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: PART I: Back pain in children!
This is a symptom that is becoming more and more commonly seen in the Pediatric world (backpacks, etc) Most children have a sprain, contusion, or other benign entity, but, unfortunately, there are times when the etiology is not so benign.

Our case this November is is child who has had several evaluations for back pain and limping until the diagnosis is made. It also highlights that, sometimes, history can be misleading.......
Case History:

A 2 year old male child, typically very active, is not as active these days. It seems that he has been complaining of limping for the past two weeks. Apparently, he was riding in the stroller when he tried to wiggle his way out. He did so successfully, but in the process the somehow may have injured his foot. He was evaluated by an Urgent Care facility and, during the exam, it was difficult to tell if the pain was confined to the foot, or the leg, as when the child was allowed to walk, he did so with a limp, favoring the left leg/foot. There was also no evidence of erythema, edema, ecchymoses, or abrasion. He has good range of motion of the ankle, knee, and hip joints. Films were obtained which demonstrated no obvious abnormality (mom’s not sure what was imaged). He was diagnosed with a probable contusion, and his mother was advised to give Ibuprofen as needed for pain. He was also placed in a splint, as a growth plate fracture could not be excluded, and, since he was in pain, for comfort purposes as well. Followup with his Pediatrician was advised.

He followed up with his Pediatrician. At that time, the splint was removed (his mother thought he had been feeling better), and he was re-examined. During this exam, he was noted to continue to limp. Films were again obtained, which looked normal (again, mom was not sure what was imaged). His mother told the Pediatrician that she did not feel that the splint was helpful, so it was left off. Very careful observation and followup were ordered, with instructions to return immediately for any persistent or new symptoms.

During that week, he continued to limp and began to complain of back pain. The child was brought several more times for evaluation with his Pediatrician. Several days after his last visit, he began to refuse to ambulate at all. He was then referred to the Pediatric Emergency Department for evaluation.

On his evaluation in the ED, he appears uncomfortable. His vitals look normal and he is not (nor has been) febrile. His mother also reports that he has been “fussy” for the past few days, and not really himself. He indicates that his back hurts, which his mother has attributed to the child “suddenly throwing himself backwards” around a month ago while being held by his father, although he didn’t fall. His exam is remarkable for his refusing to stand and, when, well, forced to walk, he seems unsteady on his legs, limping a bit. He does not have any erythema, tenderness, or edema of his back, extremities or joints. Being a good clinician, you test his reflexes and strength of his extremities and they seem weaker in his lower extremities bilaterally.

Wow. Lots to consider here. Why won’t he walk? When he does, why does he seem so unsteady on his legs? Is it due to pain? If so, what is causing his discomfort? He’s had several imaging tests already...they failed to show an apparent cause of his symptoms. Does he need new images? If so, as we always ask, which tests would be appropriate for this patient?

Limping, Back Pain, Leg Pain: Clinician Pain

Children who are limping and/or complaining of, or indicating, pain either in the back or legs have a broad differential. One good rule of thumb is not to dismiss these symptoms without considering more serious conditions. It is true that most of these symptoms can be attributed to strains, contusions, activity-related musculoskeletal etiologies. But back pain, especially in young children, or pain without a preceding trauma history, is especially concerning and should be investigated. Persistent pain, or the presence of neurologic symptoms, should be investigated even more carefully.
John F. Kennedy was assassinated in November 1963, some 52 years ago. While the youngest person ever elected president, he was not the youngest president; Theodore Roosevelt was, who became president after William McKinley was assassinated in September of 1901.

Three towns in the U.S. take their name from the traditional Thanksgiving bird, including Turkey, Texas (pop. 465); Turkey Creek, Louisiana (pop. 363); and Turkey, North Carolina (pop. 270).

OK, the differential here is enormous, and there are certainly concerning physical examination findings, notably refusal to walk, probable persistent pain (including back pain), and now weakness on physical examination. One could obtain pelvis/femur/tib-fib films (which were likely done this past week) or image the back, which the mother states emphatically was not yet done. Of greater concern is the weakness on physical examination that is new, or at least was never noticed.

