A Middle Cuneiform Stress Fracture in an Adolescent Athlete: A Case Report and Literature Review

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ABSTRACT: A 13-year-old female soccer and basketball athlete presented with pain in the arch of her foot. Magnetic resonance imaging confirmed the diagnosis of a middle cuneiform stress fracture. The patient's stress fracture healed nonoperatively over a 10-week period complicated by nonadherence to a fracture boot, after which she was progressed back to full activity. Knowledge of these fractures and their treatment are important for sports medicine physicians, as they can often be overlooked, given their infrequent occurrence. There have been 8 previous case reports and 1 case series on cuneiform stress fractures, and these are summarized with this case report.

KEYWORDS: cuneiform, stress fracture, athlete, foot

RECEIVED: September 4, 2019. ACCEPTED: September 5, 2019.

TYPE: Case Report

FUNDING: The author(s) received no financial support for the research, authorship, and/or publication of this article.

DECLARATION OF CONFLICTING INTERESTS: The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Introduction

The foot is made up of a series of arches, which dissipate force and provide for functional movement during ambulation. Each arch is made up of bones, ligaments, tendons, and muscles. The cuneiforms role in maintaining the medial longitudinal arch and the transverse arch makes them a central part of the foot biomechanics exposed to both bending and compressive forces.¹,² While stress fractures in athletes are common injuries, stress fractures of the cuneiform bones are rare with a limited number of case studies.² The purpose of this case is to highlight a middle cuneiform stress fracture seen in an adolescent athlete and to provide a brief review of cuneiform stress fractures.

Case Report

A 13-year-old female athlete presented to the office with left foot pain of 2 weeks duration. The pain had started gradually as she transitioned directly into basketball following her soccer season, moving from soccer cleats to basketball shoes. She participated at a high level for both sports for her age. She had no history of similar pain, but had sprained her ankle 1 month ago. She had no recent dietary changes, and there were not any concerns about her diet from her parents. The pain was located in the arch and described as tingling, worse at night, and after practice, but improved in the morning. She tried putting inserts

Figure 1. Axial MRI left foot demonstrating cuneiform stress fracture.

Figure 2. Sagital MRI left foot demonstrating cuneiform stress fracture.
Table 1. Literature review of all case studies and series related to cuneiform stress fractures.

| AUTHOR                     | YEAR | DIAGNOSIS                                                   | MECHANISM/HISTORY OF INJURY                                      | CLINICAL COURSE                                                                 |
|----------------------------|------|-------------------------------------------------------------|-----------------------------------------------------------------|---------------------------------------------------------------------------------|
| Maseritz                   | 1936 | Left medial cuneiform stress fracture (first cuneiform)     | 39-year-old man with 10 days of pain and swelling of his left foot, worse with ambulation | Immobilization and treatment duration of 4 months                                |
| Childress                  | 1943 | Right middle cuneiform stress fracture (second cuneiform)   | 34-year-old man, developed pain 5 weeks after induction into the army | Treated for other foot conditions thought to be causing pain (ulcer and infection) but eventually improved with 8 weeks of regulated weight-bearing in a medium-soft rubber arch support |
| Muerman and Elfving (Case 1)| 1980 | Case 1: left lateral cuneiform stress fracture (third cuneiform) | Case 1: 20-year-old male military recruit with pain after running test | Not discussed in article                                                        |
| Muerman and Elfving (Case 2)| 1980 | Case 2: right medial cuneiform stress fracture (first cuneiform) | Case 2: 18-year-old male military recruit with several weeks of foot pain | Not discussed in article                                                        |
| Creighton et al            | 1990 | Left middle cuneiform stress fracture (second cuneiform)     | 55-year-old competitive triathlete with 4 months of dorsal mid-foot pain | Failed 7 months of conservative treatment, proceeded to have operative osseous decompression of the middle cuneiform, and began return to running schedule 4 months later |
| Khan et al                 | 1993 | Right medial cuneiform stress fracture (first cuneiform)     | 41-year-old male recreational runner with medial mid-foot pain running 25 km/week | 12 weeks of weight-bearing rest followed by a 4 weeks return to running progression |
| Bui-Mansfield and Thomas   | 2009 | Case 1: lateral cuneiform stress fracture (third cuneiform)  | Case 1: 330 lb 41-year-old man with heel pain and lateral foot pain | Not discussed in article                                                        |
|                            | 2009 | Case 2: middle cuneiform stress fracture (second cuneiform)  | Case 2: 208 lb 45-year-old woman with heel pain and mid-foot pain | Not discussed in article                                                        |
|                            | 2009 | Case 3: middle cuneiform stress fracture (second cuneiform), associated with a second metatarsal stress fracture, plantar fascia tear, and peroneus brevis tear | Case 3: 189 lb 50-year-old woman with heel pain and medial mid-foot pain | Not discussed in article                                                        |
|                            | 2009 | Case 4: lateral and medial cuneiform stress fracture (first and third cuneiforms) | Case 4: 200 lb 62-year-old woman with heel pain and dorsal mid-foot pain | Not discussed in article                                                        |
|                            | 2009 | Case 5: medial, middle, and lateral cuneiform stress fractures (first, second, and third cuneiforms) | Case 5: 132 lb 77-year-old woman with heel pain and mid-foot pain | Not discussed in article                                                        |
| Vukic et al                | 2013 | Right lateral cuneiform stress fracture (transverse stress fracture, third cuneiform) | 19-year-old female competitive soccer player with 12 months of mid-foot pain | Non-weight-bearing cast for 6 weeks, followed by 8 weeks of progressive rehabilitation with return to full activity at 14 weeks |
| Williams et al             | 2013 | Left lateral cuneiform stress fracture (third cuneiform)     | 15-year-old female cross-country runner and lacrosse player with 2 weeks of left foot pain during preseason lacrosse conditioning | 4 weeks of protected weight-bearing in a fracture boot, followed by gradual reintroduction to impact activities with return to full play at 6 weeks |
| Paisan et al               | 2017 | Right medial cuneiform stress fracture (first cuneiform)     | 23-year-old female recreational runner with several weeks of right foot pain | 4 weeks non-weight-bearing, followed by 4 weeks of progressive weight bearing in a boot, then gradual return to activity |
| This case                  | 2019 | Left middle cuneiform stress fracture (second cuneiform)     | 13-year-old female soccer and basketball athlete with 2 weeks of foot pain while transitioning seasons | 6 weeks of protected weight-bearing in a boot, followed by 2 weeks of partial weight-bearing with crutches in boot due to nonadherence, followed by 2 weeks of progression out of boot and then gradual return to activity |

