

COMMON SPORTS-RELATED LOWER LEG INJURIES

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COMMON CAUSES

- Gastrocnemius Strain
- Contusions
- Fractures
- Medial Tibial Stress Syndrome (Shin splints)
- Muscle Cramping
- Delayed onset muscle soreness
- Chronic Compartment Syndromes
- Stress Fractures

LESS COMMON CAUSES

- Referred Pain
- Vascular insufficiency/ Claudication
- Deep Vein Thrombosis
- Popliteal artery entrapment
- Baker's cyst or ganglion cyst
- Pes anserine bursitis
- Acute compartment syndrome

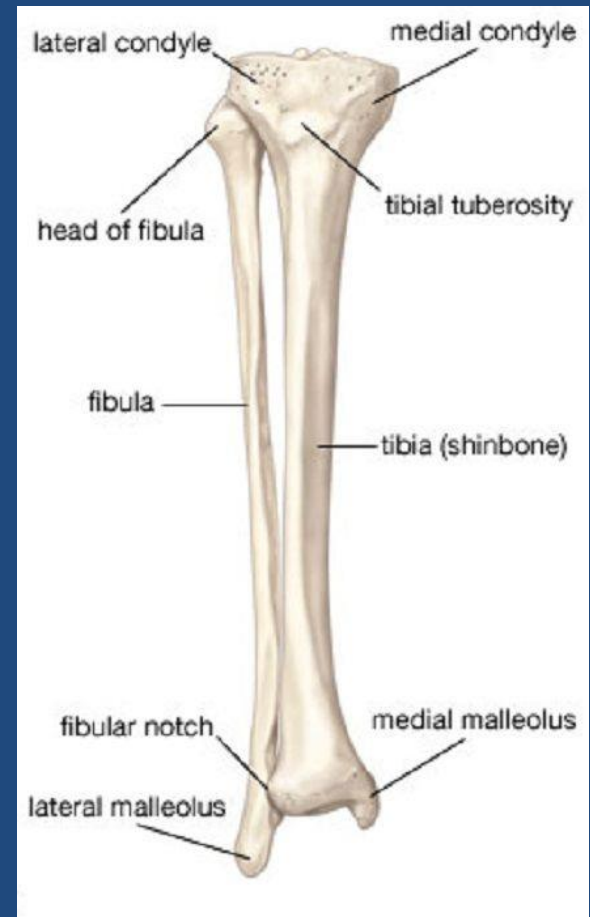
CAUSES NOT TO BE MISSED

- Tumors
(osteosarcoma, osteoid osteoma)
- Infection
(osteomyelitis, cellulitis)
- Acute compartment syndrome

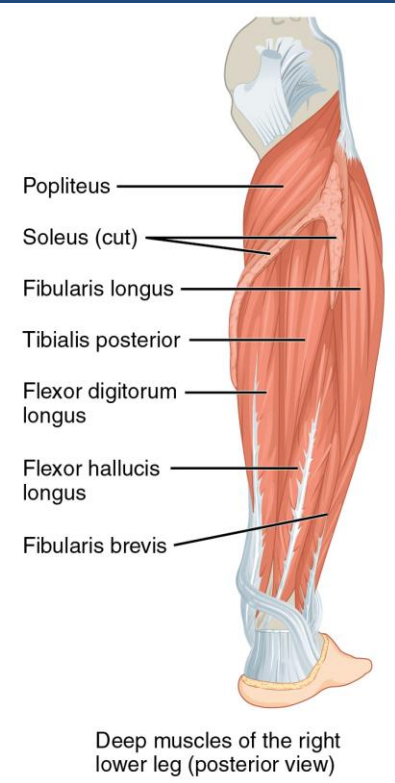
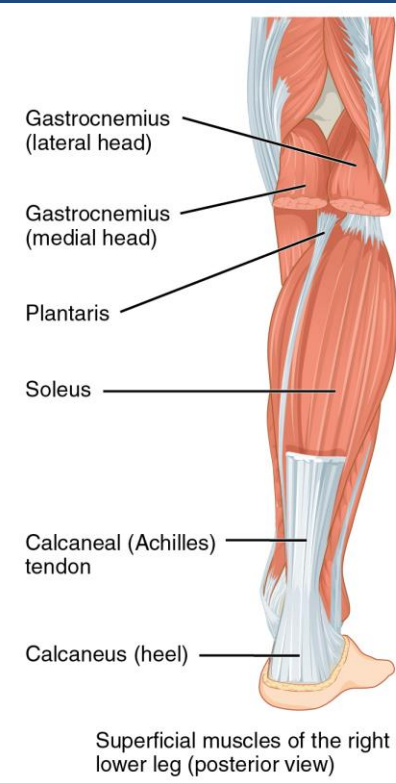
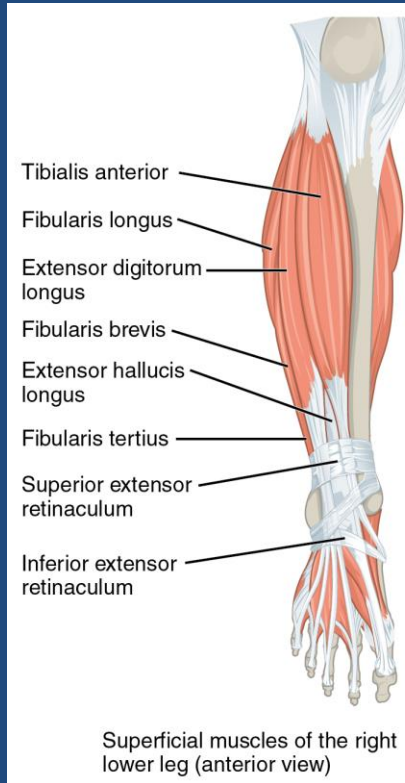
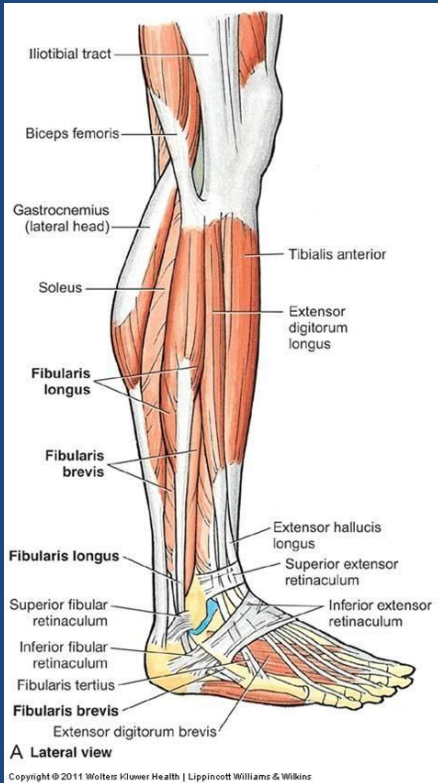