Back Pain Differential To Consider

Acute Causes
- Muscle injury
- Herniated discs
- Fractures
- Discitis
- Osteomyelitis
- Epidural Abscess
- Spondyloarthropathies
- Urinary causes (stone, UTI, Pyelo)

Chronic Causes
- Inflammatory Disorders
- Developmental (scoliosis, etc)
- Chronic Osteomyelitis
- Abscess
- Discitis
- Spondyloarthropathies

Limping Differential To Consider

Acute Causes
- Fractures
- Contusions
- Sprains/Strains
- Discitis
- Osteomyelitis
- Myositis
- HSP

Chronic Causes
- Legg Calve Perthes Disease
- SCFE
- Joint Infections
- Osteomyelitis
- Myositis
- Inflammatory Arthropaties

Back pathology may present with limping, especially early in a disease course!

BEWARE OF:
1. Night time pain
2. Fever
3. Pain in younger children
4. Pain without history of trauma
5. Weight loss
6. Weakness or numbness
7. Incontinence

The easiest place to begin is at the beginning! You were able to contact both the Urgent Care and Pediatrician and discover that films of the pelvis, femur, tib-fib, ankle, and foot were all done and were all normal. So, you decide to image the back. Plain films are a good first step, but, admittedly, with the presence of bilateral leg weakness and decreased reflexes, more sophisticated studies may be needed.

Plain views of the lumbar-sacral spine are obtained. Looking at the films, there really is nothing remarkable here. The vertebral bodies are symmetric, the spinous processes appear normal; there is no evidence of fracture, spondyloysis, mass, cortex irregularities to suggest osteo, and the disc spaces look normal and symmetric as well. Now what?
November 30, 1835... Mark Twain's Birthday. Born Samuel Langhorne Clemens, he grew up in Hannibal, Missouri. He is arguably one of the greatest American humorist and author, if not one of the most colorful. His birth coincided with a visit by Halley's Comet and he famously said he “would go out with it too”. He did, dying one day before the comet returned in 1910.

According to the Guinness Book of World Records, the largest pumpkin pie ever baked weighed 2,020 pounds and measured just over 12 feet long. It was baked on October 8, 2005 by the New Bremen Giant Pumpkin Growers in Ohio.
Here are selected MRI images for this patient. Needless to say, they are very concerning. The first noticeable finding is that T9 is compressed and abnormal compared to the other vertebrae (yellow arrow). Additionally, there is edema surrounding that vertebra, even extending to the cord space (purple arrow). Most concerning of all, however, is the presence of a mass (red arrow) causing all of the trouble. The MRI images of the cervical spine were normal.

OK, we have a probable cause of this child’s symptoms. Next steps?

This child needs admission to the hospital and further imaging. The working diagnosis includes, at this point, neuroblastoma, sarcomatous lesions, and other neuroblastic tumors. MRI scanning of his brain and chest are performed, in addition to laboratory testing.

This child was admitted to the Pediatric Intensive Care Unit after consultation with the Pediatric Intensivist, as well as Pediatric Hematology-Oncology, and Pediatric Neurosurgery. He underwent an MRI of the brain, of which selected images are seen here. The most notable finding is the presence of a mildly enhancing mass, seen in the posterior region of the right temporal lobe (blue arrow). There were also two smaller lesions in the right occipital and right frontal lobe. All of these lesions were thought to represent metastasis. An MRI of his chest was also obtained.

Tony Sarg, a children’s book illustrator and puppeteer, designed the first giant hot air balloons for the Macy’s Thanksgiving Day Parade in 1927. He later created the elaborate mechanically animated window displays that grace the façade of the New York store from Thanksgiving to Christmas.
Snoopy has appeared as a giant balloon in the Macy’s Thanksgiving Day Parade more times than any other character in history. As the Flying Ace, Snoopy made his sixth appearance in the 2006 parade.

