Nagging Injuries in the Athlete: Tibial, 5th Metatarsal and Navicular Stress Fractures

Kenneth J. Hunt, M.D.
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Nagging Injuries in the Athlete

Stress Fractures in the foot, ankle and lower extremity are very common in elite athletes.
Nagging Injuries in the Athlete

**Stress fracture:**

A partial or complete bone fracture that results from **repeated application** of **stress** of a **lower magnitude** than the stress required for bone to fail in a single loading.

Many occur as an acute injury **after** build-up of stress.
Nagging Injuries in the Athlete

Who gets them?

• Annual incidence of stress fractures in athletes estimated 2% to 21%.

• Track and field
  – Distance runners
  – Sprinters

• Basketball

• Tennis

• Volleyball

• Soccer
Stress Fractures in the Athlete

The Burden

- Up to 20% of Sports Medicine Visits
- 80% are in Foot/Legs
- “High Risk” stress fx:
  - Tibia
  - Navicular
  - Proximal 5th Metatarsal (Jones)

High risk of displacement, non-union or refracture, requires surgical decision-making

Fredericson et al. 2006. Top Magn Reson Imaging
Risk Factors
Stress Fractures

• Intrinsic risk factors:
  – Muscle fatigue/poor conditioning
  – Weakness/strength imbalance
  – Menstrual/hormonal irregularities
  – Lower limb malalignment
  – Foot structure (cavovarus)
  – Height - Tall stature
  – Genetic predisposition

Unmodifiable
Risk Factors

Stress Fractures

Pes cavus = High arch foot

Varus

Pes planus = Flatfoot

Valgus
Risk Factors

Stress Fractures

• **Extrinsic risk factors**
  – Excessive volume or intensity of training
  – Change in training regimen
  – Change in training surface
  – Worn-out training shoes
  – Cigarette smoking
  – Inadequate nutrition –
    • calories, calcium, vitamin D
  – Medications-
    • chronic steroid use
Risk Factors
Stress Fractures

- Female Athlete Triad:
  - Disordered eating
  - Amenorrhoea/oligomenorrhoea
  - Osteopenia

- 50% increase in stress fracture risk

Barrack et al., 2014 AJSM
High Risk Stress Fractures

• Tibia
  – Posterior cortex
  – Anterior tibial cortex
  – Medial malleolus

• Navicular

• 5th Metatarsal (Jones fracture)
High Risk Stress Fractures

- **Tibia**
  - Posterior cortex
  - Anterior tibial cortex
  - Medial malleolus
- **Navicular**
- **5th Metatarsal (Jones fracture)**
Tibia Stress Fractures

- Most common stress fx in active population
  - Military recruits
  - Running and jumping athletes (very little data)
- Up to 75% of chronic leg pain in athletes
- Posteromedial cortex is most common location
Pathophysiology

• Disrupted bone homoeostasis and inadequate repair in the face of repetitive overload
Pathophysiology

- Disrupted bone homoeostasis and inadequate repair in the face of repetitive overload
- Wolff’s law
  - Remodeling of microdamage
Pathophysiology

- Disrupted bone homoeostasis and inadequate repair in the face of repetitive overload
- Wolff’s law
  - Remodeling of microdamage
- Repeated pull of the gastrocnemius/soleus complex contributes to failure the bone
  - Proximal third in young patients
  - Mid/distal 1/3 junction in runners
Clinical Features

• Pain with activity
  – Especially longer periods
• Mild discomfort → persistent pain
• Eventually unable to participate/train
• Pain persists after cessation of activity
  – Night pain
• Exam:
  – Tenderness at midshaft tibia (medial border)
  – Swelling, erythema, warmth
Radiographs

- Normal in early stages
- Lucency followed by Cortical thickening at 2-3 weeks
### $^{99}$Tc Bone Scan versus MRI

- Bone scan pos at 2-8 days
- MRI more sensitive and specific

<table>
<thead>
<tr>
<th></th>
<th>MRI</th>
<th>CT</th>
<th>Bone Scan</th>
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<tbody>
<tr>
<td>Sensitivity</td>
<td>88%</td>
<td>42%</td>
<td>74-90%</td>
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<tr>
<td>Specificity</td>
<td>95-100%</td>
<td>89-100%</td>
<td>33-47%</td>
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Treatment

Low Risk

- **Phase 1**
  - Rest from aggravating activities
  - Ice, NSAIDs, Diet
  - Usually No immobilization
  - Pool, elliptical, weights

