



## Chapter 49 – General Principles of Orthopedic Injuries

### Episode Overview

1. List 10 complications of fractures
2. Describe the classification system for open fractures
  - a. Describe the management goals in open fracture
3. Link the nerve injury expected with the following orthopedic injuries:
  - a. Distal radius
  - b. Elbow
  - c. shoulder dislocation
  - d. Sacral
  - e. Acetabulum fracture
  - f. hip fracture.
  - g. femoral shaft fracture
  - h. knee dislocation
  - i. lateral tibial plateau fracture
4. List 10 causes of compartment syndrome
5. List 7 physical findings in compartment syndrome
6. Describe the management of compartment syndrome
7. List 5 bones predisposed to AVN
8. Describe diagnostic criteria for CRPS
9. List 6 complications of prolonged immobility

### Wise Cracks

1. Describe fat embolism syndrome and its management
  2. What is the most common site of compartment syndrome?
  3. Are open or closed fractures at higher risk of compartment syndrome?
  4. Please differentiate between sprain, strain and bursitis
  5. Please differentiate between tendonitis and tendonosis?
- 

## Rosen's in Perspective

### Management principles

- Reasons for urgent orthopedic consultation:
  - Long bone #s
  - Open fractures
  - Fractures or injuries violating joints
  - Neurovascular compromise
- See Table 49-1 for a list of >40 fracture eponyms
- Principles
  - Get key information from patient re: age, mechanism of injury, chief complaint, medical Hx
  - Do a physical exam to predict the injury and what additional imaging is needed
  - If imaging shows no #, but patient examines as clinically having a # → TREAT as a fracture



- Get adequate imaging!
- Generally obtain an X-Ray before reducing a dislocation (unless in some potential field situations)
- Assess and document neurovascular status before, during and after any reduction / immobilization
- Don't discharge any patient who can't safely ambulate
- Patients need good discharge instructions: things to monitor and potential complications

## Fractures

### Box 49-1 Fracture Description

#### Identification

Open versus closed  
Exact anatomic location  
Direction of fracture line  
Simple, comminuted  
Position (displacement, alignment)

#### Additional Modifiers

Complete versus incomplete  
Involvement of articular surface (%)  
Avulsion  
Impaction  
    Depression  
    Compression

#### Special Situations

Pathologic  
Stress

- **Fracture nomenclature**
  - General descriptors:
    - Closed or Open
      - Open if the bone can be exposed to the outside environment in ANY way: e.g. A small puncture wound even in close proximity should be assessed and considered
    - Exact anatomic location:
      - Bone name, left/right, and reference points:
        - E.g. Right posterior tibial tubercle
        - Long bones are divided into thirds
    - Describe the direction of the fracture line
      - Transverse
      - Oblique
      - Spiral
      - Comminuted (>2 fragments)
    - Position and alignment of the fracture fragments:
      - The amount of displacement of the distal fragment is always described first
    - Valgus = angling AWAY from the midline

- Varus = angling of the part is toward the midline
- Alignment: the relationship of the long axis of one fragment to another → creating angulation. Defined by the apex
- Rotational deformity: very important in the hand
- Descriptive modifiers:
  - Complete = both cortices disrupted. Incomplete = only one
  - Assess articular involvement (at high risk for articular arthropathy)
  - Avulsion: when a bony fragment is pulled away from its normal position due to a tendon / muscle / ligament (phalynx or humeral head)
  - Impaction: forceful collapse of a fragment into the bone - vertebral, humeral head
  - Pathologic: a fracture through abnormal bone.
    - Primary or metastatic cancer,
    - Cysts,
    - Osteogenesis imperfecta
    - Scurvy
    - Rickets
    - Paget's disease
    - Osteoporotic bone - due to a disease (polio)
  - Stress fracture: repeated low intensity forces leading to the resorption of bone: running, sports, dancing.
    - Due to intrinsic and extrinsic causes: training regimen, equipment, nutrition, hormones.
      - Tibia, fibula, metatarsals, navicular, cuneiform, calcaneus, femoral neck, femoral shaft.
- Fracture eponyms: used to describe fractures BEFORE radiography existed

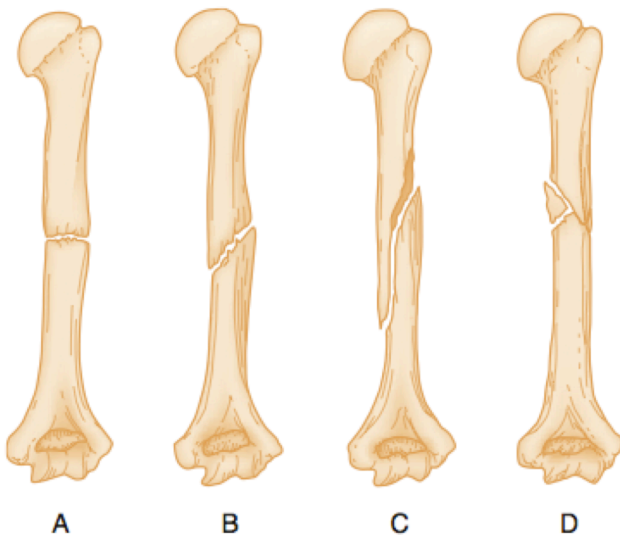


Figure 49-1. Types of fractures. A, Transverse. B, Oblique. C, Spiral. D, Comminuted.

