



*Red Flags in Orthopaedics:
Pearls to Prevent Pitfalls*

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Objectives

1. Identify musculoskeletal red flags that require immediate intervention or orthopaedic consultation.
2. Differentiate between urgent and emergent conditions based on clinical presentation and diagnostics.
3. Discern vital information and relate findings to an orthopaedic specialist.
4. Discuss first-line treatment options for common musculoskeletal emergencies.
5. Prevent common pitfalls in orthopaedic care.



Case #1

Patient: 36-year-old mountain biker

Mechanism of Injury: Fall from bike

Chief Complaint: Severe right leg pain

Exam Findings:

Laceration over tibia

Neurovascularly intact in right leg

Left leg uninjured

Imaging: Radiographs show comminuted tibia and fibula fractures

Other Notes: Patient was helmeted; no additional injuries identified



OPEN FRACTURE

Red Flags: Open Fracture

Soft tissue wound in proximity of a fracture should be considered open until proven otherwise!

- Osteomyelitis occurs in the setting of up to 25% of open fractures dependent on the following:
 - Severity of fracture and soft tissue involvement
 - Amount of bacterial contamination
 - Vascular supply
 - **Quality of surgical debridement**
 - **“Prophylactic” antibiotics**





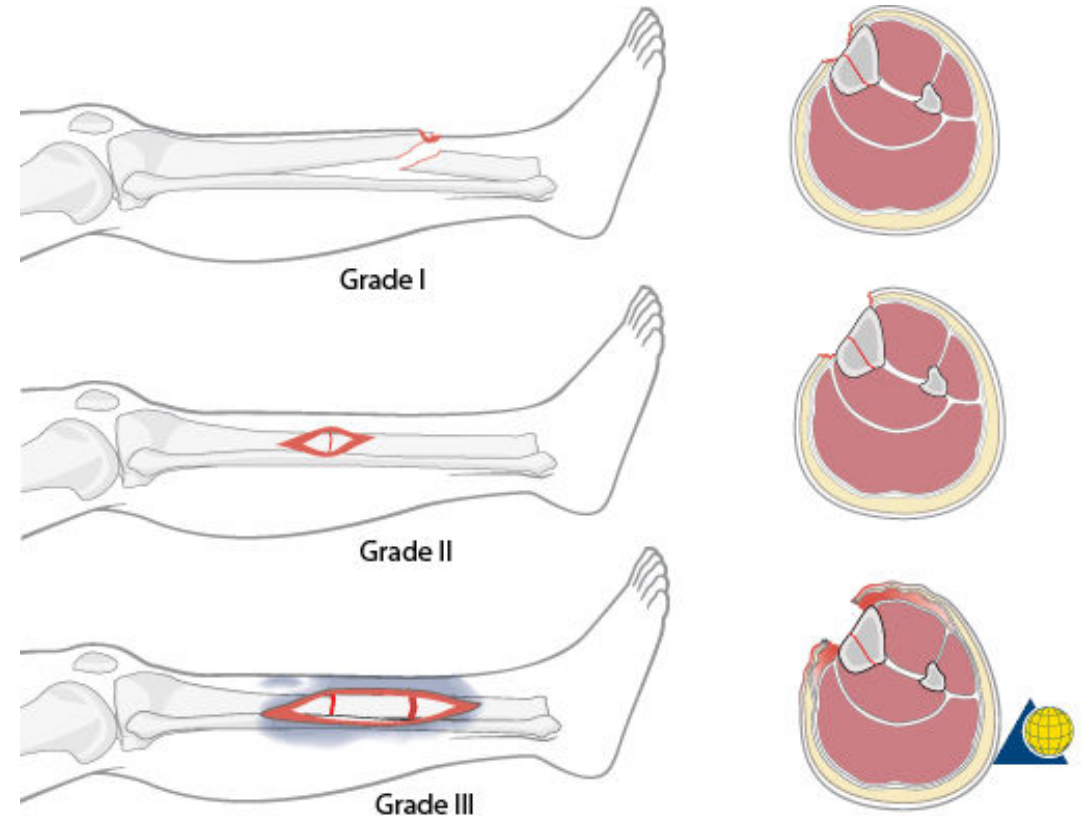
Key Diagnostic Steps: Open Fracture

- Document neurovascular status thoroughly
- Radiographs to confirm fracture pattern
- Assess wound size, contamination, and amount of soft tissue injury
 - Gustilo-Anderson classification

