



## A retrospective study of using removable occlusal splint in the treatment of condylar fracture in children



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### ABSTRACT

**Background:** Although the concept of conservative treatment for paediatric condylar fracture is well understood, there is still a lack of a recognized method for treating child patients with a condylar fracture. The purpose of this study was to investigate the effect of the removable occlusal splint in treating condylar fractures in children and adolescents.

**Materials and methods:** Forty children and adolescents with condylar fracture, aged 3–16, were included in this study. A removable occlusal splint with varying thickness was fabricated according to the age, developmental stage of the mandible, and degree of condylar dislocation. This was worn for 1–3 months, accompanied by functional exercises. Follow-up was carried out by clinical observation and panoramic X-ray.

**Results:** Clinically satisfactory results with good occlusion were obtained in all the patients, along with unimpaired function and normal growth and development of the mandible. The panoramic image showed remodelling and reconstruction of the fractured condyles.

**Conclusions:** Our results confirm that conservative treatment has a satisfactory clinical outcome in treating condylar fracture in children. The removable occlusal splint is a promising approach for treating condylar fracture in children and adolescents.

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### 1. Introduction

Fracture of the mandibular condyle is reported to be the most common type of fracture of the mandible in children (Iida and Matsuya, 2002). Its frequency ranges from 28% to 62% (Posnick et al., 1993). It is suggested that, if not properly managed, condylar fractures in children may give rise to serious problems (eg. malocclusion, temporomandibular dysfunction, disturbed mandibular growth and ankylosis of the temporomandibular joint [TMJ]) (Dimitroulis, 1997).

For condylar fractures, there are two principal therapeutic approaches: functional and surgical. In adult patients, mandibular function and condylar remodelling was better improved after operative treatment (Sforza et al., 2011; Eckelt et al., 2006). However, it is widely accepted that conservative or functional treatment is the first choice in the management of condylar fractures in children (Dahlstrom et al., 1989; Crean et al., 2000). This is

because condylar regeneration and remodelling with adaptive changes will lead to functional restitution of the TMJ. Also, surgeons are concerned that surgery will cause a growth disturbance either from the surgical manipulation of the fracture segments or from the placement of rigid hardware across the condylar process (Zide, 1989).

The recommended non-surgical treatment is the re-establishment of normal occlusion, with a short course of maxillomandibular (MMF) fixation, followed by physiotherapy (Norholt et al., 1993). Some surgeons have found no benefit in using MMF because of its many disadvantages: deterioration in oral hygiene secondary to MMF leading to tooth decay, injury to the dentition by fixation methods, malnutrition, and weight loss. It is also reported that longer periods of MMF can lead to bony ankylosis or fibrosis and severely limited mouth opening (de Amaratunga, 1987). For children, the treatment of condylar fractures with MMF is complicated by poor patient compliance, difficulty in applying MMF, and, in the case of mixed dentition, lack of sufficient support. Therefore, until now there has been a lack of an agreed protocol for conservative, functional methods. The purpose of the present study was to evaluate the clinical and radiographic effect of functional treatment in children and adolescents with condylar fracture.

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## 2. Material and methods

From Sept 2004 to Oct 2010, 48 children with mandibular condylar fracture aged between 3 and 16 were treated conservatively at the Department of Paediatric Dentistry, Peking University School and Hospital of Stomatology. Of these patients, 40 (83.3%) were followed up for more than 1 year and included in this retrospective study. Before treatment, the children were assessed by clinical and radiographic examination. Facial asymmetry, occlusal relationships, reduction in mouth opening, and shift of the chin during mouth opening were recorded. Definitive diagnosis of condylar fracture was based on radiological investigation, including panoramic radiograph or computed tomography. Fracture location, displacement of the fragments, and associated mandibular fractures were identified. Fractures were classified as unilateral or bilateral and according to the Spiessl and Schroll classification (Spiessl and Schroll, 1972): (1) undisplaced fracture, (2) low-neck fracture with displacement, (3) high-neck fracture with displacement, (4) low-neck fracture with dislocation, (5) high-neck fracture with dislocation, and (6) head fracture.

