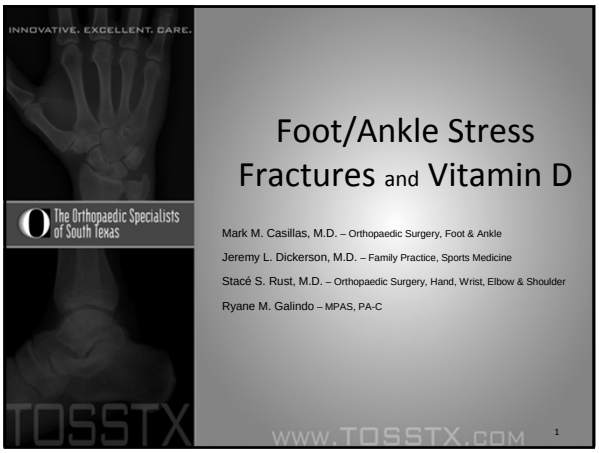

Disclosures

- I have none

Objectives

- Understand the risk factors of lower leg stress fractures
- Understand the pertinent history of stress fractures
- Understand the role of imaging in detecting stress fractures
- Know the common stress fractures of the lower leg, ankle, and foot
- Know the treatment options for the fractures

Objectives

- Understand how vitamin D is obtained
- Understand who is at risk for vitamin D deficiency
- Understand the role of vitamin D in the prevention of fractures
- Understand the role of vitamin D in the prevention of falls
- Understand Vitamin D replacement dosing

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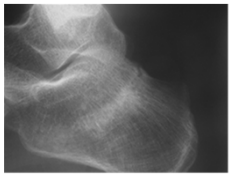
Stress Fractures

- Overuse injury
- Abnormal balance between osteoblast and osteoclast activity
- Occur most often in the lower leg



Stress Fractures

- Tibia
- Fibula
- Calcaneus
- Navicular
- Metatarsals
- Sesamoids

Risk Factors

- Cavus foot
- Long second metatarsal
- Metatarsus adductus
- Amenorrhea
- Hyperthyroidism
- Malnutrition
- Training errors
- Poor footwear

History

- Pain with exertion
  - May progress to pain with daily activities
- Relief with rest
- Training errors
  - Rapid increase in intensity, duration, or frequency
  - No rest day
- Ask about normal menstration in females
- Ask about vitamin deficiencies (vitamin D) or disordered eating

Exam

- Look for abnormal alignment
- Swelling
- Warmth
- Tenderness
- Pain with percussion
- Pain with 3-point stress
- Pain with single leg hop

Imaging

- Standard x-rays
- Bone Scan
- CT
- MR

X-ray

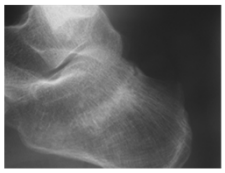
- 320 stress fractures in athletes
  - Pain to onset x-ray changes
    - Weeks to months
    - Average 10 to 21 days
    - Changes in 30-70% of cases

X-ray

- *Diaphyseal*
  - *Cortical*
  - *Transverse*
  - *Fracture line followed by callus*
  - *Example: 5th MT diaphysis*

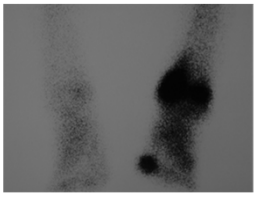
X-ray

- *Metaphyseal*
  - *Cancellous*
  - *Perpendicular to stress*
  - *Sclerosis*
  - *Example: Calcaneus*



Bone Scan

- Focal increased activity
- Increased bone turnover
- Sensitive

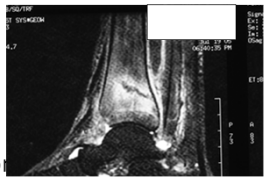


CT

- Fracture line
- Callus
- Specific
- Radiation

MR

- Increased marrow edema
- Linear decreased signal
- Associated soft tissue swelling or joint effusion
- Sensitive and specific
- No radiation



