Pediatric Lower Extremity Fractures

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ORTHOPAEDIC SURGERY

1

Outline

- Epidemiology
- Principles of care
- Femur
  - Proximal
  - Shaft
  - Distal
- Patella
- Tibia
  - Proximal
  - Shaft
  - Distal/Ankle
- Foot
  - Hindfoot
  - Midfoot
  - Forefoot

2

Epidemiology

- One in three children will have a fracture[1]
- Boys more likely to fracture[1-4]

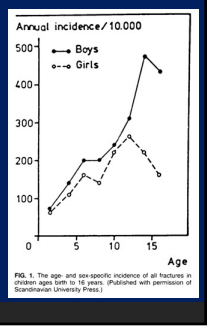


FIG. 1. The age- and sex-specific incidence of all fractures in children ages birth to 16 years. (Published with permission of Scandinavian University Press.)

3

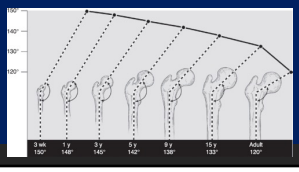
Epidemiology

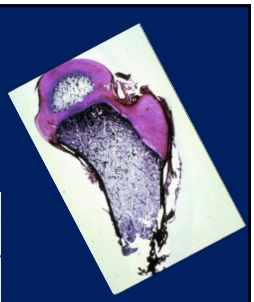
- 23% in the lower extremity (LE)[4]
  - Most common in tibia (38% of all LE)
  - Average age 9.5 years
  - <20% treated surgically

4

Proximal Femur[5]

- Proximal femur physes
  - Femoral head
  - Femoral neck
  - Greater trochanter
- Injury creates growth disturbance





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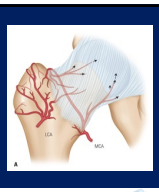
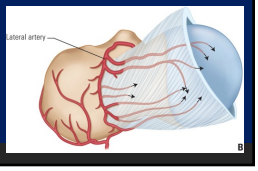
Proximal Femur[5]

- Blood supply - LAMP
  - Lateral circumflex artery (LCA)
    - Greater trochanter and metaphysis
    - Anterior
  - Medial circumflex artery (MCA)
    - Femoral head and neck
    - Posterior
    - Enters capsule around piriformis fossa

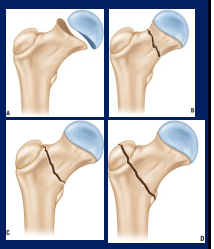




6

Proximal Femur[5]

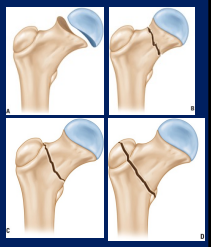
- High energy
- Look for pathologic fracture
- Delbet's Classification
  - Type I – transepiphyseal
  - Type II – femoral neck
  - Type III – basicervical
  - Type IV - intertrochanteric



7

Proximal Femur[5]

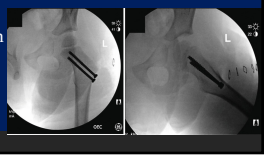
- Treatment
  - Type I – transepiphyseal
    - Almost always operative
    - Must restore anatomic → blood supply
    - Closed/open reduction and casting in infants



8

Proximal Femur[5]

- Treatment
  - Type II/III – femoral neck
    - Spica casting in <5 years and nondisplaced
    - Displaced: must restore anatomic → blood supply
    - Closed vs open reduction and fixation
      - Screw fixation
      - Blade plate
      - Proximal femoral locking plate
      - Sliding hip screw



9

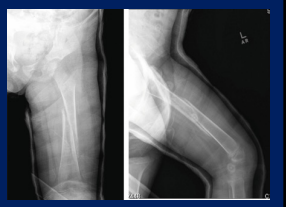
Proximal Femur[5]

