Symposium I

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ABCD of Lateral Condyle Humerus Fracture in Children: Anatomy, Biomechanics, Classification and Diagnosis

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Abstract

The lateral condyle fractures which form less than 20% of paediatric elbow fractures are seen at average 6 years age and have less severity of signs and symptoms which may lead to delayed diagnosis. Internal rotation view of X-ray of elbow is important in addition to standard AP and Lateral views. Jakob, Weiss and Song are commonly used classification systems in decision making.

Keywords: Lateral condyle fracture, Children, Classification, Anatomy, Diagnosis

Introduction

Fracture of lateral humeral condyle in children accounts for 12% to 20% of pediatric elbow fractures, making it the second most common fracture about the elbow in children with an annual incidence of 1.6 per 100,000. Fractures involving the lateral condyle typically occur early in childhood with avarage age being around 6 years of age .

The current review deals with anatomical aspects of the injury, biomechanics including mechanisms of injury, various classifications including their significance and methods of diagnosis.

Anatomy:

1.1 Ossification: Lateral condyle of the lower humerus is not ossified at birth. The ossification center of the lateral condyle appears just before 1 year of age but may be delayed as late as 18 to 24 months. On an anteroposterior (AP) radiograph of the elbow, the capitellar ossification center is usually spherical when it first appears. It becomes more hemispherical as the distal humerus matures, and the ossific nucleus extends into the lateral ridge of the trochlea. On the lateral view, the physis of the capitellum is wider posteriorly.

Just before completion of growth, the capitellum, lateral epicondyle and trochlea fuse to form one epiphyseal center (Figure 1). Metaphyseal bone separates the extra-articular medial epicondyle from this common humeral epiphyseal center. The common epiphyseal center ultimately fuses with the distal humeral

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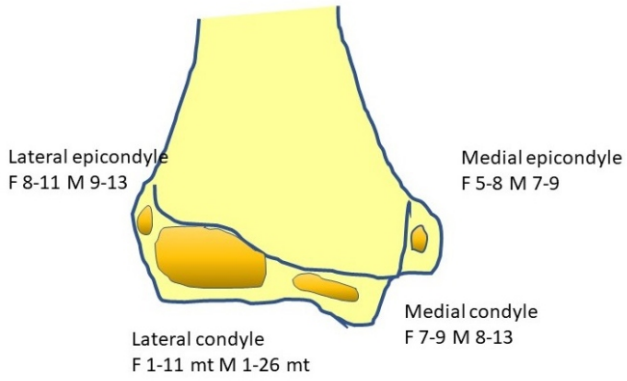


Figure 1: Ossification centers at lower humerus

metaphysis at skeletal maturity. The medial epicondyle may not fuse with the metaphysis until the late teens.

1.2 Capsule: The entire articular surface of the distal end of the humerus is intracapsular; however, the medial and lateral epicondyles are both extra articular. Anterior and posterior elbow fat pads are located between the capsule and the distal end of the humerus.

1.3 Blood supply: Most of the intraosseous blood supply of the distal humerus comes from the anastomotic vessels that course posteriorly (Figure 2). There are two types of blood vessels in the developing lateral condyle. These vessels enter the posterior portion of the condyle just lateral to the origin of the capsule and proximal to the articular cartilage near the origin of the anconeus muscle. These vessels communicate with one another within the ossific nucleus but do not communicate with vessels in either the metaphysis or non-ossified chondro-epiphysis. Thus, for practical purposes, they are end vessels. The ossification center of the lateral condyle extends into the lateral portion of the trochlea. Thus, the lateral crista or ridge of the trochlea derives its blood supply from these condylar vessels.

