Orthopaedic Trauma Review for Medical Students

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# Discussion Topics

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PERSONAL NOTE

Throughout my career as an Orthopaedic Trauma Surgeon, I have encountered some of the most complicated cases and as a result I have met some truly inspirational patients. These patients, despite their challenges, maintain focus on their goals, their faith and their blessings. Each day I am reminded to be thankful for my family and my ability to practice medicine, never forgetting that it is my duty to offer help to those in need and my responsibility to keep learning. It is this focus, this commitment to learning, which has helped me to achieve successes in my life. I dedicate time each and every day for maintaining and advancing my knowledge of science and medicine. And over the years, my passion for learning has only further developed my passion for teaching. I embrace the technological advances in education and am passionate about teaching the future doctors and clinicians of this world. I thank you for the opportunity to share in your learning. I hope that you will find these materials useful and that they will excite your love of medicine and enable you to fulfill your gift for helping others.

Sincerely, Dr. Nabil Ebraheim

Dr. Nabil Ebraheim has been a practicing orthopaedic surgeon for approximately 35 years and has trained around the globe with leaders in orthopaedic trauma. He is renowned for his ability to handle the most difficult of trauma cases and has dedicated his life, not only to his patients, but also to teaching the surgeons of the future. The last 30 years have been spent at the University of Toledo, building a department that includes all orthopaedic specialties and is dedicated to providing the surrounding area with superior orthopaedic care. The residency program receives numerous applications, a testament to the training provided, and selects the best and the brightest each year. Dr. Ebraheim is proud to lead the Department of Orthopaedic Surgery for the University of Toledo as Chairman and Professor and will continue to dedicate himself to its clinical and academic success.
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1. Bone Healing

PREREQUISITES FOR BONE HEALING

Vascularity + Mechanical Stability

VASCULARITY

- Blood supply of Long Bone
  - Metaphyseal arteries (Metaphysis)
  - Nutrient artery (Diaphysis)
  - Periosteal vessels (Periosteum)

*Preservation of the blood supply is critical for fracture healing
BONE HEALING (continued):

**MECHANICAL STABILITY**

- Mechanical stability is provided by
  - Cast
  - Rods
  - Plates
  - Screws
  - External fixation devices

*Note: Minimal incision preserves a greater blood supply.*
COMPLICATION OF BONE HEALING

Common complications of fracture healing are:

- Nonunion

Valgus

Deformities

Varus
COMMON COMPLICATIONS (continued):

Osteomyelitis

- Long standing sinus can change into Squamous Cell Carcinoma (SCC)
- In Chronic Osteomyelitis cases, check for SCC in sinus tract

The sequestrum will drain through the sinus.
MECHANISMS OF BONE HEALING PROCESSES

1. Primary healing
   • Cutting cone mechanism
     o **Osteoclasts** eat up or dissolve the bone tissue with their powerful enzyme systems
     o **Osteoblasts** lay down new bone with the help of hormones and growth factors
   • Observed in *rigid fixation* of fractures such as in plate fixation
   • **Minimal Callus** (observed on X-ray)
MECHANISMS OF BONE HEALING (continued):

2. Secondary bone healing
   - Endochondral mechanism
   - Observed in *Flexible Fixation* of fractures (such as fractures stabilized by rods and cast)
   - *Abundant Callus* (as shown in *Red Circle* below)
STAGES OF FRACTURE HEALING

1. Hematoma
2. Stage of Inflammation (time of injury up to 24-72 hrs)
3. Stage of Soft Callus (new blood vessels)
4. Stage of Hard Callus
5. Stage of Remodeling

Remodeling is the process by which immature or woven (cartilage) bone (endochondral mechanism) is converted to mature or lamellar bone; the medullary cavity is reconstituted and bone is restructured in response to stress and strain (Wolff’s Law).