- Treatment
  - Type IV – intertrochanteric
    - Restore neck shaft angle
    - Spica casting in <5 years and nondisplaced
    - Displaced: closed reduction and casting in <5 years
    - Closed vs open reduction and fixation
      - Proximal femoral locking plate
      - Blade plate
      - Sliding hip screw

10

Femoral Shaft[5]

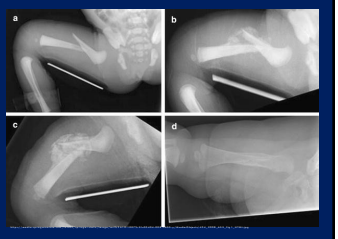
- Bimodal age distribution
  - 2-3 years
  - Adolescents
- Nonaccidental trauma
  - Nonambulatory child
  - Age <1
  - No specific fracture pattern
- Treatment based on age and fracture characteristics



11

Femoral Shaft[5]

- Age < 6 months
  - Birth injury
  - Non-accidental trauma
  - Osteogenesis imperfecta
  - Treatment
    - Immobilization
      - Splint
      - Pavlik harness
      - Spica cast



12

Femoral Shaft[5]

- Age 6 months – 5 years
  - Low energy fractures
  - Eval for non-accidental trauma
  - Treatment
    - Closed reduction and spica casting
    - Closed vs open reduction and flexible nails
    - Alignment parameters
      - <3 cm of shortening
      - 20-30 degrees of angulation

13

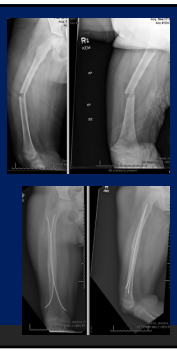
Femoral Shaft[5]

- Age 5 to 11 years
  - Alignment parameters
    - <15 degrees varus/valgus
    - <15 degrees recurvatum/procurvatum
    - <2 cm chortening
  - Nonoperative - immobilization
    - Nondisplaced
    - Patient specific parameters

14

Femoral Shaft[5]

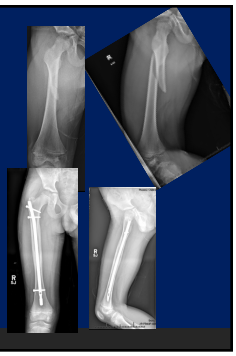
- Age 5 to 11 years
  - Alignment parameters
    - <15 degrees varus/valgus
    - <15 degrees recurvatum/procurvatum
    - <2 cm chortening
  - Surgical stabilization
    - Closed vs open reduction and flexible nails
    - Submuscular plating
    - Rigid intramedullary nail (> age 8)



15

Femoral Shaft[5]

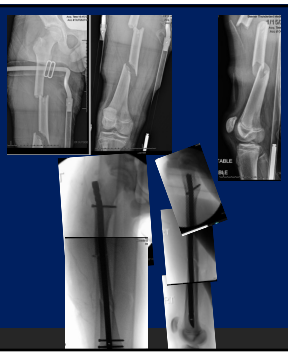
- Age 5 to 11 years
  - Surgical stabilization
    - Closed vs open reduction and flexible nails
    - Submuscular plating
    - Rigid intramedullary nail (> age 8)
      - Allows early weight bearing
      - Reliable fixation for length unstable fractures



16

Femoral Shaft[5]

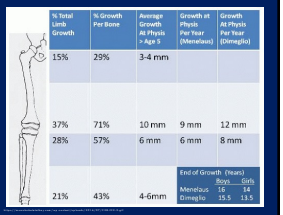
- Age >11 years
  - Alignment parameters
    - <10 degrees varus/valgus
    - <10 degrees recurvatum/procurvatum
    - <1.5 cm chortening
  - Nonoperative - immobilization
    - Nondisplaced
    - Patient specific parameters
  - Surgical stabilization
    - Plating
    - Rigid intramedullary nail



17

Distal Femur[5]

