SESSION FIVE

Pediatric Fracture Complications
Arthur B. Meyers, MD

1. What is the typical cause of a cubitus varus deformity after a supracondylar fracture?
   A. Injury to the distal humeral physis and peripheral physeal bridge formation.
   B. Incomplete reduction and malunion.
   C. Osteonecrosis of the trochlea.
   D. Cubitus varus does not typically occur after supracondylar fractures.

Correct Answer: B

Reference

Rationale
Answer is B. “Cubitus varus is the most common complication after supracondylar fractures and is typically due to persistent angulation of the distal fragment and malunion, not a growth disturbance. Answer A and C are not correct. Cubitus varus after supracondylar fractures is typically secondary to malunion not an osseous bridge or osteonecrosis. Answer D is not correct. Cubitus varus is the most common complication encountered after supracondylar fractures.

2. In a child with a post traumatic physeal bridge, in which of the following situations would bridge resection be considered?
   A. Bridge occupies > 50% of the physis, < 2 years of expected growth
   B. Bridge occupies > 75% of the physis, > 3 years of expected growth
   C. Bridge occupies < 2% of the physis, < 1 year of expected growth
   D. Bridge occupies < 50% of the physis, > 2 years of expected growth

Correct Answer: D

References

Rationale
Answer is D. When a bridge occupies less than 50% of the area of the physis and the child is expected to have greater than two years of growth, this is the clinical scenario when bridge resection is considered. A and B are not correct. If a bridge occupies greater than 50% of the physis, then bridge resection is not typically considered. C is not correct. A bridge which occupies <2% of the physis with less than 1 year of expected growth is not likely to cause a substantial growth disturbance and would not typically be resected.

3. Which of the following scenarios has the highest risk for developing a clinically significant growth disturbance after a physeal injury?
   A. 15 year-old with a distal femoral fracture involving the germinal zone of the physis.
   B. 14 year-old with a distal radial fracture involving the hypertrophic zone of the physis.
   C. 10 year-old with a distal femoral fracture involving the germinal zone of the physis.
   D. 10 year-old with a distal radial fracture involving the hypertrophic zone of the physis.

Correct Answer: C

Reference

Rationale
Answer is C. Distal femoral physeal fractures are at high risk of post-traumatic bridges. Extension into the germinal zone of the physis increases the risk of bridge. Also younger patients with more expected growth are more likely to form bridges. Answers A and D are not correct. Distal radial fractures are common but bridge formation is less likely to occur at this location versus the distal femoral physis. Answer B is not correct. While distal femoral fractures are at high risk for physeal bridges the older age of the patient and involvement of the hypertrophic zone rather than the germinal zone make this patient at less risk than the patient in answer C.
1. Which of the following are positive risk factors for recurrent anterior shoulder dislocation?
   A. Hill-Sachs lesion
   B. Under 20 years of age for first time dislocation
   C. >25% loss of the glenoid width (osseous Bankart)
   D. All of the above

   Correct Answer: B

   Reference

2. Which of the following is most commonly identified on MR arthrography in patients with multidirectional instability?
   A. Normal shoulder findings
   B. Chondral injury
   C. Hills-Sachs fracture and Bankart injury
   D. Patulous axillary recess

   Correct Answer: A

   Reference

3. At what age does the glenoid secondary ossification centers first appear?
   A. At birth
   B. 5 years
   C. 11 years
   D. 18 years

   Correct Answer: C

   Reference
4. Which of the following statements are true regarding rotator cuff tears in children?
   A. Full thickness tears are more common than partial thickness tears
   B. 90% of labral tears have associated rotator cuff tears
   C. Unlike adult patients, MR arthrography has low sensitivity for rotator cuff tears in children
   D. All the above are true statements

Correct Answer: C

Reference

Orthopedic Perspective: The Shoulder
Scott B. Rosenfeld, MD

1. A patient undergoes an MRI arthrogram for recurrent shoulder instability. Based on the imaging, the surgeon feels that arthroscopic treatment is contra-indicated and recommends open treatment. What is the most likely diagnosis?
   A. Glenolabral articular disruption (GLAD)
   B. Humeral avulsion of the glenohumeral ligament (HAGL)
   C. Superior labrum tear from anterior and posterior (SLAP)
   D. Anterior labro-ligamentous periosteal sleeve avulsion (ALPSA)

Correct Answer: B

References


Rationale
Humeral avulsion of the glenohumeral ligament (HAGL) occurs when the IGHL tears away from its humeral insertion without an associated subscapular tear. HAGL lesions are known to contribute to shoulder instability and is a likely culprit for recurrent dislocation. The classic teaching is that HAGL lesions requires open repair of the capsule, whereas the other lesions listed are felt to be better addressed with an arthroscopic approach.