Notes:

- Bone is made from collagen Type I.
- Hyaline cartilage contains Type II collagen

MORE REMODELING POTENTIAL IN CHILDREN
2. Classification of Fractures

Extra-articular or Intra-articular

Diaphyseal or Metaphyseal
CLASSIFICATION OF FRACTURES (continued):

Simple  or  Comminuted

Open  or  Closed

(Skin is not intact)  (Skin is intact)
3. Open Fractures

DEFINITION
Fracture of the bone where bone and surrounding Hematoma are in communication with the external environment through break in skin.

CLASSIFICATION
According to severity of soft tissue damage open fractures are classified in three following types:

- **Type I**: wound about 1cm, simple fracture, clean wound
- **Type II**: wound 2-5cm, moderate soft tissue damage
- **Type III**: wound more than 5cm, extensive muscle devitalization, high energy injury; wound that is 1 cm with segmental fracture is considered Type III.

   **Type III** is further classified into following three types:
   - **Type III A: Adequate** soft tissue coverage
   - **Type III B: Require** local or distant skin flap for wound coverage. Early flaps prevent infection.
   - **Type IIIC: Vascular Injury** – Requiring Repair
     25-90% cases results in Limb Amputation

**AMPUTATION** is required if:

- Extensive Soft Tissue Injury  **(Very Important)**
- Extensive Vascular Injury
- Muscle & Tissue Ischemia of more than 8 hours
- Nerve Injury, e.g., no plantar sensation due to Posterior Tibial Nerve injury (not an absolute indication for amputation)
TREATMENT OF OPEN FRACTURES

1. Treat with antibiotics within 3 hours.

2. Irrigation and debridement of devitalized tissue

3. Reduction of fractured bone fragments

4. Stabilization with external fixation (if the wound is dirty), rods or internal fixation with plates and screws (e.g., joint injury).

5. Wound should be covered EARLY with skin graft or flap.

6. Bone graft or bone graft substitute is often used to promote the healing process if the surgeon thinks nonunion might occur.
4. Injuries Around Shoulder Joint

FRACTURES OF CLAVICLE

A. Group I:  Middle third (80%)
B. Group II:  Distal Third (10-15%)
C. Group III: Medial Third (5%)

TREATMENT

- Clavicle fractures are usually treated conservatively. However, there is high incidence of non-union in distal third fractures.

- Surgical fixation of clavicle fractures is gaining popularity in cases of:
  - Non-union (may need bone graft and plate)
  - If there is more than 2 cm displacement or overlap in acute fractures
  - Neurovascular Injury
  - Open Injury
ACROMIOCLAVICULAR SEPARATION

Classified in six types:

- Types I, II and III range from sprains to tears of the ACROMIOCLAVICULAR and CORACOCLAVICULAR ligaments
  
  **TREATMENT (I, II, III) --------- Conservative**

- Type IV: *Posterior*
  - Require axillary view images

- Type V: *Very High*

- Type VI: *Inferior*
  
  **TREATMENT (IV, V, VI) --------- Surgical Stabilization**
STERNOCLAVICULAR JOINT

Dislocation can occur in two directions:

1. **Anterior:**
   
   *Closed reduction often fails*, recurrence is common however it is benign and leads to residual *cosmetic deformity*.

2. **Posterior:**
   
   Posterior sternoclavicular dislocations are SERIOUS and may affect the airway and other mediastinal structures.

*Closed reduction is often successful and remains stable.*

*Open reduction – you may need a cardiothoracic surgery backup.*
SCAPULAR FRACTURE

- May be complicated by pulmonary complications

**ADMIT & OBSERVE**

- ALWAYS RULE OUT PNEUMOTHORAX.
SHOULDER JOINT

SURGICAL ANATOMY

- Though controversial, it is thought that injury to “Ascending branch of Anterior Circumflex Humeral Artery” leads to AVN (Avascular Necrosis) of humeral head.

- The Axillary Nerve, which innervates the Deltoid and Teres Minor, is the most commonly involved nerve in injuries around shoulder joint. It results in:
  - Numbness around the shoulder
  - Weakness of shoulder joint abduction

Rotator Cuff Muscles

- Supraspinatus
- Infraspinatus
- Teres Minor
- Subscapularis
TYPES OF SHOULDER JOINT DISLOCATIONS

- Anterior Dislocation
- Posterior Dislocation

ANTERIOR SHOULDER DISLOCATION:

- Shoulder Joint is the most commonly dislocated joint in body.
- Anterior dislocation is observed in more than 95% of cases.

