

Growth Plate Fractures

Recognition and Age-Related Sequela

by Mark T. Dahl, MD

Wrists, elbows, ankles and knees. An injury to these areas in an adult might very well result in a torn ligament, fracture or dislocation of a joint. But in children under about age 16, the ligaments and structures of the joint capsules are two to five times stronger than the growth plates at either end of the long bones, and a fracture is more likely to result from a blow or fall.

Fractures that involve the growth plate frequently occur in kids. They can occur at any of the junctures where the long bones meet the joints. Injuries to the fingers and wrists are particularly common, often as a consequence of skateboard, snowboard or bicycle accidents.

The growth plate (physis) separates the epiphysis (the very end of the bone) from the metaphysis (the wide area next to the diaphysis) which is the bone shaft. The growth plate is a disc-like formation that is a few millimeters thick. It consists of a rubbery yet soft cartilage, making it susceptible to fractures. The growth plate provides for the lengthwise growth of the bone during childhood and adolescence. As growth ceases at maturity, the growth plate fuses with the surrounding bone.

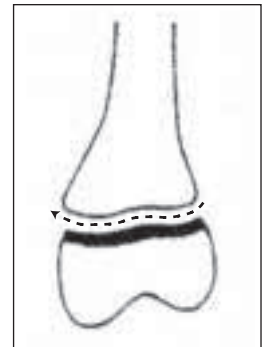
The consequences of a growth plate fracture depend on the type of injury, location of the growth plate, and age of the child. The younger the child, and the more years of growth that remain, the greater the potential for long-term deformity, such as limb-length discrepancy or bone angulation.

The key to preventing deformity is early diagnosis and treatment of the growth plate injury.

Salter-Harris Classification

Growth plate injuries generally fall into five categories, as specified by the Salter-Harris Classification of Growth Plate Injuries.

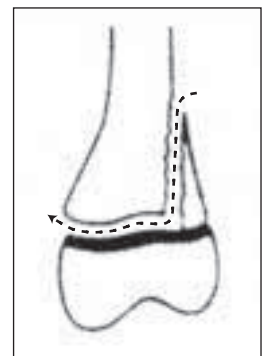
Type 1 — This type of fracture splits the growth plate, separating the epiphysis from the metaphysis. If the patient presents with a complaint of tenderness just above the joint, a possible growth plate fracture should be considered, even if X-rays are inconclusive. Because type 1 fractures pass only through cartilage and not bone, they are not readily evident on X-rays. An X-ray one or two weeks after the injury that shows widening of the plate or new bone growth along the growth plate margin may confirm the presence of a fracture.



Type 1

In most cases, simple casting will result in complete healing of a type 1 fracture. Manipulating the fracture with a closed reduction is required when displacement is present. Most type 1 fractures heal in about four to five weeks. Post-fracture X-rays can reveal problems with growth weeks to months later.

Type 2 — This fracture splits partially through the growth plate and then upward across one corner of the metaphysis. This common growth plate fracture occurs in approximately 75 percent of injuries of the growth plate.



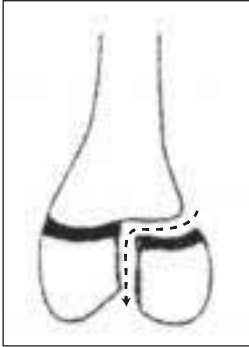
Type 2

If the fracture is not properly set (reduced), bone may bridge across the growth plate as the fracture heals, resulting in a premature arrest of the growth plate and subsequent angulation of the bone.

In some cases, even with ideal reduction of the fracture,

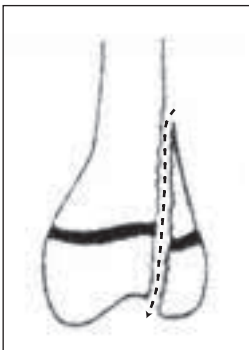
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the growth plate will heal with bone rather than cartilage, resulting in premature physal arrest (known as a physal bar). Initial treatment of these fractures requires reduction and immobilization, improving the prognosis for normal growth.



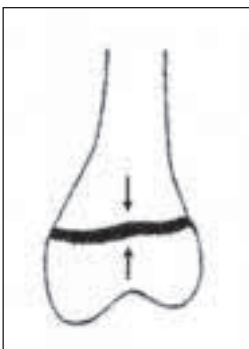
Type 3

Type 3 — A type 3 fracture runs across a portion of the growth plate, then completely through the epiphysis and into the joint. This separates a part of the epiphysis and growth plate from the metaphysis and creates a disrupted joint surface. This injury is less common, and usually requires open reduction (incision and setting the fragments into position) and internal fixation (screws or pins).



Type 4

Type 4 — This fracture runs obliquely through the metaphysis, across the growth plate, and finally splits the epiphysis into the joint. The result may be the malunion or nonunion of the growth plate with the bone as the injury heals. Surgery to perfectly realign the growth plate and bone segments, and fixation with screws or casting is required. Failure to do so can lead to difficulties with growth.



Type 5

Type 5 — This type of injury occurs when the growth plate is compressed. It is difficult to recognize, as no fracture line is evident on initial X-rays. It is often associated with a fracture in the diaphysis, and commonly discovered long after the diaphyseal fracture has healed. There is arrest of growth in most cases. Treatment is difficult, even with early diagnosis. Usually, treatment is compensatory and depends on the child's stage of growth.