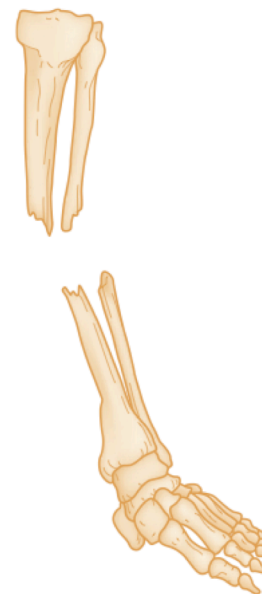


Figure 49-3. Valgus displacement of the distal tibia and fibula. The distal segment is angled away from the midline of the body.

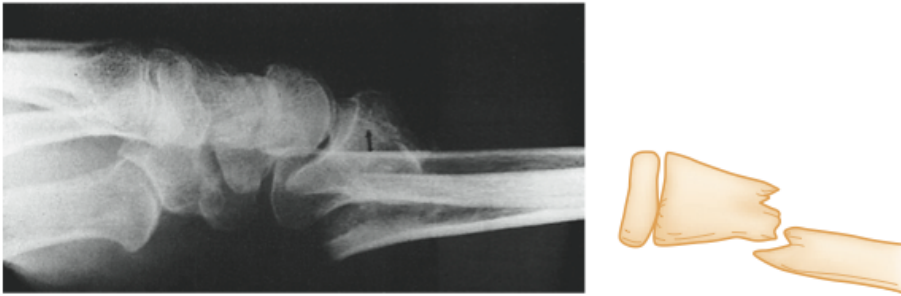


Figure 49-2. Dorsal displacement of distal radius.

- **Fracture healing:**
  - Process:
    - Hematoma formation which bridges the fracture fragments
    - Inflammation leading to granulation tissue formation
    - Resorption phase - joints the fragments with a procallus
    - REmineralization phase - calcium phosphate and osseous metaplasia
    - Callus resorption
      - Callus usually appears on radiographs around 3 weeks
  - Takes **2-4 months** for bone consolidation in normal adults
    - Oblique fractures heal more quickly
    - Healing faster in kids and slower in the elderly
  - Factors affecting healing time:
    - Age
    - Type of bone: cancellous > cortical
    - Fracture opposition
    - Systemic states (hypothyroid, renal disease, illness)
    - Drugs - steroids
    - Exercise - helps speed healing, hypoxia slows healing
  - Delayed Union: longer than usual time to unite
  - Malunion: residual deformity post Union
  - Nonunion : failure to unite → may lead to a pseudoarthrosis
  
- **Fractures in children**

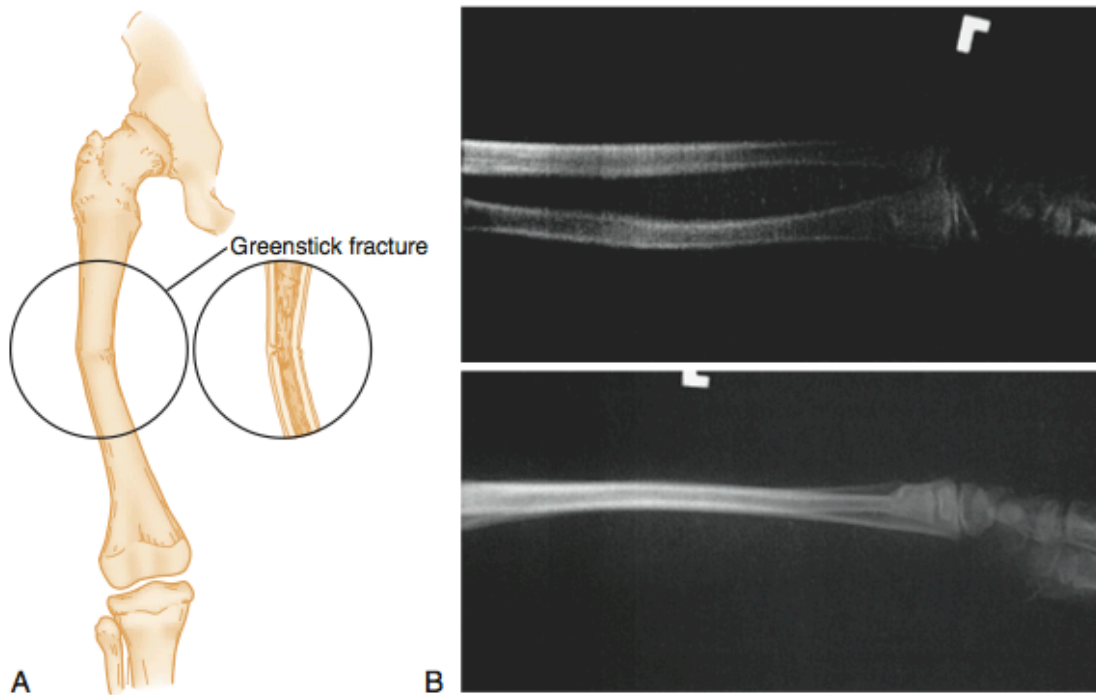


Figure 49-7. A, Greenstick fracture of midshaft of femur. B, Torus fracture of distal third of radius.