Grading: Open Fracture

Gustilo-Anderson Grading

- **Type I:** Wound < 1 cm with minimal contamination and adequate soft tissue
- **Type II:** Wound 1-10 cm with moderate soft tissue injury and simple underlying fx
- **Type III:** Wound > 10 cm with extensive soft tissue damage and multifragmental fx or crush injury
 - Subgrades A, B, C



Initial Management: Open Fracture



- Control bleeding with direct pressure
- Remove gross debris and sterile dressing
- Stabilize
- Immediate IV antibiotics within 1 hour
 - *Infection rate increases if delayed by 2-3 hours
 - Type I/II: First-generation cephalosporin (cefazolin)
 - Type III: Add gram-negative coverage (gentamicin)
 - Duration: 24 hours post-operatively (up to 72 hours for severe contamination/Type III)
- Tetanus prophylaxis
- Urgent orthopedic referral
 - Surgical irrigation/debridement ideally within 24 hours

Pearls to Prevent Pitfalls: Open Fracture

- Small puncture wounds can communicate with fractures
 - Any fracture with a skin break = open fracture
- **Do not delay antibiotics** awaiting consultation
- Document baseline neurovascular exam and routinely reassess



6 Hours
Later...

Increasing leg pain despite
adequate analgesia



ACUTE COMPARTMENT SYNDROME

Red Flags: Acute Compartment Syndrome

- **Pain** out of proportion to injury
- Pain with passive stretch (earliest reliable sign)
- Progressive paresthesias
- Tense, swollen compartment
- Late findings: pulselessness, paralysis, pallor

6 Ps

Paresthesia

Pallor: Less Common

Pulselessness: Late

Poikilothermia: Late

Paralysis: 8-24 hours

Pain

Key Diagnostics: Acute Compartment Syndrome

- Serial clinical examinations (every 2-4 hours in high-risk patients)
- Assess all "6 P's" but don't wait for late signs
- Compartment pressure measurement if diagnosis uncertain (>30 mmHg or within 30 mmHg of diastolic BP)

Initial Management: Acute Compartment Syndrome

- Remove all constrictive dressings/casts immediately
- Elevate limb to heart level
- **Emergent orthopedic consultation**
 - Maintain NPO status
 - Likely needs emergent fasciotomy

Pearls to Prevent Pitfalls: Acute Compartment Syndrome

- Presence of pulses does NOT exclude compartment syndrome
- Pain control should not mask worsening symptoms (maintain high suspicion)
- Any high-energy fracture (especially tibia) warrants close monitoring
- Document serial neurovascular exams



Patient: 18-month-old

Chief Complaint: Refusal to walk

History:

Mother reports child was well yesterday

No reported trauma

Exam Findings:

Right leg held flexed and externally rotated

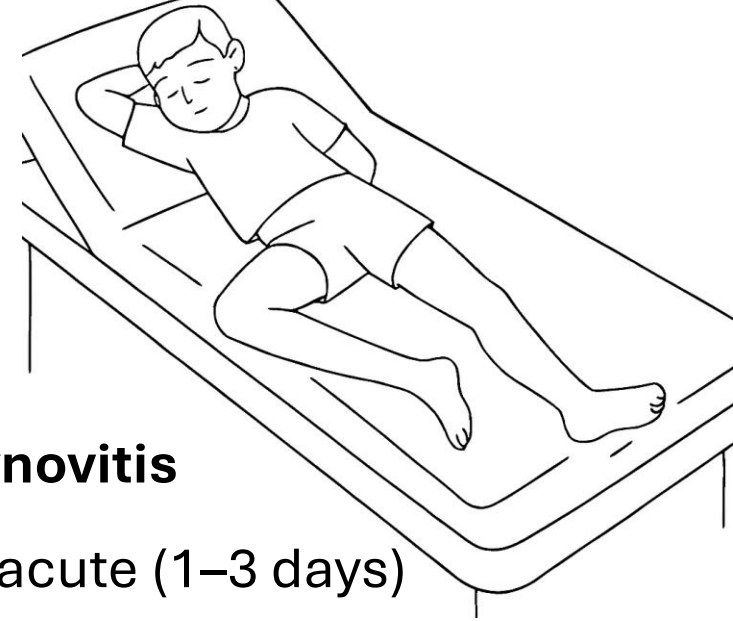
Febrile: 38.9°C (102°F)

