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AMIC EDUCATIONAL NEWSLETTER

OUTSIDE SUMMER ACTIVITIES 7/1/2016 Volume 2, Issue 2

OUTSIDE SUMMER ACTIVITIES

Swimming Pool Injuries

By Kenneth Cicuto, MD

There is nothing better than cooling down after fun in the Colorado sun. Pools provide joy, exercise and relaxation, but, unfortunately, they are not without risk if not used properly. Out of all the injuries associated with pools, drowning carries the highest morbidity and morality

Statistics:

From 2005-2014, there was an average of 10 deaths per day related to water use; that's an average of 3,536 fatal unintentional drownings annually in the United States. About 20% of all drownings are children 14 years or younger. For every childhood death due to drowning, there are 5 times the amount of emergency visit for non-fatal submersion injuries. One half of all patients who present to an ER with a submersion injury require hospitalization/ escalation of care.

Nearly 80% of drowning victims are male. Child aged 1-4 have the highest drowning rates and among all unintentional deaths at this age, 33% percent are from drowning. *The vast majority of childhood drownings occur at a home swimming pool.*

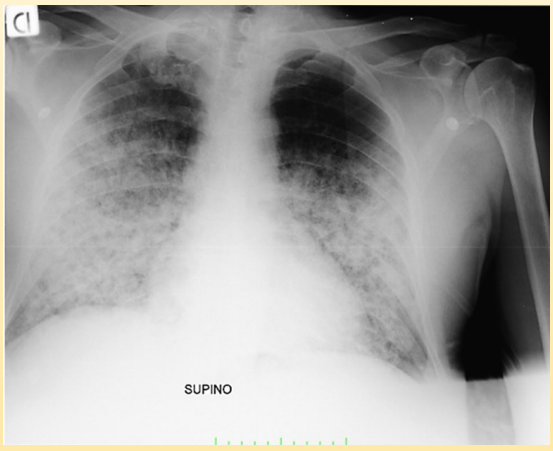


Figure 1:

Drowning/ near drowning is a type of non-cardiogenic pulmonary edema that causes lung damage with subsequent ventilation perfusion mismatching. This is typically classified into 3 categories:

Stage I: laryngospasm that occurs after inhalation of a small amount of water

Stage II: victim still usually presents with laryngospasm but may begin to swallow water into the stomach

Stage III:

a. **10-15% of patients still present with dry drowning caused by persistence of the associated laryngospasm**
b. **In the remaining 85-90% of patients, the laryngospasm relaxes secondary to hypoxia and large amounts of water are aspirated**

Radiographic findings:

Near drowning episode has a similar appear to most non-cardiogenic pulmonary edema. In mild near drowning, findings range from normal to confluent fluffy perihilar opacities with peripheral sparing. The more volume of aspirated water, the more coalescent the alveolar opacities become. Depending on the water source, there can be superimposed pneumonia with different bacteria, fungi or mycobacterium. Figure 1.

Swimming Pool Injuries Continued...

In response to the pulmonary insult, the patient can develop acute respiratory distress syndrome (ARDS) with increased vascular permeability increased alveolar fluid and subsequent end airway collapse. The response can be a combination of the hypoxia, cellular damage from water/debris or chemical insult from aspirated gastric contents. The alveolar opacities do not respond to diuretics and as the pathology clears can leave the lungs with a reticular pattern secondary to type 2 pneumocyte proliferation and fibrosis. Figure 2

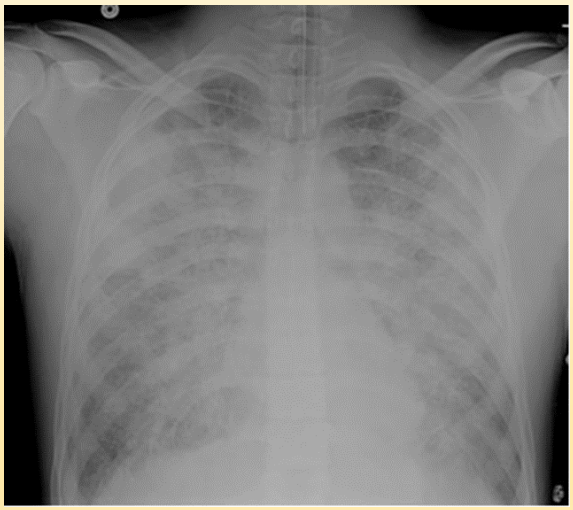


Figure 2:

Unfortunately, the lungs are not the only important organ damaged during near drowning episodes. Adequate oxygen is vital for the brain. Anoxic brain injury (cerebral hypoxia or hypoxic-anoxic injury) is a serious, life-threatening injury that can cause long term cognitive issues, physical disability or death. In simple terms, greater the loss of oxygen, the more wide-spread and serious the injury will be.

Clinically, cognitive issues from anoxia include short term memory loss, word finding/ processing (anomia), visual disturbances, and performance of executive functions such as reasoning, judgement and concentration.

Physical disabilities include lack of coordination (ataxia), headache, difficulty in completing activities of daily living (apraxia), personality changes, and movement disorders such as rigidity and muscle spasms.

Injury pattern is variable on severity, length of anoxia and maturity of the brain.