According to the literature review by Stein et al., patients with significant glenoid bone loss, attenuated capsulolabral tissue, engaging Hill-Sachs lesions, and HAGL lesions are contraindicated for arthroscopic repair. They state that while arthroscopy has better cosmesis, decreased perioperative morbidity, decrease loss of external rotation, and is valuable in the confirmation of the extent and severity of shoulder instability, for these lesions open techniques are the gold standard.
2. A 21-year-old rugby player has recurrent pain and instability of the right shoulder recalcitrant to conservative management. Figure A is an image taken during diagnostic arthroscopy in the lateral decubitus position viewing from the posterior portal with instrument through a rotator interval anterior portal. In addition to a Bankart lesion, what other associated intra-articular condition is most likely present?

A. Rotator cuff tear  
B. SLAP tear  
C. Posterior labral tear  
D. Hill-Sachs lesion

Correct Answer: D

References


Rationale
Bankart lesions frequently result from traumatic anterior shoulder dislocations and may result in recurrent instability, especially in younger patients. Because of the violent mechanism of injury, compression fractures of the posterolateral humeral head (Hill-Sachs lesions) may also result as the soft humeral head impacts against the relatively hard anterior glenoid. It is important to note that the presence of a Hill-Sachs lesion may destabilize the GH joint and predispose to subsequent dislocation if it engages the glenoid.

Hintermann et al conducted a prospective study to evaluate the arthroscopic findings of the unstable shoulder to provide insights in the causes and mechanisms of shoulder instability. In 212 patients who had at least 1 documented shoulder dislocation; 87% had anterior glenoid labral tears (Bankart lesion), 79% had ventral capsule insufficiency, 68% had Hill-Sachs compression fractures, 55% had glenohumeral ligament insufficiency, 14% had complete rotator cuff tears, 12% had posterior glenoid labral tears, and 7% had SLAP tears. Thus, of the choices, Hill-Sachs lesions are the most common finding.

3. Which of the following is the most common long term consequence of untreated brachial plexus birth palsy?

A. Humeral length inequality  
B. Glenoid hypoplasia and retroversion  
C. Scapular winging  
D. Anterior shoulder instability

Correct Answer: B
Reference


Rationale
With or without nerve repair or transfer, internal rotation contracture of the shoulder is the most common problem requiring treatment in children with incomplete brachial plexus palsy recovery. This contracture results from an imbalance between the strength of the relatively unaffected internal rotators and the paralytic external rotators. Untreated, it usually leads to progressive glenohumeral deformity characterized by posterior displacement of the humeral head on an increasingly dysplastic and retroverted glenoid.

Waters et al. performed a study to determine the effects of correction of external rotation weakness and internal rotation contractures on glenohumeral development in patients with brachial plexus birth palsy. Twenty-five patients who underwent latissimus dorsi and teres major tendon transfers to the rotator cuff were evaluated clinically and radiographically before the operation and at a minimum 2 years postoperatively. Soft-tissue rebalancing procedures alone were found to have halted the progression of, but not to have markedly decreased, glenohumeral dysplasia at the time of a 2-5 year follow-up.

Pearl et al. completed a review article on shoulder problems related to children with brachial plexus palsy. They discuss the clinical workup, imaging studies, and surgical interventions used to treat these difficult clinical problems. They also state that evaluating the status of glenohumeral development is critical throughout the treatment of these palsies.

SESSION SIX
MRI Anatomy and Injuries of the Elbow
Nancy A. Chauvin, MD

1. In throwing athletes, what structure is the primary passive stabilizer to valgus stress at the elbow?
   A. Common flexor tendon
   B. Lateral ulnar collateral ligament
   C. Posterior bundle of the ulnar collateral ligament
   D. Anterior bundle of the ulnar collateral ligament

   Correction Answer: D

Reference
Rationale
The anterior bundle of the ulnar collateral ligament is the primary passive stabilizer to valgus stress while the posterior bundle of the ulnar collateral ligament is a minor stabilizer. The common flexor tendon is an active stabilizer. The lateral ulnar collateral ligament functions as a stabilizer to varus stress.

2. Of the following, what preoperative MRI feature is least likely to be associated with unstable osteochondritis dissecans of the capitellum?
   A. Displaced osteochondral fragment
   B. Focal high-signal T2-weighted line crossing the articular cartilage
   C. Fluid-filled osteochondral defect
   D. High-signal fluid interface between the articular cartilage and the subchondral bone

Correct Answer: B

References


Rationale
A high-signal T2-weighted line that crosses the articular cartilage indicates a focal cartilage defect/fissure. The other findings directly or indirectly indicate motion of the osteochondral fragment.

