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ORIGINAL ARTICLE

Medial humeral condyle fracture in childhood: a rare but often overlooked injury

F. F. Fernandez[1] · S. Vatlach[1] · T. Wirth[1] · O. Eberhardt[1]

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Abstract
The medial condyle fracture of the humerus is—in comparison to the lateral condyle fracture—a very rare Salter-Harrison IV-fracture of the elbow. In this prospective study 14 children were included and reviewed. One child had minimal displacement fracture type I, one child had type II, and 12 children had type III-fractures. One patient was treated conservatively by an upper arm cast; thirteen were surgically treated using open reduction and osteosynthetical treatment. Postoperatively the elbow was immobilized in 90° flexion and neutral position in a long-arm cast for 4–6 weeks. In 11 children the diagnosis was made immediately after trauma, in 3 children the fracture was overlooked initially. Medial condyle fractures may be difficult to diagnose in children younger than 6 years and the lesion may be mistaken for a simple avulsion of the medial epicondyle or even missed. The C-sign is a hint for a medial condyle fracture. The development of nonunion happens in consequence of failure to recognize the fractures. Results after an average follow-up of 36 months showed that children who were diagnosed immediately and received operative stabilization had very good functional and aesthetical results. Three children with delayed diagnosis of the fracture had open surgery with reposition and osteosynthetical fixation. In two of the overlooked cases a slight contracture and angular misalignment persisted. If in this injury the diagnosis is made without delay, an appropriate therapy is implemented and radiographical controls are performed until consolidation, good results can be expected. The main risk in medial condyle fractures of the humerus is to overlook them. This can lead to the development of a nonunion with joint malformations.

Keywords Children · Medial humeral condyle fracture · Overlook injury

Introduction

In contrast to lateral condyle fractures and medial epicondyle avulsion fractures, medial condyle fractures are very rare fractures in children. For various reasons the treatment of these fractures demands high standards of the concerned surgeon. Even finding the diagnosis is challenging due to time of ossification of the humeral trochlea. While the ossification center of the medial epicondyle can be seen between the ages of 5 and 9 years, the ossification core of the trochlea is visible only between the ages of 7 and 13 years.

As soon as ossification has started, finding of the diagnosis is easier, if ossification has not started yet it is more difficult [1–3]. The fragment of the condyle has a metaphyseal part which is the medial condyle and the cartilage trochlea. However, if the metaphyseal part consists of a small skeletal disc, the fracture can be missed or misinterpreted as medial epicondyle. The risk of making a wrong diagnosis is higher in children younger than 6 years [1, 2, 4]. Furthermore the transepiphyseal fractures type Salter-Harris IV lead to growth disorders with a high risk of nonunions [5].

Because there are only few publications dealing with this type of fracture we compared our results to the small number of cases in literature. We worked out common features, but also the great differences and the reasons for them.

Method

Since 2002 all children with a medial or lateral humeral condylar fracture were included in a prospective study. 14 medial humeral fractures were identified. Demographic data were recorded as well as initial, postoperative and final

✉ F. F. Fernandez
f.fernandez@klinikum-stuttgart.de

[1] Olgahospital, Stuttgart, Germany

follow-up physical examinations and type of treatment. Radiographic evaluation of the X-rays was used for the classification system of Jakob et al. and reviewed at final follow-up for evidence of growth disturbances or deformities of the joint. The Jakob and Fowles classification divides the fractures in three types. Type I is an undislocated complete joint fracture in which the joint cartilage is intact. This is an incomplete so-called hanging fracture. Type II corresponds to an undislocated complete joint fracture which may dislocate and type III is a complete dislocated fracture with a rotated fracture fragment.

Results

Fourteen children with an average age of 8.5 years (between 4 and 14 years) were registered prospectively (Table 1). There were 6 girls and 8 boys. In ten cases the right arm was affected, in four cases the left arm. All cases were solitary injuries which occurred during leisure activities.

One child had a minimal displaced fracture type I-, one child a type II-, and 12 children a type III-fracture. All fractures were closed.

None of the children had a traumatic damage of the ulnar nerve. All children were presented to a doctor on the day of the accident and an X-ray of the elbow was done.

The primary diagnosis of a medial condyle fracture was made in 11 children; in three children the injury was initially overlooked. One child was treated conservatively with an upper arm cast.