- Mechanism is indirect force with combination of **ABDUCTION, EXTENSION, and EXTERNAL ROTATION**.
- If patient can touch opposite shoulder with the hand of involved extremity ------- this EXCLUDES ANTERIOR SHOULDER DISLOCATION

- May be associated with nerve injuries (e.g., Axillary nerve, Brachial Plexus).
- Often found in combination with greater tuberosity fracture and humeral head fracture (Hill-Sachs Lesion).

- There is high recurrence rate in young patients (e.g., labral or bankart injury).
- Anterior Inferior Labrum is usually involved = Bankart Lesion
  Anterior Dislocation = Anterior Labrum Involvement
- In elderly it is often associated with **rotator cuff tears**.
ANTERIOR SHOULDER DISLOCATION (continued):

Unable to lift arm after reduction of shoulder dislocation

- Young patients------ Axillary Nerve Injury
- Elderly patients------ Rotator Cuff Tear

Unable to lift arm due to axillary nerve injury.
POSTERIOR SHOULDER DISLOCATION

- Associated with seizures or electrical shock
- Often missed on radiographs
- Often goes unidentified upon initial ER visit
- May be associated with lesser tuberosity fracture or reverse Hill Sachs lesion.
- There is lack of EXTERNAL ROTATION movement at shoulder joint on examination.
- AXILLARY RADIOGRAPHIC VIEW is used to correctly diagnose posterior shoulder dislocation.

DIRECTION OF THE DISLOCATION IS KEY TO DIAGNOSIS

CORACOID IS ANTERIOR

ACROMION IS POSTERIOR

Axillary View: **Yellow arrow in figure B** indicates posterior dislocation.

Note: The direction of the dislocation – key to diagnosis.
INFERIOR SUBLUXATION

- Caused by Deltoid Muscle Atony
  - Often confused with posterior shoulder joint dislocation.
  - AXILLARY VIEW IS NORMAL IN THESE CASES.
  - Use Electrical Stimulation of surrounding muscle groups to regain muscle tone / strength.

Shoulder Joint Inferior Subluxation
PROXIMAL HUMERUS FRACTURES

- Incidence 5%
- 85% are non-displaced
- More common in females than males (2:1)
- Fracture involves one or combination of following four anatomical structures:
  1. Articular surface of humeral head
  2. Greater tuberosity
  3. Lesser tuberosity
  4. Humeral shaft
PROXIMAL HUMERUS FRACTURES: TREATMENT

- **Sling is used for:**
  - Non-displaced
  - Minimally displaced
  - Impacted fractures

- **Displaced fractures are stabilized surgically** with pins (note: could migrate), plates, sutures or external fixators.

- In severe cases where humeral head cannot be salvaged prosthesis is used.

- **Post-operative rehabilitation is very important.**
- Significant **residual stiffness may remain in elderly.**
5. Forearm, Wrist & Hand Injuries

**FOREARM FRACTURES**

**Monteggia Fracture**  
- Ulna shaft fracture  
- Radial head dislocation

**VS**

**Galeazzi Fracture**  
- Distal radio-ulnar joint dislocation  
- Distal Radius Fracture

**Monteggia Fracture**  
![Monteggia Fracture Image](image1)

**Galeazzi Fracture**  
![Galeazzi Fracture Image](image2)

*Note the radial head dislocation indicated by the green arrow and the ulna shaft fracture indicated by the blue arrow.*  
*Note the radio-ulnar subluxation indicated by the yellow arrow and the distal radius fracture indicated by the red arrow.*
WRIST JOINT FRACTURES

MECHANISM OF INJURY

Colles Radius Fracture
- Distal fracture fragment displaced dorsally
- AWAY FROM PALM
- ‘Dinner Fork Deformity’
- Can be treated conservatively