ANATOMY

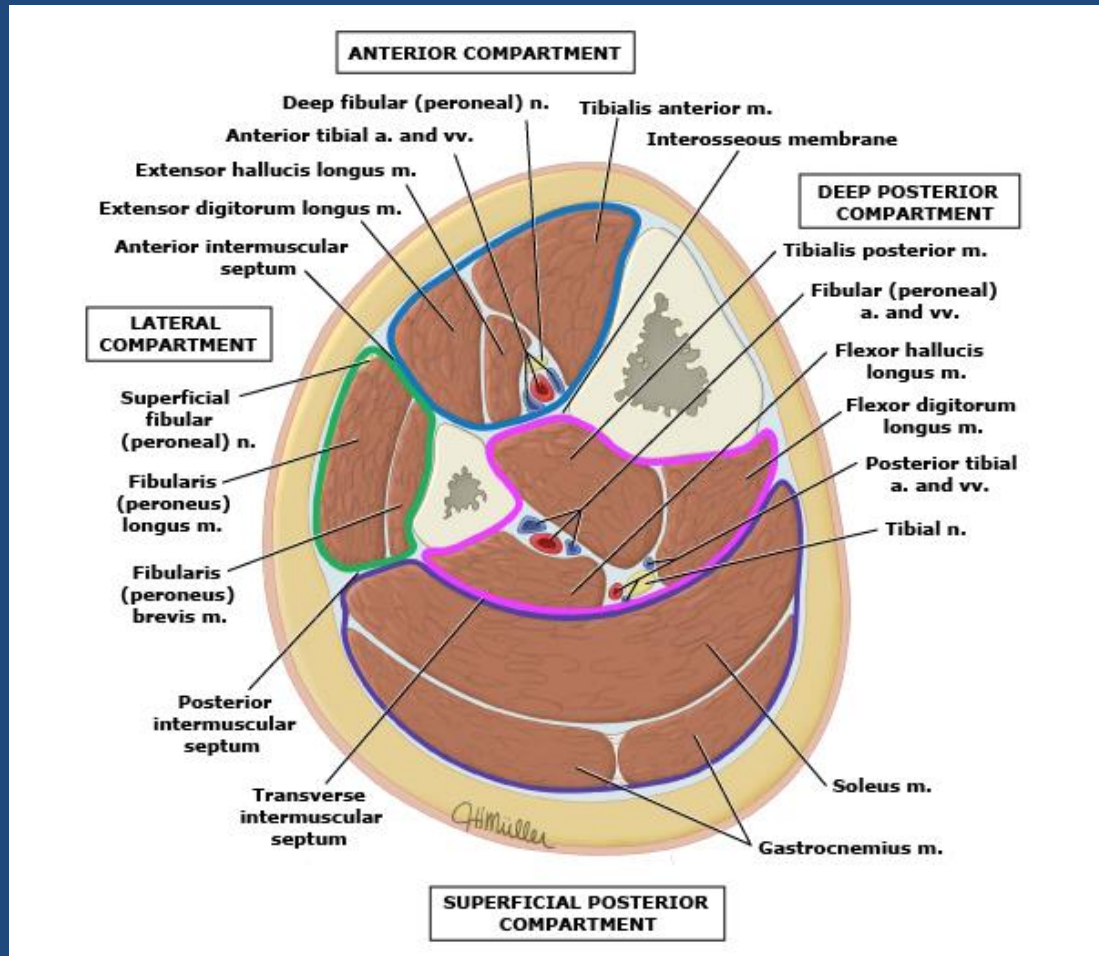
- Tibia
- Fibula
- Muscles
 - Compartments



ANATOMY

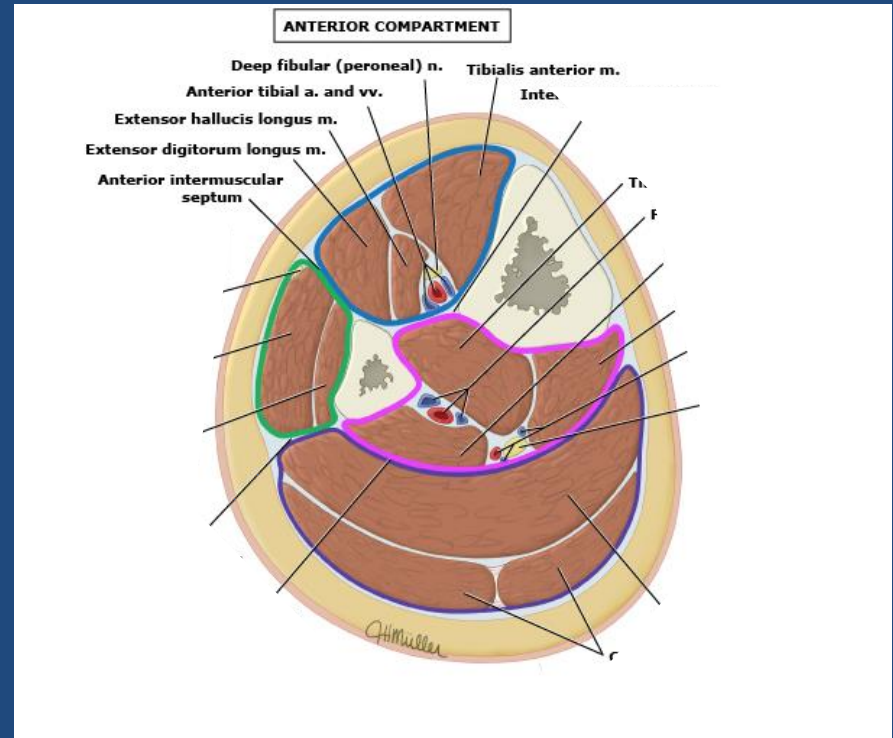


MUSCLE COMPARTMENTS



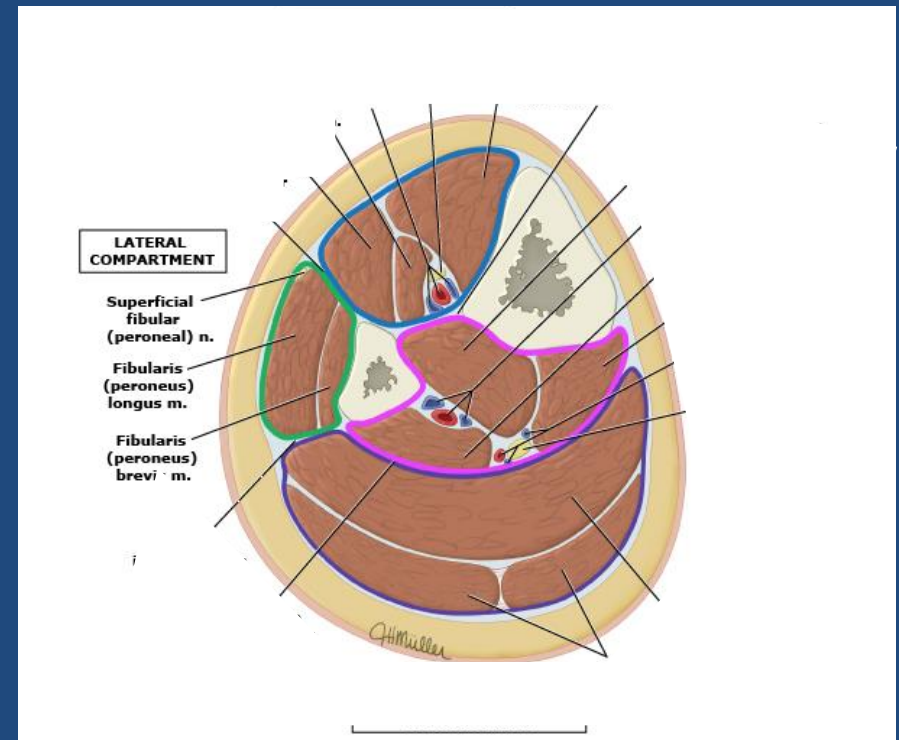
ANTERIOR COMPARTMENT

- Muscles (dorsiflex the ankle & extend the toes)
 - Tibialis anterior
 - Extensor digitorum longus
 - Extensor hallucis longus
- Blood supply
 - Anterior tibial artery & vein
- Innervation
 - Deep peroneal nerve



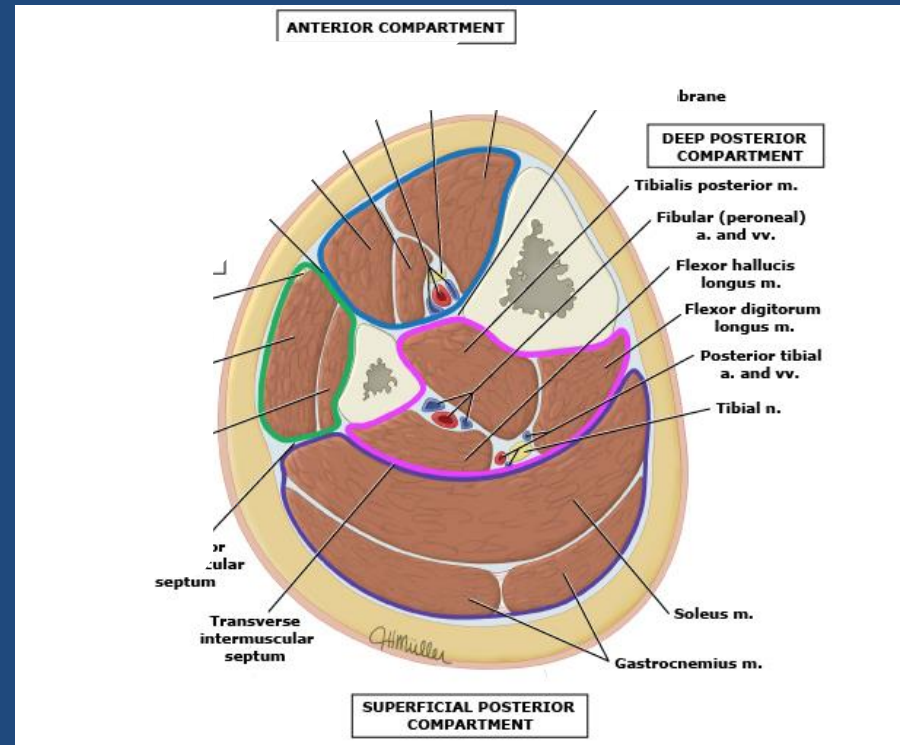
LATERAL COMPARTMENT

- Muscles
 - Peroneus Longus
 - Peroneus Brevis
- Blood supply
 - Peroneal artery & vein
- Innervation
 - Superficial peroneal nerve



