Management of Stress Fractures of the Lower Leg

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I have no disclosures
Questions:

• How common are stress fractures of the lower leg?
• What factors contribute to stress fracture?
• What are the treatment options?
The Problem

- More than 3.5 million children under the age of 14 treated annually for sports injuries.  
  *(Source: Safe Kids USA)*

- Overuse injuries account for **half** of all sports injuries in middle school and high school.  
  *(Source: Safe Kids USA)*

- High school athletics account for more than 2 million injuries annually, including
  - 500,000 doctor visits
  - 30,000 hospitalizations
  *(Source: Centers for Disease Control)*
Growing Up Today Study

- Prospective cohort study
- 6831 girls aged 9-15 years

3.9% developed stress fractures

Running, cheerleading, gymnastics, basketball

Increased age at menarche, family hx of osteoporosis
Overall stress fx rate of 1.54 per 100,000 athlete-exposures

- Rate highest in boys and girls CC and gymnastics
- Girls had almost twice the relative risk as boys

- 99% managed non-surgically
- Majority resulted in ≥ 3 wks time lost from sport
www.stressfxregistry.net

- High school athletes
- 75 athletic trainers contributing data.
- 11 different states
- Online database
- Quick and easy
www.stressfxregistry.net

- 263 stress fractures over 2.5 years
- Females : Males  1.35:1
- Females
  - Avg age 15
  - First time out for sports
  - Decreasing incidence with increased age
- Males
  - Avg age 16
  - 10/11th grade
Interesting findings

- Avg subjective pain complaint 7/10
  - Boys 6.6, girls 7.2

- Track - 65% in tibia

- 54% Start Stop sports

- Tibia 3 x more common than any other bone

- 19% indicated they had a prior stress fracture

- 45% noted they had prior hx shin pain > 4 weeks

- Some sort of change (73%)

- Slept 1 hour less than controls (7 vs 8 hours)

- Weight trained less than controls
Keep in Mind:

- Adolescent bone different than adult bone
  - Less mineralized
  - Not as strong
  - More flexible
- Undergoing axial growth
- Will achieve 92% of lifetime bone by age 19
- Prime time to develop bone strength
- Prime time to overload the process!
Help Prevent Sports Injuries

Share sports injury information and prevention tips to help the young athletes in your own community! Learn more about the resources we have available.

Tip Sheets:

Browse and download sport- and issue-specific information straight
Typical case

- 14 year old female
- 9th grade cross country runner, 6 weeks into season
- Progressively worsening left shin pain over 2 weeks, no trauma
- Worse after running, no pain with ambulation
- Tender to palpation posteromedial tibia at junction of middle and distal thirds
- No swelling, ecchymosis
Case management

• Stop running?
  A. Yes
  B. No
  C. Need further workup to make decision

• How long?
  A. 1 week
  B. 2 weeks
  C. 4 weeks
  D. 6 weeks
Case management

• X-ray?
  A. Yes
  B. No

• MRI?
  A. Yes
  B. No
Shin pain evaluation

• Key screening questions
  » How long have you had shin pain?
  » Rate your worst pain during activity (1-10)?
  » When do you have shin pain?
  » Do you limp at any time?
  » Have you had any changes in training recently?
  » How many hours per week do you spend participating in sports?
  » How many servings of dairy do you get in day?
  » Prior stress fracture
  » Menstrual dysfunction
  » Diet
Shin pain evaluation

• Physical examination

  » Palpation – tibia and fibula
  » Fulcrum test
  » Single leg hop
Radiographs

- AP and lateral views of tibia & fibula
- Limited utility of x-rays
  » Only 10-29% of initial x-rays are positive
  » On follow up, the sensitivity of x-rays increases to 40-54%
  » (Greaney et al., 1983 & Zwas, 1987)
Radiographs

- AP and lateral views of tibia & fibula
- Periosteal reaction posteromedial tibia at site of tenderness
Management

• Mild findings, negative x-ray
  » Short duration pain, pain < 5, (-) hop test
  » Exercise modification: decrease impact aerobic training
  » pool running, non-impact aerobic training
  » May compete as long as symptoms do not worsen
  » Don’t give up sport
Advanced imaging

Comparison of Scintigraphy and Magnetic Resonance Imaging for Stress Injuries of Bone

Yasuyuki Ishibashi, MD, Yoshihisa Okamura, MD, Hironori Otsuka, MD, *Kazuharu Nishizawa, MD, *Taisuke Sasaki, MD, and Satoshi Toh, MD

