



PEDIATRICS

Understanding and Identifying Pediatric Growth-Plate Fractures

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In general, fractures in children heal well with little intervention as long as the alignment is good. Fractures involving the growth plate, however, are a different issue. In fact, growth-plate injuries are the primary reason for the subspecialty of pediatric orthopedics.

Adult vs. Pediatric Bone

The anatomy and biomechanics of pediatric bone differ from that of adult bone, leading to unique pediatric fracture patterns, healing mechanisms and management. In comparison to adult bone, pediatric bone is significantly less dense, more porous and penetrated throughout by capillary channels. Pediatric bone has a lower modulus of elasticity, lower bending strength and lower mineral content.

The low bending strength induces more strain in pediatric bone compared with the same stress on adult bone, and the low modulus of elasticity allows for greater energy absorption before failure. The increased porosity of pediatric bone prevents propagation of fractures, thereby decreasing the incidence of [comminuted fractures](#). The pediatric periosteum is extremely strong and thick, functioning to reduce and maintain fracture alignment and healing.

The mechanisms of fracture change as children age. Younger children are more likely to sustain a fracture while playing and falling on an outstretched arm. Older children tend to injure themselves while playing sports or riding bicycles, and in motor-vehicle accidents.



Because a child's ligaments are stronger than those of an adult, forces that tend to cause a sprain in an older individual are transmitted to bone and cause a fracture in a child. Caution should therefore be exercised when assessing a young child diagnosed with a sprain. The most common locations for fractures in children are the distal radius, hand / phalanges, elbow, clavicle and tibia.

Pediatric long bones have three main regions: epiphysis, physis and metaphysis. In addition, the periosteum, a thick nutrient layer, wraps circumferentially around the bones.

- *Epiphysis*: each end of a long bone with associated joint cartilage
- *Physis* (growth plate): cartilage cells that create solid bone with growth
- *Metaphysis*: wide area below the physis, closest to the diaphysis / shaft

Children's bones tend to bow, rather than break; therefore, it is more likely that they will have an incomplete fracture (a fracture that only goes partially through the bone). Incomplete fracture may not be visible on X-ray. Common incomplete fracture types include the following:

- *Buckle or torus fracture*, in which one side of the bone bends, causing a buckling of the cortex, without breaking through to the opposite side. Compressive force creates a torus fracture or buckle fracture.
- *Greenstick fracture*: A force to the side of bone may cause a break in only one side of the cortex, while the opposite cortex only bends; this is termed a *greenstick fracture*. In very young children, neither cortex may break, causing plastic deformation.

Growth-plate fractures account for 15-20 percent of major long-bone fractures and 34 percent of hand fractures in childhood. The large majority of these fractures heal without any impairment of the

growth mechanism, but some lead to clinically important shortening and angulation. Growth-plate fractures may lead to growth disorders due to destruction of epiphyseal circulation, which inhibits growth; or by the formation of a bone bridge across the growth plate.

Classifying Growth-Plate Fractures: Salter Harris

Growth-plate fractures are classified according to the location of the fracture. The Salter Harris classification is the most common classification of growth-plate fractures.

Type I affects young children. The growth plate is thick, with large, hypertrophying chondrocytes and a weak zone of provisional calcification. The mechanism is a pure shearing force; fracture lines follow the growth plate, separating epiphysis from metaphysis. Unless the periosteum is torn, displacement does not occur, making the injury invisible on radiograph. Healing is rapid, usually within 2-3 weeks, and complications are rare.

Type II occurs after age 10. The mechanism is a shearing force or avulsion with an angular force; there is cartilage failure on the tension side and metaphyseal failure on the compression side. With type II fractures, there is a division between epiphysis and metaphysis, except for a fragment of metaphyseal bone, which is still attached to the epiphysis. Healing is rapid and growth is rarely disturbed. However, type II fracture of the distal femur and tibia may result in growth deformities.

Type III usually occurs after 10 years of age; this type of fracture generally occurs when the growth plate is partially fused. Prognosis is poor unless there is early, accurate reduction. Type III physeal injuries involve separations of a portion of the epiphysis and its associated growth plate from the rest of the epiphysis.

Type IV may occur at any age. Type IV fractures potentially interfere with normal growth. The fracture line crosses the physis, separating a portion of the metaphysis and epiphysis from the remaining metaphysis-physis-epiphysis. If the fracture is displaced, open reduction and internal fixation are indicated. Even with perfect reduction, growth is affected and prognosis is guarded.

Type V growth-plate injuries are due to severe axial loading. Some or all of the physis is so severely compressed that growth potential is destroyed. Angulation and limb-length inequality may be long-term complications.

The most common Salter Harris fracture is a type II, followed by I, III, IV and V. Most type I and type II fractures can be effectively managed conservatively.

Average Healing Times of Common Pediatric Fractures

- Phalanges: 3 weeks
- Metacarpals: 4-6 weeks
- Distal radius: 4-6 weeks
- Lower arm: 8-10 weeks
- Humerus: 6-8 weeks
- Femoral neck: 12 weeks
- Femoral shaft: 12 weeks
- Tibia: 10 weeks

If a fracture is suspected due to clinical findings, but no fracture is apparent on the X-ray, you should

treat the injury as if there is a fracture. In children, fractures will heal very quickly with near-anatomical alignment. Restrict motion with splinting and re-evaluate within two weeks of the injury.

If no fracture is evident on repeat X-rays and range of motion is normal with no discomfort, normal activity can be allowed. If a fracture remains apparent, continue the splinting and reassess at four and six weeks. Once there is a hard callous formation, physical therapy can begin – but not full weight-bearing. Once remodeling appears sufficient, full weight-bearing with mild exercise is possible.

If you are uncomfortable treating uncomplicated fractures or if there is a concern that the growth plate might be injured, a pediatric orthopedic consultation is most prudent.

Resources

- [Slideshow](#): Typical Fractures Seen in Children.
- Rang M, Pring ME, Wenger DR. *Rang's Children's Fractures*. Lippincott Williams & Wilkins, 2005.
- Islam O, Soboleski D, Symons S, et al. Development and duration of radiographic signs of bone healing in children. *Am J Roentgenol*, 2000 Jul;175(1):75-8.

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