CHAPTER **22**

OCCULT NAVICULAR FRACTURE: Proper Use of Advanced Imaging Modalities

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The practice of podiatric medicine has evolved into an advanced medical and surgical sub-specialty. In the care of patients, the podiatric physician has a wide range of diagnostic and treatment options available. However, with the increase in these options can come a dependence on new technology. In the past, the diagnosis of pathology was made by the physician and then confirmed with a radiographic study. This placed the primary burden of "arriving at a diagnosis" firmly in the hands of the physician. Today however, the situation is frequently quite different. Magnetic resonance imaging (MRI), Computed tomography (CT), ultrasound, and a host of nuclear medicine imaging studies are frequently employed to establish a diagnosis, not confirm one. This can unfortunately lead to overuse and abuse of the new technology while also blunting the diagnostic skill of the physician who solely depends on the radiology report.

The case of the Achilles tendon rupture is a classic example. In the acute situation, the clinical findings are usually quite dramatic, consisting of a palpable defect, positive Thompson-Doherty test, and pain and edema at the site of rupture. Rarely is MRI or ultrasound required to arrive at this diagnosis, but they are frequently ordered.[1,2] This is not the case with a bone or soft tissue neoplasm, where CT and MRI are indispensable in aiding in proper diagnosis. The overall impression is that advanced imaging modalities are a valuable asset to the practice of podiatric medicine, but must be properly employed.

BASIC PRINCIPLES

The basic principles involved with both CT and MRI are essential for proper interpretation and implementation. Both techniques depend on an accurate history to correlate results with clinical presentation. Computed tomography (CT), is similar to conventional radiography in its utilization of ionizing radiation to generate images. However, this is where similarities cease. Unlike conventional radiography, a CT scan directs x-rays in a narrow beam to create a series of profiles that are then analyzed by a computer to provide a detailed cross-sectional image. Utilizing this technique, the CT scan is able to eliminate interference from surrounding structures. The section will only include data from the desired section. As a result a CT must be ordered very specifically. In the foot and ankle, a CT is generally able to provide frontal (coronal/axial) and transverse (horizontal) sections. (Fig. 1) With computer enhancement, sagittal sections and 3-D reconstructions are also possible, but not routinely performed. (Fig. 2) Additionally, after specifying the desired planes, the tissue of interest must be specified. A "window" must be set to highlight osseous or soft tissue pathology.

Of perhaps greatest importance is the section thickness and space between sections. The thinnest images practical should be obtained if a small focal region is being investigated.[2] Practicality becomes an issue because if the region of interest is the

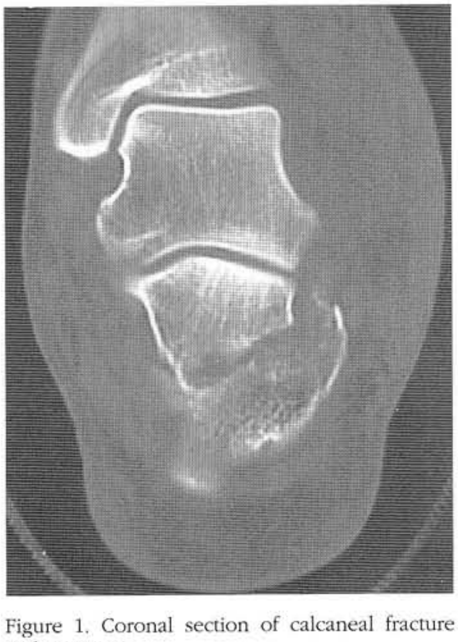

Figure 1. Coronal section of calcaneal fracture with CT Scan.

