NAVICULAR FRACTURES: Diagnosis & Treatment

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Quick and accurate diagnosis of a navicular fracture requires a high index of suspicion on the part of the clinician.[1] While displaced fractures are observable on standard radiographs, they are relatively uncommon, because the middle part of the foot is rigidly stabilized by an extensive network of plantar and dorsal ligaments.[2] Incomplete, non-displaced, and stress fractures of the navicular are often not detected on standard radiographs, ultimately delaying diagnosis. Most navicular fractures occur as either dorsal avulsion fractures, tuberosity fractures, stress fractures, or body fractures, both displaced and non-displaced.[1-4] The signs, symptoms diagnostic modalities and recommended treatment plans for the navicular fracture will be discussed.

DIAGNOSIS

The diagnosis of navicular fractures, especially stress fractures, is often delayed.[5] In one study, the average time from onset of pain to diagnosis was 4 months with a range of 3 to 60 months. Torg's study of navicular stress fractures showed the average diagnosis being made 7.2 months after the beginning of symptoms, with a range of 1 to 38 months.[5,6] Navicular fractures are often not included in the clinician's differential diagnosis because of the vagueness of the pain, the absence of major trauma, and the patient population in which these fractures most commonly occur. Delayed diagnosis often results in protracted and complicated treatment.

Because the talonavicular joint is supplied by the medial plantar nerve, the pain of a navicular fracture may radiate along the medial arch of the foot and not directly over the talonavicular joint. Sometimes the pain radiates distally causing the practitioner to suspect a neuroma or metatarsalgia.[5] Athletes often try to "run through the pain," or find that the pain disappears after a few days of rest only to return once activity is reinstated. Navicular fractures usually show tenderness with or without subtle edema on palpation over the navicular, regardless of the navicular fracture.

Fractures of any bones involving the midfoot are difficult to evaluate with standard radiographs because of the multiple overlapping of irregular bones which sometimes creates shadows and increased densities.[1] Contralateral foot x-rays help differentiate abnormalities from normal findings for a particular patient. If a navicular fracture is suspected and radiographic views are equivocal, a bone scan should be ordered. Positive bone scans should be followed by a CT scan. Dorsal avulsion fractures are best visualized on lateral radiographs.[1,4]

Tuberosity fractures are visualized on dorsal-plantar and oblique views. Accessory ossicles are present 2% to 12% of the time.[1,4] These accessory ossicles can articulate with the true navicular by either a fibrous union or a true synovial joint.[1,4] To help differentiate an avulsion fracture from an accessory bone, a contralateral view of the non-injured foot should be obtained. Accessory bones are bilateral 64% of the time.[3] True fractures usually display an irregular or jagged edge while the accessory bone is round and smooth. If the accessory ossicle has a fibrous union or shared a synovial joint, which is injured the symptoms can be just as disabling as a true avulsion injury.

Non-displaced vertical or horizontal fractures are generally best visualized on an oblique or lateral view. Vertical fractures sometimes show the fracture line passing between the second and third cuneiform. Again, examination will usually yield tenderness with palpation over the navicular.[1,4]

Stress fractures are difficult to distinguish on plain radiographs unless they have become complete with or without displacement. Microangiographic studies of the navicular demonstrate a relative avascularity of the middle third of the bone.[6] This is the site where most stress fractures of the navicular develop.[1,3,4,6] Repetitive cyclic loading may be the cause of failure through this relatively avascular area.[6] Stress fractures are usually oriented sagittally through the middle one-third of the navicular. The oblique orientation of the fracture makes it difficult to visualize with standard radiographs. In addition to the standard lateral, dorsal-plantar, and lateral-oblique projection films, a modified medial oblique projection should be obtained with the foot in a supinated position. This positioning of the foot, or alteration of the x-ray beam, allows the x-ray beam to project parallel to the line of the fracture which allows for better penetration and visualization of the fracture. (Fig. 1) The symptoms of the navicular stress fracture, not unlike other stress fractures of the foot, are usually exacerbated by activity and relieved with rest. This will help to differentiate stress fractures from soft tissue strain or tendonitis in which the symptoms typically improve with activity, once past the warm-up stage, but become more painful once the activity is ceased.[1] Early accurate diagnosis of stress fractures is exceedingly important because they have a tendency to displace if an athlete continues to be active.[7]