Ongoing observation is key

Referral to an orthopaedic surgeon is prudent with most fractures that involve the growth plate. These fractures need to be observed for over a year or more, even when initial treatment appears to be successful. Deviations in the healing process can be difficult to recognize without periodic X-rays, as subsequent deformity occurs slowly and subtly.

What's age got to do with it?

In short — just about everything. After it is confirmed that a child has a growth plate injury, the child's age and the location and pattern of the injury are the primary determinants of risk for future deformity. For example, a complete growth plate arrest in the distal femur of a 15-year-old boy (with one year of growth remaining) will result only in a loss of about one centimeter of growth. A similar injury in a 5-year-old boy (with 11 years of growth remaining) will result in an 11 centimeter discrepancy.

Treatment options for premature growth arrest

There are several types of treatment for growth plate deformities:

1. Opposite side growth arrest (epiphyseodesis) for small leg length discrepancy
2. Arrest of the remainder of a damaged growth plate to prevent deformity
3. Removal of physal bar
4. Limb lengthening
5. Corrective osteotomy

Intentional Growth Plate Arrest

Depending on a child's stage of growth and development, completely or partially arresting a growth plate (epiphyseodesis) may be the treatment of choice.

Kate is a 12-year-old girl with a premature fusion of the lower tibial growth plate. The growth of her fibula continues at a normal rate and her ankle begins to angulate. Arresting the fibular growth plate can prevent such angulation. With growth ceasing by age 14 in most girls, she would likely lose five to 10 millimeters of length. Alternatively, if the angulation wasn't detected until after maturity, an osteotomy to realign the bone would be necessary.

Similarly, if angulation is developing as the result of a partial arrest of a growth plate, small bone staples can be used to tether the remainder of the growth plate if the adolescent is approaching maturity.

In the case of a growth plate arrest at one end of a long bone — for example at the distal femur — an X-ray can help determine how short the leg is going to be when the lower femur stops growing. A growth plate arrest can then be performed on the opposite leg to slow growth so that the leg lengths are symmetric at maturity.

Parents are often concerned that this treatment method will result in their child losing considerable height. In reality, stature shortening from epiphyseodesis is generally less than one inch.

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Bar excision

When the healing of an injury results in bone forming across the growth plate, it is sometimes possible to remove this bone scar or "bar." This helps restore more normal growth and can help prevent deformity. This relatively non-invasive procedure can be done when the bar formation constitutes less than 20 to 30 percent of the growth plate, as determined by an MRI scan.

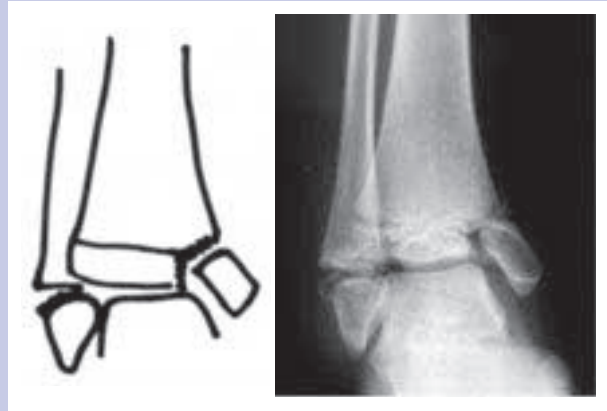
Small dental burs are used to take the bone scar out, which is then replaced by a small amount of fat taken from the surrounding skin. The fat blocks the return of bone formation, allowing the rest of the growth plate to function more normally.

Limb lengthening

Limb lengthening may be the best option when a growth plate is prematurely arrested in a young child with many years of future growth.

Unlike congenital conditions that can result in limb-length discrepancies of 20 to 25 centimeters, growth plate arrests usually manifest differences of five to 10 centimeters. Surgical lengthening, using an external fixator, is therefore possible in one treatment.

CASE STUDY:



1A

1B

1A & B: This 7-year-old girl sustained a Salter Harris III fracture of the medical distal tibia and a Salter Harris I fracture of the distal fibula. It was initially treated with open reduction internal fixation.



1C

1D

1E

1C: Shows a 22° varus deformity secondary to premature asymmetric medial distal tibial physal arrest.

1D: X-ray demonstrates an osteotomy with an interpositional bone graft to realign the ankle. At the same setting, the physal bar was removed and interposition fat graft applied.

1E: Shows a two year follow-up with no recurrence of deformity and excellent function.

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Mark T. Dahl, MD, specializes in adult and pediatric limb reconstruction surgery. He graduated from Mayo Medical School and completed his residency in orthopaedic surgery at the University of Minnesota in Minneapolis. He began working at Gillette Children's in 1989, and is director of Gillette's Limb Length & Deformity Clinic and medical director of the Minnesota Limb Length Center.

Dr. Dahl's ongoing education has included specialized training on the application of the Ilizarov procedure (for limb lengthening) in Russia, where the technique was originated.

He is certified by the American Board of Orthopaedics. His professional associations include the American Academy of Orthopaedics, Minnesota Orthopaedic Society, Pediatric Orthopaedic Society of North America and the Association for the Study and Application of the Methods of Ilizarov — North America. For further information, contact Dr. Dahl at (612) 672-2911.