Case #2



SEPTIC ARTHRITIS

Red Flags: Septic Arthritis vs. Transient Synovitis



	Septic Arthritis	Transient Synovitis
Onset	Acute (hours to 1–2 days)	Acute to subacute (1–3 days)
Preceding Illness	Recent infection or bacteremia	Often recent viral URI
Duration	Progressive worsening	Self-limited; improves in 1–2 weeks
Appearance	Toxic, ill-appearing, Fever	Well-appearing, playful, low grade or absent
Hip Position	Flexed & externally rotated, markedly reduced ROM	Similar, but less restricted ROM
Weight-Bearing	Refusal to bear weight	May limp

A photograph showing the lower legs and feet of an adult and a child walking together. The adult is on the left, wearing dark blue jeans, and the child is on the right, wearing striped shorts. The background is a light-colored floor. The text 'Next Step...' is overlaid in white outline font.

Next Step...

Labs: CBC with differential, ESR, CRP, blood cultures

Red Flags: Septic Arthritis vs. Transient Synovitis

Kocher Criteria

- Fever $>38.5^{\circ}\text{C}$ (101.3°F)
- Non-weight-bearing status
- ESR ≥ 40 mm/hour
- WBC $>12,000/\text{mm}^3$

Probability of Septic Arthritis

- 0 predictors: $<0.2\%$
- 1 predictor: 3%
- 2 predictors: 40%
- 3 predictors: 93.1%
- 4 predictors: 99.6%

*Additional Predictor: CRP >2.0 mg/dL (additional predictor)

Initial Management:

Septic Arthritis vs. Transient Synovitis

Kocher Criteria:

- ≥ 3 Kocher criteria: **Emergent intervention with orthopaedic consultation**
- 1-2 criteria: Close observation/communication
 - Consider repeating labs in 24 hours, low threshold for referral
- 0 criteria with benign exam: May observe with close follow-up

- MRI vs ultrasound can identify effusion and assist with surgical planning
 - Definitive diagnosis requires arthrocentesis

- IV antibiotics following arthrocentesis if septic arthritis is suspected (do not delay)

Pearls to Prevent Pitfalls: Septic Arthritis vs. Transient Synovitis

- **Septic arthritis is an orthopedic emergency!**
 - Cartilage damage occurs within hours
 - Kocher criteria is key!
 - Fever may be absent in up to 25% of cases
 - Hip pathology commonly presents as knee pain in children
- **Tip to help differentiate: Response to NSAIDS**
- Significant improvement within 24-48 hours for transient synovitis and minimal improvement in septic arthritis





Image created by Co-Pilot

Case #3

Patient: 13-year-old

Chief Complaint: Increasing right hip, knee, and thigh pain

History:

3-week history of right hip and knee pain

Pain worsens with activity

No acute trauma reported

Exam Findings:

Overweight

Antalgic gait, externally rotated right leg

Limited internal rotation of hip

Knee exam normal



SLIPPED CAPITAL
FEMORAL
EPIPHYSIS (SCFE)



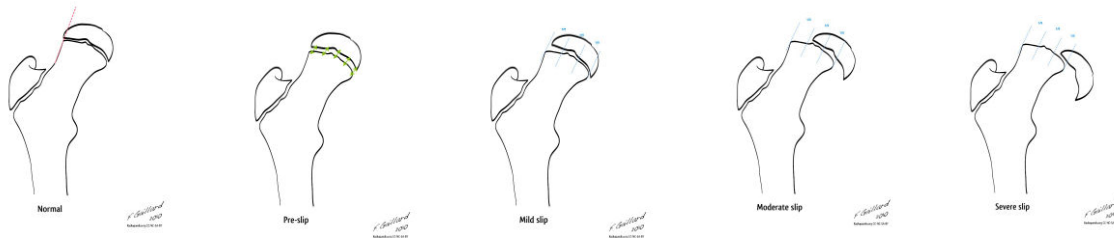
Red Flags: SCFE

- Adolescent age (10-16 years)
- Overweight/Obesity
- Atraumatic hip or knee pain with antalgic gait or non-weight bearing
- Limited internal rotation and abduction
- **Bilateral in 20-40% of cases**

