Pediatric Orthopaedic Emergencies

Meg Grisell, MD
Assistant Professor
Saint Louis University
Department of Orthopaedic Surgery
May 15, 2015
Objectives:

• Review presentation, history, outcomes of common pediatric urgent/emergent diagnoses
• Discuss treatment of above
• Help clarify transfer recommendations

Disclosure: I have no financial associations to disclose
What we will cover:

• Supracondylar Humerus Fractures
• Compartment Syndrome
• Neonatal infections
• Open Fractures
Supracondylar Humerus Fractures
SCH Fractures

• 3 – 30% of limb fractures

• Most common elbow injury – 50-70%

• Peak 5-7 years old

• Boys = girls

• Left > right
SCH Fractures

• 98% extension type:
SCH Fractures

- Associated fractures:
  - Distal radius 5-6%
  - Diaphyseal forearm fractures = ↑ compartment syndrome risk

- Obtain forearm imaging in addition to elbow imaging
Gartland classification:

- **Type I:**
  - non-displaced
Gartland classification:

- **Type II:**
  - intact posterior hinge
Gartland classification:

- **Type III:**
  - complete displacement
Gartland classification:

- **Leitch Type IV:**
  - unstable in flexion and extension
  - **DO NOT CHECK FOR THIS**
SCH Fx – Neuro Exam:

• Neurologic deficit at presentation 2-35%:

• Anterior Interosseus Nerve [AIN]:
  • 34.1%
  • Sensory:
    • NONE
  • Motor:
    • Thumb and index DIP joint flexion
    • Beware extension and relax
SCH Fx – Neuro Exam:

• **Median Nerve:**
  • 21.3%

• **Sensory:**
  • Volar hand and fingertips

• **Motor:**
  • Wrist flexion
  • Finger flexion except AIN distribution

• If median n. out, the child cannot sense compartment syndrome
SCH Fx – Neuro Exam:

- **Radial Nerve:**
  - 26.6%

- **Sensory:**
  - Dorsal first web space

- **Motor:**
  - Wrist and finger extension
  - Beware tenodesis effect
SCH Fx – Neuro Exam:

- **Ulnar Nerve:**
  - 15.8%
  - Most common in *flexion* type – 16.6%

- **Sensory:**
  - Small finger & ulnar side of hand

- **Motor:**
  - Small finger flexors
  - Finger adductors/abductors
SCH Fx – Neuro Exam:

• Why do we care? They “all” recover in 6-12 weeks if occur at time of injury

• Vascular exam…
SCH Fx – Vascular Exam:

- 2-20% pulseless at presentation
  - Radial pulse – Doppler if necessary
  - Clinical indicators of perfusion adequacy:
    - Skin temperature
    - Capillary refill
    - Color (pink)
SCH Fx – Vascular Exam:

• Classify vascular status as:
  • Normal
  • Pulseless with a pink hand
  • Dysvascular [pulseless with white hand]
SCH Fx – Vascular Exam:

• Supracondylar humerus fracture with a dysvascular hand is a surgical emergency.

• Perfusion status of the hand at presentation correlates significantly with the ultimate need for vascular repair.
Pulseless SCH Fx – initial tx

- Emergent reduction and re-examination

- Pulse returns

- Pulse does not return
  - Hand pink, perfused
  - Hand not perfused
    - Exploration
Pulseless SCH Fractures
Pulseless SCH Fractures

• What about the patients with nerve injury or palsy??

• Recommend early exploration if associated nerve deficit
SCH Fx – Next step:

• OR

• Reduce and reassess

• Explore if still dysvascular or if unable to reduce fracture
SCH Fractures

• **Summary:**
  
  • Type I can be splinted and sent to clinic
  • Type II should be evaluated sooner, wide variety of “Type II”
  • Type III should be sent

• Hand perfusion – assess how quickly able to get reduction
Compartment Syndrome
Compartment Syndrome:

- **Definition:**
  - Increased pressure within a closed space leading to decreased perfusion

- **Pathogenesis:**
  - Too much inflow
  - Too little outflow
Compartment Syndrome:

• **Intrinsic causes:**
  • Increase in the contents of a space
    • Bleeding
    • Swelling
    • Infusion or injection
  
