Educational review of common pediatric musculoskeletal injuries presenting to the emergency department of a level one-trauma center

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Learning objectives

- To understand the special considerations that apply to paediatric musculoskeletal trauma patients.
- To understand the most common paediatric musculoskeletal injuries that present to the emergency department.

Background

Trauma is the leading cause of death in children over one year of age and exceeds all other causes of death combined.

Sports injuries in children and adolescents are by far the most common cause of musculoskeletal injuries treated in the emergency department, accounting for 41% of all musculoskeletal injuries. (1)

Falls, especially in the infant and toddler age group, pedestrian accidents, and motor vehicle accidents also account for a large portion of injuries of childhood.

The most frequently injured bones are the femur, humerus, tibia/fibula, ankle/foot, and radius/ulna. (2) Forearm and wrist injuries are most commonly seen in biking, hand injuries in football and basketball, knee injuries in soccer, and ankle and foot injuries in basketball.

Several factors influence paediatric musculoskeletal trauma, including age, sex, behaviour, and environment. Male children have higher injury and mortality rates compared to female children (62% in one series), perhaps in part because of their more aggressive behaviour and exposure to contact sports. (1)

Sprains and fractures are the most common injury types, with female patients suffering more sprains and fewer fractures than male patients.

Paediatric bone is less dense, more elastic, and more porous and penetrated by more vascular channels than adult bone. This prolongs the time and energy required before bone is broken. The porosity of childhood bone helps prevent propagation of fractures; hence comminuted fractures are infrequently encountered in children.

Osseous healing in children is faster compared to adult patients due to the extremely osteogenic perosteum. The rate of healing declines with age with younger patients experiencing more rapid healing of fractures. (3)
Most injuries in children are simple fractures and relatively easy to treat with closed reduction and immobilisation.

Dislocations and ligamentous injuries are generally less common in children than in adults, as the physis is usually the weakest link and most prone to injury.

Certain fractures such as those involving the physis are unique to the paediatric population and warrant special consideration as they can result in growth disturbance and deformity.

**Imaging findings OR Procedure Details**

We present a pictorial review of the more common paediatric musculoskeletal injuries presenting to our emergency department.

There are several fracture types that are specific to the paediatric population:

**Plastic deformation**

This fracture is unique to children and occurs when a force produces microscopic failure on the tensile or convex side of the bone which does not propagate to the concave side. Essentially, the bone is angulated beyond its elastic limit, but the energy is insufficient to produce a fracture. This occurs most commonly in the ulna and fibula and a fracture line will not be visible radiographically.

If this occurs in a child less than 4 years of age or the angulation is less than 20°, the deformity usually corrects with growth. (4)

**Buckle fracture**

Buckle (torus) fractures are common in infants and children and generally occur at the junction of the metaphysis and the diaphysis. They result from axial loading of a long bone with resultant impactive buckling of the trabeculae along the fracture line and unilateral or bilateral outward bulging of the cortex. In other cases, only angulation of the cortex is seen. Commonly affected sites are the wrist, radius, humerus, and ankle. In the wrist, the radius is more commonly involved than the ulna, and in the foot, the tibia is more commonly involved. (5)
Greenstick fracture

A greenstick fracture occurs when a bone is bent and the tension side of the bone fails. The bone fractures but does not propagate completely through the bone with plastic formation at the compression side. (6)

Complete fracture

Complete fractures propagate completely through a bone and may be of a transverse, oblique or spiral pattern.

Physeal fractures

Fractures of the growth plate are unique to childhood and account for up to 30% of long bone fractures. (7) The Salter-Harris classification of growth plate injuries guides both the prognosis and the potential for growth disturbance. This system classifies growth plate fractures into five groups: type I, fracture through the growth plate; type II, fracture through the growth plate and metaphysis; type III, fracture through the growth plate and epiphysis; type IV, fracture through the growth plate, epiphysis and metaphysis, and type V, crush or compression injury of the growth plate. Most of these fractures heal without permanent deformity; however, a small minority are complicated by growth arrest and deformity. (8) There is a limited window for the reduction of deformity as the physis heals rapidly, usually within 3 weeks.(3)

Apophyseal avulsion fractures

Apophyseal avulsion fractures occur most commonly between the ages of 14 and 25 years and are frequently missed on initial radiographs.

