Stress Injuries in the Young Athlete
3rd Annual Young Athlete Conference

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Neither I, nor any family member, have a financial relationship with products discussed in this presentation.
The “Gameplan”

1. Recognize the trend of overuse injuries in young athletes
2. Understand the risk factors leading to stress injuries and fractures
3. Efficiently diagnose and implement treatment strategies for stress injuries
Show Me the Numbers!

- 30 - 45 million children participate in some form of athletics
- > 7.3 million athletes participate at the high school level annually and numbers increasing
Cross Country Running

- NFHS reported 429,000 young athletes participating in 2008-09
- 20% increase from data compiled in ‘03-04
- Most injuries in young runners are due to overtraining or “mis-training”
Epidemic of Overuse Injuries!

Nearly 50% of all injuries sustained by middle school and high school students during sports are overuse injuries.*

Overuse injuries can cause permanent damage and increase the chances of surgeries and arthritis later in life. Keep kids in the game for life by regularly discussing how they feel physically before, during, and after games and practice. Open lines of communication can help keep athletes in top physical condition all year round. Become an advocate for safe sports participation.

For more information, visit www.STOPSportsInjuries.org

*American Academy of Orthopaedic Surgeons, AAOS News 2009
Acute vs. Overuse Injuries

- **Acute** - fractures, dislocations, sprains, strains result from a single event caused by maximal forces

- **Overuse** - stress fractures, tendonitis, apophysitis, periostitis, and fasciitis result from repetitive, submaximal trauma that develop over time
Overuse Injury

- Microtraumatic damage to a bone, muscle or tendon that has been subject to repetitive stress without sufficient time to heal or undergo the natural reparative process

- Immature bones, insufficient rest, poor training & conditioning, sports specialization, tremendous pressure from peers, coaches, parents, etc

- Often seen with new participants, increased “mileage,” and increased intensity of exercise
The Growing Bone...
Stress fractures occur when bone fails to remodel adequately following repetitive stress.

Bone is dynamic with continual remodeling from osteoblasts, osteocytes, and osteoclasts.

Peak bone mass is between 25-30 yo.

Most bone mass is acquired by 11-14y (F) and 13-17y (M).

Chronic undernutrition & amenorrhea may affect bone formation in adolescents.
**Types of Bone**

- **Cortical (compact)** - (80% of skeleton), tightly packed (4x greater mass), slower turnover (8x). Found in diaphysis of long bones, “shell” of vertebrae & tarsal/carpal bones.

- **Trabecular (cancellous)** - less dense and found in metaphysis/epiphysis, cuboid-like bones. ↑ remodeling!
1. Accumulation of microtrauma from repetitive loading of bone (fatigue failure)

2. Fatigue failure persists → crack initiation

3. If initial failure is inadequately repaired, it can lead to more loading and crack propagation
Causes of Overuse Injuries

Extrinsic factors
- Nature of the sport
  - contact, endurance, etc
- Training regimens
  - overtraining
- Coaching
- Playing surface
- Equipment

Intrinsic factors
- Age
- Maturation
- Gender
- Flexibility
- Alignment
- Strength imbalances
- Proprioception
Who is most at risk?

- Folks in repetitive, high-intensity training such as athletes and military recruits
- 2 high risk groups...military and young athletes
- Track (running), basketball, soccer, and dance
- Females ?? esp Female athlete triad (eating disorders, amenorrhea, osteoporosis)
- >25 miles running per week, ballet >5 hr/day
- Sudden increase in physical activity
Extrinsic

- *Training regimen - duration, frequency, intensity
- Footwear - shoe age more important than cost...>6 months increases risk
- Training surface - hard surfaces i.e. cement
Factors leading to Stress Injury

Intrinsic

- Gender ??
- Age ??
- Race (.DataTable.Caucasian, Asian)
- Foot structure ??
- Leg Length Discrepancy ??
- Hormonal (delayed menarche, menstrual disturbance)
History