3. Fishtail deformities of the distal humerus are delayed complications due to:
   A. Panner’s disease
   B. Avascular necrosis of the proximal radius
   C. Distal humeral fractures
   D. Radial head dislocations

Correct Answer: C

Reference

Rationale
Fishtail deformities of the distal humerus are rare delayed complications of distal humeral fractures in children. The deformity likely results from post-traumatic avascular necrosis of the trochlear cartilage which gives rise to a fishtail configuration of the distal humerus. The other responses involve the medial compartment and are not associated with fishtail deformities.
4. **Which is the optimal MR sequence to diagnose Panner's disease?**
   A. T1-weighted imaging
   B. T2-weighted fat suppressed imaging
   C. Gradient imaging
   D. T1-weighted fat suppressed post-contrast imaging

   **Correct Answer:** A

   **Reference**

   **Rationale**
   Panner’s disease is typically low on T1-weighted imaging. It can have variable signal on T2-weighted imaging due to viability of the tissue and stage of the disease. While the capitellum can appear fragmented on gradient imaging, it is the low T1-weighted signal which is most diagnostic. Gadolinium is not necessary to make the diagnosis.

**Anatomy and Abnormalities of the Wrist**
*Mahesh M. Thapa, MD*

1. **Which carpal bone is the first to demonstrate an ossific center?**
   A. Lunate
   B. Capitate
   C. Hamate
   D. Scaphoid

   **Correct Answer:** B

   **References**


2. **Galeazzi-equivalent fracture differs from a Galeazzi fracture in that a Galeazzi-equivalent fracture involves the _______.**
   A. Ulnar physis
   B. TFCC
   C. DRUJ
   D. Extensor carpi ulnaris

   **Correct Answer:** A
3. In gymnast’s wrist, the distal radial physis is affected much more commonly than the distal ulnar physis. Which of the following is a likely contributing factor for this phenomenon?
   A. Cross-sectional area of the distal radial physis is larger
   B. Children normally tend to have ulnar positive-variance
   C. Axial loading affects the distal ulna more
   D. Radial physes loses its growth potential earlier

Correct Answer: A

Reference

Unknown Cases 3
Erica K. Schallert, MD

1. The percentage of giant cell tumors of bone diagnosed in skeletally immature patients (<14 years of age) is:
   A. <1%
   B. 1-3%
   C. 4-6%
   D. 7-10 %

Correct Answer: B

Reference
2. Which of the following is the LEAST common location for chronic recurrent multifocal osteomyelitis (CRMO) at initial presentation?
   A. Lower extremities
   B. Spine
   C. Pelvic
   D. Mandible

Correct Answer: D

Reference

Rationale
In the three year institutional experience detailed in the reference below, the most common sites of CRMO at initial presentation were the lower extremities at 39.7%, followed by the spine at 25.9% and the pelvis at 20.7%.

3. Synovial (intra-articular) venous vascular malformations can cause which of the following bony abnormalities?
   A. Overgrowth
   B. Hypoplasia
   C. Early physeal closure
   D. All of the above

Correct Answer: D

Reference
Quinn SF. Venous Malformations. MRI Web Clinic - November 2007. www.radsources.us

Rationale
Synovial venous malformations cause a wide range of bony abnormalities including hypoplasia, demineralization, overgrowth, sclerosis, erosion, periosteal reaction, early growth plate fusion and advanced epiphysial maturation.
1. A Stener lesion refers to a ligamentous injury to the thumb metacarpophalangeal joint in which:
   A. The radial collateral ligament retracts superficial to the abductor pollicis brevis tendon
   B. The ulnar collateral ligament retracts superficial to the abductor pollicis brevis tendon
   C. The ulnar collateral ligament retracts superficial to the adductor pollicis aponeurosis
   D. The radial collateral ligament retracts superficial to the adductor pollicis aponeurosis

   Correct Answer: C

Reference:

2. Jersey finger refers to:
   A. Injury to the extensor mechanism at the distal interphalangeal joint
   B. Injury to the flexor digitorum profundus at the distal interphalangeal joint
   C. Injury to the flexor digitorum superficialis at the distal interphalangeal joint
   D. Volar plate avulsion injury at the proximal interphalangeal joint

   Correct Answer: B

Reference:

3. Which of the following is true regarding bizarre parosteal osteochondromatous proliferation (BPOP):
   A. Presence of corticomedullary continuity and a cartilage cap are diagnostic
   B. Most commonly involves the long bones
   C. Strong potential for malignant degeneration and metastasis
   D. May mimic chondrosarcoma on histology