They are the result of a sudden forceful concentric or eccentric contraction of a muscle attached to the apophysis with the fracture failing through the physis.

The most common sites are in the pelvis and include the anterior superior iliac spine, anterior inferior iliac spine, ischial tuberosity, lesser trochanter and iliac crest.

Several classification systems have been proposed. One system accounts for the degree of displacement: Type 1 - nondisplaced; type II - displaced up to 2 cm; type III - displaced > 2cm; type IV - symptomatic nonunions or painful exostosis. (9)

Images for this section:
Fig. 9: Ankel radiograph AP and lateral. Spiral fracture of the distal tibial metaphysis with extension to the physis - Salter-Harris II injury.
Fig. 10: AP pelvic radiograph. Chronic avulsion fracture of the right ischial tuberosity.
**Fig. 11:** Bilateral frog-leg lateral radiograph. Slipped capital femoral epiphysis on the left.
Fig. 4: Coronal CT image left ankle. Salter-Harris type IV fracture of the distal tibia with intra-articular extension from the lateral tibial metaphysis through the physis.
Fig. 12: Sagittal CT image left ankle. Triplane fracture of the distal tibia.
Fig. 3: Oblique foot radiograph. Displaced avulsion fracture from the base of the fifth metatarsal.
**Fig. 14:** Oblique foot radiograph. Displaced avulsion fracture from the base of the fifth metatarsal.

**Fig. 18:** PA hand radiograph. Fracture of the neck of the fifth metacarpal with volar angulation.
Fig. 2: AP humerus. Salter-Harris type I fracture through the proximal humeral physics with superolateral displacement of the distal component.
Fig. 13: AP humerus radiograph. Displaced spiral fracture of the distal humeral shaft.
Fig. 5: PA index finger radiograph. Salter-Harris type II fracture of the base of the middle phalanx of the index finger.

Fig. 15: AP shoulder radiograph. Transverse fracture of the distal third of the clavicle with inferior displacement of the inferior component.
Fig. 7: AP pelvic radiograph. Avulsion fracture of the left anterior superior iliac spine.
Fig. 6: AP pelvic radiograph. Avulsion fracture of the left anterior inferior iliac spine.
Fig. 16: AP elbow radiograph. Displaced avulsion fracture of the medial humeral epicondyle.
Fig. 17: Lateral elbow radiograph. Displaced supracondylar fracture with an associated elbow joint effusion.
Fig. 19: Lateral elbow radiograph. Displaced fracture of the neck of the radius with an associated elbow joint effusion.
**Fig. 1:** Oblique elbow radiograph. Displaced supracondylar fracture with an associated elbow joint effusion.
Fig. 20: Lateral elbow radiograph. Avulsion fracture from the posterior distal humerus.
**Fig. 21:** Lateral knee radiograph. Avulsion fracture of the tibial tuberosity with evidence of Osgood-Schlatter disease.
Fig. 22: Lateral wrist radiograph. Greenstick fracture of the distal radial metaphysis.

Fig. 23: PA wrist radiograph. Torus fracture of the distal radial metaphysis.
**Fig. 8:** AP knee radiograph. Salter-Harris type II fracture of the proximal tibial metaphysis.

**Fig. 24:** Oblique femur radiograph. Displaced oblique fracture of the mid femoral shaft.
**Fig. 25:** Lateral knee radiograph. Patellar sleeve avulsion fracture.

**Fig. 26:** AP and lateral ankle radiograph. Triplane fracture of the distal tibia.
Fig. 27: AP knee radiograph. Salter-Harris type II fracture of the supracondylar femur.
Conclusion

Care of the pediatric trauma patient is a complex and integrated process with its own unique considerations that differs it from the care of the adult patient. Certain musculoskeletal injuries in the pediatric population are recurrent and commonplace and it is imperative that the reporting radiologist be familiar with their typical presentation and radiological features.

References


Personal Information