Intra Articular Fracture
- Surgery could be necessary
- 2mm displacement = 90% arthritis

Smith Fracture
- Distal fracture fragment displaced ventrally
- TOWARDS PALM
WRIST JOINT FRACTURES: SCAPHOID FRACTURE

- Fracture of the scaphoid usually occurs from a fall onto an outstretched hand.
- *Non-union* and *Navicular Avascular Necrosis* are common
- Fracture can be missed
HAND INJURIES & FRACTURES

BENNETT’S FRACTURE

Fracture and dislocation of the first carpometacarpal joint

1. Forceful adduction causes first metacarpal base fracture
2. Pull of abductor pollicis longus tendon causes dislocation
   
   (black arrow notes direction of force)

BOXER’S FRACTURE

- Fracture of the fifth metacarpal bone
- Accept some deformity
HAND INJURIES & FRACTURES (continued):

THUMB – ULNAR COLLATERAL LIGAMENT INJURY

- Skier’s Thumb: Acute Injury
- Game Keeper’s Thumb: Chronic Injury

BOUTONNIERE’S DEFORMITY

Tear in the central part of the extensor tendon that extends the finger at the PIP joint.
HAND INJURIES & FRACTURES (continued):

MALLET FINGER

Extensor Tendon Injury at the DIP joint
6. Spine Injuries

FRACTURE OF (CERVICAL VERTEBRA) C1

- Also called Jefferson Fracture
- Mechanism of injury --------- Axial Loading

- CLASSIFICATION: TYPE I
  - Type I: Bony Injury - Treated with a Rigid Brace or Halo
FRACTURE OF (CERVICAL VERTEBRA) C1 (continued):

- **CLASSIFICATION: TYPE II**
  - Type II: Tear of transverse ligament in addition to the bony injury
  - If ADI > 3mm -------- this **Injury is Unstable** ----- can cause spinal cord compression.
  - **TREATMENT** is to consider fusion of C1 & C2

```
“50 % of Cervical Spine Rotation occurs between C1 & C2”
```
FRACTURE OF C2

- ODONTOID FRACTURES
  - Classified in following three types;

  - Type I is managed by Cervical Collar
  - Type II is managed by HALO or Surgery
  - Type III is managed by Cervical Orthosis or a HALO

- Do not use a HALO in the elderly
FRACTURE OF C2 (continued):

- HANGMAN’S FRACTURE:

  o Pedicles are fractured in Hangman’s Fracture
  o Spinal canal is widened
  o Neurological Injury ------ RARE
  o Hangman’s Fracture is stabilized by a RIGID ORTHOSIS or a HALO (depending on fracture displacement)
SPINE LIGAMENTOUS INSTABILITY

- Patient presents with unexplained pain in cervical spine after trauma.
- Fracture is NOT observed in radiographs.
- Cervical Spine Flexion & Extension radiographic views are taken to assess spine stability and to demonstrate occult ligamentous injury.
- MRI is a better alternative.

- **MORE THAN 3.5 mm DISPLACEMENT or 11° angle** (as shown in figures 1 and 2, respectively, see below)
  
  ➢ **INDICATES SIGNIFICANT SPINE INSTABILITY**

*Figure 1: Note displacement in both images of >3.5 mm.*
SPINE LIGAMENTOUS INSTABILITY (continued):

- More than 11 degrees angulation between adjacent vertebral bodies is another significant parameter of spine instability

![Figure 2: Note angle > 11°](image)

- ANGLE MORE THAN 11 DEGREES
- SPINE COULD BE UNSTABLE
WHIPLASH INJURY

MECHANISM

Sudden *flexion* and *extension* movement of the cervical spine

- Radiographs can be **negative** for fractures
- **LOSS** of LORDOSIS
- Treatment = Physical Therapy, Muscle Relaxants and Soft Collar
VERTEBRAL BURST FRACTURE

- Increased inter pedicular distance at the level of the broken vertebra compared with the level above and below.
- Fracture extends to middle column with bone in the canal.

