Welcome to the DCMC Emergency Department Radiology case of the month!

In conjunction with our pediatric radiology specialists from ARA we hope you enjoy these monthly radiological highlights from the case files of the Emergency Department at DCMC. These cases are meant to highlight important chief complaints, cases, and radiology findings that we all encounter every day.

If you enjoy these reviews we invite you check out Pediatric Emergency Medicine Fellowship Radiology Rounds, which are currently offered quarterly and are held with the outstanding support of the pediatric radiology specialists at Austin Radiologic Association.

If you have any questions or feedback regarding the Case of the Month format, feel free to email Robert Vezzetti, MD at rmvezzetti@seton.org.

This Month: Every medical specialty has, I believe, at least one chief complaint in a patient that they just don’t like to hear. For example, many of my adult medicine colleagues state they cringe when they hear a patient has “weakness” or “numbness”. For me, it’s “fussy”. So, here is a case of an infant who presented to the Pediatric Emergency Department with a complaint of fussy. Seems easy enough, but, as you will see, there was more than meets the eye with this young patient!

August is named after Augustus Caesar, founder and the first emperor of the Roman Empire, who was posthumously adopted by his maternal great-uncle Gaius Julius Caesar.
On Aug. 21, 1911, the Mona Lisa was stolen from the Louvre Gallery and not recovered for two years.

Case History: Well, it appears that the Summertime lull hat is typically enjoyed this time of year by Emergency Departments across the country has finally hit Dell Children's; at least for tonight, because the 5-midnight rush has started to die down.

The next chart you pick up is a 3 month old infant with a chief complaint of fussy. Great. You note the vital signs: Temp 99.0 HR 130 RR 25 Sats 100% (RA) No BP. Ok, seems innocent enough. You walk in the room and begin to speak with the child’s mother. Upon entering, you note that the infant is asleep, comfortably, in his mother's arms. Mom is speaking on her cell phone, but she does hang up long enough to tell you that “all this kid has done for the past 3 days is scream”. Interestingly enough, he is calm now in the Emergency Department and mom states she thinks everything is fine and she would like to go home now. You persuade her to remain and at least let you have a look at her son, since they waited long enough in the Department. She agrees.

As you begin to examine what appears to be a very cute infant, she tells you that while he has been feeding normally and otherwise has been fine, he screams frequently during the day, especially when his diaper is changed. Mom tells you that she thinks “he might be allergic to his diaper” and has tried switching to a different brand (I'm not making this up!) She denies fever, vomiting, diarrhea, cough, congestion, or really any other symptom, other than the fussy periods have become very frequent over the past 3 days. She then adds that maybe he is constipated, because he has not had a bowel movement in several days.

As you begin to examine the infant, you really can’t find any remarkable findings. Midway through your exam, he wakes up, and begins to scream. He calms down after you stop touching him, but when you start your exam again, he starts to scream. He is especially irritable when you palpate his abdomen and manipulate his legs. What? Again, he calms when you stop examining him. You then specifically manipulate his legs: there is some crying with left leg examination, but he starts to scream when you attempt to flex, extend, and otherwise move his right leg. You look more closely and do not not any erythema, edema, lesions, ecchymoses, or other findings. He has excellent femoral, posterior tibial, and dorsalis pedis pulses, as well as brisk cap refill.

What's going on here? There is no fever, no history of trauma, really nothing except a very irritable infant who seems to have either abdominal pain or hip pain (right, it appears) during his exam. He does calm down and is feeding well. What sort of workup does this infant need, if any? Will imaging help? If so, what?

The Infant With Unexplained Crying

Before we proceed, let’s take a very quick look at crying in infants, particularly unexplained crying. The incidence is approximately 1.5-43% of the population; this wide range may be due to the variation in exactly what is meant by unexplained crying. The prevalence of an organic cause of unexplained crying is approx 5-76%, but the true number is really not known.

There is debate about how to approach an infant with crying, as the cause is typically not readily apparent. Here are some diagnostic considerations when approaching an infant with crying and no obvious, readily apparent, cause:

**Potentially Life-threatening**
- Trauma/NAT
- Dysrhythmias
- CHF/Cardiac Disease
- Pneumonia/UTI/Sepsis
- FB ingestion/aspiration
- Intestinal obstruction/Intussusception
- Appendicitis
- Testicular/Ovarian torsion
- Meningitis/Encephalitis
- Increased ICP
- Metabolic Disease

**Non Life-threatening**
- Corneal abrasions
- Teething
- Oral lesions
- URI/AOM
- Constipation/Anal fissure
- GERD
- Tourniquets
- Fractures (beware NAT!)
- Colic
- Idiopathic
The differential is quite extensive, and, while this infant seems on the whole fine (no fever, feeding well, no signs of trauma), the fussiness during his examination is worrisome. What’s with the right leg (you think the right leg): it seemed to increase the fussiness when manipulated. Or was the abdomen the problem? You decide to start with plain films and see if anything pops up.

