

Pediatric Hip Fractures and Dislocations

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Objectives

- Review relevant pediatric proximal femoral development and anatomy
- Review the types of pediatric hip fractures
- Discuss complications and treatment options for pediatric hip fractures
- Discuss pediatric hip dislocations and treatment options

Pediatric Hip Fractures

- Less than 1% of all pediatric fractures
- 80-90% are a result of high energy trauma
- 10% due to moderate trauma or pathologic lesions

Pediatric Proximal Femur: Development

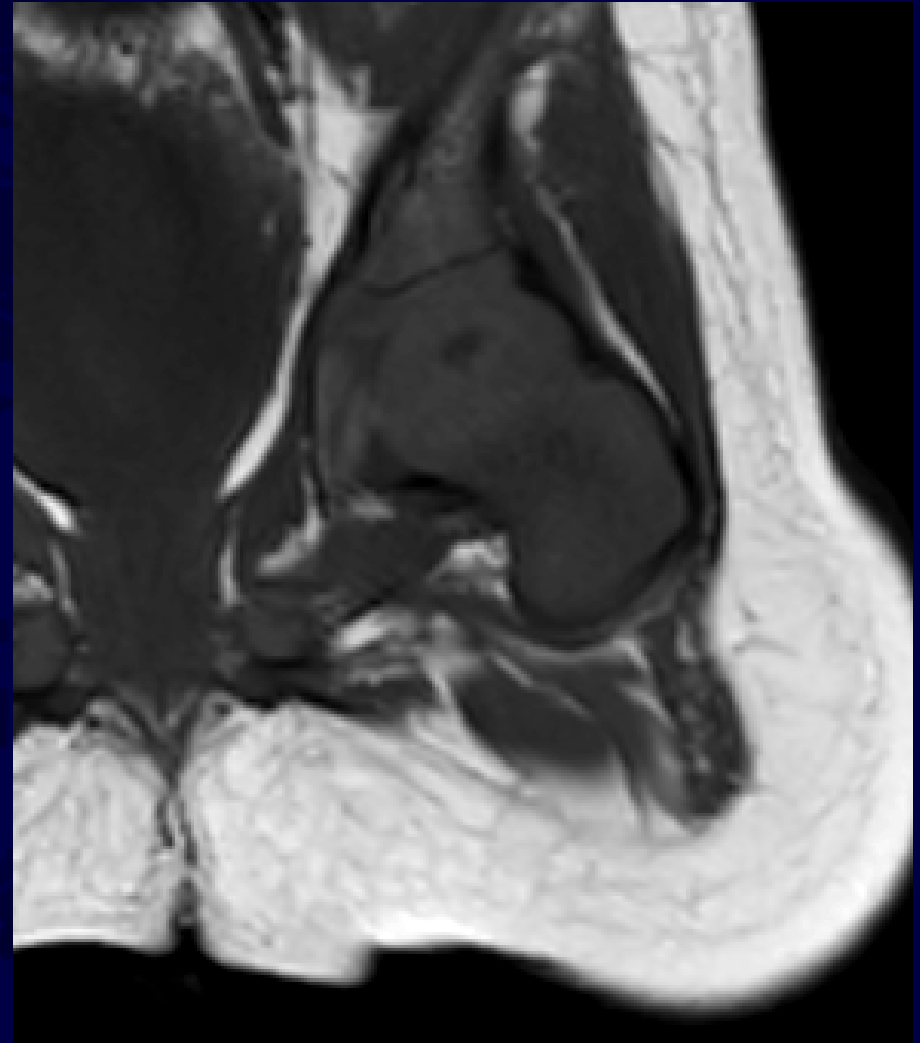
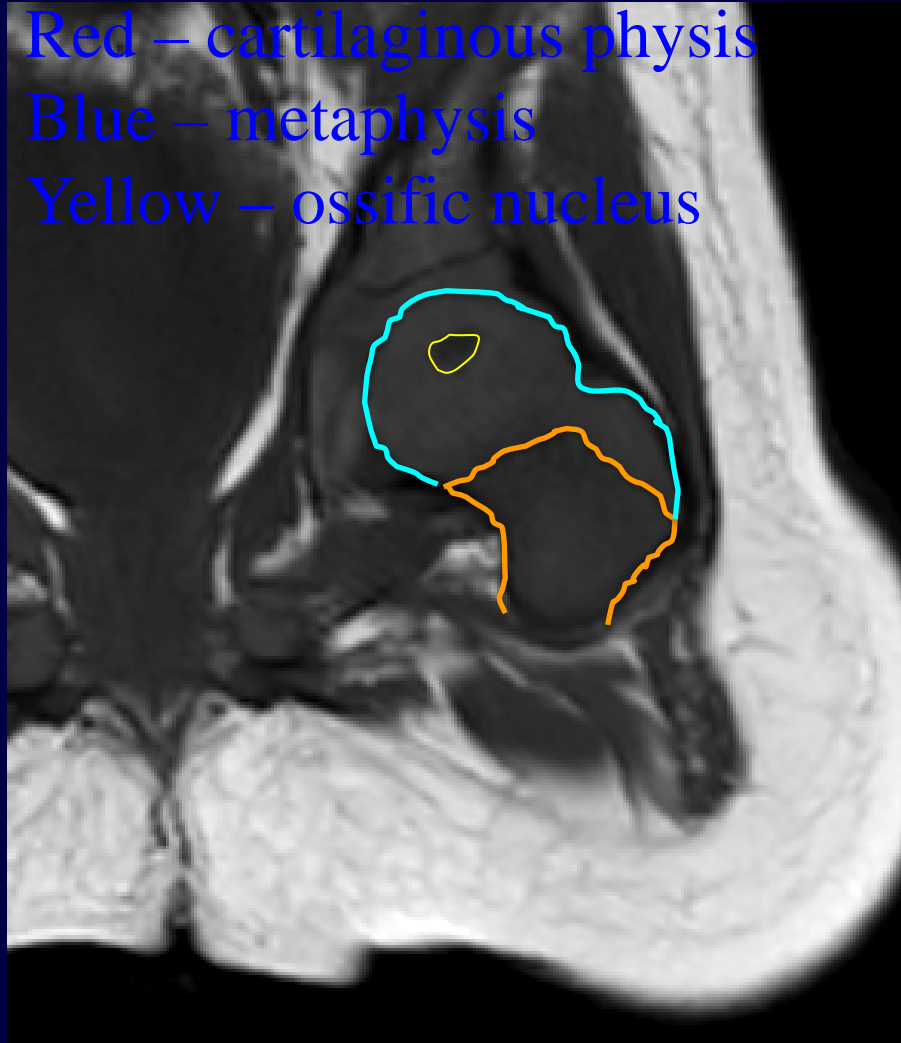
- Single physis at birth
- Develops two separate centers of ossification
- Ossific nucleus of femoral head forms between 4-6 months
- Ossific nucleus of greater trochanter forms at about 4 years of age