   Correct Answer: D
Update on Vascular Anomalies
Arnold Carl Merrow, MD

1. Which of the following is NOT a recognized complication of extremity venous malformations?
   A. Hemarthrosis with joint degeneration
   B. Limb length discrepancy
   C. Thrombosis
   D. Malignant degeneration

Correct Answer: D

References


Rationale
Malignant degeneration. Degeneration of a preexisting vascular anomaly into malignancy has rarely been reported with infantile hemangiomas and lymphatic malformations but has not been reported with venous malformations. (D)

Venous and lymphatic malformations may have intra-articular extension with synovial involvement. Such lesions can cause recurrent hemarthrosis with erosions of cartilage and bone. (A)

Vascular malformations of the extremity can cause overgrowth or undergrowth, either of which may lead to a limb length discrepancy. (B)

Venous malformations may have an intralesional (or "localized intravascular") coagulopathy, leading to internal thrombi. (C)
2. Which of the following lesions is NOT associated with a coagulopathy?
   A. Congenital hemangioma
   B. Infantile hemangioma
   C. Venous malformation
   D. Kaposiform hemangioendothelioma

   Correct Answer: B

References


Rationale
Infantile hemangioma. The term “infantile hemangioma” will sometimes be misapplied to lesions that can cause a coagulopathy, such as the large solitary congenital hemangiomas of the liver or soft tissue, visceral, or bony venous malformations. (B)

Congenital hemangioma. The rapidly involuting subtype of congenital hemangioma (RICH) may cause a mild to moderate transient thrombocytopenia with or without a consumptive coagulopathy and elevated D-dimer. This coagulopathy is sometimes confused with the Kasabach-Merritt phenomenon. (A)

Venous malformation. These congenital anomalies cause a chronic localized intravascular/intralesional coagulopathy with elevated D-dimer and mild to moderate thrombocytopenia. (C)

Kaposiform hemangioendothelioma (KHE). KHE is an intermediate grade, locally invasive neoplasm typically found in infants. This lesion causes the true Kasabach-Merritt phenomenon (KMP), which consists of a consumptive coagulopathy with a severe and sustained thrombocytopenia and hypofibrinogenemia with elevated D-dimer. (D)

3. Which imaging feature separates Gorham-Stout disease from Generalized Lymphatic Anomaly (GLA)?
   A. Splenic lesions
   B. Pleural effusions
   C. Bone lesions
   D. Cortical bone destruction

   Correct Answer: D
Rationale

Splenic lesions, B) pleural effusions, and C) bone lesions can be seen with either Gorham-Stout disease or GLA, though involvement of the spleen and pleura occurs more frequently in GLA.

4. Which characteristic imaging finding is NOT paired correctly with the vascular anomaly in which it is commonly seen?

A. Phleboliths, low flow vessels: Infantile hemangioma  
B. Fatty mass with high flow vessels: PHOST  
C. Septa in cysts + fluid-fluid levels: Lymphatic malformation  
D. Solid, enhancing, infiltrating mass: Kaposiform hemangioendothelioma

Correct Answer: A

References


Rationale

A) Phleboliths, low flow vessels: Infantile hemangioma. Phleboliths associated with vascular anomalies are almost always within venous malformations. Rarely, they may also be seen in spindle cell hemangiomas (not infantile hemangiomas).
Incorrect answers: B) Fatty mass with high flow vessels: PHOST, C) Septa in cysts + fluid-fluid levels: Lymphatic malformation, and D) Solid, enhancing, infiltrating mass: Kaposiform hemangioendothelioma are all correct pairings between characteristic imaging findings and the vascular anomalies in which they are frequently seen.

Update on Pediatric Musculoskeletal Intervention
John H. Naheedy, MD

1. All of the following are acceptable therapeutic regimens for the treatment of an Osteoid Osteoma, EXCEPT:
   A. Medical management with Oral NSAIDs
   B. Surgical Excision
   C. Sclerotherapy with Doxycycline
   D. Radiofrequency Ablation

   Correct Answer: C

   Reference

2. All of the following lesions may potentially be amenable to percutaneous sclerotherapy, EXCEPT:
   A. Venous Malformations
   B. Fibrous Dysplasia
   C. Arteriovenous Malformations
   D. Primary Aneurysmal Bone Cysts

   Correct Answer: B

   Reference
   Shiels WE, Mayerson JL. Percutaneous Doxycycline Treatment of Aneurysmal Bone Cysts With Low Recurrence Rate: A Preliminary Report