Another helpful diagnostic tool to facilitate visualization of these fractures is fluoroscopy. This allows the clinician to manipulate the foot and visualize the navicular under real time. This technique can allow visualization of a non-displaced body fracture in which the radiographs are equivocal. With any of the navicular fractures, if plain films are equivocal and the clinician suspects a possible fracture, a bone scan should be ordered, and all positive scans should be followed with a CT scan.[1-5,7-9]

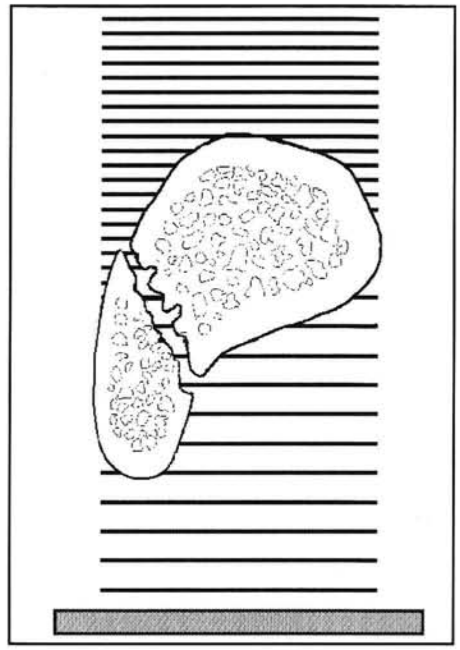

Figure 1A.The normal orientation of the navicular on a standard dorsal-plantar view often causes an obliquity of the fracture line as compared to the x-ray beam. This makes the fracture difficult to appreciate because of the bone overlap.

TREATMENT

With any fracture or injury, if there is a significant amount of edema present, a compressive dressing in conjunction with elevation and non-weight bearing should be employed for the first 48 to 72 hours. This is done prior to the application of a weight-bearing or non-weightbearing short-leg cast.

Dorsal avulsion fractures usually do not require open reduction, however, if there is a large fragment with some displacement, closed manipulation can improve the positioning. Edema and the inherent instability of the fracture usually only allow for modest improvement and incomplete reduction.[1,4] Typically these fractures are treated with a short-leg walking cast for 4 to 6 weeks with the foot in neutral position. On rare occasion, if the fragment fails to unite or forms a painful exostosis, surgical excision may be indicated. Open reduction with internal fixation is recommended if the fracture represents more than 20% to 25% of the articular surface.[1,3-4]

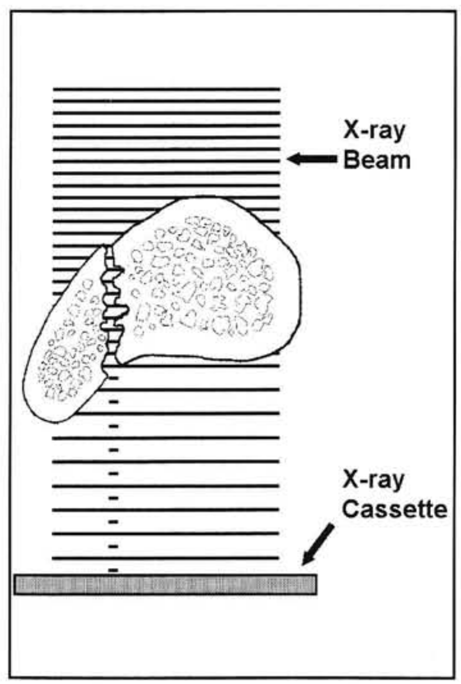

Figure 1B. By supinating the foot, the fracture line can be positioned parallel to the x-ray beams allowing additional penetration and ultimately better visualization of the fracture line.