POSTERIOR COMPARTMENT

- Superficial muscles
 - Gastrocnemius
 - Soleus
- Deep muscles
 - Popliteus
 - Tibialis posterior
 - Flexor digitorum longus
 - Flexor hallucis longus
- Blood Supply
 - Posterior tibial artery
 - Peroneal artery
- Innervation
 - Tibial nerve



HISTORY CONSIDERATIONS

- Detailed training history
- Prior injuries and their treatment
- Menstrual history
- Footwear
- When does pain occur relative to activity?
- Does pain alter activity?

KEY DIAGNOSTIC QUESTIONS

Question	Clinical Significance of Response
Was there an acute onset of pain?	Fractures or tendon ruptures are usually acute traumatic events
Is there a history of injury or prior leg pains?	Old fractures/injuries can lead to scar tissue, stiffness & pain
Is the pain worse with impact?	Stress fractures are classically exacerbated with impact. MTSS & muscle strains may also be made worse with load & resistance
Is the pain worse with exertion?	Pain absent at rest that presents with exertion is classic for exertional compartment syndrome. Popliteal artery entrapment can have a similar presentation with posterior rather than anterior/lateral pain
Does the pain improve with warm-up & stretching?	MTSS & muscle strains frequently improve with pre-participation stretching while stress fractures & exertional compartment syndrome generally don't
Does the pain get worse with stretching or resistance?	Exacerbate symptoms related to MTSS & muscle tendon strains & tendinopathy
Is there pain at night?	Raise concern for tumor
Is there electrical shooting pain, weakness with pain or numbness with pain	Concern for nerve injury , entrapment or radiculopathy. Always check lumbar spine.

PHYSICAL EXAMINATION

- Look for malalignment and joint laxity
- Check strength and flexibility of entire lower extremity
- Localize pain and injured structure
- Functional movements (i.e. hopping)
- Palpation - distribution
- If asymptomatic, examine after exercise
- Check shoes

SHOE WEAR



OVERPRONATION



NEUTRAL



UNDERPRONATION

CASE #1

- 17 y/o male volleyball player who presents with 3 months of bilateral anterior knee pain. His pain is made worse with sports (volleyball & basketball) and with prolonged sitting. Denies any specific injury/trauma. No swelling, locking or instability.

KNEE EXAM

- No effusion
- ROM 0-135⁰
- Tenderness to palpation over patellar tendon, especially over the proximal insertion of the patellar tendon into the patella
- Neg Patella grind, inhibition or apprehension
- Neg Lachman, ant/post drawer, McMurray
- No laxity with valgus/varus stress at 0/30⁰

DISCUSSION

- What's the diagnosis?

PATELLAR TENDINOPATHY

- Major cause is overuse in activities involving rapid changes in direction, jumping & running
- Overall prevalence is 14.2% but as high as 40% in elite volleyball players
- Male: female ratio is equal



RISK FACTORS

Intrinsic

- Strength imbalance
- Postural alignment
- Foot structure
- Reduced ankle dorsiflexion
- Lack of muscle strength & flexibility

Extrinsic

- OVERUSE
- Fatigue
- Poor technique
- Training errors
- Improper training surfaces
- Insufficient footwear

IMAGING

- X-ray - identify bony abnormalities or intratendinous calcification
- U/S - ill-defined hypoechogenic zone often associated with tendon thickening
- MRI - thickened tendon with areas of increased signal intensity
 - Changes seen on MRI & U/S correlate well with histopathological findings
 - Do not correspond to a good clinical correlation or guidance of therapy

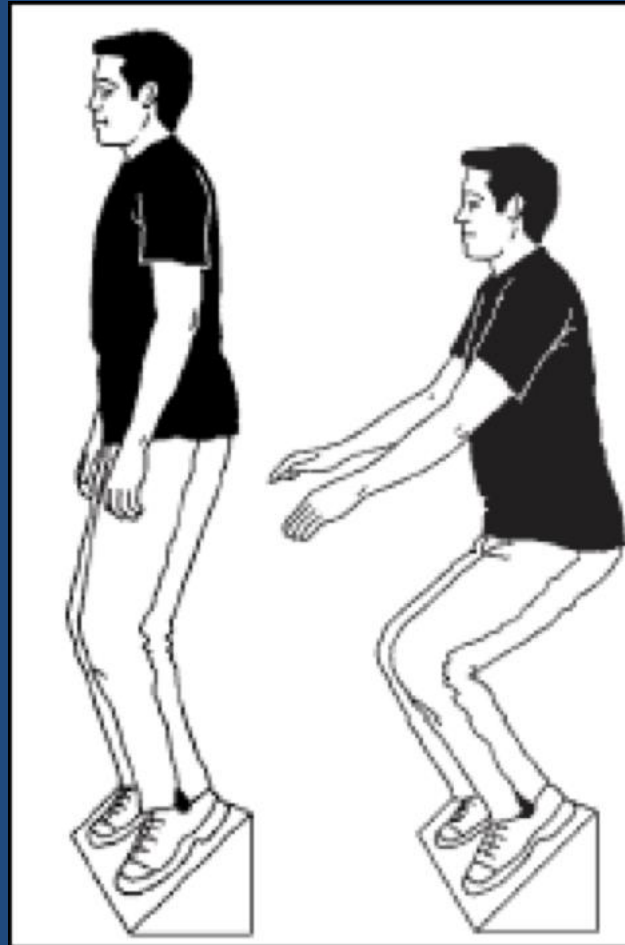
TREATMENT

- Correction of intrinsic & extrinsic risk factors
 - Sufficient variation in training program
 - Hamstring & quadriceps flexibility
 - Correcting biomechanics (i.e. better landing techniques)
- Symptomatic approach
 - Relative rest
 - Orthotics, taping, &/or patella tendon straps
 - NSAIDs?
 - Nitroglycerin
 - Tenotomy

REHABILITATION

- Cornerstone of tendinopathy treatment
- Incorporates strength, flexibility, motor patterns, closed-chain rehabilitation, proprioception, endurance and gradual progression.
- Strength training is emphasized using eccentric exercise
- Incorporates 3 stages
 - Limited weight bearing loaded exercise
 - Progression
 - Sports specific return to play protocol

DECLINE ECCENTRIC SQUATS



CASE #2

- A 35-year-old female is training for the LA marathon. She was running 20 mi/wk and increased to 30mi/wk one month ago. For the last 2 weeks, she has had right leg pain with her training runs. The pain is noticeable at the beginning of the run, then dissipates after a mile or so. It then increases again toward the end the run and lasts into the next day.

EXAM

- The gait is normal. Mild pes planus is observed. The right leg is not swollen, skin is clear and there are no masses.
- There is TTP along the posteromedial border of the tibia extending proximally from 3 cm above the medial malleolus to the mid tibia. Hopping on the left leg causes pain. There is no pain with resisted plantar flexion or inversion. Normal neurovascular exam.