- Properties:
  - More common to have incomplete fractures
    - Greenstick # - incomplete angulated fractures of long bones
    - Torus # - incomplete fracture with wrinkling/buckling of the cortex \*\*\*can be VERY subtle\*\*\*

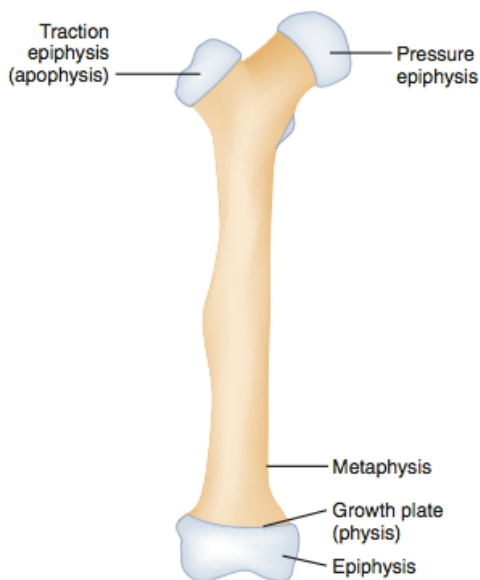




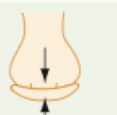


Figure 49-8. Anatomy of growing bone.

- Epiphyses - are made of cartilage and are radiolucent



- \*\*\*don't neglect to consider injury to the physis: as a potential fracture\*\*\* due to compression or shearing
- This may require a comparison view of the other extremity - and should be described using the SALTER system
- SALTER:
  - I: a slip in the provisional calcification zone
    - Dx clinically as tenderness and swelling over an epiphysis (.e.g lateral ankle)
    - **\*\*\*tenderness over an epiphysis = salter I fracture, NOT a sprain, because the ligaments are weaker\*\*\* (except lateral ankle - based on recent research)**
  - II: 75% of all epiphyseal #s.
    - Very low risk of growth disruption, can be managed non-operatively
  - III: involves the articular surface, germinal layer and growth plate
    - At high risk for growth disturbance
  - IV: through and through. Often need surgery and close follow-up
  - V:
    - Most commonly in the knee and ankle
    - Difficult to see on radiograph
    - NEED an MRI to dx in some cases to look for hemorrhage or edema
- Physical injuries most common in boys 12-15 yrs old. And girls 9-12 yr old
- Most common sites for growth arrest.
  - Distal radius, phalanges, distal tibia
  - Most salter I and II can be fixed with a closed reduction and follow-up for premature physeal closure: more prevalent if > 3 mm displacement post-reduction
  - Growth arrest most common in the distal femur, distal and proximal tibia and distal radius.

	DESCRIPTION	DIAGRAM
Type I	Fracture extends through the epiphyseal plate, resulting in displacement of the epiphysis (this may appear merely as widening of the radiolucent area representing the growth plate).	
Type II	As above; in addition, a triangular segment of metaphysis is fractured.	
Type III	Fracture line runs from the joint surface through epiphyseal plate and epiphysis.	
Type IV	Fracture line occurs as in type III but also passes through adjacent metaphysis.	
Type V	This is a crush injury of the epiphysis; it may be difficult to determine by radiographic examination.	



- **Diagnostic modalities for fracture diagnosis**

- Plain radiography
  - 2-3 views are the mainstay
    - Fractures best seen when x-ray is parallel to the beam
  - NEVER accept one view
  - Occult fractures may be missed - until bone absorbs at 7-10 days post injury
  - Stress views - rarely helpful, and may make the injury worse
  - Comparison views
    - Helpful in pediatrics to assess growth plates and bone maturity
    - Helpful to assess for congenital abnormalities that may be present bilaterally
    - Help assess for fat/fluid levels
  - Nutrient arteries may mislead as a fracture:
    - They are fine: sharply corticated, and less radiolucent than fractures
  - Pseudofractures may appear from folded clothing or bandages
  - Accessory ossicles are well corticated and smoothly defined
- Bone scanning
  - Radionuclide useful for:
    - Stress #s
    - Acute osteomyelitis
    - Tumours
- CT
  - Most accurate method of imaging bony #s, displacement, and fragmentation
  - Very useful for
    - Spinal imaging
    - Knee
    - Acetabulum
    - Wrist
    - Ankle
    - Salter IV #s
- MRI
  - Helpful for:
    - Osteochondral lesions, cartilage, ligaments, meniscus, disks,
- Ultrasound
  - Can very accurately dx disruptions of bony cortices:
    - Long bones
    - Orbital floor
    - Ankle/foot
    - Rib fractures





