Stress Fractures of the Lower Extremity:

Diagnosis, Prevention, and Management

Thomas L. Hand, MD

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Disclosures

- New Standard Devices
  - Royalties and Consulting

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Outline

1. Background
2. Risk factors
3. High vs Low Risk Fxs
4. Diagnosis
5. Treatment
6. Prevention
7. Specifics
8. Case example

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Objectives

- Understand the impact and significance of stress fxs
- Become familiar with the etiology to understand prevention
- Be able to identify *risk factors* to aid in diagnosis, management, and prevention
- Clearly delineate “high risk” vs “low risk” stress fxs
- Understand primary prevention is the key to success!

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Background

- Incidence of LE Stress Fractures
  - LE (80-95% of all) > UE, ribs, etc…[1,2]
  - LE stress fxs 0.7% – 20% of ALL sports med injuries
  - General pop <1%[3]

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  - LE stress fxs 0.7% – 20% of ALL sports med injuries
  - General pop <1%[3]
  - Athletes 6-13%[4]
  - Endurance Runners 15% to 52%[3,4]

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  - LE stress fxs 0.7% – 20% of ALL sports med injuries
  - General pop <1%[3]
  - Athletes 6-13%[4]
  - Endurance Runners 15% to 52%[3,4]
- Tibia (~40-70%)> tarsal bones > metatarsals > femur > fibula > pelvis[1,4,5]
- …but has been described in every bone in the lower extremity!

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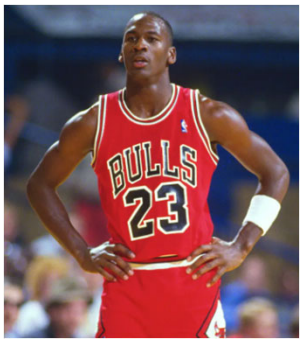
Background

- Impact
  - NBA[6]
    - 75 NBA players with 76 LE stress fxs/stress rxns
    - Avg games missed 25.1 +/- 21.3
    - Decreased steals per game 1-2 yrs after injury (P = 0.004)
    - ***30.2% (23/76)*** unable to return to previous level of play



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Background

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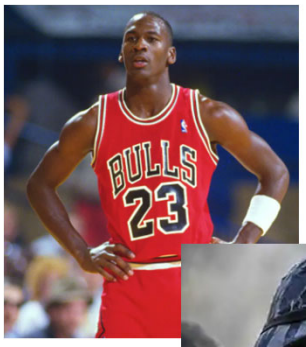
  - NBA[6]
    - 75 NBA players with 76 LE stress fxs/stress rxns
    - Avg games missed 25.1 +/- 21.3
    - Decreased steals per game 1-2 yrs after injury (*P* = 0.004)
    - ***30.2% (23/76)*** unable to return to previous level of play
  - Military[7]
    - Overuse injuries (i.e. stress fxs): 3.2 – 10.6% discharge
    - Loss of recruit = $7,000-$16,000
    - Total annual avg cost from lost recruits <6mos, $390 million (Gov't Accountability Office)
    - Total cost - ***$12.5 – 41.3 million*** loss per year



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Background

- Overall Impact:
  - Loss of activity and/or productivity x weeks to months
  - Possible loss of return to previous activity level

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Pathophysiology

- Simplistic Summary:
  - Overuse injury to specific bone due to bone fatigue and/or bone insufficiency[8]

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  - Defn: Bone adaptation to the stresses/demands placed on them

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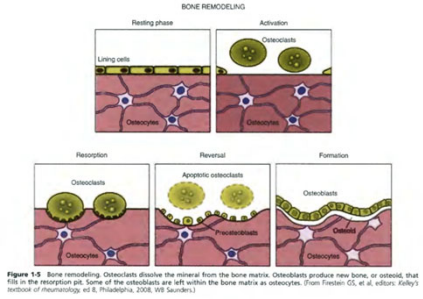

Figure 1-5 Bone remodeling. Osteoclasts dissolve the mineral from the bone matrix. Osteoblasts produce new bone, or osteoid, that fills in the resorption pit. Some of the osteoblasts are left within the bone matrix as osteocytes. (From Firestein GS, et al, editors: Kelley's textbook of rheumatology, ed 8, Philadelphia, 2008, WB Saunders.)