T1 Coronal MRI Left Hip: 7-month old

Red – cartilaginous physis

Blue – metaphysis

Yellow – ossific nucleus



Pediatric Femur: Development

- Femoral neck shaft angle
 - 135 degrees at birth
 - 145 degrees by 1-3 years of age
 - Gradually matures to 130 degrees at skeletal maturity
- Femoral anteversion
 - 30 degrees at birth
 - Matures to about 10 degrees at skeletal maturity

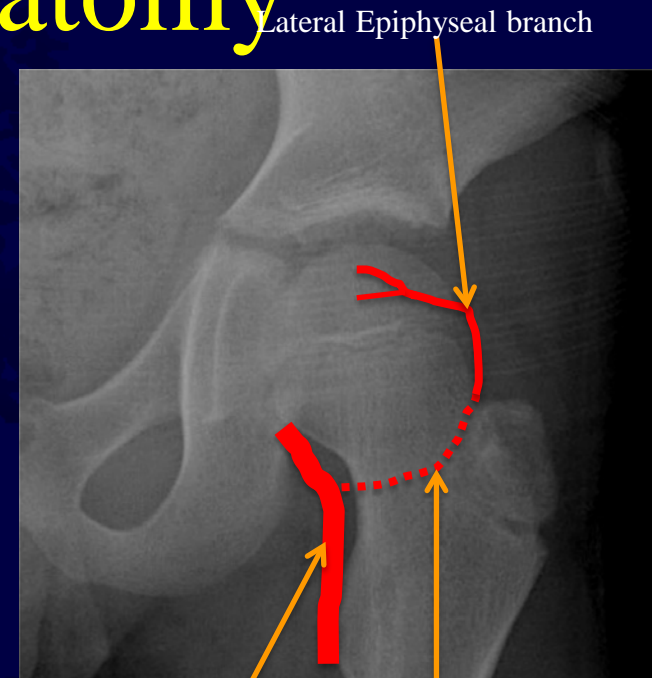
Implications of Injuries Across the Proximal Femoral Physis

- Abnormal neck shaft angle
- Abnormal femoral neck version
- Decreased articulo-trochanteric distance
- Mild limb length discrepancy



Pediatric Hip: Anatomy

- Lateral Circumflex
 - Supplies the anterior portion of the femoral epiphysis and physis until 5-6 months of age
 - Contribution to femoral head blood supply diminishes by 3 years of age
- Medial Circumflex
 - Major blood supply to proximal femur
 - The entire blood supply to the proximal femoral epiphysis comes from the lateral epiphyseal branches of the medial circumflex by 3 years of age
- 20 % blood supply to femoral head by artery of ligamentum teres after 8 years of age



Femoral Artery

Medial Femoral Circumflex
(coursing posteriorly around femoral neck)

Pediatric Hip Fractures

- 85-90% due to high energy
- 30% with associated major injuries
 - Intraabdominal & intrapelvic
- Hip dislocations, pelvic fractures and femoral fractures
- <10% - pathologic
- Non-accidental trauma rare <12 months of age

LEFT

PORT

SUPINE

Femoral Neck Fracture

Delbet Classification

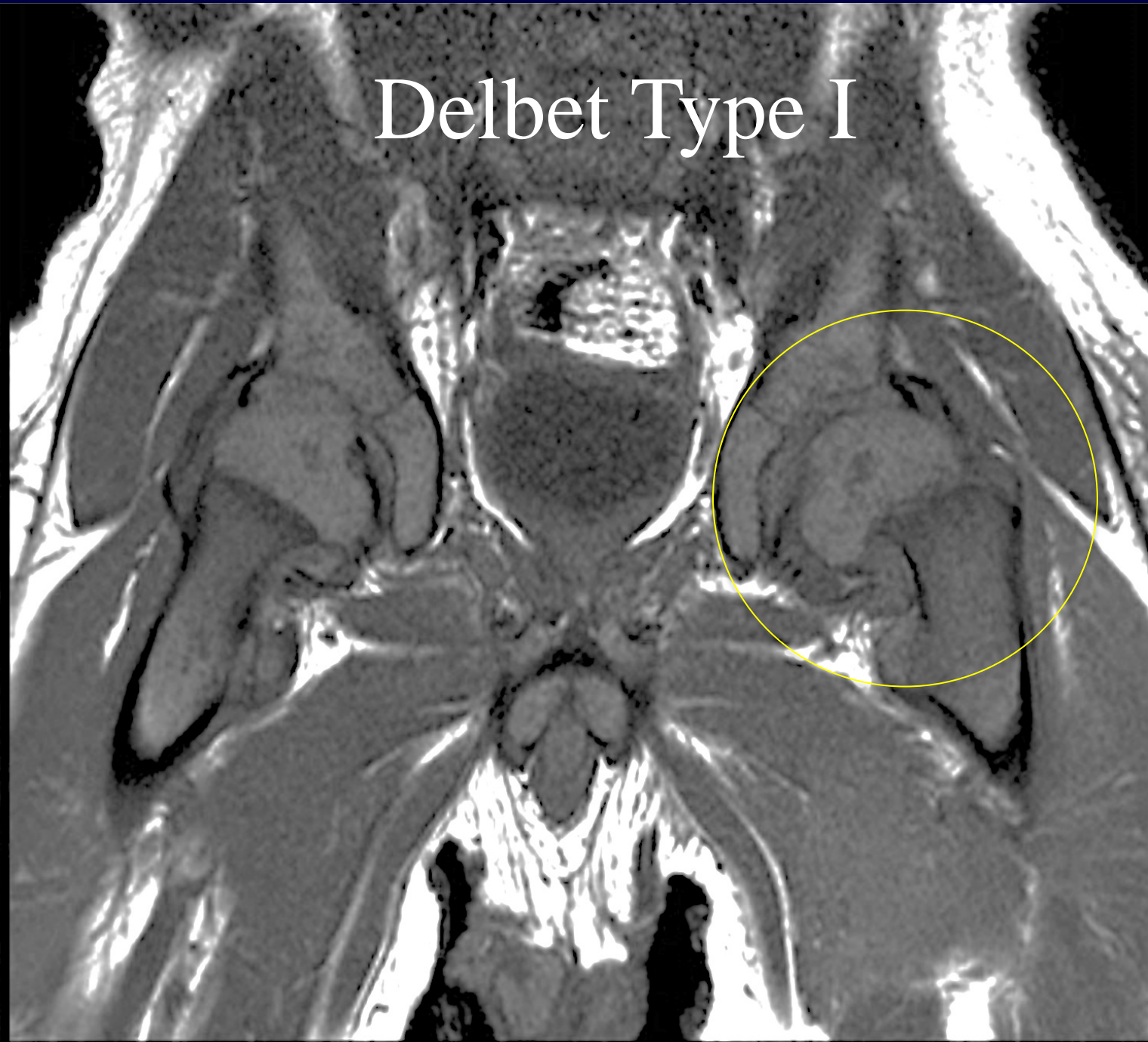
- Type I: Transphyseal
 - <10% of hip fractures
 - Most in children less than 2 or between 5 and 10 years of age
 - Diagnosed late in newborns and infants
 - Can result from child abuse
 - Subtypes
 - Type IA – no dislocation of the epiphysis from the acetabulum
 - Type IB - associated dislocation of epiphysis