Note: The red line shows the widening of the interpedicular distance at the fracture level relative to the vertebra above and below.
TRAUMATIC SPINAL CHANCE FRACTURE

Flexion distraction injury results in a Chance Fracture.

- **Mechanism:** Distraction of the posterior spine around a fixed point anterior to the spine (i.e., a seat belt).
  - Bony
  - Ligamentous

- **Treatment**
  - Ligamentous (*figure 1*): Requires surgery
  - Bony (*figure 2*): Can be treated with casting

**Note:** Rule out colon injury in children.

*Figure 1: Ligamentous*  
*Figure 2: Bony*
DISC HERNIATION

CLASSIFICATIONS

Disc herniations are classified as Central, Posterolateral and Far Lateral.

1. CENTRAL DISC HERNIATION = CAUDA EQUINA

- Bilateral Leg Pain & Weakness
- Back Pain
- Can cause Cauda Equina Syndrome (bowel and bladder symptoms); considered a SURGICAL EMERGENCY

2. POSTEROLATERAL DISC HERNIATION

- Unilateral leg pain and weakness
- Positive straight leg raising test
- Nerve root injury

3. FAR LATERAL

A foraminal herniated disc (not common) affects the exiting nerve root (the upper nerve root). For example, an L4/L5 disc herniation affects the L4 nerve root.
7. Pelvic Fractures

- Mortality correlates with shock at presentation.

- Life threatening bleeding is major concern.

- Severe bleeding due to injury to “Superior Gluteal Artery”

- **Requires Blood Transfusion.** May require 15 to 20 units of blood.

- **Open fracture ------** HIGH MORTALITY RATE, may need colostomy

- The PELVIS IS A RING. An anterior injury or fracture (usually noted on radiographs) could be associated with posterior injury or fracture (could be occult).
• ALWAYS CHECK POSTERIOR PELVIS FOR FRACTURES OR INJURIES

• OBTAIN SPECIAL VIEWS: INLET and OUTLET radiographic views

• CT scan is the study of choice.

PELVIC FRACTURES ARE CLASSIFIED AS FOLLOWING:

1. Vertical Shear with Posterior Disruption
   • BAD FRACTURE
     ○ REQUIRES SURGERY Anteriorly and Posteriorly
   • Requires major blood transfusion. Outcome is guarded.

More severe injuries completely disrupt the sacroiliac joint.

2. Anteroposterior Compression (Open Book Fracture)

Close the Open Book Fracture by a binder initially to decrease pelvic volume and blood loss.
PELVIC FRACTURES (continued):

“CLOSE THE BOOK” by

- Sling
- Anterior Pelvic Surgery such as external fixator or plates

3. Lateral Compression

- Most Common
- Good prognosis, usually does not require surgical fixation
PELVIC FRACTURES - TREATMENT (continued):

- Pelvic Fractures are stabilized surgically by:
  - Blood, Blood, Blood
  - Initial binder and external stabilization
  - After patient becomes hemodynamically stable, internal fixation with plates and/or screws is performed.

ACETABULAR FRACTURES

- *Posterior Wall Fractures* are the most common and observed with *Hip Dislocations*. The **Obturator View**, one of the Judet views, will show the posterior wall fracture.
- Possibility of AVN: reduce dislocation early
- May lead to arthritis
- ALWAYS CHECK SCIATIC NERVE FUNCTION (Dorsi-flexion of Ankle & Toes) ------ **Peroneal Division could be affected.**
- In cases of “**Fracture with Dislocation**”, **IMMEDIATELY** reduce the dislocation. *(This should be done URGENTLY.)*

Posterior Wall Acetabular Fracture
8. Injuries Around Hip Joint

HIP JOINT DISLOCATIONS

ANTERIOR ------ RARE
POSTERIOR ------ COMMON

MECHANISM

- Anterior Dislocation:
  
  *Extension, External Rotation and Abduction*

- Posterior Dislocation:
  
  *Flexion, Internal Rotation and Adduction*

➢ URGENT REDUCTION IS MANDATORY TO AVOID AVASCULAR NECROSIS* OF FEMORAL HEAD

  *Avascular Necrosis is the death of a segment of bone.*
FRACTURES OF PROXIMAL FEMUR

