Literature Review of Navicular Fractures

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Although not overwhelmingly fraught with complications, navicular fractures, especially in young athletes, can cause prolonged disabling foot pain if not diagnosed and treated adequately. The navicular plays a vital role in maintaining the medial longitudinal arch of the foot, and acute fracture or dislocation of the navicular can have a major impact on overall foot function. This review looks at the background, etiology, diagnoses, and standard treatment for navicular fractures.

Key words: navicular, fracture, stress

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The talonavicular joint plays an essential role in the stability, alignment, and accommodative motion of the foot during gait. Although well recognized in the athlete, these injuries are often overlooked in the polytrauma patient. This leads to a delay in diagnosis, which may lead to prolonged disabling foot pain. The purpose of this review is to explore current standards of treatment in order to optimize navicular fracture management.

Background

The navicular, cuboid, and cuneiform bones make up the midfoot with the navicular playing a vital role in maintaining the medial longitudinal arch of the foot. Acute midfoot injuries are quite uncommon and can have unusual patterns. They are usually the result of high-energy trauma. Therefore, injuries to the individual midfoot bones usually occur in a complex with other injuries, both bony and ligamentous. More than 70% of these navicular fractures are associated with dislocation or subluxation of the Lisfranc or midtarsal joint. Commonly, fractures of the navicular are not evident on plain radiographs. This often leads to a delay in diagnosis, which may result in prolonged disabling foot pain in individuals, particularly young athletes. These fractures, in particular, have a high incidence of avascular necrosis. Post-traumatic degenerative joint disease is not uncommon if the talonavicular joint surface is not adequately realigned.

The navicular is the most commonly fractured midfoot bone. It accounts for 0.5% of all fractures and may account for up to 35% of stress fractures in athletes. The overall incidence may appear to be
increasing due to advances in imaging and a higher index of suspicion. Among track-and-field athletes, up to 21% may experience a stress fracture in the course of a year. In these athletes, up to 15% of the stress fractures are of the navicular [2]. Navicular fractures are often the result of high-energy injuries. In athletic injuries, they are most common in jumping sports, such as track and field and basketball.

The navicular is boat-shaped. It is a pyriform-shaped when viewed from the posterior, the plantar-medial tuberosity is the bow, and the broader dorsal-lateral end is the stern. The proximal aspect is composed almost entirely of the cartilage-covered biconcave “socket” that articulates with the “dome” of the talar head. The distal surface of the navicular has three cartilage-covered articular facets, which are divided by two minor crests that articulate with the medial, middle and lateral cuneiforms. In some instances, a small lateral facet may articulate with the cuboid. The navicular also has a rich ligamentous network. The plantar calcaneonavicular ligament, or spring ligament, inserts onto the plantar aspect of the navicular to form the major static stabilizer of the talonavicular joint. This very strong ligament forms a joint surface of the talocalcaneonavicular joint as there is articular cartilage on the dorsal surface of this ligament. It supports the head of the talus and also helps support the medial longitudinal arch of the foot. The second major stabilizer is the medial component of the bifurcate ligament, or the calcaneonavicular ligament, which extends from the anterior process of the calcaneus to the superior lateral aspect of the navicular. The cuboideonavicular ligament has three components including the dorsal, interosseous, and plantar ligaments. The interosseous part is present when the joint is fibrous but not when the joint is synovial. There are also the cuneionavicular ligaments and the talonavicular ligaments as well. Eichenholtz and Levine described this dorsal talonavicular ligament and an anterior division of the deltoid ligament, known as the tibionavicular ligament [3]. Both offer strong support on the anteromedial aspect of the joint.

Vascular Supply

In 1982, Torg and colleagues performed microangiographic studies on five fresh cadaveric specimens [4]. Sarrafian also performed microangiographic studies on four year-old girl and thirteen year-old boy showing the blood supply to the navicular [5]. They noted it to be radial in nature. The blood supplied was predominately from branches of the dorsalis pedis artery and medial plantar artery. Torg noted that it received anywhere from 15-21 arterial branches total. They also noted the central third relatively hypovascular which is why most non-unions and stress fractures occur there. It is not unusual to see evidence of navicular collapse or avascularity in older patients who do not have a history of acute trauma. The navicular also has poor penetrating nutrient vessels. Sarrafian noted that perfusion tends to recede over time from ages from 20-65.

