These cases have been removed of identifying information. These cases are intended for peer review and educational purposes only.

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 to check out Pediatric Emergency Medicine Fellowship Radiology rounds, which are 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: Lower extremity injuries in pediatrics. These common injuries are generally pretty easy to manage, if you remember some important points. Imaging for these children can yield impressive results! How impressive? Well, read on and enjoy this month’s spotlight on lower extremity trauma in children and enjoy some 4th of July trivia along the way!
Case Histories

Case 1 - Summer has arrived in the Pediatric Emergency Department and, rather than the traditional slow down, you’ve seen quite the opposite. What is not unusual, though, is the injuries that you have been seeing; lots of falls, scrapes, fractures. The next chart is no exception.

You see that the next patient you are to evaluate is a 6 year old boy who was riding on a four wheeler with his cousin. Sounds like fun. The child then jumped off the vehicle and landed on his feet. His parents state that he really landed directly on his right foot, before he placed his left foot on the ground. He seemed uninjured, but for the past few hours he has been complaining of right foot pain. He has no other apparent injuries and in fact, has been walking on the foot with some mild pain.

His exam reveals a very active child who has normal viral signs for his age. Given the mechanism of the injury, you perform a very careful physical examination. You note that he does not have any neck or back pain and he does not appear to have any head injury. You note that his chest and abdomen are nontender. His hips are stable and his extremities are all without tenderness, edema or deformity, util you examine his right foot. He has specific tenderness over the anterior portion of the base of the ankle/top of the foot. He is neurovascularly intact. The joint is stable. This child seems to have an unimpressive exam, other than the specific tenderness at the base of the ankle. What to image? Plain films?

Case 2 - As you ponder the previous case, you are called to another room in the ED. EMS has brought in a patient with an obvious right leg deformity. The patient is a 14 year old, who was attempting to perform a dive. He jumped up on the diving board and, somehow, came down and injured the leg on the board itself. EMS, the family, and the patient are very clear that the child did not sustain in the injury in the pool and in fact, didn’t even make it into the pool. His vitals are normal for his age. He has an IV placed by EMS, who also have given the child a dose of Fentanyl. His pain seems well-controlled for the time being, so you examine the patient. He has no head, neck, back, chest, or abdominal tenderness or injury. His pelvis is stable. His exam is remarkable for an obvious deformity to the mid portion of his left lower leg. There is also skin dimpling present, but no bleeding or obvious laceration. he is neurovascularly intact. You know this patient needs imaging, but what about the skin dimpling? Is this considered an open fracture? If so, what antibiotics are needed?

Case 3 - The last patient in our trifecta is a 15 year old patient who was riding his bike and fell off when he attempted to jump a curve. He also has only one complaint: his left foot hurts. You examine him and find edema and tenderness to the dorsal aspect of his left foot.
Pediatric Foot Injuries: Imaging

A good first step (yes, pun intended) in imaging pediatric foot injuries is to understand that good radiographic technique is key. Weight bearing anteroposterior and lateral views should be obtained in those with presumed closed growth plates (ie older children). If a child can't bear weight, because of developmental stage (ie infants) or injury, then weight bearing can be simulated. The anteroposterior view is accomplished with the cild standing and the tibia perpendicular to the plane of the film. Ideally, the lateral view should also be obtained standing. In non ambulatory patients, plantar pressure can be applied to simulate weight bearing.

Infant weight bearing imaging technique. The technician is applying pressure to the foot to simulate a weight bearing image.

Here are imaging techniques for non weight bearing patients. On the left we see an anteroposterior (AP) view; the beam is angled 15 degrees and aimed at the third metatarsal. The middle image shows a lateral view; the beam here is aimed at the fifth metatarsal. The last image on the upper right shows an oblique view. This view is used to image the toes, metatarsals and tarsals that are anterior to the ankle. It is not a view that is commonly used in pediatric patients. Most of the time a 2 view series is obtained (AP and Lateral).

Here are some examples of a normal foot series: AP, lateral and oblique.