- **Inter-trochanteric Fracture** ----- High Mortality Rate
  - 2 Types
    - Regular Pattern (figure 1)
    - Reverse Oblique Pattern (figure 2) - *Do not use sliding hip screw*
FRACTURES OF THE PROXIMAL FEMUR (continued):

- **Sub-trochanteric Fracture** -------- High stress fracture, *Non-union common / Complex Fracture.*
FRACTURES OF THE PROXIMAL FEMUR - TREATMENT

1. Femoral Neck Fracture
   a) Non-displaced: percutaneous screw fixation
   b) Displaced:
      i) Close reduction or ORIF in young patients.
      ii) Utilize a prosthesis in older patients. (Arthroplasty or Hemi-arthroplasty)

2. Inter-trochanteric
   a) Regular Pattern: Use a sliding hip screw or rod
   b) Reverse Oblique Pattern: Do not use the sliding hip screw

3. Subtrochanteric Fracture
   ➢ Intramedullary Nail
9. Knee Joint Dislocations

TYPES OF KNEE JOINT DISLOCATIONS

- THERE IS HIGH RISK OF NEUROVASCULAR INJURY

- ALWAYS CHECK DISTAL PULSES, rule out popliteal artery injury

- May need ARTERIOGRAM

- Perform the Ankle-Brachial Index test (i.e., ABI). ABI must be above 0.9. Then monitor with serial exam. If ABI is less than 0.9 (ABI < 0.9), then study with a CT angiogram or arterial ultrasound.
10. Compartment Syndrome: LEG

The lower leg is divided into following four muscular compartments by strong fascia extending from subcutaneous tissue to bone. Each compartment contains a nerve. Involvement of the specific nerve guides the clinician to the affected compartment.

- **Anterior** Compartment (Deep Peroneal Nerve)
- **Lateral** Compartment (Superficial Peroneal Nerve)
- **Superficial Posterior** Compartment (Sural Nerve)
- **Deep Posterior** Compartment (Posterior Tibial Nerve)
TYPICAL FEATURES OF COMPARTMENT SYNDROME

“Paresthesia, Pulselessness and Paralysis are late findings”

Late Findings: Five P’s
Always split the cast and examine the patient.

For practical purposes, the following are important initial features of compartment syndrome:

- Pain out of proportion to injury or surgery
- Tense swelling of leg
- Pain with passive stretch

- Increased analgesic requirement in children is important
- *Anterior Compartment Syndrome* is most common
- Check for LOSS OF SENSATION IN *FIRST WEB SPACE OF FOOT*
TYPICAL FEATURES OF COMPARTMENT SYNDROME (continued):

- **DEEP POSTERIOR COMPARTMENT** syndrome
  - IF MISSED ➔ **CLAW TOES**

  ➤ *Claw toes could indicate old tibial fracture or missed deep posterior compartment syndrome*

- Total ischemia of 8 hrs produces irreversible changes in muscle

- **Compartment Pressure Measurement** is KEY in salvaging the limb

- **Acute Compartment Syndrome:**
  - Absolute Intra-compartmental Pressure of 30 mmHg or more
  - ∆P within 30 mmHg of diastolic BP
    - ∆P = diastolic BP – intracompartmental pressure
    - i.e., Increased intracompartmental pressure within 30 mmHg of diastolic BP
    - **NOTE:** Intraoperative diastolic BP is usually low and therefore does not provide an accurate measurement. Please use preoperative diastolic BP reading **NOT** the intraoperative diastolic BP.
COMPARTMENT SYNDROME (LEG) - TREATMENT

Immediate Fasciotomy
11. Ankle Fractures

USUALLY BENIGN

IN CASES OF ANKLE FRACTURE LOOK FOR SIGNS OF SYNDESMOTIC INJURY”

Normal SYNDESMOSIS
(radiographic evaluation)
ANKLE PILON FRACTURE

- Complicated
- SIGNIFICANT Soft Tissue Injury
ANKLE FRACTURES: MAISONNEUVE FRACTURE

- Fracture of the *proximal fibula* is associated with an occult injury of the ankle. Often the *ankle mortise is widened*, and the *tibiofibular syndesmosis is disrupted*.