Imaging:

In reference to the pediatric population, certain differences exist between the patterns of injury observed in neonates and those seen in older infants; these differences are probably related to rapid brain maturation during the perinatal period. As myelination nears completion by about 2 years of age, injuries similar to the pattern seen in adults begin to appear. MRI is the first modality to demonstrate changes and is most indicative of the severity of injury within 24 hours.

Perinatal -1

Demonstrate features of both birth asphyxia and later infantile asphyxia, with involvement of the basal ganglia (predominantly posteriorly), lateral thalami, and dorsal midbrain, as well as cortical injury.

Figure 3.

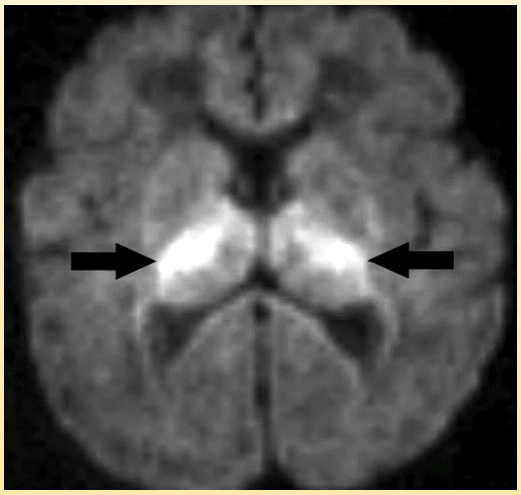


Figure 3: Severe neonatal HII in a 2-day-old term infant who suffered severe birth asphyxia. Diffusion-weighted MR images show increased signal intensity in the ventrolateral thalami

Swimming Pool Injuries Continued...

Figure 4: Unenhanced head CT scan shows bilateral cortical and subcortical hypoattenuation in the parasagittal watershed regions. show increased signal intensity in the ventrolateral thalami

Age 2-Adult

1. Mild to moderate injury demonstrates a watershed distribution Figure 4.
2. Severe injury manifest with the deep gray matter structures such as the basal ganglia, thalami, cortex, cerebellum and hippocampi. There is cerebral edema with effacement of the normal gray-white differentiation, decreased BG attenuation and the "white cerebellar" sign (figures 5)

References:

1. Benjamin Y. Huang; Mauricio Castillo; *RadioGraphics* **2008,** 28, 417-439. DOI: 10.1148/rg.282075066
2. http://www.cdc.gov/healthywater/swimming

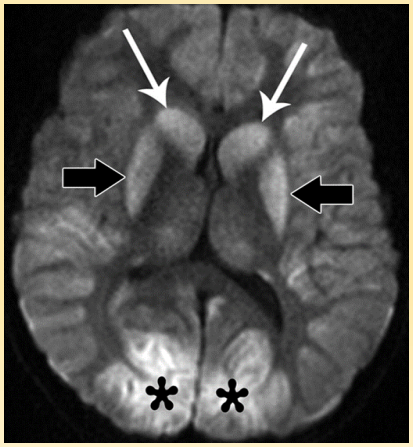
What can I do as a parent to decrease drowning risk???

As with most things in life, the simple answers are usually the right ones. Start with close supervision, an exclusion fence and the avoidance of drugs or alcohol. The combination of alcohol with sun exposure, heat, and dehydration is no friend to your balance, coordination and decision making skills. Alcohol use is involved in up to 70% of deaths associated with water recreation, almost a quarter of ED visits for drowning, and about 20% reported boating deaths. Parents can designate one adult as a rotating supervisor and encourage your kids to always swim with a buddy. Remember to pick up toys, floats, etc. which could act as a tripping hazard adjacent the pool. From a formal perspective, research demonstrates that formal swimming lessons do decrease the risk of childhood drowning, so teach those little ones to swim and teach them early. Parents are encouraged to know and stay updated on their CPR training. Pools are fantastic summer recreation for the family. Stay cool, have fun, be safe.

Dr. Kenneth Cicuto

Figure 5: The cerebellum appears slightly hyperattenuating relative to the rest of the brain. This finding is another example of the white cerebellum sign as an early CT indicator of HII.

MR images obtained 4 days after HII show high signal intensity with corresponding abnormalities in the caudate nuclei (white arrows), lentiform nuclei (black arrows), and occipital lobes.



Bicycle Imaging

By Michael Rogan, MD

The combination of nice weather in the summer, and mountain terrain makes bicycling a very popular hobby in the Fort Collins and Loveland and Greeley area. As part of the imaging team at the area hospitals, it is helpful to review how common bicycle injuries are, what types of injuries occur, and what imaging demonstrates to help the area physicians get accurate diagnosis of the injuries.

Table 1: Overuse injuries

Neck and Back	Cervical straining, back pain
Hand	Ulnar and median nerve neuropathies
Pelvis	Saddle irritation, skin chafing, ulceration
Hip	Trochanteric Bursitis
Knee	Patellofemoral syndrome
Foot and Ankle	Metatarsalgia, plantar fasciitis

Worldwide, cycling accounts for the highest number of sports-related pathologies (3). Bicycle riding has been increasing over the last few years. Hospital admissions because of bike injuries has more than doubled between 1998 and 2013 (1). A report in the journal Morbidity and Mortality Weekly Report found that death rate among child cyclists has plummeted in the past 4 decades, but the mortality among cyclists ages 35 – 54 has tripled (1). Bicycle- related injuries account for 900 deaths, 23,000 hospital admissions, and more than 580,000 emergency department visit each year (2).

