 patients were treated for unilateral condyle fractures during the study period. 101 patients who met the inclusion criteria were included in this study. Fifty one patients were treated by open reduction and internal fixation using a single L-shaped 2.3 mm locking miniplate (Orthomax Ltd, Baroda, Gujarat, India) and four 8 mm length screws (Group A) (Figure 1) and fifty patients using one L-shaped 2.0 mm non locking miniplate (Orthomax Ltd, Baroda, Gujarat, India) and four 8 mm length screws (Group B). All cases were evaluated clinically and radiographically using orthopantomographs (Figure 2). The fractures were divided based on the degree of fracture displacement as undisplaced, displaced and dislocated. All patients received intravenous antibiotics from the time of admission until discharge. Oral antibiotics were prescribed for a week upon discharge. In all patients occlusion was established with temporary maxillomandibular fixation (MMF) using upper

Figure 2. Preoperative orthopantomograph showing a left subcondylar fracture.

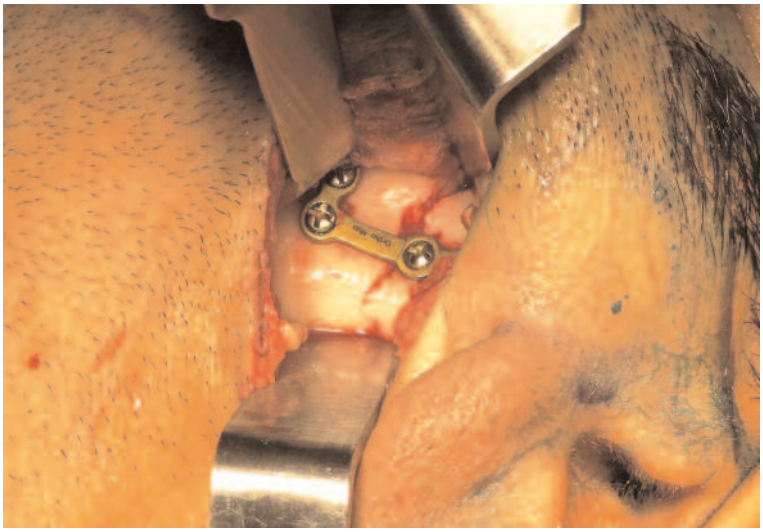

Figure 3. Locking miniplate in position at a left subcondylar fracture.

and lower Erich arch bars. The surgical technique included a retro mandibular transparotid approach to the fractured condyle. The technique used to apply both plating systems was the same, except that a locking drill guide was used with the locking plates (Figure 3). All patients were treated under general anesthesia with nasotracheal intubation by two surgeons. Post operatively, occlusal discrepancies, need for MMF and its duration, screw loosening/plate fracture and mandibular functions were analyzed. Facial nerve damage was recorded using the House Brackman Grading System (Table I). Post operative orthopantomographs were analyzed by an independent investigator not involved in the surgical treatment of cases, to analyze anatomic fracture reduction (Figure 4). All arch bars were removed 4 weeks postoperatively. Patients were advised to take liquid diet for 2 days and thereafter on a soft diet for 2 weeks. Postoperative clinical checks were made postoperatively on the 1st, 3rd, 7th postoperative days and at 1, 2, 3 and 6 months.

Statistical Analysis

Results were statistically evaluated with the Chi square test (χ^2) test. $p < 0.05$ was considered ststistically significant.

Results

One hundred one patients who met the inclusion criteria for the study were included. Group A (n=51, locking plate group) included 32 male and 19 females, Group B (n=50, non locking plate group) included 34 male and 16 females. Average age was 35.4 (18-56 years) in Group A and 37.3 (19-60 years) in Group B. Group A included 33 right and 18 left condyle fractures while Group B included 34 right and 16 left condyle fractures. Group A included 10 undisplaced, 25 displaced and 16 dislocated fractures while Group B included 12 undisplaced, 24 displaced and 14 dislocated fractures. The fractures were treated ranging from 1 to 3 days with a mean of 1.6 days from the time of injury.

