



Standard of Care: Tibial stress injuries

ICD-9 code: 733.93 Tibial Stress Fracture
719.46 Lower extremity pain

Tibial stress injuries, commonly called “shin splints”, result when the bone remodeling process adapts inadequately to repetitive stress. Controversy and confusion exists with the term shin splints. Many have advocated the term medial tibial stress syndrome to refer to anterior shin pain as a result of exercise. [3][13] [14] However, periostitis, medial tibial stress syndrome (MTSS) and tibial stress fracture should be viewed as a continuum of injuries resulting from exercise induced shin pain. [3] The incidence of shin pain is estimated at 10-20% of all injuries in runners and accounts for 60% of all overuse injuries in the lower leg. [3] Basketball, soccer, volleyball, ballet, aerobics participants and military recruits also demonstrate a high incidence for shin pain.

There are two theories for the pathophysiology of anterior shin pain. The most supported theory is the bone reaction theory. The lesion of MTSS is a result of a hypermetabolic state within cortical bone. Bone is in a phase of chronic remodeling as a result of persistent and increasing strain on porous bone. [1] Bone in athletes participating in running or jumping sports may have difficulty remodeling at a rate fast enough to adapt to the changes from mechanical loading. Ideally osteoblasts fill the tunnels left by osteoclasts, however in pathologic situations the porous bone inadequately accommodates to continued loading and microfissures may result and possibly progress to stress fracture. [1] It is known that the bone-remodeling sequence at the start of an exercise program commences approximately 5 days after stimulation and that the bone is weakened for the first eight weeks. Jones et al graded this stress reaction from normal remodeling (grade 0) to stress fracture (grade 4), with mild, moderate and severe stress reaction in between. [7]

Another theory for the pathophysiology of anterior shin pain is overuse syndrome involving the fascia of the soleus, as the fascia inserts on the posterior medial tibia or to the periosteum underneath the tibialis posterior. [14] This pain is diagnosed as periostitis or fasciitis. There are a few studies that report no evidence of inflammation, in patients with shin pain, and thus support the more current theory of bone stress reaction theory. [14] Other studies indicate that 90% of all pain symptoms occur in regions of the tibia far distal to the proximal origins of the soleus, tibialis posterior and flexor digitorum longus muscles, thus supporting the bone stress reaction theory. [1][14]

Patients with MTSS report a *diffuse pain* along the middle and distal third of the posteromedial tibia. In the early stages of the disorder, pain is present at the beginning of the workout/run, then stops and may return after the workout. In the later stages, pain can occur at rest and will subsequently take longer to resolve after the workout/run is stopped. Patients whose injury has

Standard of Care: Tibial stress injuries

progressed to stress fracture will have a *focal pain* along the middle to distal third of the posteromedial tibia. [3] The pain may begin insidiously, not just with running, intensify with training and persist at rest, even with sleep. Anterior cortex fractures are more typical in jumping athletes and are particularly prone to nonunion and progression to complete fracture. These fractures are typically located anteriolateral and at the midtibia. [3]

Indications for Treatment:

- Pain
- Antalgic gait
- Impaired functional mobility- impaired running, jumping or sports participation

Contraindications / Precautions for Treatment:

If fracture is suspected the patient should be assessed by their physician and or referred to an orthopedist for fracture management.

See modality standards for contraindications/precautions for use of modalities with fracture.

Examination:

Medical History: Complete review of medical history questionnaire (ambulatory evaluation), and medical history in hospitalized computer system record/ LMR. Review of diagnostic imaging in LMR or centrality and/or operative notes in LMR should also be examined. Triple phase bone scans are typically positive within 3 days of symptom onset and are highly sensitive (between 84% and 100%) for tibial stress injury. Plain x-rays are typically normal. MRI will detect tibial stress fracture and can pick up acute bone stress (medullary edema) and or periostitis. [1][3][6][8][10]

History of Present Illness/ Social History: Questions regarding the onset of pain (acute or gradual), location of pain (only in the leg vs. symptoms which may have proximal spine etiology), focal or diffuse (fracture vs. periostitis / MTSS), and what activities bring on the pain and at what point during the activity does the pain occur (may rule out muscle-tendon pathology, or chronic exertional compartment syndrome) should be asked. Intrinsic factors and extrinsic factors leading to injury should be considered including:

Extrinsic factors: [3]

- 1) Training Methods: abrupt increases in frequency, duration, intensity or changes in technique of workout (i.e., over-striding) may lead to increased loads and tibial stress.
- 2) Surfaces: type and incline of training surfaces can influence tibial stress and strain. Stairs, sloped/banked, curbs and irregular surfaces such as grass, sand and gravel will increase strain. Athletes should vary surfaces and avoid abrupt changes.
- 3) Footwear: shock absorption is the most important characteristic of sneakers. Shoes should be replaced every 350-450 miles.

Intrinsic factors:

- 1) Previous injury or inadequate rehabilitation from another injury.

Standard of Care: Tibial stress injuries

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- 2) Low bone mineral density. The incidence of stress fractures increases in females who have menstrual disturbances. Amenorrhea, osteoporosis and disordered eating have been linked to fractures. Lower estrogen levels may contribute to decreased bone mineral density, accelerated remodeling and increased calcium excretion.
- 3) Poor nutrition/ eating disorders will contribute to inadequate calcium intake and amenorrhea.

Medications: Nonsteroidal anti-inflammatory drugs may be helpful. However, some authors have reported NSAIDs slow the bone healing response and should be avoided. These authors recommend acetaminophen. [3][6][10] Patients may also undergo anesthetic injections. These medications will not alter the course of the disorder but will treat secondary inflammatory processes. Female athletes with menstrual disturbances may regulate estrogen levels with oral contraceptives. There are conflicting results regarding the impact of contraceptive pills and bone mineral density and the incidence of stress fracture. [6]

Examination:

Palpation: Palpation of the tibia is critical for differential diagnosis. Diffuse tenderness along the posterior medial tibia to the middle and distal third is the hallmark of MTSS. Focal or local tenderness at the posteromedial margin of the tibia near the middle and distal thirds of the bone are a sign of tibial stress fracture. It should be noted that there could be multiple sites of fracture in the same limb. The area of focal tenderness should be able to be covered by a single finger (or a pencil), if a stress fracture is suspected. Tenderness to the anteriolateral margin of the midshaft would be suspicious for anterior cortex fracture. Palpable callous, swelling or erythema in the area may indicate a stress fracture. Pain with percussion or vibration can also indicate a fracture. Percussion and vibration maneuvers have a low sensitivity (50%) but have a high specificity in diagnosing stress fracture from MTSS. [1][6][10]

Observation: Inspection of entire lower leg should be done to note areas of focal deformity, swelling or redness. Footwear should also be inspected for wear patterns.

Special testing: Tuning fork test can be performed if stress fracture is suspected. [10] Navicular drop can be measured to determine the amount of medial longitudinal arch loss. Yates et al also describe a foot posture index (FPI) that is an observational test that determines whether a foot is in a pronated, supinated or neutral position based on 8 parameters. The intra and inter tester reliability data is good ranging from 0.73-0.87 to 0.66 to 0.78 respectively. [11][14]

ROM: Ankle ROM is typically unaffected with MTSS and/ or stress fracture. However in some studies decreased dorsiflexion is associated with increased pronation. Testing should be done with both the knee extended and flexed, and the ankle in subtalar joint neutral to determine differences in flexibility between the soleus and gastrocnemius. [4]

Posture: The anatomic characteristics that can predispose patients to tibial stress injury include hindfoot varus and forefoot varus, both lead to excessive subtalar pronation.

