LATERAL HUMERAL CONDYLE FRACTURES IN CHILDREN – CASE SERIES AND REVIEW OF LITERATURE

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Abstract

The three most common elbow fractures classically reported in pediatric orthopedic literature are supracondylar (50–70%), lateral condylar (17–34%), and medial epicondylar fractures (10%). The mechanism of injury varies, but the most commonly described mechanism involves a fall on an outstretched hand with varus, valgus or rotational force or a combination thereof. The vectors of force and the degree of chondro-osseous development dictate the type of injury incurred.14 cases of lateral humeral condylar fractures between the years 2013 and 2018 were reviewed. A review of the literature was also conducted to see the most frequent injuries and complications.

Key words: trauma, humerus, lateral humeral condyle fracture, children

Introduction

The three most common elbow fractures classically reported in pediatric orthopedic literature are supracondylar (50–70%), lateral condylar (17–34%), and medial epicondylar fractures (10%).

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Material and methods

14 cases of lateral humeral condyle fractures between the years 2013 and 2018 were reviewed.

There were 10 male and 4 female patients. 8 patients were treated with a long arm cast and 6 patients with open reduction and osteosynthesis with screw, Kirschner wires or a combination of both. The osteosynthesis material was buried under the skin in all 6 patients.

There were no notable complications in both groups with good clinical outcome. 1 patient developed a wound infection which responded well to antibiotics. 2 patients had a decrease in range of motion of the elbow after conservative treatment with long arm cast. They responded well to physiotherapy.

A review of the literature on this complex subject was also conducted using the key words “trauma”, “humerus”, “lateral humeral condyle fracture”, “children”.

Results

Lateral humeral condylar fractures are the second most common pediatric elbow fractures after supracondylar humeral fractures [1, 2]. They comprise about 10–20% of all childhood elbow fractures having the annual incidence of 1.6/10,000 partly because of the increasing number of young athletes participating in highly competitive athletics [3].

Fractures involving the lateral condyle in the immature skeleton can either cross the physis or follow it for a short distance into the trochlear cartilage.

Associated injuries

Fractures of the lateral condylar physis rarely are associated with injuries outside the elbow region and unlike supracondylar humeral fractures, fractures of the lateral condyle rarely are associated with neurovascular injuries. Within the elbow region, the associated injuries that uncommonly occur with this fracture include dislocation of the elbow (which may be a result of the injury to the lateral condylar physis rather than a separate injury), radial head fractures, and fractures of the olecranon, which are often greenstick fractures. Acute fractures involving only the articular capitellum are rare in skeletally immature patients but are serious injuries that need to be recognized and treated appropriately.

Mechanism of injury

Two mechanisms have been suggested: “push-off” and “pull-off.” The pull-off or avulsion theory has more advocates than the push-off mechanism.

The mechanism of injury includes either avulsion forces from the lateral ligaments with the elbow extended, or impaction of the radius on the capitellum after a fall on an outstretched arm [4].

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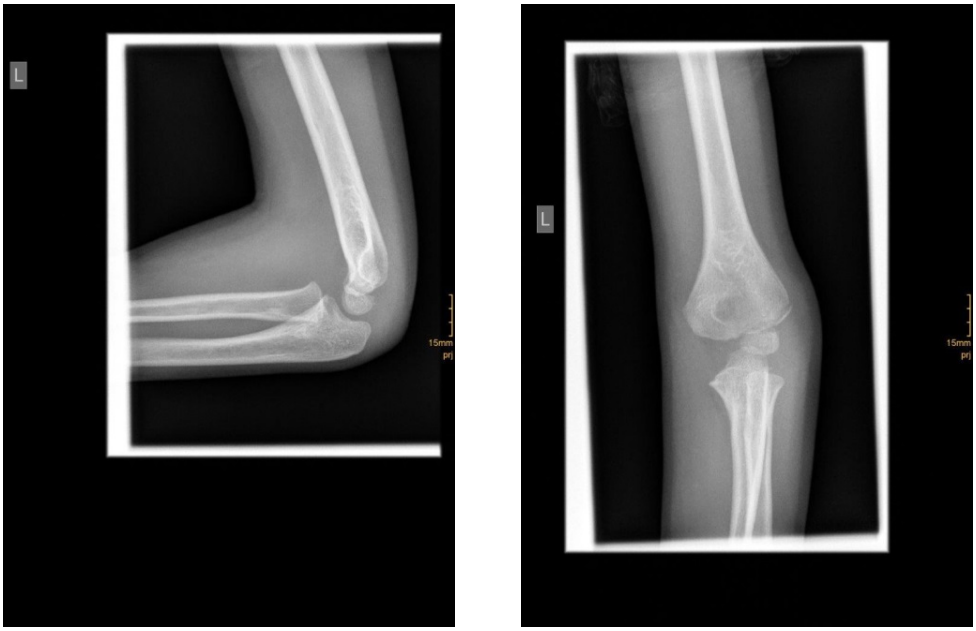