More recently, McKeon and others looked at both the intraosseous and extraosseous blood supply to the navicular in adults [6]. They used sixty below-the-knee legs from thirty cadavers. They injected India ink and Ward’s blue latex into the anterior tibial, peroneal and posterior tibial arteries. After freezing and then thawing these cadavers, authors assessed the navicular vascular supply in fifty-five specimens and reviewed the intraosseous vascularity in fifty-four specimens. The results showed the medial tarsal branches of the dorsalis pedis consistently supplied the dorsal navicular in 53/55 specimens or 96.4%. Lateral tarsal branches also supplied the dorsal navicular. The medial plantar bone received blood supply from small branches of the superficial branch of the medial
plantar artery. A large percentage, or 58.8% of the specimens, had a diffuse intraosseous vascular supply throughout the bone while only 11.8% of specimens, or 6/54, had an avascular zone in the central third of the navicular extending to the dorsal cortex. The authors concluded that biomechanical or other clinical factors might play a more prominent role in these types of stress fractures.

Figure 3. Navicular Blood Supply [6]

Biomechanics

Acute fracture or dislocation of the navicular can have a major impact on overall foot function. Talonavicular joint plays an essential role in the stability, alignment, and accommodative motion of the foot during gait. Hansen described essential joints which are needed for proper gait and include the talonavicular joint; non-essential joints which provide a function but are not absolutely needed; and unnecessary joints which are usually the flat stable midfoot bones which do not provide much motion [7]. The navicular is part of two important structures that are essential for normal gait: the medial longitudinal arch and the transverse tarsal joint. The medial longitudinal arch is composed of the navicular as the keystone or the “spacer”, the calcaneus, talus, three cuneiforms, and three medial metatarsals. This arch provides support for normal gait, in particular from mid-stance until push-off. The transverse tarsal joint is essential for normal gait and is composed of the talonavicular joint and the calcaneocuboid joint. At heel strike, this joint is flexible as the TN and CC joints are parallel and unlocked. This plays an important role in absorbing ground impact and accommodating the foot to the ground. At push-off, the transverse tarsal joint is nonparallel and locked and this stability allows for forward propulsion. Cadaveric studies have shown the TN articulation to control approximately 80% of hindfoot motion. Therefore, restoration of anatomic integrity of this joint complex is paramount to maintaining normal gait mechanics after injury.

Stress fractures of the navicular bone, which are common, are a result of an impact to the bone resulting in compression between the cuneiforms and the talus acting like a nutcracker. This type of stress to the bone is likely cause stress injury or fracture. Some authors believe the central portion of the navicular, unlike the medial and lateral poles, has a decreased amount of cancellous bone that will also decrease the navicular bone’s ability to handle compression. There is also the torsional shear to the central portion of the bone as the strong posterior tibial tendon, spring ligament and tibio-navicular ligament pull medially while the bifurcate ligament pulls laterally. It is the combination of these genetically-induced shear and longitudinal forces superimposed upon a hypovascular region that sets the stage for a stress injury.

Symptoms & Diagnosis

In the poly-trauma patient, navicular fractures are often overlooked. If there is an acute injury, more edema is localized dorsally rather than plantarly due to soft tissue coverage. Compartment syndrome must also be ruled out in these patients. If the condition is subacute, most pain may be during and after physical activity. It can initially be generalized following injury, but as time progresses, the pain is typically located to the dorsum of the navicular. It is aggravated with pressure over the dorsal central navicular or upon single heel rise or upon push off. Patients may have pain when standing on their toes or hopping from a plantarflexed position. This should be part of the physical exam. Uncommonly, they may be unable to bear weight. In the subacute cases, they will not have ecchymosis nor edema and range of motion will be full. If insidious in nature, a stress
fracture must be ruled out. Symptoms of navicular stress fractures are often misdiagnosed with a midfoot sprain, anterior or posterior tibial tendinitis, or plantar fascia injury. Pain is often described radiating into medial arch. In 1982, Torg and colleagues described an area between the tibialis anterior tendon and the extensor hallucis longus tendons corresponding to the dorsal central portion of the navicular, which is tender on palpation in 81% of his cases [4]. Khan et al later referred to this as the “N-Spot” in his 1994 study [8].