MEDIAL TIBIAL STRESS SYNDROME

“SHIN SPLINTS”

- Exercise induced pain of the posteromedial border of the tibia
 - Excludes stress fracture, fascial hernia or compartment syndrome
- A diffuse painful area over a length of at least 5 cm
- Incidence - from 4% to 35% in military & sportspeople
- Etiology – Due to a stress reaction involving the fascia, periosteum, or bone or some combination of these structures at the posteromedial tibial border



ETIOLOGY

- Early reports: the tibialis posterior was the primary structure involved (Slocum 1967, D'Ambrosia 1977)
- Studies using bone scans and anatomic dissection provided evidence that the soleus and its fascia play a direct role (Holder and Michael 1984)
- Anatomic study confirmed that the fibers of the soleus, the flexor digitorum longus, and the deep crural fascia attach along the posteromedial border of the tibia, where symptoms, exam findings and bone scans have localized the injury (Beck 1994)
- MR imaging found that of those with MTSS, had edema at the insertions of the soleus, flexor digitorum longus and the tibialis posterior (1995)

MTSS HISTORY

- Pain occurs with exercise but may become more tolerable as the exercise continues
 - May return after exercise & then resolve with rest
- May be bilateral
- Look for overuse risk factors



OVERUSE RISK FACTORS

- Training progression too rapid
- Inadequate rest/recovery
- Inappropriate equipment and/or footwear
- Incorrect sport technique
- Peer and/or adult influences
- Muscle imbalances
- Uneven or hard surfaces



MTSS EXAM

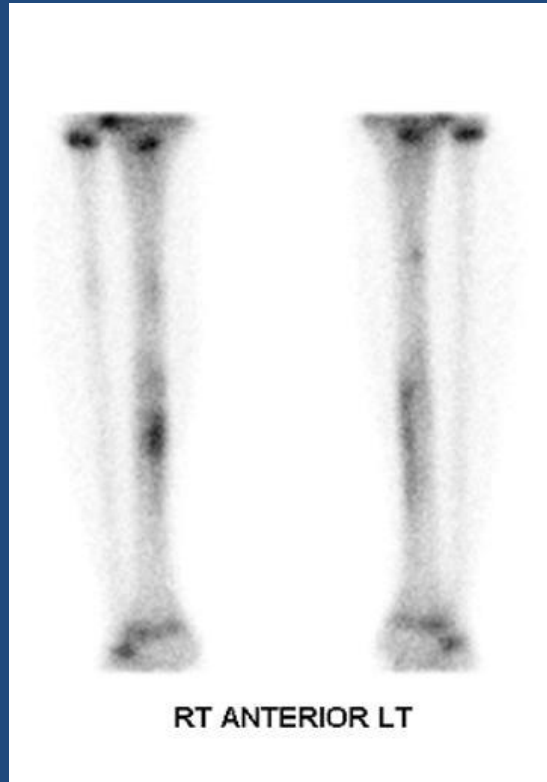
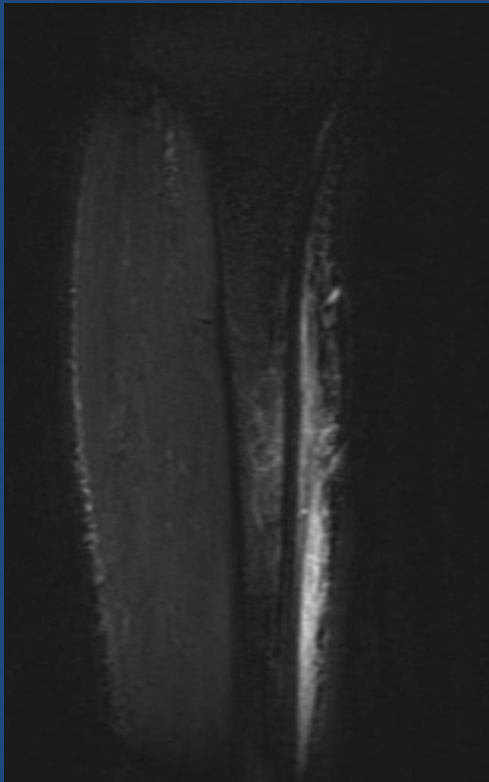
- Tenderness along the posteromedial border of the tibia
- Resisted muscle testing usually does not cause pain
- Pain with single leg hop
- **No** pain with indirect percussion
- Normal neurovascular exam
- Check for malalignment (esp. pronation), inflexibility, weakness
- Check shoes for excessive wear



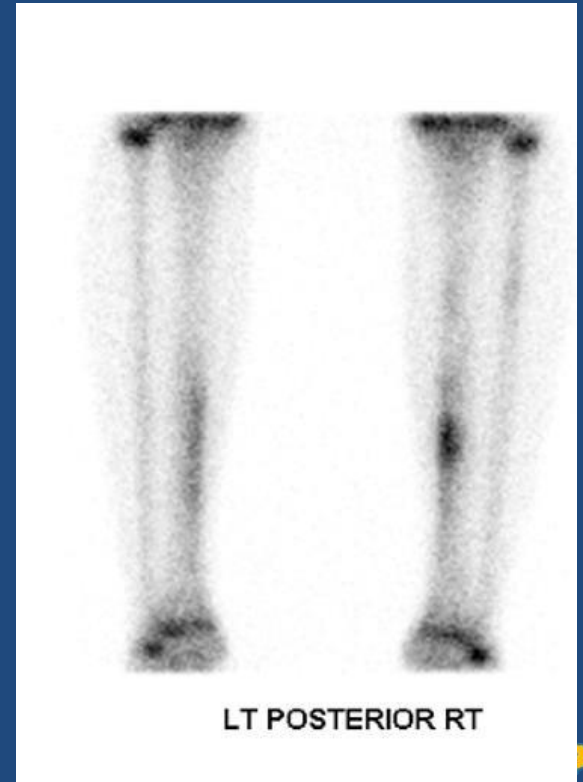
IMAGING

- Usually not necessary – clinical diagnosis is the gold standard
- X-ray usually normal
- A three-phase bone scan may demonstrate diffuse uptake in the delayed phase
- MRI may - periosteal edema with/without associated bone marrow edema

IMAGING



RT ANTERIOR LT



LT POSTERIOR RT

TREATMENT

- Sport specific relative rest from impact loading
- Ice massage
- Maintain conditioning via non-impact activities (cycling, pool running, swimming)
- Soft tissue therapy



TREATMENT

- Consider NSAID's
- Rehab to increase strength and flexibility
 - Especially heel cord & dorsiflexors
- Consider modification of malalignment
 - Orthotics



RETURN TO PLAY

- Gradual return to impact activities
- Training volume slowly increased
- Use symptoms & physical findings as a guide to progression
- 6-week return – actually very variable



CASE #3

- 36-year-old man with a history of bilateral "shin splints" presents with 2 weeks of worsening right shin pain. He has been training for the LA marathon. He typically runs on sand at the beach but one month ago he started to increase his mileage on the roads. His pain is located primarily medial aspect of his tibia. He rested from running for three days and the pain resolved. On his first run back from resting his pain almost immediately returned. Denies low back pain or numbness/tingling down his leg. Denies swelling, skin discoloration or temperature changes.

