Pediatric Hip Fractures and Dislocations

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Objectives

• Understand the anatomy and development of the pediatric proximal femur
• Recognize the fracture types (Delbet classification)
• Review the treatment options
• Identify complications
• Review pediatric hip dislocations
Pediatric Hip Fractures

- Rare
  - < 1% of all pediatric fractures

- Commonly a result of a high energy mechanism

- High complication rates and poor outcomes when compared to other pediatric fractures

- Poor outcomes can be due to severity of associated injuries
Pediatric Proximal Femur

Single Physis $\rightarrow$ Epiphyseal Nucleus Develops $\rightarrow$ Greater Trochanter Ossific Nucleus Develops

Maturity at 14 years for girls and 16 years for boys
Pediatric Proximal Femur

7 month old MRI

Cartilaginous Physis
Metaphysis
Ossific Nucleus
Pediatric Proximal Femur Development

• Femoral neck shaft angle
  • 150 (birth) → 145 degrees (1-3 yrs) → 130 degrees (maturity)

• Femoral anteversion
  • 30 degrees (birth) → 10 degrees (maturity)
Vascular Supply to Proximal Femur

**Medial femoral circumflex artery** (2) and its branches are primary perfusers of the femoral head: acetabular (4), posterior inferior (5), ascending (6), transverse (7).

Entire blood supply to proximal femoral epiphysis comes from **superior retinacular vessels (15)**, terminal branch of ascending (6), by 3 years of age.

Lateral femoral circumflex artery (3) supplies the greater trochanter, lateral proximal femoral physis, and anteromedial metaphysis. Contribution to femoral head blood supply diminishes by 3 years of age.
Pediatric Femoral Head Blood Supply Development

**Birth to 4-6 months**
Tri-arterial blood supply

**4-6 months until Mature**
Single vessel supply (ARA blocked by physis)

**Mature**
Tri-arterial blood supply

ARA = anterior retinacular artery; IRA = inferior retinacular artery; LFCA = lateral femoral circumflex artery; MFCA = medial femoral circumflex artery; SRA = superior retinacular artery
Classification—Delbet

Type I, transphyseal, without (A) or with (B) dislocation of the capital femoral epiphysis

Type II, transcervical

Type III, cervicotrochanteric

Type IV, intertrochanteric
Delbet Type 1

- Transphyseal
- < 10% of pediatric hip fractures
- Most commonly seen in young children
- Often diagnosed late in newborns/infants
  - Possible non accidental trauma
- Subtypes
  - 1A – no dislocation
  - 1B – dislocation of the epiphysis from acetabulum
Delbet Type 1

• Usually from severe trauma
• 50% with femoral head dislocation
• Associated injuries in > 60% of cases
  • Pelvic fractures most common associated injury
• High rate of AVN
  • 38% in type 1A
  • ~100% in type 1B
Delbet Type 1

- Often missed in newborns/infants
- Subtle radiographic findings easy to miss
Delbet Type 1

MRI may be more diagnostic
Delbet Type 2

- Transcervical
- Most common
  - ~50% of all pediatric FN fractures
- 70-80% present displaced
- High rates of complication
Delbet Type 2

- Usually displaced
- 28-50% AVN rate
  - Increased AVN with increased displacement
    - Initial displacement is the best predictor of AVN
    - Increased AVN in kids over 10 years of age
- 15% nonunion rate
Delbet Type 3

- Cervicotrechanteric (or basicervical)
- ~30% of pediatric hip fractures
- 18-25% AVN rate
  - Related to amount of displacement
- 20% malunion rate
- 10% nonunion rate
Delbet Type 4

• Peritrochanteric or Intertrochanteric
• 6-15% of pediatric hip fractures
• < 10% AVN rate
• Most favorable of all pediatric hip fractures
Treatment: Delbet 1

• < 2 years
  • Closed reduction + spica cast

• 2-9 years
  • Smooth pins + spica cast

• ≥ 10 years
  • Transphyseal screw fixation

• ORIF required for dislocated epiphysis using a direct anterior, posterior or surgical dislocation approach depending on direction of the dislocation
Treatment: Delbet 1B

11 year old male, football injury

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Sankar WN, Mehlman CT. The community orthopaedic trauma surgeon taking trauma call: pediatric femoral neck fracture pearls and pitfalls. J Ortho Trauma. 2019;33:S22-S26
Treatment: Delbet 2 and 3

- Nondisplaced in < 6 years old in spica cast
  - Consider supplemental fixation ≥ 2 years to prevent displacement in cast

- Acceptable reduction
  - < 5° angulation
  - < 2 mm cortical translation

- < 4 years
  - Smooth k wires + spica cast

- 4-9 years
  - Physeal sparing cannulated screws
    - *Strongly consider including a spica cast*

- ≥ 10 years
  - Transphyseal cannulated screws
Treatment: Delbet 2 and 3

- For unstable fracture patterns, consider fixed angle constructs

- ± needle or open capsular decompression
  - Possible decrease in rates of AVN
    - controversial but minimal morbidity