Unfortunately, diagnosis is often delayed after onset of symptoms. Initially imaging should almost always be plain film radiographs. The primary advanced imaging modality is based on the history of present illness and physical exam. Most fractures are incomplete fractures, as in stress fractures, or spontaneously reduce after injury. Therefore, they are commonly missed and diagnosed as a midfoot sprain. It is only after the patient has continued pain that more imaging or advanced imaging is pursued. Bone scans are highly sensitive but not specific. They can be hot for up to sixteen months after union. Bone scans are only valuable to confirm the absence of a stress injury or reaction. Secondly, bone scans yield no qualitative information; therefore, the physician cannot appreciate the “personality” of the fracture. Several studies have shown only 10% to 39% of positive bone scans had plain radiographic evidence of a stress fracture leading to the fact that bone scans can be more valuable to diagnosis that plain film [2]. Magnetic resonance imaging are highly sensitive but costly. Advantages include the absence of radiation exposure to the patient. MRIs deliver detailed information about soft tissue injuries. It will also aid in assessing the integrity of posterior tibial tendon if suspicion has arisen during the physical exam (of greater significance if the medial oblique x-ray has shown a tuberosity fracture). MRIs are also valuable in helping to determine the possible presence of avascular necrosis and the extent of talonavicular arthritis. However, it should be noted that MRI does not differentiate between edema of navicular stress fracture and AVN.

Physicians should only consider computerized tomography imaging of the tarsal navicular after making the primary diagnosis of a stress injury either by bone scan or MRI, or by first acquiring an x-ray if it is an acute injury. If CT scanning is the first imaging modality used, then the physician will not appreciate early stress reactions without fracture. Failure to identify early stress reactions could lead to a misdiagnosis and eventual fractures. Therefore, CT is the gold standard after positive bone scan or MRI. Computed Tomography allows one to determine the characteristics of the fracture, including location, completeness, displacement, and direction. Sclerosis and cystic changes can also be appreciated. A CT scan can also play a vital role to confirm healing of the fracture even with the presence of screw fixation over both MRI and bone scan.

Titanium hardware is not advisable in the fixation of navicular fractures. Although it permits the use of MRI in the event of nonunion or avascular necrosis, these diagnoses can be made with a CT scan. Most importantly, removal of titanium hardware from the foot in these instances is fraught with complications such as head stripping, breakage, and extensive bone removal to identify the buried hardware. Most surgeons would stick with the traditional cheaper stainless steel constructs.

**Classification**

Most midfoot injuries are not isolated and are part of a complex of injuries including Lisfranc and Chopart patterns. Therefore, isolated navicular fractures are more the exception than the rule. Watson-Jones published a paper in 1955 describing these fractures.
based on their patterns [9]. Type 1 Watson-Jones navicular fractures are tuberosity fractures; type 2 are dorsal lip avulsion fractures; and type 3 are body fractures. Towne and colleagues first described stress fracture of the tarsal navicular in 1970 [10]. Walter and Goss later modified this and although non-acute, stress fracture is commonly added as the fourth type of navicular fracture.

Navicular tuberosity fractures make up approximately one-quarter of navicular fractures. They accounted for 24% of fractures of the navicular in the series reported by Eichenholtz and Levine [3]. It is caused by the anterior slip of the posterior tibialis tendon with a forced eversion of the foot. The physician must distinguish a tuberosity from an os tibiale externum or accessory navicular, which is found in about 12% of the population. This fracture can be seen on a medial oblique view of plain film x-ray, however a CT scan is best for diagnosis.