Standard of Care: Tibial stress injuries

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Excessive subtalar pronation creates an increase stress generated by the soleus. Thereby causing a “bowing” of the tibia. Increased stress at the soleus fascial origin medially can be transmitted to underlying bone (tibia) by Sharpey’s fibers inciting a maladaptive remodeling sequence. Other anatomic considerations are genu varum, pes planus, external rotation of the hip, and leg length discrepancy. [1][3][4][14]

Muscle testing: Lower extremity screening for muscle strength impairments should be noted by manual muscle testing or resisted isometric testing. However, specific notation of ankle strength and intrinsic foot strength are important. Some studies have linked weak intrinsic foot muscles and larger extrinsic anti-pronatory muscle weakness to timing or velocity problems with pronation during dynamic gait analysis. Appropriate subtalar joint pronation is an integral component in the absorption of joint reaction forces during gait. It has been demonstrated that foot weakness and not lack of dorsiflexion is the more likely reason for an increased pronated foot position. [3]

Functional testing: Having the patient run or hop/jump may be the most helpful test to elicit the pain, especially if there is no pain at rest. If a patient cannot hop five times it has been reported this is suggestive of a stress fracture. [8] [10]

Gait analysis: Note assistive devices, antalgia, stride length, and stance time. Assessment of gait during running and ambulation should be noted. It is important to note dynamic foot postures versus static postures already assessed during the postural analysis. [4]

Pain: Use of the VAS scale and body charts that document changes in intensity and location of pain at rest and with functional activities.

Screening: Both lower extremities: hip, knee and ankle as well as lumbar spine should include ROM and neurological examination to rule out other causes of lower extremity leg pain.

Differential Diagnosis: [1][2][3][5][6][14]

- Compartment syndromes are the most common problem confused with tibial stress injuries. This is determined by direct anterior compartment pressure measurements immediately after exercise. Distal numbness or dysesthesias may be present. Abnormal pressures are 25-35 mm Hg post exercise or 20mm Hg at rest. The physical exam at rest is normal.
- Tibiofibular synostoses.
- Bone tumors.
- Bursitis or tendonitis. Pes anserine bursitis: pain will be proximal and medial: the bursa does not overlap with the region of tibial MTSS or fracture. Anterior tibialis tendonitis: pain is anterior lateral.
- Infection: Osteomyelitis, cellulitis.
- Musculotendinous injuries, sprain, strain or tears.
- Lumbar radiculopathy
- Thrombophlebitis or vascular claudication.

Standard of Care: Tibial stress injuries

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- Nerve entrapments: superficial peroneal nerve, deep peroneal nerve and/or the sural nerve can be entrapped.

Problem List:

- Increased pain
- Impaired functional mobility: running, jumping or sports participation
- Impaired gait: biomechanics
- Impaired knowledge regarding preventative training methods, footwear, proper nutrition pain management techniques and home therapeutic exercise program
- Impaired muscle performance
- Impaired range of motion

Prognosis:

The recovery time for periostitis or medial tibial stress syndrome is three to four weeks. Patient with stress fractures typically resume unprotected activities in 4-6wks and impact activities in 2-3 months. Adequate healing and the resolution of symptoms determine the rate at which the resumption of activities occurs with the impact activity. [1][10]

Goals:

- Non- antalgic gait and return to pain free sports/recreational activities in 8wks.
- Full ankle, knee and hip range of motion in the painful limb equal to the non-painful limb or within normal limits in 4wks.
- Patients will be independent with training methods, footwear use including orthosis, proper nutrition, and progressed home/gym therapeutic program in 8wks.
- Increased strength all impaired muscle groups to 5/5 manual muscle testing in 6wks.

Age Specific Considerations:

Bone density must be considered in the adolescent, postmenopausal women and in the female athlete. Growing adolescents require adequate calcium (1500mg) and vitamin D 400mg/day. The female athlete triad of amenorrhea, osteoporosis and anorexia contribute to decreased density. [2, 8][10]

Treatment Planning / Interventions

Established Pathway	<input type="checkbox"/> yes, see attached.	<input checked="" type="checkbox"/> No
Established Protocol	<input checked="" type="checkbox"/> yes, see attached.	<input type="checkbox"/> No

Interventions most commonly used for this case type/diagnosis...