There are 2 broad categories that bicycle injuries can be placed into: overuse injuries and traumatic injuries. Overuse injuries most frequently affect the knee, and trauma most frequently affects the shoulder (3). The most common injuries are listed in table 1 and table 2.

A frequent repetitive injury with professional cyclists is iliotibial band syndrome. The band symptom, pain, is caused by excessive friction of the distal iliotibial band as it slides over the lateral femoral epicondyle, resulting in bursitis. The pain occurs about 2 cm above the joint line. (Figure 1).

Table 2: Traumatic Injuries

Head	Skull fractures, intracranial hemorrhage
Face/Eye	Facial fractures, dental fracture, corneal abrasion
MSK	Fractures, dislocation, strains
Chest	Rib fracture, lung injury
Abdomen	Splenic/Liver/Kidney/ Pancreas laceration
Genitourinary	Urethral or vulvar injury
Skin	Abrasions

Plantar Neuropathies have been described by a burning sensation in the sole of the foot. They are related to compression of the interdigital nerve between the toe clips and the pedal. Morton's neuroma (which is in fact not a tumor but consists of perineural thickening) may also be present, principally in the second and third intermetatarsal spaces. (Fig 2).

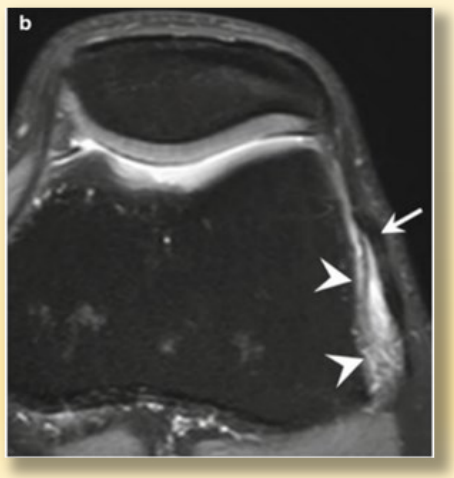


Figure 1: MRI demonstrating iliotibial band syndrome. Edema (arrowhead) shown between the iliotibial band (arrow) and the femur.

Bicycle Imaging Continued...

Figure 3: Clavicle fracture in a professional

Clavicle fractures are frequent injuries in professional cyclists. (Fig 3).

Patellar tendinopathy affects the proximal part of the patellar tendon. It is often referred to "jumpers knee"

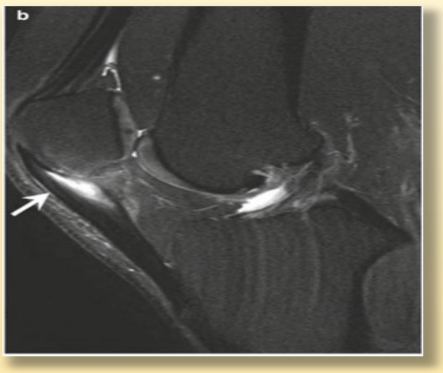


Figure 4: Sagittal fat suppressed image demonstrates hyperintensity signal at the proximal patellar tendon (arrow)

and is caused by repetitive contraction of the quadriceps. (Fig 4) Traumatic injuries to the abdomen can occur after the cyclist slides forward and hits the handlebars. Children who ride on BMX bikes can have this occur. In the following example, a 7 y/o boy fell onto his handlebars while riding his BMX bike and had persistent abdominal pain. (Fig 5).

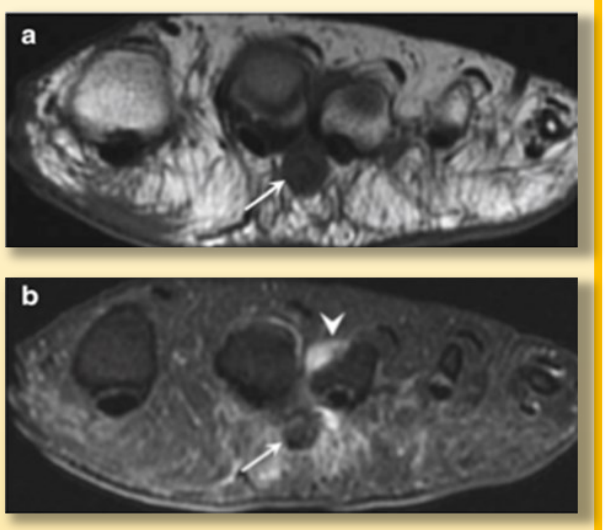


Figure 2: Axial T1 and fat-suppressed contrast-enhanced T1 MRI of the foot show Morton's neuroma in the second intercapitometatarsal space (arrows) and the satellite bursitis (arrowhead) in a professional cyclist.

As you can see, bicycle injuries can be both traumatic and repetitive in nature. As technologists and physicians on the imaging team in both hospitals and outpatient settings, knowing some of the common injuries and imaging findings can help the clinician accurately diagnose an injury. With the summer and fall months ahead of us in the imaging department, we will probably see an increase in these patients. I hope this article will help you when a cyclist is seen in the radiology department..

