

## Radiologic Imaging

X-ray has always been the golden rule in diagnosing and treating podiatric patients. Unfortunately, for some patients the diagnosis is not as evident. That is when we need to utilize other Radiographic modalities. We will explore some options that are available to your patients.

Before referring your patient to a facility, do some homework first. Make sure you are using a facility that has been accredited by the American College of Radiology. Simply go on the website [www.acr.org](http://www.acr.org) and look for patient info. Click on "find an accredited facility" and search. This ensures that the equipment used and the staff involved has met the highest standards that are required.

### Magnetic Resonance Imaging (MRI)

MRI has been used in research since the late 1970's. Diagnostic use began in the early 1980's, but still in the very primitive stages. The latest technology has brought superconductive magnets to strengths that are ten times the strength of the old permanent magnets. Using a magnetic field combined with radiofrequency pulses has made MRI imaging one of the few modalities that is considered non-invasive. There is no ionizing radiation involved in MRI scanning. During an MRI, radiofrequency pulses bombard the atoms in the body part being imaged. Data is then acquired from signals emitted from the relaxing protons. This data is sent to a computer where it eventually is turned into an image. MRI is the best diagnostic tool in evaluation of soft tissues. The computer will receive signals from all different tissue types as they relax after being bombarded by RF pulses. MRI is able to evaluate bone, muscle, tendons, ligaments, fluid (blood/water), fat and masses. A typical foot or ankle MRI exam can contain well over 100 images. Images are obtained in all three planes (sagittal, axial, coronal). Each image represents a slice of information obtained in one of the three planes, and can range in thickness from 2.0 mm-3.0 mm. Tendons in the feet range from 3.0-10.0 mm in thickness, so thin slice imaging is a must. This is only available on high field, superconductive magnets that run at strengths 1.5 Tesla- 3.0 Tesla.

Imaging of the foot and ankle in MRI is considered non-claustrophobic. This is due to the fact that the patient enters the magnet feet first. The rest of their body from the thighs to their head is located outside the scanner. The scanner will make a series of very loud tapping noises, similar to a jack hammer. The use of noise cancellation headphones will make it comfortable for the patient while they are in the exam room. A typical scan takes only around 20-25 minutes depending on the scanner strength. The stronger the scanner, the faster the scan. 3 Tesla MRI's are the fastest scanners available today.

MRI is useful in diagnosing conditions involving the soft tissues as well as bone marrow abnormalities. The following conditions can be found on an MRI:

Tendon tears/ruptures

- Neuromas
- Metastatic lesions
- Avascular necrosis
- Stress fractures
- Plantar fasciitis
- Osteomyelitis
- Osteochondritis dessicans
- Bone contusions

## **Computed Axial Tomography (CAT)**

CT scanning has been used diagnostically since the early 1970's. The first prototype was made in 1968 by Sir Godfrey Hounsfield in England, thanks to the success of the Beatles. EMI record company was part owner in the research lab that funded the first prototype. CT scanning utilizes a fan x-ray beam in conjunction with gas radiation detectors to produce high resolution images. It can be said that CT scanning was the pioneer in digital x-ray imaging because of its use of detectors. The majority of CT scanners today have between 16 and 64 rows of detectors compared to 2 originally. Housed inside the gantry is an x-ray tube that has the ability to spin 360 degrees around a patient with a ring of detectors to receive the image information. The detectors act like intensifying screens in film-screen radiography. As the tube encircles the patient, the table moves to cover the imaging area. A volume of data is acquired axially using <1mm increments so that it can be re-formatted in all three planes, sagittal, coronal and axial.

CT scanning utilizes ionizing radiation, and is categorized as an invasive procedure. CT is also considered the best modality in evaluating bone, due to the atomic number of calcium. Remember your x-ray physics and how the atomic number determines whether or not something will show up on an x-ray. Ultra fine detail can be seen in the trabecular pattern, matrix and cortex of the bone due to the thin slices that are obtained.

As in MRI imaging, the patient will enter the scanner feet first for lower extremity studies. With today's technology, scans take less than five minutes to perform. The majority of time spent on the scan is during post-processing of the images, long after the patient is gone.

CT is useful in diagnosing conditions involving the bones. The following conditions can be found on a CT:

- Fractures
- Cortex integrity
- Bone Cysts
- Tarsal Coalitions

## **Nuclear Medicine**

Nuclear scanning is one of the oldest Radiographic modalities. It has been used to detect diseases in their earliest stages since the early 1950's. This was the first imaging tool that was able to show function of an organ, not just its structure. Nuclear scanners are called Gamma cameras that have the ability to pick up Gamma rays and produce an image. Radioactive isotopes, which are called tracers, are injected into the patient hours before their scan. As the isotope decays it emits Gamma rays. These rays are then picked up by the Gamma camera. In areas of increased activity of the isotope, you will see what is called a "hot spot" on the film. These "hot spots" help diagnose certain conditions. This study is usually a lengthy study, and you should expect to spend a good portion of your day at the facility. Certain exams require additional imaging 24-48 hours after injection.