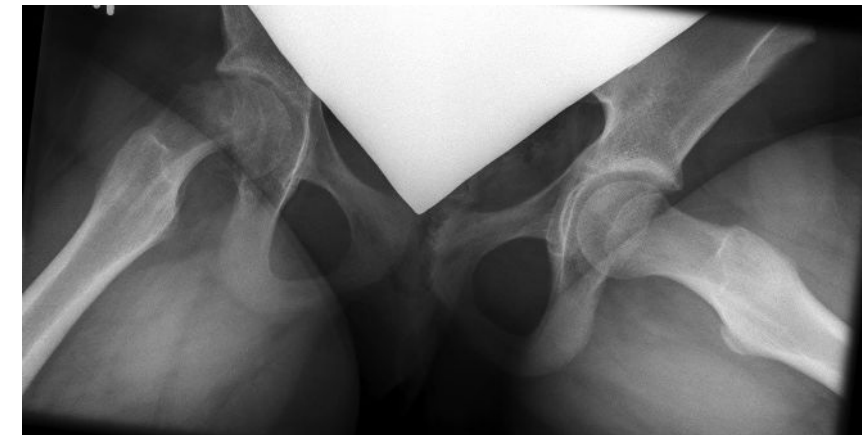
Key Diagnostic Steps: SCFE

- AP and **frog-leg lateral radiographs of BOTH hips**
 - Widened, irregular physis

Klein's line: draw line along superior femoral neck, should intersect femoral head

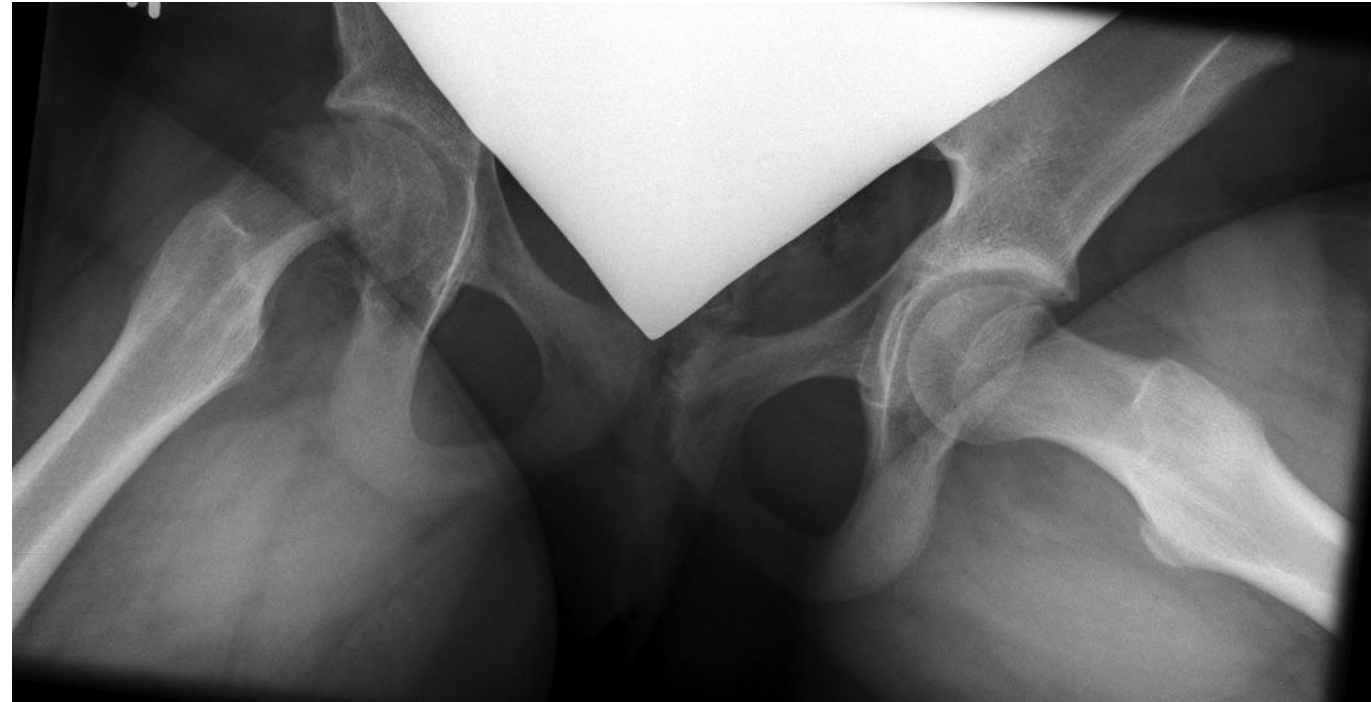
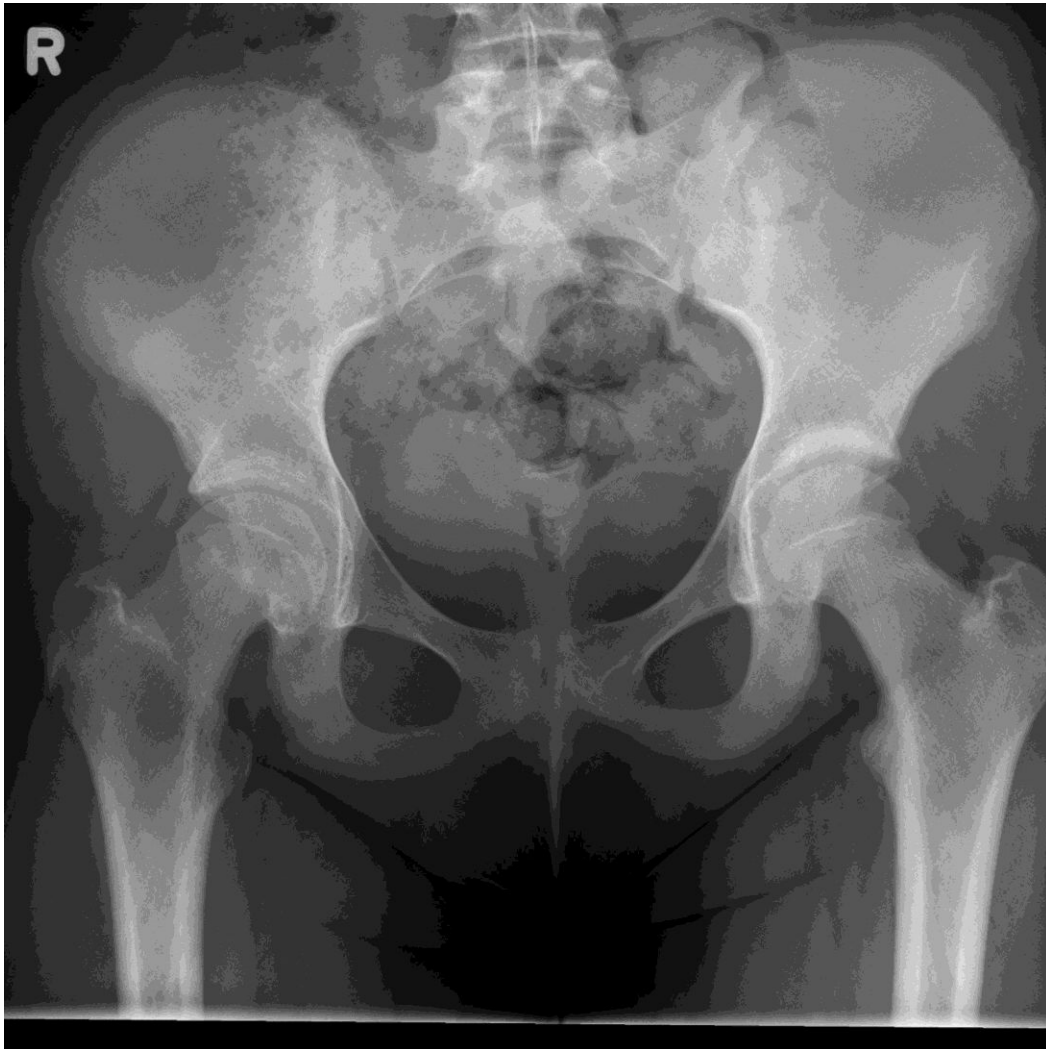


