Leg Pain in the Athlete

Matthew Handling

Differential Diagnosis

- Effort-induced DVT
- Stress Fractures
- Compartment Syndromes
- Popliteal Artery Entrapment
- Shin Splints
- Tennis Leg
- Proximal Tib/fib joint pathology
- Tib/fib synostosis
- Nerve Entrapment

40 ♀ c/o soreness L leg

- New Year’s resolution to join gym & run 3x’s/wk
- Pain started in beginning of February
- Dull ache when first gets on treadmill, goes away after 10 minutes
- Seems to be getting worse

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20 ♀ student c/o soreness L leg

- Tender posteromedial border tibia
- Pain reproduced when does multiple toe raises
- No pain PROM
- XR normal

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Shin Splint Syndrome

- AMA Subcommittee on Classification Sports Injuries, 1966

“condition that produces pain and discomfort in the leg owing to repetitive running or hiking”

Limit to musculotendinous inflammations, excludes stress fxs & ischemia
Medial Tibial Stress Syndrome = “Shin Splints”

• Symptoms
  – Early
    • Dull ache, soreness on initial exertion
    • Relieved with continued running
  – Advanced
    • Sharp, penetrating pain
    • Can extend through entire time of exertion
    • ADLs

MTSS (Shin Splints)

• Risk Factors
  – Unconditioned individual who begins training
  – Changes in footwear
  – Changes in running terrain
  – Increased intensity of workout
  – Females

MTSS (Shin Splints)

• Clinical
  – Tenderness along the posteromedial border of the tibia
    • From 4cm above medial malleolus to 12cm
    • One third of the tibia is tender, centered over junction of middle & distal 1/3’s
  – Slight swelling
  – Pain with active resisted plantarflexion
  – No pain with P or AROM ankle/foot

MTSS (Shin Splints)

• Studies
  – X-ray typically normal
    • Hypertrophy posterior cortex tibia
    • Subperiosteal lucency & scalloping on anterior or medial side tibia
    • Faint periosteal reaction
      – Periostitis vs Stress fracture

MTSS (Shin Splints)

• Studies
  – Bone Scan
    • Angiogram & blood pool phases always normal (Phase I & II)
    • Delayed Images show moderate ↑radionucleotide activity
      – along posteromedial border tibia
      – ¼ to 1/3 bone involved (stress fx will be <1/5)
  – MRI: Sensitive & specific

MTSS (Shin Splints)

• Proposed Etiology
  – Posterior Tibialis overload
    • Anatomically, tenderness corresponds to origin
    • Stress fractures of tibia → Ruled out with bone scan
MTSS (Shin Splints)

- Proposed Etiology
  - Posterior Tibialis overload
  - Deep posterior compartment syndrome →
    - tends to get better with exercise
    - Compartment pressures normal <Mubarak SJ, 1982>

- Proposed Etiology
  - Posterior Tibialis overload
  - Medial origin of soleus
    - Anatomic correlation of bone scans & tenderness with soleus origin
    - Biomechanics <Messier SP, 1988>
      - associated with higher maximum pronation velocity & degree pronation
      - Association with heel cord tightness

MTSS (Shin Splints)

- Biomechanics of running
  - Initial contact
    - Lateral aspect of the foot makes contact
    - Tibia is externally rotated
  - As stance phase progresses
    - Tibia internally rotates
    - Eversion of subtalar joint occurs to compensate resulting in pronation of foot
    - Eccentric contraction of medial soleus (an invertor of the calcaneus)

MTSS (Shin Splints)

- Treatment
  - Relative rest
    - NSAIDs 2 weeks
    - Theoretically to decrease periostitis
    - Heel cord stretching & strengthening posterior muscles
  - Naval Academy cadets
    - No combination of NSAIDs, stretching, heel pads, or casting was better than rest alone

MTSS (Shin Splints)

- Treatment
  - Footwear adjustments
    - Avoid wide heel (↑’s pronation velocity)
    - Hindfoot varus → medial heel wedge
    - Hindfoot valgus → heel cup
    - Excessive pronation → orthotic
MTSS (Shin Splints)

