Avascular or Fragmented Navicular: Either Way to the Nutcracker

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Fractures of the Navicular & Their Complications

I. Case 1 - Fracture leading to AVN
   A. These cases demonstrate complications that may arise related to traumatic injuries of the tarsal navicular, whether that be acute, chronic or repetitive microtrauma (stress injuries)
      1. Navicular anatomy
         a. Keystone to the longitudinal arch
         b. Bears longitudinal stresses
         c. Base of the medial column
      2. Vascular anatomy
         a. Dorsal \rightarrow branch of dorsalis pedis artery
         b. Plantar \rightarrow medial plantar artery
         c. Extensive articular surface limits vascular supply
         d. Central 1/3 relatively avascular “watershed” area
            i. Recent study suggestive of a more dense/diffuse intraosseous blood supply indicating a possible larger biomechanical and clinical role in the development of stress fractures (McKeon et al. FAI 2012)
      3. Traumatic injuries are the most common cause of AVN (Buchan et al. 2012)
         a. Sangeorzan classification for navicular body fractures (Sangeorzan et al. JBJS 1989)

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
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<tr>
<td>Type I</td>
<td>Transverse fracture producing plantar fragment and a dorsal fragment that involves &lt;50% of bone. NO associated deformity.</td>
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<tr>
<td>Type II</td>
<td>Oblique fracture, usually from dorsolateral to plantar-medial. May have forefoot ADDuction deformity.</td>
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<tr>
<td>Type III</td>
<td>Central or lateral comminution. ABDuction deformity.</td>
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b. Types I & III body fractures \rightarrow greatest disruption in radial blood supply and risk of AVN
i. Probable soft tissue stripping contribution at time of injury/surgical exposure

4. Treatment
   a. Goal of late treatment in symptomatic collapse is to eliminate painful motion and maintain medial column length (DiGiovanni et al. JAAOS 2007)
      i. Bone-block midfoot fusion
      ii. Triple arthrodesis

II. Case 2 - Fracture leading to nonunion
   1. Etiology
      a. Likely again related to the tenuous blood supply of the navicular and propensity for initial/early injuries to be missed or go undiagnosed (Tuthill et al. Foot Ankle Spec 2014)
      b. Type I & III body fractures also at greatest risk of nonunion (DiGiovanni et al. Foot Ankle Clin 2004, DiGiovanni et al. JAAOS 2007)
      c. Typically occurs in the central “watershed” area
   2. Incidence
      a. Difficult to determine true incidence due to lack of post-treatment imaging to determine healing vs. nonunion
      b. Varying reports
      c. Conservative treatment
         i. Torg et al.: JBJS, 1982
            • 0/10 patients with navicular stress fractures had a nonunion after at least 6 weeks of NWB and cast immobilization
         ii. Khan et al.: AJSM, 1992
            • 1/22 patients with navicular stress fractures had a nonunion after 6-8 weeks of NWB and cast immobilization
         iii. Saxena et al.: J Foot Ankle Surg, 2000
            • 2/13 conservatively treated navicular stress fractures went on to apparent nonunion
      d. Surgical Treatment
         i. Fitch et al.: JBJS Br, 1989
            • 1/19 patients with navicular stress fractures went on to nonunion after surgery with bone grafting
            • 0/22 patients with navicular stress fractures had a nonunion following ORIF
         iii. McCormick et al.: AJSM, 2011
            • 2/10 patients experienced a nonunion following surgical treatment with rigid fixation for a navicular stress fracture
   3. Treatment
      a. Should be managed surgically with bone grafting and rigid fixation (Mann & Pedowitz Foot Ankle Clin 2009; Rosenbaum et al. Orthopedics 2014)

III. Case 3 - Fracture with healing and subsequent re-fracture
   1. Fractures divided into 4 categories
      a. Avulsion fractures
         i. Low energy, excessive plantar flexion forces applied to midfoot
      b. Tuberosity fractures
         i. Also an avulsion type fracture
ii. Forced foot eversion against a contracting posterior tibial tendon  
c. Body fractures  
i. High energy, axial load or crushing-type mechanisms  
ii. Broken down into 3 types as noted above  
d. Stress fractures  
i. Usually seen in athletes, such as basketball players, sprinters or gymnasts, performing explosive activities or jumping  
ii. Typically occurs at junction of central and lateral thirds due to area of hypovascularity with area of maximal shear stress  
iii. 3 types described by Saxena et al.  

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<tr>
<td>Type I</td>
<td>Dorsal cortical fracture</td>
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<tr>
<td>Type II</td>
<td>Dorsal fracture propagates into navicular body</td>
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<tr>
<td>Type III</td>
<td>Fracture penetrates second cortex</td>
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2. Typical conservative treatment regimen for partial or non-displaced fractures:  
a. Short leg cast and NWB for at least 6 weeks  
i. Repeat full WB radiograph in 10-14 days to ensure fracture stability  
b. Progression to WB after patient is asymptomatic to manual manipulation  
c. Start with nonimpact activities (stationary bike, elliptical, swimming)  
d. Slowly progress through strengthening and sport specific training as long as pain/symptoms do not recur  

IV. Case 4 - Re-fracture following removal of hardware  
1. Typical post-op rehab includes:  
a. 6-8 weeks NWB cast immobilization  
b. ROM and gradual progression of weight-bearing as symptoms allow starting at 6-8 weeks  
i. Supportive brace should be used until pain-free full WB is achieved  
c. Sport specific training  
d. Return to full activity around 4 to 6 months  
2. As with any injury/surgical repair, premature return to activity/play greatly increases risk for re-injury  

V. Case 5 - Comminuted fracture leading to osteoarthritis  
1. Post-traumatic arthrosis common following intra-articular fractures  
a. Goal should be for anatomic reduction and >2 mm articular step-off should be managed surgically to achieve best reduction possible  
2. Chondral damage at time of injury often leads to degenerative changes regardless of acceptable articular surface reduction  
3. Arthrodesis in the anatomic alignment often effective in relieving pain  
a. Naviculocuneiform arthrodesis well tolerated
b. Talonavicular arthrodesis limits hindfoot motion by 80% and impairs ability for foot to accommodate uneven surfaces

VI. Case 6 - Long screw penetrating medial navicular leading to posterior tibialis tendon rupture
   1. Placement of the cannulated cancellous screws should be placed with caution due to the size, shape and curvature of the navicular bone

References

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