- Physeal considerations
  - Distal femur physis is fastest growing
  - Up to 50% premature physeal closure
  - Treatment
    - Immobilization
    - Closed vs open reduction and casting
    - Closed vs open reduction and surgical stabilization



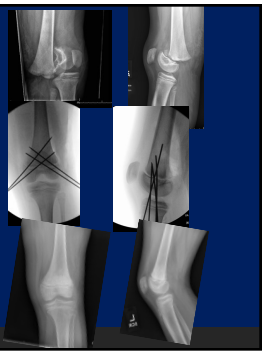
% Total Limb Growth	% Growth Per Bone	Average Growth At Physis > Age 5	Growth at Physis Per Year (Menelaus)	Growth At Physis Per Year (Dimeglio)
15%	29%	3-4 mm		
37%	71%	10 mm	9 mm	12 mm
28%	57%	6 mm	6 mm	8 mm
21%	43%	4-6mm		

End of Growth (Years)	Boys	Girls
Menelaus	16	14
Dimeglio	15.5	13.5

18

Distal Femur[5]

- Physeal considerations
  - Distal femur physis is fastest growing
  - Up to 50% premature physeal closure
  - Treatment
    - Immobilization
    - Closed vs open reduction and casting
    - Closed vs open reduction and surgical stabilization
      - Pin fixation
      - Screw fixation +/- pin
      - Rigid plate fixation



19

Distal Femur[5]

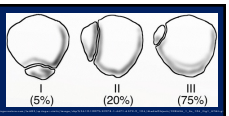
20

Distal Femur[5]

21

Patella Fractures[5]

- Less common in children than adults
  - Direct trauma
  - Cartilagenous even into adolescence
  - More mobile
  - Incomplete ossification
  - Bipartite patella
  - Patellar sleeve
    - Age 8-12
    - Avulsion of cartilaginous portion of distal patella
    - Lateral radiographs demonstrate patella alta



22

Patella Fractures[5]

- Treatment
  - Immobilization
    - Nondisplaced
    - Intact extensor mechanism
  - Surgical stabilization
    - Displaced fractures
    - Tension band technique
    - Plate or suture augmentation

23

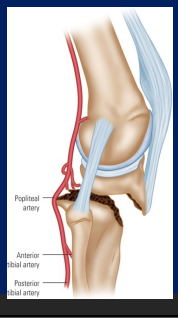
Tibial Spine Fractures[5]

- Also known as tibial eminence fracture
- Myers and McKeever classification
  - Type I: Minimally displaced, slight elevation of the anterior margin
  - Type II: Hinged posteriorly, beak-like appearance on the lateral radiograph
  - Type III: Completely displaced and elevated
- Treatment
  - Immobilization
    - Nondisplaced (Type I)
    - Long leg cast or knee immobilizer
  - Surgical stabilization
    - Displaced fractures (Type II, III)
    - Arthroscopic vs open reduction and fixation

24

Tibial Tubercle Fracture[5]

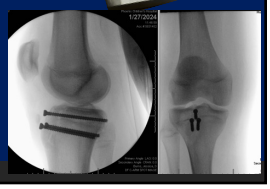
- Extension of proximal tibial epiphysis
- Secondary ossification center
- Insertion of the patellar tendon
- Fracture of adolescence
- Possible history of Osgood-Schlatter disease
- Complications
  - Vascualar injury
  - Compartment syndrome



25

Tibial Tubercle Fracture[5]

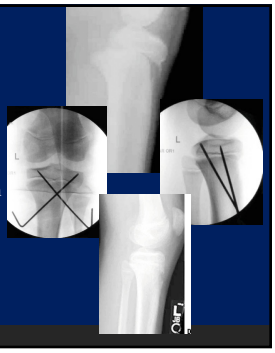
- Treatment
  - Nonoperative
    - Nondisplaced
    - Knee immobilizer vs long leg cast
  - Operative
    - Open reduction with removal of periosteum/muscle
    - Screw fixation



26

Proximal Tibia[5]