Fig. 1. 6 year old male patient with a undislocated left lateral condyle fracture which was succesfully treated with a long arm cast (personal collection)

Clinical presentation

Compared with the marked distortion of the elbow that occurs with displaced supracondylar fractures, little distortion of the elbow, other than that produced by the fracture hematoma, may be present with lateral condylar fractures. The key to the clinical evaluation of this fracture is the location of soft-tissue swelling and pain concentrated over the lateral aspect of the distal humerus.

Imaging investigations

Diagnosis is made based on radiographs and it may be difficult in children [5]. The radiographic appearance varies according to the fracture line's anatomic location and the displacement stage

The degree of displacement may be seen on the true lateral view. In determining whether the articular hinge is intact (i.e., stage I vs. stage II), the relationship of the proximal ulna to the distal humerus is evaluated for the presence of lateral translocation. Oblique views are especially helpful in patients in whom a stage I displacement is suspected but not evident on AP and lateral views.

Arthrography or MRI evaluation has been suggested to identify unstable fractures in the acute setting and to aid in preoperative planning for those with late displacement, delayed union, or malunion. MRI can be a very useful diagnostic aid to guiding treatment, especially with delayed unions.

Classification of lateral humeral condylar fractures

The Milch classification, based on whether or not the fracture extends through (type I) or around (type II) the capitellar ossific nucleus, is used infrequently because of its poor reliability and poor predictive value. Salter and Harris classified lateral condylar physeal injuries as a form of type IV injuries in their classification of physeal fractures. A true Salter– Harris type IV injury through the ossific nucleus of the lateral condyle is rare. Although lateral condylar fractures are similar to Salter–Harris type II and IV fractures, treatment guidelines follow those of a type IV injury: open reduction and internal fixation of displaced intra-articular fractures. Weiss et al. modified this classification based on fracture displacement and disruption of the cartilaginous hinge [6]. They classified the lateral humeral condyle fractures in 3 types: type I, less than 2 mm of displacement; type II, 2 mm or more of displacement and congruity of the articular surface; type III, more than 2 mm of displacement and lack of articular congruity.

Treatment

Non-displaced and stable fractures may be treated by cast immobilization with close follow-up, but fractures displaced >2 to 3 mm may indicate surgical fixation [7, 8]. Surgical treatment can be done either by closed reduction and percutaneous osteosynthesis or open reduction and osteosynthesis.

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Fig. 2. 6 year old male patient with a dislocated right lateral condyle fracture which was treated by open reduction and osteosynthesis with a screw and a Kirschner wire (personal collection)

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Surgical fixation is either by screw, smooth K-wires or both. The K-wires can be buried under the skin or not.

The idea behind burying K-wires is to reduce infection rates because it is felt that the wires have to stay in for a minimum of six weeks to prevent non-union. Some studies show no cases of non-union in either the buried or unburied wires group and infection rates that were comparable. In addition some of the cases with buried wires became effectively unburied. So that is why some authors concluded there is no justification in burying wires, which requires an additional general anaesthesia for removal [9].

Regarding pin orientation, most authors favor a divergent construct for greater stability.

For 2-pin constructs, maximizing pin divergence at the fracture site provided greater stability in torsional loading and valgus loading. The addition of a third pin in a divergent orientation increases stability compared with 2-pin constructs in valgus, internal, and external rotation loading. The pins must be placed in a bicortical manner, with maximum divergence and spread at the fracture site [10].