Treatment

- Confirm diagnosis
- Patient education
- Rest
- Avoid NSAIDs
- Immobilization/Internal fixation
- Bone stimulation
- Cross-training/rehabilitation
- Gradual return to sport

Tibia

- Medial tibial stress syndrome
- Posterior medial tibia stress fracture
- Anterior tibia stress fracture

Medial Tibial Stress Syndrome

- "Shin splints"
- Pain at the posteromedial border of the tibia
- 15% of all running injuries
- Thought to be a traction periostitis of the posteromedial tibia (attachment of the posterior tibialis, flexor digitorum longus, or soleus muscles)

Medial Tibial Stress Syndrome

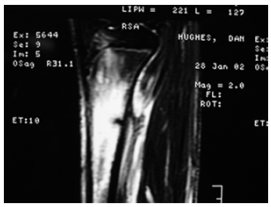
- Usually a history of poor conditioning, training errors, or sloped/banked surfaces (excessive foot pronation)
- Exam demonstrates longitudinal tenderness along the posteromedial tibia, also look for valgus hindfoot/pes planus
- X-rays may show cortex irregularity along the posterior tibialis origin
- MRI will show marrow edema in a longitudinal pattern without fracture line

Medial Tibial Stress Syndrome

- Treatment
  - Relative rest (25-75% reduction in training)
  - Stretching
  - Medial posted shoes or orthotics if needed
  - Gradual return to full training
  - Correct training errors

Posterior-medial Tibia Stress Fracture

- Same predisposing factors as MTSS



Posterior-medial Tibia

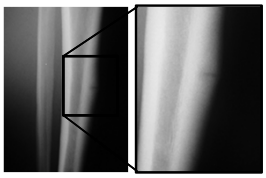
- History of pain with exertion that is relieved with rest
  - May progress to pain with normal walking
- Exam shows focal tenderness
  - May also see swelling or limp
- X-rays may show periosteal reaction, sclerosis, or fracture line
- MRI will show marrow edema and may show fracture line

Posterior-medial Tibia

- Treatment consists of rest
  - May require non-weightbearing or immobilization initially
  - No impact activities for 6 weeks
  - May cross train during this time
    - Swimming, stationary bike, elliptical
  - Gradual return to training

Anterior Tibia Stress Fracture

- Less common
- "Dreaded black line"
- Increased risk of non-union
- Focal anterior tenderness on exam
- MRI if needed to confirm



Anterior Tibia

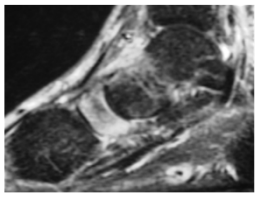
- Treatment
  - Non-weightbearing/Immobilization
    - Up to 4-6 months
  - Possible IM fixation
  - Bone stimulator
  - Cross training
  - Rehabilitation
  - Gradual return to play

Fibula

- Valgus heel/Pronation
- Treatment
  - Rest
  - Cast boot
  - Functional brace
  - Medial posted shoe or insert

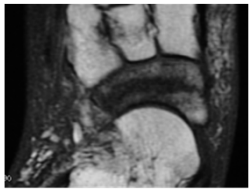
Navicular

- Central hypovascular zone
- Risk of AVN or non-union
- Pain with WB
- Tenderness over the navicular



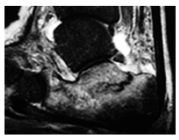
Navicular

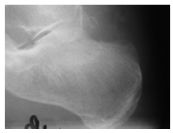
- Treatment
  - Non-displaced
    - Non-weight bearing
      - 6-8 weeks
    - Cast-boot
    - Motion control insert
    - Bone stimulator
  - Displaced, recalcitrant, sclerotic
    - ORIF
    - Autologous bone graft



Calcaneus

- Tender tuberosity
- Painful squeeze test
- Non-weight bearing
- Cast-boot
- Cushioned heel





