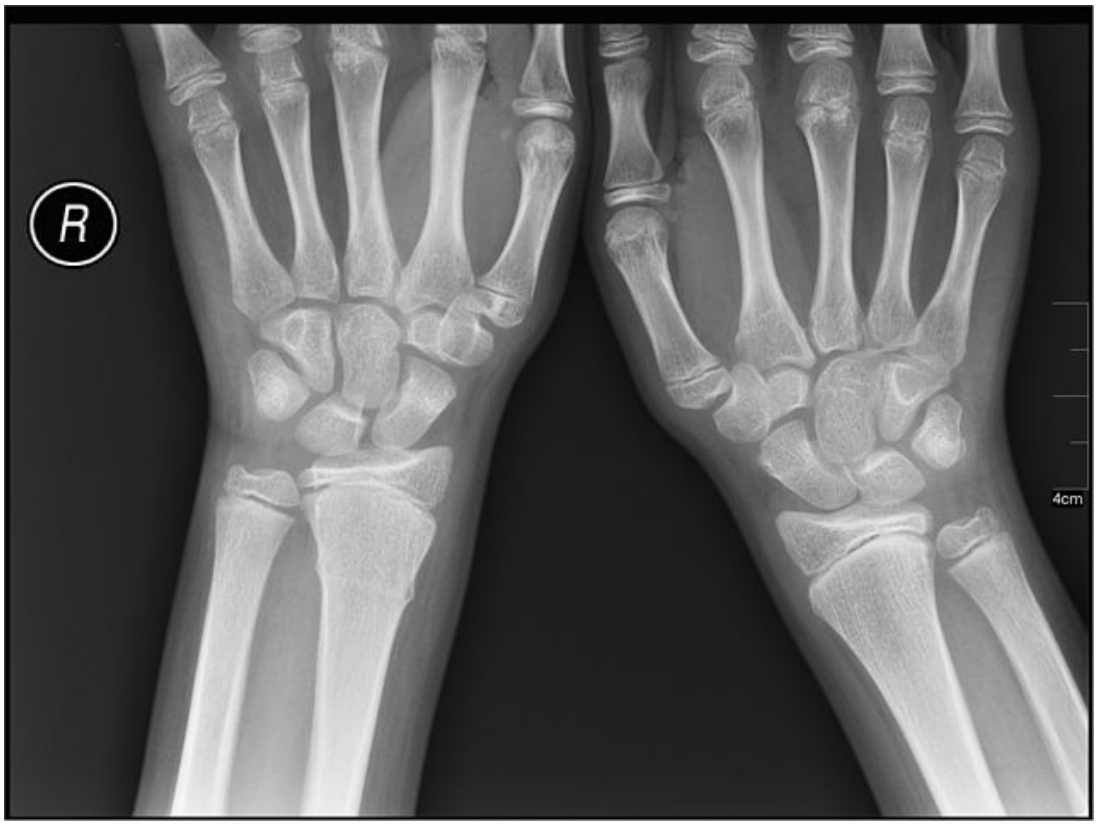
Common Pediatric Fractures — Classification and Radiology

See online here

The most common cause of death in the pediatric population is an unintentional injury. Approximately 20,000 children each year become disabled because of trauma, and 15 million children per year visit the emergency department because of unintentional injuries. The incidence of musculoskeletal injuries in children is around 1068 cases per 10,000.



Initial Evaluation of the Injured Child

When a child presents to the emergency department with a history of trauma to an upper or lower extremity, one should avoid jumping to treat the suspected fracture before performing a complete primary survey of the child.

A **careful history of the mechanism of injury, a complete and thorough physical examination, followed by the basic airway, breathing and circulation management is the best approach** to manage an injured child.

Physical examination

Physical examination of the injured limb should include a **formal neurovascular assessment**. Whenever examining an injured limb, it is always beneficial to compare with the non-injured limb. Once the injured limb is fully examined and the neurovascular status of the injury is documented, one should start **looking for associated injuries** which can be more life-threatening than the obvious limb injury.