EXAM

- No palpable defects, deformities, or asymmetry
- Thompson test Neg
- Achilles tendon, gastroc and soleus muscles were non-tender
- **Focal** area tender to palpation along the distal tibia medially. There was no overlying soft-tissue swelling noted
- Ankle with full range of motion & no tenderness to palpation and ligaments were stable

STRESS FRACTURES

- Etiology: inability of bone to effectively remodel in response to repetitive loading
 - Ground reaction forces, repeated muscle contractions across the bone and muscle fatigue play a role
- Tibia & fibula are among the most common sites for stress fractures
 - Tibia 19-55% of all sites
 - Posteromedial border of either the proximal or distal third of the shaft
 - Fibula up to 30%

HISTORY

- Gradual onset of pain
- Initially pain occurs only with exercise & relieved with rest
- **Does not** dissipate as activity continues
- Eventually limits training and may become painful with daily activities (walking)
- Pain may occur at night
- Symptoms may resolve with several days of rest but return when training is reattempted

OVERUSE RISK FACTORS

- Training progression too rapid
- Inadequate rest/recovery
- Inappropriate equipment and/or footwear
- Incorrect sport technique
- Peer and/or adult influences
- Muscle imbalances
- Uneven or hard surfaces



EXAMINATION

- Well localized tibial tenderness
- Pain with single leg hop
- May have pain with indirect percussion
- Resisted manual muscle testing usually does not produce symptoms
- Check for malalignment, inflexibility, weakness and muscle imbalance



IMAGING

- Radiographs – periosteal reaction, sclerosis, callus formation or lucent fracture line
 - Often negative initially
- Three phase bone scan – localized uptake in delayed phase, all phases abnormal
- MRI – more specific than bone scan
 - Graded on presence of periosteal edema, marrow edema and fracture line

MRI GRADING OF TIBIAL STRESS INJURY

Grade	Periosteal Edema	Marrow Edema	Fracture Line
1	Mild – Moderate on T2-weighted images	None	None
2	Moderate – severe on T2-weighted images	Seen on T-2 weighted images	None
3	Moderate – severe on T2-weighted images	Seen on T1 & T2 weighted images	None
4	Moderate – severe on T2-weighted images	Seen on T1 & T2 weighted images	Visible

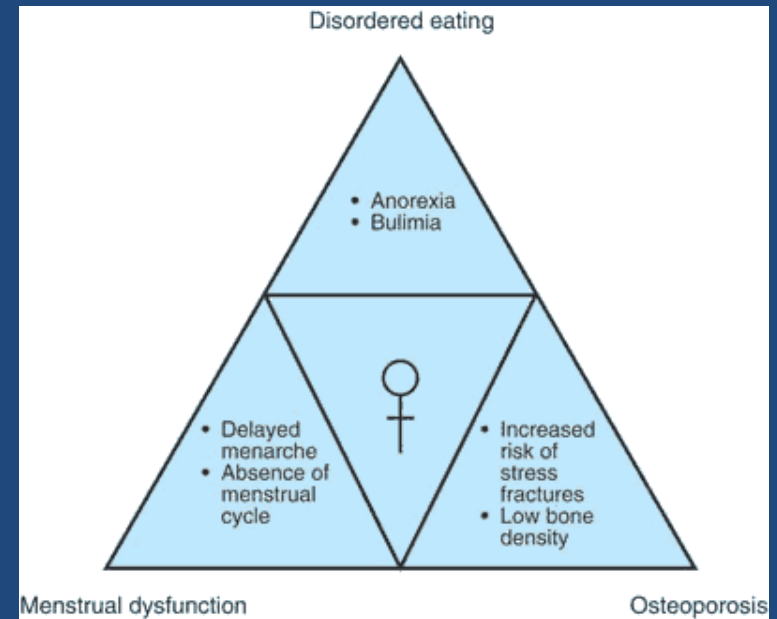
MANAGEMENT

- Rest from impact activities
- Long pneumatic splint or walking boot if daily activities are painful
 - Crutches if needed
- Maintain conditioning
 - Low/no impact activities – cycling & swimming
 - Stair climbers and ski machines may be painful



MANAGEMENT

- Rehab to address flexibility and strength
- Calcium + Vit D supplementation if needed
- Address menstrual dysfunction and /or disordered eating if present
- Consider modification of malalignment
- Rule out underlying metabolic cause



RETURN TO PLAY

- Once pain with daily activities has resolved, begin brisk walking
- Gradually increase time
- Introduce jogging
- Gradual increase duration & frequency if symptom free
- Begin faster running & sprinting when able to jog daily without pain
- Add sport specific skills
- Resume training when able to perform sport specific activities without symptoms



RUN PROGRESSION

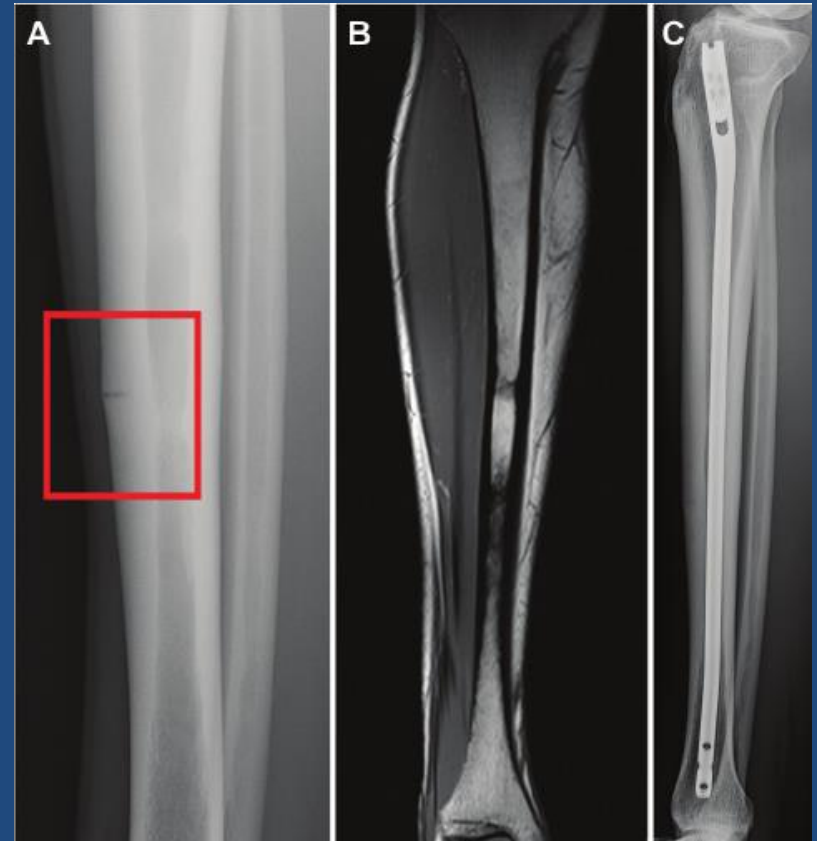
1. Complete rest x 2 weeks, if pain with walking use crutches.
2. If no pain with walking can do non-weight bearing activities such as swimming or cycling x 2 weeks. Stop if becomes painful.
3. After 2 weeks of pain free walking can start low impact activities 3 days a week x 2 weeks, no 2 days in a row (ie. M/W/F). Initially start at 15 min and can increase by 5 minutes every 2nd or 3rd session. Example Elliptical or arc trainer. Can supplement additional cardio with non-weight bearing cardio as in step 2.
4. Running progression (start if pain free after 2 weeks of low impact activities above): 3 days/week starting at 10 minutes (no 2 days in a row, ideally on softer surfaces, this is all just building base- no sprinting/stadiums/speed work). Increase weekly volume by no more than 10% per week spread out over the 3 runs. Once running 30 minutes 3d/week could add in a 4th day but still obeying the 10% rule.

PREVENTION

- Review factors that may have lead to the stress fracture
- Menstrual disturbances and disordered eating behavior should be evaluated & treated
- Consider use of custom orthoses
 - 50% reduction in military recruits (Finestone 1997)

SURGICAL INDICATIONS

- Fractures of the anterior cortex of the midshaft
 - “dreaded black line”
- High rate of delayed union, nonunion & complete fracture
- Intramedullary rod and/or bone grafting may be required



DIFFERENTIATING MTSS FROM TIBIAL STRESS FRACTURE

	MTSS	Tibial Stress Fx
Character	Bony, aching; Often continue activity with pain abating	Bony, aching; usually cannot continue w/o increasing pain
Pain location	Mid-distal 1/3 posteromedial tibial border	Anywhere on tibia, including posteromedial border
Pain distribution	Several cm w/o distinct focal area	Distinct focal area
Indirect percussion	Pain free	May be painful
Single leg hop	Usually painful	Usually painful
X-ray	Normal	May show periosteal reaction, fracture line
3-phse Bone scan	Diffuse uptake in delayed phase only	Focal uptake, all phases abnormal
MRI	Periosteal edema w/ or w/o mild-moderate marrow edema	Periosteal edema w/ extensive marrow edema, fracture line



CASE #4

- 24 y/o female triathlete describes recurrent left leg tightness with running. No history of trauma. Her symptoms are anterior and occur about 2-3 miles into each run. The symptoms are relieved within an hour or less with rest. No swelling or skin discoloration. Occasional tingling of the dorsum of the foot can occur with running.



EXAM

NORMAL !!!