Dorsal avulsion fractures are the most common type of navicular fracture. They accounted for 47% of fractures of the navicular in the series reported by Eichenholtz and Levine. The mechanism of injury is usually caused by a minor twisting that results in a cortical avulsion fracture with or without ligamentous or capsular involvement. It is commonly associated with a midfoot sprain, lateral ankle sprain, or forced inversion or eversion on a plantarflexed foot. It is best seen on the lateral radiograph. Patients typically will have point tenderness on the dorsal or dorsal-medial aspect. Navicular body fractures are typically described as the least common of the three types. They account for 19.67% of all navicular fractures. The mechanism of injury of this type of navicular fracture is usually through an axial load when the ankle is in equinus and a longitudinal thrust is forced along the metatarsals. This was first described as a transverse body fracture with dorsal fragment dislocation but may also follow an unhealed stress fracture. Isolated injuries are rare due to the high-energy impact of these types of injuries.

Proper management of these fractures is imperative and it is vital to not lose the keystone of the medial longitudinal arch and eventual progression to a flatfoot deformity. TN or NC arthrodesis may be warranted depending upon the amount of comminution and articular incongruity. Unfortunately, talonavicular subluxation is seen frequently. CT scans are extremely helpful in preoperative planning and anatomic reduction essential.

In 1989, Sangeorzan et al reported a 7-year retrospective study that described a classification system for displaced intra-articular navicular body fractures based on the orientation of the fracture line [11]. These three types which seem to, based on Sangeorzan’s article, increase in injury severity with regard to relative energy and fracture personality and decrease in propensity for gaining a satisfactory operative reduction as one proceeds from type 1 to 3.

Type 1 navicular body fractures display a fracture line in the coronal plane, parallel to the WB surface, with dorsal and plantar fragments with no angulation of the forefoot. The dorsal fragment consists of less than 50% of navicular body. Type 2 body fractures have a primary fracture line in the dorsal-lateral to plantar-medial orientation. With this injury, the major fragment and forefoot are displaced medially. The major fragment is dorsomedial, with a small, often comminuted plantar lateral fragment. The calcaneonavicular joint is not disrupted. Type 2 body fractures the most common type of body fracture. Type 3 body fractures are comminuted fractures usually in the sagittal plane and the forefoot is laterally displaced. The medial NC joint is disrupted and the
CC joint may be disrupted. Restoration of the talonavicular joint is imperative to prevent subluxation.

Towne and others first described stress fracture of the tarsal navicular in 1970 [10] explaining it as an impaction to the bone resulting in compression between the cuneiforms and the talus. This impingement is more significant in light of vascular anatomy. Torg and colleagues first described this avascularity to the central one third of the body in 1982 when he performed microvascular studies on five fresh cadaveric specimens [4]. There is a male predilection and 14-35% of all patients with stress fractures that present to a primary care physician are of the navicular. One study stated that of all the navicular stress fractures that came in, 59% were track and field athletes. Patients’ symptoms are typically insidious or misdiagnosed with a midfoot sprain, anterior or posterior tibial tendinitis, or plantar fascia injury. The majority of patients, 81%, displayed pain at the N-spot. Pain was worst when standing on their toes due to the compression that it creates across the navicular [4]. They also may have pain along dorsal-medial foot radiating into medial arch. The physician needs to have a high index of suspicion for the stress fractures. According to the Torg study in 1982 of 21 navicular fractures, diagnosis was delayed a mean interval of 7.2 months between the onset of symptoms and diagnosis.

CT is the gold standard as it allows one to determine the characteristics of the fracture, including location, completeness, displacement, and direction. Early stages of involvement demonstrate a partial fracture line that appears to propagate from the proximal dorsal cortex. The fracture line develops in the sagittal plane and courses from the proximal dorsal cortex to the distal plantar aspect of the navicular in a slight oblique direction, usually dorsal-medial to plantar-lateral. This fracture pattern almost always arises in the central to central-lateral one third of the navicular, which coincides with a vascular watershed in the bone.