- Treatment recalcitrant shin splints (2-3 times)
  - <Yates, JBJS, 2003>
  - 46 patients treated surgically
    - middle-distal inner tibial border
    - "soleus bridge" thick fascia of deep posterior compartment incised at bone interface
    - removed 2cm strip of periosteum
  - compartment pressures normal, + bone scan, conservative tx 12mos
  - F/U 30mos
  - visual analog pain score & level of activity 69% Excellent/good, 41% at pre-symptom LOA
  - <Detmer DE, 1986> 78% described themselves as cured
    - 29-66% in literature

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Tennis Leg

- Symptoms
  - Middle-aged athlete, ♂>
  - Acute pain in calf while running or making sudden stop, "kicked in back of leg"
  - Pain & swelling increase over next 24hrs

Tennis Leg

- Clinical
  - Tenderness well-localized to medial head gastrocs (musculotendinous junction)
  - Duplex can be used to distinguish from thrombophlebitis
  - Direct compartment pressure measurement if pain out of proportion, paresthesias or weakness

Tennis Leg

- Why medial gastrocs & not lateral head or soleus?
  - Medial half muscle larger than lateral
  - Fast twitch fibers (soleus slow twitch)
  - Crosses two joints
Tennis Leg

- **Mechanism**
  - Forced ankle dorsiflexion in combination with extended knee

- **Treatment**
  - 48-72 hrs
    - Crutches
    - Ice 3-5 times/day
    - Elevate
    - Compressive dressing
  - 3-14 days
    - Heel lift, WBAT
    - Pain-free, gentle active-assisted ROM
  - 14 days
    - Strengthening exercises as tolerates
  - 3-6 wks
    - Graduated activity
    - When calf strength 90% contralateral, nontender, & normal ROM can return to full participation

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33♂ c/o pain top of leg

- Slide-tackle in game last week, severe pain
- Since then, hurts any time moves ankle
- Feels like he can’t straighten knee
- Wants to know if he hurt his ACL

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25♂ c/o pain top of leg

- No instability knee
- Palpable deformity

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Proximal Tibiofibular Joint

- Ogden Classification 1974
  - Type I subluxation 23.3%
  - Type II anterolateral dislocation 67.4%
  - Type III posteromedial dislocation 7%
  - Type IV superior dislocation (usually associated with Tib/fib fx or syndesmotic injury 2.3%)

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**Proximal Tibiofibular Joint**

**Anatomy**
- Diarthrodial joint
- Joint space communicates with knee in 10% population
- Capsule thicker and stronger anteriorly
- Tibiofibular ligaments
  - Single ligamentous band posteriorly
  - 2-3 anterior ligamentous bands
- Biceps femoris inserts on lateral side of fibula

**Function**
- Relieve torsional stresses applied to ankle
- Relieve lateral tibial bending moments
- Allows fibula to move distally with weight-bearing

**Mechanism of Injury**
- Fall on adducted leg with knee flexed & foot plantarflexed
  - Inversion & plantarflexion of foot causes tension on peroneals, EDL, EHL
  - Combined violent contraction of these muscles pulls fibula forward
  - Biceps tendon & LCL relaxed in flexion, lowering resistance to anterior subluxation
- Slide tackle in soccer, knee-boarding

**Symptoms**
- Acute pain & tenderness at joint
- Aggravated by ankle & subtalar motion
- Can’t fully extend knee
- Transient paresthesias peroneal nerve
- May complain of knee instability when chronic

**Physical Examination**
- Tender
- Deformity of joint may be visible
- May have gross instability on AP pressure on fibular head

**Studies**
- X-rays
  - IR 30-90 degrees to maximize tib/fib diastasis
- Fluoroscopy
Proximal Tibiofibular Joint

- **Treatment**
  - **Acute Injury**
    - Closed reduction under anesthesia
      - Knee flexed 90°, foot dorsiflexed & everted followed by direct AP pressure
      - 3 weeks knee immobilizer, light TTWB
      - Protected WB 3 more weeks
      - Quad strengthening whenever pain-free full extension achieved
    - Chronic
      - Open reduction with ligamentous reconstruction (biceps femoris)
    - Failed reconstruction
      - Arthrodesis with partial fibular resection