Michael Rogan, MD

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3. Guermazi, Ali et al. Imaging in Sports-Specific Musculoskeletal Injuries. Pp 467-493

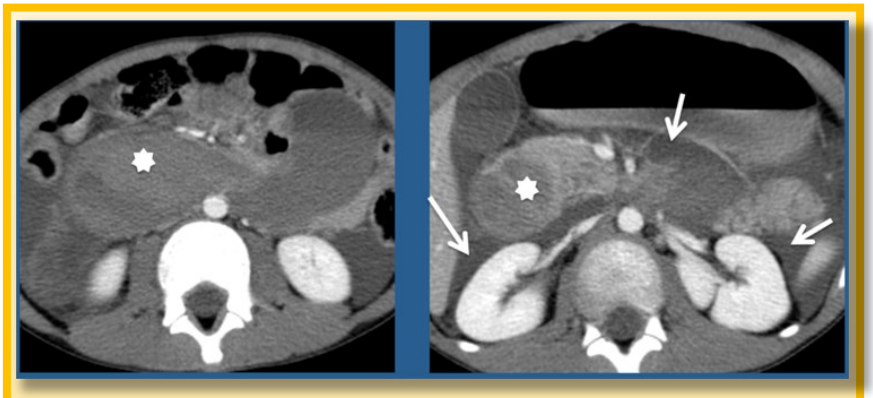

Figure 5: Star demonstrates duodenal hematoma, and arrows show peri-pancreatic fluid and blood in the anterior pararenal space.

West Nile Virus Encephalitis

By Nick Statkus, MD

Wyoming had 8 documented cases of WNV in 2015, 3 with neuroinvasive disease, 5 with non-neuroinvasive disease and 0 deaths.

Nebraska had 68 documented cases of WNV in 2015, 17 with neuroinvasive disease, 51 with non-neuroinvasive disease and 2 deaths.

Colorado had 101 confirmed cases of WNV in 2015. 44 of these cases had uncomplicated fever, 29 cases developed meningitis, and 28 cases developed encephalitis. 2 of the patients who developed neuroinvasive infection died from the infection.

West Nile Virus (WNV) is an arbovirus (virus transmitted by arthropod vector) which is transmitted via mosquito bites. The mosquito infects birds and humans with the bird source being an important pool for infectious spread to humans. The disease can be obtained whenever mosquitos are present in the environment with the majority of cases identified in the summer months of August and September.

There is year to year variability in the incidence of West Nile Virus infection as mosquito populations are influenced by temperature, humidity and rainfall.

Approximately 1 out of 140 patients infected with WNV develop CNS symptoms.

Approximately 80% of infected individuals are asymptomatic. Approximately 20% of patients develop a mild febrile syndrome with fever, headache, lymphadenopathy, arthralgia and occasional GI symptoms. Meningoencephalitis (neuroinvasive infection) occurs in less than 1% with development of alteration in mental status, coma, and seizures.

There is no cure or vaccine for WNV and treatment is supportive.

Laboratory testing for infection includes blood antibody testing and lumbar puncture with CSF analysis for neuroinvasive patients.

Patients with neuroinvasive disease will usually first be imaged with non-contrast head CT which will likely be normal. Brain MR without and with contrast is the imaging modality of choice in those patients with neurologic symptomatology. Patients with less advanced neuroinvasive infection may have a normal brain MR. Those with more severe neuroinvasive infections and those with the worse prognosis will have an abnormal brain MR.

"There is year to year variability in the incidents of West Nile Virus infection as mosquito populations are influence by temperature, humidity and rainfall."

West Nile Virus Encephalitis Continued...

A frequent MR imaging finding in those with severe neuroinvasive infection is symmetric high signal and parenchymal swelling on T2 and FLAIR acquisitions in the bilateral basal ganglia, thalami and brainstem without enhancement (figures 1 and 2). Diffusion restriction may or may not be present. The infection can extend into the supratentorial brain parenchyma as well as into the cerebellum (figure 2).

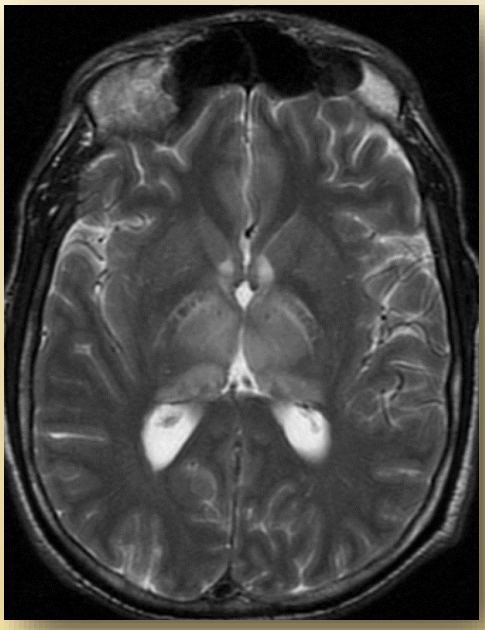

Figure 1: T2 axial image in a confirmed case of West Nile Virus encephalitis shows bilateral high signal/edema and parenchymal swelling in the thalami.

