How to Triage Orthopaedic Care

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OBJECTIVES:

• Define basic assessments skills needed to identify orthopedic injuries

• Differentiate when an orthopedic injury is a medical emergency

• Determine best level of care, when to refer to a higher level medical care, and which healthcare professional is the most appropriate (ER, UCC, PCP, or Specialist)
Skeletal Trauma

• 10 to 15% of all Childhood Injuries
• Physeal Injuries are ~15% of all Skeletal Injuries
Immediate Referral for Musculoskeletal Injuries

- Suspected Spinal Cord Injury
- Obvious Deformity - extremity is bent or bowed
- Dislocation of Joint
- Open Laceration
- Neurologic Injury
- Vascular Injury - be able to assess pulses and color of extremity
Immediate Referral for Musculoskeletal Injuries

- Neurologic Injury - especially loss of motor function
- Tingling or Numbness in a single extremity after injury is not an uncommon complaint - reassess and know how to do a Neurologic Exam of an Extremity - you have to develop your skills
- Assess by Doing a Motor and Sensory Examination
- Light touch, Pin prick (use a paper clip)
Immediate Referral for Musculoskeletal Injuries

- Neurologic Injury
- Assess by Doing a Motor and Sensory Examination
- Light touch, Pin prick, and 2 point Discrimination
- Paper Clip helpful for Pin Prick and 2 point discrimination
- 2 Point Discrimination very helpful for hand injuries and lacerations
Immediate Referral for Musculoskeletal Injuries

- Vascular Injury - be able to assess pulses and color of extremity
- Capillary refill is variable
- If the environment is cold and having difficulty with vascular exam warm the extremity
Immediate Referral for Musculoskeletal Injuries

• Compartment Syndrome is swelling within a Muscular Compartment that closes off the capillary flow to the soft tissue of that compartment
• The Muscle Compartment is very firm, tense and painful to touch.
• This is a surgical emergency and needs immediate evaluation
• Can be associated with fractures, crush injuries or vascular injuries, or after extreme exertion
Immediate Referral for Musculoskeletal Injuries

• This is a surgical emergency and needs immediate evaluation
• It can happen acutely within an hour of injury or develop over several hours after injury
• Most commonly seen in leg (below the knee) and forearm
Immediate Referral for Musculoskeletal Injuries

• Compartment Syndrome
• Pain out of Proportion - First sign is Pain on Passive Range of Motion
• Extreme Pain on Passive Motion of the Muscles in that Compartment - example severe pain on movement of fingers or toes after injury to the leg or forearm above
• Pulses are Intact early on!
• Neurologic Exam is Intact early on! (May have some some tingling )
• The Muscle Compartment is very firm, tense and painful to touch.
Delayed Referral for Medical Evaluation

• Persistent Swelling
• Persistent Loss of Range of Motion
• Difficulty with Ambulation
• Persistent Pain
• Constitutional Symptoms - fever, weight loss
The History

• How, When and Where?
• Swelling?
• Ability to Ambulate?
• Did you hear or feel a Pop?
• Did you Relocate an Injured part?
Extremity Examination

• Learn How to Examine an Extremity
• Know the Vascular and Neurologic Examination - Study
• Know the Extremity Anatomy - Bone, Muscle, Ligament, Nerve, Vascular
• Don't be afraid to Reassess and Repeat your Examination
• Stay Calm
Physical Exam

- Visual Inspection for Swelling, Discoloration, Bruising, and Obvious Deformity?
- Open Laceration or Wound?
- Range of Motion - can the injured area move - either with the patient moving it or examiner?
- Stability of the Joint - may or may not be able to assess
Physical Exam

• Tenderness: Where is the maximal tenderness - over the Bone, Ligaments, Muscle or Joint?
• Is the Patient able to Weight Bear?
• Neurovascular Exam of the Extremity
• Are they able to Move the Injured Area
The Physical Exam

- Have the patient demonstrate the area of maximal tenderness
- Use one finger to localize tenderness
- Is the tenderness located over the bone or the soft tissues?
- Compare the 2 sides looking for swelling
Orthopaedic Assessment

- Palpate for Tenderness
- Deformity
- Evaluate Neurologic Status
- Evaluate the Vascular Status
- Assess the Soft Tissue Injury
- Understand the Mechanism of Injury
Orthopaedic Resources