Postoperatively, 2 patients in group A presented mild occlusal derangement. Both of these patients had a dislocated fracture. Both patients returned to normal occlusion following application of guiding rubber elastics secured to Erich arch bars for a week. No patient in group A presented with postoperative gross occlusal derangement or plate fracture/screw loosening. Two patients experienced facial nerve damage with 1 demonstrating a House Brackman Grade III injury and 1 with a House Brackman Grade IV injury. Both patients demonstrated complete motor recovery by 3 months postoperatively. No patient developed parotid fistulae. In group B, 5 patients had mild occlusal derangement (2 with fracture displacement and 3 with fracture dislocation) while 8 patients (3 with fracture displacement and 5 with fracture dislocation) had gross occlusal derangement. Guiding elastics were utilized for 1 week in the mild occlusal derangement patients

Table I. House brackman grading system.

Grade	Description	Characteristics
I	Normal	Normal facial function in all nerve branches
II	Slight	Gross: Slight weakness on close inspection, slight synkinesis. At rest: Normal tone & symmetry. Motion: Forehead: Good to moderate movement. Eye: Complete closure with minimum effort. Mouth: Slight asymmetry.
III	Moderate	Gross: Obvious but not disfiguring facial asymmetry. Synkinesis is noticeable but not severe. May have hemi-facial spasm or contracture. At rest: Normal tone & symmetry. Motion: Forehead: Slight to moderate movement. Eye: Complete closure with effort. Mouth: Slight weakness with maximum effort.
IV	Moderately Severe	Gross: Asymmetry is disfiguring and/or obvious facial weakness. At rest: Normal tone & symmetry. Motion: Forehead: No movement. Eye: Incomplete eye closure. Mouth: Asymmetrical with maximum effort.
V	Severe	Gross: Only slight, barely noticeable, movement. At rest: Asymmetrical facial appearance. Motion: Forehead: No movement. Eye: Incomplete closure. Mouth: Slight movement.
VI	Total	No facial function

and MMF was performed for two weeks followed by guiding elastics for one week in patients with gross occlusal derangement. After four weeks all the patients had a functional occlusion. There were two cases of screw loosening and deviation of the reduced condylar segment. There was 1 case of parotid fistula in which responded to application of pressure dressing. Two patients experienced facial nerve injury with 1 demonstrating House Brackman Grade III and 1 House Brackman Grade IV injuries. Both patients had complete motor recovery within 3 months postoperatively. There was a statistically significant difference between group A and B with respect to occlusal stability and need and duration of MMF ($p = 0.004$ and $p = 0.007$ respectively) while there was no statistically significant difference between the two groups with regards to facial nerve injury or parotid fistulae ($p = 0.16$).

Anatomic reduction (as assessed by panoramic radiographs) was observed to be significant better in group A than group B, with contingency coefficient value of 0.417 and $p = 0.006$.

The overall complication rate in group A was 8% (4/51) and in group B was 36% (18/50). There was a statistically significant difference between the two groups ($p < 0.005$).

Discussion

The goal of rigid internal fixation of the fractured mandibular condyle is to eliminate the need for IMF, to achieve accurate anatomic reduction of the fracture segments, reduce the risk of postoperative displacement of the fractured segments while allowing an immediate return to func-

Figure 4. Six months postoperative radiograph of a left subcondylar fracture.

tion[9,10]. Research continues to focus on the number, size, shape and biomechanics of plate/screw systems to improve surgical outcomes.

In this study, the locking plates for fracture fixation at the mandibular condyle showed better stability after fixation when compared to non locking plates. This was evident from the number of cases that developed occlusal derangement and required an addition period of MMF post fixation (2 in Group A [4%] vs 13 in Group B [26%]). Similar findings were reported by Singh et al[11] in their study comparing locking to non locking miniplates in surgical treatment of mandibular fractures. These findings may be due to the fact that conventional miniplates demand accurate adaptation to the underlying bone to prevent alterations in the alignment of fractured segments and changes in occlusal relationship[12]. The locking plate/screw system is designed to allow the screw to lock into the plate by a second thread under the screw head, thereby acting as an internal fixator by locking the screw into the plate[12]. The result of this locking mechanism is that it becomes unnecessary to adapt the plate to the underlying bone making plate adaptation easier leading to lesser alterations in alignment of fracture segments and changes in occlusal relationship upon screw tightening[12].