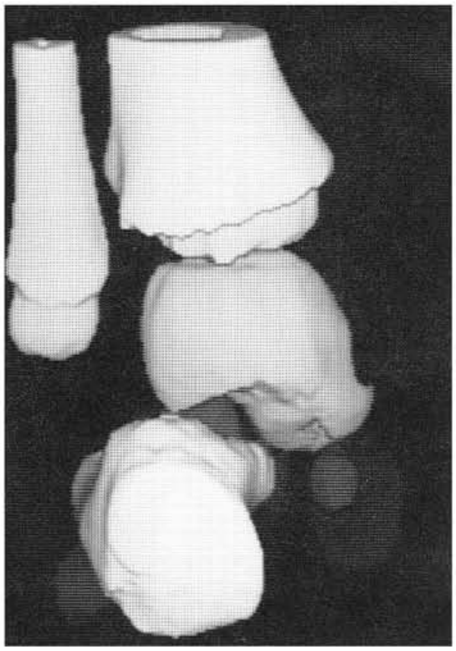

Figure 2. Three-dimensional reconstruction CT scan.

entire foot, around 25 cm, then one could acquire 250 sections if they are ordered 1 mm thick. Such a number would not only be unnecessary, but would also anger your radiologist. Typical sections between 1.5 to 3.0 mm should prove adequate for most situations. The final issue is spacing of the sections. To "stack" the images is acceptable in most circumstances. This means that after obtaining a 2.0 mm section, the gantry moves 2.0 mm, allowing the scanned images to "stack" without overlap or gap. The thickness of sections is critical and highly dependent on the target. If your region of interest is small, only 2.0 mm, then a 5.0 mm section could completely miss the lesion. This simply illustrates again the need for physician input prior to the ordering of these studies. The following case study will attempt to illustrate this point.

CASE REPORT

A 13-year-old female presented to the Emory Northlake Regional Medical Center with complaint of right ankle pain for the past four years. The patient relates that she had suffered an ankle injury playing soccer approximately four years ago. The patient described an inversion-type mechanism, but also relates that she may have been kicked in the ankle. The patient was originally seen at a local emergency room and was placed into a cast for treatment of an ankle sprain. The patient then followed up with a podiatrist who diagnosed her continued pain as acute plantar fasciitis and again placed her into a cast for three weeks on two separate occasions. Throughout this treatment, the patient did not significantly improve.

The patient was then seen by an orthopedist for a second opinion. The orthopedic surgeon ordered an MRI, and in addition to plantar fasciitis felt the patient had sinus tarsi inflammation. A technetium B 99 bone scan was also obtained that demonstrated an area of inflammation in the ankle area. The patient was then placed in an immobilizer for approximately two months. After no relief, the patient underwent a sinus tarsi exploration. Again the patient had no improvement.

At this point, approximately two years following the initial injury, the patient was still not improving and then underwent a second surgical procedure, this time to address "scar tissue" in the ankle that the MRI had detected. Frustrated, the patient was referred to a rheumatologist to be evaluated for a possible arthritic disorder. All blood tests for rheumatoid arthritis were negative, and questions regarding chronic pain syndromes were raised. At this point, four years had passed and the patient had experienced no significant pain relief despite numerous courses of immobilization, anti-inflammatories, x-rays, an MRI, bone scan, physical therapy and two surgical procedures.

The patient was finally seen in another podiatric physician's office who completely revaluated the patient. Reviewing the case and the history of trauma lead to a close evaluation of the previous studies. The bone scan, very sensitive, but not very specific, only yielded regional inflammation. The MRI again only showed inflammatory changes and some scar tissue around the ankle. At this point, it was determined that the history of trauma could have resulted in osseous pathology, however conventional x-rays revealed no abnormalities.

A CT scan was then ordered of the patient's right foot. The scan was ordered with 3 mm thick sections, spaced only 2 mm apart. The spacing is actually less than section thickness to provide for a small amount of overlap, reducing the chance of missing a small osseous defect. In addition, if three-dimensional reconstruction is undertaken, the overlap provides for a more accurate reconstruction. This essentially means that every 2 mm, a new

3 mm thick image is obtained. The CT images clearly show a fracture fragment on the lateral side of the navicular in the region where the bifurcate ligament attaches. (Figs. 3A, 3B) The bifurcate ligament is stressed during a plantarflexion inversion injury and likely caused the avulsion fracture. The patient underwent surgery to excise the fracture fragment. Intraoperative visualization revealed an obviously loose fragment that was easily removed, and the rough edges smoothed. (Figs. 4,5) The patient had an uneventful recovery and is now painfree at more than one year postoperative.