Radiographic imaging

When the examined limb is obviously fractured, **temporary immobilization using either a Thomas splint or back slab is indicated before obtaining radiographs as it helps to prevent further damage and control the pain.**

Radiological investigation of a fracture follows the rule of two that states:

Two limbs/sides: when obtaining a radiograph of an injured limb, it is also considered good practice to obtain a radiograph of the non-injured limb for comparison since children have bones that may not have already ossified thus possessing variant anatomy that may lead to misinterpretation of the images.

Two joints: the radiograph should always include one joint below and one joint above the supposed injury site.

Two views: the minimum views obtained for the initial evaluation of a suspected fracture in a child are an **anteroposterior and a lateral view**. Comparison with the contralateral side is useful when someone is confused whether a transverse line is a true fracture, or the normal growth plate expected to be seen in the child.

Two times: upon obtaining images for diagnosis all fractures must be followed up with another set of images after healing.

Important Considerations During the Radiographic Evaluation of Pediatric Fractures

Differences between children and adults

When you read and interpret a radiograph film of a child fracture, you should take into consideration **multiple differences between children and adults**. In children, the growth plates are usually still open, and they can be mistaken for a fracture. To overcome this issue it is necessary to compare the injured limb with the non-injured contralateral side.

Another important point to consider is whether a fracture involves the growth plate or not. The **involvement of the growth plate in a child fracture is associated with progressive limb deformity**. Additionally, bone separation at the growth plate can be seen in children who have sustained a significant trauma to the limb.

The **periosteum is much thicker in children** compared to adults, therefore, fracture displacement in children is usually minimal. As a result, a fracture that does not involve the periosteum can be seen in children, and the **fractures in children usually show higher inherent stability** compared to adults. Additionally, in children, fractures are **expected to heal faster**, and **non-union fractures are rarely observed**.

Children's bones are also more porous which makes them more susceptible to bending and compression that can often cause greenstick fractures.

Interpretation of a Limb Radiograph of a Child

Systematic approach

Similar to adults, when someone interprets the radiograph of the injured limb of a child, a **systematic approach should be followed.** This way, no subtle injury would be overlooked, in expense for the more obvious fracture.

The following features should be checked on the radiograph:

1. Anatomic location of the fracture
2. Configuration of the fracture
3. Relationship of the fracture fragments to each other
4. Relationship of the fractured segment to adjacent structures

Classification of the fracture

The anatomical description of the fractured site helps in the classification of the fracture into:

1. Diaphyseal fracture that involves the central shaft of a long bone
2. Physeal fracture that involves the growth plate
3. Epiphyseal fracture that involves the chondro-osseous end of a long bone

The involvement of the growth plate, known as a physeal fracture, is specific to the pediatric population.

Configuration of a fracture

Image: "Pediatric Tibial Fracture" by James Heilman, MD. License: CC BY-SA 4.0

The configuration of a **child's fracture can be quite different** from the one observed in adults.

1. **Plastic deformation fracture** is characterized by bone bowing beyond the natural capacity of the elastic recoil of the bone.
2. A **buckle fracture** occurs at the junction between the metaphysis and diaphysis.
3. A **greenstick fracture** is characterized by a complete linear fracture of the bone with an intact periosteum.
4. A **complete fracture** is classified similarly to what you would expect in an adult: transverse, spiral, oblique, comminuted or butterfly.

The relationship of the fractured fragments is described similarly to when interpreting a radiograph of an adult's fracture. It involves a mention of the **angulation**, whether the fragments are **overriding** each other and whether the fracture is in **bayonet relation,** that is, 'minimal displacement with cortical contact'.
The fracture can be **open**, i.e., 'a break in the skin', or **closed**.

Classification of Physeal Fractures in Children

The **presence of a growth plate in children's bones is of great clinical significance** to the emergency doctor. The involvement of the physeal portion, a.k.a. the growth plate, is known to be **associated with progressive disability and abnormal growth of the bone**. Therefore, a classification system of the nature of physeal involvement has been put in place by Salter-Harris.

Classification System by Salter-Harris

A **Type 1 physeal fracture** is characterized by **epiphyseal separation limited to the physis**. This fracture type can be displaced or undisplaced. If undisplaced, the radiograph will not show any abnormality, and the diagnosis is based on the clinical observationof tenderness over the physis.

Type 2 physeal fractures are characterized by a **triangular fractured fragment of the metaphysis** which remains attached to the epiphysis but with separation through the physis.