Saxena published a study in 2000 based on twenty-two stress fractures proposing a CT scan-based classification system that divided these fractures into three groups: type I dorsal cortical break; type II fracture propagation into the navicular body; and type III fracture propagation into another cortex [12]. Numerous predisposing factors have been implicated in the development of navicular stress fractures including pes cavus, short first metatarsal, metatarsus adductus, limited subtalar or ankle motion, medial narrowing of the talonavicular joint. No study has clearly demonstrated a statistical significance in any of these. However, Torg in his 1982 study found that 80% of his patients had metatarsus adductus.

Management

Digiovanni in 2004 recommended four keys in operative management of navicular fractures [2]. He noted that the keys to successful operative management of navicular fractures are careful planning of surgical approaches and indirect reduction in order to: 1. restore its length and relationships along the medial column 2. maintain the integrity of the posterior tibial tendon insertion 3. preserve early range of motion and articular congruity of the talonavicular joint 4. preserve stability and alignment of the naviculocuneiform joint. This standard should be kept in mind when addressing all types of navicular fractures.

Navicular tuberosity fractures, or type 1 Watson-Jones fractures, are caused by the anterior slip of the posterior tibialis tendon with a forced eversion of the foot. Due to the broad attachment of posterior tibial tendon, DiGiovanni recommended small or minimally displaced fragments, 2-3mm, to be treated symptomatically in a short-leg cast or walking boot for four to six weeks [2]. Non-unions are uncommon in these fracture patterns. Indications for fixation of the avulsed tuberosity include involvement of a significant portion of the articular surface and displacement of the fragment. Sangeorzan in 1989 recommended operative fixation for displacement of 5mm or more, which indicates incompetence of the
posterior tibialis tendon [11]. Closed reduction can be performed by adducting and inverting the foot, opposite the mechanism of injury, followed by k-wire stabilization. If closed reduction fails, limited open reduction can be performed through a dorsomedial incision between the insertions of the anterior and posterior tibial tendons. Fixation of large tuberosity fractures can be achieved with a mini or small fragment lag screw and washer construct. If the symptomatic displaced navicular tuberosity is significantly comminuted or too small to hold adequate fixation, excision of the accessory bone or small fracture fragments and advancement of the PT tendon to the remaining intact navicular body can be performed.

Dorsal avulsion fractures, or type 2 Watson-Jones fractures, are caused by minor twisting injury that results in a dorsal ligamentous and capsular avulsion fracture. Despite these being articular, they do not often require surgical intervention due to their small size. Typical conservative treatment is four to six weeks in immobilization boot with progressive weightbearing. Eichenholtz stated if the avulsion is greater than 20% of the articular surface, then limited open reduction internal fixation is warranted [3]. This is particularly true when the intra-articular involvement is on the talonavicular side as opposed to the naviculo-cuneiform side.

Navicular body fractures, or type 3 Watson-Jones fractures, were further divided by Sangeorzan into three subtypes. These body fractures are treated invariably treated surgically, and anatomic reduction is absolutely essential. Timing of surgery is important in these high-energy injuries and edema control must be addressed. Allowing the soft tissues to subside in swelling is vital and can be evaluated with the wrinkle test. Surgical intervention can be pursued typically five to ten days after injury. During operative intervention of the navicular body itself, two important premises guide the surgical approach regarding incision placement and number: only two thirds of the talonavicular joint can be visualized through any single incision; and incision location should be determined by the fact that one must be able to see two joints and the fracture fragments at the same time [11].

Type 1 body fractures have a primary fracture line in the coronal plane and are the easiest body fracture to reduce and fix. Typically, an anteromedial approach is made between anterior and posterior tibial tendons. A small capsulotomy can be performed over the TN joint to visualize TN articular surface. Direct reduction can be performed using pointed reduction forceps through stab incisions or indirect reduction using distractor or external fixation. Using a distractor or external fixator, which is placed proximally in the talus or medial malleolus and distally in the cuneiforms or first metatarsal, the surgeon can visualize the articular surfaces for more precise reduction before placing the compression screws. If it is a large fragment, two 3.5mm cortical screws in a lag fashion from dorsal to plantar can be used. If it is a smaller fragment, 2.4 or 2.7mm screws can be used.

