Evaluation of using microplates osteosynthesis for pediatric mandibular fractures

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Abstract

Objective: The purpose of this study was to evaluate both clinically and radiographically using of two microplates in treatment of displaced pediatric mandibular fractures.

Materials & methods: This study included ten children had displaced mandibular fracture with age ranged between (4—11) years were treated using two microplates and microscrews through intraoral approach. All children were examined preoperative clinically and radiographically by panoramic view and computed tomography (CT) or lower occlusal view. All children were evaluated postoperative clinically at one week, one and three months for wound healing, occlusion, infection, nerve affection and stability of fracture and radiographically by panoramic view at second postoperative day, one and three months and by quantitative CT at one and three months to evaluate the accuracy of reduction and bone healing at fracture line.

Results: Clinically there were no complications in all cases overall follow up period except for two cases showing occlusal discrepancy treated with guiding elastics. Radiographic results showed that good alignment of fracture segments horizontally and vertically without displacement and significant increase in bone mineral density gain after one and three months.

Conclusion: Titanium microplates provide adequate stability for fracture segments in treatment of pediatric mandibular fracture. Low profile and malleability of microplates allow adaptation to mandible easily and minimize the possibility of trauma to teeth buds.

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Keywords: Pediatric; Mandibular fracture; Titanium microplates

1. Introduction

Excluding the nasal bones, the mandible is the most frequently fractured facial bone in the pediatric patient. One third of pediatric trauma patients with facial fractures have a mandibular fracture [1,2].

Less than 15% of all facial fractures occur in the pediatric population. They are very rare below the age of five (0.6—1.4). The incidence rises as children begin school and peaks during puberty and adolescence, with increased unsupervised physical activity and sports [3].

Boys are more commonly affected than girls in all age groups. The male predilection has been attributed to more dangerous physical activities among boys [4].

When planning treatment for fractures in children, the choice of therapeutic option depends on the
inherent characteristics of the fracture, the complexity, the patient age, the state of dental development and the associated injuries. Furthermore, one should consider other factors like the smaller size of the mandible in relation to the elasticity of the bone, possible injury in the mandibular condylar of the growth center, great osteogenic potential and rapid healing rates observed in these patients [5].

Pediatric mandibular fractures are treated by a wide variety of fixation methods such as acrylic splint with circummandibular wiring, intermaxillary fixation (IMF), transosseous wiring and internal fixation. Displaced fractures are better served by open reduction and internal fixation [6].

The primary and early mixed dentitions have numerous anatomic challenges associated with placement of IMF devices. The crowns of the teeth are short, squatty, and bulbous, and can be loose. In addition, replacement of teeth as a normal process of the succedaneous dentition leads to edentulous areas awaiting full eruption [7].

Later open reduction and rigid internal fixation (ORIF) has become the standard of care for management of displaced fractures. ORIF provides stable three-dimensional reconstruction, promotes primary bone healing, shortens treatment time and eliminates the need for or permits early release of IMF [8].

Microsystem for internal fixation of maxillofacial fractures was introduced because of a growing demand for smaller systems and the improved technical ability to produce them [9]. Microdimensioned osteosynthesis plates have the advantage that they can anatomically fix small bone pieces, which was not possible with the earlier wiring techniques or the larger miniplate systems [10].

These smaller plating systems could only be used where torsional forces from muscles of mastication would not disrupt the reduction [11]. Hardt and Gottsauner [12] stated that microplates are often sufficient in children because of lesser torsional force applied on broken segments in children.

Microplate technique is performed with minimal effort, more convenient access and less stripping of surrounding periosteum. Their low profile and tiny screws decrease the chance of neurovascular injury so less postoperative paresthesia and possible damage to adjacent teeth [13]. They also decrease the interference with current imaging modalities such as radiography, magnetic resonance imaging or computed axial tomography [14].

The objective of this study was to evaluate using two titanium microplates in fixation of displaced pediatric mandibular fractures both clinically and radiographically.

2. Patients and methods

This study included ten children with displaced mandibular fracture. They were all males, their ages ranged from 4 to 11 years with a mean age of 7 years, (Table 1). The patients were selected from the Out-Patient Clinic of Oral and Maxillofacial Surgery Department, Faculty of Dentistry, Tanta University.