Here are selected images from the chest MRI study which demonstrate a large (9.4 x 5.4 x 9.6 cm) anterior mediastinal mass (red arrow). This large mass actually was displacing the esophagus posteriorly (yellow arrow) as well as displacing the thoracic trachea posteriorly (purple arrow). The mass is lobulated (green arrow) and heterogeneous, with enhancing septations (orange arrow). Internal organs (liver, heart, spleen, kidneys) are all normal. What could this mass be? While the differential is pondered, the child develops incontinence and flaccid paralysis of his bilateral lower extremities. He is immediately taken by Pediatric Neurosurgery for laminectomy and debulking of the mass, along with decompression of the spinal cord.

Recognize this diagram to the left? You should. In March (2015) we presented a case of a child with an mediastinal chest mass that was determined to be posterior in location and was diagnosed with a Ewing Sarcoma; there is a thorough review of chest masses in that issue.

Anterior mediastinal masses can often look like cardiomegaly on plain radiographs. To help determine if this is a mass or cardiomegaly, chest CT is often a first line study. Chest MRI is also a good test, but CT is better at differentiating lung parenchyma than MRI.

**Cardiothoracic Ratio**

Ratio of:
- **Maximal Horizontal Cardiac Diameter**
- **Maximal Horizontal Thoracic Diameter (Inner Edge of Ribs / Edge of Pleura)**

A normal measurement should be less than 0.5.
IN ADDITION TO TUMOR DEBULKING, IV Decadron was started before surgery (and continued thereafter): this helps to reduce inflammation and edema caused by tumor compression. The child had bone marrow studies and Immunostain testing done. The pathology determined that the mass was a Stage IV Metastatic Yolk Sac Tumor. Thankfully, the bone marrow and blood pathology tests were negative. His Immunostaining tests were positive for AE1/AE3, AFP, Vimentin, and S100. He also underwent and abdominal CT scan and was found not to have additional organ involvement.

Yolk sac tumors typically involve the testes/ovaries, but can occur in other locations (mediastinum), and are a type of germ cell tumor. Pure yolk sac tumors are the most common in children. It is theorized that hypermethylation of the RUNX3 gene promoter, which is involved in the differentiation of the yolk sac endoderm. These tumors often present as painless testicular masses and metastasis is uncommon.

On imaging, these tumors are heterogeneous. They are composed of cells that resemble embryonal structures. They are positive for AFP, and, in some patients, Vimentin. Remember, though, AFP can be positive in a variety of tumors.

These tumors are highly aggressive, but with treatment the survival rate is quite good.

Case Resolution

After tumor debulking and decompression of the spinal cord, this child continued his stay in the Pediatric Intensive Care Unit for some time. Pediatric Hematology–Oncology was consulted, and, based on tumor pathology results, including genetic markers, he began chemotherapy with Etoposide, Aprepitant, and Cisplatin. After debulking he continued to have lower extremity flaccid paralysis; Pediatric Rehabilitation medicine was consulted in addition to Pediatric Urology, as the child developed neurogenic bladder. He was transferred out of the PICU to the Oncology floor and remains in treatment.

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Teaching Points:

1. Beware of back pain in children, particularly young children or when there is a lack of a history of trauma.
2. Physical examination findings that are especially concerning are persistent or worsening pain, fever, or any neurological signs, such as weakness, incontinence, or numbness.
3. The differential diagnosis of back pain and limping is broad. History is key when evaluating these patients.
4. Plain radiographs are a reasonable way to being a radiological evaluation of a patient with back pain. Often, obtaining images above and below where the suspected pain is at is suggested, as referred pain can cloud the clinical picture.
5. Limping children also should be approached with caution; often the pathology may be in the back or hip and not just the lower extremities. (more on this in Part II of this series!)
6. Basic laboratory investigation (CBC, ESR< CRP, CK) is a good, but not definitive, adjunct to the evaluation of a child with back pain. Normal labs, however, do not completely eliminate pathology and must be used in the clinical context of the child.

REFERENCES