Thirteen of the children underwent surgical treatment over medial operative access with demonstration of the ulnar nerve, open reduction and the following osteosynthetical treatments were performed: nine K-wire osteosyntheses, four screw osteosyntheses and one plate osteosynthesis. Postoperatively, the elbow was immobilized in 90° flexion and neutral position for 4–6 weeks with a long-arm cast.

In three children the grossly dislocated medial condyle fracture was not detected. These were three boys at the age of 6 (Fig. 1a) and 7 years (Table 1). All three fractures were type III-fractures. In two cases the fragments were rotated through 180°. The medial condyle fragment looks like a C-formed bone shell of the metaphysis in radiography due to the twist (Fig. 1a). In these children the trochlea was not ossified yet. In both children an additional MRI was performed after 5 and 7 months, respectively, as well as examination of the elbow (Fig. 2a, b).

In older children with type III-fracture the trochlea was always ossified. The medial condyle fracture is always a Salter Harris-fracture type IV. The fracture line crosses the epiphyseal growth plate. In seven of eight cases the fracture gap runs into the trochlea instead of the capitulum humeri. This was only observed in one case with type I-fracture.

No postoperative complications like infections, nerve lesions or nonunions were seen (Table 1). Especially no ulnar nerve lesions were observed.

All primarily recognized fractures were consolidated after 4–6 weeks—even the older medial condyle fractures. The osteosynthetical material was removed between weeks 9 and 12. The average time to removal was 11.6 weeks. For both children with overlooked fractures and nonunion the osteosynthesis remained longer in place.

The average time to follow-up examination was 36 months (between 6 and 84 months). At that time nine

Table 1 Patient demographics and injury information

Patient	Age (years)	Sex	Side	Type	Delay to treatment (days)	OP/kons	Flexion/exten	Pron/supi	Complication
1	10	M	L	III	0	OR/K-wire	5/0/140	Full/full	None
2	12	F	R	III	0	OR/K-wire	0/0/130	Full/full	None
3	6	F	L	II	0	OR/K-wire	0/0/130	Full/full	None
4	4	F	R	I	0	Cast	0/0/130	Full/full	None
5	7	M	R	III	210 days	OR/screw	0/10/130	Full/full	Fishtail-def
6	12	M	R	III	0	OR/K-wire	0/10/130	Full/full	None
7	12	F	R	III	0	OR/screw	5/0/130	Full/full	None
8	6	M	R	III	155 days	OR/K-wire	0/20/110	Full/full	Fishtail-def
9	12	M	L	III	0	OR/screw	0/0/130	Full/full	None
10	6	M	R	III	5 days	OR / K-wire	0/0/130	Full/full	None
11	7	M	R	III	0	OR/K-wire	5/0/140	Full/full	None
12	7	F	R	III	0	OR/K-wire	5/0/140	Full/full	None
13	13	F	R	III	0	OR/plate	0/0/140	Full/full	None
14	6	M	L	III	0	OR/K-wire	5/0/130	Full/full	None

OR open reduction

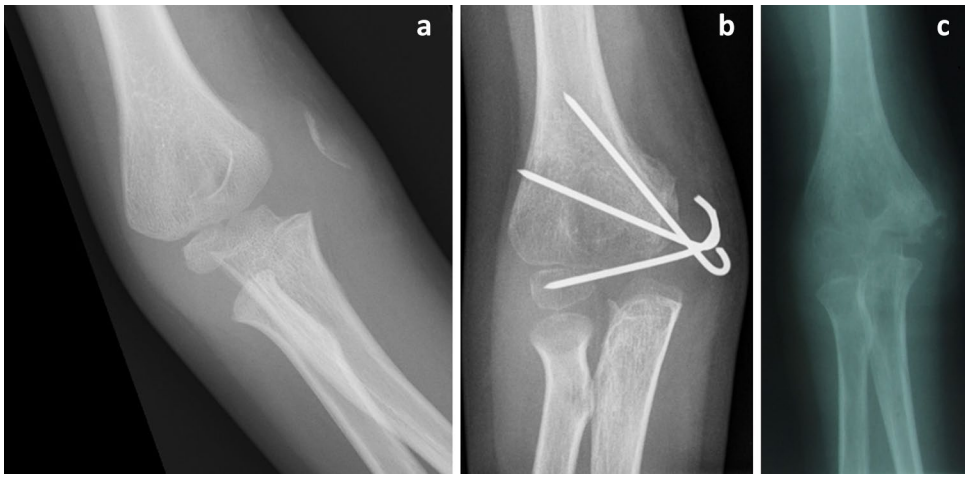

Fig. 1 **a–c** 6-year-old boy with sickle-shaped malrotated small metaphyseal bone scale with C-formation which was wrongly interpreted over 5 months. The trochlea was openly reducted and fixed with three K-wires. In the follow-up at 2 years: the anteroposterior radiograph shows a slight partial necrosis of the trochlea