- **20♂ rugby player c/o chronic leg pain**
  - h/o multiple high ankle sprains, but this is different feeling
  - He never let injuries slow him down much but feels like his ankle is stiff
  - Tenderness to deep palpation mid-distal 1/3 tibia

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- **20♂ rugby player c/o chronic leg pain**

Tibiofibular Synostosis

- **Etiology**
  - Congenital
  - Acquired
    - Interosseous membrane trauma & resultant hemorrhage

- **Anatomy & Biomechanics**
  - IOM originates from tibia periosteum & angles 15-20° obliquely & distally to insert on fibula
  - Fibula transmits 1/6 weight
  - Widening of mortise must occur for full dorsiflexion of ankle
  - Distal excursion of fibula results in deepening of mortise during plantarflexion
**Tibiofibular Synostosis**

- **Clinical**
  - Congenital may first become symptomatic in teenage years
  - Acquired cases may report multiple high-ankle sprains
  - Tender over synostosis
  - Pain with weight-bearing
  - Limited motion (dorsiflexion)
  - X-rays diagnostic

- **Treatment**
  - Don’t treat something that doesn’t hurt
  - Conservative Tx
    - Activity modification & NSAIDs initially
    - Cycling to maintain cardio
    - Ankle rehab: strength, proprioception & flexibility
    - Gradual return to running
  - Surgery
    - Excise & irradiate

**30yo c/o mass side leg**

- Mass gets bigger when works out
- Sometimes he gets some burning on top of foot
- Tender just above lateral malleolus
- Burns in foot when tap there

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**Nerve Entrapment**

- **Common Peroneal**
  - Activity-related pain & numbness in peroneal distribution
  - Sharp fibrous origin of peroneus longus
  - Contraction of peroneal muscles combined with plantarflexion/inversion force to foot elicits sx

- **Superficial peroneal**
  - Most common
  - Travels in lateral compartment & pierces fascia 10-12cm above lateral malleolus
  - Purely sensory at this point
  - Provocative tests
    - Passive Plantarflexion/inversion of foot elicits pain or tenderness
    - Tenderness 10cm proximal to lateral malleolus while pt holds foot dorsiflexed & everted
    - Tinel’s sign
Nerve Entrapment

- **Sural Nerve**
  - Posterolateral leg, just posterior to peroneal tendons
  - Lateral calcaneal to ankle & heel, then sensory to lateral border foot & 5th toe
  - Compression by soft tissue bands or ganglia at lateral ankle or foot or point where it exits fascia of leg

Nerve Entrapment

- **Clinical**
  - Sensory distribution
  - Compartment pressures
  - Motor involvement
  - EMG shows delayed conduction velocity
  - MRI may show muscle hernias

Nerve Entrapment

- **Treatment**
  - **Acute**
    - Lateral sole wedge to decrease inversion stress
    - Peroneal muscle strengthening & proprioceptive training to prevent recurrence
  - **Established syndrome**
    - Fasciotomy with neurolysis
    - *Never close fascial defects associated with muscle hernias*

20 yrs field hockey player c/o pain leg

- Never had any problems before
- Came on gradually during Spring training this year
- Hurts more at end of practice & with every step in the evening
- Point tenderness posterior midshaft tibia

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20 yrs field hockey player c/o pain leg

- XR normal
Stress Fractures

• Epidemiology
  – Incidence
    • Athletes 0.12%
    • Runners 4-15%
  – Location
    • Competitive athletes tibia most common 50%
    • Recreational athlete, metatarsals & pelvis more common
    • If proximal or distal 1/3 → posteromedial compression side
    • Middle 1/3 → anterior tension side
    • Bilateral 11-23%

Stress Fractures

• Risk Factors
  – Females 12x’s risk <Barrow, 1988>
  – Runners Irregular Menses 50% incidence
  – Runners with regular cycle 30%
  – Oral contraceptives protective
  – Narrow tibial width <Giladi, 1987>
  – Change in intensity workout
  – Hard running surface, poor footwear
  – Forefoot varus, hyperpronation, tibia vara