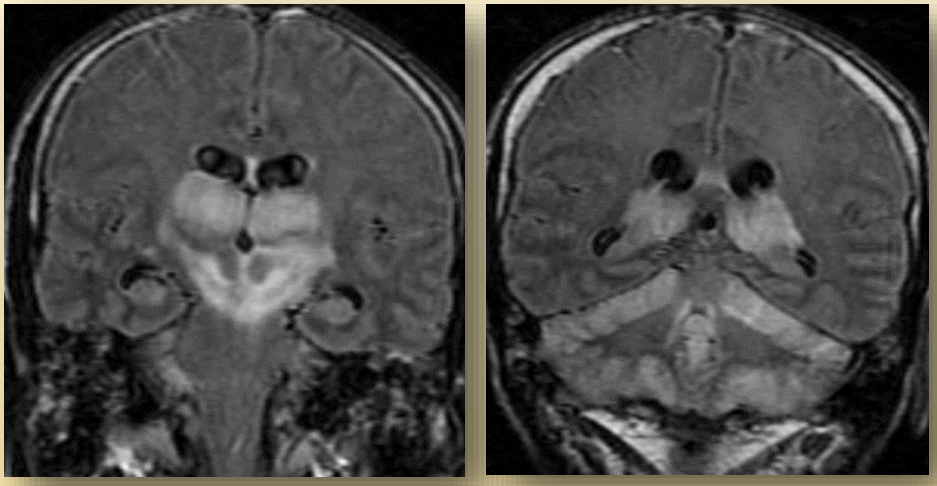

Figure 2: Two coronal FLAIR images from the same patient as figure 1 showing bilateral symmetric high signal/edema and parenchyma swelling in the thalami, within the upper brainstem and within the upper and lower cerebellar cortex. As is usually the case the edema is much more visible on the FLAIR sequence when compared to the T2 acquisition.

Nick Statkus, MD

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2. Centers for Disease Control and Prevention West Nile Virus Disease Cases and Presumptive Viremic Blood Donors by State-United States, 2015 http://www.cdc.gov/westnile/statsmaps/preliminarymapsdata/histatedate.html

3. Nebraska Department of Health & Human Services West Nile Surveillance Program http://dhhs.ne.gov/publichealth/Pages/wnv.aspx

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The Weekend Warrior with Heel Pain

By Jamie S. Colonnello, MD

Many of us are former athletes and as time has passed since high school and college, life at times gets in the way, yet we still feel committed to our sport or activity. Due to various work and family commitments, exercise may take a back seat during the work week. There may be a dramatic change from our weekday activity to our weekend activity. Many of us have become….. weekend warriors.

"As the spring thaw begins and the daytime temperature rises, weekend warriors hit the streets, trails and playing fields with excitement. For many, heel pain may be a new aggravating complaint come Monday morning."

As we age our tendons and ligaments become less flexible. Combine this with the addition of a few extra pounds, sitting behind a desk 40-50 hours per week without a regular exercise routine (1 in 10 Americans exercises regularly), and it is no surprise the "weekend warrior" is prone to sports injuries. The Saturday morning pick-up basketball game, the Sunday tennis match or tackling the big landscaping project on that first warm spring weekend may all be problematic.

Common "weekend warrior" injuries in the upper extremity include rotator cuff injuries, tennis elbow (lateral epicondylitis) golfers elbow (medial epicondylitis) and biceps injuries. Many lower extremity injuries can be seen such as groin (adductor) strains, hamstring strains or runners knee. Below the knee, shin splints, Achilles injuries, ankle sprains and plantar fasciitis are all common injuries.

As the spring thaw begins and the daytime temperature rises, weekend warriors hit the streets, trails and playing fields with excitement. For many, heel pain may be a new aggravating complaint come Monday morning.

Plantar fasciitis is one of the most common causes of plantar heel pain. The plantar fascia is the strong fibrous investing layer of the sole of the foot. It has both a static and dynamic role in arch support and allows the loading capacity on the foot during weight bearing. Typically, symptoms are most severe with the first few steps of the morning or after prolonged sitting/standing. Repetitive stretching and microtears lead to swelling and inflammation. Running/jumping activities with forcible plantar flexion can cause partial tearing or rupture. Typically, treatment is conservative. Anti-inflammatory medications, physical therapy for stretching and strengthening and night splints are common treatment strategies. Newer treatments include injections with platelet rich plasma or stem cells.

Imaging in those with heel pain may begin with plain films of the foot. It is important to note that heel spurs are not the cause of plantar fasciitis if seen on foot images. Heel spurs are found in symptomatic and asymptomatic individuals. In certain patients, like those who don't respond to initial treatment (or elite Broncos quarterbacks), ultrasound or MRI may be ordered. With MRI, the plantar fascia is adequately evaluated with

The Weekend Warrior with Heel Pain Continued...

a routine ankle MRI. The sagittal water sensitive sequence is the most useful sequence demonstrating the plantar fascia longitudinally. With plantar fasciitis, the plantar fascia will be thickened on all sequences with increased T2 signal within the fascia and in the surrounding tissue. Images will demonstrate the presence or absence of tears (partial vs complete) and the presence or absence of reactive marrow edema/swelling in the calcaneus. (Figure 1). The Achilles tendon, the strongest, largest and thickest tendon in the body inserts on the posterior calcaneus. Achilles tendinopathy occurs from a similar mechanism of repeated microtrauma and incomplete healing which leads to posterior heel pain, swelling and stiffness. Injuries to the Achilles tendon have a broad spectrum ranging from peritendinitis to interstitial tears to partial tears to complete rupture. Typically, symptoms are worse in the morning. Runners are commonly affected and describe pain prior to a run which tends to improve during the run but which increases upon completion of the run. As with plantar fasciitis, initial treatment is conservative utilizing rest, ice, and physical therapy. Injections with platelet rich plasma (PRP) and stem cells are other potential therapies/treatments.