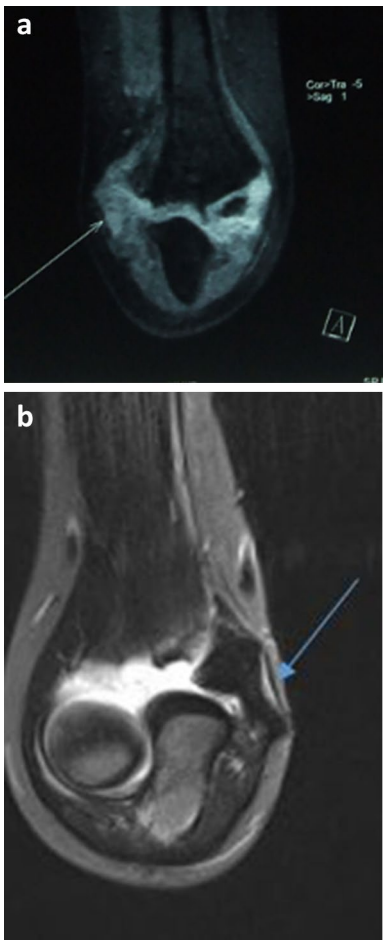

Fig. 2 **a, b** The MRI of both children showed complete rotation of the dislocated medial condyle fracture of the humerus

children showed full range of motion of the elbow, three showed light contractures of 10°–20°. All children had a free forearm range of motion. Seven patients showed a regular arm axis, two a light cubitus valgus of about 5° in contrast to the other side. Radiographically both children with delayed surgical treatment showed a partial necrosis of the trochlea (Fig. 1a–c). None of the patients felt impaired in consequence of the fracture.

Discussion

The fracture of the medial condyle is an epiphyseal plate crossing joint fracture corresponding to a Salter Harris IV-lesion. In comparison to the lateral condyle fractures that occur with an incidence of 15–25% of all osseous injuries of the elbow, the medial condyle fracture is a very rare fracture with an incidence of 0.5–1% [5–7].

There is a wide range of opinions on the typical age. In literature, the average age oscillates between 4.7 and 12.9 years. Leets [7] reports an average age of 4.7 years in 21 children, Bensahel [5] that of 6.5 years in 27 children. In our patients, we saw two age groups: one around the age of 6 years and the other around the age of 12 years.

Based on his examination Bensahel [5] held the opinion that the age is an important factor concerning dislocation. The data of our examination show that the age does not play a decisive role for the extent of dislocation. However, with 78% of type III-fractures the incidence of severe dislocations in our collective differs strongly from the data of other groups [5–7] who report of 22–28% type III-fractures.

The classification of the lateral condyle fracture developed by Jakob and Fowles [9] is helpful for making decisions concerning therapy and we think that it can be transferred to fractures of the medial condyle. In dislocated fractures type III, the indication for operative surgery is clear as soon as diagnosis is made [3, 5–7]. It is more difficult to differentiate between an undislocated fracture, hanging type I, and the complete not dislocated type II-fracture. In many cases it is not possible to discover a difference in native radiography because the cartilage fracture is not displayed. To distinguish

these two types one must conduct a cast-free X-ray examination 5–7 days after trauma to exclude secondary dislocation. The proportion of secondary dislocations of the lateral condyle is about 7–10% [10]. There is no data concerning this for medial condyle fractures yet.

The diagnosis was made by regular two axis X-rays of the elbow in 12 children. In accordance to other authors [2, 3, 6] 11 children showed big ossified metaphyseal fragments so that the fracture was obvious. In the three cases with late diagnosis no step or other bone lesion was to be detected in the area of the distal humerus. You could see the sickle-shaped malrotated small metaphyseal bone scale with c-formation which was misinterpreted several times. In our opinion this c-form is pathognomonic and we call it C-sign. It is recorded in a case report of Song [11] and in a series of Fowles [2] describing two children (4- and 7-years-old) with identical fracture geometries who were not diagnosed until 4 month and respectively 4 years after fracture. If this C-sign appears in younger children on the medial edge of the elbow, a medial condyle fracture must be excluded.