Five cases had displaced parasympophysial fractures case no. (1, 2, 3, 6 and 9) three cases had displaced body fractures case no. (5, 7 and 8) and two cases had displaced symphysial fractures case no. (4 and 10). All cases were treated using two 0.6 mm thickness titanium microplates\(^1\) and 1.5 mm diameter center drive screws (4–7 mm) in length using a drill 1.1 mm in diameter.

Fracture of condyle and non displaced fracture were treated conservatively in all cases.

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\(^1\) KLS Martin co., Tuttlingen, Fedral Republic of Germany.
All children were examined clinically by inspection and palpation both extraorally and intraorally for clinical features of mandibular fractures such as swelling, pain, displacement, malocclusion and sensory deficits Fig. 1.

Radiographic examination was done by standard panoramic view and computed tomography (CT) for each patient at the time of presentation to detect vertically or horizontally displaced fracture Figs. 2 and 3.

The surgical technique was performed under general anesthesia via nasotracheal intubation. Arch bars were applied to upper and lower teeth. The fracture was approached through intraoral vestibular incision. The mucoperiostal flap was elevated to expose the fracture line, granulation tissues removed if found and the original occlusion was re-established. The mandible was placed on maxillomandibular fixation Fig. 4. The fracture line was fixed using two 0.6 mm thickness titanium microplates and center drive screws with 4–7 mm in length and 1.5 mm in diameter. The first plate was adapted to the bulky inferior mandibular border and the second plate was adapted between the first one and apices of the lower teeth. The plates were secured in place with 2–3 monocortical screws tightened in each fragment Fig. 5.

The tie wire of maxillomandibular fixation was removed immediately after fixation of the fracture, stability of the fracture site was checked by manual testing. The occlusion was checked to be certain that the relation between the upper and lower teeth in good relation passively.
Clinical evaluation were done for all children postoperatively for wound healing, occlusion, union and stability of fracture, infection and nerve affection after one week, one and three months following operation.

For radiographic evaluation, Standard panoramic radiograph were done for all children at the second postoperative day, one and three months to evaluate the accuracy of reduction of the segments. Quantitative computed tomography (CT) were done to detect the amount of bone mineral density gain at the fracture line to evaluate the bone healing after one and three months.

3. Results

Clinically primary wound healing was achieved uneventfully in all children without any signs of dehiscence or infection.

All children had good alignment and proper occlusion without any discrepancy post-operative as Fig. 6. Except two cases (Case No. 1 & No. 8) showed occlusal disturbance in the second postoperative day. The patients were treated by IMF using guiding elastics until proper occlusion obtained after one week.

All cases showed initial stability of fracture segments bimanually intra-operative which increased all-over follow up periods after one week, one and three months.

Radiographic results, the second post-operative day panoramic radiograph showed accurate reduction and excellent vertical alignment of the fracture segments in all cases Fig. 7.

Radiographic examination after one month post-operatively revealed no change in the position of the fractured segments or plates and the fracture line still easily detected until the first month post-operatively.

After three months, the radiographic examination revealed that the fracture line could be hardly detected Fig. 8.

Quantitative computed tomography (CT) showed proper horizontal alignment of fracture segments after one and three months Fig. 9.

The mean of bone mineral density after one month was ±384.200 which increased significantly to ±631.400 after three months which indicated good healing of bone at the fracture segments as shown in Table 2, Fig. 10.
that bone is mobile and therefore has less bone support than the bones of the middle third.

The low profile of microplates allows them to overcome the problems of miniplates as palpability and thermal conductivity [16]. According to Feller et al. [17] microplates decrease the chance of injury to dental roots and neurovascular bundle which cause paresthesia especially in the region of mental foramen where limited space is available.

Titanium microplates have far better mechanical properties than resorbable plates and small dimension at the same time [18]. The economic factor was also one of the advantages of microplates compared with resorbable plates [19].

The risk of facial growth disturbance in ORIF has not been supported [2]. Especially that the mandible is a membranous bone which growth is done by two mechanisms; cartilaginous tissue which undergo of a secondary calcification (condylar growth centre for instance) and forces developed by facial muscles like masticator muscles so the growth of the mandible depends on dental occlusion obtained by the traction realized by muscles [20].

