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Rare, non-displaced, sagittal plane fractures of the navicular body: A report of two cases

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Cases of non-displaced, sagittal plane fractures of the navicular are most commonly seen as stress fractures. Previous literature suggests that the mechanism of injury of most high impact falls have shown significant dislocation of the navicular counterparts or comminution to other structures of the foot. We present two rare cases of high impact injury creating sagittal plane fractures through the navicular body without any dislocation of the navicular or trauma to any surrounding structures. Two patients had similar high impact falls and mechanisms of injury leading to mirrored navicular fracture patterns. Surgical correction was performed in both patients. At three months postoperative both patients were clinically pain free in normal shoe gear, and radiographically healed. At one year postoperative both patients had maintained correction and had returned to full activity prior to injury, pain free. Both of these cases resulted from falls with a longitudinal compression force and an axial loading mechanism, generating these non-displaced, sagittal, navicular body fractures. Due to the avascularity of the body of the navicular and age of the patients, surgical correction of the fracture site was performed to help prevent non-union, avascular necrosis, displacement and future arthritic changes. Both patients had favorable surgical outcomes. There is a need to denote this mechanism of injury and corresponding fracture pattern within the current literature.

Keywords: bone, fall, foot, mechanism, midfoot, stress, trauma

Isolated fractures of the navicular bone are rare [1]. The navicular plays an essential role in the medial longitudinal arch and the stability of the midfoot structure as the keystone [2]. Loss of the height or alignment of the keystone can result in loss of 90% or greater of complex hindfoot motion [3]. Classification systems have been derived for fractures of the navicular and corresponding midfoot. Sangeorzan, et al., [4] classified displaced, intra-articular fractures of the tarsal navicular, while Watson-Jones [5] classified multiple navicular fracture patterns including the stress fracture. Though there have been classifications of fracture patterns, the discussion of the mechanism of action and injury is rarely researched and cited. Main and Jowett [6] were the first authors to describe multiple potential mechanisms of action of the navicular fracture. Rymaszewski and Robb [1] in 1976, proposed one revisional mechanism in a later case report and finally, Rockett and Brage [7] in 1997 assessed navicular fractures on Computerized Tomography reviewing five different fracture patterns and proposed another potential mechanism of injury not previously discussed in the literature.

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Figure 1 Preoperative radiograph of right foot in Patient 1.

Main and Jowett is still the most cited and well recognized classification system of navicular fracture mechanisms. This classification system was based solely on assessment of radiographic appearance of midtarsal fractures. It was developed by considering the direction of the fracture, the disruption of joints and malalignment of the foot. As stated by Main et al. tarsal navicular body fractures result from axial loading forces that occur frequently when falling from a height. The longitudinal compression forces on the talus lead to compression of the navicular into the cuneiforms, and the navicular to absorb the shock of impact [6].

We present two cases of high impact injury causing sagittal plane fractures through the navicular body, without dislocation of the navicular or surrounding structures.

Figure 2 Eight weeks postoperative radiograph of right foot in Patient 1.

Our case report reveals fracture patterns that appear consistent with stress fractures [8] while the mechanism of action correlates to dislocated, comminuted, corresponding fracture patterns. This mechanism of injury and corresponding fracture pattern has yet to be recognized in the current literature or described in any classification system.

Case Report 1

A 17-year-old male, with no significant past medical history, was treated from 08/2017 to 06/2019. He first presented to the emergency department after a bike riding accident. The patient reported he was 10-15 feet in the air doing a bike trick when he fell and landed directly on his right foot. He stated that he landed with his foot being pointed downward (plantarflexed) and landing on the ball of his foot.

The patient admitted to continuing to ride his bike for 20 minutes after initial injury until the pain became too severe. On physical exam the patient had midfoot edema but no ecchymosis or visible deformity present.

Plain radiographs were taken revealing a non-displaced, fracture in the sagittal plane through the body of the navicular. No comminution or dislocation was noted (Figure 1). The patient had surgery three weeks from the initial injury date. He was placed on the operating table in the supine position with an ankle tourniquet inflated. After IV sedation and local anesthesia, the fracture site was reduced percutaneously with a point-to-point clamp and a guide wire was placed across the fracture site from medial to lateral. Guide wire alignment and fracture reduction were then assessed with fluoroscopy imaging intra-operatively. Next, a small stab incision was made on the medial aspect of the navicular and a single 4.0 mm cannulated, cancellous, partially threaded screw was placed across the fracture site. The skin was closed with 3-0 nylon suture.