Type 2 body fractures are the most common type of body fracture with the primary fracture line in the dorsal-lateral to plantar-medial orientation. Longitudinal mid-axial dorsomedial incision is usually performed. Indirect reduction is ideal with the use of k-wires as joysticks. The primary goal is to realign the TN articular surface and the NC joint is more forgiving in articular incongruity. The dorsomedial fragment may be reduced and fixed with 2.4-mm, 2.7-mm, or 3.5-mm lag screws that are aimed obliquely.
into the plantar lateral fragment if there is no significant comminution. Alternatively, the medial fragment may be stabilized with screws or wires into middle and/or lateral cuneiforms if the plantar lateral fragment is comminuted. Relationships among the medial and lateral columns are important otherwise abnormal midfoot and hindfoot motion result. Because the talonavicular joint tolerates little stiffness or posttraumatic arthrosis before significantly impacting long-term foot function, a mini external fixator is often required to decompress the joint. It also allows comminuted fragments to reduce adequately. External fixation is usually taken out at the six to eight week mark.

Figure 7. Type 2 Navicular Body Fracture with External Fixation

Type 3 body fractures are the most severe type of navicular fracture with the worst prognosis due to their comminuted nature. They are the most prone to avascular necrosis, posttraumatic arthrosis, stiffness, and late collapse. A standard dorsomedia and mediodorsolateral incision can be centered over the predominant, most lateral fracture line. Care must be taken to avoid the deep peroneal nerve. Interfragmentary compression is typically not possible while buttressing and neutralization is the goal to maintain navicular length and TN reduction. The surgeon can fixate the medial or dorsomedial fragment to cuneiforms thereby reducing the navicular fracture and NC joint disruption. Restoration of talonavicular joint is imperative to prevent subluxation. Satisfactory reduction is defined as restoration of at least 60% of TN joint surface as 60% is required to prevent subluxation of talonavicular joint after healing [11]. Bone grafting is required for most of these fractures with autogenous bone graft being preferred. Bone stimulation should be used for central third fractures while a mini external fixator can be used to decompress the joint. External fixation also allows comminuted fragments to reduce adequately and after an acute injury to allow the soft tissue edema to subside. NC fusions may be of benefit for medial column stability if the joint surfaces are inadequate due to comminution. NC fusions also have the theoretical advantage of improving the vascular inflow of a severely devascularized navicular but no studies have proven this.

Post-operative care for navicular body fractures vary by type. For type 1, non-weightbearing for two weeks with gradual progression to weightbearing in an immobilization boot is recommended. Then early active range of motion at the two-week mark is typically begun. For types 2 and 3 body fractures, non-weightbearing for six weeks is recommended with a short leg cast at the two-week mark. Physical therapy and weight-of-leg WB begins at the six-week mark in an immobilization boot. Gradual progression to WB can begin at the twelve-week mark pending x-ray or CT. Full weightbearing and bony union at is commenced at week 16. Full recovery takes upwards of one year.

Most stress fractures are non-displaced complete and partial stress fracture patterns. These warrant six to eight weeks in a non-weightbearing cast followed by functional rehab and progressive weightbearing. This protocol was established by Torg and then later by Khan. In 1992, Khan and colleagues made the most extensive series of navicular stress fractures comparing conservative and surgical treatments [13]. This was a retrospective study with eighty-two athletes with eighty-six clinical navicular stress fractures from five institutions. The delay in diagnosis had a mean of four months. They reported that 86% of their patients were able to return to
activity in their respective sport at approximately 5.6 months with a 6-week course in a non-weightbearing cast. This result was significantly poorer in patients who were in a non-weightbearing cast for less than six weeks (69%), with limitation of activity with full weight bearing (50%), or with no limitation and activity restriction (20%). They had an 83% success rate with immediate surgical intervention on five out of six patients with earlier return to activity at 3.8 months. However, their study did not provide a stratification of the fracture type or pattern in each group. A repeat CT scan may be used as an adjunct to clinical evaluation of healing in highly competitive athletes.