Delbet Classification

- Type I:
 - Usually a result of severe trauma
 - 50% associated with femoral head dislocation
 - Associated injuries in over 60% of patients
 - Pelvic fractures most common associated orthopaedic injury
 - High rate of AVN

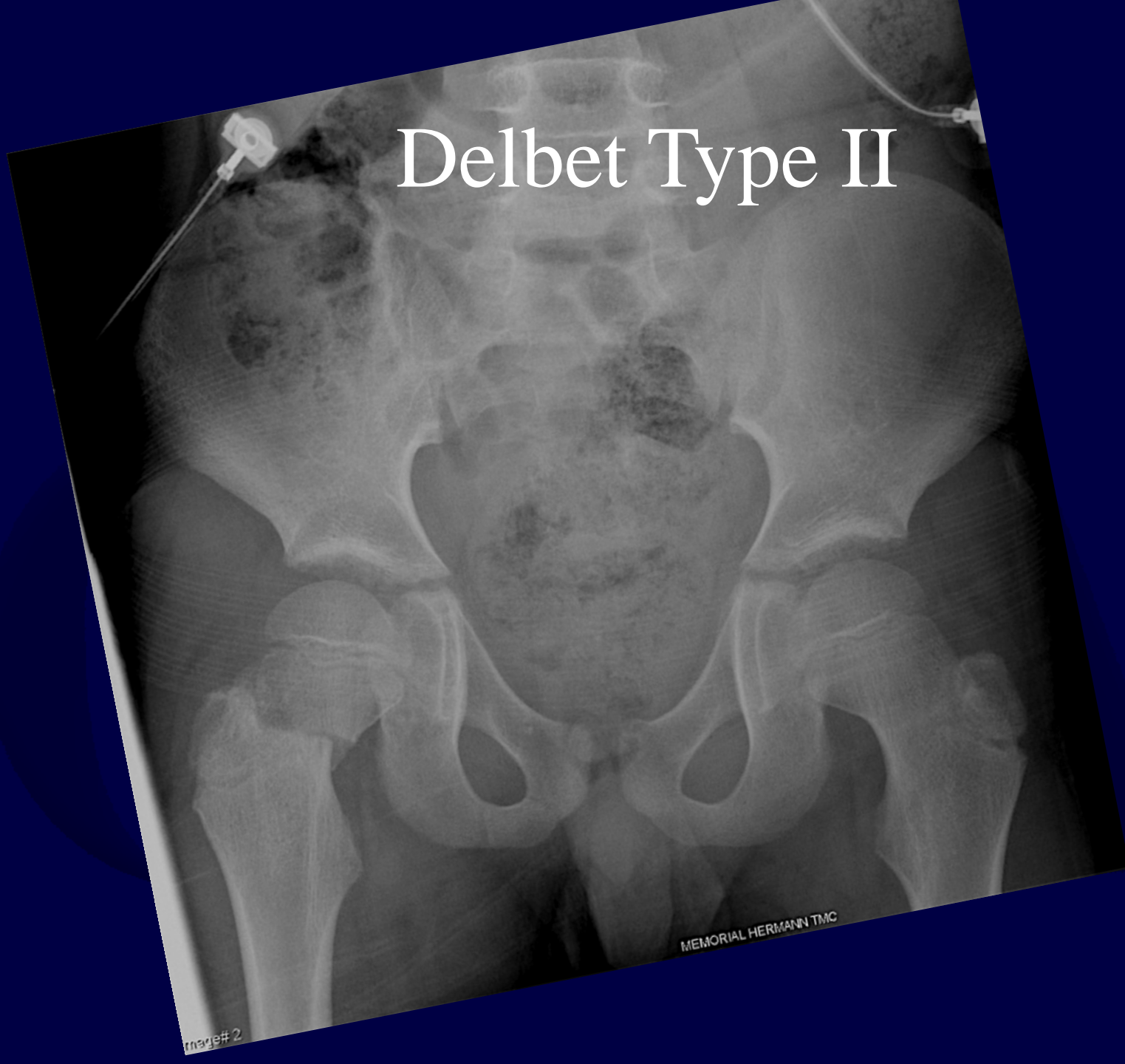
Delbet Type I



Delbet Classification

- Type II: Trans-cervical
 - Most common pediatric hip fracture (40-50%)
 - Result from severe trauma
 - 70-80% displaced at initial presentation
 - Initial displacement at time of injury best predictor of AVN
 - Higher complication rate than type III and IV
 - AVN reported up to 50% although thought to be less with more aggressive management

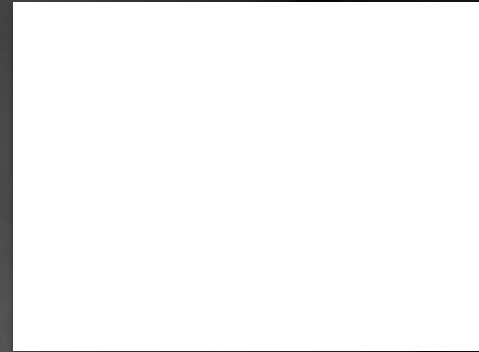
Delbet Type II



Delbet Classification

- Type III: Cervicotrochanteric
 - 25-30% of hip fractures
 - 20-25% AVN rate
 - AVN rate directly related to amount of displacement at time of injury

