CHILDRENS’ FRACTURES

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Children Are Not Small Adults

- Anatomical differences
- Biomechanical differences
- Physiological differences
Incidence - Mortality

• Overall
  – 1900 1:250 /yr
  – 1986 1:4000 /yr

• Accidents
  – Adolescents vs Adults
    1 : 3
Incidence - Mortality

- Death from accidents is relatively uncommon
- 1 - 14 yrs, accidents are leading cause of death
Gender variation - mortality

![Bar chart showing gender variation in mortality among children's fractures]

- Male <5yr: 1.5
- Male >5yr: 1.88
- Female <5yr: 1.5
- Female >5yr: 1.88

Children’s fractures
Incidence - Fractures

• Risk of fracture during childhood
  – Male 42% Female 27%
  – ↑ incidence with ↑ age

• Physeal fracture 21.7%
• Open fracture 2.9%
• Multiple fracture 3.6%
Anatomical Differences

- Growth plates
- Epiphyses
- Apophyses
- Thicker periosteum
Children’s bone compared to adults

- **Physis**
  - Radiolucent
  - Diagnosis of fractures by inference
- **Force & pattern of injury**
- **Growth**
- **Remodelling**
Anatomy of a Childs’ Bone

- Epiphysis
- Physis
- Metaphysis
- Diaphysis
- Apophysis
Biomechanical Differences

- **Ligaments stronger than growth plate**
  - easy to produce epiphyseal separation
  - difficult to produce dislocations or sprains

- **Young bone more porous**
  - tolerates more deformation (plasticity)
  - fails in compression as well as tension
Children’s bone compared to adults

- **Porous**
  - Less dense
  - Haversian canals wider
  - Deforms more easily

- **Periosteum**
  - Thicker & stronger
  - Biologically more active
Classification of Children's Fractures

- Torus (compression) fracture
  - Junction of fenestrated cortex and denser cortical bone
- Plastic deformation
- Greenstick fracture
- Complete fracture
Differing injury patterns
Salter-Harris Classification
Epiphyseal Injuries

- Avulsion at site of ligamentous attachment
- Osteochondral fracture
- Compression fracture
Growth Plate Biomechanics

- Strength dependent on
  - age
  - direction of applied force

  - traction
  - angulation
  - torsion
Physiological Differences

- Remodelling
- Overgrowth
- Growth arrest
  - complete
  - partial
- Nonunion
- Speed of healing
Remodelling

Children’s fractures
Remodelling

• **Expected when:**
  – >2 years growth remaining
  – fracture is near the metaphysis
  – deformity is in the plane of joint movement
Remodelling

– Friberg 1979 Acta Orthop Scand
  • 10° maximum in diaphysis

– Gandhi 1962 BJS
  • 8yrs of age
  • 18° in diaphysis
  • 28° in metaphysis
Remodelling

• Not expected in:
  – intra-articular fractures
  – diaphyseal fractures with gross angulation, shortening or rotation
  – fractures with deformity at right angles to plane of joint movement
Children’s fractures

Remodelling

Unacceptable

Acceptable
Overgrowth

• Fracture stimulates longitudinal growth
  – increased blood flow associated with fracture healing stimulates growth plate
  – loss of “tether” of periosteum

• Usually only a consideration in femur
  – 1-2cm overgrowth after fracture
Growth Plate Injuries

- Progressive angular deformity
- Progressive limb-length discrepancy
- Joint incongruity
Nonunion

- Uncommon but can happen
  - displaced intra-articular fractures
    - synovial fluid inhibits callus formation
    - eg lateral humeral condyle
  - fractures with soft tissue interposition
Speed of Healing

• Quicker than adults
  – less time for deliberation

• Femoral # will heal in:
  – 3-4 weeks at birth
  – 10-14 weeks in adolescence
  – 14-20 weeks in adulthood

• Physeal injuries heal in 3 weeks
Neurovascular impairment

- Displaced fractures
- Dislocations
- Penetrating injuries

Elbow
  - Supracondylar

Knee
  - Distal 1/3 shaft
  - Supracondylar
  - Proximal tibia

Ankle

Midtarsal
Neurovascular impairment

- **Complete occlusion**
  - Pulseless, painful, cold, paraesthesia, paralysis

- **Incomplete occlusion**
  - Compartment syndrome (Volkmann’s ischaemia)
  - Pain, passive stretch, pulse present

- **Compensated occlusion**
  - Pulseless, painless, good collateral circulation
Children’s fractures

Neurovascular impairment
Neurovascular impairment
Open fractures

- **Blood loss**
  - Smaller volume to lose

- **Higher energy injuries in children**
  - Associated injuries

- **Infection**
  - Soft tissue
  - Osteomyelitis
Open Fractures

- An orthopaedic emergency
  - polaroid photo of wound
  - remove large contaminants
  - sterile dressing (do not disturb!)
  - IV antibiotics
  - tetanus prophylaxis
  - then xray
  - surgery within 6hrs of injury
Pelvic fractures

- AP compression (front to back) “Open book”
- Haemodynamic observations
- Hypovolaemia
Skin tension

Children’s fractures
Skin tension

Children’s fractures
Treatment of Children’s fractures
Treatment - Initial

- Splintage
- Analgesia
- Antibiotics
- IV fluids
- Reduction of fracture or dislocation
Fracture stabilisation - Plaster

