Clinical and radiological outcomes after treatment of sagittal fracture of mandibular condyle (SFMC) by using occlusal splint in children

Chang-Kui Liu a, Fan-Wen Meng b, Xin-Ying Tan a, Juan Xu a, Hua-Wei Liu a, San-Xia Liu a, Hai-Tao Huang a, Rong-Zeng Yan a, Min Hu a,*, Kai-Jin Hu c,‡

a Department of Stomatology, General Hospital of the PLA, Beijing 100853, China
b Department of Stomatology, 359th Hospital of the People’s Liberation Army, Zhenjiang 212001, China
c Department of Oral and Maxillofacial Surgery, School of Stomatology, The Fourth Military Medical University, Xi’an 710032, China

Accepted 23 October 2013
Available online 18 November 2013

Abstract

This study was designed to investigate the effects of occlusal splints in the treatment of sagittal fractures of the mandibular condyle in children. From January 1995 to December 2011, 37 sagittal fractures of the mandibular condyle in 30 patients aged 4–8 years old were included in this study. All the patients were treated with 1–2 mm occlusal splints in the molar region. The mouths of the patients were kept slightly open by the occlusal splints for 3–6 months, and we reviewed the clinical and radiological remodelling of the affected condyles after treatment. Excellent (n = 20) and good (n = 10) clinical outcomes were achieved with full radiological remodelling seen in 19 and partial remodelling in 11. Treatment with occlusal splints is effective in delivering good results and function with minimal morbidity in children with sagittal fractures of the condyle, while permitting ongoing remodelling and growth in the short term.

© 2013 The British Association of Oral and Maxillofacial Surgeons. Published by Elsevier Ltd. All rights reserved.

Keywords: Mandible; Sagittal fracture of mandibular condyle (SFMC); Occlusal splint; Children

Introduction

Sagittal fracture of the mandibular condyle is the most common injury in children and is complicated by ankylosis of the temporomandibular joint (TMJ) in 4–26% of cases.1–3 The fracture pattern is a fracture line that begins from the lateral pole of the condylar surface and runs to the medial side of the condylar neck.4 The current management of condylar fractures in children is non-surgical, and usually consists of 1–2 weeks of maxillomandibular fixation followed by elastics to bring the mandible into its habitual occlusion.5,6 Although there is excellent or good mandibular function in many cases, the condyles are not completely remodelled in most patients and late complications such as ankylosis, disturbances of facial growth, or functional disorders of the TMJ have occurred in some cases.2,3,6 We suggest that management may be improved by introducing the use of an occlusal splint to aid stabilisation and rehabilitation while minimising morbidity.

Materials and methods

Patients

From January 1995 to December 2011, 30 patients (18 boys and 12 girls aged 4–8 years old), with 37 sagittal fractures of
the mandibular condyle, were treated with occlusal splints. The fractures were diagnosed on clinical and radiographic examination, including orthopantomograms and helical computed tomography (CT). Twenty-three patients had unilateral fractures, 9 of which were on the left and the remainder on the right. Seven patients had bilateral fractures. Patients with any other fractures were excluded. The follow-up period ranged from 1 to 6 years (mean 3.5).

**Treatment**

All sagittal fractures of the mandibular condyle were treated with occlusal splints, which were made of self-curing resin or transparent plastic. They were 1–2 mm high and placed in the molar region in a slightly open-mouth position. They were used by the children with the help of doctors or parents for 3–6 months (mean 4.5). The height of the splints ranged from 1 to 2 mm, based on the degree of displacement of the fracture and the age of the child (Fig. 1). The patients used the splints all the time except while eating. The height of the splint was not adjusted for the first month of treatment, which caused the condyle and the articular disc to separate so that the condyle would have adequate time to heal, and to avoid further damage to the disc. The height of the occlusal splint was decreased regularly from the second month after treatment, which caused regular contact between the condyle and the articular disc for functional stimulation, condylar remodelling, and rehabilitation. The occlusal splint was used until a stable occlusion had been achieved, which was defined as that position in which the teeth met in all positions of occlusal function.

**Clinical and radiological examinations**

The clinical examination was primarily aimed at detecting possible disorders of the joint or disturbances of growth. The patients were followed up for 1–6 years and were evaluated for mandibular function such as mouth opening, deviation of the mandible at mouth opening, protrusion, and lateral movements. Occlusion, symptoms in the TMJ, and facial symmetry were also studied. They were examined by the method described by Helkimo. Integration of mandibular function evaluated using these clinical measurements was classified into 4 categories: excellent, good, fair, and poor (excellent = absence of objective or subjective symptoms; good = absence of subjective symptoms but slight objective symptoms; fair = objective and subjective symptoms but without limitations to daily life; and poor = presence of objective and subjective symptoms with limitations to daily life).