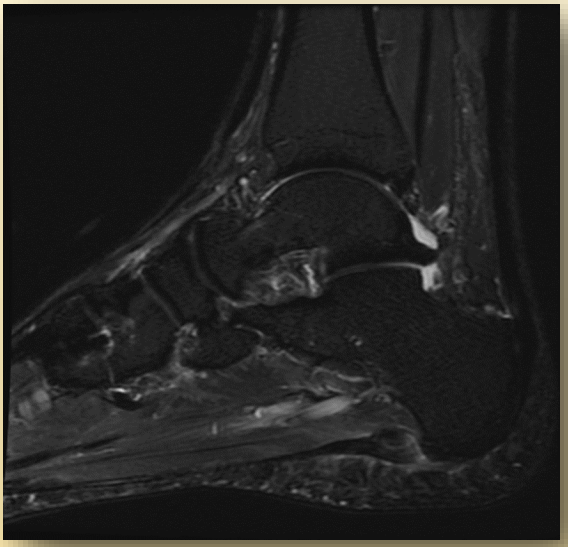


Figure 1:
Acute plantar fasciitis. Sagittal water sensitive sequence with markedly thickened plantar fascia with internal and surrounding bright T2 signal. Plantar fascia is partially torn at the attachment site to the calcaneus.

Imaging of patients with Achilles tendinopathy begin with plain films that could show enthesophyte at the calcaneal insertion. To evaluate the tendon further, ultrasound and MRI are commonly used modalities. Physicians refer patients to MRI many times to evaluate for the extent of tearing and/or rupture. With MRI, the Achilles should be dark on T1 and T2 sequences (Figure 2A, 2B).

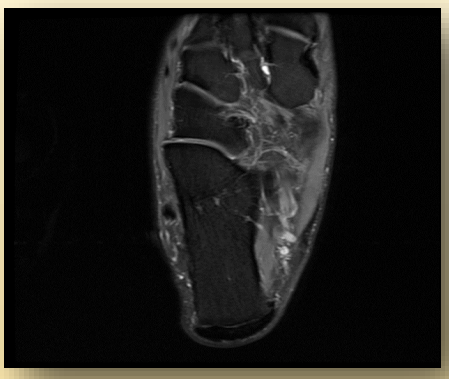


Figure 2A: Normal Achilles insertion on the calcaneus in the short axis.

Figure 2B: Normal Achilles insertion on the calcaneus-sagittal plane. Also, notice the normal plantar fascia origin.

The Weekend Warrior with Heel Pain Continued...

Figure 3A : Achilles tendinopathy short axis with peritendinitis and a fluid filled retrocalcaneal bursa.

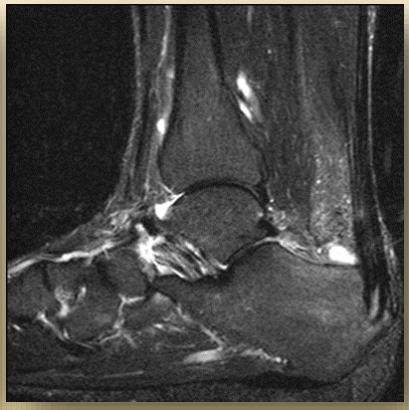


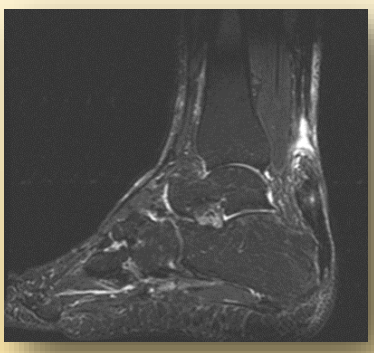
Figure 3B: Achilles tendinopathy sagittal plane with thickening and increased T2 signal.

With tendinopathy, there will varying degrees of tendon thickening with internal and surrounding T2 signal on the water sensitive sequences. (Figure 3A, 3B).

The tendon typically ruptures 2 to 6 cm proximal to the insertion on the calcaneus. A routine ankle MRI should suffice for imaging a ruptured tendon. In the event of a more proximal rupture, the field of view may need to be increased or repositioned to include the proximally retracted/torn edge of the tendon. This adjustment should be made by the technologist while the patient is on the table. Interpreting radiologists can always be contacted with questions.

In conclusion, "weekend warriors" are prone to sports injuries which can effect the upper and lower extremities. These injuries are typically diagnosed with a good history and physical exam and are treated conservatively. The R.I.C.E. principal may be implemented for acute injuries which includes Rest, Ice (10-15min 4 times per day), Compression and Elevation. Some patients may ultimately require imaging. A regular exercise routine including cardiovascular, stretching and weightlifting is the key to preventing weekend warrior injuries. Cross training can prevent over use injuries by adding variety and limiting the use of the same muscle/tendon groups.

