 Pediatric Fractures

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Objectives

- Background
- Incidence
- Anatomy
- Classification
- Diagnosis
- Treatment
- Summary
- References
Management requires awareness of unique anatomy of pediatric patient.

Physis is the weakest area of the skeletally immature bone.

Higher water content in pediatric bone, so more likely to bend rather than fail.

Pediatric ankle fractures often missed.

Children cannot always accurately convey their symptoms.
Incidence

- Tibial and fibular epiphyseal injuries make up 15 - 38% of all epiphyseal injuries.
- Ankle fractures account for approximately 5% of all pediatric fractures.
- Most prevalent between ages 8-15.
- Premature physeal closure only about 2%.
Anatomy

- Epiphyses
  - secondary ossification center

- Physis
  - growth plate

- Metaphysis
  - Location of active bone growth and vascular elements

- Diaphysis
  - primary growth center

- Zone of Ranvier
  - Circumferential groove surrounding periphery of the physis
  - Supports physis
Anatomy

- Pediatric bone is more porous than adult bone.
- Increased water content makes bone more malleable.
- Pediatric bone:
  - More likely to bend than fail
  - Unique fracture patterns
  - Greenstick fractures
  - Torus fractures
Damage to the germinal cells of the physis can lead to growth arrest—partial or complete.

After trauma, growth at the physis temporarily stops.

When growth resumes, radiopaque line can be seen denoting growth recovery (Harris Growth Lines)

May see 6 weeks following trauma
Classification

- Salter Harris — growth plate injury anatomic classification scheme.
- Dias and Tachdjian — merged Lauge-Hansen and Salter Harris classifications.
- Transitional Fractures
  - Triplane fracture
  - Juvenile Tillaux fracture
Type I
- Complete separation of the epiphysis from the metaphysis
- Line of fracture passes through physis
- 6 – 8.5% of physeal injuries
- Minimal displacement due to strong periosteal adhesions
- Minimal risk for premature physeal closure.
Type II
- 73 – 75% of all physeal injuries
- Fracture through the physis and exiting through metaphysis
- Metaphyseal avulsion – Thurston-Holland Sign
Type III
- Begins at the joint surface and exits through physis
- Occur in older children where physis is nearing closure
- May have ischemic necrosis due to epiphyseal blood vessel damage.
Salter - Harris

- Type IV
  - Fracture begins at the joint and extends through epiphysis, physis and exits through metaphysis.
  - More likely to displace
  - Higher likelihood of growth arrest and post traumatic arthritis.

- Goal of treatment:
  - Prevent physeal bridging/growth arrest
  - Preservation of joint surface
Salter - Harris

- Type V
  - Crush injury to physis
  - Destroys structural integrity of physis
  - Often times diagnosed retrospectively
Juvenile Tillaux Fracture

- 3-5% of all pediatric ankle fractures
- Salter - Harris III fracture of the lateral aspect of the tibial physis
- **Anterolateral** aspect of the physis still open while the remaining plate is closed
- External rotation of the fibula causes the anterior tibiofibular ligament to avulse the anterolateral epiphysis through the growth plate
- CT to fully evaluate injury
Triplane Fractures

- First described by Marmor in 1970
- 5-7% of all pediatric fractures
- Children reaching skeletal maturity
- May consist of 2, 3 or 4 fragments
- Number of fragments related to age of child and maturity of physis

- 3 planes
  - Sagittal fracture extending from the joint, through the epiphysis of the tibia to the level of the physis
  - Transverse fracture through the physis
  - Coronal fracture of the posterior tibial metaphysis
Triplane Fractures
Clinical exam
- Pain
- Limping/refusal to walk
- Decrease in activity/regression of developmental landmark
- Guarding
- Edema
- Ecchymosis
- Deformity
Diagnosis

- X-ray
  - Clinical correlation
  - May require imaging of contralateral limb
  - Physis may appear wider

- CT
  - Better able to evaluate physis, ankle articular surface
  - Surgical planning

- Bone Scan

- MRI
  - If suspect tendon or ligament injury
  - New literature suggests SHI of fibula more likely ligamentous injury
Treatment

- Reduce displaced physeal fractures with gentle traction and manipulation.
- Closed reduction should not be attempted >7 days after injury unless intra-articular step-off >2mm.
- Compressive fixation parallel to the physis.
- If must cross physis use smooth pins, remove after healing.
- Most physeal fractures have significant healing within 3 weeks.
- Monitor for growth disturbances at least 6 months or until skeletal maturity.
Type I and II Salter Harris fractures
- Closed reduction
- 7-10 days post injury, callus well established, better left alone
- Remodeling of minor displacement will take place
- Advocates for removable splint and return to activity as tolerated for SHI lateral malleoli injuries
Type III and IV Salter Harris fractures
- Require adequate reduction
- Restore physis and preserve articular surface
- Open reduction: periosteum handled with care
- Fine, smooth K-wires can transverse the growth plate for a few weeks without interruption
- Percutaneous cannulated screw fixation parallel to the physis
Pearls

- Minimally displaced fractures with anatomic alignment - percutaneous fixation with k-wires and cannulated screws.
- Larger fracture fragments and those with greater displacement may benefit most from ORIF.
- Closed reduction and percutaneous fixation best achieved within 24 hours of injury.
- Closure with absorbable sutures
- Early ROM and return to weight bearing achieves best results
Complications

- Premature or asymmetric growth arrest
  - 2-5%
  - Reported in upwards of 14-40% in Salter III and IV
- Rotational deformities
- Infection
- Wound healing
- CRPS
- Post traumatic arthritis
Premature Physeal Closure

- If less than 40 - 50%:
  - Resect osseous bridge
  - Interpose adipose tissue or methyl methacrylate

- If greater than 40 - 50%:
  - Supramalleolar osteotomy (opening wedge) > 10°
  - Epiphysiodesis - 2-5 cm anticipated growth
  - Limb lengthening via Ilizarov technique > 5cm difference
Summary

- SH I and II injuries do well with closed reduction and modified immobilization.
- SH III and IV anatomic reduction necessary > 2mm displacement.
- Transitional fractures have less likely chance of growth disturbances.
- No compression across the physis.
- CT scan for best evaluation and surgical planning.
References