Here is the right femur. Overall, an unremarkable film. There is no evidence of acute fracture or mass. The bones are normally aligned.

The abdominal film is also unremarkable. The bowel gas pattern is normal, the visualized bones are normal. There is no free air or evidence of obstruction. The heart and lung portions that are visualized on this study appear normal. Looking a little more closely, though, the right hip joint looks distended versus the left side (yellow arrow). This could be positional, however. On the other hand, could this be an indication of real pathology?

Here are the tibial views of the infant. They also appear to be normal. There is no evidence of fracture, mass, or soft tissue air.

Did you notice this linear lucency (blue arrow)? Looks a bit like a fracture, doesn’t it. Well, it’s actually a confluence of shadows (tissue, for example). Note how the lucency is also present across the inferior portion of the femur and the medial aspect of the entire leg itself (purple arrow).

So, these images are overall unremarkable, but these is the question of the right hip joint possible widening of the right hip joint. Again, this could be positional, but there is one way to be sure: obtain dedicated views of the pelvis. This was done......
On Aug. 24th in 79 A.D., the volcano Mount Vesuvius erupted, destroying the city of Pompeii and others.

Here is the dedicated pelvis view (the frog leg view was obtained but not shown here). While grossly normal in appearance, there is a subtle finding: The right hip joint is most certainly widened when compared to the left (yellow arrow). As you are thinking over your next step, the nurse comes to you and reports that the child now has a fever of 101.5.

Alright, now things have started to get interesting. You have a fussy, now febrile infant, with apparent pain in what is likely the right leg (possibly the hip), and a widened right hip joint on plain films. The differential now has narrowed some. What next?

In light of the fever, you obtain a CBC, CMP, Blood culture, ESR, CRP, CK, UA, and Urine culture. The WBC is 12.9 (47 segs and 40 lymphs); the CMP, UA, and CK are all normal. The ESR is 61 and the CRP is 4.3. While nonspecific, these elevated inflammatory markers, in the context of probably hip pain, are concerning for either a septic joint or osteomyelitis. Pediatric Orthopedics is consulted and they recommend an Ultrasound of the hip.

For comparison, here’s the left hip. The blue arrow shows the femoral head and the purple arrow shows the joint space.

Reading hip ultrasounds can be tricky, especially when looking at joints (that’s a whole other topic). But above is the right hip ultrasound. The blue arrow points to the femoral head and above that is the joint space. The red arrow shows an area of fluid collection; this should not be there, and, given the exam and laboratory values, suggests infection.
Here's a side by side comparison of the two hip joint spaces. The red arrows show the fluid collection and the blue arrows show the femoral head/joint.

A word about Ultrasound and hips in infants: There is some controversy using US to evaluate for joint effusions. In cases of transient synovitis, effusions may be present and do not warrant antibiotic treatment. Some centers do not recommend routine US because if an effusion is encountered, then either further workup is needed (ie MRI) or arthrocentesis must be performed to rule out infection. The general guideline is US is an appropriate initial imaging modality (obvious reasons: no radiation, painless, quick) in children whom the possibility of a septic joint exists. The result of any US should be taken in the context of the child's history, physical examination, and laboratory investigation. Of course, in any child in whom a septic hip is suspected, prompt consultation with Pediatric Orthopedics is highly recommended and always appropriate.

**Criteria For Effusion:**

- **Anterior Synovial Space Thickness > 5 mm**
- **Anterior Synovial Space Thickness > 2 mm**
- Difference when compared to the other side.

Comparison views are critical. US can't distinguish between sterile and inflammatory effusions based on appearance.

**Measurement of the Anterior Synovial Fluid Space.**


**Comparison views of the right and Left Hips.**


**Normal Anatomy of a Pediatric Hip Ultrasound.**


**Hip US technique: A high frequency transducer is typically used. The landmarks that are identified are the femoral neck, joint capsule, ilioptosus muscle. There can normally be a small amount of physiologic fluid present within the joint space in children.**

**Interpret US results in the context of history, physical and laboratory findings!**

Twenty-two per cent of Norwegians named August were born in August.
The presence of the right hip effusion is concerning, especially in light of the physical examination findings and the laboratory values. Pediatric Orthopedics is called to evaluate the child and graciously does so. After their evaluation, they state they are suspicious, but would like a confirmatory MRI.

In these MRI images, we see a with and without contrast MRI of the femurs and tibias/fibulas (the left tib/fib view was cropped out but it is normal). What is outstanding is the synovitis (red arrow) and osteomyelitis (yellow arrow) of the proximal right femur. There is also associated adjacent fasciitis (blue arrow). The small hip effusion can also be seen (purple arrow). This confirms that there is not only an effusion, but associated osteomyelitis and synovitis. Next steps? What happened? Keep reading (Case Resolution coming up)........

Imaging Options In Suspected Cases of Joint Infections:

1. **Plain Radiographs**: Initial study of choice, as they can show soft tissue edema, joint space abnormalities, and (in up to 50% with osteomyelitis) bone changes. However, it often takes at least a week or more for bone changes to be detected. Any abnormal radiographs should prompt further investigation and a normal film does NOT rule out infection.