• **Extrinsic causes:**
  • Decrease in the volume of a space
    • Constrictive dressing
    • Tight wound closure
Compartment Syndrome

- **Lower Extremity**
  - Gluteal
  - Thigh
  - Lower leg
  - Foot

- **Upper Extremity**
  - Deltoid
  - Arm
  - Forearm
  - Hand
CS – Causes:

Trauma – cause in 75-85% of cases

Most common pediatric fx associated with CS:

• Femur - Traction to the limb while placing spica
• Forearm
• SCH:
  • Median nerve injuries, vascular injuries
  • Flexion >90 degrees
• Tibial tubercle – anterior compartment
• Tibial shaft – don’t forget the elective osteotomy patient
CS – Causes:
CS – Causes:

• Fractures associated with a nerve injury/palsy:
  • Mask the clinical signs of CS
  • SCH with Median nerve injury
  • Tibia fracture with peroneal nerve injury
  • Distal radius fracture with acute carpal tunnel syndrome
CS – Causes:

- Multiple fractures in one limb:
  - 33% in ipsilateral displaced distal humerus and forearm fractures
  - Obtain stable fixation to enable splint placement and frequent evaluation
CS – Causes:

- Constrictive dressings or casts:
CS – Causes:

Constrictive dressings or casts:
CS – Causes:

• IV infiltration:
  • Especially obtunded or critically ill
  • Intrinsic minus position most common finding in children with CS of hand
IO Access - Pitfalls

• Too deep
  • Through and through

• Too shallow
  • Subcutaneous
  • Subperiosteal
CS – Causes:

- Bleeding or clotting disorders
- Septicemia
- Animal bites
- Burns – circumferential eschar
- Reperfusion injury
CS – Boston experience

• 33 patients:
  • 21% MVC
  • 18% fall from height
  • 15% high-impact sports injury
  • 21% post op:
    • 4 acute fracture fixation
    • 3 elective correctional osteotomy

CS – Boston experience

• 76% in setting of fracture:
  • Lower leg – tibia/fibula
  • Distal radius/wrist
  • Forearm – radius/ulna shaft
  • 40% open

• 15% isolated soft tissue injury

• UE vs LE:
  • 50:50 split upper/lower
CS – Diagnosis: 5 P’s

- **Pain:**
  - “Out of proportion”
  - With passive stretch

- **Parasthesias:**
  - Earliest subjective complaint
  - Reflect increased pressure on the nerve

- **Paralysis**

- **Pallor**

- **Pulselessness – too late**
CS – Diagnosis: Peds

• High-risk pediatric patient:
  • Inability to effectively communicate
    • All pediatric patients
    • Obtunded or comatose
  • Patient with impaired sensation
    • SCI
    • Myelomeningocele
    • Nerve blocks
  • Spasticity
• Compartment syndromes are often missed or diagnosed late in children because of a lack of ability to effectively communicate and difficulty cooperating with an examination while being in pain.

• Is ‘P’ the best letter of the alphabet for kids?
CS – Diagnosis:

• Three A’s
  • Analgesic requirement
    • Can precede change in vascular status by 7 hours (Bae et al)
    • 90% of kids had pain, but only 70% had another “P”
  • Agitation
  • Anxiety

Compartment Syndrome:

- How long do we have?
Compartment Syndrome:

**Muscle:**

- 3-4 hours:
  - Reversible
- 6 hours:
  - Variable damage
- 8 hours:
  - Irreversible damage
Compartment Syndrome:

- **Nerve:**
  - 2 hours:
    - Lose nerve conduction
  - 4 hours:
    - Neuropraxia
  - 8 hours:
    - Irreversible damage

- Less time in injured tissue
Compartment Syndrome

- Clinical Diagnosis:
  - Don’t need to measure to prove it
  - May need to measure to exclude it
  - Reference for pain (it hurts!)
Compartment Syndrome

- **Needle**
  - 18 gauge
  - Side ported

- Performed within 5 cm of the injury if possible

*Side port*
Compartment Syndrome

• What Pressure is abnormal?
  – Absolute
    • 30-50 mmHg
  – Relative
    • $\Delta P$ ($DBP \cdot Compartment \ pressure$)
    • 30 mmHg

What do we use? $\Delta P$ less than 30 mmHg
Compartment Syndrome

• How do we treat it?