CHRONIC EXERTIONAL COMPARTMENT SYNDROME (CECS)

- 1st described by Mavor in 1956
- 1962 typical hx & symptoms were matched to rise in intramuscular compartment pressure
- Most commonly affects the lower leg but also can occur in other locations



PATHOPHYSIOLOGY

- Ischemic condition that occurs when a fascial compartment is unable to accommodate the increase in volume associated with muscle contraction and swelling.
 - Normal or abnormal muscle swelling with activity
 - There is evidence that this does not necessarily result in tissue hypoperfusion & ischemic muscle pain *
 - Abnormally thickened fascia
 - Normal muscle hypertrophy in response to resistance training
 - Dynamic contraction patterns during gait

* Andreisek G, White LM, Sussman MS, et al. T2*-weighted and arterial spin labeling MRI of calf muscles in healthy volunteers and patients with chronic exertional compartment syndrome: preliminary experience. *AJR Am J Roentgenol.* 2009;193(4):W327-W333.

HISTORY

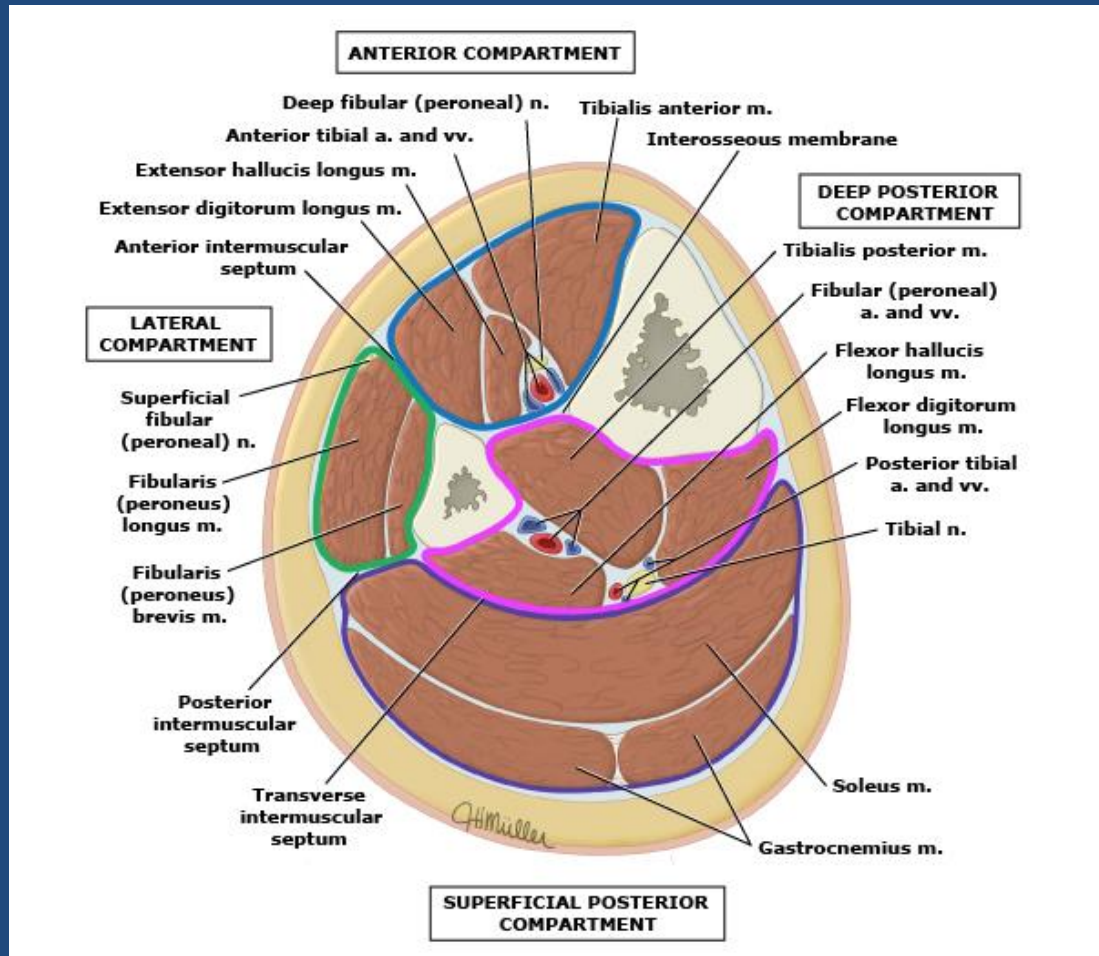
- Aching or cramping leg pain or leg tightness over affected compartment, only with exercise
- Transient neurologic symptoms may occur, but pain is often the only symptoms
- Pain gradually subsides with rest
- Symptoms may be very reproducible (e.g. running a certain distance or time)
- Average of 22-28 months from presentation to correct diagnosis

EXAM

- Usually normal
- May be helpful to examine after symptom provoking activity
- May find palpable tightness over compartment
- Passive stretching may reproduce symptoms
- Pulses are normal
- If present, a palpable fascial hernia is highly suggestive of CECS

Anterior compartment is the most commonly involved

MUSCLE COMPARTMENTS



DIAGNOSIS

- X-ray – normal
- Bone scans & MRI – may be helpful to r/o other causes of leg pain
- Compartment pressure testing is the gold standard - either a slit-catheter technique or hand-held fluid pressure monitoring
 - Pre-exertional & post-exertional measurements
- Positive = Pedowitz et al*
 - Pre-exercise resting pressure of 15mmHg
 - 1 minute post-exercise pressure of 30mmHg
 - 5 minute post-exercise pressure of 20mmHg

*Pedowitz RA, Hargens AR, Mubarak SJ, Gershuni DH. Modified criteria for the objective diagnosis of chronic compartment syndrome of the leg. Am J Sports Med 1990;18:35-40.

TREATMENT

- Nonsurgical
 - Massage with stretching, tapping, orthotics, and NSAIDs
 - Only evidence-based treatment is activity modification & rest
- Surgical = fasciotomy
 - Anterior or lateral compartment symptoms tend to have better outcomes (>80% success rate as compared with deep posterior CECS which is 50%)

FASCIOTOMY

- Single incision (open) technique
- Subcutaneous (1 or 2 incision) techniques with or without endoscopic assistance
- Complications - infection, nerve or vascular injury, DVT, wound dehiscence, CRPS, scar hypersensitivity, and seroma/hematoma formation
- Recurrences are thought to be due to incomplete release, incorrect diagnosis, excessive scarring, or inappropriate rehabilitation
- Post-op includes 12-week rehab starting with protection & mobility, early light stretching, scar massage with mobility & desensitization

FASCIOTOMY



APPROACH TO LEG PAIN

	Stress Fx	MTSS	CECS
Onset	Gradual or acute	Gradual	Gradual
Pain Character	Increases with ongoing activity	Soon after exercise onset, intensity decreases	Pain onset at specific point during running
Exam	Focal TTP	TTP several cm long posteromedial tibia	May be difficult to localize
Xay Bone Scan MRI	Often Neg Focal uptake Focal edema, fx line	Neg Diffuse uptake Diffuse edema	Compartment pressure testing
Treatment	REST from impact activity! Protection. Gradual return to activity	REST from impact activity! Protection. Gradual return to activity	May require fasciotomy

CASE #5

- A 44 y/o female was playing tennis over the weekend when she felt sudden sharp pain of her right leg. Felt as she had been kicked by her doubles partner. She was unable to continue to play. Later that day swelling developed. Extensive bruising of the leg was seen the next day.