The results of CT with a GE light-speed 32-slice CT scanner (120 kV, 80 mA, 0.8-s rotation time, and 0.2-mm slice thickness) were recorded every 6 months. These were reconstructed in 3 dimensions so that we could see the shape of the TMJ (Figs. 2 and 3). The shape of the condyle was classified into 3 categories: complete, partial, and poor remodelling (complete = complete recovery in the shape and height of the condyle with no difference from an intact condyle; partial = partial recovery in the shape and height of the condyle with a slight difference from an intact condyle; and poor = deformity and shortness of the condyle with pronounced difference from an intact condyle). The maximum anteroposterior and mediolateral diameters of the condyles were measured on CT. The method of measuring these is shown in Fig. 4.
Results

All the patients were followed up for 1–6 years (mean 3.5). The mean unassisted interincisal opening without pain was 15.8 (range 10.6–25.4) mm before treatment (about a week after the injury), 35.9 (range 24.7–39.8) mm 6 months after treatment, and 38.6 (range 27.9–43.2) mm 12 months after treatment. In all the unilateral fractures there were minor deviations to the side of the fracture during maximal mouth opening, and the mean laterotrusion width on the fractured side was 8.9 (range 7–10) mm compared with 7.1 (range 6.5–9.8) mm on the normal side 6 months after the fracture. In bilateral cases, the mean laterotrusion width was 7.5 (range 6.1–8.4) mm. Maximal protrusion ranged from 5.6 to 9.1 (mean 7.8) mm. Maximal mouth opening of more than 35 mm was achieved by 6 months. However, 9 of the 30 patients had some deviation on mouth opening at the sixth month. The outcome was excellent (n = 25) or good (n = 5) in all patients.

Table 1
The mean (SD) size of the condyles on computed tomography (mm).

<table>
<thead>
<tr>
<th>Time</th>
<th>Anteroposterior diameter</th>
<th>Mediolateral diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fractured</td>
<td></td>
<td></td>
</tr>
<tr>
<td>At 6 months</td>
<td>10.5 (2.1)</td>
<td>16.6 (2.3)</td>
</tr>
<tr>
<td>At 12 months</td>
<td>9.6 (2.5)</td>
<td>16.1 (2.5)</td>
</tr>
<tr>
<td>Injured</td>
<td></td>
<td></td>
</tr>
<tr>
<td>At 6 months</td>
<td>9.1 (2.2)</td>
<td>15.9 (2.2)</td>
</tr>
<tr>
<td>At 12 months</td>
<td>9.4 (2.4)</td>
<td>16.3 (2.3)</td>
</tr>
</tbody>
</table>

The shape of the condyle was assessed as excellent (complete remodelling) in 23 condyles (n = 19 patients), or good (partial remodelling) in 14 condyles (n = 11 patients). In no case was it poor. The maximum anteroposterior and mediolateral diameters of the condyles were measured on CT (Table 1). The maximum anteroposterior and mediolateral diameters of the fractured condyles were slightly larger than those of normal condyles, but there were no significant differences between them. No patient developed a complication.

Discussion

Sagittal fractures of the mandibular condyle are often missed on standard radiographs. With the introduction of CT such fractures have been diagnosed more often in recent years, and have been reported in 9–29% of cases of all condylar fractures. They are noted for their susceptibility to ankylosis of the TMJ and ankylosis is predominantly a complication of condylar fractures in the young. Coincidentally, sagittal fractures are the most common fractures in children and account for 50–70% of cases, and the main complication of condylar fractures in a growing child is
ankylosis, which develops in 4–26.2% of cases.\textsuperscript{2,3} It is therefore important to treat such fractures.

Guven\textsuperscript{2} concluded that the reason for ankylosis in children was probably inadequate or delayed treatment of fractures of the TMJ. Special considerations are required for the treatment of condylar fractures in children because they differ from adults in terms of management, incomplete dislocation, and the presence of a condylar growth centre.\textsuperscript{1} However, how such fractures should be treated remains a matter of debate,\textsuperscript{5,6,18,19} though conservative management is generally considered to be the method of choice. Serious disturbances of growth after conservative treatment have been rare, although unpredictable, based on the type of fracture. Havinga et al.\textsuperscript{19} insisted that open reduction should be avoided in patients younger than 12 years old, as the regeneration of the condylar process and mandibular function in patients who were managed conservatively seemed to be at least as good as that in those treated surgically.

Primary surgical management should be considered only for patients who have extensive dislocation, while making no contact between the bony fragments from dislocation of the condyle into the intracranial fossa, or those who had multiple fractures of the midface, in whom the mandible must serve as a guide to reposition the facial bones.\textsuperscript{5,6} Myall\textsuperscript{20} also stated that the only indications for open treatment of the condyle were when the fracture interfered with mandibular function or there was gross lateral displacement.

