Medial Tibial Stress Syndrome

Background
1. Condition of pain/discomfort along posteromedial aspect of distal two-thirds of the tibia
   - Mechanical failure of bone due to accumulation of micro-damage
   - Secondary to repetitive strain episode
   - Bone fatigue failure continuum
     - Shin splints early (mild) side of spectrum
       - Can lead to stress fractures (severe)
   - Associated with tendonitis/periostitis of anterior tibialis, posterior tibialis or medial soleus muscles.
2. Also known as:
   - Shin splints, medial distal tibial syndrome (MDTS) or medial tibial syndrome
3. Useful web sites:
   - AAFP:
     - "Common Stress Fractures" - Common Stress Fractures - October 15, 2003 - American Family Physician
   - AAFP:
     - http://www.aafp.org/afp/20070715/237.html
   - ACSM (American College of Sports Medicine):
     - Exercise-induced lower leg pain
     - http://www.acsm.org/AM/Template.cfm?Section=Search&;section=20026&template=/CM/ContentDisplay.cfm&ContentFileID=298

Pathophysiology
1. Pathology of disease
   - Shin splits-early symptoms of progressive injury process
     - Periostial edema
     - Marrow involvement
     - Resorption outweighs formation
       - Due to repetitive loading on bone
     - Results in microfissures
       - Continued stress without adequate repair time
         - Micro fractures propagate (crack propagation)
         - Can lead to stress fractures
   - Treatment and return-to-play instructions based on:
     - Location of injury
       - Low Risk:
         - Not likely to recur, experience non-union or complications
         - Femoral shaft
         - Medial tibia
         - Ribs
         - Ulna shaft
         - First-fourth metatarsals
- **High Risk:**
  - Delay in diagnosis or aggressive treatment can lead to non-union, complete fracture, surgical intervention or recurrence
    - Femoral neck
    - Patella
    - Anterior tibial diaphysis
    - Medial malleolus
    - Talus
    - Tarsal navicular
    - Proximal 5th metatarsal and 1st metatarsal phalangeal sesamoids
- Grade of fatigue failure
- Low Grade (Arendt & Griffiths criteria)
  - Grades 1-3 reflect increasing degree of periosteal change and marrow edema
- High Grade:
  - Grade 4 is complete fracture

2. **Cause**
   - Biomechanical abnormalities
3. **Incidence, prevalence**
   - Most common lower leg injury in sports
   - Accounts for 6-16% of all running injuries
4. **Risk factors**
   - Sport-dependent
     - Runners (most common)
     - Sports with frequent starts and stops (jumping, basketball, racket sports)
   - Change in exercise regimens (new or increased)
     - Military recruits
     - Poor conditioning
     - Novice runners
     - Recent increased mileage
     - Training too hard, too fast or too long
   - Biomechanical anomalies
     - Intrinsic:
       - Structural abnormalities:
         - Hyperpronation
         - Femoral neck anteversion
         - Genu varus (bow-legged)
         - Genu valgus (knock-knees)
         - Pes planus (flat arches)
         - Pes clavus (high arches)
         - External rotation of hip
         - Leg-length discrepancy
         - Low bone density
     - Extrinsic:
       - Running in worn-out or ill-fitting footwear
       - Running on uneven surface
       - Running downhill
5. Morbidity / mortality
   - Most cases of MTSS recover completely with proper therapeutics
   - Complications-characterized by prolonged, increased or more frequent pain despite conservative therapy
     - Stress fracture
       - Requires relative to complete rest
       - May need crutches/orthosis
     - Chronic Ischemic Compartment Syndrome
       - Requires a non-urgent orthopedic surgeon evaluation
       - Stat referral if evidence of neurovascular compromise
       - Patient at risk for limb loss/possible death

Diagnoses

1. History
   - Location of pain:
     - Distal two-thirds of posteromedial border of tibia
       - Most common
     - Anterior tibial compartment
       - Tibialis anterior and extensor hallucis longus muscles
     - Interosseous membrane region of lower leg
   - Area of discomfort 4-6 inches (10-15 cm) in length frequently present
   - Pain noted at early portion of workout, then lessens
     - Often reappears near end of training session
   - Discomfort described as dull initially, gradually worsens
   - Pain can lead to cessation of workouts, can interfere with activities of daily living or can become continuous
     - Signs of advancement of disease to severe end of spectrum

2. Physical exam
   - Diffuse tenderness along posteromedial tibia (distal two-thirds)
   - Pain elicited by maneuvers that contract or stretch soleus muscle:
     - Plantar flexion of ankle against resistance
     - Passive ankle dorsiflexion
     - Standing on tiptoe
     - Jumping in place
   - Mild swelling/induration possible
   - Suspect compartment syndrome:
     - If pain worsens during exercise
     - If sensory or motor nerve deficit (tingling in foot)
   - Suspect stress fracture:
     - If localized rather than diffuse tenderness