Patients were treated non-surgically. Under parental supervision, the children were instructed to have a soft diet and wear the removable semihard occlusal splint (Fig. 1) for 1–3 months, 24 h per day until restoration of the occlusion relationship. The thickness of the splint and the duration of wear were determined according to the age, the developmental stage of the dentition, the level of the fracture and the degree of dislocation. Mouth-opening exercises began on the third week after injury and included vertical opening, contralateral excursions, and protrusive movements in front of a mirror. Exercises continued for more than 6 months. Patients were recalled at 1, 3, and 6 months after treatment, and then once a year. Physical complaints, facial asymmetry, anteroposterior position of the mandible, joint pain on palpation, maximal mouth opening, deviation from the midline during opening, protrusive and lateral movement and occlusion were recorded. Panoramic radiographs were taken to evaluate the remodelling and development of the condyle after 6 months.

The criteria of clinical success were as follows: satisfactory occlusion, maximal interincisal distance was more than 35 mm; deviation from the midline during mouth opening was less than 3 mm; no sign of ankylosis; no functional and growth disturbance; radiographs showed no condylar deformity.

## 3. Results

Among the 40 children reviewed in this study, 10 were under 6 years and in the primary dentition, 20 were aged 6–11 and in the mixed dentition, and 10 were from 12 to 16 and in the permanent dentition. There were 17 boys and 23 girls. Twenty-seven patients sustained unilateral fractures of the mandibular condyle, and 13 had bilateral fractures (Table 1). The distribution of fracture



Fig. 1. Removable occlusal splint fabricated and worn by child patient with condylar fracture.

according to the Spiessl and Schroll classification showed Type 5 (42.5%) to be the predominant followed by Type 3 (22.5%), Type 6 (20%) and 4 (10%). Only 2 (5%) patients were diagnosed as Type 2 fractures, and no Type 1 fracture was observed (Table 2). Associated mandibular fractures in the anterior region were found in 6 patients.

Most patients received treatment within 3–7 days after injury, except one 8-year girl with a unilateral condylar neck fracture who came to our hospital after one and a half months due to craniocerebral injury. The removable occlusal splint was well accepted by the children. They all reported symptomatic relief after wearing the splint. The longest follow-up period was 4 years and the shortest period was 14 months after removable occlusal splint treatment. Complete clinical and functional recovery was observed in all patients, and there were no sex differences in clinical outcomes. There were no complaints of pain or subjective restriction of mouth opening. One 5-year-old boy with bilateral condylar neck fracture recorded TMJ clicking at 3 months' follow-up.

Clinical examination showed no instance of ankylosis, malocclusion, functional disturbance, or facial asymmetry after the respective follow-up periods. No patients who had a bilateral condylar fracture developed anterior open bite. There was no tilting of the occlusal plane in patients with a unilateral fracture. Maximal mouth opening was more than 35 mm in all children at 3 months' follow-up. No lateral deviation was observed at maximum mouth opening in patients with bilateral condylar fracture, while patients with unilateral condylar fracture showed some degree of lateral deviation during mouth opening. After 1 year, deviation to the affected side during mouth opening was less than 3 mm in all but two patients with unilateral condylar neck fracture (Table 3). Of these two patients, one was the 8-year-old girl (8 mm) accompanying with craniocerebral injury who received treatment one and

Table 1

Age and gender distribution of 40 child patients with condylar fracture.

Fracture pattern	3–5-year old		6–11-year old		12–16-year old		Total
	Male	Female	Male	Female	Male	Female	
Bilateral	2	1	1	5	1	3	13
Unilateral	3	4	6	8	4	2	27
Total	5	5	7	13	5	5	40

Table 2

Distribution of fracture types in 40 child patients.

Fracture type	3–5-year old	6–11-year old	12–16-year old	Total
Type 1	–	–	–	0
Type 2	1	1	–	2
Type 3	2	3	4	9
Type 4	1	3	–	4
Type 5	5	9	3	17
Type 6	1	4	3	8
Total	10	20	10	40

Table 3

Clinical analysis of TMJ function at follow-up.