Displaced complete fracture patterns or even non-displaced complete stress fractures with sclerotic changes are also conditions to which surgical treatment should be warranted; however, some controversy exists on whether non-displaced complete fractures warrant surgical intervention. The literature demonstrates the ability of these fractures to heal without surgery but often at the cost of prolonged cast immobilization and non-weightbearing. Surgical treatment is becoming more commonly accepted as the primary treatment in the athlete in order to minimize time away from the sport and risk of refracture. Displaced complete stress fracture patterns warrant ORIF with screws perpendicular to fracture plane with or without bone graft. Most surgeons err on the side of bone grafting. If the CT scan shows no signs of any sclerosis of the bone, one can place two percutaneous screws. However, this is often the exception rather than the rule as most patients present with some degree of sclerosis (thus requiring some type of graft). All sclerotic bone must be removed. A wire pass drill can be used medially and laterally to stimulate blood flow to the area. It is important to release the tourniquet at this time to check for adequate removal of the sclerotic bone and the return of blood flow medially and laterally. One of the errors that leads to nonunions is the inadequate removal of all the sclerotic bone. Autologous bone graft is preferred and Grambart described using the lateral wall of the calcaneus for navicular stress fractures [14]. Two 4.0mm partially threaded screws can be placed perpendicular across the fracture site usually in the lateral to medial direction. Care must be taken not to violate the PT tendon and that the hardware is not palpable. Patients are typically in a NWB cast for four to six weeks.

Kiss and colleagues performed a retrospective review in 1993 reporting on CT scan findings before and after treatment, both surgical and conservative, of fifty-five navicular stress fractures in fifty-four patients [15]. They found that the earliest clinical sign of healing was dorsal cortical bridging and that this was clearly seen in eight patients that were scanned at the six-week mark. It was also noted that all fifty-five of the fractures were in the central one-third. Ninety-four percent (53/55) were partial fractures as well. Saxena reported on nineteen patients, all athletes, involving twenty-two navicular fractures in whom they found a significant difference in time to return to activity in type I and II versus type III 3.0 and 3.6 months to 6.8 months, respectively [12]. The average return to activity for the ORIF group was 3.1 months while the average return to activity for the nonsurgical group was 4.3 months. However, as this was a retrospective study, approximately half of each of the three groups each underwent surgery while the other half underwent NWB. Their conclusion was that complete fractures take nearly twice as long to heal and ORIF in any of the three groups will significantly decrease the healing time. The authors also felt that type II and III fractures should be approached more aggressively and advocated early surgical intervention.
There are numerous complications that all navicular fractures share. Partial or complete avascular necrosis, with subsequent late partial collapse of the bone and narrowing of the joint cartilage, are common. It occurs in approximately one-third of body fractures and has a higher incidence in more comminuted fracture types. Nonunions, delayed unions, and malunions have a higher incidence in more comminuted fracture types. These are best treated with autogenous bone grafting and arthrodesis. Post-traumatic DJD and arthrosis are the most common complications of navicular fractures. It is vitally important to adequately reduce the talonavicular articular surface to at least 60% as sited. In Sangeorzan’s study, type 3 body fractures had the worst prognosis with only half adequately reduced. Post-traumatic arthrosis is most likely to have a similar frequency in the NC joint compared to the TN joint but less noticed secondary to the mobility. Gastrocnemius recession should be considered to prevent midfoot breakdown. Medial column fusion with an interposition bone graft to reestablish the length of the medial column or even a triple arthrodesis may later be required. Arthrodesis of the essential talonavicular joint should be avoided if at all possible.

Conclusion

To summarize, the primary goal is the preservation of length and stability along the medial column of the foot. Open reduction and internal fixation may be required for anatomic restoration of displaced intra-articular fractures. Due to tenuous blood supply, navicular vascular supply must not be compromised in order to reduce risks of avascular necrosis and nonunion. The talonavicular joint plays an “essential” role in the stability, alignment, and accommodative motion of the foot during gait and therefore, congruity and early range of motion are vital. External fixation, bone grafting, and bone stimulation are all adjuncts that aid in proper navicular fracture management.

References

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