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  - AKA: Stress magnitude exceeds bone capacity to heal microfractures[11]

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  - AKA: Stress magnitude exceeds bone capacity to heal microfractures[11]
- Fatigue Contribution
  - Muscular fatigue may lead to excessive forces transmitted to bone[3]

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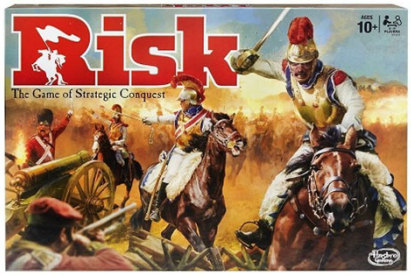
Risk Factors

- Intrinsic vs Extrinsic
- Modifiable vs Non-modifiable



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Risk Factors: Intrinsic vs. Extrinsic[4]

Intrinsic

- Prior hx of stress fx (5-6x risk)
- Sex (Females 2-3x risk)
- Menstrual status
  - Oligo/amenorrhea
  - Menarche, early or later onset both risk
- BMI (low <19 kg/m2 or high >30 kg/m2)
- Age: 21-29 > 17-19

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Risk Factors: Intrinsic vs. Extrinsic[4]

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Extrinsic

- Nutrition
  - Low Vit D and/or Calcium
  - Anorexia/Bulimia nervosa
- Activity type
  - Running, jumping, marching, ballet
- New exercise patterns and lack of adequate rest
- Forefoot varus, cavus foot, leg-length discrepancy
- *Female Athlete Triad*
  - Disordered eating, amenorrhea, and osteoporosis

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Risk Factors: Modifiable vs Non[12]

Modifiable

- BMI
- Nutrition
- Menstrual status
- Rapid or new progression in intensity
- ***Smoking and tobacco use**
- ***Worn or nonsupportive shoe wear**
- ***Running surface (hard>soft)**
- ***Lower entry-level fitness**

Non-Modifiable

- Female sex
- Increased age
- Hx of prior stress fx
- High arch foot, LLD
- ***White race**
- ***Genu valgum**
- ***Increased Q angle**
- ***Bone geometry[13]**
  - ***Slender, thin corticies, ↓cross section area, lower bending strength***

***Indicates additions to prior list**

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High Risk vs. Low Risk

- Delineation based on prognosis and delayed/non-union risk, requirement for more aggressive tx
- This is <u>everything</u> -> prognosis and treatment!
- **Low risk:** *usually* heal reliably with rest, limitation of activity, and rehab[5]
- **High risk:** orthopaedic referral for close monitoring and/or operative intervention

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High Risk vs. Low Risk[3,5]

High Risk

- Anterior tibial cortex
- Navicular
- 5th Metatarsal base
- 2nd Metatarsal base
- Femoral neck
- Talus
- Great toe sesamoids
- Patella

Low Risk

- Pelvis
- Femoral shaft
- Tibial shaft (posteromedial)
- Fibula
- Calcaneus
- Metatarsal shafts

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Put it all together…

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“Red Flags” and Work-up

- Always start with history!
  - Insidious activity related pain
    - Usually localized to particular region of concern or classic distribution (i.e. groin)
    - Usually atraumatic
  - Training history, intensity, changes, rest days, etc..
  - Prior hx of stress fx (most imp!)
  - Females: oligo/amenorrhea
  - Diet and supplements

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“Red Flags” and Work-up

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  - Training history, intensity, changes, rest days, etc..
  - Prior hx of stress fx (most imp!)
  - Females: oligo/amenorrhea
  - Diet and supplements
- Physical exam
  - May be nonspecific
  - *Superficial bones*: point tenderness
  - *Deep bones*: ROM or stress-exam pain
  - Limb-length inequality
  - Specific exams to r/o other MSK injuries (ligamentous, muscular strain, infection, neoplasm, etc.)[3]

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“Red Flags” and Work-up

- DDx in mind
  - Don’t forget about other causes!
  - Depends on region *(see specifics)*
    - Muscular strain
    - Ligamentous strain/tear
    - Impingement
    - Exertional comp syndrome

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“Red Flags” and Work-up

- Imaging
  - Plain radiographs
    - Part of initial w/u
    - May be normal w/in 2-3wks onset
    - Later: fx line, periosteal rxn, callus, or focal sclerosis
  - MRI
    - Gold standard for diagnosis
    - Indicated for high risk fxs or unclear dx
  - Bone scan
    - Sensitive but +radiation
    - Highly sensitive, not specific[17]
  - Ultrasound
    - Limited and controversial

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Treatment – Low Risk

- Step 1: Identify and correct modifiable risk factors if able[3]

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Treatment – Low Risk

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- Many
  - Resolve with rest and gradual return