- **Phase 2**
  - Graduated return when pain-free
  - Shoe wear and running surface
  - Functional orthotics, bracing
    - Shock absorption
    - Correct mechanical imbalance
Treatment

Low Risk

• Other modalities
  – Bisphosphonates
    • Stewart et al., 2005, CJSM
  – Bone stimulators
    • Effective in delayed unions
    • Theoretical in stress fx
    • No evidence in stress fractures
High Risk Stress Fractures

• Tibia
  – Posterior cortex
  – Anterior tibial cortex
  – Medial malleolus
• Navicular
• 5th Metatarsal (Jones fracture)
Tibial Stress Fractures
Anterior Cortex

- More common in jumpers
  - Rare in distance runners
- Poor vascularity and repetitive loads
- Dreaded black line on radiograph
  - Non-union
  - Bone scan may be normal
Tibial Stress Fractures
Anterior Cortex

- More common in jumpers
  - Rare in distance runners
- Poor vascularity and repetitive loads
- Dreaded black line on XR
  - Non-union
  - Bone scan may be normal
- MRI Scan
  - Confirm location/extent
  - Acuity
Tibial Stress Fractures
Anterior Cortex

• **Treatment**
  – Immobilize NWB 6-8 weeks
  – Pneumatic leg brace
  – Electric stim up to 10 hrs per day

• **Return to sport**
  – Radiographic healing
  – Resolution of symptoms

• **Surgery if no healing at 4-6 months**
  – Sooner in elite athletes?
Treatment

• Surgical treatments
  – Excision and bone grafting (Green 1985 AJSM)
  – Drilling of defect (Rettig AJSM 1988)
  – Reamed IM Nailing (Varner et al., 2005 AJSM)
    • 11 tibia stress fractures (failed non-op)
    • All fractures healed (mean 3 months)
    • Return to sport by 4 months
High Risk Stress Fractures

- Tibia
  - Posterior cortex
  - Anterior tibial cortex
  - Medial malleolus
- Navicular
- 5th Metatarsal (Jones fracture)
Medial Malleolar Stress Fractures

- Running/jumping athletes
  - Repeated dorsiflexion, pronation and rotation
  - Insidious onset of medial ankle pain
Medial Malleolar Stress Fractures

Clinical Features

• **History**
  – Pain over medial malleolus
  – Swelling, no loss of ROM

• **Radiographs**
  – May be negative up to 2 months
  – Bone scan or MRI
  – CT scan to confirm fracture
Medial Malleolar Stress Fractures

Treatment

- **Modified rest 3-8 weeks**
  - Transition to boot when pain-free
  - Gradual return to activity
    - Complete healing averages 6 months

- **Surgery**
  - Any displacement
  - Fracture line on x-ray in high level athlete
Medial Malleolar Stress Fractures

Treatment

- Plate and screws
- Graft for non-union
- 4-6 weeks NWB
- Return to sport - 4.2 months
- No level 1 or 2 studies
Medial Malleolar Stress Fractures

Treatment

- Associated impingement lesion common
  - Jowett et al (2008, FAI)
- Advanced imaging can usually detect
- Consider arthroscopy to remove
High Risk Stress Fractures

- Tibia
  - Posterior cortex
  - Anterior tibial cortex
  - Medial malleolus
- Navicular
- 5th Metatarsal (Jones fracture)
Navicular Stress Fracture
Evaluation

• Diagnosis
  – Running athletes
  – “Ankle pain”
  – Navicular Tenderness
    • The “N” spot
Navicular Stress Fracture
Radiographs

- X-rays often normal
Navicular Stress Fracture
Radiographic Imaging

- Imaging
  - Bone scan/MRI
  - Positive before fracture appears
Navicular Stress Fracture
Radiographic Imaging

- Imaging
  - Early CT scan if stress fracture is suspected
Navicular Stress Fracture
Radiographic Imaging

- **CT scan**
  - Determines whether complete or incomplete
  - Surgery planning
Navicular Stress Fracture

Blood Supply

- Central hypovascular region
  - Only in 20% of patients
  - 60% with normal vascularity

McKeon et al. 2012 FAI
Navicular Stress Fracture

Treatment

“Incomplete”

I: Dorsal cortex

II: Extends to N-C joint

“Complete”