- Insidious onset progressive pain in focal area
- Initially pain only with activity
- Pain starts to affect performance and persists into daily living
Exam

- *Focal tenderness*
- Edema possible
- Hop test may be helpful
- Tuning fork test
### Suspicious Locations for Stress Injury

<table>
<thead>
<tr>
<th>Common</th>
<th>Less common</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tibia</td>
<td>Femur (shaft &amp; neck)</td>
</tr>
<tr>
<td>Fibula</td>
<td>Sesamoid</td>
</tr>
<tr>
<td>Metatarsals</td>
<td>Pelvis</td>
</tr>
<tr>
<td>Pars Interarticularis</td>
<td>Upper extremity</td>
</tr>
</tbody>
</table>
Differential Diagnosis

- Medial Tibia Stress Syndrome “shin splints”
- Plantar fasciitis
- Tendinopathy
- Compartment Syndrome
- Pathologic fracture
### Imaging

<table>
<thead>
<tr>
<th>Test</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plain radiography⁴,¹¹,¹⁵</td>
<td>Low cost, little radiation, wide availability</td>
<td>Limited differential detail, poor initial sensitivity</td>
</tr>
<tr>
<td>Bone scintigraphy¹⁰-¹²,¹⁶</td>
<td>Low cost, high sensitivity</td>
<td>Some radiation exposure, limited differential detail, may be falsely positive if focal infection or tumor is present</td>
</tr>
<tr>
<td>Magnetic resonance imaging¹⁰,¹¹,¹⁵,¹⁶</td>
<td>Best differential detail, no radiation, equal or slightly better sensitivity than scintigraphy and higher specificity</td>
<td>Highest cost</td>
</tr>
<tr>
<td>Ultrasonography¹⁷</td>
<td>No radiation, low cost</td>
<td>Limited availability, little differential detail, limited data on use in diagnosing stress fractures</td>
</tr>
</tbody>
</table>

*American Family Physician Jan 2011, Vol 83(1)*
Plain Xray

- First line based on availability and cost
- Initial sensitivity 10% but improves over time
- May repeat in 2-3 weeks before more advanced imaging if not urgent
- Faint lucency is rare
- Periosteal reaction and callus more common
Bone Scan

- Regularly used before MRI
- Highly sensitive early in symptoms
- Non-specific
- False positive with infection or tumor
- No role in follow-up care because uptake can last for months
CT Scan

- Higher radiation exposure
- Lower sensitivity
- Less expensive than MRI
- Helpful in certain areas such as the tarsal navicular because of great bony detail
MRI

- Expensive
- No radiation
- Sensitivity compares to bone scan
- Precise location and detail are more specific
- T2 images detect marrow edema and early changes
- Has become the method of choice for advanced imaging
Classification

- 2 common types of classification systems which can be helpful in treatment

- High-risk vs. Low-risk locations

- Grading of stress injury based on scale of 1-4
High Risk

- Femoral neck - superolateral
- Anterior Tibial Diaphysis
- Patella
- Medial Malleolus
- Talus
- Tarsal Navicular
- 5th Metatarsal
- Sesamoids
Low Risk

- Posterior-medial tibia
- Femoral shaft
- Calcaneus
- Lateral malleolus/fibula
- 2nd-4th Metatarsals
### Classification

<table>
<thead>
<tr>
<th>Grade</th>
<th>Radiographic Findings</th>
<th>MRI Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Normal</td>
<td>Positive STIR image</td>
</tr>
<tr>
<td>2</td>
<td>Normal</td>
<td>Positive STIR image, plus positive T2-weighted image</td>
</tr>
<tr>
<td>3</td>
<td>Periosteal reaction</td>
<td>Positive T1- and T2-weighted images; STIR without cortical break</td>
</tr>
<tr>
<td>4</td>
<td>Fracture line or periosteal reaction</td>
<td>Fracture line on T1- or T2-weighted images</td>
</tr>
</tbody>
</table>

MRI, magnetic resonance imaging; STIR, short T1 inversion recovery.
Treatment