

Tarsal Navicular Stress Fracture in a Young Athlete: Case Report With Clinical, Radiologic, and Pathophysiologic Correlations

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Background: Tarsal navicular fractures are uncommon but important causes of foot pain. Being alert to this condition can help prevent a delay in the diagnosis.

Methods: A literature search of MEDLINE was undertaken, and a case report of an adolescent with tarsal navicular stress fracture is described.

Results and Conclusions: Tarsal navicular fractures are often misdiagnosed for months. Because plain radiographs are unreliable, the diagnosis of tarsal navicular fractures requires the use of bone scan, fine-cut computed tomographic scans, or magnetic resonance imaging. Treatment requires strict non-weight-bearing activities to avoid complications. When the alert primary care physician can diagnose this condition, treatment of tarsal navicular fractures can be effective and rewarding. (J Am Board Fam Pract 2001;14:381-5.)

As more young athletes are training and competing in sports, physicians will likely see more stress fractures among the young. A recent study of track athletes showed an incidence of stress fractures of 20%.¹ Tarsal navicular stress fractures, while uncommon, are important causes of foot pain in athletes. A review of the literature failed to find a reported case of tarsal navicular stress fracture among 13-year-old children. The following case highlights such an injury.

Methods

A case report of an adolescent girl with tarsal navicular stress fracture is described. A literature search of MEDLINE using the key words "navicular" and "fracture" failed to find such an injury at this age. A discussion of the clinical findings, etiology, diagnosis, and treatment of this injury follows.

Case Report

A 13-year-old girl complained of a 6-week history of left "ankle pain." Her pain began insidiously without any specific incident or trauma. Her symptoms developed while participating simultaneously in soccer and cross-country track at a moderate skill

level. Her training regimen had recently increased from 7 to 15 hours per week at the start of the cross-country season. She complained of dull, aching pain focused along the anterior-medial aspect of her foot and ankle. Her symptoms had progressed from pain with running to a constant pain that affected her during activities of daily living. She denied having any foot swelling, bruising, skin changes, or neurologic symptoms, and she had never had any previous foot problems. She denied using new shoes.

Her condition was initially diagnosed as anterior tibialis tendonitis, and the patient was started on a program of stretching, icing, and relative rest. After 2 weeks of no improvement, nonsteroidal anti-inflammatory medications were prescribed, but she continued to have foot pain. Four weeks later the patient was referred for a sports medicine consultation.

Her medical history was unremarkable. She was not taking medications and had no known allergies. Likewise, her family history was unremarkable, and she had a normal social history. She had no menstrual irregularities, previous stress fractures, or other problems. Gait analysis showed mild pronation but no major anomalies. When examined, the affected left foot and ankle showed no swelling, ecchymosis, or deformity. Arch height was normal. The talocrural joint had normal plantarflexion, inversion, and eversion. Dorsiflexion was limited to 0° with the knee straight and 10° with the knee

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Figure 1. Coronal section through midfoot. Fracture is evident in middle third dorsal cortex of tarsal navicular bone, a typical configuration.

flexed. There was no particular pain produced with resisted active motion by foot dorsiflexors or plantar flexors. No focal tenderness was found on the malleoli or the base of the fifth metatarsal. There was focal tenderness over the dorsal aspect of the medial midfoot.

Initial plain radiographs of the ankle were obtained 6 weeks earlier, and findings were normal. A fine-cut computed tomographic (CT) scan of the foot showed a dorsal cortex stress fracture to the tarsal navicular (Figures 1 and 2).

Treatment was started by placing the patient in a non-weight-bearing short leg cast for 6 weeks. Once out of the cast, she was given a weight-bearing short leg cast for 4 weeks. Subsequently, ankle and foot flexibility exercises were undertaken to improve talocrural dorsiflexion. The patient was fitted for semirigid orthotics to improve midfoot support, and she was allowed to return to participation in sports gradually during the next 6 months.

A follow-up CT scan was performed to look for bony union; the scan findings correlated with the patient's clinical cure (Figure 3).