Metatarsals 1-4

- 2nd most common
- Risk factors
  - Varus foot
  - Cavus foot
  - Adducted foot
  - Anterior ankle impingement
- Treatment – cast boot and protected weight-bearing

Metatarsals 1-4

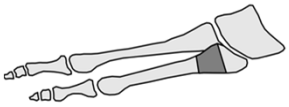
- Tenderness to the metatarsal
- X-rays may be negative initially
- Treatment
  - Cast boot and protected weightbearing
  - Crosstraining
  - Gradual return to training after 6 weeks

5th Metatarsal

- Metaphyseal-diaphyseal junction
- Risk factors
  - Varus heel
  - Cavus foot
  - Adducted foot

Metaphyseal-Diaphsyseal Classification

- Acute (aka Jones fracture)
- Acute-on-chronic
- Chronic (stress fracture)

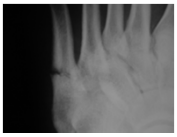


Imaging- Proximal metaphyseal-diaphyseal junction fractures

- Transverse
- Corresponds to the articulation between the fourth and fifth metatarsal base
- Acute
  - Clean, narrow, and distinct fracture line

Imaging- Proximal metaphyseal-diaphyseal junction fractures

- Acute-on-chronic fracture
  - acute fracture line over thickened and sclerotic bone

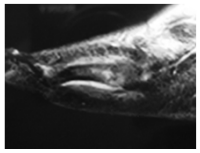


Imaging- Proximal metaphyseal-diaphyseal junction fractures

- Chronic
  - Sclerosis
  - Cortical thickening
  - Obliteration of the medullary canal

Imaging

- MR
  - Occult fractures
  - Early stress fractures
    - Intramedullary edema
    - Low signal line confirms a fracture



Treatment- Proximal Metaphyseal-Diaphyseal Fracture

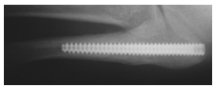
- Potential vascular watershed
- Non-weight bearing
- Short leg cast
- Up to 12 weeks

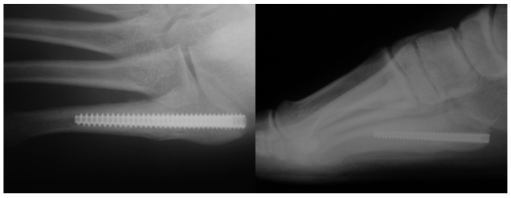
Complications-Proximal Metaphyseal-Diaphyseal Fractures

- Non-surgical treatment
  - Delayed union
  - Nonunion
  - Malunion
  - Re-fracture

Treatment- Proximal Metaphyseal-Diaphyseal Fracture

- Surgical treatment
  - Treatment failures
  - Healthy, athletic patients
- ORIF
- Percutaneous intramedullary fixation
- Bone graft



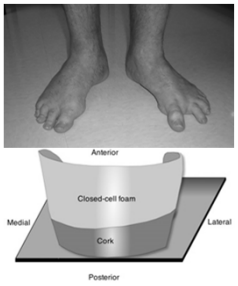


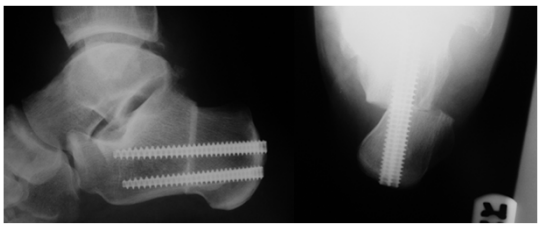
Complications-Proximal Metaphyseal-Diaphyseal Fractures

- Surgical treatment
  - Prominent, failed, incarcerated, or painful hardware
  - Sural neuroma

Treatment- Proximal Metaphyseal-Diaphyseal Fracture

- Hindfoot varus
  - Motion control shoe
  - Lateral posted shoe
  - Lateral posted insert
  - Concomitant calcaneal osteotomy