Tuberosity fractures are usually treated with a short-leg walking cast with a well-molded arch for six to eight weeks.[1,3-4,6] Casting for greater than 2 months is generally not indicated even when radiographs do not show osseous union.[1] As mentioned earlier, some of these injuries may represent a disrupted fibrous union or synovial joint with an accessory ossicle as opposed to a true avulsion fracture. Both the disrupted accessory ossicle and true avulsion fracture are treated similarly. Even with accurate diagnosis and treatment, some patients remain symptomatic and require surgical excision of the fragment or ossicle.[1,3-4]

Non-displaced body fractures are treated with a short-leg walking cast for six to eight weeks. Inlay bone grafting may be indicated if the fracture fails to heal. Non-unions are usually attributed to sclerosis of the fracture margins secondary to delayed diagnosis and/or the precarious blood supply of the navicular. Adequate closed reduction of displaced fractures is difficult. Displaced fractures are usually treated with open reduction and internal fixation.[1,3-4]

The recommended treatment of navicular stress fractures is immobilization and non-weightbearing for six to eight weeks with or without a cast.[1,3-4,6] After six weeks of immobilization and non-weightbearing the patient can be evaluated. Tenderness to palpation at the fracture site (dorsal-proximal region) is the best guide to fracture healing. If pain with palpation persists, continue with two more weeks of immobilization and non-weightbearing.[5] Some of these fractures may require 8 to 12 weeks to heal.[7] As with any condition that requires extended immobilization and non-weightbearing, the patient may feel discomfort once unrestricted weightbearing is begun. This discomfort is usually different from the pain they felt prior to treatment and can be due to a stiff subtalar and/or midtarsal joints. Fractures complicated by delayed union or non-union are generally treated by inlay bone grafting.[1,3-4,7] Any and all of these patients with the different fracture types can benefit from an orthotic device once full unrestricted weightbearing is begun.

CASE STUDY

A distressed world-class 400 meter Olympic sprinter presented less than one week before the opening ceremonies of the 1996 Summer Olympic games in Atlanta. She had been suffering from pain in her foot for several months prior to her arrival in the United States, and her symptoms were becoming progressively debilitating. Her country's team physicians indicated that she was suffering from plantar fasciitis. However, the athlete failed to respond to NSAIDs (which led to a gastric ulcer), cortisone injections, and appropriate analgesics. She modified her training by taking periods of rest, only to have her pain return with activity. When the athlete continued to complain of pain, which was now severely affecting her ability to run, the team orthopedists told her there was "nothing wrong with her" and it was "in her head." She was released from the team and instructed to return to her home country.

The patient described the pain as being located in the arch region, and radiating to the dorsal-medial aspect of the foot. Standard plain-film radiographs were equivocal, however, they suggested a reactive process within the body of the navicular bone. The report of a previously performed bone scan demonstrated significant increased uptake in the tarsal region. The scan itself was not available. The index of suspicion was high for a stress fracture, and a CT scan was performed, with emphasis on the tarsal bone region of the foot. The scan demonstrated an intra-articular, vertical obliquely-oriented fracture of the navicular bone. The presumptive diagnosis was confirmed. (Figs. 2A,2B)

With evidence of bony separation and fracture margin sclerosis, this was apparently a sub-acute process which had been developing over the period of the athlete's symptoms. The patient had no chance of competing in the Olympic games, therefore, surgical stabilization of the fracture was performed. Under fluoroscopic examination, the fracture was clearly visible by supinating the foot into a medial oblique projection position. A Kirschner-wire was driven across the fracture from lateral to medial (Fig. 3A), and after confirming that the wire was centrally located within the bone, it was replaced with a 4.0 mm cancellous screw. Fluoroscopic examination, and plain film radiographs demonstrated the position of the compression screw.(Figs. 3B,4A,4B) The patient was placed in a non-weightbearing cast following surgery, and then returned to her home country with detailed instructions for postoperative care. She underwent an uneventful postoperative course and returned to training and competing at the world class level.

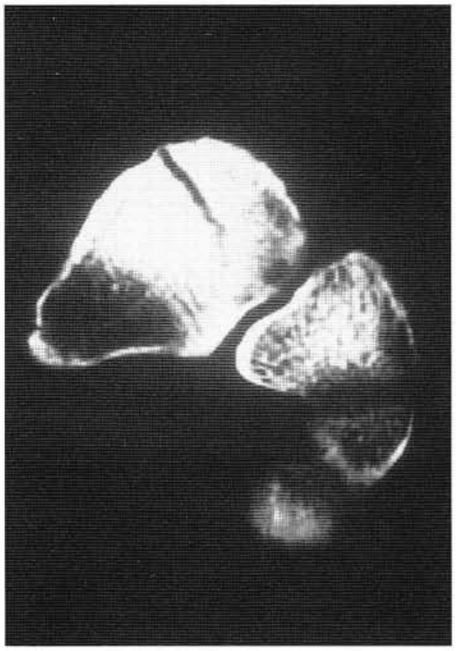

Figure 2A. CT scan (frontal view) showing navicular fracture.