Stress Fractures

• Basic science
  – Repetitive stress
  – Vascular congestion & thrombosis
  – Osteoclastic resorption
  – Periosteal reaction & new bone formation leads to callus
  – Resorption cavities develop in cortex & remodelling begins
  – Cortical hypertrophy is the result

Stress Fractures

• Pathomechanics
  – Muscles fatigue, ↑stress transmitted to bone <Clement,1974>
  – Forceful contraction of muscle stresses bone <Stanitski, 1978>
  – Anterior cortex tibia fxs from repetitive jumping activity, “bow-string”

Stress Fractures

• Other stress fxs in the leg
  – Medial malleolus, from plafond obliquely proximal
  – Fibula, usually just above syndesmosis

Stress Fractures

• Clinical
  – Pain after activity, progresses to pain during activity & finally with ADLs
  – Well-localized tenderness
  – Palpable bump = periosteal thickening or callus (usually sx at this stage)
  – US at fx can elicit tenderness
**Stress Fractures**

- **Studies**
  - X-ray changes visible at 2-3 weeks
  - Periosteal rxn
  - Scalloping (subperiosteal resorption)
  - Cortical hypertrophy
  - 1/3 of stress fxs dxed by bone scan also have XR abnormalities

- **Stress Fractures**
  - Bone scan positive within 1st week (100% sensitivity)
    - "focal fusiform activity" classic
    - All 3 phases abnormal acutely (2-4wks)
    - Delayed stays abnormal 3-6mos
  - MRI
    - Comparable sensitivity & cost to bone scan with no radiation

- **Stress Fractures**
  - Conservative Tx 93% successful <Orava, 1987>
    - 4-6 wks rest <Clement>
      - NSAIDs
      - Can weight-bear, but no running
      - +/- pneumatic brace <Allen, 2004> showed no benefit
      - Cycling, swimming
      - When pain-free 2 wks can start graduated return to sport
    - 12wks until full activity

- **Stress Fractures**
  - "Dreaded black line"
    - Can treat conservatively, but more prone to nonunion
    - NWB SLC 6-8wks
    - Excision & grafting if not healed in 3-6mos
    - IM nailing allows quicker return to sports, (4mos) & reliable union (3mos) <Varner KL, 2005>
  - Medial Malleolus
    - Internal fixation to prevent displacement <Shelbourne>

25♂ runner pain both legs

- L leg hurt a little last year, but got better in off-season
- Feels fine at beginning of workout but starts hurting 5 minutes into run
- Does not hurt after practice

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**Stress Fractures**

- Examination WNL
- XR, bone scan normal
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Compartment Syndrome

Condition in which an elevated tissue pressure exists within a closed fascial space, resulting in reduced capillary blood perfusion & compromised neuromuscular function.

Compartment Syndrome

- **Pathogenesis**
  - Acute
    - Tibia fx or muscle rupture
    - casts & circumferential dressings can contribute
  - Chronic Exertional
    - Etiology unclear
    - Muscle contraction alone causes compartment pressures to ↑ up to 80mmHg
    - Muscle weight ↑’s up to 20% due to ↑ed tissue perfusion with exercise <Fronk J, 1987>
    - Fascia may be thicker & stiffer in affected individuals <Hurschler, 1994>
    - As pressure approaches diastolic BP, microcirculation impeded

Compartment Syndrome

- **Anatomy**
  1. Superficial posterior: Sural N
  2. Deep posterior: Tibial N
  3. Anterior: Deep Peroneal
  4. Lateral: Superficial Peroneal
  5. Fibular origin of FDL can be extensive (>8cm) → subcompartments of deep posterior

Compartment Syndrome

- **Clinical**
  - Acute
    - Pain out of proportion
    - Tense muscle compartments
    - Paresthesias
    - Severe pain with PROM
Compartment Syndrome

- Clinical:
  - Chronic Exertional
    - History of being asymptomatic in off-season
    - Dull aching pain with exercise
    - Paresthesias dorsum or plantar foot (Anterior 60% & deep posterior 20% most common)
    - Ankle weakness/instability with fatigue <Martens, 1984>
    - Distension & or weakness of affected compartments on exam after exercise
      - 95% bilateral <Reneman, 1975>
      - Fascial defects 40% cases versus 5% in normal