## 1) List 10 complications of fractures

Complication	Info	Key points
<b>Hemorrhage</b>	Blood loss, shock, and death!	Pelvic, femur, tib-fib
<b>Vascular injury</b>	See chapter 48! Knee - popliteal artery Femoral neck - AVN of femoral head	10-20% of injuries may have normal palpable pulses  These injuries can lead to late complications
<b>Nerve injury</b>	Neuropraxia - contusion to a nerve leading to transient paralysis and return to function in weeks - months  Axonotmesis - crush injury to a nerve - slow nerve healing  Neurotmesis - severing of a nerve that requires surgical repair	See table 49-4  Light touch is a good <i>screening</i> test, but two-point discrimination is more sensitive (especially for digital nerves).  Compare the sensation bilaterally.  Consider the O’Riain wrinkle test or the Ninhydrin sweat test for digital nerve injuries.
<b>Compartment Syndrome</b>	Any # or damage in an osseofascial space = can lead to CS: <ul style="list-style-type: none"> <li>• Closed OR open #</li> <li>• Prolonged immobility in certain operative/comatose positions</li> <li>• Spontaneous injections</li> <li>• IV injections</li> <li>• Excessive fracture traction/trauma</li> </ul> Pathophysiology: <ul style="list-style-type: none"> <li>• Mismatch between a closed, nonexpandable space and its contents: - see Box 49-3</li> <li>• <b>1) increased compartment contents</b> <ul style="list-style-type: none"> <li>○ Bleeding (1 or 2ndary)                             <ul style="list-style-type: none"> <li>■ Vasc. injury, coagulation disorder, anticoagulant therapy</li> </ul> </li> <li>○ Increased capillary filtration                             <ul style="list-style-type: none"> <li>■ Reperfusion after ischemia</li> <li>■ Trauma</li> <li>■ Intense muscle use</li> <li>■ Burns</li> </ul> </li> <li>○ Increased capillary pressure                             <ul style="list-style-type: none"> <li>■ Venous obstruction (DVT)</li> <li>■ Venous ligation</li> </ul> </li> </ul> </li> <li>• <b>2) Decreased compartment volume</b> <ul style="list-style-type: none"> <li>○ Closure of fascial defects</li> <li>○ Excessive traction of #’d limbs</li> </ul> </li> <li>• <b>3) External pressure</b> <ul style="list-style-type: none"> <li>○ Casts, air splints, dressings</li> <li>○ Lying on a limb</li> </ul> </li> <li>• <b>4) Misc:</b> <ul style="list-style-type: none"> <li>○ Muscle hypertrophy</li> <li>○ popliteal cysts</li> <li>○ Leaky cannulae</li> <li>○ Interstitial infusions / pressure infusions</li> </ul> </li> </ul>	Sites: <ol style="list-style-type: none"> <li>1. Tibia</li> <li>2. Forearm</li> <li>3. Thigh</li> <li>4. hand/foot</li> </ol> Interesting causes (based on etiology): <ol style="list-style-type: none"> <li>1. Content increase                             <ol style="list-style-type: none"> <li>a. anticoagulant/coagulopathic bleed</li> <li>b. Post-op arterial bypass graft</li> <li>c. Exercise induced</li> <li>d. Seizures</li> <li>e. Eclampsia</li> <li>f. Tetany</li> <li>g. Post thermal/electrical burn</li> <li>h. Snakebite</li> <li>i. Intra-arterial drug injection</li> <li>j. Nephrotic syndrome</li> </ol> </li> <li>2. Dec. compartment volume                             <ol style="list-style-type: none"> <li>a. post-operative</li> </ol> </li> <li>3. External pressure                             <ol style="list-style-type: none"> <li>a. Comatose drug user</li> </ol> </li> </ol>
<b>Osteomyelitis</b>	Due to OPEN fractures = any communication of bone with the outside	ANCEF for prevention, add gentamicin for contaminated





