STRESS FRACTURES AND VIT D

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Incidence

1% of HS athletes overall will have a stress Fx

Highest in Girls/boys XC, girls gymnastics

63% female

Lower extremity is most common

65% >3 weeks for RTP

Pathophysiology

**Bone Remodeling Cycle**

When bone turnover is increased, bone loss dominates...

- Pre-Osteoclasts
- Osteoclasts
- Mononuclear Cells
- Pre-Osteoblasts
- Osteoblasts
- Osteocytes

Resting Bone Surface → Resorption → Reversal → Bone Formation → Mineralization

↓ 3 WEEKS → ↑ PTH

↓ 3 MONTHS → ↑ PTH

Diagnosis

- **Index of suspicion**
- **Exam:** Focal TTP
- **X-ray:** at least 3 weeks
- **Bone-scan:** 72 hours. Not Specific
- **MRI:** Prob best test. Can guide treatment too.

Risk factors

- **Training Changes**
- **Poor flexibility**
- **Weakness**
- **Poor mechanics**
- **Poor nutrition/deficiencies**
- **Hormone abnormalities**

**Table 1**

**Lower limb stress fractures in athletes**

<table>
<thead>
<tr>
<th>Site</th>
<th>Stress fractures (%)</th>
<th>Predominant sporting associations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metatarsals 8.0–24.6</td>
<td></td>
<td>Second and third metatarsal distal shaft and neck: Long distance runners</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Jones fracture: Long-distance runners</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Calcaneum: Long-distance runners; Jumps</td>
</tr>
<tr>
<td>Tarsals</td>
<td>7.0–25.3</td>
<td>Navicular: Track and field athletes; Rugby and basketball</td>
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<tr>
<td></td>
<td></td>
<td>Talus: Long-distance runners; Gymnasts</td>
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<tr>
<td></td>
<td></td>
<td>Transverse (posterior): Long-distance runners</td>
</tr>
<tr>
<td>Tibia</td>
<td>16.0–49.1</td>
<td>Transverse (anterior): Jumps</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Longitudinal: Long-distance runners</td>
</tr>
<tr>
<td>Fibula</td>
<td>1.3–12.1</td>
<td>Long-distance runners; Jumps</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Neck: Long distance runners</td>
</tr>
<tr>
<td>Patients/Sports</td>
<td>Sites</td>
<td></td>
</tr>
<tr>
<td>----------------------</td>
<td>--------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Marathon runners</td>
<td>distal third of the fibula, distal third of the tibia, 2nd and 3rd metatarsal</td>
<td></td>
</tr>
<tr>
<td>Ballet dancers</td>
<td>fibula, medial third of the tibia</td>
<td></td>
</tr>
<tr>
<td>Military</td>
<td>proximal and distal third of the tibia, 2nd and 3rd metatarsal</td>
<td></td>
</tr>
<tr>
<td>Acrobats</td>
<td>fibula</td>
<td></td>
</tr>
<tr>
<td>Golf players</td>
<td>ribs</td>
<td></td>
</tr>
<tr>
<td>Tennis players</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight lifting, Dart throwing</td>
<td>humerus</td>
<td></td>
</tr>
<tr>
<td>Fighting, Dart throwing</td>
<td>calcaneus</td>
<td></td>
</tr>
<tr>
<td>Elderly</td>
<td>sacrum, proximal third of the tibia</td>
<td></td>
</tr>
</tbody>
</table>

**Main sites of stress fracture in athletes**

**Comparison of bone scan and MRI grading of stress fracture**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Radiograph</th>
<th>Bone scan</th>
<th>MRI</th>
<th>Prognosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Normal</td>
<td>Poorly defined area of increased activity</td>
<td>Bone edema on STIR image</td>
<td>3 weeks</td>
</tr>
<tr>
<td>2-4a</td>
<td>Normal</td>
<td>More intense uptake, but still poorly defined</td>
<td>Bone edema on STIR and T2 images</td>
<td>3–6 weeks</td>
</tr>
<tr>
<td></td>
<td>Periosteal reaction</td>
<td>Sharply marginated area of increase uptake</td>
<td>Bone edema on T1 and T2 without definite fracture line</td>
<td>12–16 weeks</td>
</tr>
<tr>
<td></td>
<td>Fracture line</td>
<td>More intense transcortical uptake</td>
<td>Bone edema on T1 and T2 with a definitive fracture</td>
<td>16+ weeks</td>
</tr>
</tbody>
</table>

**Concepts in the evaluation and management of stress fractures**

- Grade 1: 2-3 weeks
- Grade 2-4a: 6-7 weeks
- Grade 4B: 9-10 weeks or more
Rehab Principles

- Activity guided by symptoms/pain
- Relative rest: Time by Dx/severity.
- Evaluate the kinetic chain
- Cross training, aquatics, strength, flexibility.
- Nutrition, metabolic, endocrine
- Educate

**NSAIDS:** delay healing

- Leg support  may help

**Orthotics**

**Bone Stim**

**Biphosphonates**

**High risk**

- Femoral neck
- Tibia shaft
- 5th Metatarsal (Jones)
- Tarsal Navicular

**Femoral neck**

- May have groin, back, lat. hip or knee pain
- hop test, faddir +
- compression side: Tx conservatively
- Tension side: ORIF
Tibia Shaft

- Compression vs Tension side involvement.
- 6mo of tx for tension side.
- 3mo for comp. side
- Surgery if fails non op treatment.

Tarsal Navicular

- Dx delayed avg. 4-7 months
- Poor blood supply
- 6-8wks cast NWB, “N-Spot
- May need ORIF

5th Metatarsal

- Risk factor with cavus foot
- Poor shock absorption and high lateral loads
- Poor blood supply
- Consider ORIF: avg 8wks for RTP
Female triad

- Amenorrhea, low bone density, eating disorder
- Not too much exercise. Problem is <GnTRH
- Result is suppressed bone formation
- Needs a team approach to tx.

