Normal Growth and Growth Cartilage

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1. A 12-year-old boy with a history of a fracture of the distal tibia 10 months earlier undergoes an MRI for evaluation of the distal tibial and fibular physes. Signs of a bony bridge with growth arrest include all except:
   A. Interruption of the physeal cartilage
   B. Interruption of the zone of provisional calcification
   C. Growth recovery line parallel to the physis
   D. Deformity in varus

   **Correct Answer: C**

**Rationale**

Following an injury to the physis, there is a slowdown of growth related to decreased activity during immobilization. This results in increased mineralization of the metaphyseal side of the physeal cartilage. With resumption of growth, the physis leaves behind this disc of mineralized cartilage, so that a line becomes visible. This line is sclerotic on radiographs and of low signal intensity on MR images and indicates the position of the physis at the time of injury. The mechanism is similar to the formation of a ring on a tree during the slowdown of growth that occurs every winter. This growth recovery line has also been called a growth arrest line and is commonly referred to as a Harris line by Orthopaedic surgeons.

If the physis is intact, all of the cartilage will migrate away from the growth recovery line and they will be parallel to each other. If there is a focal area of growth arrest, the physis will be tethered by the bony bridge. The abnormal physis will be unable to migrate away from the growth recovery line at the bony bridge, whereas it will move away from the physis in the regions that have more normal growth. The physis will thus converge with the growth recovery line at the site of the bridge but will be distant from the line where the cartilage is more normal.

Answers A and B are incorrect. Explanation: A bony bridge after physeal injury results in interruption of the physeal cartilage and of the zone of provisional calcification, so A and B are true. Answer D is incorrect. Explanation: The abnormal growth will often lead to angular deformity so D is true.

**References**

2. A 10-year-old girl has an MRI of the knee for evaluation of trauma. On the fat-suppressed proton density images, the high signal intensity of the physeal cartilage extends into the metaphysis, and the zone of provisional calcification is poorly defined. Extension of cartilage from the physis into the metaphysis can be seen in the following except:

A. Chronic sports injury  
B. Scurvy  
C. Metaphyseal infarct  
D. Non-accidental trauma  
E. Rickets

**Correct Answer:** B

**Rationale**

Normal endochondral ossification occurs when the chondrocytes from the hypertrophic zone of the physis undergo normal apoptosis. The integrity of the metaphysis, particularly of the metaphyseal vessels, is essential for the normal death of the chondrocytes. If the metaphysis adjacent to the physis is disrupted, the physeal cartilage widens and becomes irregular because it does not ossify normally. On the contrary, scurvy does not alter mineralization of the cartilage, and in fact, the zone of provisional calcification is very prominent in this condition.

Answer C is incorrect. Explanation: A metaphyseal infarct results in disruption of the metaphyseal vascularity and focal areas of physeal cartilage persisting into the metaphysis. This is seen following radiation therapy, steroids and in Legg-Calve-Perthes disease. Therefore, C. is true. Answer D is incorrect. Explanation: Trauma to the metaphyseal spongiosa can injure the metaphyseal vessels and alter endochondral ossification. Persistence of cartilage into the metaphysis is seen following the classic metaphyseal injury in non-accidental trauma, so D. is true.

Answer A is incorrect. Explanation: Similar disruption occurs after certain Salter-Harris fractures that involve the metaphysis, and is typical for the lesions due to chronic physeal stress from chronic sports injury; A. is true. Answer E is incorrect. Explanation: Vitamin D deficiency also results in failure of endochondral ossification. The tongues of physeal cartilage extending into the metaphysis result in the classic picture of metaphyseal fraying. Vitamin D is necessary for normal metaphyseal angiogenesis, and with rickets the normal apoptosis of the physeal chondrocytes does not occur; thus, E. is true.

**References**

3. A single sagittal grayscale image of the volar surface of the middle finger demonstrates an injury to which structure?
   A. Flexor tendon
   B. Sagittal band
   C. Annular pulley
   D. Volar bowstring

   **Correct Answer: C**

**Rationale**

The ultrasound image depicts the normal flexor tendon crossing over the proximal interphalangeal joint with fluid deep to the tendon. Superficial to the flexor tendon is a linear area of hypoechogenicity that represents an injured A3 annular pulley. This injury is most commonly seen in competitive rock-climbers. Answer _A_ is incorrect. Explanation: The flexor tendon appears normal. Answer _B_ is incorrect. Explanation: The sagittal band, or extensor hood, is a band of ligaments that encompasses the extensor tendons on the dorsal side of the metacarpophalangeal joints. The integrity of the sagittal band prevents extensor tendon subluxation. Answer _D_ is incorrect. Explanation: This is a distractor. The volar bowstring is not an anatomic structure but an indirect sign of full thickness pulley injury. With flexion of the finger against resistance, the flexor tendon will become displaced away from the joint creating a so-called “bowstring” of the tendon.

**Reference**


4. Which of the following will distinguish a full-thickness ulnar collateral ligament tear in the elbow from a partial-thickness injury on ultrasound?
   A. Widening of the ulnohumeral joint with valgus stress
   B. The presence of ligament calcifications.
   C. Hypoechoic swelling and heterogeneity to the ligament fibers.
   D. Fluid in the elbow joint.

   **Correct Answer: A**

**Rationale**

Distinguishing between a partial and full-thickness tear of the ulnar collateral ligament can be difficult especially if there is fluid or hemorrhage in the ligament fibers due to an acute injury. Using dynamic sonographic evaluation of the ligament while applying valgus stress to the elbow can demonstrate widening of the ulnohumeral joint, asymmetric to the contralateral side, in the setting of a full-thickness tear.

Answer _B_ is incorrect. Explanation: The presence of ligament calcifications can be detected by plain film or ultrasound and suggests the presence of a chronic or remote ligament injury. Answer _C_ is incorrect. Explanation: Hypoechoic swelling and heterogeneity of the ligament can be seen in a partial ligament tear or sprain injury. Answer _D_ is incorrect. Explanation: An elbow joint effusion is non-specific and can be seen in the setting of a number of pathologies of the elbow.
5. Of these imaging features, the most specific for diagnosis of sacroiliitis is:
   A. periarticular fat infiltration  
   B. bone marrow lesion (BML)  
   C. subchondral sclerosis  
   D. erosions  

**Correct Answer: D**

**Rationale**
Erosions, when present, were much more specific for sacroiliitis than the other listed imaging features. Answer _A_ is incorrect. Explanation: Sacral marrow fat infiltration can also occur with normal development and from mechanical changes. Answer _B_ is incorrect. Explanation: BML is the second-best answer but can also be seen from mechanical etiologies such as transitional lumbosacral junction. Answer _C_ is incorrect. Explanation: Sclerosis is highly nonspecific and can be normal.

Reference

6. To diagnose sacroiliitis at MRI in pediatric patients, evidence suggests gadolinium is most appropriate:
   A. in every case  
   B. never  
   C. if high intra-articular STIR signal is seen without BML  
   D. if BML is seen without high intra-articular STIR signal  

**Correct Answer: C**

**Rationale**
Gadolinium provides minimal diagnostic benefit over a T1/STIR protocol except in selected cases with isolated high intra-articular STIR signal. Answer _A_ is incorrect. Explanation: Fluid-sensitive sequences are sufficient to detect acute & chronic lesions consistent with...sacroiliitis in children”. Answer _B_ is incorrect. Explanation: As above, there are situations in which gadolinium can clarify the diagnosis. Answer _D_ is incorrect. Explanation: BML is well visualized without gadolinium.

Reference
2. Weiss et al., Arth Rheum, 2015;67(8):2250-6