The patient was placed in a CAM boot to remain non-weight bearing with use of crutches. The sutures were removed at four weeks and the patient was permitted partial weight-bearing in a CAM boot at this time. He was seen again at eight weeks with zero out of ten pain. The radiographs revealed bony callus with cortical healing across the fracture site (Figure 2). The patient was advised to continue use of the CAM boot for two more weeks and then transition into normal shoe gear. The patient started his wrestling season at ten weeks post-operatively, and he was pain free. The patient was seen at three months postoperatively and had been ambulating in supportive shoe gear without pain and participating in wrestling and snow-boarding. The patient was evaluated again 12 months from initial surgery date and remained actively participating in sports and daily activities pain free.

Case Report 2

The second patient was a 26-year-old female, with no significant past medical history, treated from 10/2017 to 05/2019. She presented to our office after being referred from an orthopedic surgeon one week after her initial injury. The patient stated that she fell down a flight of stairs and landed on the ball of her left foot. On physical exam she had no apparent deformity, but localized edema at the midfoot. Plain radiographs showed a complete, non-displaced, sagittal plane fracture through the body of the navicular (Figure 3).

Surgery was performed one week after the initial injury date. She was placed on the operating table in the supine position with an ankle tourniquet inflated. After IV sedation and local anesthesia, the fracture site was reduced percutaneously and stabilized with a point-to-point clamp. Two guide wires were placed from medial to lateral, percutaneously, crossing the fracture site. A small stab incision was then made medially and two 4.0 mm cannulated, partially threaded screws were placed across the fracture site. Fluoroscopy imaging was performed intra-operatively confirming reduction of the fracture site and alignment of the screws. The skin was closed with 3-0 nylon.

The patient was placed in a CAM boot to remain non-weight bearing with use of crutches. Sutures were removed at four weeks postoperatively and the patient was permitted to partial weight-bear in CAM boot at this time. The patient was seen at eight weeks with two out of ten pain. The radiographs revealed bony callus and healing across the fracture site (Figure 4). She was advised to slowly transition out of the CAM boot over the following two weeks. The patient was evaluated again at three months postoperatively and she was playing with her kids pain free at this time. The patient was seen again at 12 months postoperatively and she continued to remain asymptomatic and ambulating in normal shoe gear and full activity.

Figure 3 Preoperative radiograph of left foot in Patient 2.

Figure 4 Eight weeks postoperative radiograph of left foot in Patient 2.

Discussion

These isolated fracture patterns with associated mechanisms of action are rarely cited in literature. Cases of non-displaced, sagittal plane fractures are most commonly seen as stress fractures. Most high impact falls have shown significant dislocation of the navicular counterparts or surrounding structures [9]. Although both cases resulted from high energy falls with longitudinal compression and an axial loading mechanism, they exhibited non-displaced, sagittal, navicular body fractures, without dislocation or comminution. This fracture pattern and corresponding mechanism of injury does not fit into any previously cited case.

Main and Jowett [6] go into great detail when discussing mechanism, classification and treatment of midtarsal joint injuries. They divided the midtarsal injuries into five major categories when assessing mechanism and fracture pattern. The two navicular injuries presented do not fit into any current classification of mechanism of injury and corresponding fracture pattern. The study by Rocket and Brage [7] most closely correlates to our findings. In their 4th patient, the radiograph revealed what appeared to be a non-comminuted, sagittal plane fracture through the body of the navicular. After computed tomography was performed they found a corresponding large plantar fragment suggestive of comminution. It is also important to note the patient had multiple calcaneal fractures from the corresponding injury as well. As Sangeorzan, et al., classified all of their fracture patterns as displaced fractures of the navicular, our fractures only revealed

a sagittal plane fracture without dislocation or comminution [4]. The majority of high impact navicular fractures are associated with either dislocation of navicular components or multiple bone injuries of the foot.

Isolated fractures through the body of the navicular lack significant blood flow [10] and frequently require internal fixation to ensure higher healing probabilities. Due to the avascularity of the body of the navicular [3] and young age of patients, it was appropriate to have surgical correction of the fracture site to help prevent non-union, avascular necrosis and future displacement or arthritic changes. Due to the lack of dislocation and ease of fracture site approximation, the ability to reduce and fixate these fractures percutaneously was both imperative and beneficial. Both patients having suffered high impact falls with minor osseous injury, had excellent surgical outcomes.

We propose the concept that there is potentially another mechanism of injury with corresponding fracture patterns, not previously cited in literature. The foot is accepting forces in an axial loading mechanism while the navicular is able to completely absorb the forces of the impact due to the talus and corresponding cuneiforms compressing at equal energies. These cases resulted from longitudinal compressive forces through the foot without any dislocation and allowing solely the navicular bone to absorb their impact.

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