III: Extends to plantar cortex
Navicular Stress Fracture

Treatment

“Incomplete” Stress Fx

• In the athlete these tend to progress → screw fixation
  – 1-2 screws
Navicular Stress Fracture
Treatment

“Incomplete” Stress Fx

• 20 yo basketball player
• Negative x-rays
Navicular Stress Fracture

Treatment

“Incomplete” Stress Fx

- 20 yo basketball player
Navicular Stress Fracture

Treatment

“Incomplete” Stress Fx

- 20 yo basketball player
Navicular Stress Fracture
Treatment

“Incomplete” Stress Fx

• 20 yo basketball player
• Post-op
  – 6 weeks NWB
  – Early ROM
  – Return to play 4-6 months
Navicular Stress Fracture

Treatment

“Incomplete” Stress Fx

• 20 yo basketball player
• Post-op CT
Navicular Stress Fracture
Treatment

“Complete” Stress Fx

- In Athletes – without delay
  - Open bone grafting and screw fixation
  - Often need to debride joints
Navicular Stress Fracture

Results

“Complete” Stress Fx

• In non-athletes
  • Fixation is preferred by most
  • Role for conservative management?
  • Torg et al., 2010 AJSM
    – Non-op best for both complete and incomplete
      Non-op: 96% success
      Surgery: 82% success
Nagging Injuries in the Athlete

- Posteromedial diaphysis \(\xrightarrow{\text{Low risk}}\)
- Anterior tibial cortex
- Medial malleolus
- Navicular
- 5\textsuperscript{th} Metatarsal (Jones fracture)
What is a Jones Fracture?

Definition=

• A fracture of the 5th metatarsal at the metaphyseal-diaphyseal junction in the region the 4/5 intermetatarsal articulation
Vascular water-shed region
Jones Fracture

The Problem

Non-operative Treatment

- 72-76% heal by 5 months
- Many fail to heal or refracture

Surgical Treatment

• Indications
  – Athlete
    • Acute/stress fx
  – Nonunion
  – Refracture

*In Sports Medicine- Our Threshold to operate is decreasing!*
Jones Fracture
Treatment

Operative goals
• Expedite healing
• More rapid recovery
• Accelerated rehab
• Decrease refracture risk
Jones Fracture
Treatment

Operative technique

• Screw fixation
  – Percutaneous (no big incision)
Jones Fracture

Treatment

Operative technique

- Percutaneus approach
- (+/-) Bone graft or substitute
Insert Screw “High and Inside”

HIGH & INSIDE
Jones Fracture

Surgical treatment

• Option to inject bone graft or BMA + DBM
Jones Fracture

Treatment

Aggressive postoperative management

– Weight bearing at 2 weeks
– Begin running in modified shoewear at 6 weeks (if clinically nontender)
– Avg. return to play 8 weeks
Post-Operative Bracing
Clamshell Orthosis
Post-Operative Bracing
Clamshell Orthosis
Post-Operative Bracing
Custom Orthoses
Gait Analysis
Gait Analysis
Jones Fractures

Pitfalls

• Beware of Cavus Foot
Jones Fractures

Pitfalls

• Beware of Cavus Foot
• Beware of Medial Cortex Penetration
  – Use multiple fluoro views
Jones Fractures

Pitfalls

• Beware of Cavus Foot
• Beware of Medial Cortex Penetration
• Beware of poor start point
Jones Fracture

Treatment

- Treatment of Refractures and non-unions
- Revision Fixation
- Larger diameter screw
- ICBG, or BMA + DBM
Jones Fracture
Treatment

Treatment of Jones Fracture Nonunions and Refractures in the Elite Athlete
Outcomes of Intramedullary Screw Fixation With Bone Grafting

- 21 Elite Athletes
- Mean Age: 27 yrs
- Union: 100%
- Ave Return 12 weeks
  - (8 weeks for primary)

Jones Fracture

Treatment

Meta analysis - mostly Level 4 data

• Return to sport ranged from 4 to 18 weeks
• Non-operative treatment: union rate 76 %
• Surgical treatment: union rate 96 %
• Non-unions:
  – Treated non-operatively had a union rate of 44%
  – Treated surgically had union rate of 97 %

Roche and Calder, KSSTA (2013) 21:1307–1315
Summary
Nagging injuries in the Athlete

• Stress Fractures are very common
• Be aware of risk factors – good history
• Pay attention to alignment – correct as needed
• Get the imaging you need
• Remember that sometimes surgery is the more conservative treatment
Thank You