2. **Ultrasound**: The advantage for this modality is the low cost, lack of pain, and lack of ionizing radiation. It is also quick to perform. For a suspected septic joint, it can be very useful in identifying fluid collections, and guiding drainage, although children can have a normal amount of physiologic fluid in the joint space. For osteomyelitis, it is not very sensitive or specific. However, it can help detect DVT, a rare but known complication of osteomyelitis.

3. **Bone Scan**: Ah the bone scan! Using a technetium-labeled bone scan to detect osteomyelitis has been a time-honored tradition and has variable sensitivity (50%-100%). It is particularly useful in detecting pelvic osteomyelitis. They are not as useful for septic joint investigations, though, as they lack resolution and are poor at detecting fluid collections. Also, false positive results can occur in the context of trauma, malignancy, and normal bone growth.

4. **MRI**: The gold standard! Excellent resolution and can detect cortical destruction, edema, fluid collections, muscle involvement, and abscesses. The main disadvantage the likely need for sedation and the time it takes to perform the study. It may also not be available in all facilities.

5. **CT**: This modality has the advantage of being readily available and is generally quick. However, bone changes may not be detected early in the course of infection and sensitivity is around 60% for osteo. It can detect fluid collections and abscesses in the case of septic joints. But CT involves ionizing radiation. If MRI and bone scan are not available, this may be an option.

The most common route that pathogens enter the joint space is through hematogenous spread, although sometimes this can occur through direct trauma. In young children, it is extremely common to have osteomyelitis accompanying a septic joint.

**Common Pathogens/Unique situations:**

- *Staphylococcus aureus* (E Coli, Group B Strep)
- *Streptococcus pneumoniae* (Staph, Group A strep, Strep pneumo)
- *Neisseria gonorrhoea* (neonates too!)
- *Mycobacterium tuberculosis* (Adolescents)
- *Neisseria gonorrhoea* (Sickle Cell)
- *Salmonella* (Chronic)
- *Kingella kingae* (Emerging)
- *Borrelia burgdorferi* (Reactive)
Septic arthritis is more common in children but there is little data on the true incidence. Neonates and children with medical conditions (such as sickle cell or immune issues) are at greatest risk.

How Do Children Present?
Joint inflammation with swelling and pain is the hallmark of the disease. Unfortunately, this can be subtle in infants, who may present with irritability or pain when changing a diaper (or any manipulation of the hip). Older children may not want to bear weight or ambulate on the affected extremity. Most of the time, a single joint is involved. The classic position of comfort for a septic joint is the extremity held in flexion and abducted from the midline (see left).

Case Resolution:
After the MRI was resulted, Pediatric Orthopedics took him immediately to the Operating Room for joint aspiration and debridement. Some frank pus as encountered and this was sent for culture, which ultimately grew Streptococcus pneumoniae. The child was started on Clindamycin and Ceftriaxone. Once the culture results were known, he was switched to monotherapy with Ceftriaxone only. Pediatric Infectious Disease was also consulted to help with antibiotic therapy choice early on in the child’s hospitalization course. A PICC line was placed during the hospitalization, and the child was discharged home to complete a 6 week course of Ceftriaxone. His blood culture was ultimately was negative. He is currently doing well.

Septic arthritis can be a difficult diagnosis to make, especially early in the course of the illness. It is imperative, however, to make the diagnosis as soon as possible. A common complication is degenerative arthritis, especially in cases of femoral head involvement, which tends to have a worse prognosis. Sepsis is also a concern in young children. Other potential complications include osteonecrosis and growth arrest of the involved bone.

**Teaching Points:**

1. **Beware the fussy infant!** While most of the time the cause of fussiness is benign, a thorough history and physical examination is absolutely essential.

2. A septic joint can be extremely difficult to diagnose. Very careful attention must be paid to the physical exam, especially when there is a concern about a septic hip. Be sure to look in the diaper area in ANY fussy infant and range the hips during the physical exam.

3. Plain radiographs are very useful in the diagnosis of any child in which either a septic joint or osteomyelitis is a possibility. While it takes time for changes to develop, other causes of pain (fractures, masses, for example) can be picked up.

4. MRI is the gold standard for the evaluation of a septic joint. Other modalities include ultrasound to look for effusions, bone scan to look for increased isotope uptake, and CT.

5. Adjunct laboratory tests include CBC, Blood Culture, ESR, CRP, and CK. However, normal values does NOT eliminate a septic joint.

6. If a septic joint is suspected, immediate consultation with Pediatric Orthopedic Surgery is required for joint aspiration, usually in the Operating Room. Remember, TIME IS JOINT!

7. Antibiotic coverage should include Staph and Strep; in infants Group B Strep and E coli are common. In adolescents, N gonorrhea should be a consideration. Sickle cell patients should have Salmonella coverage.

**REFERENCES**