"Ice cream falling off cone" appearance on lateral view





SCFE: Imaging



Initial Management: SCFE

Non-weight-bearing immediately

Stability:

- Stable slip: patient able to walk or weight bear
 - Unstable slip: unable to bear weight even with crutches due to pain and displacement, pain severe
-
- **Urgent orthopedic referral** (same day)
 - Emergent surgical fixation

Classification Patterns	Symptoms	Imaging
Pre-slip	Pain present	Physeal widening (-) Displacement
Acute	Sx < 3 weeks Severe pain Limited ROM	(+) Joint effusion (-) Metaphyseal remodeling
Acute-on-chronic	Sx ≥ 3 weeks Acute increase in pain Decreased ROM	(+) Joint effusion (+) Metaphyseal remodeling
Chronic	Sx ≥ 3 weeks Vague, intermittent pain	(-) Joint effusion (+) Metaphyseal remodeling

Pearls to Prevent Pitfalls: SCFE

- Knee pain may be only presenting symptom
 - Evaluate hip abduction and internal rotation
- Always obtain bilateral hip radiographs
 - Contralateral hip at risk and able to compare
- Frog-leg lateral view is essential!
 - May be only view showing slip
- If suspicion is high, MRI is sensitive for pre-slip
- Do not allow weight-bearing
 - Risk of converting stable to unstable slip



Case #4

Patient: 52-year-old man

History:

3 days of worsening lower back pain

Pain radiates to both legs

Chronic back pain history, no trauma

New Symptoms (this morning):

Difficulty urinating

“Numbness between my legs on both sides”

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CAUDA EQUINA

Red Flags: Cauda Equina Syndrome



Classic presentation could all be red flags!