Case

- 42 y/o female rec runner.
- Hip pain for 6 months.
- MRI: stress fx of femoral neck.
- Tx’d with rest, takes calcium for 3 months.
- Bone density test WNL

Factors Influencing Bone Healing

<table>
<thead>
<tr>
<th>AIMS TO PROMOTE BONE HEALING</th>
<th>FACTORS CLAIMED TO RETARD BONE HEALING</th>
</tr>
</thead>
<tbody>
<tr>
<td>References</td>
<td>Factor</td>
</tr>
<tr>
<td>Hormone</td>
<td>Corticosteroids</td>
</tr>
<tr>
<td>T3</td>
<td>Alloxan diabetes</td>
</tr>
<tr>
<td>T4</td>
<td>Castration</td>
</tr>
<tr>
<td>PTH</td>
<td>Vitamin A, high dose</td>
</tr>
<tr>
<td>25(OH)D</td>
<td>Vitamin D, high dose</td>
</tr>
<tr>
<td>Rodenticides</td>
<td>Rachitis</td>
</tr>
<tr>
<td>Anticoagulants</td>
<td>Anemia</td>
</tr>
<tr>
<td>Anticoagulants</td>
<td>Aminooxyacetonitrile</td>
</tr>
<tr>
<td>Anticoagulants</td>
<td>B-aminopropionitrile</td>
</tr>
<tr>
<td>Anticoagulants</td>
<td>Bone wax</td>
</tr>
<tr>
<td>Anticoagulants</td>
<td>Delayed manipulation</td>
</tr>
<tr>
<td>Anticoagulants</td>
<td>Denervation</td>
</tr>
<tr>
<td>Anticoagulants</td>
<td>X-irradiation</td>
</tr>
<tr>
<td>Anticoagulants</td>
<td>Hyperbaric oxygen</td>
</tr>
<tr>
<td>Anticoagulants (DIC, heparin)</td>
<td>6 hr, 2 atm daily</td>
</tr>
<tr>
<td>Anticoagulants</td>
<td>Anticoagulants (dicumarel)</td>
</tr>
</tbody>
</table>

Note: The table provides a list of factors that can either promote or retard bone healing. The references (56, 68, 72, 62, 63, 69, 98, 53, 51, 71, 59, 65, 83, 89, 47, 100, 54, 101, 55) are cited for further reading.
- Vitamin D level <20
- Tx’d with 50,000 units D for 8 weeks then 5000 units/day.
- Back to running in 3 months.
- D level at 40+

Vitamin D3

- Main job: maintain homeostasis of calcium and phosphates in the body (muscle, bone, kidney and parathyroid.
- Minimal amt in diet (dairy, eggs, and fish)
- Major production is from UVB and skin.
- Normal range: 30-50 ng/ml (up to 100 in some reports)

D3 vs D2

D3 - “Natural form”
- From Irradiated fungus
- Cholecalciferol
- Made from lambs wool fat
- Potent and stable form
- Mult. Studies

D2 - common in vit D supplements


- 1200 female naval recruits 2002-2009
- 600 control and 600 Dx with stress fx
- 2X the risk in levels below 20 ug/ml vs 40 ug/ml or greater.
- Recommended level was 40 ug/ml
- 4000 iu D3/day
Multiple studies: 42-48% Insufficient and 25-33% Deficient. Gen Population 77% with deficiency

NFL Team: Low D Players had a > incidence of muscle injuries.

Cause: Low UVB Exposure

**Vitamin D and Bone**

- Activates calcium absorption from the intestine.
- Levels are directly related to bone density
- Below 30 ug/ml cause PTH to > osteoclast activity
- This can > risk of stress fractures in athletes.

**Vitamin D and Muscle**

- Regulates muscle cell function
- Helps in cell protein synthesis, growth, and role as anti-inflam
- Receptors decrease with age
- So it helps strength, mass and function of muscle cells.
Performance & Vit D

- Russians 1938: improved 100m dash in UVB radiated athletes
- Germany 1952: Improved bike erg. in children with UVB, or Vit D supplement
- Seasonal performance improves in summer in northern hemisphere. 1950's reports.
- More recent reports support this theory.

Vit D Def. a problem in low light areas and in high sunscreen areas.

Tx May help prevention and performance.

NO level one studies as of now.

Be careful on supplementation. There are downsides too. (kidney, tissue)

Statement of the Society for Adolescent Health and Medicine

www.jahonline.org

Low D=PTH > and osteoclast activity

Rec serum level 30-50 ug/ml

Intake of 1000 iu/day if 21-30 ug/ml

Deficient-(20 ug/ml or less) then 50,000 IU/week for 8 weeks.

Recommend to take with dinner.

how much to take?


women who took <800mg of calcium had a 6X increased rate of stress fx than those who took 1500mg.

15 min of unprotected UVB exposure = 10-20,000 units of Vit D in light skin.

SPF 15 blocks 99% of UVB
Review of Bone Growth Stimulation for Fracture Treatment

- Looked at different modes/types
- low intensity pulsed US vs pulse EM field
- Data was mixed on outcomes
- Few level one studies
- still used in many cases today
- High cost but otherwise no real downside

Prevention

Milgrom et al, Bone, 2005

- Function to stop Osteoclast activity
- double blind study in 324 military recruits
- no decrease in percentages noted.

Summary

Prevention is the best treatment.

Pre participation screening.

Know the “high Risk” areas.

Vit D is one component of the problem but easily addressed.

Thank You

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