The primary issues surrounding this case stem from the initial physicians depending on advanced imaging to make their diagnosis. The initial physicians should have used the advanced studies to help confirm a diagnosis, not make it for them. The CT scan was able to confirm a diagnosis of missed osseous pathology only because the treating physician initially suspected it. CT and MRI certainly can assist in the clear identification of many musculoskeletal pathologies.

REFERENCES

1. Daffner RH, Riemer BL, Lupetin AR, Et al: Magnetic resonance imaging in acute tendon ruptures. *Skeletal Radiol* 15:619-621, 1986.
2. Oloff-Solomon J, Solomon MA: Computed tomographic scanning of the foot and ankle. *Clin Pod Med Surg* 5:931-944, 1988.

Figure 3A. Coronal section from patient demonstrating small navicular fracture fragment

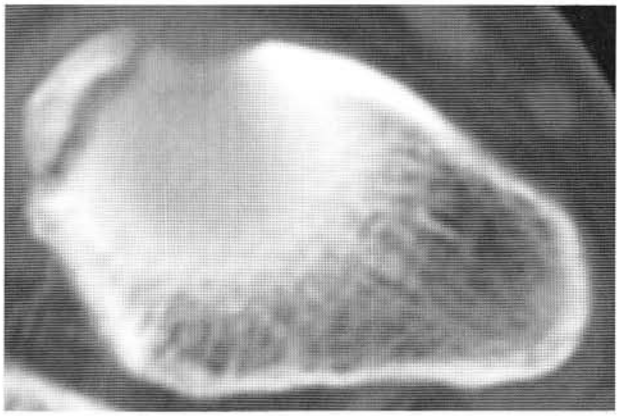

Figure 3B. Close up view of same navicular fracture fragment.

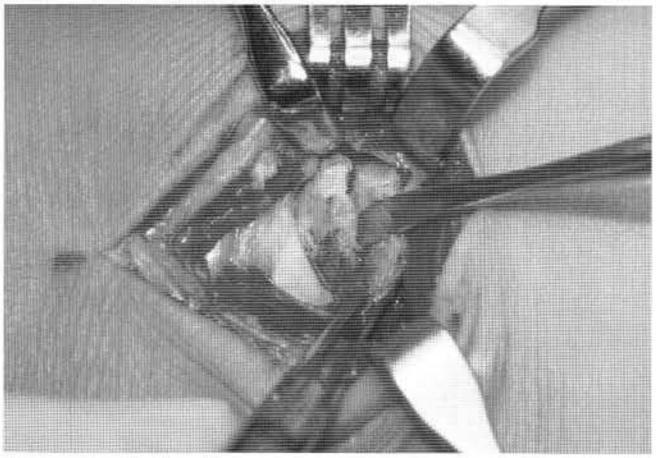

Figure 4. Intraoperative view of non-united navicular fracture fragment.

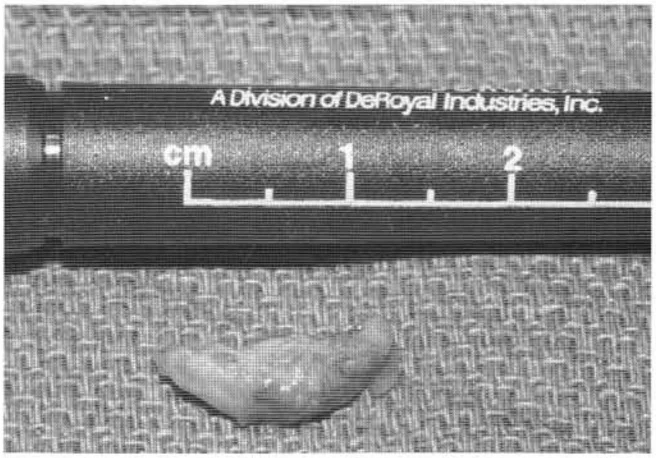

Figure 5. Fracture fragment following excision.