This lateral view shows an os trigonum, which is a boney ossicle of the foot that usually forms between 7-13 years of age; it is a failure of fusion of the lateral tubercle of the posterior process and can be mistaken for a fracture.
Pediatric Tibia-Fibula Injuries: Imaging

Plain radiographs are the imaging test of choice of potential leg fractures in pediatric patients. AP and lateral views are standard imaging views. Don’t forget to consider knee and/or ankle imaging if clinically appropriate.

Oblique or transverse fractures are more apt to be open and are higher risk injuries, especially for compartment syndrome.

Toddler’s Fractures may be subtle. Sometimes a bone scan is needed to detect them.

Bowing fractures may have minimal edema or tenderness but are easily seen on plain imaging. Torus (buckel) fractures are also usually seen easily.

Pediatric Ankle Injuries: Imaging

Pediatric ankle injuries can be imaged with three important views: Anteroposterior, lateral, and the mortise view. In some patients, an oblique view is obtained instead of the mortise if the joint is stable. In older patients (those with close growth plates) weight bearing imaging is preferred but not necessary in most pediatric patients.

Which patients require imaging has been a matter of debate. The Ottawa Ankle rules were developed to predict the presence of a fracture in patients with ankle injury. They have been validated in adults and in children above the age of 6 years.

The images to the right show AP, lateral, and oblique views of a normal ankle.

Ottowa Ankle Rules:

- There is any pain in the malleolar zone; and,
- Any one of the following:
  - Bone tenderness along the distal 6 cm of the posterior edge of the tibia or tip of the medial malleolus, OR
  - Bone tenderness along the distal 6 cm of the posterior edge of the fibula or tip of the lateral malleolus, OR
  - An inability to bear weight both immediately and in the emergency department for four steps.

The rules also recommend a foot series if:

- There is any pain in the midfoot zone; and,
- Any one of the following:
  - Bone tenderness at the base of the fifth metatarsal (for foot injuries), OR
  - Bone tenderness at the navicular bone (for foot injuries), OR
  - An inability to bear weight both immediately and in the emergency department for four steps.

Positioning techniques for obtaining AP, Lateral, and Mortise views of the ankle.

Ossification Centers of the Tibia, Fibula, Foot
Case 1:

Well, given the child’s exam, you opt to obtain plain imaging of the ankle. The views you order are AP, lateral and oblique, since the joint seemed stable. The images are seen on the above. The AP view looks pretty good, but on the oblique view there is an irregularity of the talus; this is confirmed on the lateral, which demonstrates a tarsus fracture that is anatomically aligned (blue arrow).

Talus Fractures

Talus fractures are not common in children. Most of the time, the mechanism of injury involves a direct impact to the dorsal aspect of the foot, but twisting mechanisms have been described.

Blood is supplied to the talus by the posterior tibial, anterior tibial, and perineal arteries. There are 2 components to the bone: the head, neck, and body.

Treatment usually is conservative, with casting and close observation. Occasionally, surgery may be required. Avascular necrosis of the bone is a complication, and these fractures can be difficult to identify.
Case 2:

Well, the obvious deformity prompted you to obtain a 2 view tibia/fibula xray, after you administered pain medication (Fentanyl). The other issue with this child is the dimpling of the skin where the fracture site is. You explored this very carefully and found that there is no puncture wound and the fracture, therefore, does not appear to be open. This will need to be reduced, though.

The films for this patient are noted above. It’s obvious that he has two fractures, which can be described as an acute, oblique fracture of mid tibial shaft, with mild anterior displacement and mild posterolateral angulation of distal portion (red arrow). There is also an acute, transverse, fracture of mid fibular shaft with mild proximal migration, moderate medial displacement, and mild posterolateral angulation of distal portion (blue arrow). Time to speak to Pediatric Orthopedics!

To the right is an example of a toddler’s fracture (blue arrow).

By the way, here is the patient’s reduced skin dimpling:

Tibia and Fibula Fractures

Most occur in the diaphysis and about 1/3 of tibia fractures are associated with fibula fractures. They are the 3rd most common fractures in children. Injury mechanisms vary, but rotation injuries often cause toddler’s fractures, transverse fractures are associated with higher risk mechanisms, bowing fractures are caused by microfractures along the cortex and may be subtle as well. Treatment usually is closed reduction and casting. If there is an open fracture, or if there is significant angulation, operative treatment is needed.
Case 3:

So you decide to obtain a complete foot series of images since the patient has obvious edema and tenderness of the dorsum of the foot. The good news is that the child’s ankle was stable and nontender, so you felt that ankle imaging was not indicated. The results of the foot series are shown below.