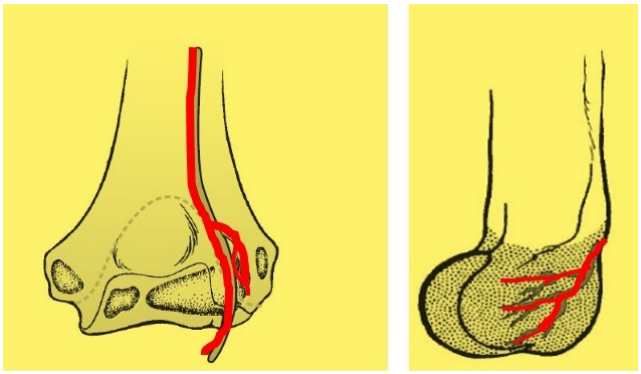


Figure 2: Vascular supply of the lateral condyle

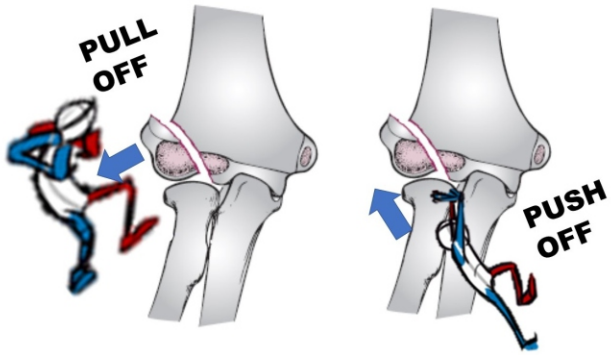


Figure 3: Mechanism of injury

Biomechanics

2.1 Mechanism of injury (Figure 3)

Two mechanisms for this fracture have been proposed.

1. The "Pull off" mechanism: A fall on the outstretched hand with the forearm supinated causes the lateral condyle to pull off from the humerus. A varus force on the arm transmits through the forearm extensor muscles (extensor carpi radialis longus and brevis and brachioradialis), which attach to the lateral condyle, resulting in avulsion of the condyle.
2. The "Push-off" mechanism: A sharp blow to the palm with the elbow flexed, causes the radial head to push off the lateral condyle. This push-off injury also can result from a direct blow to the olecranon.

It is likely that both mechanisms in combination produce this injury with avulsion forces pulling the condyle and the olecranon's sharp articular surface serving to direct the force along the physeal line into the trochlea.

2.2 Stability of Elbow

The lateral condyle anatomy decides the stability of elbow. In fractures which exit lateral to trochlea the elbow is stable. In fractures which exit through the trochlea, the elbow is unstable. Both fractures are Salter Harris Type IV injuries. Uncommonly the fracture line exits medially along the physis and represent a Salter Harris Type II injury.

Classifications

3.1 Milch Classification (1964)

Basis: Exit of the anatomical fracture line

Details (Figure 4):

Type I – Fracture extends through the capitellum lateral to the

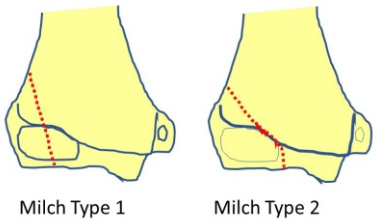


Figure 4: Milch Classification 1964

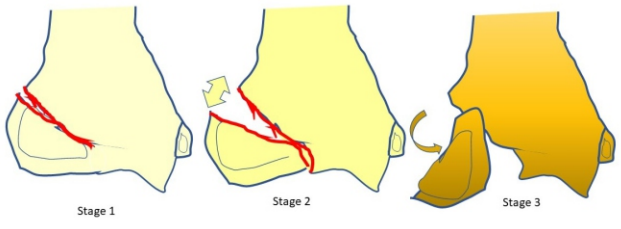


Figure 5: Jakob Classification 1985

crista of the trochlea

Type II – Fracture extends around the capitellum through the trochlea.

Value:

Milch type 2 fracture traverses through the crista of trochlea and represents an unstable elbow. This classification is used infrequently because of poor reliability and predictive value and is of historical importance.

3.2 Jakob Classification (1985)

Basis: This classification is based on the amount of displacement of the fracture and extension to the articular surface (Figure 5).

Details: It is divided into three stages depending on the displacement.

Stage I (Crack) Undisplaced with intact articular surface.

Stage II (Tilt) Fracture extends completely through the articular surface.

Stage III (Flip) The condylar fragment is completely displaced proximally and rotated.

Value: This classification has been used in management of lateral condyle fractures where undisplaced fractures are treated conservatively, complete fractures without rotation can be closed reduced and fixed, whereas complete fractures which are rotated need open reduction and fixation. Since children with stage 1 displaced fractures can develop a nonunion, this classification is not entirely reliable.