- Bilateral neurogenic sciatica/leg pain (most common presenting symptom)
- Saddle anesthesia (reduced perineal sensation)
- Bladder dysfunction: retention leading to overflow incontinence
- Loss of anal sphincter tone
- Sexual dysfunction
- Lower extremity motor weakness (variable)
- Absent or reduced lower limb reflexes (especially bilateral ankle reflexes)



Pause for Critical Pearls

- **Most patients do NOT present with all symptoms**
 - Symptoms may occur suddenly or gradually. Diagnosis is often delayed because early signs are subtle.
- **High-risk clinical combinations:**
 - **Bilateral leg pain + absent bilateral ankle reflexes**
- Markedly reduced range of motion increases suspicion

Management: Cauda Equina



Immediate Actions:

- Do NOT delay imaging if suspecting cauda equina!
 - Urgent MRI of lumbosacral spine (preferred imaging)
 - Should be performed within 1 hour of suspicion being raised
- **Emergent neurosurgery/spine surgery consultation**
 - Decompressive surgery should occur as soon as possible
 - Keep patient NPO

*If clinical suspicion for neoplastic cause: dexamethasone 10 mg IV immediately. If non-neoplastic: focus on emergent surgical decompression.

Pearls to Prevent Pitfalls: Cauda Equina Syndrome

- Surgical Emergency: Damage occurs continuously and progressively
- Bilateral symptoms are key!
- Urgent MRI within 1 hour of suspicion, regardless of time of day
- Emergent neurosurgical consultation immediately
 - Do not wait for MRI results

Case #5



Patient: 8-month-old infant

History: 2 days of fussiness and poor feeding

Brought by mother's boyfriend

Reported mechanism: "rolled off the couch"
(details vague)

Exam Findings:

Multiple bruises on upper arms

Small bruise on left cheek

Torn frenulum

Infant is pre-ambulatory and not yet pulling to stand

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NON-ACCIDENTAL TRAUMA



Red Flags: Non-Accidental Trauma

Historical Red Flags

- History changes or is inconsistent between caregivers
- Delay in seeking care for a significant injury
- History incompatible with injury severity or type
- Vague or absent explanation for injury ("I don't know how it happened")
- Blame placed on sibling or the child

Key Diagnostics: Non-Accidental Trauma

Trauma-Informed History Taking:

- **Use nonaccusatory, nonjudgmental language**
- Determine all caregivers
 - Obtain history from each caregiver separately when possible to assess for consistency
- Document exact quotes from caregivers regarding mechanism and timing[

***Screen for intimate partner violence** when interviewing caregivers separately





Key Diagnostics: Non-Accidental Trauma

Trauma-Informed Physical Exam

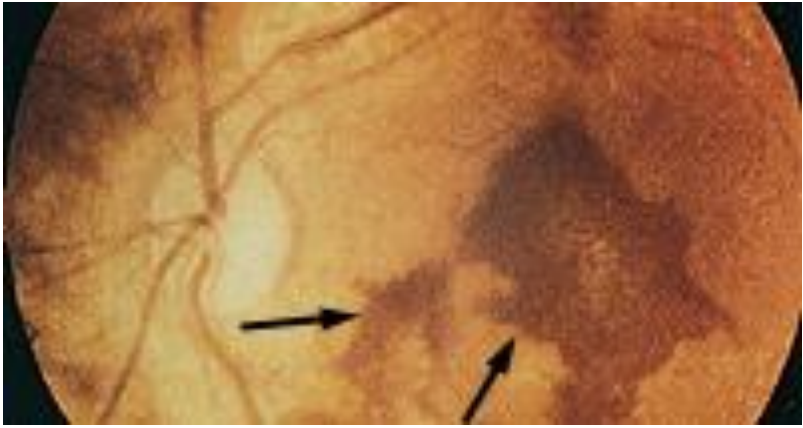
- Emphasizes safety, choice, and trust
 - Explain each step in child-friendly language, involving caregivers when appropriate, minimizing exposure, and stopping immediately if the child shows distress
- Examine all skin surfaces including scalp, behind ears, and genitalia
 - Document size, shape, color, and location of all injuries with photographs when possible
 - Examine oral cavity thoroughly for frenulum tears, palatal bruising, dental trauma
 - Assess for subconjunctival hemorrhages
- Palpate entire head
- Complete neurologic examination including pupillary response, tone, reflexes
- Look for injuries in different stages of healing