Complications

Many complications are known to be associated with childhood lateral condylar humeral fractures, with poor outcomes often related to delayed or inadequate initial treatment [5,11].

Lateral humeral condylar fractures are the most common injuries that involve the growth line around the elbow region [12]. There are also intra-articular fractures, which may affect bone healing and the joint surface [13]. These fractures more commonly result in decreased range of movement more than any other elbow fractures [14]. Up to 20% of patients with lateral condylar fractures show a cubitus varus deformity and >10% show a cubitus valgus deformity [15,16,17].

Discussion

Fractures involving the lateral condylar physis occur early, with the average age around 6 years [18,19]. All the physes of the distal humerus are vulnerable to injury, each with a distinct fracture pattern. Next to those of the distal radius, injuries to the distal humeral physes are the most common the first 2 to 3 years of life [19,20,21].

Fractures concerning the medial condylar physis are rare and occur most often in children 8 to 12 years of age [22].

The diagnosis of lateral condylar physeal injuries may be less obvious both clinically and on radiographs than that of supracondylar fractures, especially if the fracture is minimally displaced..

Further, the fracture line usually lies posterolaterally and may not be captured in the conventional radiographs[1].

Oblique views of the distal humerus are very helpful in making accurate diagnosis and defining the extent of fracture displacement for treatment decisions Such cartilaginous anatomy affects the prognosis of the lateral humeral condylar fractures: growth disturbance can occur in the form of a partial lateral growth plate closure or partial closure of the centre of the physis[23].

The central insult between the lateral condylar physis and the trochlea can result in a deep groove, forming the typical “fishtail deformity”[16].

Regardless, the extremity should be evaluated for concomitant injuries of forearm, wrist, or hand, and the radiographs should be inspected for additional fractures about the elbow.

Humeral condyle fractures can be associated with elbow joint dislocations, although dislocations of the elbow joint in children are not common. Of all elbow injuries in skeletally immature patients, Henrikson [24] found that only about 3% of all were dislocations. The peak incidence of pediatric elbow dislocations typically occurs in the second decade of life, usually between 13 and 14 years of age when the physes begin to close [25]

The largest proportion of elbow dislocations (44.5%) occur in conjunction with sports activities; football/ rugby, wrestling, and basketball being the most common sports for males and gymnastics and skating being the most common sports for females [25]. Almost 60% of medial epicondyle fractures are associated with elbow dislocations in this age group. As with all joint dislocations, the principles of treatment include promptly obtaining a concentric reduction of the elbow joint while identifying and treating all associated injuries. The ultimate goal is allowing protected motion and rehabilitation with the goal of restoring full elbow motion without recurrent instability.

Because of the location of critical stabilizing factors and surrounding neurovascular structures, elbow dislocations should be considered based on the direction of dislocation and the associated fractures which may be present. As the mechanism of injury, the associated injuries, and imaging differ based on the nature of the injury, these factors should be considered for each dislocation pattern.

Diagnosis of these traumatic entities is done by clinical examination and paraclinical investigations.

Trauma is a common indication for elbow imaging in children. Fractures in the developing pediatric elbow occur frequently and can be challenging to diagnose radiographically.

Although some fractures are quite apparent, knowledge of the normal developmental appearances and the radiographic clues to injury are necessary to optimize detection of more occult fractures. Sometimes a CT or better yet a CT with 3D reconstruction can help in the diagnosis and treatment of these fractures. A intraoperative arthrography is sometimes also useful.

The most important problem in the treatment of humeral condyle fractures is the pseudarthrosis that can happen in the framework of a conservative treatment of displaced fractures, rarely after operative treatment with K-wires or screws. A rather academic problem is the obligatory growth disturbance of a partial stimulation of the lateral part of the growth plate. This leads to radial overgrowth and thus to a more or less distinct varus deformity.