- Rang’s Childrens Fractures
Extremity Examination Resources

- Hoppenfeld
  Physical Examination of Spine and Extremities
Extremity Examination Resources

- Hoppenfeld - Orthopaedic Neurology
Extremity Examination Resources

- Ciba Collection of Medical Illustrations Volume 8 Part 1
  Anatomy, Physiology and Metabolic Disorders by Frank Netter
Skeletally Immature Patients

• Possess Unique Characteristics Compared to the Adults
• The Closer to Skeletal Maturity the more the Injury Patterns Mimic Adults
Unique Anatomy For Children and Implications for Injury

Physis ("Growth Plates")

- Adds longitudinal growth of the bone
- Peak height velocity occurs later in boys (13 to 14) than girls (11 to 12)
- Periods of rapid growth put children at risk for injury as “growth plates” narrow near the end of growth
Orthopedic Anatomy

Parts of a growing bone

- Epiphysis
- Physis
- Metaphysis
- Diaphysis
Anatomy

- Epiphysis
- Physis
- Metaphysis
- Diaphysis
Apophysis

Growth Area of bone where a muscle tendon attaches

Highest risk of injury during peak growth rate

Best Known - Tibial Tubercle - Osgood Schlatter
Tibial Tubercle is an Apophysis- Osgood Schlatter is inflammation of the tibial tubercle - Apophysitis
Injury Terms: Fractures

- Fracture - Broken, Break, Crack etc.
- Open - soft tissue envelope open allowing contamination of bone to dirt and bacteria
- Closed - soft tissue envelope intact - no communication to outside world
- Comminuted - multiple pieces
- Compound - we do not use this term - it was primarily used to indicate an open fracture in older literature
Injury Terms:

Sprain  vs  Strain
Sprains

Severity:

Grade I - min. structural disruption
Grade II - partial disruption
Grade III - complete disruption
Strain vs. Avulsion Fracture

Ischial Apophysis
Avulsion - pulled away by Hamstring Origin
Pelvic Avulsion Fractures

- Often preceding symptoms
- Multiple Apophyseal Sites in the Pelvis
- Sometimes occult
- Disabling and can be slow to heal
Anterior Inferior Iliac Spine (Apophysis) Pelvic Avulsion Fracture

the Rectus Femoris Muscle has its origin here - one of the 4 muscles that constitute the Quadriceps
Physeal Fracture Patterns

Type I

Type II

Type III

Type IV

Type V
Salter Harris Classification System

I. Separation
II. Above
III. Lower (beLow)
IV. Through
V. EveRything Ruined
Salter II Fracture Distal Radius
Physeal Anatomy and Knee Ligaments Insertion Sites in Children May Create Unique Injuries
Salter I Fracture Distal Femur

Fracture at Distal Femoral Physis (Growth Plate) as seen on Stress Film - the Physis Failed in this case instead of the Medial Collateral Ligament Tearing
Salter I Fracture Distal Femur

How would you know to refer?

Exam will show Swelling at the Joint - Large Joint Effusion

Tender on the Femur - Directly on the Bone

Unable to bear weight
Radius and Ulna Fractures

Deformity - Bowing of Arm
Open area that may represent an Open Fracture
Radius and/or Ulna Fractures

» This was an open fracture
» Immediate Referral
» Often will see Dark Blood and Fat Globules in the Blood Oozing from Wound
» Splint and Send
Supracondylar Fractures

» Most common type is Fall on Outstretched Elbow
» Marked Swelling around the Elbow
» Splint with long arm splint with comfortable position.
Supracondylar Humerus Fracture

- Marked Swelling around Elbow
- May Have Ecchymosis Anteriorly from the Proximal humerus tearing thru the Brachialis Muscle and Coming up to the Skin
- May even have “Dimpling” or “Puckering” of the Skin - which has been pulled back into the fracture
- Refer Immediately
- Splint in Position of Slight Flexion - 20 to 45 degrees
Supracondylar Humerus

» General

- Typical age range 1-10 years
- Males > females by 2:1
- Peak incidence: 5 to 8 years
- Approximately 1% are open
- concurrent forearm fractures in ~
Supracondylar Humerus