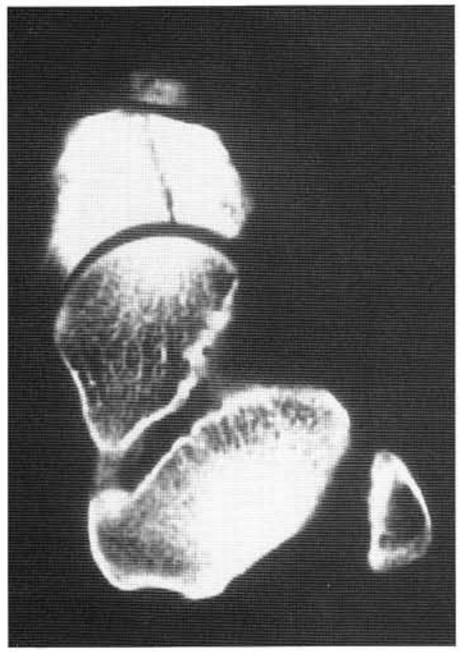

Figure 2B. CT scan (axial view) showing the intra-articular fracture.

Figure 3A. Intraoperative fluoroscopic view showing K-wire placement.

Figure 3B. Intraoperative fluoroscopic view confirming screw placement.

Figure 4A. Dorsal-plantar radiograph showing screw orientation.

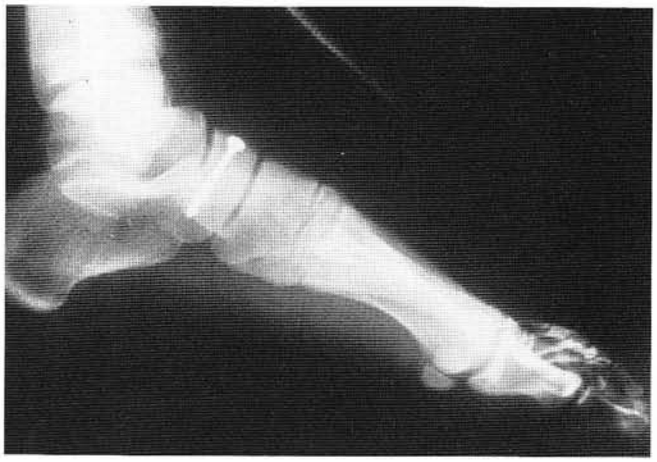

Figure 4B. Lateral radiograph showing screw orientation.

DISCUSSION

The small number of navicular fractures in previous studies may in part be due to the under diagnosis of navicular fractures.[9] Because of the unique blood supply of the navicular body, unrecognized and untreated navicular fractures have a high morbidity and may progress onto non-union, avascular necrosis, or osteoarthritis.[8] Any patient, particularly an athlete who presents with vague midfoot pain, should have navicular fracture included in the differential diagnosis. If radiographs are equivocal, and a navicular injury is still suspect, a bone scan should be ordered. All positive bone scans should be followed with a CT scan. When CT scans are ordered and read as "normal," the clinician should review the scans. In Khan's study, errors reported on the CT scan occurred in 6 of the 86 (7%) cases they reviewed. When the films were reviewed, the fracture was apparent.[5] The author has recently experienced this same problem with a patient sent for a CT scan to rule out a navicular fracture. The scan was read as "normal", but upon reviewing the scan a fracture was seen and was confirmed intraoperatively. Also, it is important to be sure the CT scan slices are not being taken too far apart (>1.5mm).

CONCLUSION

A high index of suspicion is needed to diagnosis navicular fractures not clearly apparent on standard radiographs. If plain films are negative or equivocal, a bone scan should be ordered with all positive scans being followed with a CT scan. Delays in the diagnosis will extend the treatment time and increase the complexity of the surgical procedure if surgery is indicated. Most non-displaced fractures that are diagnosed early will heal with conservative treatment.

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