In a clinical study of 92 children with mandibular fractures, Hardt and Gottsauner [12] found no growth disturbance caused by miniplates or surgical procedures for reduction and fixation on the treated side when miniplates were removed after osseous union.

![Fig. 8. Three months postoperative panoramic photograph showing that the fracture line is hardly detected (Case No. 4).](image1)

![Fig. 9. Three month postoperative axial (CT) showing bone mineral density gain at the fracture line and fracture segments properly reduced horizontally (Case No. 4).](image2)

### Table 2

<table>
<thead>
<tr>
<th>Bone mineral density</th>
<th>Range</th>
<th>Mean ± SD</th>
<th>Mean ± SD</th>
<th>Paired t-test</th>
</tr>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Difference</td>
</tr>
<tr>
<td>After 1 month</td>
<td>265.000 ± 514.000</td>
<td>384.200 ± 84.080</td>
<td>−247.200 ± 63.713</td>
<td>−12.269 &lt;0.001*</td>
</tr>
<tr>
<td>After 3 months</td>
<td>432.000 ± 784.000</td>
<td>631.400 ± 108.894</td>
<td></td>
<td></td>
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</tbody>
</table>

Significant.
In our study, we found that boys had a greater likelihood of suffering fractures than girls because of their activities which was in agreement with the studies done by Zachariades et al. [21] and Posnick et al. [8]. Traffic accidents and falls were the main causes of fractured mandible in children involved in our study and this agreed with the studies of Seiji and Tokuzo [22] and Abdullah [23].

We used two microplates so that the torsional forces from muscles of mastication would not disrupt the reduction. This is in agreement with Khalil [24] who used three dimensional microplate in all sites of pediatric mandibular fractures. We chose the plates with thickness 0.6 mm and length of screws ranged from (4–7 mm) according to the child’s age, development and the presence of tooth germ and this in agreement with Pape et al. [25], Bauman et al. [26] and Zimmermann et al. [27].

The application of microplates in our study was done with minimal effort due to its malleability so it was easily adapted to the bone, there were no cases of palpability or postoperative paresthesia and this is according to Haug and Morgan [13]. The risk of potential damage to tooth roots and follicles in our study might be minimized with a careful technique which places short monocortical screws especially in superior plate and as possible away from teeth buds and this is according to Davison et al. [28] and Nixon and Lowey [29].

In this study, primary wound healing was achieved in most of children. This incidence may be due to application of the plates via an intraoral approach, where intraoral incision limits the amount of disruption of peristemeum resulting in improved vascularity to the surgical site which promotes healing and decrease the chance of post-operative complication. This is in accordance with findings of Shetty et al. [30] and Ellis and Walker [31].

Panoramic radiographic examination of children showed perfectly aligned fracture segments vertically without resorption or rarefaction around plates and after three months the fracture line was hardly detection. This was explained by Montry and William [32] who stated that the function on the fractured parts plays a significant role in healing process. Quantitative (CT) showed proper alignment of fracture segments horizontally and significant increase in bone mineral density gain. This is because of the ability of microplates to provide sufficient stability horizontally and vertically for primary bone healing in pediatric mandibular fracture as reported by Khalil [24]. Also according to Abdullah [23] who found no displacement in any of follow up intervals either in panoramic radiograph or in CT scan investigations.

All cases of our study achieved initial stability of fracture segments intra-operative and allover different follow up period, this is proved that the mechanical properties of titanium microplates were enough to produce stability in pediatric mandibular fractures; this is also may be due to that the strength of musculature of children is less than adults. According to Davison et al. [28] the pediatric mandible is fairly malleable, fractures tend to be less displaced and more bone growth expected, absolute compression of the fracture edges together is not necessary.

The results of microplates in this study were promising as they provide adequate stability of fracture segments with minimal complication and at the same time microplates had low profile and enough rigidity which suitable for mandibular fracture in children and this is in agreement with Abdulla [23], Khalil [24] and Bos [18].

5. Conclusion

Titanium microplates provide adequate stability in treatment of pediatric displaced mandibular fracture either horizontally or vertically besides the mechanical properties of titanium microplates is adequate and small dimensions at the same time which suitable to children’s anatomy. The small profile of microplates and monocortical screws might minimize the possibility of injury of teeth buds especially with using careful technique.

References