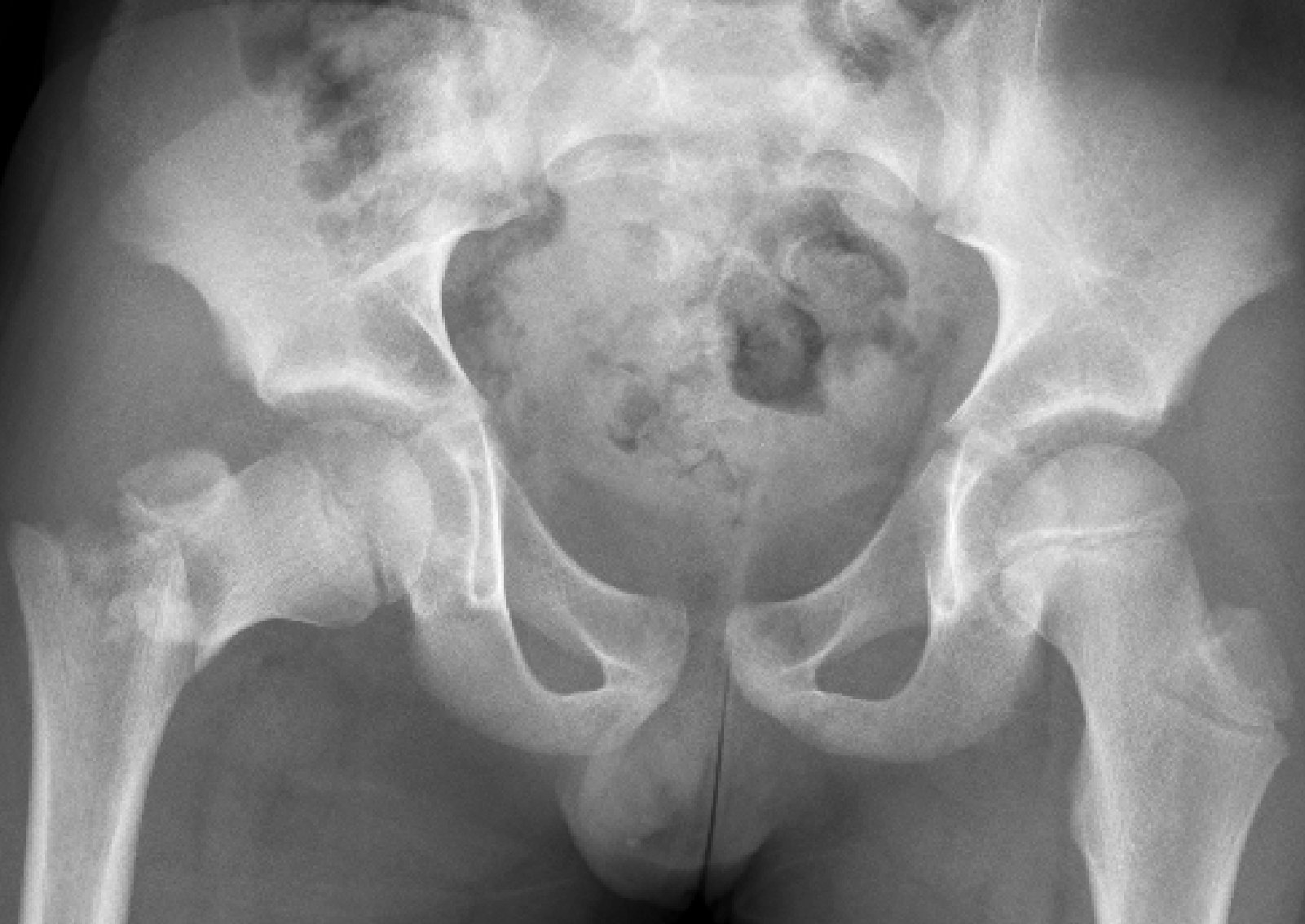
Delbet Type III



Delbet Classification

- Type IV: peritrochanteric or intertrochanteric
 - 6-15% of pediatric hip fractures
 - AVN in less than 10%
 - Most favorable outcomes

Delbet Type IV



Femoral Neck Fractures

Missed/Delayed Diagnosis

- Pain from hip fractures may obscure associated injuries.
- Concomitant injuries, especially head injuries can lead to delay in diagnosis (up to 20% of hip fractures)
- Often missed in newborns and infants
- Stress fractures may be ignored as hip/groin sprains

Femoral Neck Fracture

Treatment: Delbet Type I

- 35% loss of reduction rate with cast immobilization alone
- Rigid internal fixation for acute presentation with cast immobilization
- Gentle reduction maneuvers: Flexion, slight abduction and internal rotation under fluoroscopy

Femoral Neck Fracture

Treatment: Delbet Type I Fractures

- If femoral head is not in acetabulum, one attempt at closed reduction followed by open reduction
- Smooth pins in children less than 4, 4.0 mm cannulated screws in 4-7 year range, and larger cannulated screws in older children
- Pin/screw placement through lateral incision. Avoid threads across the physis.

Pediatric Hip Fractures:

Treatment Type II fractures

- Stable internal fixation for all fractures
- Complications more common with closed treatment
- Gentle closed reduction attempted under fluoro
- Open reduction through anterior or anterolateral approach

Pediatric Hip Fractures:

Treatment Type II fractures

- Threaded steinman pins in younger child, cannulated screws in older
- Keep fixation distal to physis if possible
- At least two screws in older patients
- Needle or open hip capsular decompression **highly** recommended
- One and a half hip spica cast until radiographic healing

Pediatric Hip Fractures: Treatment Type III fractures

- Abduction casting for nondisplaced fractures in children less than 6
- Internal fixation for all type III fractures in children greater than 6 years, displaced fractures in children less than 6
- Augment cannulated screws with casting
- Avoid physis

Pediatric Hip Fractures: Treatment Type IV fractures

- Cast immobilization for nondisplaced fractures in younger patients
- Internal fixation for all displaced fractures and nondisplaced fractures in children over 6
- More favorable outcomes



Pediatric Hip Fractures: Complications

- AVN: (historic vs. recent)
 - Type I: 100% vs 38%
 - Type II: 50% vs 28%
 - Type III: 25% vs 18%
 - Type IV: 15% vs 5%
 - Results from disruption of femoral head blood supply and tamponade from hemarthrosis
 - Risk Factors
 - Type I/II fractures
 - older age
 - initial displacement
 - Factors in our control
 - Time to treatment
 - Capsular decompression
 - Quality of reduction



Pediatric Hip Fractures: Complications

- Coxa Vara
 - 10-32% of cases
 - Causes
 - Malreduction
 - Delayed union or nonunion
 - Premature proximal femoral physeal closure with greater troch overgrowth
 - Casting alone (especially in older patients)
 - Less likely with rigid internal fixation

Pediatric Hip Fractures: Complications

- Nonunion
 - 6.5-12.5%
 - Higher rates with casting alone
 - Poor reduction
 - Distraction at fracture site
 - Fracture orientation (higher Pauwel's angle)
 - Can result in coxa vara or AVN

Pediatric Hip Fractures: Complications

- Premature Physeal Closure
 - 10-62%
 - AVN most common cause
 - Crossing the physis with hardware risk factor (62% vs. 12 %)

Literature update

- Panigrahi, *Int Orthop* 2015
 - Prospective study, 28 pts.
 - 71% presented within 48 hrs. and operated on same day
 - 14% AVN
 - Capsulotomy in all cases
 - releases the tamponade effect
 - Recommend capsular decompression to be performed in all cases (due to lower AVN rate than other reported series)

Literature update

- Spence *JPO* 2015
 - Level III, retrospective comparative
 - 70 pts
 - Multiple reduction and fixation methods
 - 29% osteonecrosis
 - Significant predictors – fracture displacement, fracture location
 - Not predictive – Patient age, type of fixation, mechanism of injury, capsular decompression, postoperative alignment, and performance of reduction

Literature update

- Riley *JOT* 2015 – Evaluated time to reduction and association with AVN
 - Retrospective prognostic Level II
 - 44 cases
 - Results/Conclusions
 - 20% AVN
 - No child <11 yrs old developed AVN
 - Unable to show that early reduction (<12 hours) or capsular decompression decreased AVN (but underpowered)

Presentation

- 7 month old child presents with one day history of refusal to move left leg



Initial Films





Injury?
Associated injury?