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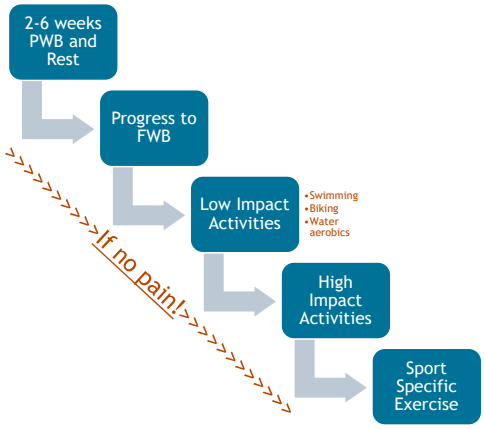
Treatment – Low Risk

- Step 1: Identify and correct modifiable risk factors if able[3]



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Treatment – Low Risk

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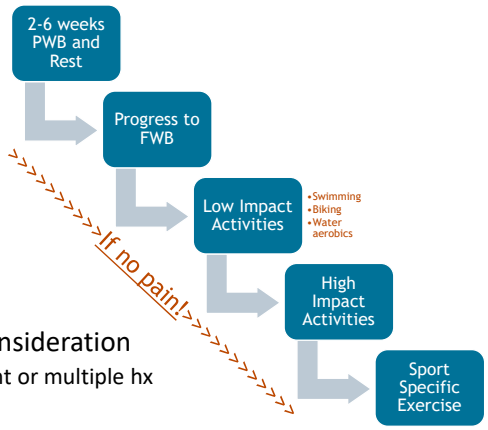

- Special consideration
  - Recurrent or multiple hx

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Treatment – Low Risk

Stress Fx	Mean recovery time to WB activities[1]
Pelvis	7-12 weeks
Femur shaft	6-8 weeks
Tibia (not anterior)	3-12 weeks
Fibula	2-4 weeks
Metatarsal	4-6 weeks

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Treatment – HIGH RISK

- Step 1: Identify and correct modifiable risk factors if able[3]
  - Don't forget….
- Step 2: Orthopaedic referral!
  - Tx variable *(specifics next section)*
  - Depends on
    - Severity and location of fx
    - Displacement
    - Chronicity
    - Level of play

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Prevention

- Step 1: Identify and correct modifiable risk factors if able[3]
  - *See the importance yet???*
  - Balanced diet (Vit D, >1500mg Ca), eating disorders, training regimen, etc…
  - Strengthen lower extremity muscles and improve flexibility
  - Condition of running shoes and running surface[3,9]
    - Change every 300-500 miles
    - Running shoes < 6 months old
    - Hard surface ↑ risk

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  - Condition of running shoes and running surface[3,9]
    - Change every 300-500 miles
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    - Hard surface ↑ risk
- Step 2: Education!
  - Risks of over training
  - Progressive exercise, variety, and periodization
    - **Limit 10% increase load/mileage per wk[14]**
  - Need for rest days
  - Adverse effects of eating disorders

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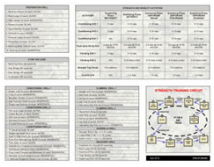
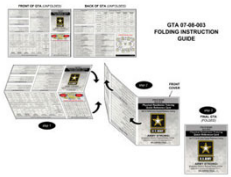
Prevention

- Army Physical Readiness Training (PRT) Program[7]
  - Est. October 2010
  - Decreased running miles
  - Increased exercise variety
  - Progressive training enforced
  - 5000 recruits, 6 months before PRT, 6 months after PRT
    - 49.3% decrease in femur (neck and shaft) stress fxs
    - 28.8% decrease in foot stress fxs





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Specifics

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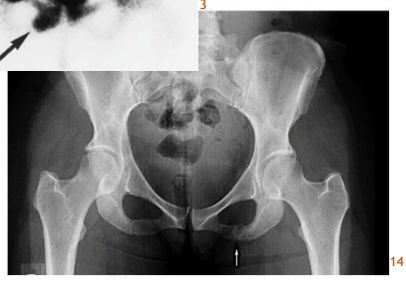
Pelvis

- Rare, 1-7%[11,14]
  - Sacrum and pubic rami most common
- Generally **low risk**
  - High healing rate and RTP @ 6-12 wks[1,11]
- DDx: Sports hernia, sciatica, Apophyseal avulsions – ischial tuberosity, ASIS, AIIS, iliac crest