EXAM

- The right leg was noticeably swollen
- Ecchymosis extended from mid portion of the leg to the medial aspect of the foot
- Thompson's test was negative
- Achilles tendon was non-tender
- Posteromedial aspect of the leg was TTP
- Pain was elicited with passive dorsiflexion

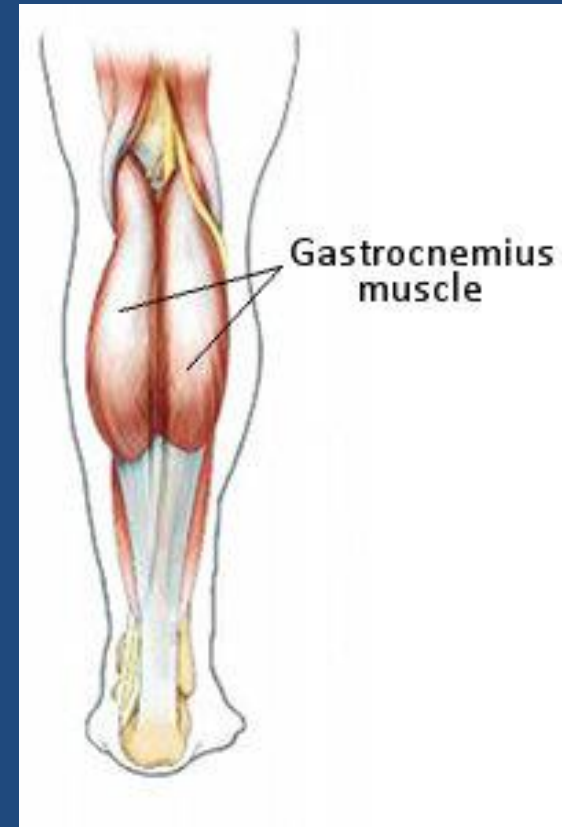


HISTORY

- Common cause of acute leg injury, most typically in middle age adults
- Etiology
 - Forced knee extension with the foot in dorsiflexion
 - Leaping or sprinting from a crouched position
 - “Tennis Leg”
- Acute onset of severe posterior leg pain
- Extensive ecchymosis
- Patient may feel as if shot or kicked in leg
- Usually unable to continue activity after injury

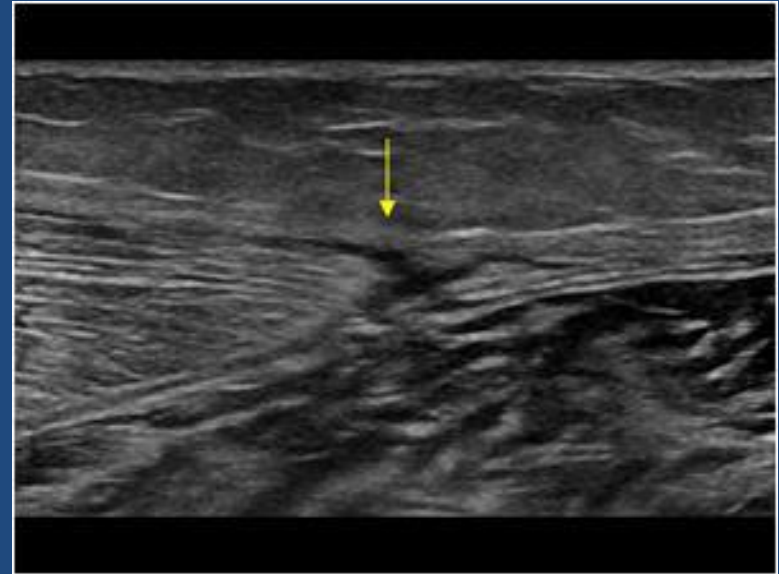
EXAMINATION

- Tenderness at medial head of gastrocnemius
- Swelling & ecchymosis may be present
- Amount of swelling may make palpation of a defect difficult
- Pain reproduced with passive ankle dorsiflexion with the knee extended
- Patient may be unable to perform a single leg heel raise



IMAGING

- Usually not necessary
- May be difficult to distinguish from DVT
- Ultrasound and MRI can demonstrate injury if needed



MANAGEMENT

- RICE therapy
- Crutches if unable to ambulate
- Early active range of motion (not stretching)
- Gradual flexibility & strengthening as weight bearing becomes tolerable
- Concentric strengthening (bilateral heel raise)
- Heel raise on a step -> single leg heel raise -> eccentric strengthening -> controlled plyometrics
 - Flexibility and soft tissue techniques
- Can use heel lifts when weight bearing (wean in 1-2 weeks)

RETURN TO PLAY

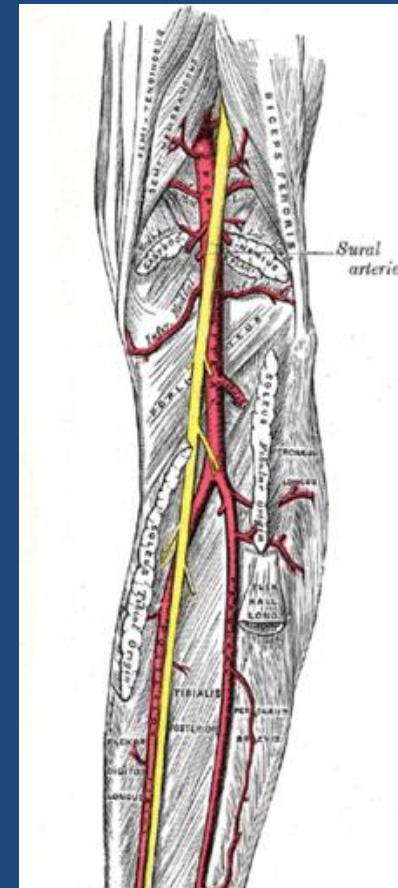
- Most helpful guide is ability to perform controlled jumping & running
 - Want patient with pain-free ROM
 - Strength within 90% of contralateral leg
 - Ability to perform functional skills required by the sport
- Time to return varies dependent on severity of injury
 - Mild ~ 2 weeks
 - Severe ~ 8 weeks or longer
- Flexibility is important but strengthening is the key
- No role for bracing

THE MASQUERADERS



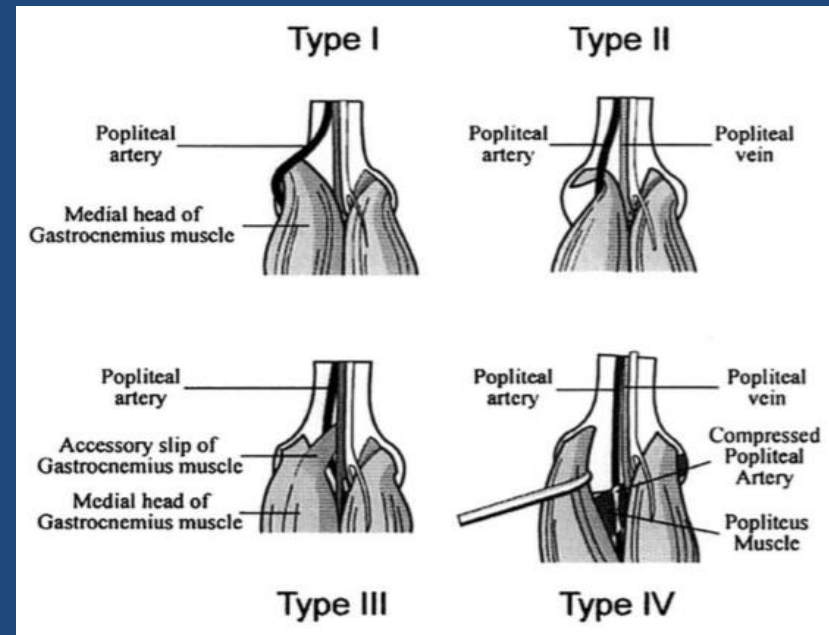
POPLITEAL ARTERY ENTRAPMENT SYNDROME (PAES)

- Often confused with CECS and can even co-exist with CECS
- Usually unilateral calf pain during strenuous exercise
- Calf pain can be associated with leg weakness & paraesthesias
- Pain is elicited by a specific amount of exercise, aggravated by leg elevation & relieved by cessation of activity & placing the leg in a dependent position
- Reduction in pulses is considered pathognomonic



CAUSES

- Compression of popliteal artery by surrounding musculotendinous structures as it exits the popliteal fossa
 - Abnormal origin of the medial head of the gastrocnemius
 - Fibrous bands of the gastrocnemius or popliteus muscle
 - An aberrant course of the popliteal artery - passing deep to the popliteus muscle



DIAGNOSIS

- X-rays to r/o other cause of lower leg pain
- Ankle-brachial index (ABI) with the ankle in neutral, forced dorsiflexion and forced plantar flexion positions
 - ABI of < 0.9 = abnormal
 - ABI sensitivity & specificity is 90 & 98%
- CT angio & MRI angio are helpful
- Direct angiography considered gold standard