Department of Orthopaedic Surgery and *Department of Radiology, Hirosaki University School of Medicine, Aomori, Japan

- 31 patients had clinical exam, x-ray, bone scan, and MRI
- Similar sensitivities (reported up to 100%)
- MRI higher specificity
- Severity on bone scan and MRI were highly correlated
  » Also matched degree of clinical symptoms
- MRI provided more information
  » Periosteal edema, bone marrow edema, fracture line
MRI Grades

MRI Grading Scales for Bone Stress Injuries

<table>
<thead>
<tr>
<th>MRI Grade</th>
<th>Fredericson et al(^1)(^8)</th>
<th>Arendt et al(^2)</th>
<th>Nattiv et al 2013 (Current Study)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mild to moderate periosteal edema on T2; normal marrow on T2 and T1</td>
<td>Positive signal change on STIR</td>
<td>Mild marrow or periosteal edema on T2(^h); T1 normal(^c)</td>
</tr>
<tr>
<td>2</td>
<td>Moderate to severe periosteal edema on T2; marrow edema on T2 but not T1</td>
<td>Positive STIR plus positive T2</td>
<td>Moderate marrow or periosteal edema plus positive T2; T1 normal</td>
</tr>
<tr>
<td>3</td>
<td>Moderate to severe periosteal edema on T2; marrow edema on T2 and T1</td>
<td>Positive STIR plus positive T2 and T1</td>
<td>Severe marrow or periosteal edema on T2 and T1</td>
</tr>
<tr>
<td>4</td>
<td>Moderate to severe periosteal edema on T2; marrow edema on T2 and T1; fracture line present</td>
<td>Positive fracture line on T2 or T1</td>
<td>Severe marrow or periosteal edema on T2 and T1 plus fracture line on T2 or T1</td>
</tr>
</tbody>
</table>

- Originally described by Fredericson et al. (1995)
- Modified over the years
- Simplified by Dobrindt et al. (2012) into two grades
  - Low grade: bone marrow edema in STIR images, possibly in T2-weighted images
  - High grade: bone marrow edema in T1- and T2-weighted image with or without a fracture line
Examples

Grade 1
edema - mild

Grade 2
moderate

Grade 3
severe

Grade 4
fracture line
Are MRI grades clinically relevant?

Stress Injuries to Bone in College Athletes
A Retrospective Review of Experience at a Single Institution*

Elizabeth Arendt,†‡ MD, Julie Agel,† MA, ATC, Christie Heikes,† MD, and Harry Griffiths,§ MD

From the †Department of Orthopedics, University of Minnesota, Minneapolis, Minnesota, and the §Department of Radiology, University of Missouri, Columbia, Missouri

- Reviewed 68 stress fractures in college athletes over 10 years
  » 1% overall incidence
- Return to sport time varied according to grade of injury
  » Grade 1: 3.3 wks  Grade 2: 5.5 wks
  » Grade 3: 11.4 wks  Grade 4: 14.3 wks
Can we predict severity or duration of injury?

Correlation of MRI Grading of Bone Stress Injuries With Clinical Risk Factors and Return to Play

A 5-Year Prospective Study in Collegiate Track and Field Athletes

Aurelia Nattiv,*†‡ MD, Gannon Kennedy,§ MD, Michelle T. Barrack,‡‖ PhD, RD, Ashraf Abdelkerim,¶# MD, MBA, Marci A. Goolsby,* MD, Julie C. Arends,†‡‡ MD, and Leanne L. Seeger,§§ MD

Investigation performed at the University of California, Los Angeles, Los Angeles, California

• Comprehensive annual evaluations
• 211 athletes sustained 61 stress fractures
• Lower BMD and higher MRI grade were independent predictors of longer recover time
Bone Density

Low Bone Density Is an Etiologic Factor for Stress Fractures in Athletes

Kathryn H. Myburgh, PhD; Janice Hutchins, BSc Med; Abdul B. Fataar, MMed; Stephen F. Hough, MMed; and Timothy D. Noakes, MMed

• Case-control study of 25 athletes with stress fx matched to 25 control athletes with similar exercise history
• Compared with controls, stress fracture cases had
  » Significantly lower DEXA
  » Greater likelihood of menstrual irregularity
  » Similar caloric intake
  » Lower calcium intake
Diet