Acute:

- Rest: Removal of the inciting stress is the key to treatment- including avoiding the activity that provokes the symptoms. If the removal of the activity does not result in

Standard of Care: Tibial stress injuries

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pain free ambulation, then short-term crutches or cane is required to correct antalgic gait. If the injury has progressed to stress fracture then the patient will be non-weight bearing on crutches for up to 6 weeks. The patient may also be splinted in a pneumatic boot. It is rare that complete casting is necessary. [1]

- Aerobic fitness can be maintained with cross training with non-weight bearing methods (i.e. swimming or pool running and/or biking). [3]
- Modalities: Ice is the optimal modality. Phonophoresis, Iontophoresis and whirlpool baths may be used, however, care should be taken around bone especially if the injury has progress to fracture- see contraindications/precautions for modality chosen. [3, 10]
- Therapeutic massage may be an adjunct to therapy to decrease pain, however it will not directly influence the bone-stress reaction. [3]
- Stretching program: Patients should stretch in non- weight bearing positions acutely to diminish loading the tibia. Do not stretch or strengthen the lower extremity excessively because exercise may exacerbate stress to the tibia. However any pelvic, hip or knee impairments, which contribute to gait/running dysfunction should be addressed. [1][3]
- Biomechanical correction: Orthoses designed to correct pes planus, hind foot varus or forefoot varus should be fabricated.[4][9]
- Education: Correction of training errors, and improper footwear.

Sub-Acute:

- Gait progression from crutches to full weight bearing. Once pain free ambulation is achieved resumption of training can begin with 50% intensity. Intensity may be increased weekly by 10% as long as the patient remains asymptomatic.[3]
- Cross training should be used to allow adequate recovery time from running and jumping activities.
- Strengthening and stretching the anterior and posterior compartment. Any impairment noted in the pelvis, hip, knee and foot should also be addressed.
- The therapist should address education regarding correct running or sports technique or the patient should be referred to a coach/pro.
- Please see tibial stress fracture rehabilitation protocol for specific functional activity progression for runners. Practice sessions should not be initiated until the functional rehabilitation is successfully completed.

Frequency & Duration:

The duration of treatment can be as long as 6-8wks based on fracture healing. Frequency can be as little as once a week if the patient is limiting weight bearing and performing self-management of pain verses up to three times per week if modalities that need to be administered by the physical therapist (iontophoresis, or phonophoresis) are chosen.

Patient Education: [3][8]

Prevention is the best management for stress injury. Running should be on a level, moderately firm surface. Changes in intensity, activity and terrain should be implemented gradually. Mileage should not be increased by more than 5-10% weekly. Ensure adequate nutrition and calcium intake (1,500mg/day for female athletes). Use of a multi-vitamin with vitamin D. Footwear with adequate shock absorption should be worn and replaced as needed. If athletes are participating

Standard of Care: Tibial stress injuries

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on organized sports teams, communication between coaches can be critical to ensure training errors are corrected.

Recommendations and referrals to other providers:

Referral to an Orthopedist should be made if a fracture is suspected for management. Referral to a Podiatrist or Orthotist for the fabrication of an orthotic can be made if biomechanical impairments are found. A referral to an Endocrinologist or Primary care physician for the treatment of a menstrual dysfunction can be made. A Nutritionist may be needed for optimal calcium /calorie intake for athletics. Psychologist/psychiatrist referral for eating disorder intervention may be required.

Re-evaluation / Assessment:

Standard Time Frame: Re-evaluation is every 30 days or sooner if status change occurs.

Other Possible Triggers: Change in signs or symptoms or new trauma.

Discharge Planning:

Commonly expected outcomes at discharge:

After a period of rest, activity modification, and gradual resumption of training, most athletes can return to pre injury levels of activity.

Transfer of Care:

Surgical options are limited and rare, however some stress fractures can progress to non-union and require fixation. Posterior fasciotomy can also improve symptoms in severe cases by reducing the pull of the soleus. Cauterization of the periosteum is also an option when conservative management fails. [1][3][12][15]

Patient's discharge instructions:

Continue with home progressed therapeutic exercise program. Patients should use orthotics as instructed for all sports/running activities. Running shoes should be changed every six months to 350-450 miles. Some sources state that shock absorption in sneakers can be decreased by 55% after 500 miles. [9] Modifications to training, intensity, methods, surfaces and techniques should be implemented. Patients should follow up with their physician if symptoms re-occur.

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Standard of Care: Tibial stress injuries

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Standard of Care: Tibial stress injuries

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Standard of Care: Tibial stress injuries

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