Clinical findings	Unilateral fracture (N = 27)	Bilateral fracture (N = 13)
Maximal opening >35 mm	27	13
Lateral deviation during max. opening >3 mm	2 (7%)	0
Articular noise	0	1 (8%)
Articular pain	0	0
Malocclusion	0	0
Facial asymmetry	0	0

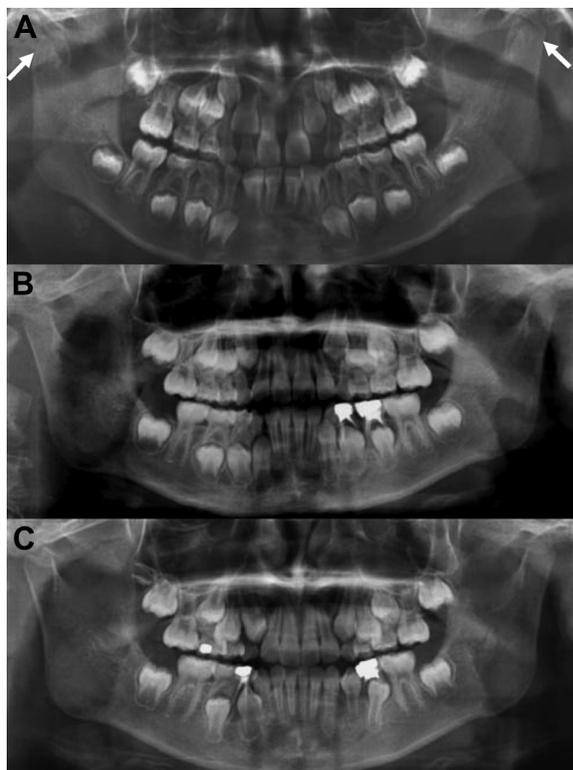
a half months after the injury; the other one was a 14-year-old boy (5 mm). The mean maximal protrusive movement was 7.4 mm (range 5–9) in all children. The mean maximal lateral movement to the right side was 7.8 mm and to the left side was 6.8 mm in patients with bilateral condylar fracture. In children with unilateral fracture, the mean maximum lateral movement to the side of fracture and to the contralateral side was 6.7 mm (range 5–8) and 8.9 mm (range 6–11), respectively.

Panoramic radiographs showed signs of bone remodelling at the 3-month follow-up. At more than 1 year follow-up, no obvious condylar deformity was observed in all child patients (Fig. 2) and adolescents (Fig. 3) who had bilateral fractures. While in children at any age with unilateral fractures, the condyles were incompletely remodelled with relatively short and flattened condylar heads and flattened glenoid fossa compared to the contralateral condyles (Fig. 4). Most of these patients (23) showed a mild difference in length between the fractured and contralateral ramus (Table 4), and the difference was more than 4 mm in two patients. No disturbance of mandibular and facial growth was detected in any of the patients.