- Physeal separation
  - Nondisplaced treated with immobilization
  - Dispaced with closed vs open reduction and stabilizaiton



27

Proximal Tibia[5]

- Proximal tibia metaphysis
  - Trampoline fracture
  - Common between ages 2-8
  - Closed reduction and casting
  - Closed vs open reduction and fixation with irreducible deformity

28

Proximal Tibia[5]

- Complications
  - Cozen's phenomenon
    - Progressive valgus deformity
    - Overgrowth of the medial tibial physis
    - Treated with observation

29

Proximal Tibia[5]

- Complications
  - Cozen's phenomenon
    - Progressive valgus deformity
    - Overgrowth of the medial tibial physis
    - Treated with observation

30

Tibial Shaft[5]

- 4-5% of all pediatric fractures
- Fracture pattern
  - Nondisplaced
  - Oblique or spiral
  - Transverse or comminuted displaced
- Remodeling potential is low
- Acceptable alignment
  - 3-12 years of age
    - 10 degrees varus/valgus
    - 10 degrees procurvatum/recurvatum

31

Tibial Shaft[5,6]

- Treatment
  - Toddler's fracture
    - Short leg walking cast
    - CAM boot – improved care at home, no difference in outcomes
  - Displaced fractures
    - Closed reduction and long leg casting
    - Consideration for short leg cast

Randomised controlled trial comparing immobilisation in above-knee plaster of Paris to controlled ankle motion boots in undisplaced paediatric spiral tibial fractures

Kate Bradman, Katherine Stannage, Sharon O'Brien, Simon Green, Natasha Bear, Meredith Borland

32

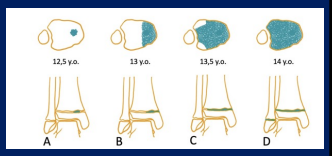
Tibial Shaft[5]

- Treatment
  - Closed vs open reduction, flexible nailing or plate fixation
    - Fractures that demonstrate instability
    - Failure of reduction with >2 years of growth remaining
  - Rigid intramedullary nailing
    - Children within 2 years of skeletal maturity
    - Tibial nail violates anterior proximal tibia physis

33

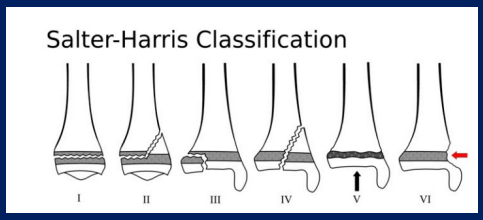
Distal Tibia/Ankle Fractures[5-8]

- Closure of distal tibia physis
  - Central
  - Medial
  - Lateral
- Fibular physis at the level of talar dome
  - Closes 1-2 years after distal tibia



34

Distal Tibia/Ankle Fractures[5,7-9]



35

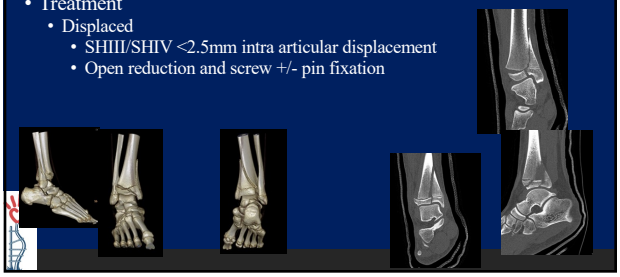
Distal Tibia/Ankle Fractures[5,7-9]

- Treatment
  - Nondisplaced - Short leg cast
  - Displaced
    - Closed reduction and casting
    - SHII distal tibia

36

Distal Tibia/Ankle Fractures[5,7-9]