<p><b>Avascular necrosis</b></p>	<p>No blood flow, bone dies</p>	<p>comminuted/untreated fractures at ^ risk</p> <ul style="list-style-type: none"> <li>● <b>Femoral head</b></li> <li>● <b>Talus</b></li> <li>● <b>Scaphoid</b></li> <li>● <b>Lunate</b></li> <li>● <b>Capitate</b></li> </ul>
<p><b>Complex regional pain syndrome - type 1</b></p>	<p>“Pain syndrome that develops after a noxious event and extends beyond a single peripheral nerve and is <b>disproportionate</b> to the inciting event”</p> <ul style="list-style-type: none"> <li>● Affects the <b>DISTAL</b> end of an extremity</li> <li>● Changes in blood flow to the extremity</li> <li>● Abnormal pseudo-motor activity in the region of pain</li> <li>● Hyperpathia (pain persisting or increasing after light or mild pressure)</li> <li>● There is no other evident diagnosis</li> </ul> <p>Etiology - unknown</p> <ul style="list-style-type: none"> <li>● Central and peripheral sensitization after an event that is pathologic and leads to maladaptive sympathetic and brain mapping responses</li> </ul> <p>Provoking factors:</p> <ul style="list-style-type: none"> <li>● Fractures, surgery, minor procedures, IV injections, idiopathic (50% of the time), tight casts.</li> <li>● Girls 3x more likely than boys to get it.</li> </ul> <p>Dx:</p> <ul style="list-style-type: none"> <li>● Difficult; because very trivial injuries can provoke it</li> <li>● No agreed upon diagnostic criteria (see table 49-6)</li> </ul> <p>Treatment:</p> <ul style="list-style-type: none"> <li>● Controversial</li> <li>● Multidisciplinary approach - PT, counselling, regional nerve blocks, surgical sympathectomy</li> <li>● PO meds:             <ul style="list-style-type: none"> <li>○ Bisphosphonates</li> <li>○ Calcitonin</li> <li>○ Indomethacin</li> <li>○ Corticosteroids</li> <li>○ TCA's, gabapentin,</li> <li>○ Acupuncture, spinal cord stimulation, regional nerve blocks</li> </ul> </li> </ul>	<p>Type 1 CRPS - many different diagnostic criteria:</p> <ul style="list-style-type: none"> <li>● Signs:             <ul style="list-style-type: none"> <li>○ Allodynia / hyperalgesia</li> <li>○ Edema, sweating</li> <li>○ Not confined to one nerve distribution</li> <li>○ Motor and sensory dysfunction</li> </ul> </li> </ul> <p><b>Distal-proximal gradient</b></p> <p><b>Type 2 - CRPS has a demonstrable peripheral nerve injury</b></p>
<p><b>Fat embolism syndrome</b></p>	<p>Fat globules in the lung or peripheral circulation after a <b>LONG</b> bone fracture or major trauma</p> <ul style="list-style-type: none"> <li>● Often subclinical</li> <li>● <input type="checkbox"/> people with major trauma have them, but most are asymptomatic</li> <li>● Signs:             <ul style="list-style-type: none"> <li>○ Resp. distress, hypoxemia, ARDS</li> <li>○ Confusion, mental status change suddenly</li> <li>○ Thrombocytopenia</li> <li>○ Petechial rash</li> <li>○ Fever, tachycardia, jaundice</li> <li>○ Fat seen in the urine in 50% of cases in 3 days post injury</li> </ul> </li> </ul>	<p>Common after Tib/fib fractures (young adults) or hip fractures in the elderly</p> <ul style="list-style-type: none"> <li>● 1-2 days post acute injury or IM nailing</li> <li>● Up to 2% in long bone #</li> <li>● Up to 10% in multi# pts</li> </ul> <p><b>Trxt:</b></p> <ul style="list-style-type: none"> <li>● <b>Supportive care</b></li> <li>● <b>20% mortality rate</b></li> <li>● <b>No therapy shown to benefit</b></li> </ul>
<p><b>Fracture blisters</b></p>	<p>Tense bullae from <b>HIGH</b> energy injuries</p> <ul style="list-style-type: none"> <li>● Due to skin near bones with little hair/sweat glands that anchors the epidermal junctions</li> <li>● Early surgery can prevent their occurrence</li> <li>● Large blisters can be deeroofed sterilely and dressed</li> </ul>	<p>High risk locations:</p> <ul style="list-style-type: none"> <li>● Ankle</li> <li>● Elbow</li> <li>● Foot</li> <li>● Knee</li> </ul> <p>May precede compartment</p>



		syndrome!
<b>Complications of immobilization</b>	<ul style="list-style-type: none"> <li>• Lead to many issues in the elderly patient                     <ul style="list-style-type: none"> <li>○ Pneumonia</li> <li>○ DVT / thrombophlebitis</li> <li>○ PE</li> <li>○ UTI</li> <li>○ Atrophy</li> <li>○ Stress ulcers</li> <li>○ GI bleed</li> </ul> </li> </ul>	<p>Fracture complications</p> <ul style="list-style-type: none"> <li>• Related to location**</li> <li>• Volkmann's ischemic contracture</li> <li>• CRPS</li> <li>• Anatomic injuries</li> </ul> <p>Immobility complications</p> <ul style="list-style-type: none"> <li>• Due to comorbidities</li> <li>• Medical issues...DVT, PE, infection</li> </ul>

- 2) Describe the classification system for open fractures  
 a) Describe the management goals in open fracture

**Box 49-2 Classification and Emergency Management of Open Fractures**

**Grades**  
 Grade I: Wound less than 1 cm long, punctured from below  
 Grade II: Laceration 5 cm long; no contamination or crush; no excessive soft tissue loss, flaps, or avulsion  
 Grade III: Large laceration, associated contamination or crush; frequently includes a segmental fracture  
 IIIA: Involves extensive soft tissue stripping of bone  
 IIIB: Periosteal stripping has occurred  
 IIC: Major vascular injury present

**Management**

1. Control hemorrhage in field with sterile pressure dressing after carefully removing gross debris (e.g., wood, clothing, leaves).
2. Splint without reduction, unless vascular compromise is present.
3. Irrigate with saline and cover with saline-soaked sponges after arrival in the emergency department.
4. Begin intravenous antibiotic prophylaxis, usually a first-generation cephalosporin for grade I, with the addition of an aminoglycoside for grades II and III.
5. Administer tetanus prophylaxis, including tetanus immune globulin, for large crush wounds.

**As above:**

1. Recognize the emergency
2. Begin irrigation (after pain control!!!)
3. Cefazolin (for Grade I)
  - a. Add Gentamicin for Grade II-III



- b. Alternatively: broad spectrum such as Pip-Tazo.
- 4. Advocate for early debridement and irrigation in the OR within 24 hrs

**Exceptions:**

- Open distal tuft fracture of the finger
  - Need vigorous irrigation and debridement with adequate primary closure (assuming adequate arterial flow!).