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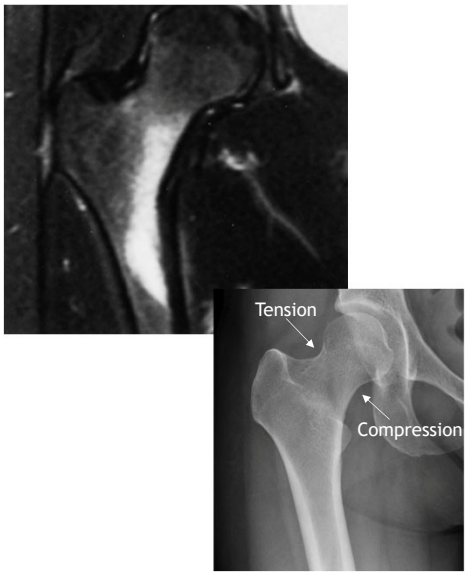
Femur

- 4th most common site (4-40%)[11]
- Femoral neck -> **HIGH RISK!!**
  - Surgery: >50% of femoral neck or any "tension-side" (superior) involvement[15]
- Femoral shaft -> **low risk**
  - IMN for delayed/nonunion
- DDx: FAI, labral tear, snapping hip syndrome, septic arthritis (gonococcal), trochanteric bursitis



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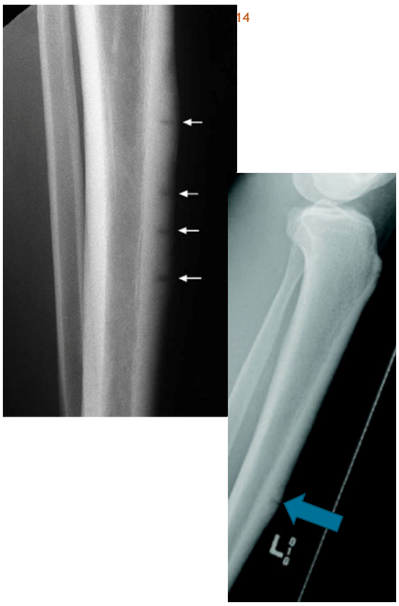
Tibia

- Most common LE stress fx (40-70%)
- Anterior cortex -> **HIGH RISK**
  - "Dreaded black line" Xray
  - High nonunion/delayed union rate[14]
    - Nonop can take up to 12 months
    - IMN full activity 3 months
- Posterior, posteromedial cortex -> **Low risk**
  - More common, usually heal 4-8wks
- DDx: shin splints, adamantinoma, Osgood Schlatter, exertional comp syndrome



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Fibula

- Less common (5-12% of all), distal 1/3[11,14]
- **Low Risk**
  - RTP once point tenderness resolves, 2-6 weeks[14]
- DDx: high ankle sprain, low ankle sprain, peroneal tendonitis/tear

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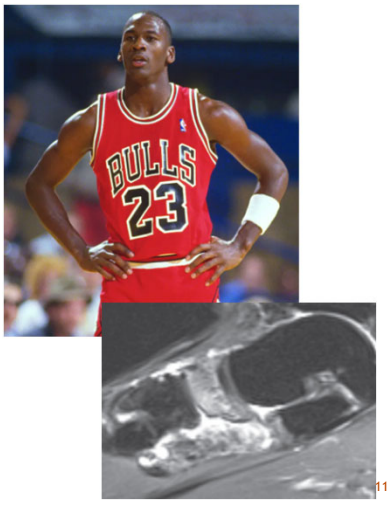
Hindfoot/Midfoot

- 2nd Most common site (7-25%)[1,11]
- Calcaneus -> **Low risk**
  - 2nd most common in foot[18]
  - Heel pads, limit activities 3-6 weeks[3,18]
- Navicular -> **HIGH RISK**
  - Poor vascularity, nonunion risk
  - Cast x6 weeks, NWB; surgery for nonunions[18]
- Talus -> **HIGH RISK**
  - Rare
  - Cast x6 weeks, NWB then WB in boot 4-6wks[8,18]



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Metatarsals

- 3rd most common (8-24%)[11]
- 2nd and 3rd MTs most common[1]
- Base vs Shaft
  - Base 2-5: **HIGH RISK** - high rate of non-union (20-67%)[8]
    - NBA players with 5th MT 43% unable to return to play![6]
  - Shaft/distal: **Low Risk** – CAM boot or stiff shoe
- DDx: Metatarsalgia, plantar fasciitis, Morton's neuroma, spring ligament tear


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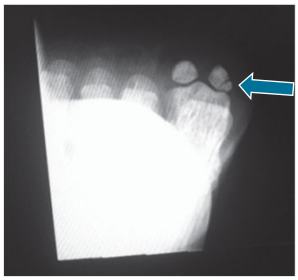
GT Sesamoids