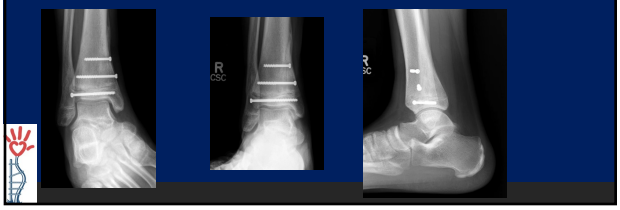
- Treatment
  - Displaced
    - SHIII/SHIV <2.5mm intra articular displacement
    - Open reduction and screw +/- pin fixation



37

Distal Tibia/Ankle Fractures[5,7-9]

- Treatment
  - Displaced
    - SHIII/SHIV <2.5mm intra articular displacement



38

Distal Tibia/Ankle Fractures[5,7-9]

- Treatment
  - Displaced
    - SHIII/SHIV <2.5mm intra articular displacement

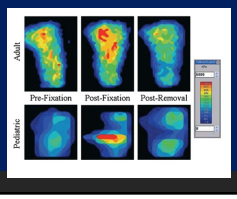
39

Distal Tibia/Ankle Fractures[5,7-9,10,11]

- Complications
  - Symptomatic screws
  - Premature physeal closure
    - Long term follow up – depends on fracture type
    - Tibia
      - Partial
        - <50% - resection
      - Complete
        - Contralateral arrest?
        - Complete affected side
    - Fibula
      - Age

Ankle Joint Biomechanics Following Transepiphyseal Screw Fixation of the Distal Tibia

Michael Charlton, MD, Richard Costello, MS, James F. Mooney, III, MD, and David A. Podeszwa, MD



40

Distal Tibia/Ankle Fractures

41

Distal Tibia/Ankle Fractures

42

Distal Tibia/Ankle Fractures


43

Distal Tibia/Ankle Fractures



44

Distal Tibia/Ankle Fractures

45

Distal Tibia/Ankle Fractures

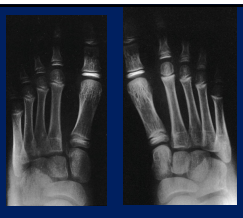
46

Hindfoot Fractures[5]

- Calcaneous
  - Extra articular
  - Intra articular
  - CT for full evaluation
  - Treatment
    - Nondisplaced and extra articular
      - 6 weeks cast immobilization
    - Displaced
      - Open reduction and pin/screw/plate fixation
- Talus
  - Talar neck fractures – blood supply, osteonecrosis
  - Treatment
    - <2mm displacement, <5 degrees angulation
    - 6 weeks cast immobilization

47

Midfoot Fractures[5]



- Treatment
  - Nondisplaced
    - CAM boot or walking cast
    - Weight bearing as tolerated
  - Displaced
    - Evaluate for ligamentous injury (Lisfranc) with weigh bearing radiographs
    - MRI if unable to assess with weight bearing radiographs
    - Dislocations or displaced fractures require open reduction and fixaiton

48

Forefoot Fractures[5]

- Metatarsal
  - Common: 5-7% of pediatric fractures
  - Young children – 1st metatarsal
  - Adolescents – 5th metatarsal
  - Treatment
    - Nondisplaced – CAM boot or walking cast
    - Displaced – age + amount of displacement

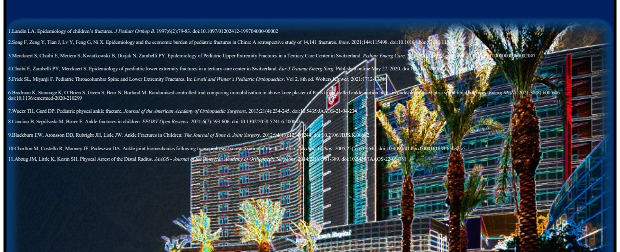
49

Forefoot Fractures[5]

- Phalangeal
  - Assess for open fracture (nailbed injury)
  - Clinical deformity or intra articular displacement
    - Closed reduction and pinning or screw fixation
  - Nondisplaced or minimally displaced
    - Buddy tape and postop shoe
    - CAM boot for younger children or pain control

50

SOURCES



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THANK YOU!

51