Original Investigation

Causes and Treatment of Mandibular and Condylar Fractures in Children and Adolescents
A Review of 104 Cases

Jun Shi, MD; Zhibiao Chen, MD; Bing Xu, DDS

IMPORTANCE There are no uniform treatments, standards, and specifications for conservative and surgical management of mandibular fractures in children and adolescents.

OBJECTIVE To review the management of mandibular fractures in children and adolescents at our institution.

DESIGN, SETTING, AND PARTICIPANTS The medical records of 104 children and adolescents (60 male and 44 female) treated for mandibular fractures from 2005 to 2012 at the Ninth People’s Hospital, Shanghai, China, were retrospectively reviewed. The participants were classified as having deciduous dentition (age ≤ 6 years), mixed dentition (age >6 but <12 years), and permanent dentition (age ≥12 but ≤16 years).

INTERVENTIONS Conservative treatment and surgical management.

MAIN OUTCOMES AND MEASURES Helkimo clinical dysfunction and anamnestic indices.

RESULTS Condylar process fractures accounted for 55.7% of the fractures (112 fractures of 201 total fracture sites), and symphysis fractures, parasympysis fractures, fractures of the body, and fractures of the angle accounted for 20.9%, 11.9%, 7.0%, and 3.5% of the fractures, respectively. A total of 83 cases with 159 fracture sites with complete follow-up data were included in the treatment analysis. In these 83 patients, 77 fractures were dentigerous bone fractures, 46 were intracapsular fractures, and 36 were extracapsular fractures. Dentigerous bone fractures of the mandible were managed by closed or open reduction in children younger than 12 years and were managed more often by open reduction and fixation in those between ages 12 and 16 years. Closed treatment was performed for 22 condylar process fractures (28.6%), and open reduction was carried out for 55 condylar process fractures (71.4%). In patients with intracapsular fractures, there was no significant relationship between dentation age and treatment method (P = .06). Most patients with extracapsular fractures with permanent dentition underwent surgical fixation (73.3%), whereas most with deciduous dentition received conservative treatment (87.5%). In patients with condylar process fractures, there was no significant difference in Ai and Di based on treatment method (P = .49 and P = .76, respectively).

CONCLUSIONS AND RELEVANCE The treatment of mandibular fractures in children and adolescents should be determined by clinical factors including age, location, and type of fracture.
Children and adolescents possess unique anatomical structures and physiological functions, and the treatment of mandibular fractures is not the same as treatment in adults.1-4 There are currently 2 views of the treatment of mandibular fractures in children and adolescents, conservative and surgical management.5-7 Conservative treatment methods include a head cap, chin cup, arch splint, mandibular brace, and diet control. Open reduction and internal fixation (ORIF) can quickly restore the anatomy to the preinjury status but requires a surgical incision as well as mandibular drilling and implantation of filling materials and can damage tooth germ cells. Both conservative and surgical treatment of mandibular fractures in children and adolescents can be successful.5-7 However, because of different developmental stages of children and adolescents, there are no uniform treatments, standards, and specifications.5,8-10 The purpose of this study was to review the clinical characteristics and management of children and adolescents treated for mandibular fractures at our hospital from 2005 to 2012.

Methods

This study was approved by the internal review board of the Ninth People’s Hospital, Shanghai Jiao Tong University School of Medicine, and because of the retrospective nature of this study, the requirement of informed consent was waived. The medical records of patients treated for mandibular fractures at the Department of Craniofacial Science, Shanghai Ninth People’s Hospital, School of Dentistry, Shanghai Jiao Tong University, between 2005 and 2012 were retrospectively reviewed. Exclusion criteria were (1) congenital dysplasia, (2) history of temporomandibular joint (TMJ) disease or surgery of the temporomandibular joint, (3) associated injuries that prevented direct management of the mandibular fracture, (4) treatment more than 4 weeks after the initial injury, (5) pathological fractures due to malignancy or other diseases, and (6) incomplete records.

Dentition was defined as follows: deciduous dentition (patients aged ≤6 years); mixed dentition (patients aged >6 years but ≤12 years); and permanent dentition (patients aged >12 years but ≤16 years).5,10 Conservative or surgical management was carried out based on the patient’s age and the site, type, and severity of the fracture. Conservative treatment included interdental wire fixation, intermaxillary fixation using arch bars, fixation using orthodontic brackets, and circummandibular wire fixation. Surgical management was defined as open fracture reduction and subsequent external fixation, internal fixation, or biodegradable material fixation. Management was carried out at the discretion of the attending physician. There was no formal treatment protocol or decision tree for the management of mandibular fractures in place at our institution during the study period.