Initial Films



Delbet Type I

Associated left subacute distal femur
SH2 fracture

Treatment options?

Closed Reduction and Casting



3 months



10 months



Follow-up

2 yrs postop



3 yrs postop



Initial Presentation

- 7 year old male involved in auto vs pedestrian accident
- Right hip pain with movement

Initial Films



Initial Films



Injury?

Concerns the family should know about preoperatively?



Delbet type II

Treatment options?

ORIF

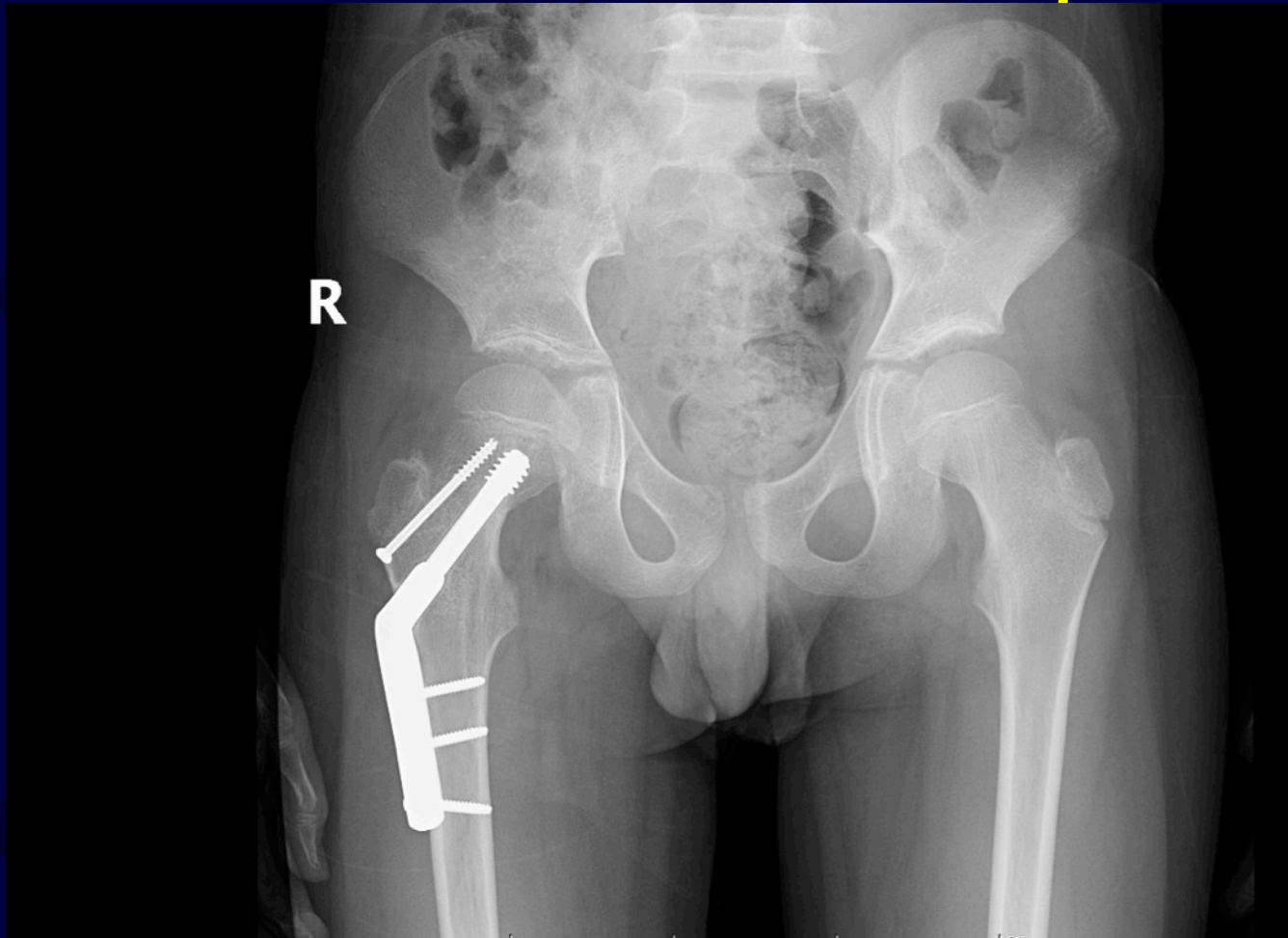


Fixed angle construct with supplemental antirotation screw
Sparing the physis
Options for Approach?

Approach Options for ORIF

- Watson-Jones (anterolateral)
 - Single incision
 - Easier fracture visualization for Delbet III than I or II
- Smith-Peterson (anterior)
 - Need separate lateral incision of hardware insertion
 - More direct visualization of fracture site (especially Delbet I and II)