• Risk factors (Moran et al., 2012)
  » Stress fx associated with dietary deficiency before induction and during basic training for elite combat recruits
  » Calcium & vitamin D

• Vitamin D levels in athletes (Farrokhyar et al., 2014)
  » Overall 56% inadequate
  » Prevalence increased at higher latitude, indoor sports, winter and early spring seasons

• Supplements (Lappe et al., 2008)
  » Large study of navy recruits randomized to received either 2000 mg Ca and 800 IU Vit D or placebo
  » 5.9% incidence of stress fx per 8 wks
  » 21% fewer fx in the supplement group
Long term implications

Fractures in Relation to Menstrual Status and Bone Parameters in Young Athletes

Kathryn E. Ackerman\textsuperscript{1,2}, Natalia Cano Sokoloff\textsuperscript{1}, Giovana De Nardo Maffazioli\textsuperscript{1}, Hannah Clarke\textsuperscript{1}, Hang Lee\textsuperscript{3}, and Madhusmita Misra\textsuperscript{1,4}

- 175 females studied (14 - 25 y/o)
  - Eumenorrheic athletes had highest BMD
  - Amenorrheic athletes BMD similar to non-athletes
  - AA highest incidence of fx and disordered eating
  - AA with $\geq 2$ fxs, lowest stiffness and failure load
    - Probable increased lifetime risk for fragility fx
- Recommend checking DXA on adolescents with $> 1$ stress fx
Stress fractures

• Treatment
  – Xray neg + MR pos, < GrIV - activity modification
    • Pool running, non-impact aerobic training
    • Competition only
    • Symptoms MUST NOT WORSE
    • COMMUNICATION
  – Xray positive or Grade IV MRI
    • Rest, potential protected weight bearing, immobilization
Stress fractures

- Treatment
  - Pulsed ultrasound, pulsed EM, calcitonin
  - No good data to support use

- Rue, et al 2007
  - 43 tibial stress fx
  - Randomized, blinded pulsed US vs placebo
  - No difference in symptom relief, return to play

Validation of shin pain scoring system

Nussbaum, Gatt, Bechler, Hosea, Swan

- IRB approved protocol
- Calculate shin pain score based on history and PE
- Correlate with x-ray and MRI findings

- Potential benefit
  - Decreased use of radiographic studies
  - Aid in return to play decisions
Validation of Shin Pain Scoring System

Initial findings:

• 75 subjects – 150 shins (130 noted symptomatic)
• 83% positive findings (125/150)
  – 84% Grade II or above
    • 66/125 - 52% Grade II
    • 39/125 - 16% Grade III
    • 3/125 - 12% Grade IV
• 70% Bilateral Findings (53/75)

* Significant number with positive findings on MRI
Validation Shin Pain Scoring System
6 month Follow up

• 36 Responses
• 17/36 (47%) were out > 8 weeks
• 14/36 (39%) Still have regular shin pain w/ activity
  – (1 Gr I, 7 Gr II, 4 Gr III, 2 Normals)
• 13/36 (36%) Have occasional shin pain
  – (2 Gr I, 9 Gr II, 2 Gr III)
• 27/36 (75%) Still have shin pain > 6 months
• 9/36 (25%) Noted they were fully recovered
  – (1 Gr I, 5 Gr II, 3 Gr III)

* Highlights prolonged history and complexity of shin pain.
Why worry?

- 19 year old female
- Division I NCAA volleyball player
- Progressively worsening left shin pain, no trauma
- Worse after jumping, occasional pain with ambulation
- Tender to palpation anterior tibia at middle third
- No swelling, ecchymosis
Why worry?

- Jumping athlete
- Pain over anterior tibial crest
- Pain with fulcrum test
- “Dreaded black line” on lateral x-ray
Considering the findings

- Do we need to rest more?
- Gait modification?
- Reconsider training hours/demands
- Minimize the changes
  - Rule of Too’s – Too Fast, Too hard, too soon, too often
- Strengthen and condition for the demands of the sport PRIOR to the season
- Supplementation
  - Particularly Vit D and Ca+
- Orthotics?
- Sleep more
- Identify menstrual issues
- Review the diet
  - Add more color
- Decrease mental stress
  - School, sport, parents, friends
Summary:

- Shin pain is a big problem in adolescent population
  - Look for red flags
    - Pain >6/10, positive hop test, prior history, change
- Tibia is most common bone
- Complex problem
  - Intrinsic and Extrinsic Factors
- Early identification is key
Thank you