# PEM GUIDE – CHILDHOOD FRACTURES

## INTRODUCTION

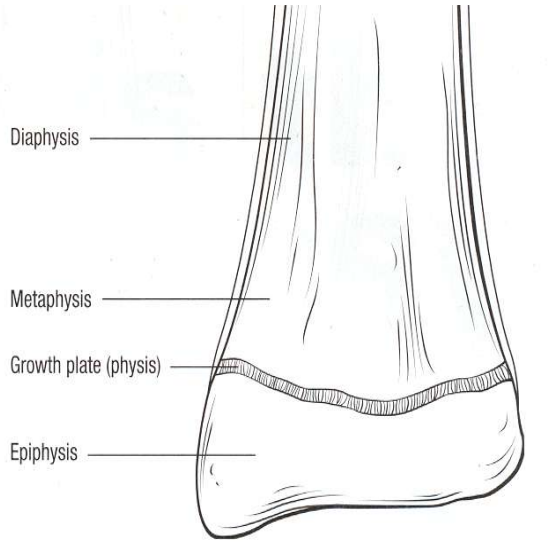
Skeletal injuries account for 10-15% of all injuries in children; 20% of those are fractures, 3 out of 4 fractures affect the physis or growth plate. Always consider the possibility of child abuse in young children presenting with skeletal injuries.

## GENERAL CONSIDERATIONS

For any injury to an extremity (fracture, contusion, dislocation) always check and document neurovascular function distal to the injury – before and after treatment. In case of missing pulses distal to a displaced fracture, consult orthopedics immediately or attempt reduction in the emergency department to regain perfusion. Always examine and include into your x-ray not only the area of interest but also both adjoining joints. The same principle applies for immobilization: ideally splint or cast the broken bone and both adjoining joints.

## THE GROWING BONE: ANATOMY

The major anatomic regions of the bone include the diaphysis, metaphysis, physis, and epiphysis. The epiphysis is a secondary center located at the end of long bones; it is separated from the rest of the bone by the cartilaginous physis. The age at which ossification centers become visible on a radiograph and the subsequent rates of physeal closure vary widely depending on the bone. The relative lack of ossification of many epiphyses in young children and the radiolucency of growth plates can make fracture identification difficult.



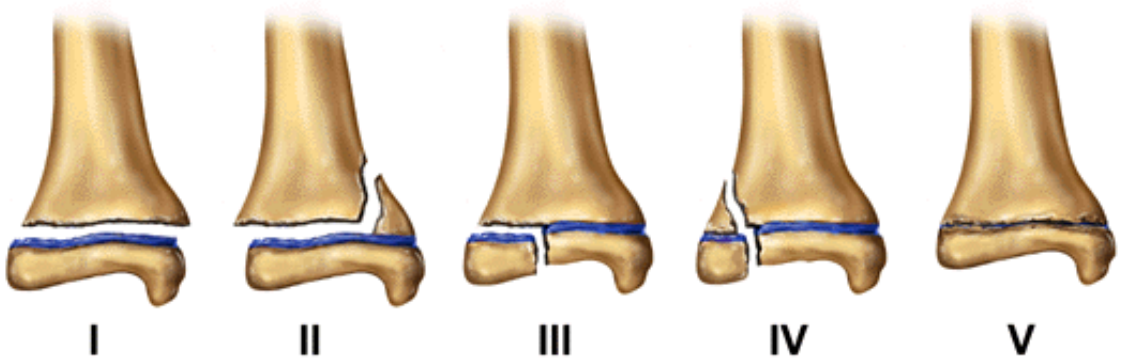

## PHYSEAL INJURIES

The attachment of the physis to the metaphysis is a point of weakness in the growing bone. Ligaments and tendons are usually stronger than the growing bone in proximity of a growth plate (such as for example in ankle-injuries) and child is more likely to fracture a bone, whereas once the physis has closed, an adult is more likely to tear a ligament, muscle, or tendon.