» Arterial Injury:
  - Pink hand
    - Be highly suspicious of entrapment especially if:
      - Anterior puckering
      - Anterior medial ecchymosis
      - Median nerve injury
Supracondylar Humerus Fracture

» Examination

• Always check for palpable pulses (Doppler pulse may be present in spite of complete occlusion of the brachial artery)
• Check compartments
• Surgeons should Always document detailed neurovascular examination before any treatment!!
Supracondylar Humerus Type III

» Arterial Injury
» Brachial Artery Occluded

» Reconstituted Flow by Collaterals Dist
Supracondylar Humerus Fracture

» Neurologic Examination

• Nerve injury is present in about 8%

• Of this 8%
  – Radial nerve 40%
  – Median nerve (complete) 35%
  – Ulnar nerve 22% (but most common with flexion supracondylar)
  – Anterior interosseous nerve is actually the most common (but requires detailed neuro exam)
Deformity

- This is a Femoral Shaft Fracture
- Note the Bowing of the Thigh
- Splint the Extremity
- If there are No Pulses and there is an Obvious Deformity Gently Straighten the Extremity and Splint prior to Transport

- For Example if the Extremity is Rotated more than 90 degrees
- For Example if the extremity is Bent more than 45 degrees and “Floppy” (Unstable)
Symmetric Hand Closure

For finger and hand I look for Symmetric Closure. If the fingers do not lie or they "cross over" it indicates angular or rotational deformity of the bone.
Patellar Dislocation

Referral Needed to Assess for any occult Fractures that are Intra-Articular. Referral Does not have to be Immediate if the Patella is Reduced.
Anterior Thigh

Femoral Artery
Femoral Nerve - Quadriceps
Saphenous Nerve end branch of Femoral Nerve
Obturator Nerve - supplies Adductor Muscles and Sensory Branches to Hip - Reason for Referred pain from Hip to Thigh and Knee
Medial Thigh

Obturator Nerve (L2, 3, 4)

- Iliohypogastric n.
- Iliolinguinal n.
- Genitofemoral n.
- Lateral femoral cutaneous n.
- Femoral n.

Obturator nerve
- Posterior branch
- Articular branch
- Anterior branch
- Posterior branch
- Cutaneous branch
- Articular branch to knee joint

- Obturator externus m.
- Adductor brevis m.
- Adductor longus m.
- Adductor magnus m.
- Gracilis m.

Note: only muscles innervated by obturator nerve are shown
Posterior Thigh

Sciatic Nerve - Posterior Compartment of Thigh
Supplies Hamstring Muscles
Branches to Common Peroneal and Tibial Nerve Near Knee
Anterior Lateral Leg

- Common Peroneal Nerve
  - Lateral sural cutaneous nerve (L4, 5; S1, 2)
  - Articular branches
  - Recurrent articular nerve
  - Extensor digitorum longus m. (cut)
- Deep peroneal nerve
  - Tibialis anterior m.
- Superficial peroneal nerve
  - Branches of lateral sural cutaneous nerve
  - Peroneus longus m.
  - Peroneus brevis m.
- Medial dorsal cutaneous nerve
- Intermediate dorsal cutaneous nerve
- Lateral branch of deep peroneal nerve to extensor hallucis brevis m. and extensor digitorum brevis m.
- Medial branch of deep peroneal nerve
- Lateral sural cutaneous nerve (branch of sural nerve)
- Dorsal digital nn.
- Sural nn.
- Deep peroneal nn.
Posterior Leg

Tibial Nerve (L4, 5; S1, 2, 3)

Posterior Leg

Tibial Nerve - Posterior Compartment of the Leg - also called Posterior Tibial Nerve - supplies the Flexors of the Foot and Toes - Plantar Flexion
Posterior Leg

Muscles, Arteries, and Nerves of Leg: Deep Dissection (posterior view)

- Femoral Artery becomes the Popliteal Artery - moving from Anterior Compartment of Thigh to Posterior Compartment on Medial Side of Distal Femur

- Popliteal Artery Splits into Anterior Tibial Artery, Posterior Tibial Artery, Peroneal Artery
Anterior Leg