10 month follow-up



19 months postop

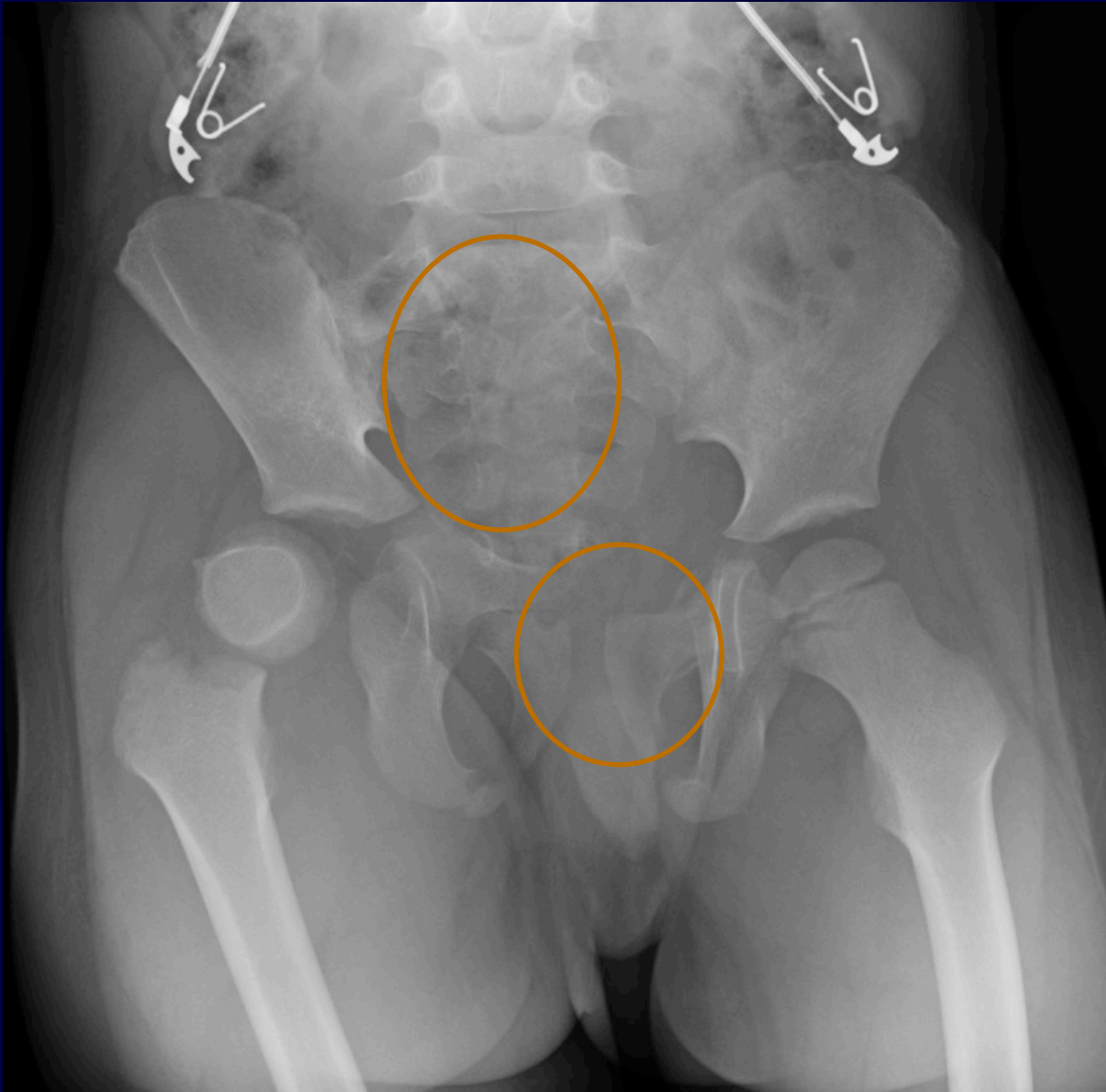


After hardware removal.
No AVN...yet.

Initial Presentation

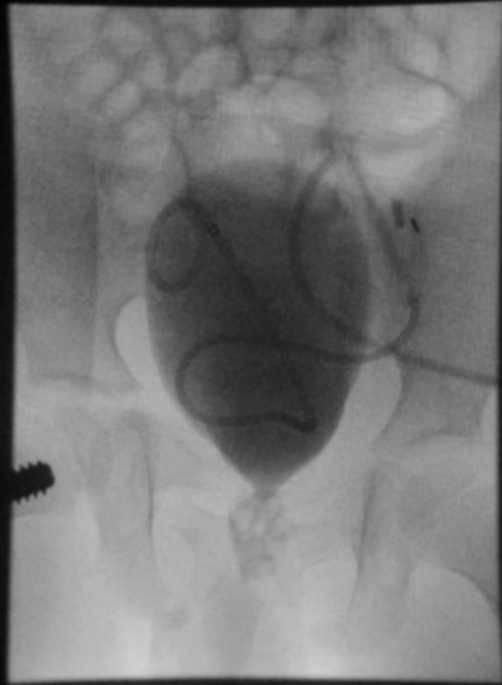
- 3 yr old male involved in auto pedestrian accident
- Brought in with shortened externally rotated right lower extremity, blood at urethral meatus

Initial Films



Notice the
proximal fragment
is also dislocated...

Associated Injuries

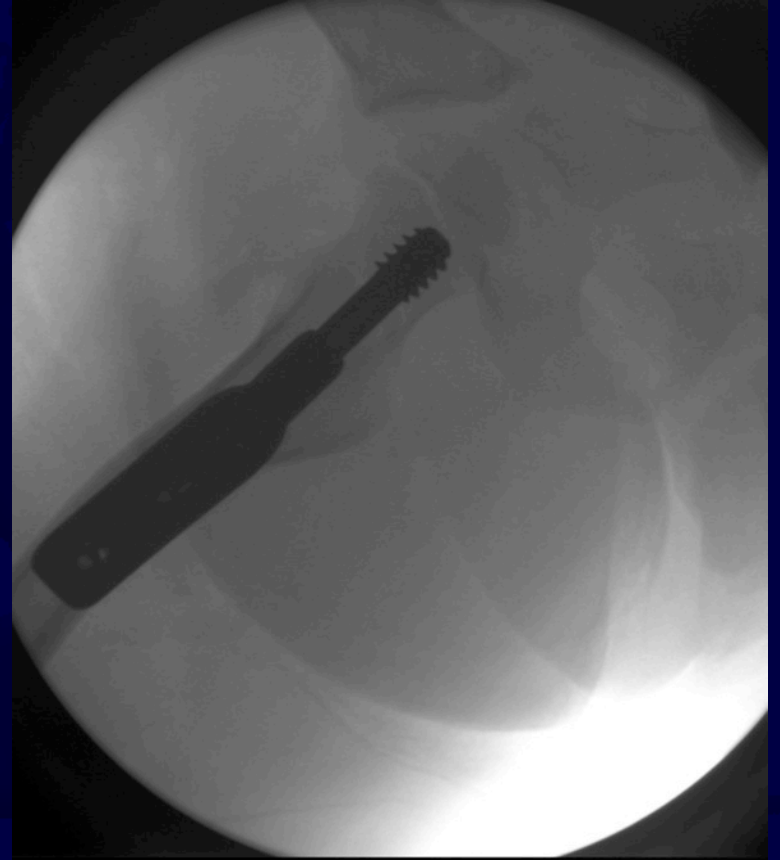


A faint, stylized background image featuring a tree with a dense canopy and a thick trunk. Overlaid on the tree are large, light-colored letters: a large 'O' on the left, a smaller 'I' in the center, and a large 'A' on the right. The text 'Delbet type III' is written in a yellow serif font across the middle of the image, and 'Treatment options?' is written in a white serif font below it.