Damage to the physis can disrupt future growth. Several factors determine the prognosis for physeal injuries. These include severity of injury, degree of displacement, and the location of the physis involved ( eg weight bearing extremity)

**SALTER-HARRIS CLASSIFICATION**

The Salter-Harris classification scheme is designed to stratify injuries according to the physeal involvement and implements a relative risk of growth disturbance: Types I and II have a low risk of growth disturbance, and the relative risk increases from type II to V. However, it is important to consider all factors when assessing the risk of growth disturbance and to remember that growth disturbance can occur after any fracture in the region of a physis.




Displaced physeal fractures should be reduced as soon as possible by an experienced clinician. The longer the delay in reduction, the greater the force that must be applied to obtain an adequate reduction, which puts the physis at greater risk of injury and subsequent growth arrest

**SALTER-HARRIS TYPE I FRACTURE**

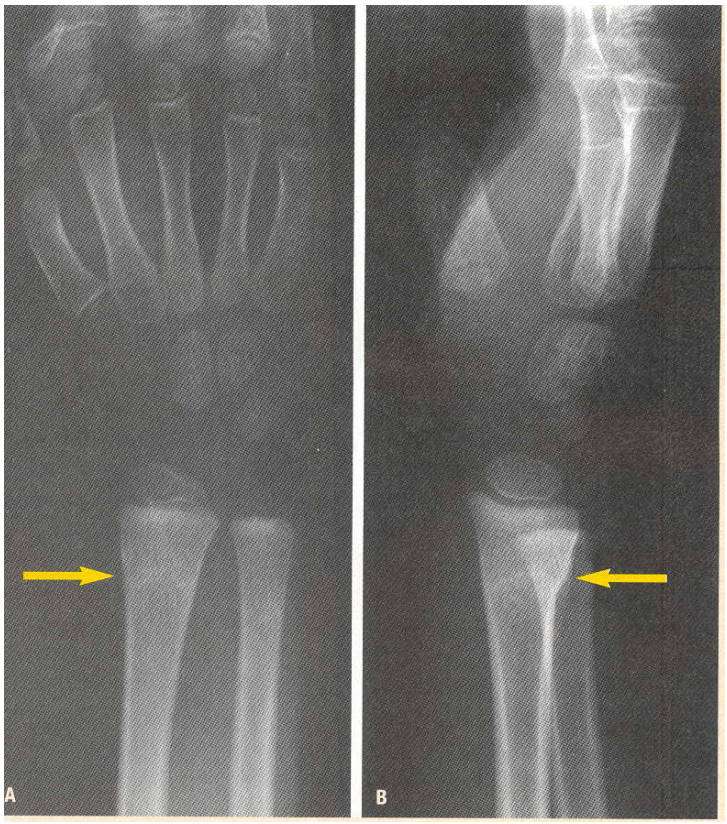
The classic Salter Harris 1 Fracture is the Slipped Capital Femoral Epiphysis (SCFE). Unfortunately SH1 fractures may not be radiographically apparent unless the epiphysis is moved relative to the metaphysis (distracted – pulled away, displaced – moved laterally). Patients with pain on palpation over the growth plate without radiologic evidence of a fracture are considered Salter-Harris type 1 fractures and warrant immobilization with splint or cast and follow up with orthopedics.

**SHAFT INJURIES**

In children a strong, thick, and very elastic periosteum acts like a splint around broken bone. Immature bone has the ability to bow rather than break in response to force.