3.3 Weiss Classification (2009)

Basis: This is a modification of Jakob's Classification and is based on fracture displacement and disruption of the cartilaginous hinge. (Figure 6)

Details: The fractures are divided into 3 types.

Type I – Fractures are displaced less than 2mm.

Type II – Fractures are displaced more than 2mm but have intact cartilaginous hinge.

Type III – Fracture displaced more than 2mm and do not have an intact hinge.

Value: Weiss et al modified the Jacob classification to determine the amount of displacement, presence of medial hinge based on articular surface congruency as determined on

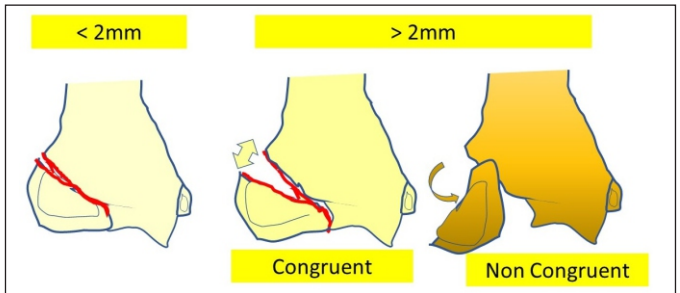


Figure 6: Weiss Classification 2009

elbow arthrography intraoperatively, especially in the type II fractures with an aim to give a more predictive system to determine surgical complications.

Weiss et al retrospectively studied 158 patients with type II and III lateral condyle fractures and reported an overall complication rate of 25%. The authors highlighted that this classification and treatment based on it predicts the risk of complications with both the major and minor complication rates correlating with fracture type. Type II fractures were statistically less likely to develop complications compared with type III fractures. This classification is useful for intra-operative decision making, advocates arthrography for all type II fractures and open reduction for type III fractures.

3.4 Finnbogason classification (1995) (Figure 7)

Basis: Fracture gaps for lateral condyle fractures displaced less than 2 mm.

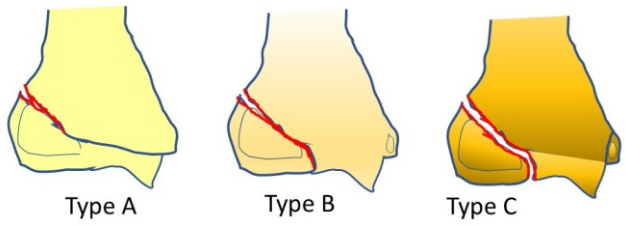
Details: The fractures are divided into 3 groups.

Group A fractures have a small gap at the dorsolateral aspect of the humeral metaphyseal fracture site, but do not extend to the articular surface.

Group B fractures have the same radiographic pattern, but the fracture can be visualized extending to the articular surface.

Group C fractures extend widely both medially at the articular surface and laterally at the dorsolateral portion.

Value: Finnbogason and colleagues casted 112 children in their study regardless of their group classification, and determined group A fractures were stable and did not require any further treatment, while group C fractures had a 0.42 increased risk of further displacement, which subsequently



Type A: Stable No or minimal gap not extending to physeal cartilage
Type B: Fracture can be followed to physeal cartilage lateral gap more than medial gap.
Type C: Unstable Medial gap more than or equal to lateral gap

Figure 7: Finnbogason Classification 1995

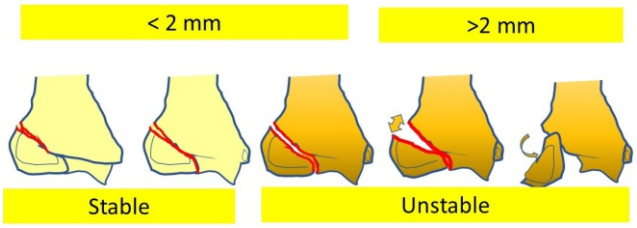


Figure 8: Song classification 2008

required surgery. They designated group A fractures as stable, group B as unstable and group C as indeterminant.

3.5 Song Classification (2008)

Basis: Fracture displacement and stability on internal rotation view (Figure 8).

Details: Stages of displacement of fractures of the lateral humeral condyle in children as per Song classification is as follows.