3. All of the following are FDA approved for intra-articular use in children, EXCEPT:
   A. Aristospan (Triamcinolone hexacetonide)
   B. Synvisc-One (Hylan G-F 20)
   C. Kenalog-40 (Triamcinolone acetonide)
   D. Depo-Medrol (Methylprednisolone acetate)

   Correct Answer: B

   Reference
   http://products.sanofi.us/synviscone/synviscone.html
SESSION EIGHT

Scoliosis and Other Spine Abnormalities

Jerry R. Dwek, MD

1. Markers for a scoliosis which requires further neurosurgical imaging includes
   A. Thoracic hyperkyphosis
   B. Dextroscoliosis with a single major curve
   C. Stable thoracic levoscoliosis
   D. Non painful curvature

Correct: A

Reference

Rationale
There are many studies documenting the need for preoperative neurosurgical imaging in the scoliosis. Although many risk factors have been assessed, increased thoracic hyperkyphosis has been shown to be one risk predictor(1). Others include a pain (answer 4 is wrong), and juvenile onset curves(1). While some studies have suggested a leftward curve is atypical and should be imaged, the largest studies have not if the curve is a stable thoracic leftward curve (answer 3 is wrong). Simple single major thoracic curves are the most typical types of scoliosis and unless there are other risk factors, do not require imaging(2).

2. When using the Cobb angle measurement:
   A. The measurement is taken from one vertebral body above the most tilted vertebral body superiorly to one vertebral body below the most tilted vertebral body.
   B. The measurement is taken from the most tilted vertebral body superiorly to the most tilted vertebral body inferiorly.
   C. The measurement is taken from one vertebral body below the most tilted vertebral body superiorly to one vertebral body above the most tilted vertebral body.
   D. The measurement is taken between the two vertebral bodies at the apex of the curve.

Correct: B

Reference
Rationale
When measuring curvature in scoliosis, the Cobb angle system of measurement is overwhelmingly the most common in use. The taken most tilted vertebral body superiorly and the most tilted vertebral body inferiorly are taken as the end vertebral bodies of the curve and are the ones used for measurement. Essentially the curvature is measured at its maximum. Neither the body above or the body below the most tilted bodies are used for measurement as that would underestimate the curvature (answer 1 and 3 are wrong). While the bodies at the apex of the curvature can be used to indicate the level of maximum curvature they are not used for curve measurement (answer 4 is wrong) (3).

3. A structural curve:
   A. Will correct to a Cobb angle of less than 25 degrees with ipsilateral bending
   B. Will not correct to a Cobb angle of less than 25 degrees with ipsilateral bending
   C. Should not be included in the fusion segment as it will correct over time
   D. Is generally the compensatory curve and latest to develop

Correct Answer: B

Reference

Rationale
A structural curve is a curve which does not correct adequately with ipsilateral bending. These structural curves do not straighten with ipsilateral bending to a Cobb angle of less than 25 degrees (answer is wrong). Structural curves do not “bend out” to less than 25 degrees due to changes in vertebral body morphology and rotation. They are thus the major focus of fusion surgery and should be included in the fusion levels. They will not correct over time (answer 3 is wrong). In contrast a non-structural curve is compensatory and latest to develop. They should correct if the main structural curve is addressed (answer 4 is wrong) (3).

4. The following are possible options for scoliosis treatment
   A. Observation
   B. Bracing
   C. Spinal fixation
   D. All of the above

Correct Answer: D

Reference
Rationale
There are many options for scoliosis treatment. Minor curves may be observed especially closer to skeletal maturity. Bracing may be effective in younger patients though patient compliance is a large problem since the brace must be worn most of each day. The mainstay of spinal curvature treatment in the current day when neither observation is not viable and bracing not an appropriate option (4).

Unknown Case 4
Mahesh M. Thapa, MD

1. A 12-year-old boy presents with right shoulder pain. What’s the most likely diagnosis?

A. Ewing Sarcoma
B. Osteosarcoma
C. Langerhans Cell Histiocytosis
D. Chronic Noninfectious Osteomyelitis

Correct Answer: A

References

2. An 11-year-old boy presents with left shoulder pain. What’s the most likely diagnosis?

A. Ewing Sarcoma  
B. Osteosarcoma  
C. Langerhans Cell Histiocytosis  
D. Chronic Noninfectious Osteomyelitis

Correct Answer: D

References

3. The arrows point to what finding in this 15-yr-old girl with Juvenile Idiopathic Arthritis?

A. Synovial Osteochondromas
B. Rice Bodies
C. Steroid injection Granulomas
D. Sequela of Infection

Correct Answer: B

Reference