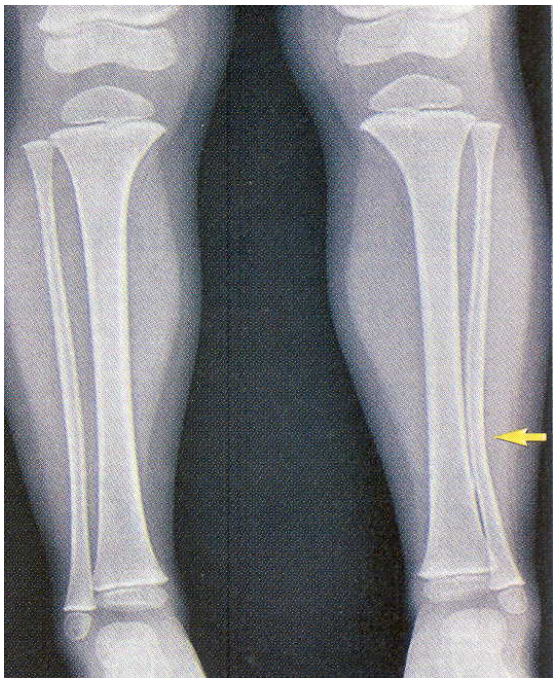
XRAY 1 - Torus / Buckle fracture

A compressive force in a child will produce a torus fracture, also called buckle fracture instead of the impacted fractures that occur in adults. Controversy exists regarding the management of buckle fractures of the distal forearm. Classically, these have been treated with casting. Recent evidence suggests that removable splints may improve function.




XRAY 2 - Greenstick fracture - A force applied to the side of a long bone may disrupt one cortex while merely bending the other, producing a greenstick fracture

XRAY 3 - Plastic deformation - In very young children, neither cortex may break, producing a bowing of the bone referred to as plastic deformation



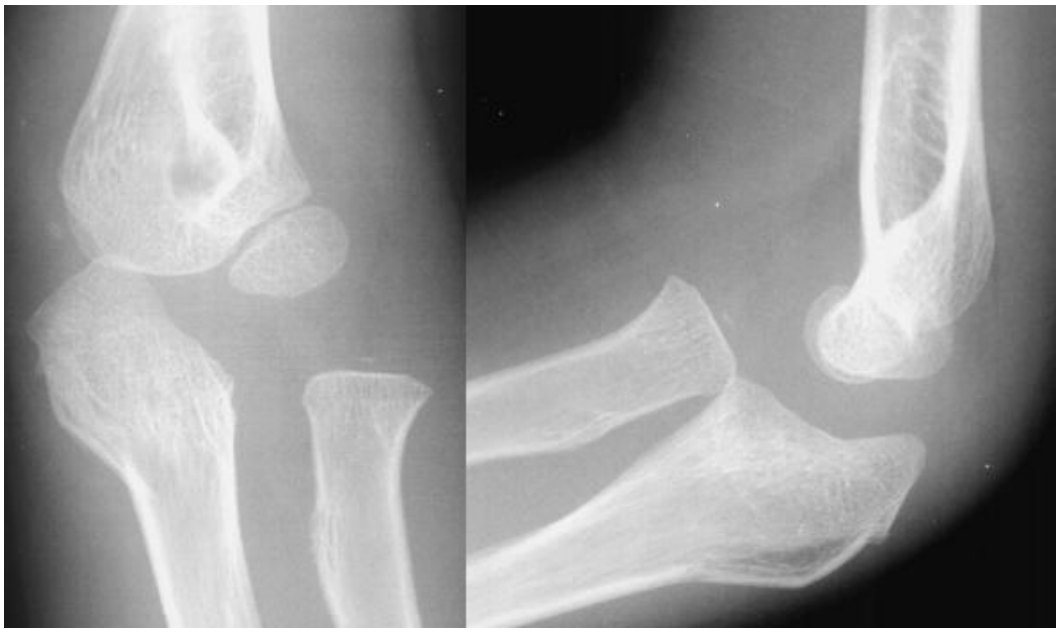
**FOREARM FRACTURES**

The distal radius is the second most common fracture site in children (after the clavicle), and the distal radial physis is the most commonly injured physis in the body. The usual mechanism of injury is a fall on to an outstretched arm with the wrist extended. A simple fall may result in a nondisplaced fracture, whereas a fall in conjunction with forward momentum (riding a bicycle or in-line skating) is more likely to produce a displaced fracture.