The medial condyle fracture can be mistaken for a simple injury of the medial epicondyle. Fowles [2] and Fahey [12] warned that dislocation of the medial epicondyle in a child whose trochlear nucleus of ossification has not appeared should arouse suspicion.

For further check up the ultrasound or even the MRI are available. If—as in one of our cases—the MRI was misinterpreted elsewhere, we agree with Song [11] that a noninvasive MRI is the first choice diagnostics instead of arthrography or a CT with exposure to radiation. The ultrasound can show clearly fractures of the radial head in not ossificated radial epiphyseal growth plates. In both of our cases diagnosis was verified by ultrasound. In an acute situation, however, the ultrasound can be very painful so that accurate diagnosing can be difficult. If imaging diagnostics are not conclusive, we agree with Fowles to insist on examination under anesthesia and to perform surgical revision during the same session if necessary.

According to literature K-wire osteosynthesis or screw osteosynthesis are both possible in open reduction, K-wires being used predominantly [2, 5, 14]. This could be due to the size of the metaphyseal fragment. If it is very thin, screw osteosynthesis should be overthought because of its epiphyseodesis effect. If the metaphyseal fragment is large enough a screw can be placed alternatively with the opportunity of a cast-free post-treatment.

The rate of nonunions given in literature lies between 8 and 33% and is thus remarkably high [2, 5–8], however, the numbers of patients in the collectives were low. In our patients two of 14 children showed a nonunion. The comparison of these small numbers of nonunions is difficult because the age at trauma was between 4 and 10 years and thus clearly diverged [5, 7, 8, 11, 13].

Because of the high risk of avascular necrosis after surgical treatment in nonunions, controversial concepts for therapy are suggested. Fowles [2] and Ippolito [14] believe that accepting the nonunion leads to better functional results than avascular necrosis. Due to bad surgical results in a single case, Ippolito recommends generally not to operate on nonunions [14].

Papvasilion [6] describes two patients with nonunions who underwent supracondylar corrective osteotomy as an alternative to open reduction with fixation of the nonunion to correct the misalignment and improve elbow movement. Another concept to treat nonunions is suggested by Ryu [13] and Song [11]. They present case reports about a 14-year-old boy and a 5-year-old boy with good results after open reduction and osteosynthesis of nonunion of the medial humeral condyle.

The direct comparison of nonunions is not clearly possible. Like in Songs [11] work, the nonunions in our cases developed in young children with rotation malalignment of 180° while the patients of Ryu [13] were considerably older and had no malrotation. We had good functional results with open reduction and internal fixation, even with a light avascular trochlear necrosis. Dissection of the medial condyle and extensive dissection of the posterior part increases the risk of avascular necrosis of the medial condyle. The only nutrient artery of the trochlea enters from the posterior; an excessive dissection may jeopardize the blood supply which may cause in fishtail deformity and trochlear irregularities.

A slight necrosis of the trochlea does not seem to lead to a meaningful limitation of the elbow function. According to the experiences of Song [11] and our own observations we recommend a mandatory open reduction of the malrotated fragment by osteosynthesis. Leaving the malrotated fragment leads to a massive deformation of the elbow.

Based on our results we agree with different authors [2, 4–7] that in primarily diagnosed medial condyle fractures with adequate treatment good results can be expected. In analogy to the treatment algorithm of the lateral condyle fracture, type I-fractures are treated conservatively by an upper arm cast. To rule out a type II-fracture a X-ray has to be performed without the cast after 5 days, which has to be compared to the initial X-ray. If there is no dislocation therapy can be continued conservatively. However, if there is a dislocation it indicates a type II-fracture and has to be treated surgically because of instability. Type III-fractures have to undergo open reduction and need to be stabilized osteosynthetically.

Summary

Medial condyle fractures of the humerus are very rare. If they are primarily diagnosed and adequately treated good results can be expected. It is a problem that these fractures

are overlooked frequently, especially in children with not yet ossificated trochlea and thus nonunion and malalignment of the elbow can result. The appearance of nonunions is multifactorial. They should not be left untreated and need individual treatment concepts. In children with an injured elbow without fracture signs, imaging diagnostics such as ultrasound and MRI should be performed.

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