- ± single leg spica cast in those potentially non compliant/younger
Treatment: Delbet 2

Physeal sparing screw fixation
Treatment: Delbet 3

Fixed angle sliding hip screw with antirotational screw
Treatment: Delbet 4

• Most favorable outcomes of all pediatric hip fractures

• < 6 years
  • Non/minimally displaced, < 10 degree angulation
    • Closed reduction and spica cast
    • Consider pin fixation in ≥ 2 year olds to prevent displacement in cast

• > 6 years
  • Internal fixation for all nondisplaced and displaced fractures
  • Pediatric sliding hip screw or proximal femoral locking plate
  • < 10 years: physeal sparing should be considered
  • Adolescents get transphyseal fixation
Treatment: Delbet 4

One year out
Implications of Pediatric Hip Fractures

- Abnormal neck shaft angle
- Abnormal femoral neck version
- Decreased articulo-trochanteric distance
- Limb length discrepancy
Complications

• AVN
  • Type 1 (38%) > Type 2 (28%) > Type 3 (18%)
    > Type 4 (5%)

• Risk Factors: older age, initial displacement

• Modifiable Factors: quality of reduction
  • Possible benefit to capsular decompression
  • Equivocal association with timing of reduction

• May take 2 years to develop
  • Important to obtain periodic radiographs
Complications

• Nonunion
  • 6-12%
  • Most common in type 2 fractures
  • Least common in type 4
• Causes
  • Poor reduction
  • Distracted fractures
  • Inadequate fixation
  • Fracture orientation (higher Pauwel’s angle)
• May result in coxa vara or AVN
• Treatment with valgus osteotomy
Complications

- Coxa Vara (<120°)
  - 10-32% of cases
  - Causes
    - Malreduction
    - Delayed union or nonunion
    - Premature proximal femoral physeal closure with greater trochanter overgrowth
    - Casting alone
  - Less likely with rigid internal fixation

- Intertrochanteric osteotomy for persistent deformity
Complications

• Premature physeal closure
  • 28% occurrence
  • Limb length inequality
    • Typically does not require treatment in adolescents
    • Can be significant in young children
      • 2-3mm of growth per year
• Trochanteric overgrowth
  • Functional coxa vara
    • Disturbs natural hip mechanics

• Treatment is trochanteric apophysiodesis in children ≤ 8 years of age
Complications

• Delayed SCFE at 9 months
  • Causes
    • Implant irritation
    • Premature initiation of weight bearing
    • Coxa vara
    • Osteonecrosis
    • Delayed union or nonunion
Complications

• Femoral neck overgrowth
  • Average 6.2 mm in series of 30 patients
  • Younger (5.5 years vs 9.9 years)
  • Lower rate of osteonecrosis and better functional outcomes
Pediatric Hip Dislocations

• Very rare
• Force required to dislocate increases with age
  • Minor injury < 10 years old
  • High energy > 12 years old
• Mostly posterior dislocations
Pediatric Hip Dislocations

• Posterior dislocations
  • Hip flexion, adduction and internal rotation

• Anterior dislocations
  • Hip extension, abduction and external rotation

• Inferior dislocations
  • Hyperflexed or abducted
Pediatric Hip Dislocations

• Xrays prior to reduction attempt
• Urgent reduction within 6 hours
  • 20x increase in AVN rate with delay > 6 hours
• Gentle reduction
  • Iatrogenic epiphyseal separation possible
• Open reduction following failed closed reduction attempt
Pediatric Hip Dislocations

- Anatomical blocks to reduction
  - Osteocartilaginous fragments
  - Interposed labrum
  - Femoral head buttonhole through capsule
  - Torn ligamentum teres

- Open reduction if needed from direction of the dislocation
  - Surgical dislocation is safe as well
  - Direct visualization of the block
Pediatric Hip Dislocations

• XR/CT or MRI to confirm concentric reduction
  • Possible acetabulum fracture or intra-articular fragments or labrum
  • MRI helpful in identifying non-ossified bony fragments and labrum

• Post reduction protocol
  • < 8 years old or non compliant
    • Spica cast 3-4 weeks
    • Abduction splinting 3-4 weeks
  • Older, more compliant patients
    • Protected non weight bearing for 6 weeks

Pediatric Hip Dislocations

• Complications
  • AVN (8-20%)
  • Myositis ossificans (8-15%)
  • Sciatic nerve palsy
  • Early secondary arthritis

• Poor prognosticators
  • Older age
  • Severe trauma
  • Delay in reduction (> 6 hours)
  • Incongruous reduction
  • AVN
Summary

- Pediatric hip fractures and dislocations are rare
- Require high suspicion in infants and patients with concomitant injuries
- Aggressive early treatment leads to lower complication rate
- Initial AVN counseling and follow up needed until skeletal maturity
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