Postoperative outcomes of different treatment methods were compared by investigating the degree of mouth opening, morphological features of mouth opening, occlusal relationship, masticatory force, presence of lower lip numbness, presence of facial nerve injury, patient satisfaction with treatment outcome, and examining the TMJ for patients with condylar process fractures. Postoperative imaging studies were examined to determine condylar morphological change.

Functional evaluation was performed using the Helkimo clinical dysfunction (Di) and anamnestic (Ai) indices, which are commonly used for the classification of TMJ dysfunction.11 The Helkimo Ai classifies TMJ dysfunction according to subjective symptoms, and the Di classifies TMJ dysfunction by clinical findings of impaired range of movement, impaired TMJ function, muscle pain, TMJ pain, and pain on movement of mandible. Briefly, the Ai score was obtained by history review and was divided into the following 3 grades: Ai 0, symptomless; Ai I, mild symptoms (ie, there are ≥1 of the following symptoms: joint noise, muscle fatigue, and/or stiffness in the morning and during the exercise); and Ai II, severe symptoms (ie, there are ≥1 of the following symptoms: limitation of mouth opening, joint locking, dislocation, motion-induced mandibular pain, and/or pain in the TMJ or masticatory muscle). For the Di clinical examination, 5 signs of movement were assessed: under the edge of the lower jaw movement, joint dysfunction, muscle tenderness, joint tenderness, and jaw pain. Each sign was evaluated separately and assigned a score ranging from 0 to 5. The sum of the scores for all 5 signs were recorded as Di grades: 0 = Di 0; 1 to 4 = Di I; 5 to 9 = Di II; and 10 to 25 = Di III (Di 0 indicated normal function, and Di III, worse function).11

According to the classification in the study by Loukota et al,12 intracapsular fractures were categorized into 3 types (A, B, and M) according to the location of the fracture line: A type, fracture line through the medial condyle, ramus height unchanged; B type, condylar fracture line through the lateral condyle, ramus height reduced significantly; and M type, condylar head showed a fracture.

As we treated each fracture site independently, categorical variables were compared using the Fisher exact test, and data are represented as number and percentage. Statistical analyses were performed using SPSS 15.0 software (SPSS Inc).

Results

Between 2005 and 2012, 104 children and adolescents (60 male and 44 female) with mandibular fractures were seen at our institution. Condylar process fractures accounted for 55.7% of the fractures (112 fractures of 201 total fracture sites), and symphysses fractures, parasympyseal fractures, fractures of the body, and fractures of the angle accounted for 29.9% (42 sites), 11.9% (24 sites), 7.0% (14 sites), and 3.5% (7 sites) of the fractures, respectively. Only 2 cases had fractures in the mandibular ramus. A summary of the patient data is given in Table 1.

Among 104 cases, 21 cases were excluded from the treatment analysis because of insufficient imaging data or they were lost to follow-up. Thus, 83 cases with 159 fracture sites were included in the treatment analysis. In these 83 patients, 77 fractures were dentigerous bone fractures, 46 were intracapsular fractures, and 36 were extracapsular fractures (Table 2). Den- tigero us bone fractures of the mandible were managed by closed or open reduction in children younger than 12 years and
were managed more often by open reduction and fixation in those aged 12 to 16 years. Closed treatment was performed for 22 condylar process fractures (28.6%), and open reduction was carried out for 55 condylar process fractures (71.4%). In patients with intracapsular fractures, there was no significant relationship between dentation age and treatment method \((P = .06)\). However, in patients with extracapsular fractures, there was significant relationship between dentation age and treatment method \((P = .02)\). Most patients with extracapsular fractures with permanent dentition underwent surgical fixation (73.3%), whereas most patients with deciduous dentition underwent conservative treatment (87.5%) (Table 2).

The follow-up duration ranged from 3 months to 6 years, and the overall patient satisfaction rate was 96.4%. Six patients had deviation of mandibular movement, and all of them had condylar fractures. Clicking in the TMJ was noted at 2 sites and pain in 3 sites; however, there was no significant difference between the conservative treatment group and the surgery group. Comparison of treatment methods for the patients with condylar process fractures showed that there was no significant difference in \(A_i\) and \(D_i\) based on treatment method \((P = .49\) and \(P = .76\), respectively; Table 3). Further comparison of treatment methods for the patients with type B intracapsular fractures showed that there was no significant difference in \(A_i\) and \(D_i\) between treatment methods \((P = .61\) and \(P > .99\); Table 3).