Children’s fractures
Fracture stabilisation - Traction
Fracture fixation - External
Fracture fixation - Intramedullary
Sequelae - healing...
Sequelae - healing...twice!
Sequelae of injury

• Major injury may cause no disability at all
  – Hopefully all!
• Minor fractures may result in major disability
  – Hands & feet
• Undiagnosed fractures may cause major disability
  – Spine
Sequelae of injury

- Malalignment
- Growth arrest
  - Partial → Angular deformity
  - Complete → Shortening
- Volkmann’s ischaemia
- Infection
Sequelae of injury

Impaired forearm rotation

Radial neck #
Recent advances
Special Fractures

- Open Fractures
- Newborn Fractures
- Pathological Fractures
- Non-Accidental Injury
Pathological Fractures

• “From normal forces on abnormal bone”
• General
  – Osteogenesis
  – Cerebral palsy
  – Metabolic bone disease
  – Post plaster
• Local
  – Simple cysts
  – Lytic lesions
Newborn Fractures

- High birthweight
- Spina bifida
- Osteogenesis imperfecta
  - humerus
  - clavicle
  - femur
Non-Accidental Injury

• High index of suspicion
• 25% of fractures under 3 years are NAI
  – rib #s
  – old #s
  – corner #s
  – bucket handle #s
Non-Accidental Injury
Delayed since injury?
Osteogenesis
Osteogenesis

Children’s fractures
Osteogenesis
Osteopetrosis
Pulled Elbow
Pulled Elbow

- 1-4 years
- Refuses to use arm
- History not always reliable
- Supination of flexed elbow
- If unsuccessful
  - reconsider diagnosis
  - rest in C&C
Traps

• Fractures through growth plates
• Separation of unossified epiphyses
• Injury not apparent on standard x-rays
• Injury apparent but not seen
• Overdiagnosis
• Think of soft tissue injury
Separation of Unossified Epiphyses

Children’s fractures
Tips

• Use clinical judgement
• Xray joint above and below
• Be certain that radial head is not dislocated in fractures of the forearm
• 2 fractures can occur in the same limb
Clinical cases
Children’s fractures
RK

- Diagnosis: Open supracondylar # Right humerus with division of bracial artery
- 15/11/97 age 7y6m
- Fall 3m from tree
- AP & lateral
- Required ORIF with K-wires followed by vein graft to artery
Children's fractures
Children's fractures

CS

- Diagnosis - Monteggia # dislocation
- Presentation films age 4y 10m
- Treated by closed reduction and cast immobilisation
Children’s fractures
ES

- Diagnosis - Salter-Harris 2 # distal radial epiphysis
- Presenting films age 8y 10m
- Treated by closed reduction
Children's fractures
NB

- Diagnosis - elbow dislocation associated with medial epicondylar avulsion
- Presenting films age 8y
- Treated by closed reduction
Children’s fractures
Children’s fractures
Children’s fractures
NT

- Diagnosis - lateral condyle #
- Presenting films age 2y 1m
- Fracture not visible
- Treated in cast, became obvious
TJ

- Diagnosis: MVA, SH2 # Left distal femur, # right femoral shaft
- 9/11/96 age 7y4m
- AP left distal femur
Children’s fractures
Summary

• Children are not little adults
• Bones are anatomically & physiologically different
• Basic principles
• Beware NAI
Orthopaedic Emergencies

- Pelvic fractures with significant hypovolaemia
- Neurovascular impairment
- Open fractures
- Skin tension
Pelvic fractures

- AP compression (front to back) “Open book”
- Haemodynamic observations
- Hypovolaemia
Neurovascular impairment

- Elbow
  - Supracondylar
- Knee
  - Distal 1/3 shaft
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  - Proximal tibia
- Ankle
- Midtarsal
Neurovascular impairment

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Compartment syndrome

A

120mmHg

30mmHg

Pulse present

B

120mmHg

30mmHg

No perfusion = DEAD muscle

Children’s fractures
Neurovascular impairment

- Complete occlusion
- Incomplete occlusion
- Compensated occlusion
- Vascular surgeon
- Fasciotomies
- Watch like a hawk
  - may be occult complete occlusion
Open fractures

- Blood loss
  - Smaller volume to lose
- Higher energy injuries in children
  - Associated injuries
- Infection
  - Soft tissue
  - Osteomyelitis
Infection risk

- **Classification**
  - Gustilo & Anderson grades 1, 2, 3a, 3b, 3c

- ↑ incidence of infection with ↑ grade

- Significant increase in colonisation after 6 hours from injury
Reducing risk of infection
Infection risk - prevention in ED

- Inspect wound (Photograph)
- Cover with betadine dressing
- Tetanus prophylaxis
- IV antibiotics
  - Cephalosporin
  - Flucloxacillin
  - Add Penicillin for farm injuries
- Urgent orthopaedic referral
Infection risk - surgical management

- **Urgent debridement** (ideally within 6 hours)
  - Skin edges, debris, devitalised tissue
  - Bone must be delivered into wound
  - Remove loose bone fragments
- **Copious lavage**
- **Leave wounds open**
- **Repeat at 48-72 hours**
Infection risk - surgical management

- **Fracture stabilisation**
  - Stabilises soft tissue envelope
  - Decreases spread of bacteria
  - Allows early soft tissue cover (5 days)
    - Delayed closure
    - Skin graft
    - Flap
  - Reduces pain
  - Enhances nursing care