Discussion

Tarsal navicular fractures were first reported on in 1970.² Since that time several excellent studies have

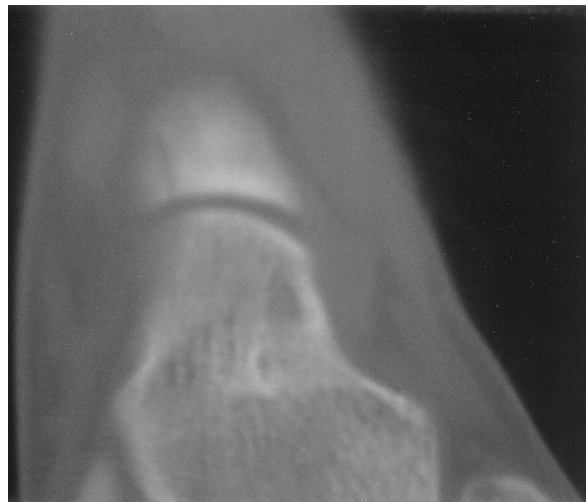


Figure 2. Transverse section through midfoot. Fracture seen in dorsal cortex extending to talonavicular joint.

emerged describing the injury. Still, there is a shortage of literature about this fracture among the youngest athletes, and many physicians who care for young athletes are unfamiliar with the fracture and its potential complications.



Figure 3. Computed tomographic (CT) scan 5 months after original CT scan shows complete resolution of fracture without residual bony sclerosis.

Table 1. Number of Navicular Fractures in Three Studies.

Sport	Torg et al (1982)	Fitch et al (1989)	Kahn et al (1992)	Total
Track and field	6	11	55	72
Football, soccer, rugby	5	5	20	30
Basketball	7	—	7	14
Racquet sports	1	2	—	3
Ballet, gymnastics	1	—	2	3

Note: Summarized from *Sports Medicine* 1994;17:65–76, with permission from Adis International, Inc.

Etiology

Stress fractures occur in persons who engage in vigorous weight-bearing activities.³ Training errors and overuse conditions are the most common pitfalls leading to tarsal navicular stress fractures.⁴ Repetitive muscle contraction and weight bearing without sufficient rest causes excessive skeletal stress that can exceed the ability of the bone to adapt.

Certain sports are associated with a higher risk of tarsal navicular stress fractures (Table 1). There is, however, no structural predisposition to developing tarsal navicular fractures. Excessive pronation or supination have been shown to increase the rate of lower extremity injuries, but there is no causal relation for developing navicular fractures.^{5–7} Similarly, a cavus foot is known to increase lower extremity injuries, yet there is no obvious link to increased incidence of navicular fractures^{5–7} Repetitive jumping has also been proposed as a risk factor for developing navicular stress fractures.^{1,5,8} It is thought that the extremes in pronation and plantarflexion during jumping could create excessive loading on the navicular bone.⁶ Despite this heavy loading, most jumping athletes do not develop navicular fractures. Several anatomic variations, including metatarsus adductus and a short first metatarsal, have been considered as risk factors.^{5,6} Unfortunately, no controlled trials have compared the incidence of navicular fractures between anatomic groups and population norms.

Diagnosis

Tarsal navicular stress fractures are often missed by physicians.^{1,5,7,9–12} The average lag time between symptoms and diagnosis is between 4 and 7 months.^{2,6} Accordingly, the best tool for attaining the correct diagnosis is to be alert to the possibility of stress fracture.

Patients initially complain of insidious onset of poorly localized foot pain, especially with running, jumping, or sprinting.¹⁰ Patients typically deny bruising, swelling, or a traumatic history, and symptoms usually abate with rest.⁶ If diagnosis is delayed, symptoms can begin to affect walking and daily activities. Initial physical findings are nonfocal, with vague pain radiating along the medial longitudinal arch or along the dorsum of the foot.¹ In later stages, the pain from a tarsal navicular stress fracture localizes along the dorsum of the navicular bone, the appropriately named N spot^{2,8} (Figure 4). Symptoms are reproducible with hopping on the affected foot in a plantarflexed position.¹⁰

The differential diagnosis for tarsal navicular stress fracture is relatively short. Many patients have midfoot sprains or anterior-posterior tibialis