Stage I: stable fracture with 2 mm or less of displacement and fracture line limited to within the metaphysis.

Stage II: undefinable fracture with 2 mm or less of displacement and fracture line extending to the epiphyseal articular cartilage; there is a lateral gap.

Stage III: unstable fracture with 2 mm or less of displacement and a gap that is wide laterally as medially.

Stage IV: unstable fracture with displacement of more than 2 mm.

Stage V: unstable fracture with displacement of more than 2 mm with rotation.

Value: Song et al combined the Jacob and Finnbogason classification with an aim to give a more descriptive classification and treatment algorithm based on fracture displacement, pattern and stability. The authors also described the utility of the internal oblique view along with the AP radiographs to analyze displacement and provided standardized technique to measure displacement is all views to guide treatment.

In their prospective study, the authors had a good inter-observer and intra observer reliability for their classification system and reported a 73% success rate with closed reduction and pinning for unstable fractures and reported that open reduction is not required for all displaced, unstable lateral condyle fractures. Ramo et al validated the Song classification with high inter-observer and intra-observer reliability along and better guidance for treatment and outcomes.

The main issue results from differentiating the Song type 2–4 stages on radiographs. Hence many have advocated the use of the Weiss and song classification together for guiding treatment.

Diagnosis

4.1 Clinical Presentation

The signs include soft tissue swelling and pain concentrated over the lateral aspect of the distal humerus. The pain may be increased on wrist flexion through stressing the wrist extensors which are attached to the fracture fragment.

The clinical presentation depends on the extent of injury. The un-displaced or minimally displaced fractures present with only local tenderness at the condylar fracture site. With displaced fractures there often is a hematoma present laterally.

The benign appearance of elbow with some stage I fractures account for delay by parents in seeking treatment for the child.

4.2 Imaging

Radiographic findings

AP and Lateral X-rays provide the standard method for assessment of injuries around the elbow. Internal oblique views are specially required to assess the degree of translation and displacement (Figure 9). Song et al compared the oblique view to standard AP view and found that the amount of displacement differed between the two views in 75% of children. Hence use of internal oblique view is recommended.

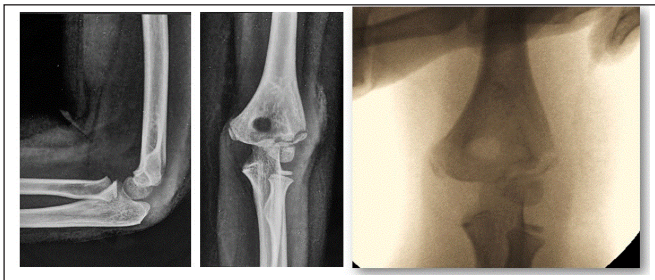


Figure 9: Internal rotation view shows true extent of the displacement

4.22 MRI

These are usually suggested to identify unstable fracture in acute setting to assess the extension of fracture line to articular surface (Figure 10). However, they are also indicated in planning for those with late displacement, delayed non-union or mal union.

Figure 10: MRI showing that the fracture extends to articular surface and warrants fixation

4.23 Ultrasonography

This method is operator-dependent and hence has not found wide applicability although it can accurately and readily determine stability of minimally displaced fractures to avoid inadequate treatment and unnecessary surgeries.

The elbow is comfortably extended on an examination table, and the hand is supinated. Evaluation with the transducer in performed in the short axis of the articular cartilage hinge just superior to the elbow joint. The hypoechoic layer over the hyperechoic cortex of distal humeral epiphysis represents the cartilaginous portion. If the articular cartilage hinge is intact, the distal humeral articular cartilage is smooth and continuous, similar to a "wave" in transverse ultrasound examinations. If the cartilage hinge is disrupted, we can determine that the fracture line extends to the joint. In displaced fractures there is massive hemorrhage between the fracture fragments, and the articular cartilage is disrupted and displaced, similar to the "stair sign" in the transverse ultrasound images.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given his consent for his images and other clinical information to be reported in the Journal. The patient understands that his name and initials will not be published, and due efforts will be made to conceal his identity, but anonymity cannot be guaranteed.

Conflict of interest: Nil; **Source of support:** None

Further Reading

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