Notice anything amiss in this series of plain radiographs? Yep, there are a few fractures here. One can see fractures of the second, third, fourth, and fifth metatarsals (red arrow). Ouch!

Notice that, depending on the view, some fractures are a lot more easily seen than others. This is why multiple views are advantageous. The second metatarsal fracture is easily seen on both AP and oblique views, but the other fractures are harder to see. For example, the fifth and fourth fractures are much more easily seen on the oblique view. Why the lateral view? Well, this view shows you the lateral cuneiform, navicular, and cuboid bones.

Treatment of metatarsal fractures are generally treated with a padded dressing combined with a soft cast shoe, a posterior leg splint, or a walking boot. Weight bearing is as tolerated for most patients. A single displaced fracture usually heal well on their own. If there is more than 4 mm displacement in a dorsal or plantar direction, or if there is angulation of more than 10 degrees, then reduction is usually performed. Fifth metatarsal fractures are differently treated (see below).
Lisfranc Fracture-Dislocation: most common type of dislocation involving the foot. The Lisfranc joint is the articulation of the tarsus with the metatarsal bones; the Lisfranc ligament attached the medial cuneiform with the 2nd metatarsal. A direct blow to the foot usually causes this injury. There are three types:

1. Homolateral - lateral displacement of the 1st - 5th metatarsals but the 1st MTP joint remains intact.
2. Divergent - lateral dislocation of the 2nd - 5th metatarsals with medial dislocation of the 1st metatarsal
3. Isolated - less than 2 metatarsals with dorsal dislocation.

Treatment is surgical reduction and fixation.

Jones Fracture: The image to the left shows a Jones fracture, which is a fracture at the base of the 5th metatarsal. A typical mechanism is adduction force with the ankle in plantar flexion. They are very prone to nonunion and take a significant amount of time to heal. Treatment is often fixation and, sometimes, bone grafting.

Sir Robert Jones
A Welsh orthopedic surgeon who established orthopedic surgery in Britain with Alfred tubby in 1888.

These selected images to the immediate right show a navicular fracture. These fractures are typically due to high mechanism injuries. They are important to treat properly because the navicular bone is important for its role in ligamentous attachments, axial load bearing, and planar arch support.
Case Resolutions

Case 1 - Pediatric Orthopedics was consulted for this child and a CT scan was recommended. This was done, which confirmed the fracture and also confirmed that the injury was not in the joint space. The child was splinted and followed up the Pediatric Orthopedic clinic.

Case 2 - The child was sedated with Ketamine in the ED and the skin dimpling was reduced easily. His NPO status did not allow the child to go immediately to the OR, so the extremity was splinted. He then underwent surgical reduction with IM nailing in the OR by the Pediatric Orthopedic team.

Case 3 - This unfortunate patient was splinted and followed up with Pediatric Orthopedics. He has sworn off bike tricks! On the bright side, he loved having his friends sign his cast and he did get some street cred!

Teaching Points

1. Fractures of the lower extremity are common in pediatrics. Accidental trauma is the usual mechanism, but don't forget non accidental trauma, especially in non ambulatory children or in patients where the history does not make sense.
2. Plain radiography is the modality of choice for the majority of lower extremity injuries. AP, Lateral, and Oblique views are the most common obtained.
3. Conduct a complete physical exam! Sometimes, there are other associated injuries with lower extremity fractures, especially in children with high risk histories (such as MVC's, or falls from greater than 10 feet).
4. Most fractures can be treated with splinting/casting; in some cases closed reduction followed by casting or pinning may be needed.
5. Don't forget the neuromuscular exam, as there may be associated injury to important blood vessel and nerve structures.
6. When in doubt about management, contact your local Pediatric Orthopedic specialist or Pediatric Emergency Department; they are there to help!

References


Have a Safe and Happy Fourth of July Holiday!