*The medial cuneiform is also known as the first cuneiform. The middle cuneiform is also known as the second or intermediate cuneiform. The lateral cuneiform is also known as the third cuneiform.*
in her shoes without relief. On exam, she was well nourished and in no acute distress. She had no visible swelling, and the alignment of her ankle, knees, and hips appeared normal. She had good arches of her feet that were symmetric bilaterally, and her gait revealed no abnormalities. Range of motion of the foot and ankle were normal. She had tenderness over the proximal second and third metatarsals on both the dorsal and plantar surfaces. She also had tenderness over the dorsal and plantar surfaces of the cuneiforms, including the arch of the foot. X-rays were obtained in the office and were negative. Due to concern for a stress injury, a magnetic resonance imaging (MRI) was obtained. The MRI showed a stress fracture involving the distal and plantar aspect of the middle cuneiform, with a stress phenomenon noted at the base of the second and third metatarsals. Figures 1 and 2 show this finding.

She was placed in a boot for all weight-bearing activities. At 4 weeks, she was only having occasional pain. The decision was made to continue the boot for 2 more weeks. At follow-up, 2 weeks later (6 weeks total), the patient was still having pain. She admitted to participating in impact activity outside the boot at the gym since her last appointment. After discussion with the patient and her father, she was made partial weight-bearing in the boot with crutches with instructions to wean off the crutches once pain free. At a recheck 2 weeks later (8 weeks total), she was pain free walking in the boot without the crutches. She was weaned out of the boot over the next 2 weeks (10 weeks total) and then began a gradual return to impact activity without set back.

Discussion

Both traumatic and nontraumatic fractures of the cuneiforms are rare. Isolated fractures of the cuneiforms are reported to represent 1.7% of tarsal fractures in studies looking at traumatic fractures. Studies on cuneiform stress fractures are mostly limited to case reports. The first case of a stress injury to a cuneiform bone was published in 1936, where fragmentation of the medial cuneiform bone was noted along with other stress injuries consistent with “march foot.” Since that time, there have been an additional 7 case reports on 8 additional patients and a case series on 5 patients with cuneiform stress injuries associated with plantar fasciitis. These cases are further described in Table 1.

Owing to their positioning in the foot architecture, the cuneiforms are exposed to multiple forces throughout the gait cycle, with the medial cuneiform supporting the medial column of the foot between the first metatarsal and the navicular bone, and the lateral cuneiform being the “keystone” of the arch with 6 articulations. Given the position they maintain in foot biomechanics, one would expect to see injuries to the bones more frequently; however, this is not evident in the literature. One factor that may protect the cuneiform bones from stress injuries is their excellent blood supply, especially when compared to the adjacent navicular bone. The cuneiforms receive vascular contributions from the dorsalis pedis and medial plantar artery, as well as adjacent vessels through a network of anastomoses. The tensile and compressive forces that lead to stress fractures may eventually lead to cuneiform stress fractures if athletes did not have to stop training due to injuries to surrounding structures that lack a rich vascular supply and are more prone to structural failure. Several of the patients in the case reports and series had additional structural injuries with the cuneiform fractures, and an MRI study in 2007 showed early stages of edema in the cuneiforms of young physically active adults on images for other injuries. Major factors thought to contribute to the development of cuneiform stress fractures are biomechanical abnormalities, either congenital or acquired, which are sometimes secondary to other injuries such as plantar fasciitis and nutritional factors.

It is important not to overlook cuneiform or other tarsal bone stress fractures as causes of foot pain. Initial X-rays are often negative, and MRI is often needed to confirm the suspected diagnosis. Treatment of uncomplicated cuneiform stress fractures depends on severity. Most should improve within 4 to 6 weeks of protected weight-bearing in a fracture boot or with partial weight-bearing, followed by a gradual return to activities over a 4-week period. If pain persists after an initial 4 to 6 weeks, an additional 2 to 4 weeks of protected weight-bearing may be needed. Longer recovery times should be expected with additional comorbid injuries. Once recovered, it may be prudent to consider a gait and functional evaluation to look for biomechanical errors that may have contributed to the stress injury. In addition, nutrition evaluation may be considered in some athletic populations.

With prompt diagnosis and appropriate treatment, cuneiform stress injuries should heal without complication and are a low risk stress fracture. It is important that physicians maintain an appropriate index of suspicion for stress injuries to the cuneiforms in patients with mid-foot pain.

Author Contributions

PK and JB drafted, revised, reviewed, and approved the manuscript.

Informed Consent

The patient’s parent provided informed consent to publish this case study.

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