- Patient could mistakenly be treated for having:
  - Proximal fibular fracture alone and *ankle injury is missed*.
  - Sprain of ankle joint and *fibular fracture is missed*.

- High index of suspicion is necessary to diagnose and treat

- **Long Leg Film** that includes the ankle is mandatory in cases of:
  - Proximal fibular fractures to exclude the presence of ankle injury
  - An unexplained *increase* in *medial clear space of ankle joint* to diagnose the presence of a *high fibular fracture*.

**SURGERY IS NECESSARY TO STABILIZE THE SYNDENOSMOSIS**
ANKLE FRACTURES - MAISONNEUVE FRACTURE (continued):

CASE EXAMPLE

- Increased syndesmosis of > 4 mm = Syndesmotic Disruption
ANKLE FRACTURES - MAISONNEUVE FRACTURE (continued):

DIAGRAMMATIC REPRESENTATION

Involves fracture of the proximal fibula (*figure 1*) associated with an occult injury of the ankle (*figure 2*).

TREATMENT

- Fixation: Syndesmotic Screws
12. Pediatric Fractures

SALTER-HARRIS CLASSIFICATION OF EPIPHYSEAL FRACTURES IN CHILDREN

A Salter-Harris fracture is a common injury found in children which involves the growth plates of the long bones.

- **Salter – Harris Classification: Type I, II, III, IV, V**
  - **Type I:**
    - 5% of fractures are Type I
    - Occurs through the weak zone of provisional calcification
  - **Type II:**
    - 75% of fractures
    - Fracture of the physis and metaphysis
    - Corner of the metaphysis separates (Thurston-Holland Sign)
SALTER – HARRIS CLASSIFICATION: TYPE I, II, III, IV, V (cont.)

Type III:
- 10% of fractures
- Fracture of the physis and epiphysis
- Fracture extends into the articular surface of the bone

Type IV:
- 10% of fractures
- Fracture passes through the epiphysis, physis and the metaphysis
- Can cause complication such as growth disturbance and angular deformity

Type V:
- Uncommon, ≤ 5%
- Compression or crush injury of the growth plate
- No associated fracture of the epiphysis or metaphysis
- Initial diagnosis may be difficult
- **Highest incidence** of *growth deformity* and disturbance
13. Child Physical Abuse

NON – ACCIDENTAL TRAUMA (NAT) in Pediatric Patients

**IF SUSPECTED:**

“CONSULT SOCIAL SERVICES IMMEDIATELY”

**COMMON ORTHOPAEDIC CLINICAL FINDINGS**

- Femur Fracture – *before walking age*
- Corner Fracture *(shown in figure below)*
  - Caused by traction / rotation
  - Less Common
COMMON ORTHOPAEDIC CLINICAL FINDINGS (continued):

- Fractures at *different stages of healing*

Multiple fracture sites at different stages of healing. Thick arrow indicates old healing callus. Thin arrows indicate new fracture.

- Transverse or Spiral fractures of long bones

- *Humerus Fracture* ------- most common

- Metaphyseal BUCKET HANDLE FRACTURE

Metaphyseal or "bucket-handle" fracture *(arrow)* of the tibia.
14. Stress Fractures

Patient populations that commonly exhibit stress fractures are:

- Runners / Athletes
- Patients with osteoporosis or diseased bone

Patients present with:

- Localized severe bony pain
- Initially, normal appearing radiographs
**DIAGNOSIS**

- MRI
- Bone Scan

**TREATMENT**

- Rest
- Immobilization
- May require surgery, as in stress fracture of the femoral neck or tibia.

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_In this patient, the bone scan revealed the presence of a hot spot at the fibula._

_X-rays ordered after obtaining the bone scan showed a fracture of the fibula which is barely visible on x-ray._