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

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 fxs will be <1/5)
  - MRI: Sensitive & speciffic

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>

MTSS (Shin Splints)

- 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
  - Relative rest (don't do anything that causes pain)
    - One week of complete rest or water training/cycling
    - When pain-free begin running half-distance & half-speed
    - Increase distance to pre-injury level over 3-6wks
    - Slowly increase pace

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 txed surgically
      - middle-distal inner tibial border
      - "soleus bridge" thick fascia of deep posterior compartment incised at bone interface
      - removed 2cm strip periosteum
    - compartment pressures normal, +bone scan, conservative tx 12mos
    - F/U 30mos
    - visual analog pain score & level of activity
    - 69% Excellent/good, 41% at presymptom LOA
  - <Detmer DE, 1986> 78% described themselves as cured
  - 29-86% in literature

35♂ hurt leg playing raquetball

- Sudden pain back of leg yesterday, thinks his girlfriend may have kicked him
- Kept playing but pain got worse last night
- Tender over inside of calf
- XR, bone scan normal

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Tennis Leg

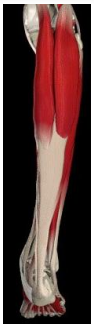
- Symptoms
  - Middle-aged athlete, ♂>♀
  - Acute pain in calf while running or making sudden stop, "kicked in back of leg"
  - Pain & swelling increase over next 24hrs

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

Tennis Leg

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

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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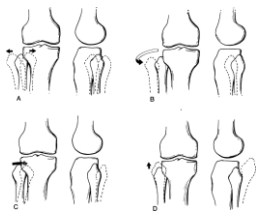
25♂ c/o pain top of leg

- No instability knee
- Palpable deformity

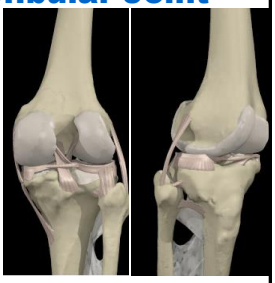
Proximal Tibiofibular Joint



- 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 fxs or syndesmotic injury 2.3%

Proximal Tibiofibular Joint

- Anatomy
  - Diarthrodial jt
  - 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

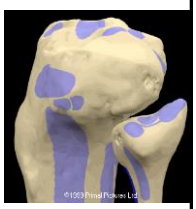


Proximal Tibiofibular Joint

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

Proximal Tibiofibular Joint

- 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



Proximal Tibiofibular Joint

- 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

Proximal Tibiofibular Joint

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

Proximal Tibiofibular Joint

- 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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Tibiofibular Synostosis

- Etiology
  - Congenital
  - Acquired
    - Interosseus membrane trauma & resultant hemorrhage

Tibiofibular Synostosis

- 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

Tibiofibular Synostosis

- 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

30♂ 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 sxs

Nerve Entrapment

- 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♀ 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

20♀ field hockey player c/o pain leg

- XR normal

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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 abovesyndesmosis

Stress Fractures

- Clinical
  - Pain after activity, progresses to pain during activity & finally with ADLs
  - Well-localized tenderness
  - Palpable bump = periosteal thickening or callus (usually sxs resolving 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

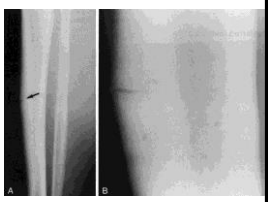
- Studies
  - Bone scan positive within 1st week (100% sensitivity)
    - "focal fusiform activity" classic
    - All 3 phases abnormal acutely (2-4wks)
    - Delayed stays abnormal 3-6mos
  - MRI
    - Comparable sensitivity & cost to bone scan with no radiation

Stress Fractures

- Treatment
  - 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

- Treatment
  - "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 KE, 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

25♂ runner pain both legs

- 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

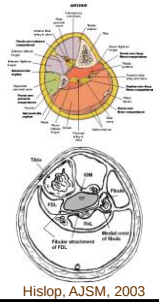
- Pathogenesis
  - Acute
    - Tibia fx or muscle rupture
    - Casts & circumferential dressings can contribute

Compartment Syndrome

- Pathogenesis
  - 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<Fronek J, 1987>
    - Fascia may be thicker & stiffer in affected individuals <Hurschler, 1994>
    - As pressure approaches diastolic BP, microcirculation impeded

Compartment Syndrome

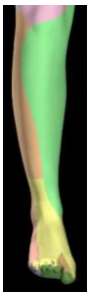
- Anatomy
  1. Superficial posterior: *Sural N*
  2. Deep posterior: *Tibial N*
  3. Anterior: *Deep Peroneal*
  4. Lateral: Superficial Peroneal
  5. Fibular origin of FDL can be extensive(>8cm) → subcompartments of deep posterior



Hislop, AJSM, 2003

Compartment Syndrome

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



Compartment Syndrome

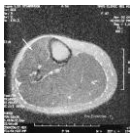
- Clinical:
  - Chronic Exertional
    - h/o being asymptomatic in off-season
    - Dull aching pain with exercise
    - Paresthesias dorsum or plantar foot (Anterior 60% & deep posterior 20% most common)
    - Ankle weakness/instability with fatigue <Martens, 1984>
    - Distension & or weakness of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

Compartment Syndrome

- Stryker
  - Acute
    - Compartment pressures
      - only needed if unconscious, need continuous monitorring, 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 pateints 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

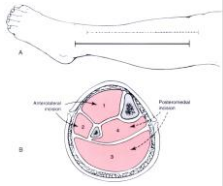


Pre-exercise

Post-exercise

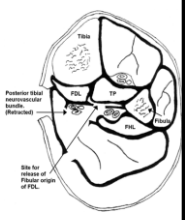
Compartment Syndrome

- Treatment
  - Acute
    - Emergent fasciotomy
    <Mubarak & Owen,1977>
    - 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

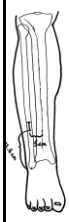


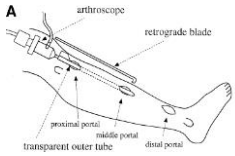
Compartment Syndrome

- Treatment
  - Chronic Exertional
    - Subcutaneous fasciotomies of affected compartments, close skin
    - 90% have marked improvement
      - Anterior & lateral compartments do best
      - Posterior compartments & females do worse



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 5minutes 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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27♂ recurrent leg cramps when jogging

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

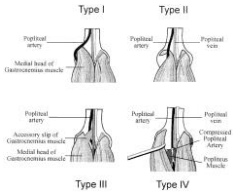
Popliteal Artery Entrapment

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

Popliteal Artery Entrapment

- Classification <Repressa, 1986>
  1. Popliteal artery deep to medial head gastrocnemius (63% cases)
  2. Artery cuts across medial head gastrocs, dividing it into two origins (23%)
  3. Passes deep to popliteus muscle (7%)
  4. Anatomic abnormality uncategorized

- Classification <Levien, 1999>



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

Popliteal Artery Entrapment

- 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
  - MRA

Popliteal Artery Entrapment

- Treatment
  - Surgical Exploration
    - Muscle hypertrophy & normal anatomy (functional PAES) → fasciotomy/myotomy
    - Anatomic variant → release
    - Medial deviation of artery → release medial head
    - *Arterial damage from severe or chronic disease* → Vascular reconstruction

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%

Summary

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

Thank You