The extent of varus deformity is dependent on the time till consolidation, which is longest in conservatively treated fractures and shortest in those treated with compression screw osteosynthesis. An additional academic problem is the so-called fishtail deformity that becomes radiological visible at the end of growth. This deformity has no clinical

significance. Pseudarthrosis, varus and fishtail deformity are a result of increasing instability of primarily or secondarily displaced fractures of humeral condyles. Cubitus valgus and tardy ulnar nerve palsy are considered the main complications of nonunion lateral humeral condyle. The treatment of nonunion of the lateral humeral condyle with <1 cm of displacement is generally recommended, if care is taken to avoid damage to the vasculature of the lateral condylar fragment [26].

Conclusion

Fractures of the distal humerus in children pose special problems which need to be addressed by a person specialized in pediatric traumatology. Conservative and operative treatment is possible, specific for each type of fracture.

Specific complications can occur after such fractures which in turn can pose problems which need special expertise in order to be solved.

The most common prenatal risk factors are: prematurity, chorioamnionitis, fetal malpresentations, birth asphyxia. In less than 10% of the cases, birth asphyxia cand be considered a cause of CP even if it occurs on a malformative background, growth restriction, severe maternofetal infections. Even in these cases, the classic diagnostic criteria for birth asphyxia have to be present: Apgar Score <4 at 5 minutes, fetal bradycardia, metabolic acidosis, multiple organ failure due to tissue hypoxia and early imaging changes [10].

Postnatal risk factors are also involved in the development of CP: periventricular leukomalacia (preterm newborns), intracranial hemorrhage, hypoxic ischemic lesion (meconium aspiration, pneumothorax), infections (meningitis, encephalitis, severe congential pneumonia), persistent fetal circulation (pulmonary hypertension of the newborn at term), nuclear jaundice [11].

Clinico-etiological forms

Spastic hemiplegia

The most frequent cases are congenital (70 – 90%) and only 10-30% of aquired causes [12].

It can be unilateral (the middle cerebral artery's teritory being the most frequent affected) and affect especially the left side (2 times more frequent than the right). From a neuropathologic point of view this type of lesion is produced on the basis of posthemorrhagic porencephaly (Figure 1), cerebral atrophy (Figure 2) and periventricular leukomalacia of the preterm newborns (Figure 3) [4].

Spastic diplegia

Is a controversial disease from an etiological point of view, especially for newborns at term. Among preterm newborns, periventricular leukomalacia and severe peri/intraventricular hemorrhage (grade IV) are most frequently involved. (Figure 4) [4].

Spastic tetraplegia

A severe form of cerebral palsy, that appears due to prenatal causes in 50% of cases, perinatal in 30% and postanatal causes in 30% of cases [5]. From a neuropathologic point of view the most common causes are: hydrocephaly (Figure 5), diffuse cortical atrophy, multicystic encephalomalacia – isolated or communicating with the ventricular system (Figure 6).

Extrapyramidal dyskinesia

Not so frequent in the common medical practice. Nuclear jaundice was the most frequent cause, but it's incidence decreased significantly. Other causes are: hypoxic-ischemic injury, prematurity, some cerebral degenerative diseases. Some cases caused by high bilirubin concentrations (without nuclear jaundice) are cited in specialized literature [10].

Hypoxic-ischemic lesions of the basal nuclei and talamus are more frequent among the term newborns than premature newborns [4].

Evolution and prognosis

Short term outcome is determined by the complication rate. The most common complications are: gastroesophageal reflux with aspiration pneumonia (sometimes with acute respiratory failure), absent or insufficient sucking and deglutition reflex, chronic constipation (even occlusion), chronic pulmonary disease (BPD – broncho-pulmonary dysplasia) [6].

Long term prognosis is severely affected by the presence of: epilepsy, deafness, halucinations, strabismus, mental retardation (30-50%), attention deficit, autism. 25% of the patients with cerebral palsy have walking disorders and 25% are severely affected and in need of intensive medical care [13].

Conclusions

1. Cerebral palsy is a serious condition, with immediate and long term sequelae that affect quality of life and social integration.
2. It is more frequent among preterm and postterm newborns. The most incriminated risk factors affect these age groups.
3. From a neuropathologic point of view, the most common lesions that cause cerebral palsy are: periventricular leukomalacia, intraparenchymal hemorrhage, cerebral atrophy, porencephaly, and hydrocephaly.

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