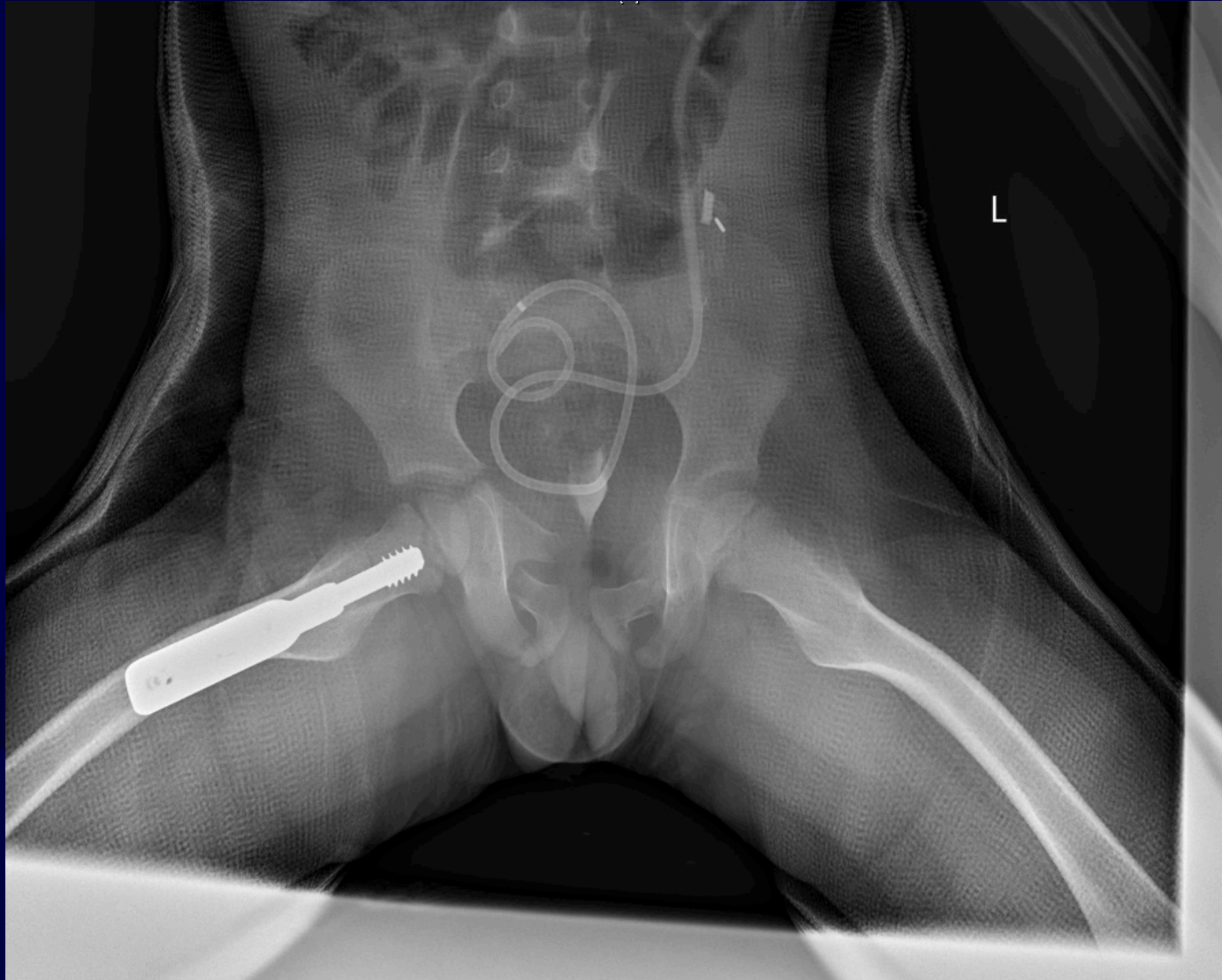
Delbet type III

Treatment options?

ORIF



Spica Cast for Pelvic Injuries



3 month follow-up



Initial Presentation

- 8 year old rode his bike into a metal post
- Developed acute right hip pain

Initial Films



Initial Films



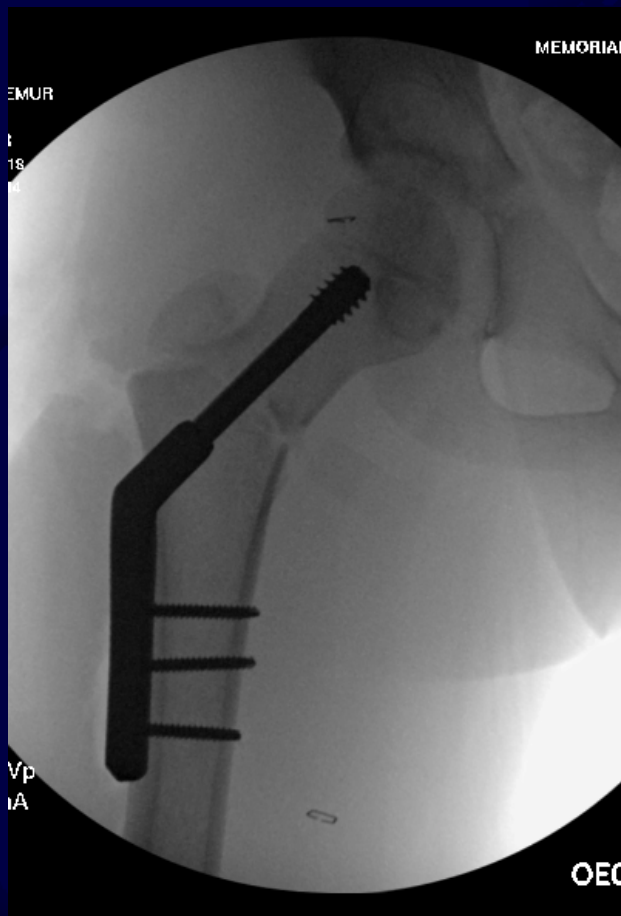


Delbet type IV

Treatment options?

Approach?

ORIF



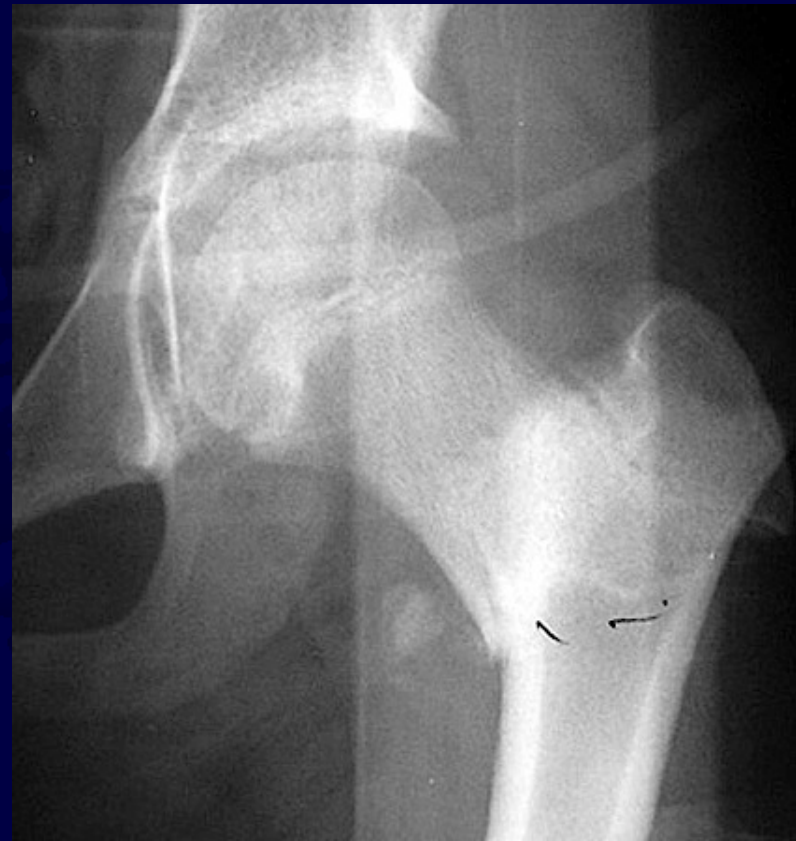
Lateral approach – clamp application on greater trochanter and vastus ridge

One year follow-up



Case

- 12 yo Female
 - MVA – 7pm
 - Father Driver Fatality
 - HD Stable
 - Left Hip Pain
 - Deformity
 - 11pm
 - Cleared for Ortho



What's the diagnosis?