**3) Link the nerve injury expected with the following orthopedic injuries:**

**a) Distal radius**

- i) Median nerve
  - (1) Motor: OK sign
  - (2) Sensation to 1-3 fingers

**b) Elbow**

- i) Median or Ulnar nerve
  - (1) As above
  - (2) Ulnar:
    - (a) Motor: finger abduction, squeezing a piece of paper in-between 4-5th digit
    - (b) Sensation: 4-5th digit

**c) Shoulder dislocation**

- i) Axillary nerve
  - (1) Motor: deltoid
  - (2) Sensation: Sergeant's patch

**d) Sacral**

- i) Cauda equina syndrome
  - (1) Bladder and bowel symptoms
  - (2) Loss of anal wink
  - (3) Saddle anesthesia

**e) Acetabular fracture**

- i) Sciatic nerve
  - (1) Motor: plantar flexion, knee flexion, lower leg muscles. Spares the hamstrings
  - (2) Sensory: peroneal, tibial, sural

**f) Hip fracture**

- i) Femoral nerve



- (1) Motor: quads weakness
- (2) Sensation: anterior or medial thigh

**g) Femoral shaft fracture**

- i) Sciatic
  - (1) Motor: leg weakness of the lower leg
  - (2) Sensation. Same as sciatic.

**h) Knee dislocation**

- i) Tibial or peroneal
  - (1) Peroneal
    - (a) M. Weak dorsiflexion and eversion
    - (b) S. dorsum of foot, first webspace, lateral foot.
  - (2) Tibial:
    - (a) Motor: foot muscle atrophy
    - (b) Sensation: sole of foot and distal toes.

**i) Lateral tibial plateau fracture**

- i) Common Peroneal
  - (1) As above

ORTHOPEDIC INJURY	NERVE INJURY
Distal radius	Median nerve
Elbow injury	Median or ulnar
Shoulder dislocation	Axillary
Sacral fracture	Cauda equina
Acetabulum fracture	Sciatic
Hip dislocation	Femoral nerve
Femoral shaft fracture	Peroneal
Knee dislocation	Tibial or peroneal
Lateral tibial plateau fracture	Peroneal

**4) List 10 causes of compartment syndrome**

- See Box 49-3 for a huge list!
- Increased tissue pressure → increased venous pressure → impaired local circulation and hypoxia



- Pressures above diastolic BP, but below SBP
- Reduced arterio-venous gradient at the tissue level
  - → histamine release to help dilate capillaries → increased capillary membrane permeability
    - → leak of proteins and fluid into the surrounding tissue
      - → compartment pressure keeps increasing!
        - Venous blood flow impaired as capillary pressure is exceeded
          - Arterial blood flow fails (pulses maintained until LATE!)
            - Ischemic necrosis and cell death!

<p><b>Compartment Syndrome</b></p>	<p>Any # or damage in an osseofascial space = can lead to CS:</p> <ul style="list-style-type: none"> <li>● Closed OR open #</li> <li>● Prolonged immobility in certain operative/comatose positions</li> <li>● Spontaneous injections</li> <li>● IV injections</li> <li>● Excessive fracture traction/trauma</li> </ul> <p>Pathophysiology:</p> <ul style="list-style-type: none"> <li>● Mismatch between a closed, non-expandable space and its contents: - see Box 49-3</li> <li>● <b>1) increased compartment contents</b> <ul style="list-style-type: none"> <li>○ Bleeding (1 or 2ndary)                             <ul style="list-style-type: none"> <li>■ Vasc. injury, coagulation disorder, anticoagulant therapy</li> </ul> </li> <li>○ Increased capillary filtration                             <ul style="list-style-type: none"> <li>■ Reperfusion after ischemia</li> <li>■ Trauma</li> <li>■ Intense muscle use</li> <li>■ Burns</li> </ul> </li> <li>○ Increased capillary pressure                             <ul style="list-style-type: none"> <li>■ Venous obstruction (DVT)</li> <li>■ Venous ligation</li> </ul> </li> </ul> </li> <li>● <b>2) decreased compartment volume</b> <ul style="list-style-type: none"> <li>○ Closure of fascial defects</li> <li>○ Excessive traction of #d limbs</li> </ul> </li> <li>● <b>3) external pressure</b> <ul style="list-style-type: none"> <li>○ Casts, air splints, dressings</li> <li>○ Lying on a limb</li> </ul> </li> <li>● <b>4) Misc:</b> <ul style="list-style-type: none"> <li>○ Muscle hypertrophy</li> <li>○ popliteal cysts</li> <li>○ Leaky cannulae</li> <li>○ Interstitial infusions / pressure infusions</li> </ul> </li> </ul>	<p>Sites:</p> <ol style="list-style-type: none"> <li>1. Tibia</li> <li>2. Forearm</li> <li>3. Thigh</li> <li>4. hand/foot</li> </ol> <p>Interesting causes (based on etiology):</p> <ol style="list-style-type: none"> <li><b>1. Increased Comp. Content</b> <ol style="list-style-type: none"> <li>a. <b>BLEED:</b> anticoagulant/coagulopathic/traumatic</li> <li>b. <b>RE/increased PERFUSION:</b> Post-op arterial bypass graft, embolectomy, lying on limb, #, convulsion</li> <li>c. Exercise induced</li> <li>d. Seizures</li> <li>e. Eclampsia</li> <li>f. Tetany</li> <li>g. Post thermal/electrical burn</li> <li>h. Snakebite</li> <li>i. Intra-arterial drug injection</li> <li>j. <b>INCREASED CAPILLARY PRESS.</b></li> <li>k. Intense muscle use</li> <li>l. Venous obstruction (phlegmasia), venous ligation</li> <li>m. Nephrotic syndrome - leading to diminished serum osmolality.</li> </ol> </li> <li><b>2. Dec. compartment volume</b> <ol style="list-style-type: none"> <li>a. Postoperative closure of fascial defects</li> <li>b. Excessive traction on limb</li> </ol> </li> <li><b>3. External pressure</b> <ol style="list-style-type: none"> <li>a. Comatose drug user</li> <li>b. Tight casts/dressings</li> </ol> </li> <li><b>4. Miscellaneous:</b> <ol style="list-style-type: none"> <li>a. Interstitial infusion</li> <li>b. Leaky dialysis cannula</li> <li>c. Muscle hypertrophy</li> <li>d. Popliteal cyst</li> </ol> </li> </ol>
------------------------------------	---	--