• Immediate fasciotomy:
  • Extensile incision!
  • Skin, fascia, muscle
  • Debridement of necrotic tissue if present
Technique

- Transverse fascial incision proximally
- Identify anterior and lateral compartments
Be generous with incision
Complete Release...OR
Aftercare

- Vessel Loops
- NPWT dressings
- Elevation of limb
- Second Look
- Wound closure
  - <10 days ideal
  - Split thickness skin graft
Wound Closure

- STSG
- Delayed primary closure with relaxing incisions
Complications

- Rhabdomyolysis
  - Ischemia for 4 hours - myoglobinuria
- Acute renal failure
  - Hypovolemia + acidemia + myoglobinemia
- Permanent tissue damage
- Infection
- Amputation
Therefore...

Never go to sleep thinking about a compartment syndrome!
Should I?

If You Are Thinking about measuring the compartments…Do It!

Better big incisions than a dead leg!
Neonatal Infections
Neonatal Infections

- 1-3 per 1,000 NICU admissions
- S. aureus, Beta-hemolytic strep, and Gm(-) infections
- Blood cultures (+) 21-47%
- Multiple sites in up to 50% of neonates
- Culture (-) septic arthritis: 43%
Neonatal Infections

• Why are these so challenging?

• We lose our signs/sxs of infection in this population
Neonatal Infections

- Underdeveloped immune system
  - WBC ranges 9K – 30K/mm$^3$ in first week of life
  - Leukopenia (<5K/mm$^3$) suggests infection

- Thermoregulatory dysfunction
  - 15-25% with sepsis are hypothermic

- Not ambulating

- ESR unreliable

- CRP:
  - NPV 95% - if negative, can be fairly sure no infection
  - PPV 60% - elevation suggestive, but not diagnostic
Neonatal Infections

• Diagnosis - XR findings:
  • Joint subluxation or dislocation – laxity
  • Metaphyseal rarefaction
  • Periosteal reaction
Neonatal Infections

- **Diagnosis - U/S findings:**
  - Intra-articular or sub-periosteal abscess

- **Consider contralateral hip**
Neonatal Infections
Neonatal Infections

- Treatment: I&D, abx
- Complications of diagnostic delay:
  - Physeal destruction
  - Limb length discrepancy
  - Osteonecrosis of epiphysis
  - Post-infectious arthritis
  - Epiphyseal separation
Neonatal Infections

• Summary:

• Keep in differential diagnosis
Open Fractures
Open Fractures Classification

• Gustilo and Anderson Type I:
  • Wound < 1 cm
  • Minimal soft tissue damage or contamination

• Vascular supply to the zone of injury intact:
  • Decreases risk factors for infection
    • Devitalized tissue, ischemia, edema
  • Allows for penetrance of host defense mechanisms and antibiotics
Open Fractures Classification

- **Gustilo and Anderson Type II:**
  - Wound $> 1$ cm, generally $< 10$ cm
  - No extensive soft tissue damage
  - Wound likely able to be closed primarily

- **Vascular supply to the zone of injury usually intact, but larger wound allows for more and deeper contamination:**
  - Devitalized tissue, ischemia, edema
Open Fractures Classification

• Gustilo and Anderson Type III:
  • Wound > 10 cm
  • Extensive soft tissue damage or contamination

• Sub-classification:
  • A – soft tissue coverage adequate
  • B – likely to need flap assisted coverage
  • C – vascular injury requiring repair
Open Fractures – Treatment

- IV antibiotics ASAP
- I&D in emergency department
- Closed reduction
- Tetanus if not recent
- IV abx for 24 hours
- Home on oral abx to complete 7 days
Open Fractures

• Most can be treated non-operatively
  • Forearm ≠ tibia

• Barnyard injuries

• Evidence of extensive soft tissue damage
Open Fractures

• Summary:

• IV antibiotics ASAP
• Tetanus if not recent
• I&D in emergency department
Questions?

I did not hit you... I simply high-fived your face.
Bibliography


Bibliography