Red Flags: Non-Accidental Trauma

Sentinel Injuries (Highest Clinical Predictive Value)

- Oral injury (torn frenulum, intraoral bruising)
 - Particularly concerning in pre-ambulatory infants
- Bruising on buttocks or neck
- Patterned bruising (handprints, loop marks, linear marks)
- Subconjunctival hemorrhage without clear accidental mechanism

**Any injury to a non-mobile infant (including bruises, oral injuries, or fractures)



Physical Abuse

Key Diagnostics: Non-Accidental Trauma

For suspected physical abuse, obtain:

- Skeletal survey: AP and lateral views of the entire skeleton
 - All children <2 years and consider for ages 2-5 years
 - Identifies occult fractures in different stages of healing
- Neuroimaging (CT or MRI)
 - Concerns for head trauma, even with nonspecific symptoms (vomiting, fussiness, lethargy)
 - *One-third of children with abusive head trauma had prior opportunities for diagnosis
- Abdominal imaging (CT)
 - Concerns for abdominal trauma or elevated liver enzymes

Consultation and Reporting: Non-Accidental Trauma

Ensuring child safety is paramount!

Consult multidisciplinary team

- Child-life specialist, if available
- Forensic specialist
- Social worker
- Pediatrician (child abuse pediatrician, if available)
- Medical specialists as indicated

Child Protective Services (CPS) and Law enforcement



Mandatory reporting when reasonable suspicion exists

- Legal requirement

Abuse-Specific Orthopedic Injury Patterns

<2 years old are at the highest risk!

Specificity of fractures

High specificity	Classic metaphyseal lesion
	Rib fractures, especially posterior
	Scapular fractures
	Spinous processes fractures
Moderate specificity	Sternal fractures
	Multiple fractures, specifically bilateral
	Fractures of different ages
	Epiphyseal separation
	Vertebral body fractures and subluxations
Low specificity but	Digital fractures
	Complex skull fractures
	Subperiosteal new-bone formation
	Clavicular fractures
	Long bone shaft fractures
	Linear skull fractures

Corner or Bucket Handle Fracture

Pathognomonic!



Non-Ambulatory Fractures





Case Example: Femur Fracture

MOI: Irritable after an inadvertent
forceful diaper change
– 6 weeks old

What is Next?

Skeletal Survey

Negative. Next?

Initial skeletal survey

Skull	AP / Lateral
Cervical spine	Lateral
Thorax	AP, to include the shoulders. Both oblique's (to include all the ribs, left and right). Lateral to include the whole spine.
Abdomen, lumbosacral spine, pelvis	AP abdomen and pelvis.
Upper extremities	Where possible: AP of the whole arm (centered at the elbow if possible) Coned lateral elbow / Coned lateral wrist In larger children: AP humerus (including the shoulder and elbow) AP forearm (including the elbow and wrist) Coned lateral elbow / Coned lateral wrist
Lower extremities	AP femur / AP tibia and fibula AP knee / Coned lateral knee Coned AP ankle (Mortise view) Coned lateral ankle
Hands	PA Hand and wrist
Feet	AP/PA

Next Step... Bone Scan

Posterior Rib Fractures





Case Example:
4 months old

A row of black spheres is blurred in the background, while a single, sharp red sphere is in the foreground. The red sphere is highly reflective and sits on a white surface.

Pearls to Prevent Pitfalls: Non-Accidental Trauma

Identify the Red Flags EARLY

- Any fracture could be non-accidental trauma, so consider all the information...
- History incongruent with injury
 - Inconsistency
 - MOI does not correlate with the injury or denial of trauma
- Fractures at various stages of healing and/or delay in presentation
- Highly suspicious fractures must be reported and documentation is key!