Sesamoid injury

- Sesamoiditis
- Sesamoid stress fracture
- Tibial sesamoid most commonly affected
- Seen in dancers, runners, basketball, tennis, and cleat sports
- Tenderness at the affected sesamoid, pain with dorsiflexion of the great toe, pain with resisted flexion of the great toe

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Sesamoid injury

- X-rays may be negative
- MRI can show edema or fracture line
- Treatment
  - Rest
  - Reduced weight bearing
  - Cast
  - Surgical resection for failed conservative treatment 3+ months
    - Complications: chronic pain,cock up deformity, hallux valgus (tibial) or varus (fibular)

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Vitamin D

- Technically a hormone
- Has receptors throughout the body
  - (not just bone)
- Synthesized in the skin from cholesterol
  - Regulated by feedback mechanism
  - Can make 10,000-20,000 IU in 30 minutes
  - SPF 15 UVB sunscreen can decrease production by 98%

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Vitamin D

- It is also obtained through diet
  - Oily fish (D3)
  - Fortified foods such as milk (D3)
  - Mushrooms (D2)
- It is converted to its biologically active form in the kidneys
- Vitamin D can be stored in body fat
  - (not enough to prevent seasonal deficiency)

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Who is at risk?

- Limited solar exposure
  - Northern latitudes, indoor athletes, increased clothing and sunscreen use
- Low dietary intake of vitamin D
- Decreased synthesis in the skin due to atrophy
- Poor absorption
- Poor renal function
  - Decreased conversion to active form

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Vitamin D and Fractures

- Vitamin D deficiency leads to:
  - Increased bone turn over
  - Accelerated bone loss
  - Increased risk of low-energy fractures
- Several studies link vitamin D deficiency to hip fractures

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Vitamin D and Fractures

- Supplementation with vitamin D and calcium reduces the risk of hip fractures and peripheral fractures
- One study showed that supplementing with 800 IU of vitamin D and 1200 mg of calcium showed hip fractures decreased by 26% and peripheral fractures decreased by 25% at 18 months

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Vitamin D and Stress Fractures

- Several military studies associate stress fracture risk with lower vitamin D levels
- One study of showed that a levels of 6.5-26.9 ng/ml (20 ng/ml) had double the risk of those in the 40.2-112.5 (50 ng/ml) range
- Another study supplementing 2000 mg calcium and 800 IU vitamin D showed a 20% reduction in the incidence of stress fractures

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Vitamin D and Falls

- Several studies have shown a connection between vitamin D status and muscle function
- Vitamin D regulates both phosphorus and calcium which are vital for muscle contraction
- Vitamin D deficiency caused impaired muscle function and weakness
- Affects proximal muscles (stabilizing) most leading to an increased risk of falls

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Vitamin D and Falls

- This is reversible with calcium and vitamin D supplementation
- One study showed that supplementing with 800 IU of vitamin D and 1200 mg of calcium daily for 8 weeks reduced body sway and number of falls over the next year

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Vitamin D Supplements and Dosing

- Vitamin D2
  - Produced by phytoplankton, invertebrates, yeasts, and mushrooms that are exposed to UV light
- Vitamin D3
  - Made by animals in the skin
  - High levels in fatty fish
  - Occurs naturally in milk
    - Can be increased by irradiating milk

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Vitamin D Supplements and Dosing

- Recommended daily intake of D3 for age 50+
  - 600-800 IU
  - Some experts believe this should be increased to 1000-2000 IU
  - Maximum tolerable dose is 4000 IU
- Recommended daily intake of calcium
  - 1200 mg

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Vitamin D Replacement

- Current recommended level is 40 ng/ml
- D2 50,000 IU weekly for 8 weeks
  - <30ng/ml will require a second round
- D3 1,000 IU daily for every 10ng/ml short for 6 weeks
- Repeat level after course

58

Thank you!

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