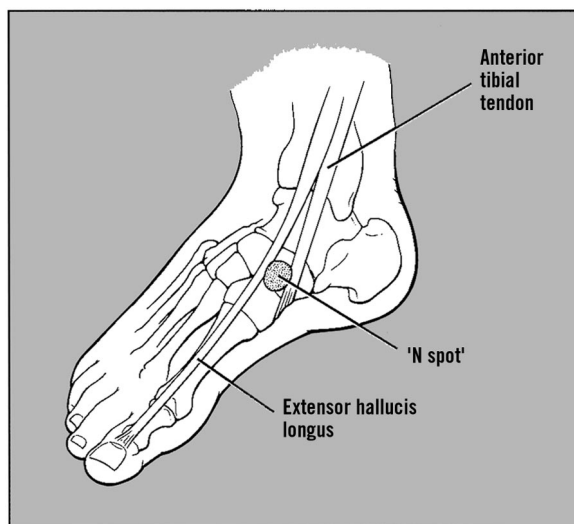


Figure 4. Illustration of the N spot. From: Simons SM. Foot injuries of the recreational athlete. *Physician Sports Med* 1999;27(1):68, Figure 4. Reproduced with permission.

tendinitis mistakenly diagnosed. Metabolic or rheumatologic disease can also result in vague foot or ankle pain. Idiopathic ischemic necrosis of the navicular bone (Kohler disease) might be considered in younger children with dorsal midfoot pain.

Plain radiographs are notoriously unreliable in diagnosing tarsal navicular stress fractures, with only 33% sensitivity.⁸ If navicular stress fracture is suspected, a radionuclide bone scan should be ordered because of its high sensitivity. Focal uptake in the navicular bone indicates either a stress reaction or a fracture.^{2,6} A fine-slice CT scan of the talonavicular joint is required to secure the diagnosis of navicular stress fracture.^{1,2,6,13} In the illustrated case, findings from the history and physical examination were highly suggestive of a tarsal navicular stress fracture, so the bone scan was omitted. In many circles, MRI is considered the imaging study of choice for stress fractures. Although MRI for diagnosing tarsal navicular stress fractures is promising, future studies are needed to determine its effectiveness in guiding treatment for this injury.

Treatment

Most experts agree that incomplete tarsal navicular stress fractures with no displacement or angulation can be managed without surgery. Khan et al² recommend strict non-weight-bearing cast immobilization as the treatment of choice for nondisplaced, nonangulated navicular stress fractures. Non-weight-bearing cast immobilization for 6 to 8 weeks produces an 86% heal rate of tarsal navicular stress fractures and an average return to sport participation of 5.6 months. Weight bearing during conservative treatment, however, increases the incidence of nonunion and avascular necrosis.² Surgery should be recommended for patients with displaced fractures or cases of nonunion, and it might also be a better option for noncompliant patients. Bone grafting, screw fixation, or both are the most common surgical procedures for tarsal navicular fractures. As primary treatment, 83% of surgically treated fractures have good outcomes, with an average return to sport participation of 3.8 months.² When surgery is used as a second-line treatment, its success rate drops to 68% with an average return to sport participation of 5.4 months.²

Tarsal navicular stress fractures are clinically healed once no tenderness is palpated along the N spot.² Patients should subsequently undergo rehabilitation, including muscle strengthening, mobili-

zation, and gradual resumption of activities. Follow-up radiographic studies are not generally useful in showing cure because radiographic findings lag clinical healing and might never completely return to normal.¹⁴ Biomechanical problems should be addressed and corrected. Many of these problems can be improved through flexibility and strengthening exercises. Poor foot biomechanics might be improved with orthotics. Training errors must be addressed as the athlete returns to sports participation. Education of the athlete, coach, and trainer continues to be an important and challenging aspect to care.

Summary

Tarsal navicular stress fractures should be considered in a young athlete with vague, ill-defined foot pain. Careful examination combined with specific radiologic studies (radionuclide scan, fine-cut CT scan) can confirm the diagnosis. Strict non-weight-bearing immobilization is required for treatment. Clinical evaluation of healing, rehabilitation, and gradual resumption of activities can improve the chances of a favorable outcome for this challenging problem.

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