Enjoy your weekends!!



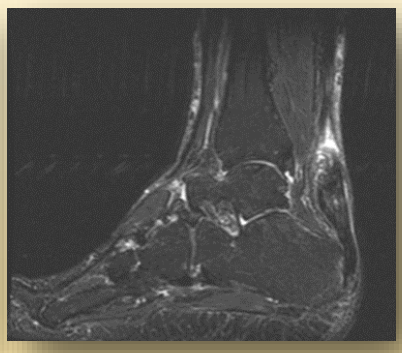


Figure 4: Achilles rupture sagittal plane- discontinuity of fibers with fluid filled cleft.

Jamie Colonnello, MD

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The Role of Interventional Radiology in Trauma

By Amy Hayes, MD

Angiography and transcatheter techniques play an important role in the management of trauma patients. The ability to treat life threatening hemorrhage and vascular injuries can save unstable patients from undergoing emergent surgery.

Interventional Treatment Modalities

The following interventional treatment methods are commonly utilized in the trauma setting:

1. Balloon occlusion: Inflation of an angioplasty balloon proximal to a major arterial injury to temporarily stop or reduce life threatening hemorrhage.

2. Transarterial embolization (TAE): Embolization can be used to stop arterial hemorrhage, improving unstable hemodynamics and often can be used to avoid surgery.

3. Stent-grafts: Stent-grafts or covered stents can be used in the treatment of large vessel injury including dissections, pseudoaneurysms, and occlusions.

Embolic Agents for Transcatheter Embolization

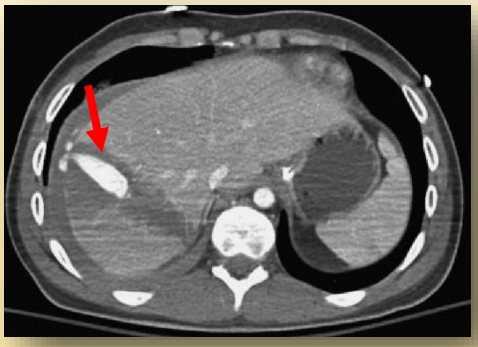
1. Coils – can be deployed through a standard 5 French angiography catheter or a microcatheter. Can be sized to the vessel diameter. Generally deployed either proximally to occlude a large vessel such as the splenic artery or deployed in small branches selectively catheterized with a microcatheter.

2. Particles such as PVA or embospheres can be used to emboilze an entire organ such as the spleen or a lobe of the liver. Often used when there is diffuse injury to a solid organ.

3. Gelfoam – water insoluble sponge prepared from purified porcine skin gelatin and capable of absorbing up to 45 times its weight of whole blood. Small pledgets of the Gelfoam or a slurry can be injected via catheter. Gelfoam is not permanent and will be resorbed between 1-6 weeks after delivery depending on the site of administration.

Patient Selection

Generally, trauma patients who are relatively hemodynamically stable will undergo contrast enhanced CT or CTA (CT angiography) of the areas of injury. Typically this is a contrast en-



CT scan of the liver from a patient with a gunshot to the Liver. Active extravasation of contrast is seen along the trajectory of the bullet.

Selective hepatic artery angiogram demonstrates active extravasation.

Hepatic angiogram after deployment of multiple coils in the bleeding arterial branch. No extravasation is seen.

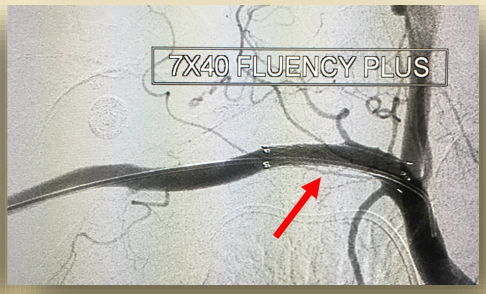
The Role of Interventional Radiology in Trauma Cont...

CT or CTA (CT angiography) of the areas of injury. Typically this is a contrast enhanced scan of the chest, abdomen and pelvis and may include the arterial phase. If there is concern for a vascular injury the patient may undergo CTA of the affected area.

CT and CTA are extremely sensitive for the detection of solid organ injury, typically spleen, liver, and kidney as well as the detection of active extravasation due to arterial injury. CTA is very sensitive for the detection of arterial dissection, pseudoaneurysm formation, traumatic arteriovenous fistula formation and occlusions.

If a patient is hemodynamically unstable and there is suspicion for a splenic laceration (splenic injury is the most common solid organ injury) the patient may go directly to surgery, but most patients will have a diagnostic scan. If there is evidence of solid organ injury or active extravasation from small arterial branches, patients are usually triaged to non operative management or IR depending hemodynamic stability, relative blood loss, coagulation status and likelihood of attaining hemostasis without intervention.