Remember: “Those who don’t cruise, don’t bruise”



Final Pearls to Prevent Orthopaedic Pitfalls

Combination of red flags are more reliable than single sign

- Open fractures need **immediate antibiotics**, surgical consult, and detailed neurovascular checks.
- Suspect acute compartment syndrome with worsening **pain** even if pulses are present.
- Septic hip is an emergency! **Kocher criteria and NSAIDs** help distinguish it from transient synovitis.
- SCFE may present as knee pain, so **always examine hips** and get pelvis/bilateral hip X-rays.
- Suspicion of cauda equina syndrome requires immediate MRI and **urgent neurosurgical consultation**.

Early recognition and documentation of musculoskeletal red flags are essential!

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QUESTIONS?

Resources

- AAOS: <http://www.aaos.org/>
- POSNA: <https://posna.org/>
- Radiopaedia: <http://radiopaedia.org/>
- Radiology Assistant: <http://www.radiologyassistant.nl>
- OrthoBullets: <https://www.orthobullets.com>
- OpenEvidence: <https://www.openevidence.com/>

Contact Information:

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References

- Kocher MS, Zurakowski D, Kasser JR. Differentiating between septic arthritis and transient synovitis of the hip in children: an evidence-based clinical prediction algorithm. *J Bone Joint Surg Am.* 1999;81(12):1662-1670.
- Caird MS, Flynn JM, Leung YL, Millman JE, D'Italia JG, Dormans JP. Factors distinguishing septic arthritis from transient synovitis of the hip in children: a prospective study. *J Bone Joint Surg Am.* 2006;88(6):1251-1257.
- Luhmann SJ, Jones A, Schootman M, Gordon JE, Schoenecker PL, Luhmann JD. Differentiation between septic arthritis and transient synovitis of the hip in children with clinical prediction algorithms. *J Bone Joint Surg Am.* 2004;86(5):956-962.
- Lack WD, Karunakar MA, Angerame MR, et al. Type III open tibia fractures: immediate antibiotic prophylaxis minimizes infection. *J Orthop Trauma.* 2015;29(1):1-6.
- Hoff WS, Bonadies JA, Cachecho R, Dorlac WC. East Practice Management Guidelines Work Group: update to practice management guidelines for prophylactic antibiotic use in open fractures. *J Trauma.* 2011;70(3):751-754.
- McQueen MM, Gaston P, Court-Brown CM. Acute compartment syndrome: who is at risk? *J Bone Joint Surg Br.* 2000;82(2):200-203.
- Ulmer T. The clinical diagnosis of compartment syndrome of the lower leg: are clinical findings predictive of the disorder? *J Orthop Trauma.* 2002;16(8):572-577.
- Germon T, Ahuja S, Casey ATH, Todd NV, Rai A. British Association of Spine Surgeons standards of care for cauda equina syndrome. *Spine J.* 2015;15(3 suppl):S2-S4.
- Shapiro S. Medical realities of cauda equina syndrome secondary to lumbar disc herniation. *Spine (Phila Pa 1976).* 2000;25(3):348-351.

References

- Peltola H, Pääkkönen M. Acute osteomyelitis in children. *N Engl J Med*. 2014;370(4):352-360.
- Pääkkönen M, Kallio MJ, Kallio PE, Peltola H. Sensitivity of erythrocyte sedimentation rate and C-reactive protein in childhood bone and joint infections. *Clin Orthop Relat Res*. 2010;468(3):861-866.
- Pierce MC, Kaczor K, Aldridge S, O'Flynn J, Lorenz DJ. Bruising characteristics discriminating physical child abuse from accidental trauma. *Pediatrics*. 2010;125(1):67-74.
- Sheets LK, Leach ME, Koszewski IJ, Lessmeier AM, Nugent M, Simpson P. Sentinel injuries in infants evaluated for child physical abuse. *Pediatrics*. 2013;131(4):701-707.
- Maguire S, Mann MK, Sibert J, Kemp A. Are there patterns of bruising in childhood which are diagnostic or suggestive of abuse? A systematic review. *Arch Dis Child*. 2005;90(2):182-186.
- American Academy of Pediatrics Section on Radiology. Diagnostic imaging of child abuse. *Pediatrics*. 2009;123(5):1430-1435.
- American College of Surgeons Committee on Trauma. *ATLS Advanced Trauma Life Support Student Course Manual*. 10th ed. American College of Surgeons; 2018.
- Gustilo RB, Anderson JT. Prevention of infection in the treatment of one thousand and twenty-five open fractures of long bones: retrospective and prospective analyses. *J Bone Joint Surg Am*. 1976;58(4):453-458.