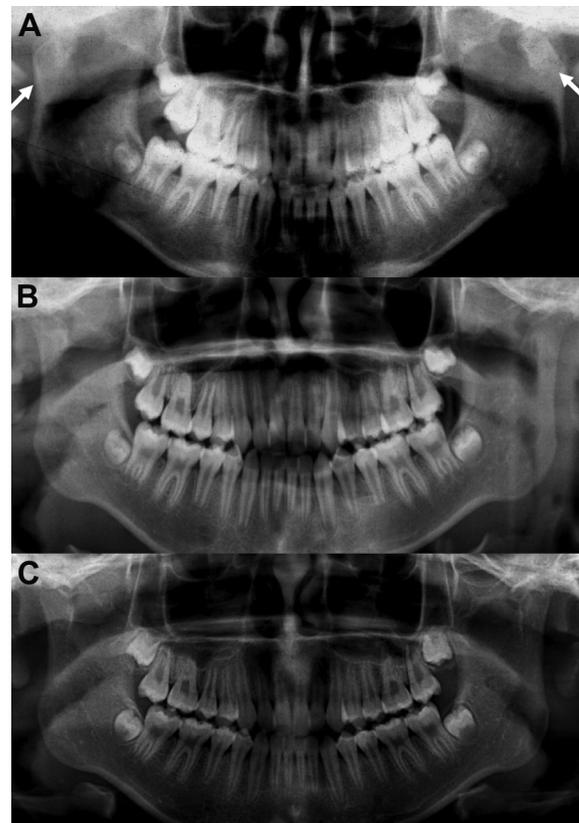
#### 4. Discussion

In this study, most child patients suffered high-neck fractures and intracapsular fractures; only six had low-neck condylar fractures, which is consistent with previous reports (Thorén et al., 1997). In the literature, satisfactory results of conservative treatment of paediatric condylar fracture have been observed (Choi et al., 2005), which is further confirmed by our study. In our study, no patient showed functional or growth disturbance of the mandible after non-surgical treatment.

Commonly used conservative approaches in treating condylar fracture include physiotherapy, MMF (Thorén et al., 2001), and



**Fig. 2.** Panoramic radiographs of 7-year-old girl with bilateral condylar fracture (Type 5) (arrow). A. Before treatment; B. 13 months after treatment with removable occlusal splint; C. 30 months after treatment. Bilateral condyles were completely remodelled. There was no disturbance of mandibular growth.

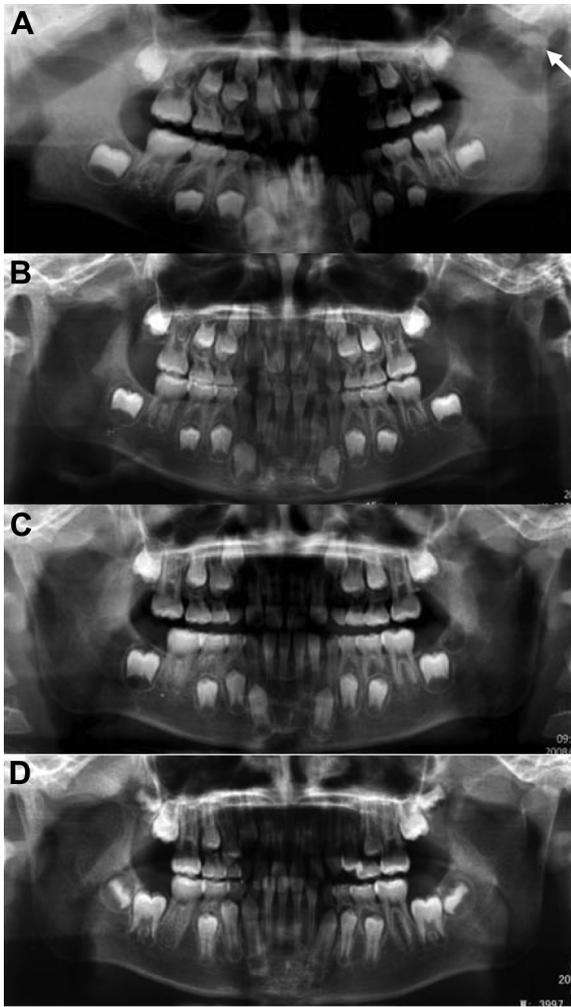


**Fig. 3.** Panoramic radiographs of 13-year-old girl with bilateral condylar fracture (Type 3) (arrow). A. Before treatment; B. 8 months after treatment with removable occlusal splint; C. 34 months after treatment. Bilateral condyles were completely remodelled.

functional appliances (eg. activator) (Strobl et al., 1999). In 2002, Defabianis proposed that when treating condylar fractures in children, restoration of a plane of occlusion orthogonally aligned to the forces of occlusion for a correct transfer of forces through the maxilla to the rest of the cranial bones is essential to allow proper facial development. The author suggested using a functional appliance to achieve this result (Defabianis, 2002). There are several splints designed on the basis of Defabianis's theory that have achieved good results in treating patients (Lloyd et al., 2001; Medina, 2009). Compared with previously described functional appliances, the removable occlusal splint used in our patients has several advantages in treating paediatric condylar fractures in that it (1) is easy to fabricate; (2) is comfortable for children to wear; (3) helps re-establish normal occlusion and keep the mandible in proper relationship to the maxilla; (4) relieves pain; and (5) allows early mobilization, eating, and mandibular exercises, which promote haematoma resolution and tissue recovery.