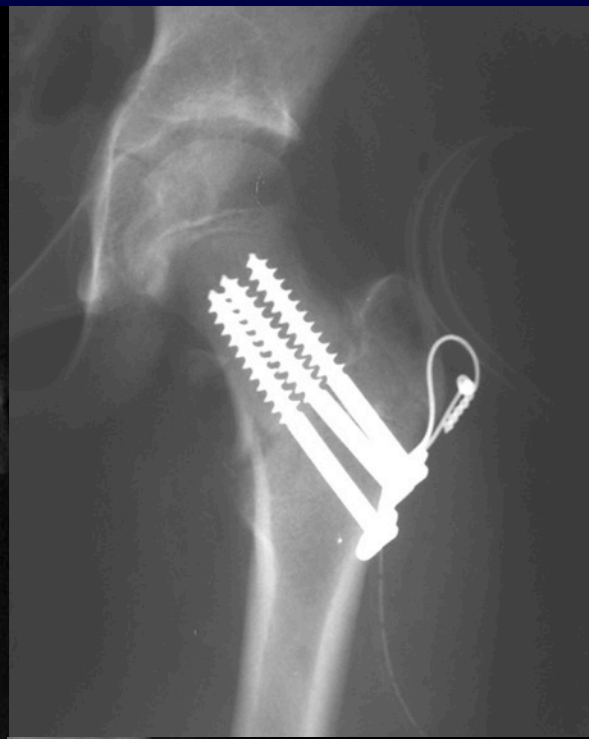
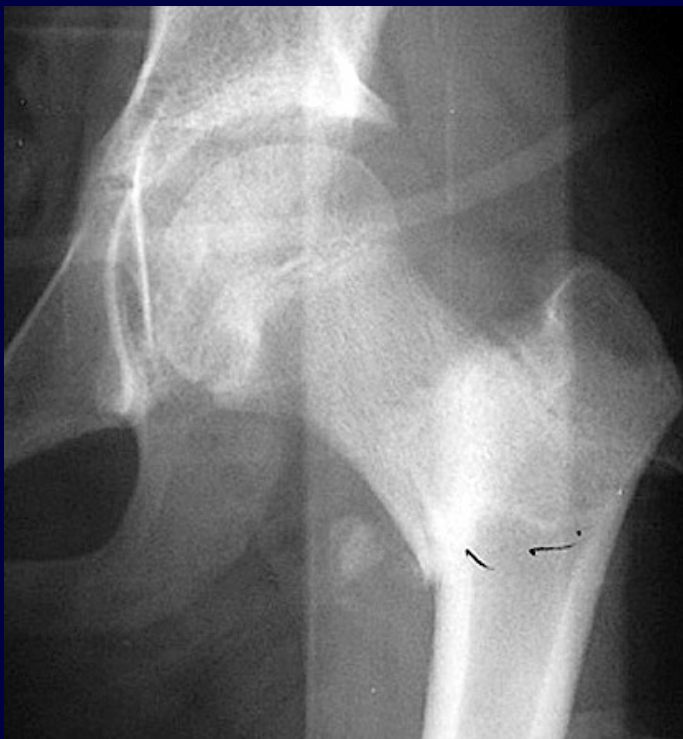
- Femoral Neck Fracture
- Delbet 1A
- Delbet 2
- Cervico-trochanteric Fracture
- Other



What would you do?

- Spica Casting
- Urgent Closed Reduction – Fix
- Urgent Open Reduction – Fix
- Delayed Operative





Preop

Immediate postop

Healed, at skeletal ma

Cervicotrochanteric – treated with urgent open reduction and internal fix



Pediatric Hip Dislocations

Pediatric Hip Dislocations

- Uncommon injury
- Force required to dislocate increases with age
 - Minor injury <10 yrs
 - Higher-energy injury >12 yrs
- Majority are posterior direction



(Vialle JPO 2005)

Pediatric Hip Dislocations

- Exam
 - Observe the position of limb
 - Posterior dislocations
 - hip flexion, adduction, and internal rotation
 - Anterior dislocations
 - hip extension, abduction, and external rotation.
 - Inferior dislocations
 - thigh is hyperflexed or abducted
 - Neurovascular examination
 - Pre and post reduction
- Xrays
 - Prior to reduction attempt

Pediatric Hip Dislocations

- Urgent Reduction
 - <6 hours to decrease AVN risk
 - 20-fold increase in AVN with delay >6 hrs (Mehlman CORR 2000)
 - Gentle reduction
 - Risk iatrogenic epiphyseal separation
 - Open reduction if failed attempts at closed reduction

Pediatric Hip Dislocations

- Post-care
 - Younger patients (<3-4 yrs)
 - Spica cast 3-4 wks
 - Abduction splinting 3-4 wks
 - Compliant patients
 - protected non-weight bearing for 6 weeks

(Vialle JPO 2005)

Pitfalls

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

Complications

- Complications
 - Avascular necrosis (8-20%)
 - Myositis ossificans (8-15%)
 - Sciatic nerve palsy
 - Early secondary arthritis
- Predisposing factors to poor result:
 - Older child
 - Severe trauma
 - Delay in reduction (> 6-8 hours)
 - Incongruous reduction
 - AVN

Herrera-Soto. *JAAOS* 2009

Imaging after Reduction

- CT and x-ray may underappreciate pediatric acetabular fractures after dislocation (Hearty *JOT* 2011)
- Consider MRI after reduction
 - Better evaluates nonossified posterior acetabular wall
 - Assist with surgical planning

Nonconcentric Reduction

- Open reduction – Approach the direction of the dislocation
 - Allows visualization of block to reduction ie. Buttonholed capsule, torn labrum, etc.
- Surgical hip dislocation is a safe technique to identify obstacles to reduction
 - Podeszwa JPO2015
 - 11 patients (mean age of 12.3 years)
 - Intraoperative findings included: labral tear (8), femoral cartilage injury (5), acetabular rim fracture (4), acetabular cartilage delamination (3), loose body (2), and femoral head osteochondral fracture (1)
 - Mean 24.5 months f/u
 - No AVN
 - At 1-year follow-up, mean Harris Hip Score was 95.8 (range, 84.7 to 100).
 - Possible risk factors for posterior hip instability
 - Acetabular dysplasia
 - relative acetabular retroversion
 - decreased femoral offset

Conclusions

- Pediatric Hip fractures and dislocations are rare injuries
- High suspicion in infants and patients with concomitant injuries leads to fewer missed injuries
- Aggressive early treatment may result in a lower complication rate than historically quoted
- Counsel the family on AVN risk initially and throughout follow-up period

References

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- For questions or comments, please send to ota@ota.org