## 5) List 7 physical findings in compartment syndrome

- At risk locations: - see Box 49-4
    - Calf
    - Thigh
    - Forearm
  - This is a clinical diagnosis!
    - “This is the hallmark diagnosis in a conscious fully alert patient who has pain that is disproportionate to the injury or physical findings”
    - Subjective complaints are important indicators of compartment syndrome
  - Skin colour, temperature, capillary refill, and distal pulses are all unreliable indicators (as are pallor, and loss of pulses!)
  - Rate of extremity swelling peaks at the 36-48 hr mark post injury
1. POOP to PxF
  2. Deep, burning, unrelenting, difficult to localize pain
  3. Increasing need for analgesics
  4. *Pain on passive stretching of the muscle groups*
  5. Pain with active flexion of the muscle groups
  6. Hypoesthesias or paresthesias in the distribution of nerves crossing the compartment
  7. Tenderness / tenseness of the compartment

### \*\*\*\*The five P's

- These are NOT signs of compartment syndrome, rather they are signs of acute disruption of arterial flow

## 6) Describe the management of compartment syndrome

- Elevating the limb may be counterproductive - because it decreases the local arterial pressure
- Normal compartment pressure is 0 mmHg
  - Microcirculation is impaired when tissue pressures > 30 mmHg
    - But this VARIES person to person based on their tolerance to ischemia
  - “Inadequate perfusion and ischemia begin when tissue pressure in a closed compartment are within 20 mmHg of a patient's diastolic BP
  - **OR** Within 30 mmHg of the MAP
  - When tissue pressure = or exceeds the patients DBP **tissue perfusion ceases**
- **Intra-compartmental** pressures don't measure muscle and nerve ischemia, they just identify a ripe environment where this ischemia could occur

### Diagnostic tests:

- Two techniques:
  - Slit-catheter
  - Side-port needle
    - Stryker compartmental pressure monitor:



- Make sure that it is zeroed in the plane in which the needle will be inserted
- A single measurement is not as important as serial measurements
- Doppler ultrasound is NOT useful.

**Management:**

1. Fasciotomy STAT
2. Fasciotomy within 12 hrs
3. Fasciotomy and DON'T elevate the limb (slight dependency)
4. Manage rhabdomyolysis, hyperkalemia, lactic acidosis.

**7) List 5 bones predisposed to AVN**

1. Femoral head
2. Talus
3. Scaphoid
4. Lunate
5. Capitate

Lippism: **FeTal ScaPLuna?**

- OR all the crescent moon-shaped bones in the hand and...

**8) Describe diagnostic criteria for CRPS**

<p><b>Complex regional pain syndrome - type 1</b></p>	<p>“Pain syndrome that develops after a noxious event and extends beyond a single peripheral nerve and is <b>disproportionate</b> to the inciting event”</p> <ul style="list-style-type: none"> <li>• Affects the DISTAL end of an extremity</li> <li>• Changes in blood flow to the extremity</li> <li>• Abnormal pseudo-motor activity in the region of pain</li> <li>• Hyperpathia (pain persisting or increasing after light or mild pressure)</li> <li>• There is no other evident diagnosis</li> </ul> <p>Etiology - unknown</p> <ul style="list-style-type: none"> <li>• Central and peripheral sensitization after an event that is pathologic and leads to maladaptive sympathetic and brain mapping responses</li> </ul> <p>Provoking factors:</p> <ul style="list-style-type: none"> <li>• Fractures, surgery, minor procedures, IV injections, idiopathic (50% of the time), tight casts.</li> <li>• Girls 3x more likely than boys to get it.</li> </ul> <p>Diagnosis:</p> <ul style="list-style-type: none"> <li>• Difficult; because very trivial injuries can provoke it</li> <li>• No agreed upon diagnostic criteria (see table 49-6)</li> </ul> <p>Treatment:</p> <ul style="list-style-type: none"> <li>• Controversial</li> <li>• Multidisciplinary approach - PT, counselling, regional nerve blocks, surgical sympathectomy</li> </ul>	<p><b>Type 1 CRPS</b> - many different diagnostic criteria:</p> <ul style="list-style-type: none"> <li>• Signs:                             <ul style="list-style-type: none"> <li>○ Allodynia</li> <li>○ Hyperalgesia</li> <li>○ Edema, sweating</li> <li>○ Not confined to one nerve distribution</li> <li>○ Motor and sensory dysfunction</li> </ul> </li> </ul> <p><b>Distal-proximal gradient</b></p> <p><b>Type 2</b> - CRPS has a demonstrable peripheral nerve injury</p>
---	---	---