Anatomically the medial pole of the condyle extends far beyond the condylar neck and has a greater chance of being split along the sagittal plane, resulting in a sagittal fracture.\textsuperscript{1,21,22} The line of the sagittal fracture usually passes through an area between the lateral and medial thirds of the condyle. As a result of distraction of the lateral pterygoid muscle, the fragments of sagittal condylar fractures are usually displaced anteromedially and inferiorly.\textsuperscript{21,22} Raveh et al.\textsuperscript{3} reported that all patients with ankylosis had had dislocated condylar fractures that had been treated non-surgically. Authors have therefore recommended surgical treatment for this type of fracture.\textsuperscript{3,4,21} The generally preferred non-surgical treatment consists of 1–2 weeks of maxillomandibular fixation followed by elastics to bring the mandible into its habitual occlusion,\textsuperscript{5,6} and this has been used to treat all types of condylar fracture. Although in children it results in satisfactory long-term outcomes for function of the jaw, radiological investigations have shown incomplete remodelling and asymmetry of the mandible in some patients.\textsuperscript{5,6} In the present study we used occlusal splints to treat sagittal fractures of the mandibular condyle in children, and we obtained excellent or good mandibular function in all patients. The radiological investigation showed complete remodelling (n = 19 patients) or partial remodelling (n = 11 patients) of the condyles. No patient had poor remodelling.

Duan and Zhang\textsuperscript{1} stated that the following factors contributed to post-traumatic ankylosis of the TMJ: the disc, the type of fracture, and the age of the patient. The intact disc can act as a physical impediment to transarticular bony fusion. However, the surface of the condyle will become rough and sharp when the mandibular sagittal condyle fractures. This fracture will further damage the disc and cause the condylar process to be in direct contact and to adhere to the joint fossa or to the bone of the zygomatic arch. This fusion could contribute to the development of ankylosis of the TMJ. None of our 30 patients developed ankylosis, perhaps because the lateral stump shifted slightly downwards while the patients wore occlusal splints (Figs. 1 and 5). This shift caused the lateral stump to separate from the articular disc, and so secondary injury to the articular disc was prevented.

The current gold standard for management of a condylar fracture is to restore both mandibular function and condylar morphology. This is required because the fine structure of the TMJ is the basis for complicated function. In the present study the results of the remodelling of the condyles were better than those reported by others. We knew that the inferior head of the lateral pterygoid muscle would insert into the pterygoid fovea under the condylar process of the mandible. Fragments from the fracture usually push anteriorly and medially as the lateral pterygoid muscle undergoes traction during the movement of opening the mouth. As occlusal splints were used, the mouth was placed in a passive and slightly open position, and the lateral pterygoid muscle was relaxed. The fragments of sagittal condylar fractures could not be pushed anteriorly or medially without traction of the lateral pterygoid muscle.

The shape of the condyles was almost normal, and we achieved complete or partial remodelling of the condyles. We had previously shown in an animal experiment that the lateral pterygoid played an important role in reconstruction of the condylar shape during the healing of a sagittal fracture of the mandibular condyle.\textsuperscript{22} This remodelling was perhaps one of the reasons. The fragments from sagittal condylar fractures usually move downward and anteriorly, or medially, or both. The lateral stump of the condyle also moves downward and anteriorly after treatment with an occlusal splint (Fig. 5). This treatment shortens the distance between the fragment and the lateral stump of the condyle and increases the likelihood of normal healing, which could be another reason. Lindahl and Hollender\textsuperscript{23} compared the processes of remodelling of the condyle after fractures in children and adults, and reported that between 3 and 11 years of age, extensive remodelling of condylar fractures generally resulted in normal anatomy. Norholt et al.\textsuperscript{25} also found that younger children had fewer long-term problems from their injuries than their older counterparts, which emphasizes the relation between age and remodelling capacity. The patients were 5–8 years old (mean 6) at the time of injury in our this study, which was younger than those patients other authors studied. This difference in age was perhaps the third reason.

The production of occlusal splints is simple, and they are easy to wear and non-invasive. However, they can be uncomfortable when they are put in place, and they take a long time to dismantle. In addition, the size of the splint must be
adjusted regularly during treatment. Whether they are suitable for older patients or adults must be studied further.

From our findings, and considering the powerful healing and reconstructive potential of the growing mandibular condyle and its ability to avoid secondary injury to the TMJ, treatment with occlusal splints should be the first choice for sagittal fractures of the mandibular condyle in children.

Conflict of interest statement
No conflict of interest.

Ethical approval
No ethical approval required and the patient permission has been obtained.

Acknowledgement
This work was supported by National Natural Science Foundation of China (81271168).

References