Popliteal Artery Splits into Anterior Tibial Artery which pierces the Intermuscular Septum from Posteriorly to Enter the Anterior Compartment. It becomes the Dorsalis Pedis Artery at the Foot.
Posterior Leg

- Posterior Leg
  - Popliteal Artery splits into Anterior Tibial Artery, Posterior Tibial Artery, Peroneal Artery
  - Posterior Tibial Artery is palpable behind medial malleolus
Upper Extremity
Dorsal Forearm

Radial Nerve in Forearm (C5, 6, 7, 8; T1) (viewed from behind and slightly laterally)

- Radial nerve
- Superficial branch
- Deep terminal branch
- Lateral epicondyle
- Anconeus m.
- Brachioradialis m.
- Extensor carpi radialis longus m.
- Supinator m.
- Extensor carpi radialis brevis m.
- Extensor carpi ulnaris m.
- Extensor digitorum m. and extensor digiti minimi m.
- Extensor indicis m.
- Extensor pollicis longus m.
- Abductor pollicis longus m.
- Extensor pollicis brevis m.
- Posterior interosseous n. (deep branch of radial n., distal to muscular branches)
- Superficial branch of radial n.

Extensor-supinator group of muscles

From axillary nerve
- Superior lateral brachial cutaneous n.

From radial nerve
- Inferior lateral brachial cutaneous n.
- Posterior brachial cutaneous n.
- Posterior antebrachial cutaneous n.
- Superficial branch of radial n.

Cutaneous innervation from radial and axillary nerves

Dorsal digital nn.
Volar Forearm

- Median Nerve
  - Musculocutaneous n.
  - Median nerve
  - Pronator teres m.
    - (humeral head)
  - Articular branch
  - Flexor carpi radialis m.
  - Palmaris longus m.
  - Pronator teres m.
    - (ulnar head)
  - Flexor digitorum superficialis m.
    - (turned up)
  - Flexor digitorum profundus m.
    - (lateral portion supplied via anterior interosseous n.; medial portion by ulnar n.)
  - Anterior interosseous n.
  - Flexor pollicis longus m.
  - Pronator quadratus m.
  - Palmar branch
  - Abductor pollicis brevis
  - Opponens pollicis
  - Flexor pollicis brevis
    - (superficial head; deep head supplied by ulnar n.)
  - 1st and 2nd lumbrical mm.

- Median brachial cutaneous n.
- Medial antebrachial cutaneous n.
- Axillary n.
- Radial n.
- Ulnar n.

- Anastomotic branch to ulnar n.
- Common digital nn.

- Branches to dorsum of middle and distal phalanges
Volar Forearm

Ulnar Nerve (C8; T1)

Cutaneous innervation

Flexor pollicis brevis m.
(deep head only; superficial head and other thenar muscles supplied by median n.)

Adductor pollicis m.

Articular branch
(behind medial condyle)

Flexor digitorum profundus m.
(medial portion only; lateral portion supplied by anterior interosseous branch of median n.)

Flexor carpi ulnaris m.
(drawn aside)

Dorsal branch

Palmar branch

Superficial branch

Deep branch

Palmaris brevis

Abductor digiti minimi

Flexor digiti minimi brevis

Opponens digiti minimi

Common palmar digital n.

Anastomotic branch to median n.

Palmar and dorsal interosseous mm.

3rd and 4th lumbrical mm. (turned down)

Proper palmar digital nn.
(dorsal digital nn. are from dorsal branch)

Branches to dorsum of middle and distal phalanges
Hand and Finger Assessment

- Medial brachial cutaneous and intercostobrachial nerves
- Upper lateral brachial cutaneous nerve
- Medial brachial cutaneous and intercostobrachial nerves
- Posterior brachial cutaneous and lower lateral brachial cutaneous nerve
- Posterior antebrachial cutaneous nerve
- Lateral antebrachial cutaneous nerve
- Radial nerve
- Medial antebrachial cutaneous nerve
- Ulnar nerve
- Median nerve
- Ulnar nerve
Hand Sensory Innervation

Division between ulnar and radial innervation on dorsum of hand is variable; it often aligns with middle of digit III instead of digit IV, as shown.

Radial n. (superficial branch and dorsal digital branches)

Ulnar n. (proper palmar digital branches)

Median n. (proper palmar digital branches)