It is well recognized that the treatment of condylar fractures depends on the level of the fracture, degree of displacement and dislocation, size and position of the fractured condylar segment, malocclusion and mandibular dysfunction, and completeness of the dentition (Zachariades et al., 2006). In our study, each child was instructed to wear the splint with different thicknesses for varied periods according to the age, the developmental stage of the mandible, the level of the fracture, and the degree of condylar dislocation. For young children with high-level and displaced condylar fractures, splints of 2.0 mm thickness were used. For older children with low-level and dislocated fractures, thicker splints (3.0–4.0 mm thick) were worn for a longer time (up to 3 months).

In this study we found that wearing the occlusal splint followed by regularly exercises resulted in good mandibular function and



**Fig. 4.** Panoramic radiographs of 6-year-old boy with unilateral (Type 5) (left arrow) condylar fracture. A. Before treatment; B. 5 months after treatment with removable occlusal splint; C. 16 months after treatment; D. 47 months after treatment. Left condyle was incompletely remodelled with relatively short and flattened head. Left ramus height was similar to that of right side. The difference was less than 2 mm.

**Table 4**  
Difference in ramal height among patients with unilateral condylar fractures.

Fracture type	N	Degree of difference in ramal height		
		None	Mild	Severe
Low condylar neck	3	0	2	1
High condylar neck	22	1	20	1
Head	2	1	1	0
Total	27	2	23	2

None: 0–2 mm; mild: 2–4 mm; severe: >4 mm.

condylar remodelling in child patients. No patient had TMJ symptoms and ankylosis, but one 5-year-old boy complained about articular noise. Güven and Keskin recommended that maximal interincisal distance is a very good indicator of TMJ function (Güven and Keskin, 2001). Our results showed that all patients had normal mouth opening (more than 35 mm) after treatment. Compared with patients suffering unilateral condylar fracture, better recovery of TMJ function was observed in patients with bilateral fracture who showed no incidence of open bite and lateral deviation during mouth opening. Most patients with unilateral fracture exhibited

slight (<3 mm) deviation to the affected side during mouth opening. The fact that the girl treated one and a half months post trauma developed obvious lateral deviation during mouth opening suggests that functional treatment should start as early as possible.

A previous study reported that, although satisfactory treatment results were observed following condylar fractures in children, some patients showed condylar deformity (Strobl et al., 1999) and altered mandibular growth (Hovinga et al., 1999). Thorén found that incomplete remodelling with a flattened or irregular surface of the condylar head associated with deformation of the condylar neck was frequently observed after condylar fracture in childhood (Thorén et al., 1998). It is recognized that compared to adolescents and adults, children aged 3–12 years have higher potential for condylar regeneration and reshaping (Güven and Keskin, 2001). Dimitroulis reported that patients under 10 years old had the greatest remodelling potential (Dimitroulis, 1997). Our study showed that at the 2-year follow-up, panoramic radiographs indicated good condylar remodelling and normal mandibular development in all children with bilateral fracture, including those over 12 years old; while children with unilateral fracture showed incomplete remodelling and relatively short ramal height even after 4 years, including those under 10. There were no physical complaints and no instances of functional or growth disturbances in all the patients; this is consistent with other investigations (Ellis, 1998; Marker et al., 2000; Choi et al., 2005). These results suggest that condylar remodelling in children is more related to the fracture pattern compared with age. Teenagers still have considerable condylar remodelling potential.

Previous studies have shown that normalization of the head–fossa relation in children seems to be re-established within 2–3 years after the trauma (Dahlstrom et al., 1989), but achievement of normal condylar morphology may require several years (Zou et al., 1987). Further investigation over a longer recall period is required to confirm the effect of functional treatment on mandibular growth while treating paediatric condylar fracture.

## 5. Conclusion

In conclusion, conservative treatment has a satisfactory clinical outcome. The removable occlusal splint is a promising approach for treating condylar fracture in children and adolescents.

## Conflict of interest

None declared.

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