The forearm is a “bony ring”, and isolated fractures are rare. Check the radiographs carefully for an associated ulnar styloid or distal ulna metaphyseal fracture, or associated dislocation of the radio-ulnar joint (Galleazi injury. XRAY 4). Proximal ulnar fractures are often associated with dislocation of the radial head: Monteggia injury. (XRAY 5).
Mnemonic - G R /U M - Galleazi - Radius fx  / Ulna fx - Monteggia

XRAY 4 – Galleazi Injury

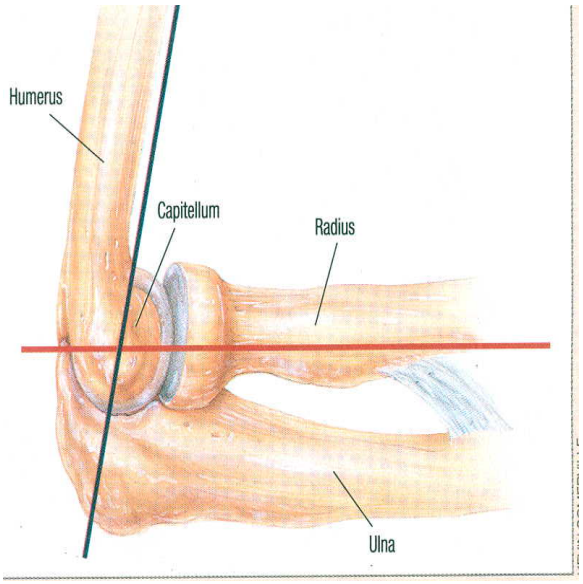
XRAY 5 – Monteggia Fracture



**ELBOW FRACTURES**

More than half of all pediatric elbow fractures are supracondylar. These, combined with lateral condylar fractures, make up more than 80% of elbow fractures in children. The fracture line may not be apparent in a nondisplaced supracondylar fracture, and a positive fat pad sign may be the only clue to an occult fracture.

Fat pad sign: Fat is normally present within the joint capsule of the elbow. Intra-articular effusion or hemorrhage cause distension of the synovium and forces the fat out of the fossa, producing triangular radiolucent shadows anterior and posterior to the distal end of the humerus. On a true lateral flexed view of the elbow a small anterior fat pad may be seen normally  while a posterior fad pad will not be seen. When present in a patient with a history of acute trauma to the elbow, the fat pad sign indicates the presence of an intra-articular hemorrhage, which in turn is often associated with an intra-articular skeletal injury.




The large amount of nonossified cartilage around the elbow makes detection of fractures and displacement of nonossified portions difficult. Some basic landmarks on the lateral view help in reviewing elbow radiographs. The anterior humeral line, drawn parallel to the anterior edge of the humerus, should course through the middle third of the capitellum. The radiocapitellar line, drawn through the axis of the radial shaft, points directly to the capitellum in all views. Disruption of these normal anatomic relationships indicates a displaced fracture. Xray 5) and 6)