Compartment Syndrome

- Stryker
  - Acute
    - Compartment pressures
      - only needed if unconscious, need continuous monitoring, or equivocal presentation
      - >30mmHg, within 30mmHg of DBP
    - Foot position affects measurements
  - Chronic Exertional
    <Pedowitz R, 1990>
    - Pre-exercise >15mmHg
    - 1-minute postexercise >30mmHg
    - 5-minute postexercise >20mmHg

Compartment Syndrome

- MRI
  <van den Brand, AJSM, 2005>
  - 42 patients bilateral CECS anterior compartment
  - Compared SN/SP
    - compartment pressures: 35mmHg after exercise
    - near-infrared spectroscopy: measure of tissue oxygen saturation
    - MRI: % T2-weighted signal in region of interest

Compartment Syndrome

- Treatment
  - Acute
    <Mubarak & Owen, 1977>
    - Emergent fasciotomy
    - Anterolateral:
      - midway between tibia & fibula
      - Short transverse incision over septum
      - Release 1cm anterior & 1cm posterior to septum
      - Superficial peroneal nerve
    - Posteromedial:
      - 1cm medial to tibia
      - Saphenous vein & nerve
    - Long incisions, release all compartments, do not close

Compartment Syndrome

- Treatment
  - Chronic Exertional
    <Schepsis, 1993>
    - 98% with anterior, 65% with posterior
    <Howard, 2000>
    - 79% pts satisfied, average 68% relief on pain scores
27♂ recurrent leg cramps when jogging

- Leg cramps start 5 minutes into workout
- Leg starts to feel cold & tingly
- Goes away if he stops to rest
- No DP pulse if passively dorsiflex ankle with knee extended

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Popliteal Artery Entrapment

- **Epidemiology**
  - Accounts for <1% of entities causing stenosis or occlusion of popliteal artery
  - Young males most common (94% are <40yo)
  - Bilateral in 25% cases

- **Why worry?**
  - Permanent arterial damage can occur if left untreated
  - Reports of progressive thrombosis & leg ischemia exist

Popliteal Artery Entrapment

- **Classification** <Repessa, 1990>
  1. Popliteal artery deep to medial head gastrocnemius (63% cases)
  2. Artery cuts across medial head gastrocnemius, dividing it into two origins (23%)
  3. Passes deep to popliteus muscle (7%)  
  4. Anatomic abnormality uncategorized

Popliteal Artery Entrapment

- **Classification** <Levien, 1999>

- Classification: Type I, Type II, Type III, Type IV
**Popliteal Artery Entrapment**

- **Symptoms**
  - Vague symptomatology months or years
  - Young athlete with intermittent claudication:
    - Calf pain
    - Cramping
    - Coolness in leg/foot
    - Paresthesias
  - Usually unilateral
  - Can be present with walking & relieved with running or vice versa
  - Worse when elevate leg, relieved in dependent position
- **Clinical**
  - Obliteration pedal pulses with active plantarflexion or passive dorsiflexion with knee in extension (can occur in up to 50% controls)
- **Arteriography**
  - Classically medial deviation of artery at level of medial head
  - Stenosis & occlusion demonstrated with provocative maneuvers
  - +/- Poststenotic dilatation

**Summary**

- <Clanton TO, 1994>
  - 150 patients with leg pain caused by exercise
    - Chronic Exertional Compartment Syndrome 33% → Fasciotomy
    - Stress fractures 25% → PWB or IM nail
    - Muscle strains 14% → RICE
    - Medial Tibial Stress Syndrome 13% → modify activity/footwear... surgery
    - Neuropathy 10% → modify activity, strengthening... neurolysis
    - Venous disease 4% → Anticoagulation
    - Spinal stenosis 1%

- Proximal tib/fib pathology → reduce/immobilize... reconstruct
- Popliteal artery entrapment → surgical release
- Tibiofibular synostosis → activity modification... excise

**Thank You**