Facial asymmetry was observed in 5 patients—3 with both condylar process fractures and symphysis fractures and 2 with fractures involving dentary bone. Titanium plate loosening occurred in 1 patient who had a comminuted fracture in the body of the mandible. Malunion was observed in 1 patient with a fracture of the angle, and in this patient a biodegradable osteosynthesis plate had been used for fixation.

Morphological abnormalities were often observed after the treatment of condylar process fractures; follow-up computed tomography revealed that 32 sites (39.0%) had morphological abnormalities, which included flat and uneven condyles and condyle bending.

### Discussion

Results of this study indicated that falls were the main cause of mandibular fractures in children and adolescents. Dentigerous bone fractures of the mandible were managed by closed or open reduction in children younger than 12 years and were managed more often by open reduction and fixation in those aged 12 to 16 years. Comminuted fractures were managed surgically in all age groups. Intracapsular fractures were treated conservatively in patients younger than 12 years. After puberty, type B fractures were treated by ORIF; type A fractures, by conservative management; and type M fractures, according to the degree of comminution and the loss of vertical height of the ramus. For extracapsular fractures, ORIF was used for displaced, considerably displaced, and bilateral fractures.

#### Fractures Involving Dentary Bone

The presence of tooth germ often creates obstacles in selecting the fixation site.\(^2,3\) Many authors suggest performing closed reduction and not performing open reduction and placement of internal fixation devices to treat fractures involving dentary bone in children and adolescents.\(^1,13\) Other authors, however, believe that closed reduction and external fixation cannot provide sufficient retention force, and it may result in displacement of the fracture fragment and subsequent fracture malunion.\(^2,3,6,16,17\) Some authors suggest that no intermaxillary ligation or special treatment is needed for the non-displaced mandibular fractures involving dentary bone, and simple observation, limitation of motion, and diet control are sufficient.\(^1,2\) However, in our experience this is difficult in children because of poor compliance. We consider that patients with deciduous and mixed dentition with or without displacement of the mandibular fracture should undergo conservative treatment, while those in permanent dentition can undergo ORIF because there will be no effect on tooth germ.

#### Mandibular Angle Fractures

Mandibular angle fractures are rarely seen in children and adolescents.\(^2,3,14\) In the present study, the incidence of mandibular angle fractures was only 3.5%, and it mainly occurred in patients with permanent dentition. Because the mandibular angle is located in a high-stress region with many attached muscles, fracture displacement may not be observed. Dislocation of fracture fragments often cause occlusal disturbance and mandibular deviation.\(^5,7\) Because the fracture line is usually located behind the dentition, and tooth germ is not an obstacle, ORIF is most commonly used for this type of fracture with removal of a titanium plate 3 to 6 months after surgery.\(^5\)

### Table 1. Demographic Data of 104 Patients With Mandibular Fractures

<table>
<thead>
<tr>
<th>Demographic</th>
<th>Patients, No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>60 (57.7)</td>
</tr>
<tr>
<td>Female</td>
<td>44 (42.3)</td>
</tr>
<tr>
<td>Age group</td>
<td></td>
</tr>
<tr>
<td>Deciduous dentition</td>
<td>22 (21.2)</td>
</tr>
<tr>
<td>Mixed dentition</td>
<td>41 (39.4)</td>
</tr>
<tr>
<td>Permanent dentition</td>
<td>41 (39.4)</td>
</tr>
<tr>
<td>Cause of the mandibular fracture</td>
<td></td>
</tr>
<tr>
<td>Falls</td>
<td>49 (47.1)</td>
</tr>
<tr>
<td>Motor vehicle crashes</td>
<td>36 (34.6)</td>
</tr>
<tr>
<td>Bicycle</td>
<td>10 (9.6)</td>
</tr>
<tr>
<td>Sports</td>
<td>3 (2.9)</td>
</tr>
<tr>
<td>Violence</td>
<td>4 (3.8)</td>
</tr>
<tr>
<td>Others</td>
<td>2 (1.9)</td>
</tr>
<tr>
<td>No. of fractures</td>
<td>201</td>
</tr>
<tr>
<td>Site distribution</td>
<td></td>
</tr>
<tr>
<td>Symphysis</td>
<td>42 (20.9)</td>
</tr>
<tr>
<td>Parasympysis</td>
<td>24 (11.9)</td>
</tr>
<tr>
<td>Body</td>
<td>14 (7.0)</td>
</tr>
<tr>
<td>Angle</td>
<td>7 (3.5)</td>
</tr>
<tr>
<td>Ramus</td>
<td>2 (1.0)</td>
</tr>
<tr>
<td>Condyle</td>
<td>112 (55.7)</td>
</tr>
</tbody>
</table>
Condylar process fractures are the most common mandibular fracture in children and adolescents and account for approximately 56% of all the mandibular fractures in this age group. In children and adolescents, the condylar process has a high bone marrow and cartilage content, and the cortex is relatively thin; thus it is difficult to carry out rigid internal fixation. Also, the narrow condylar process limits operative exposure. The most appropriate management for condylar fractures in children and adolescents is controversial. Dysfunction of the TMJ is not uncommon after condylar fractures, and it is not known whether the condylar process will maintain normal joint function after conservative treatment.