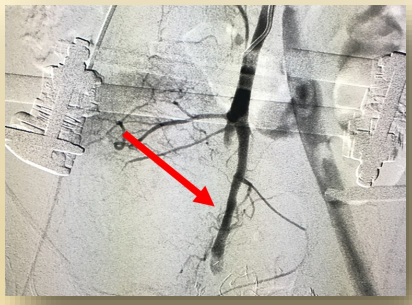
Subclavian angiogram demonstrates a pseudoaneurysm in the subclavian artery due to iatrogenic trauma during attempted line placement.



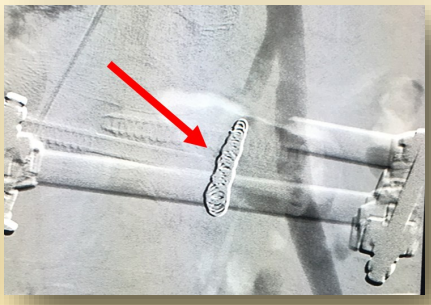
Subclavian angiogram after placement of a covered stent across the pseudoaneurysm which no longer fills with contrast.

Amy Hayes, MD

CT of the pelvis demonstrates diastasis of the left SI joint (multiplied pelvic fractures were also present) and active extravasation of contrast from a branch or the left internal iliac artery"



Left internal artery angiogram demonstrates irregularity and abnormal dilatation of a branch of the posterior division, correlating with the CT findings. There was also pooling of contrast consistent with arterial injury.



Post coil and Gelfoam embolization of the vessel.

"On The Case"

March 2016 Answers:

55 year old male presents with massive hemoptysis.

Images from a CT pulmonary angiogram are shown.

1. What are the finding?

CT scan demonstrates a cavitary mass with a contrast filled aneurysm projecting into the cavity. Aneurysm is arising from the pulmonary artery.

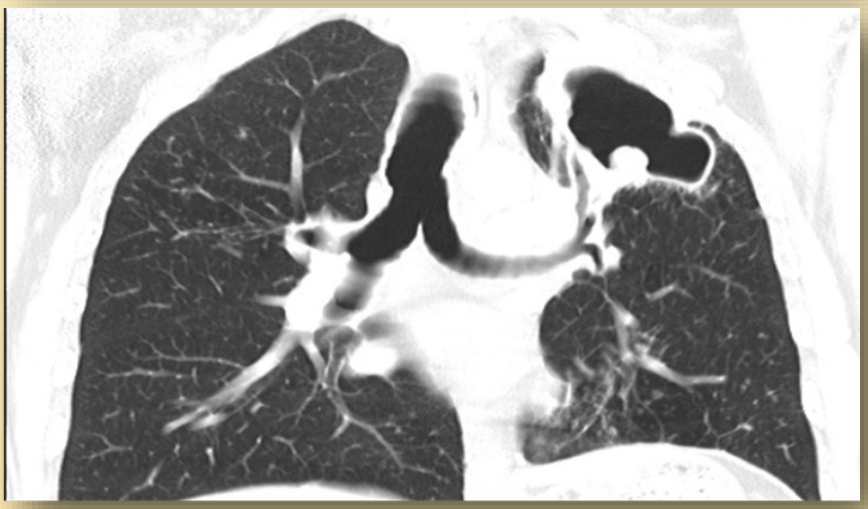
2. What is the diagnosis?

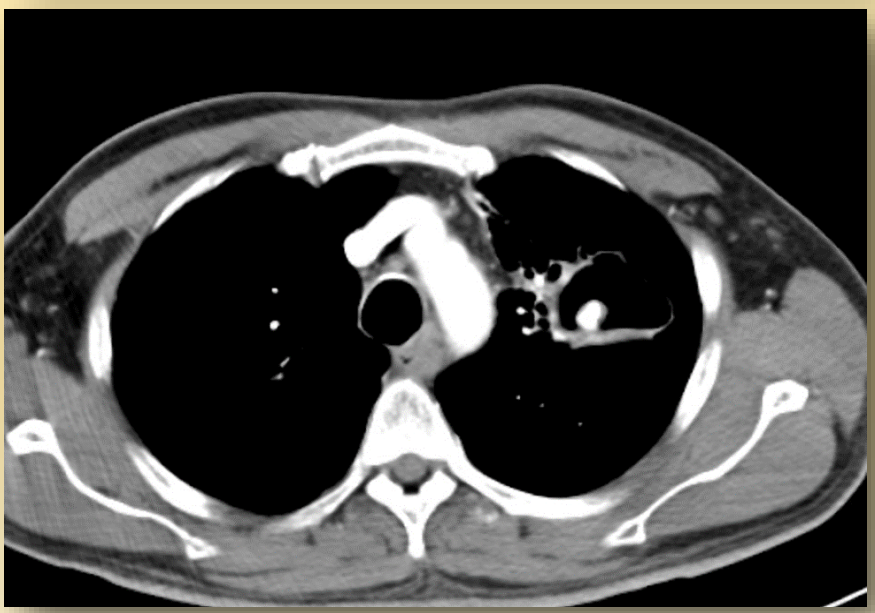
Rasmussen aneurysm.

3. What interventional procedure would you do next?

Pulmonary angiogram.

Rasmussen aneurysm is an uncommon complication of pulmonary tuberculosis and is an aneurysm of the pulmonary artery adjacent to or within a tuberculous cavity. It can be the cause of massive hemoptysis. Treatment can include pulmonary angiogram and transcatheter embolization.





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