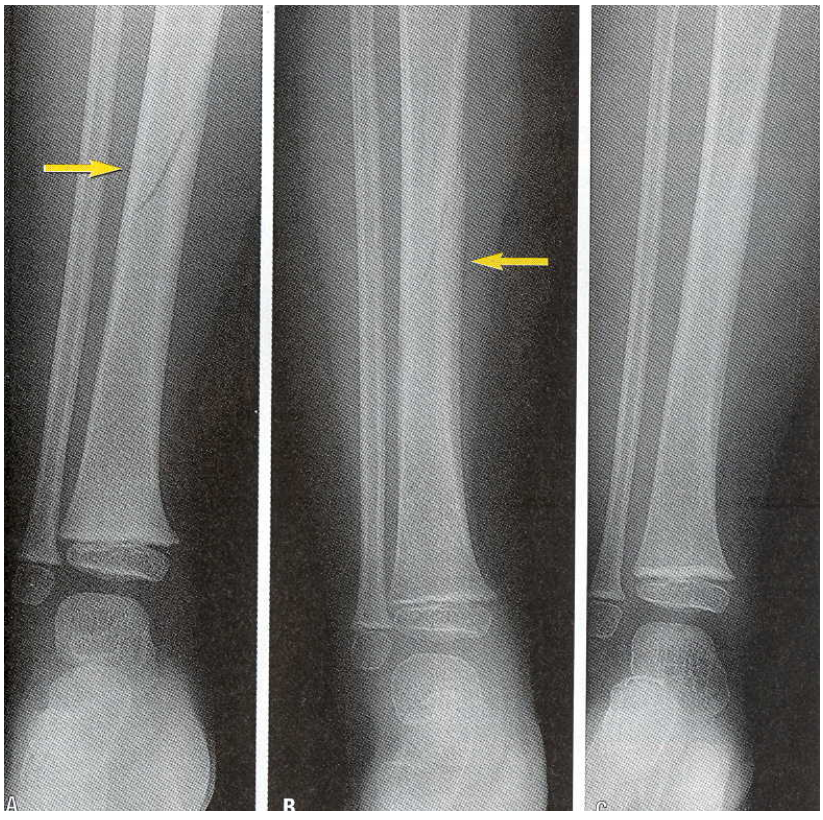
There are multiple ossifications centers in the elbow that close at various times. For this reason a contralateral view of the elbow should be obtained to aid in interpretation when an elbow fracture is suspected. The mnemonic CRITOE can aid in the identification of the ossification centers and there approximate time of closure  C – capitellum, R – radial head, I – Internal (medial) condyle, T – trochlear, O – olecranon, E- external (lateral) condyle. These close at 1,3,5,7,9 and 11 years respectively

**TIBIAL FRACTURES**

Compared to fractures of both the tibia and fibula, isolated fractures of the tibia are usually caused by relatively mild forces. Falls and twisting injuries of the foot are common mechanisms of injury.

Toddler's fractures occur most commonly in children younger than 2 years old who are learning to walk. Frequently, there is no definite history of a traumatic event, and the child is brought to the ED because of reluctance to bear weight on the leg. Examine the hip, thigh, and knee first to rule out other causes of limping. A thorough physical examination may be limited by the child's cooperation, but maximal tenderness can usually be elicited over the fracture site. Typical findings are a nondisplaced spiral fracture of the tibia and no fibular fracture. Xray 7)

Toddler's fracture often present in a pattern suspicious for child abuse because there is often no witnessed trauma and the spiral fracture suggests a twisting force. However, presence of an isolated tibia fracture in a toddler, and absence of other signs of inflicted injury (bruises, marks, old fractures) are reassuring and don’t necessary warrant further investigations.



## FRACTURES OF ABUSE

A majority of fractures in children younger than 1 year are caused by physical abuse, and a significant percentage of the fractures in children younger than 3 years are the result of abuse.

When evaluating a child with a musculoskeletal injury, you must decide whether the reported history of the trauma is consistent with the pattern, severity, and extent of the injury. Watch for signs of evasiveness, vagueness, changing details of the circumstances of the injury, or delay in seeking medical attention.
There is no predominant fracture pattern in child abuse. Diaphyseal fractures, accidental or inflicted, can be transverse, oblique, or spiral; the pattern is determined by the force applied.

Femoral fractures in children younger than 1 year are highly suspicious for child abuse. Because scapular fractures result only after significant force, a scapular fracture in a child without a clear history of violent trauma should raise suspicion of abuse. Other fracture patterns associated with child abuse include epiphyseal and metaphyseal fractures of the long bones and corner or "chip" fractures of the metaphyses. Radiographic evidence of unexplained fractures in different stages of healing is perhaps the strongest finding suggestive of child abuse.