3. Diagnostic testing typically not indicated, usually diagnosed clinically
   - Lab evaluation: not indicated
   - Diagnostic imaging:
     - May be useful to differentiate MTSS from suspected stress fractures
     - Plain film x-ray:
       - Stress fractures may not be evident early
         - Periosteal change: 2-3 weeks
Callus formation: 4-6 weeks

- X-ray normal in shin splint syndrome

**Technetium Bone Scan:**
- High sensitivity (84-100%)
- Not useful for follow-up: uptake persists
- Changes evident within three days of injury in both disorders
  - Stress fracture: localized uptake
  - Shin splints: diffuse and longitudinal uptake involving posteromedial tibia cortex

**Fat Suppressed MRI-imaging of choice in differentiating stress fractures from shin splints**
- Sensitivity equivalent to bone scan
- Stress fractures:
  - Abnormally wide region of high signal localized to bone marrow
  - Changes evident prior to periosteal changes on plain films
- Shin Splints:
  - Narrower linear high signal areas located along medial posterior surface of tibia or along medial bone marrow adjacent to cortical bone
- Other pathology evaluated:
  - Periostitis
  - Tears of musculotendinous structures
  - Ischemic compartment syndrome

**Differential Diagnosis**

1. **Key DDx**
   - Stress Fracture
     - Pain generally well localized
   - Chronic ischemic compartment syndrome:
     - Suspect if:
       - Pain out of proportion to clinical findings
       - Vascular or neurological symptoms
   - Bone tumors-pediatric
   - Pes anserine bursitis

2. **Extensive DDx - other sources of exercise-induced leg pain**
   - Fascial hernia
   - Peripheral neuropathy
   - Spinal stenosis
   - Peripheral arterial disease
   - Venous stasis

**General Therapeutics**

1. Therapy and return-to-play are dependent on:
   - Extent of fatigue failure
   - Location on stress reaction continuum
   - Individual's athletic and personal goals
Acute Treatment

1. Relative rest: (SOR:B)²
   - Duration at least 7-10 days
   - Recommend until pain-free
     - May take up to 4-8 weeks
   - Avoid activities that cause pain, swelling, discomfort
   - Can continue low-impact exercises (swimming, bicycling, water running)

2. Ice:
   - 15-20 minutes per session
   - Four times a day for 3-5 days
     - Wrap ice packs in a thin towel to avoid direct contact of ice on skin

3. Rest and ice alone promote faster recovery than rest and ice combined with NSAIDs, walking cast, heel-cord stretching (SOR:B)³

4. Compression:
   - 4-inch ace elastic bandage/compression sleeve
   - If pain worsens, loosen wrap

5. Elevation:
   - Keep affected shin above level of heart, especially at night

6. Medication:
   - NSAIDs for pain/inflammation

7. If athlete limps due to pain:
   - Consider use of crutches until normal walking does not cause pain

8. Stretching:
   - No benefit to recovery or prevention¹⁰

9. Competitive athletes:
   - Low-risk:
     - Desire to finish season and heal later
     - Goal: decrease repetitive stress at fractures site enough to allow bones to restore dynamic balance without loss of conditioning
     - Decrease volume, intensity, evaluate technique, cross-train and consider equipment change
     - If pain increases:
       - Complete rest
       - Immobilization
       - Consider surgical intervention
   - High risk:
     - Low Grade injury: treat according to individual risk for re-injury and desired speed of recovery
       - Recommendations: rest until pain-free⁸
       - Significant risk of complications if fracture progresses
     - High grade injury: athlete should cease all activities until proper treatment and complete healing
       - Goal:
         - Prevent progression of fracture
         - Avoid delayed healing
         - Avoid non-union
         - Avoid re-injury/re-fracture
       - Treatment:
- Absolute rest
- Prolonged immobilization with non-weight bearing restriction
- Internal fixation
- Depending on site and grade
- Tibial stress fracture
  - Pneumatic leg brace decreases healing time

**Further Management**

1. **Prevention**
   - Further exacerbation
   - Modifiable risk factors

2. **Proper shoes**
   - Athlete may need shoes fit to biomechanical needs
   - Physician, exercise tech, physical therapist or specialty running store should evaluate foot type, stride and particular sport
     - Fit shoe accordingly

3. **Orthotics: inserts to correct poor alignment between foot and lower leg**
   - Especially useful for "pronators" who have pain while running and repeat injuries
   - No evidence of prevention (SOR:A)
   - Do significantly relieve symptoms and promote return to running (SOR:C)