Studies have shown that both surgical and conservative management can result in satisfactory outcomes for dislocated condylar process fractures in children and adolescents. However, many physicians prefer surgical treatment. We believe that surgical treatment is suitable for dislocated fractures or severely displaced fractures (for example, >55° of angulation), whereas conservative treatment should be carried out for fractures without displacement or with mild decrease of the ramus height. The self-reconstruction ability of the condylar process and the adaptability of the masticatory system make conservative treatment of the condylar process fracture possible. However, for patients with bilateral condylar process fractures, surgical treatment should be performed in 1 side or both sides owing to the relatively high rate of occlusal disorders after conservative treatment.

The findings of this study showed that the results of conservative treatment and open surgical treatment (as measured by the Ai and Di indices) for condylar fractures were not different. However, this finding may be due to treatment biases at our institution. When examined by fracture location,
of a total of 82 fractures, there were 46 intracapsular fractures and 36 extracapsular fractures. Of the intracapsular fractures, 12 were treated surgically (most were dislocated) and 34 were treated conservatively. Of the extracapsular fractures, 19 were treated surgically and 17 treated conservatively. When comparing intracapsular fractures with extracapsular fractures, in cases of primary dentition, conservative management was performed in 77.8% vs 87.5%, respectively; for permanent dentition, conservative management was performed in 55.6% vs 46.2%, respectively; and for mixed dentition, conservative management was performed in 89.5% vs 26.7%, respectively. We also divided intracapsular fractures into 3 types according to the Neff classification. Type B was most common and accounted for approximately 65% of intracapsular fractures. Decreased ramus height was often seen in the type B fractures, while no change of ramus height was observed in the type A fractures. There were varying degrees of height changes according to the degree of comminution in type M fractures. It is clear that childhood condylar fractures tend to be treated conservatively at our institution, and in this group of patients the final treatment results are satisfactory. When choosing the treatment methods for the intracapsular fractures, we suggest conservative treatment for children aged 10 to 12 years. For adolescents, we suggest ORIF for type B fractures and conservative management for type A fractures, while the selection of treatment methods should also take into account the degree of comminution and ramus height.

Limitations to this study include its retrospective nature and the relatively small number of cases. Furthermore, we did not evaluate treatment outcomes based on the number of fractures in individual patients.

Conclusions

On the basis of the results of this study, we believe that den- tigious bone fractures of the mandible are best managed by conservative treatment in patients younger than 12 years and by open reduction and fixation in those between ages 12 and 16 years; comminuted fractures are best managed surgically in all age groups. The results also suggest that intracapsular fractures of the condyle can be treated conservatively in pa- tients younger than 12 years. After puberty, type B fractures can be treated by ORIF; type A fractures, by conservative management; and type M fractures, according to the degree of comminution and the loss of vertical height of the ramus. For extracapsular fractures, ORIF is indicated for dislocated, considerably displaced, and bilateral fractures.

ARTICLE INFORMATION
Submitted for Publication: July 10, 2013; final revision received October 9, 2013; accepted November 13, 2013.


Author Contributions: Dr Shi had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design: Shi, Xu. Analysis and interpretation of data: Shi, Chen. Drafting of the manuscript: Shi, Chen. Critical revision of the manuscript for important intellectual content: Xu. Statistical analysis: Shi, Chen.

Conflict of Interest Disclosures: None reported.

REFERENCES