Kanno et al[13] reported no postoperative malocclusion following the use of two locking miniplates for fixation of mandibular condylar fractures in nineteen patients. In our study, occlusal disturbances were noted in 7% cases in the locking plate group and 27% cases in the non locking plate group. These findings were particularly true in cases of severe fracture displacement, indicating that the greater rigidity provided by locking plate/screws was a definitive advantage.

Anatomic reduction of fracture segments, as assessed by orthopantomographs, was significantly superior in the locking plate group (p = 0.004). This may be a result of the different fixation method. When using conventional miniplates, it is essential to contour the plate precisely to the bone surface. Otherwise incongruence between the bone surface and plate will be transferred to the mobile bone fragments during tightening of screws resulting in more extended gaps and torsion leading to primary loss of reduction. If the locking plate is fixed with locking screws, reduction remains nearly unchanged[7].

Two patients in group B were observed to have screw loosening while none was observed in group A. This may be a result of the fact that in conventional miniplate system fixation is provided by the screw thread inserted into the bone, creating a friction lock between the plate and the bone which is essential to achieve stability after the reduction. Torsional forces between the bony fragments may lead to a loss of this friction lock and result in reduced primary stability. Cordey et al[14] state that the friction between the screw head and plate is the main weak point of the entire fixation. In the 2.0 locking system the thread on the screw head locks into the congruent thread of the

plate, transforming the screws and plate into a unit, creating a rigid splint with higher mechanical stability. This corresponds to the principle of an external fixator[7]. Seemann R et al[15], in a prospective randomized study, reported that screw loosening was exclusive seen in the non locking plates used for condylar fixation. They observed two plate fractures in the locking plate group (2/72) and one in the non locking group (1/74). We did not find any plate fracture in our study.

Paresthesia was noted in 2 patients (7%) in group A and 1 (3%) patients in group B. This may a result of the need for greater tissue retraction in group A to accommodate the drill guide and subsequent placement of perpendicular screws.

Wagner et al[13] performed a 3-dimensional finite element analysis investigating the biomechanical behaviour of the mandible and plate osteosynthesis in cases of fractures of the condylar process. They concluded that the stiffness of a singular osteosynthesis plate made of titanium in a diametrical dimension of approximately 5.0 x 1.75 mm was equivalent to the physiological bone stiffness in the investigated fracture sites. The actual stiffness of such a fixation plate is approximately 3 times higher than the stiffness of devices commonly in use. The increased calibre of a 2.3 mm miniplate compared to that of a conventional miniplate was observed to provide effective stabilization of the fracture fragments in our study.

Poon and Verco[16] showed on sheep models that locking plates/screws demonstrated superior fracture union at 8 weeks than conventional miniplates. Locking plates/screws do not need a friction lock between the plate and bone for stability, thereby transmitted reduced pressure on the underlying bone than conventional miniplates. Less disturbance of perfusion of the underlying bone with decreased bone necrosis is the result, which might lead to increased bone healing and regeneration[7].

Wagner et al[13] recommended the use of two conventional miniplates in parallel orientation with bicortical screws for fixation at the condylar fracture site. Our study demonstrates that a single 2.3 mm locking miniplate with monocortical screws are sufficient for the purpose. Cost issues also need to be considered when evaluating the utility of locking versus non locking hardware. Locking plate/screw system is likely to cost between 1.5 to 2 times that of the non locking system[17]. However, it is likely that the cost differential would be completely offset and justified considering the additional treatment costs incurred in treating the complications with a single non locking plate seen in group B.

Conclusions

The current study demonstrated that use of 2.3 mm locking miniplate/screw system resulted in a lower incidence of complications and provided better stability of fracture fixation in isolated mandibular condyle fractures when compared with the conventional 2.0 mm non locking miniplate/screw system.

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Conflict of Interest

The Authors declare that they have no conflict of interests.

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