Type 3 physeal fractures are **intra-articular fractures with physis separation**. Anatomic surgical reduction is indicated.

Type 4 physeal fractures involve **the metaphysis, physis, epiphysis and the joint**. Like type 3 fractures, anatomic surgical reduction is indicated.

Finally, **type 5 physeal fractures are diagnosed retrospectively** when a patient presents with permanent shortening of the bone after a compressive fracture of the physis.

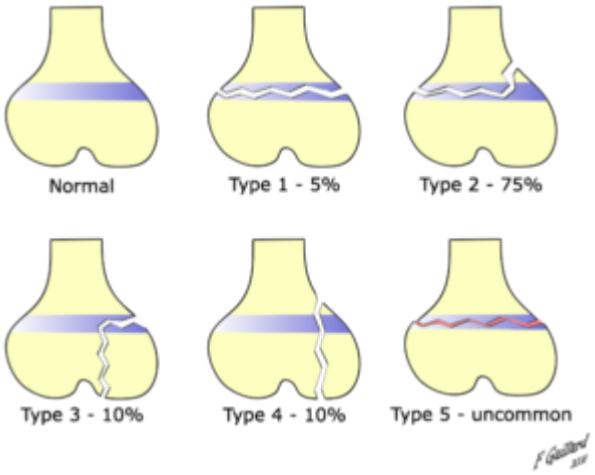


Image: “Salter-Harris Classification” by Dr Frank Gaillard. License: CC BY-SA 3.0

Imaging Characteristics of Specific Fractures in Pediatrics

Upper Limbs		
Site	**Radiographic Features**	**Comments**
Clavicle	A non-displaced fracture that can be easily identified on a good-quality radiograph.	Brachial plexus injury should be excluded.
Physeal fractures of the humerus	Type 1 physeal fractures in infants. Type 2 physeal fractures in children six years and older.	Surgical reduction and fixation are restricted to patients who show displacement after close reduction.
Supracondylar Humerus Fractures	It is usually a complete fracture with significant displacement.	
Lateral Condyle Humerus Fractures	These fractures are commonly displaced.	Non-union is common. Percutaneous pinning or open reduction is indicated.
Radial Neck Fractures	Look for other fractures in the elbow region	Percutaneous pinning is indicated.
Nursemaid’s Elbow	A normal radiograph in a child who refuses to move the affected limb.	After closed reduction, the child is expected to be able to use the arm immediately.
Forearm Fractures	The radiograph should include the site of the fracture, the elbow, and the wrist.	Closed reduction and casting for non-displaced stable fractures. Operative reduction and stabilization of displaced unstable fractures.
Spine Fractures		
Anywhere in the spinal column	A computed tomography scan to evaluate the spinal column. A magnetic resonance imaging study of the spinal cord to exclude spinal injuries such as hematoma, contusion or transection.	An intact spinal cord or a small contusion has a good prognosis. Spinal cord hemorrhage or complete transection has a grim prognosis.
Lower Limbs		

Hip Fractures	If the fracture cannot be visualized on a radiograph, obtain a technetium phosphate bone scan or a magnetic resonance image.	Proximal fractures can undergo avascular necrosis which is associated with growth disturbance in children. Hip fractures usually occur in a polytrauma setting, i.e., after a motor vehicle accident, and are usually associated with significant life-threatening injuries to the head, chest or abdomen.
Femoral Shaft Fractures	These fractures can show angulation and displacement on plain radiographic films. Therefore, one should comment about that.	These fractures are usually associated with multiple injuries in high-energy impact trauma such as in motor vehicle accidents.
Fractures Involving the Knee Joint	The involvement of the distal physis of the femur is common. A computed tomography scan for the evaluation of the knee joint is indicated.	Anatomical reduction is indicated for optimum results.
Tibia Fractures	In children aged three–four years, a spiral non-displaced fracture of the tibia is the most common finding. If the radiograph is negative, one should re-examine the radiograph after identifying the point of maximum tenderness on physical examination.	When in doubt, a cast should be placed around the injured limb anyway. After two weeks, a repeat radiograph will confirm the diagnosis retrospectively, by showing signs suggestive of a healing fracture.

References

http://dx.doi.org/10.1016/S0031-3955(05)70447-8

Notes