Nuclear Medicine tracers have specific purposes. Technetium 99m is used for bone abnormalities. Gallium-67 is used for inflammatory processes like Osteomyelitis. Indium-111 is used for bone marrow studies like tagged white cell studies. Iodine-131 is the only isotope used to treat thyroid cancer, not image the thyroid.

Nuclear Medicine is useful in diagnosing the following conditions:

- Stress fractures
- Metastatic disease
- Osteomyelitis
- Arthritis
- Bone Healing
- Acute or Chronic infections

### **Diagnostic Ultrasound**

In diagnostic ultrasound, sound waves are transmitted through a body part via a transducer with a frequency of 2-18 mega hertz. This happens to be hundreds of times greater than the limit of human hearing. The transducer can transmit and receive information at the same time, while utilizing a water based gel coupling agent. As the sound pulses are reflected off internal structures during a scan, they produce an echo. This echo is interpreted based on the structure type and can be called hyper-echoic, hypo-echoic or an-echoic. It may be solid, fluid, air filled or in motion (blood).

Ultrasound technology is a non-invasive imaging technique that has been around since the early 1960's. Since it has no ionizing radiation, this modality is beneficial for children and pregnant women. Therapeutic ultrasound is used in physical therapy and transducers have a frequency of 0.3-3.0 mega hertz. These sound waves will cause a vibration of the tissues which will then generate heat.

Ultrasound is useful in diagnosing the following conditions:

- Plantar fasciitis
- Tendon ruptures
- Cysts/fluid filled masses
- Soft tissue masses
- Neuromas
- Foreign Bodies

## Questions

1. In today's day and age, x-rays are the "golden Rule" for diagnosing podiatric patients.  
True \_\_\_\_\_ False \_\_\_\_\_
2. The \_\_\_\_\_ ensures that radiographic equipment and radiologic staff have met the highest standards that are required.
3. MRI stands for \_\_\_\_\_.
4. MRI's have been used in a diagnostic setting since \_\_\_\_\_.
5. Radiofrequency pulses are a form of ionizing radiation. True \_\_\_\_\_ False \_\_\_\_\_
6. MRI is the best imaging modality in evaluating \_\_\_\_\_.
7. List the different imaging planes that are used in lower extremity MRI's:  
a. \_\_\_\_\_ b. \_\_\_\_\_ c. \_\_\_\_\_
8. The average slice thickness in lower extremity MRI is 2-3 cm. True \_\_\_\_\_ False \_\_\_\_\_
9. MRI imaging of the foot/ankle is very claustrophobic. True \_\_\_\_\_ False \_\_\_\_\_
10. Noises from an MRI machine sound similar to a \_\_\_\_\_.
11. List four (4) conditions that MRI is useful in diagnosing:  
a. \_\_\_\_\_  
b. \_\_\_\_\_  
c. \_\_\_\_\_  
d. \_\_\_\_\_
12. CAT scanners have been used in diagnostic imaging since the invention of x-rays in 1895.  
True \_\_\_\_\_ False \_\_\_\_\_
13. CT uses a \_\_\_\_\_ x-ray beam and gas radiation detectors.
14. CT scanners were the pioneers in \_\_\_\_\_ x-ray imaging because of its use of detectors.
15. An x-ray tube inside a CT scanner can spin \_\_\_\_\_ degrees.
16. As in x-ray, CT scanner utilizes \_\_\_\_\_ radiation to produce an image.
17. CT scanning is the best modality in evaluating \_\_\_\_\_.
18. List two (2) conditions that CT is useful in diagnosing:  
a. \_\_\_\_\_  
b. \_\_\_\_\_
19. Nuclear Medicine is one of the \_\_\_\_\_ radiographic modalities.
20. NM is the only modality that can show \_\_\_\_\_ of an organ.
21. Radioactive \_\_\_\_\_ are injected into patients prior to their scans, which acts as a tracer.
22. A decaying isotope will emit faint \_\_\_\_\_ rays that are picked up by the Gamma camera.
23. "Hot spots" are hot to the touch. True \_\_\_\_\_ False \_\_\_\_\_
24. List two (2) tracers (isotopes):  
a. \_\_\_\_\_  
b. \_\_\_\_\_
25. \_\_\_\_\_ waves are transmitted through the body in diagnostic ultrasound.
26. The transducer utilizes a \_\_\_\_\_ to transmit and receive information.
27. List the three (3) types of echoes that are produced during a scan:  
a. \_\_\_\_\_ b. \_\_\_\_\_ c. \_\_\_\_\_
28. Diagnostic ultrasound is the same as therapeutic ultrasound therapy. True \_\_\_\_\_ False \_\_\_\_\_
29. Ultrasound imaging utilizes ionizing radiation. True \_\_\_\_\_ False \_\_\_\_\_

30. List three (3) conditions that Ultrasound is useful in diagnosing:

- a. \_\_\_\_\_
- b. \_\_\_\_\_
- c. \_\_\_\_\_