What do you see?

skull fracture
Head CT

On *soft tissue windows*, posterior soft tissues swelling and hemorrhage, no definite evidence of fracture

Head CT

On *bone windows*, fracture now seen subjacent to posterior soft tissue swelling
Normal Sutures of the Newborn Skull

- Lambdoic Suture
- Sagittal Suture
- Coronal Suture
- Metopic Suture
- Anterior fontanelle

Anterior
- Metopic
- Coronal
- Sagittal
- Lambdoic

Posterior
What do you see?
What do you see?

skull fracture
What do you see?
SKULL FRACTURES

• Unlike most other healing fractures, skull fractures do not show the subperiosteal new bone formation (SPNBF), a/k/a “periosteal reaction,” on x-rays that can be readily seen with other healing fractures such as rib fractures.
Metaphyseal corner fractures and bucket handle fractures

Metaphyseal corner fractures
HEALING FRACTURES
Periosteal Reaction (arrowhead)

NAT, 6-week-old
CASE 4

20-month-old girl with a limp

No recent fevers, mom doesn’t relate any specific traumatic event.

Brings her to ED for evaluation, where they got x-rays and called you for admission.

They tell you it seems weird that she has no fever and that they can’t seem to find anything wrong with her leg. They want her admitted for orthopedics consult and further evaluation for osteomyelitis...or cancer!

Looking at the x-rays before going to examine the child...

CASE 4

You go and get the best evidence to base care on...a physical exam.

They are tender to palpation on the distal left tibia, with restricted ankle range of motion secondary to guarding from pain.

Look at the x-ray...
Limping Child

• First key is pain
  – If not painful, when did limp begin
    • With onset of walking, and normal neuro exam, think orthopedics issue like DDH
    • With onset of walking and abnormal neuro exam, think CP, dysraphism, or neuromuscular disease

• Next key is trauma
• Then fever
• If no fever, the DDx is broad and includes NAT, overuse, AVN, pelvic pathology, etc.
Keys to the Limping Child

Is the limp painful?  
YES  
NO

If it began with walking and normal exam, think orthopedic issue like DDH
If it began with walking and abnormal neuro exam, think CP, spinal dysraphism or neuromuscular disease (Variant 1)

Was there trauma?  
YES  
NO

Labs to look for inflammation or infection
Imaging depending on where you PE guides you (ACR-AC are somewhat helpful) (Variant 3)

Was there fever?  
YES  
NO

DDX is very broad from AVN, to abuse, to tumors, to arthritis, SCFE, pelvic pathology... (Variant 1)

ACR Appropriateness Criteria®

LIMPING CHILD

Age 0-5 years old

Variant 1: No localized pathology on examination and no concern for infection

8 X-ray tibia and fibula
6 Ultrasound hip
5 X-ray pelvis and leg and foot
5 X-ray lumbar spine
5 Bone scan lower T-spine to distal lower extremities
5 MRI lower T-spine to distal lower extremities without contrast
5 MRI lower T-spine to distal lower extremities without contrast
LIMPING CHILD

Age 0-5 years old

Variant 2:
Isolated area of potential pathology but no concern for infection, i.e., it hurts when I push here!

1 CT area of interest with(out) contrast
2 CT area of interest with contrast
3 CT area of interest without contrast
4 CT area of interest with contrast
5 Ultrasound area of interest
6 MRI area of interest without contrast
7 MRI area of interest with(out) contrast
8 Pelvis x-ray
9 X-ray area of interest

Variation 3:
Concern for infection, including septic arthritis

This variant requires you to put on your thinking cap, localize the pathology to the best of your ability, then choose the right imaging study.

1 CT area of interest with(out) contrast
2 CT area of interest without contrast
3 CT area of interest without contrast
4 CT area of interest with contrast
5 Bone scan area of interest
6 MRI area of interest with(out) contrast
7 MRI pelvis with(out) contrast
8 Pelvis x-ray
9 Hip ultrasound

Adapted from Reference 10
20-month-old with limp
buckle fracture
Entire extremity on 1 image

• Reduces # of images, but not best strategy when findings may be subtle

Later that day: Left tibia/fibula, 3-views

buckle fracture, more obvious on lateral view
Salter-Harris Fractures

Common in children!

Salter Harris Fractures
Involve the Physis

<table>
<thead>
<tr>
<th>Salter-Harris (SH) Physeal Injury Classification</th>
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<tbody>
<tr>
<td><strong>Type</strong></td>
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SH Classification from I - V
• Salter I: **STRAIGHT** through the physis

• Salter II: Involves physis and goes **ABOVE**, into metaphysis

• Salter III: Involves physis and goes **LOWER**, into epiphysis

• Salter IV: Involves physis and goes **TOGETHER**, both above, into metaphysis, and lower, into epiphysis

• Salter V: **RUINS** (crushes) physis
Salter-Harris Classification

- Salter I: Straight
- Salter II: Above
- Salter III: Lower
- Salter IV: Together
- Salter V: Ruined

Pediatrician’s Keys to Imaging

- Phone a friend and phone often
- Include appropriate history in your request
- Many times the right thing is NO imaging
SUMMARY

• ALARA principle and principles of evidence-based imaging
  - Location and use of American College of Radiology (ACR) Appropriateness Criteria®

SUMMARY

• Evaluation process for determining when an imaging study is indicated and when none is needed
• When indicated, choosing most appropriate imaging study/studies for work-up of
  - Vomiting in an infant up to 3 months of age
  - Suspected malrotation/midgut volvulus
  - Suspected intussusception
SUMMARY

- Choosing among modified barium swallow (MBS), contrast swallow, e.g., barium swallow, upper GI series (UGI), and small bowel follow-through (SBFT)

- When barium can be used and when water-soluble contrast is indicated

SUMMARY OF FLUOROSCOPY STUDIES

Proximal to Distal

- **MBS**: Mechanics of swallow, evaluate for aspiration
- **Contrast swallow**: Mouth to gastric fundus, does not evaluate for GE reflux
- **UGI series**: Mouth to duodenojejunal junction/ligament of Treitz, includes duodenum
- **SBFT**: Entire small bowel, including terminal ileum
- **Contrast enema**: Colon and rectum
SUMMARY

- Head trauma
- Suspected nonaccidental trauma (NAT)
- Identification of common fractures seen in NAT
- Limping child, ages 0-5 years
- Mnemonic that aids in classifying Salter fractures

SUMMARY

Best practices, including Image Gently®, image collimation, and gonadal shielding

Important considerations including ionizing radiation exposure, need for sedation, etc.

Relative costs of radiology studies
Practice Changes?

• ALARA-based protocols?
• ACR Appropriateness Criteria® utilization?
• Adopt Image Gently®?
• Create clinical pathways for specific inpatient diagnoses that utilize evidence based imaging?
• Discover who my local experts are?

References

If we can be of assistance, please don’t hesitate to contact us

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Thank you for the opportunity to speak to you!