	<ul style="list-style-type: none"> <li>• PO meds:                     <ul style="list-style-type: none"> <li>○ Bisphosphonates</li> <li>○ Calcitonin</li> <li>○ Indomethacin</li> <li>○ Corticosteroids</li> <li>○ TCA's, gabapentin,</li> <li>○ acupuncture , spinal cord stimulation, regional nerve blocks</li> <li>○ Prevented by taking Vitamin C ??</li> </ul> </li> </ul>	
--	--	--

**9) List 6 complications of prolonged immobility**

<b>Complications of immobilization</b>	<ul style="list-style-type: none"> <li>• Lead to many issues in the elderly patient                     <ul style="list-style-type: none"> <li>○ Pneumonia</li> <li>○ DVT / thrombophlebitis</li> <li>○ PE</li> <li>○ UTI</li> <li>○ Wound infection</li> <li>○ Decubitus ulcers</li> <li>○ Atrophy</li> <li>○ Stress ulcers</li> <li>○ GI bleed</li> </ul> </li> </ul>	<p><b>Fracture complications</b></p> <ul style="list-style-type: none"> <li>• Related to location</li> <li>• Volkmann's ischemic contracture</li> <li>• CRPS</li> <li>• Anatomic injuries</li> </ul> <p><b>Immobility complications</b></p> <ul style="list-style-type: none"> <li>• Due to comorbidities</li> <li>• Medical issues...DVT, PE, infection</li> </ul>
--	---	---

**Wisecracks:**

**1. Describe fat embolism syndrome and its management:**

<b>Fat embolism syndrome</b>	<p>Fat globules in the lung or peripheral circulation after a LONG bone fracture or major trauma</p> <ul style="list-style-type: none"> <li>• Often subclinical</li> <li>• People with major trauma have them, but most are asymptomatic</li> <li>• Signs:                     <ul style="list-style-type: none"> <li>○ Resp. distress, hypoxemia, ARDS</li> <li>○ Confusion, mental status change suddenly</li> <li>○ Thrombocytopenia</li> <li>○ Petechial rash</li> <li>○ Fever, tachycardia, jaundice</li> <li>○ Fat seen in the urine in 50% of cases in 3 days post injury</li> </ul> </li> </ul>	<p>Common after Tib/fib fractures (young adults) OR hip fractures in the elderly</p> <ul style="list-style-type: none"> <li>• 1-2 days post acute injury or IM nailing</li> <li>• Up to 2% in long bone #</li> <li>• Up to 10% in multi# pts</li> </ul> <p><b>Treatment</b></p> <ul style="list-style-type: none"> <li>• Supportive care</li> <li>• 20% mortality rate</li> <li>• No therapy shown to benefit</li> </ul>
------------------------------	---	--

**2. What is the most common site of compartment syndrome?**

- Anterior compartment of the lower leg



### 3. Are open or closed fractures at higher risk of compartment syndrome?

OPEN!

- But as many as 30% of people (based on the UK study listed in Rosen's) only had soft tissue injuries WITHOUT fracture!
- High risk populations: men < 35, bleeding disorders, anticoagulation, MVC's or sports injuries.

### 4. Please differentiate between sprain, strain and bursitis

**Sprain:** "Ligamentous injuries resulting from an abnormal motion of a joint"

1st degree - minor tearing of ligamentous fibers w/ mild hemorrhage and swelling.

2nd degree - partial tear of ligament with moderate hemorrhage / swelling

3rd degree - complete tearing of ligament

**Strain:** "injury to musculotendinous unit resulting from violent contraction or excessive forcible stretch"

1st degree - minor tearing of muscle and/or tendon fibers w/ mild hemorrhage and swelling.

2nd degree - partial tear of muscle and/or tendon fibers with moderate hemorrhage / swelling

3rd degree - complete tearing of muscle and/or tendon fibers with possible avulsion fracture

**Bursitis.** - bursa is mad. Usually overuse or traumatic. Supportive care.

### 5. Please differentiate between tendonitis and tendinosis

*Tendonitis* classic def: inflammatory condition characterized by pain at tendinous insertions into bone, occurring in the setting of overuse

Now thought to be more than just overuse - load and use interact to affect cell-matrix interaction

*Tendinosis* - contentious name that describes more chronic conditions: eg. degenerative changes, chronic tendinopathy, or partial rupture

### Common Sites for Tendinitis

- Rotator cuff of the shoulder
- Achilles tendon
- Radial aspect of the wrist (de Quervain's tenosynovitis),
- Insertion of the hand extensors on the lateral humeral epicondyle (tennis elbow).
- Patellar tendon
- Biceps femoris, semitendinosus, and semimembranosus (hamstring syndrome);
- Posterior tibial tendon (shin splint syndrome)
- Iliotibial band;



- Common wrist extensors (medial epicondylitis) (little league pitchers and golfers)

Pearl: Don't forget about calcific tendonitis common to the common shoulder, wrist, hand, neck, hip, knee, ankle, or foot

Subluxations and dislocations .....go read the textbook!