TREATMENT

- Surgical removal of the compressing structure
 - Decompression by division of the medial head of the gastrocnemius, abnormal muscle slips or tendinous bands
- Either venous bypass or interposition graft

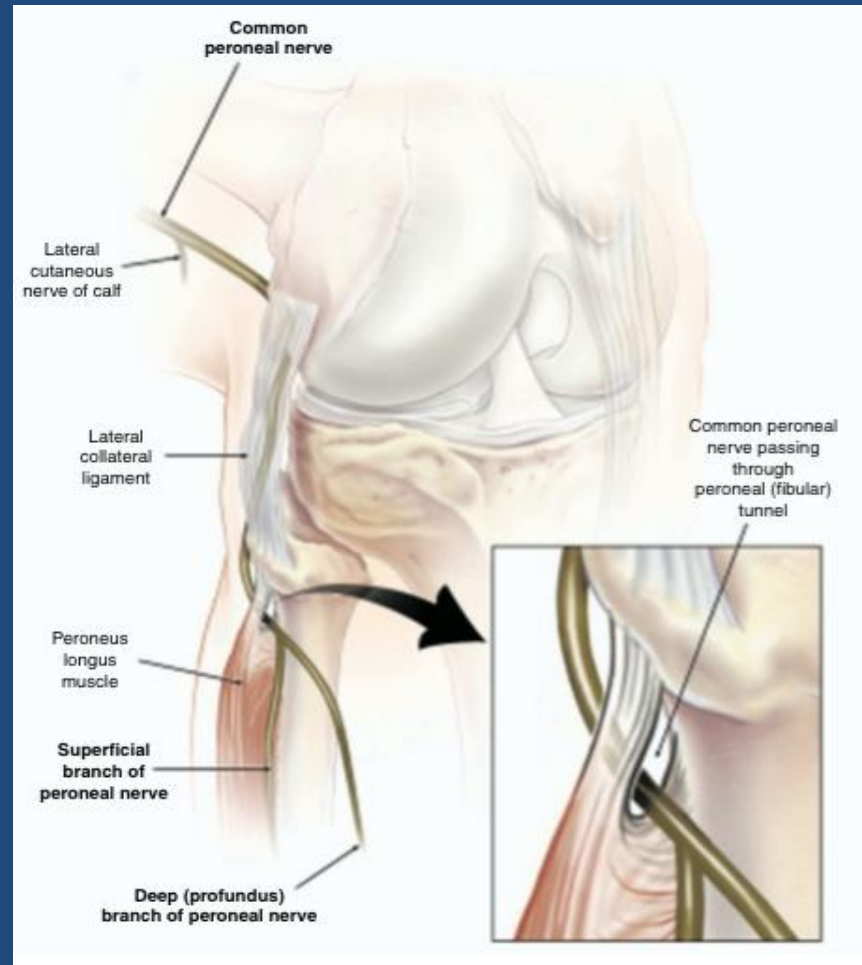
NERVE ENTRAPMENT

- Burning pain brought about by activity & exacerbation by continued exercise
- Pain in the region of the nerve compression & spreads to the sensory distribution of the nerve
- Tinel's sign can usually be elicited at the site of compression
- Sometimes can have weakness & atrophy of muscles innervated by the compressed nerve
- Trauma is the primary cause

COMMON PERONEAL NERVE

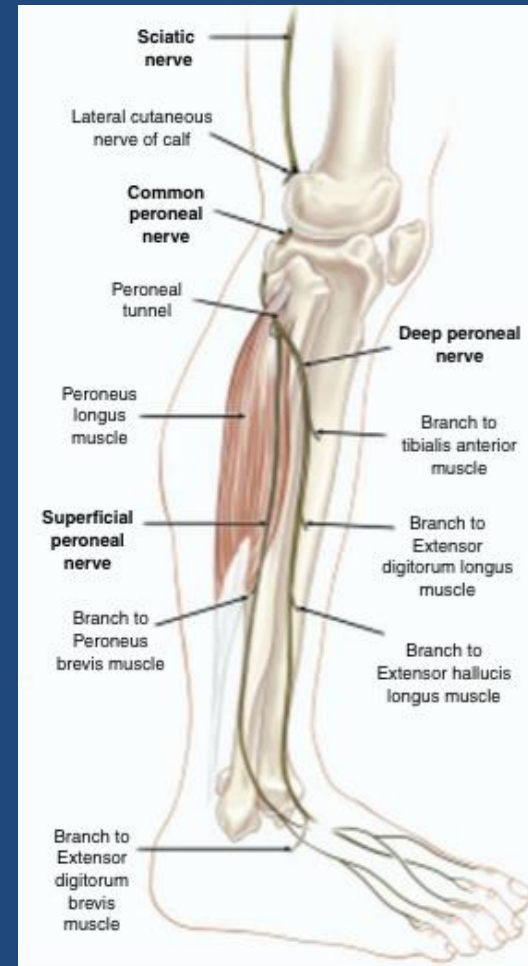
- Risk of entrapment as it enters the fibular tunnel prior to branching into the superficial, deep & recurrent peroneal nerves
- Associated with repetitive exercises involving inversion & eversion (running & cycling)
- External compression - tight plaster casts & ACL braces
- Internal compression - osteophytes or proximal tibiofibular joint ganglion cysts
- Pain is often lateral leg & foot

COMMON PERONEAL NERVE



SUPERFICIAL PERONEAL NERVE

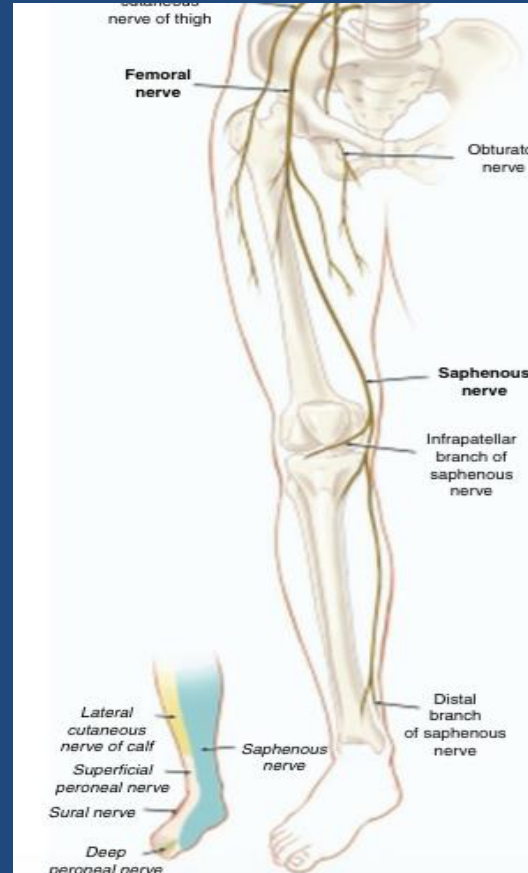
- As it exits the fascia of the lateral compartment
- Often observed in dancers & athletes involved in bodybuilding, horse racing, running, soccer and tennis
- Pain involving the lateral calf or dorsum of the foot



SAPHENOUS NERVE

- Typical presentation is of claudication or exercise-related medial leg or knee pain
- Can also mimic OA & PFPS
- May be injured in the adductor canal by local trauma, surgery or inflammatory conditions such as thrombophlebitis
- Commonly seen in cyclists and rowers - mechanism relates to repetitive knee flexion
- Also iatrogenic injury at the time of arthroscopic knee surgery

SAPHENOUS NERVE



DIAGNOSIS

- X-ray - to r/o possible compressing bony lesions, stress fractures or bone tumors
- Nerve block - best for saphenous or superficial peroneal
- Inject anesthetic where atonal sign is the strongest or at the location corresponding to maximum pain on pressure
- Immediate relief after injection = nerve entrapment
- EMG & nerve conduction
- Condition must be present for 3-4 weeks for the studies to become positive

TREATMENT

- Conservative management = mainstay of treatment
 - Modifying precipitating activity, biochemical correction, PT, massage & NSAIDs
- Nerve hydrodissection
- Radiofrequency ablation
- Surgery - superficial peroneal

THANK YOU!