4. **Arch supports**
   - Help cushion/disperse stress

5. **Nutrition**
   - High dose of calcium (2 g daily) plus a normal dose of vitamin D3 (800 IU daily)
     - Reduced the incidence of stress fractures by 20% (P<0.003) in study of female Navy recruits

6. **Training errors**

**Long-term Care**

1. **After resolution of pain**-gradually resume usual activities
   - Reduce weekly mileage
   - Avoid hard surface running
   - Shorten running stride to reduce impact
     - Soft, level terrain is best
     - Limit distance to 50% of pre-injury distance
     - Decrease intensity by half
     - Slow pace to twice as long as prior to injury
     - Gradually increase distance over 3-6 weeks
     - If tolerated, gradually increase pace

2. **If worsening/recurrent symptoms or failed therapy consider:**
   - Stress fracture
     - Pain may become more localized and persist throughout exercise
     - May need extended rest period (6 weeks+)
     - Use crutches if pain with ambulation
   - Compartment syndrome
     - No relief with conservative therapy
- Aching or cramping of leg in anatomic distribution of the compartment within 10-30 minutes of exercise
- Diagnosis confirmed with elevated compartment pressures (>20 mmHg) using a tonometer
  - Stryker, ACE tonometers
  - Compare pre- and post-exercise measurements
- Treatment is surgical
  - Chronic compartment is non-urgent versus acute which needs immediate surgical referral
  - Lower limb fasciotomy:
    - Can reduce symptoms caused by shin splints
    - Rate of return to previous level of sports activity modest at best (SOR:C)\textsuperscript{11,12,13}
    - Usually no long-term sequelae unless co-existent diabetes or alcoholism

**Follow-Up**

1. Return to office
   - Re-evaluate athlete at end of rest period ~4 weeks
     - Determine if appropriate to gradually resume activities
   - Consider re-evaluation at 2-weeks:
     - Ensure resolution of pain
     - Monitor athlete adherence to relative rest
   - Return to office sooner if pain persists, worsens, changes intensity, or if "numbness and tingling"

2. Refer to orthopedic surgeon
   - If pain persists despite conservative management
   - If suspect compartment syndrome
   - Immediately if evidence of neurovascular symptoms

3. Admit to hospital
   - If suspect Acute Compartment Syndrome-5 Ps:
     - Pain-out of proportion
     - Pulselessness
     - Pallor
     - Paresthesia
     - Paralysis
   - Consult orthopedic surgeon immediately
   - Most cases that progress are chronic ischemic compartment syndrome

**Prognosis**

1. Pain
   - Early in disorder pain usually resolves with several minutes of rest
   - Later stages pain becomes severe and more persistent
     - May require several days of rest to resolve
   - Advanced stage:
     - Can affect activities of daily living
     - Pain may occur at rest

2. Healing
   - Dependent on the Grade of Fatigue/Failure (Arendt & Griffiths)\textsuperscript{8}
- Grade 1: average 3.3 weeks for healing
- Grade 2: 5.5 weeks
- Grade 3: 11.4 weeks
- Grade 4: 14.3 weeks
  - Early intervention speeds healing and return-to-play

**Prevention**

1. Graduated training program
   - Avoid doing "too much too soon"
   - Do not increase running mileage by more than 10% per week
   - Avoid running more than 40 miles per week
     - Little evidence that running more than 40 miles per week improves performance
     - There is evidence that running more than 40 miles per week increases risk of an overuse injury
   - Follow hard training/running days with easy days
   - Cross-train with sport that places less impact on shins (swimming, walking, biking)

2. Choose appropriate shoes and terrain
   - Avoid running on slanted or uneven surfaces
   - Best running surface is soft, flat terrain
   - Get new running shoes every 500 miles
     - After 500 miles, shoes lose their ability to absorb the shock of running
   - Choose shoes appropriate for sport and alignment/biomechanics
   - Use shock-absorbing insoles (SOR:B)

3. Anticipate warning signs
   - Do not "run through pain."
     - Pain is a sign that something is wrong
   - If athletes have muscle pain after running:
     - Recommend ice and rest for two or three days
     - If the pain continues for a week, need further work-up

**Patient Education**

1. Running: Preventing Overuse Injuries:
   - familydoctor.org

2. Avoiding Running Injuries:

3. Exercise: How to get started:

4. Weight-Training and Weight-Lifting Safety:

**Evidence-Based Inquiry**

1. How can you help athletes prevent and treat shin splints?

**References**


Authors: Heather Hammonds, MD, Maria Mahmoodi, MD, & Sonya Dominguez, MD, St. Vincent’s FMR, Jacksonville, FL

Editor: Carol Scott, MD, University of Nevada Reno FPRP