- Rare (0.4-1%)[1]
- **HIGH RISK**
  - High rate of symptomatic non-union
  - NWB Cast x 6 weeks vs surgery (internal fixation or sesamoidectomy)
- DDx:
  - Sesamoiditis, AVN, Partite sesamoid, osteomyelitis, turf toe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Case Example

- 33 yo Asian female
  - Recent subscription to Orange Theory fitness 3-4x per week x 2 months
  - c/o right hip pain, atraumatic, increasing severity
  - Xrays obtained:

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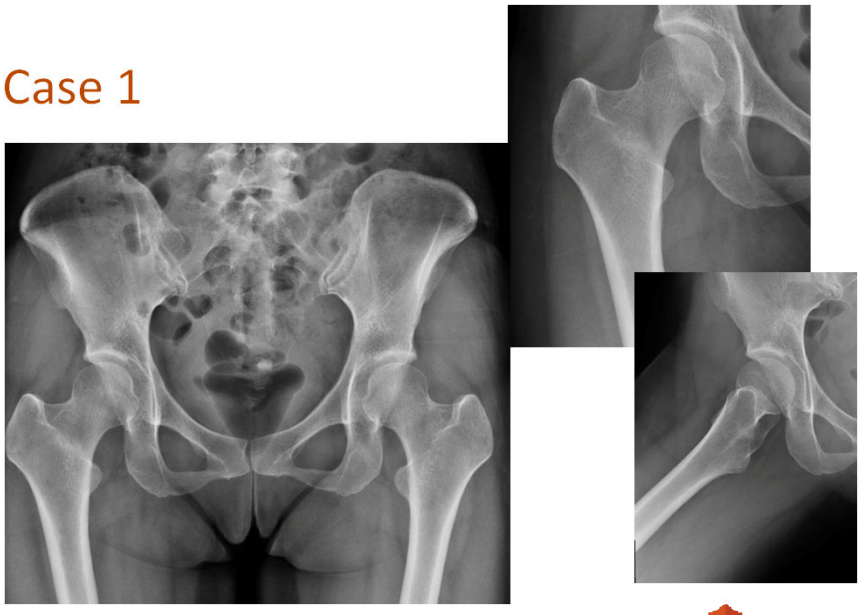
Case 1



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Case 1

- 33 yo Asian female
  - Recent subscription to Orange Theory fitness 3-4x per week x 2 months
  - c/o right hip pain, atraumatic, increasing severity
  - Xrays obtained:
  - Outside clinic -> dx'ed as trochanteric bursitis, given steroid shot and rx po prednisone burst
  - Sx's better briefly, then worse, MRI ordered:

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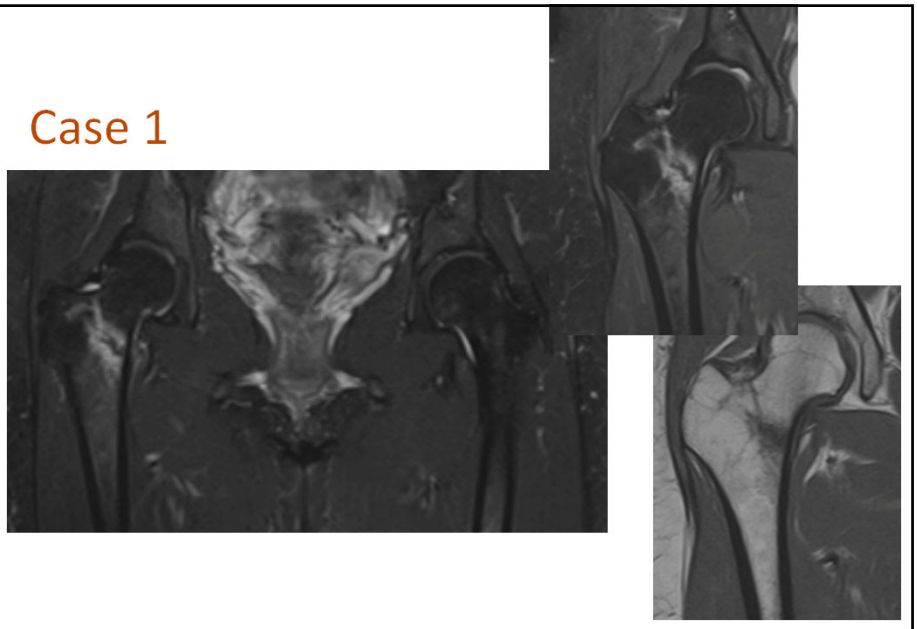
Case 1



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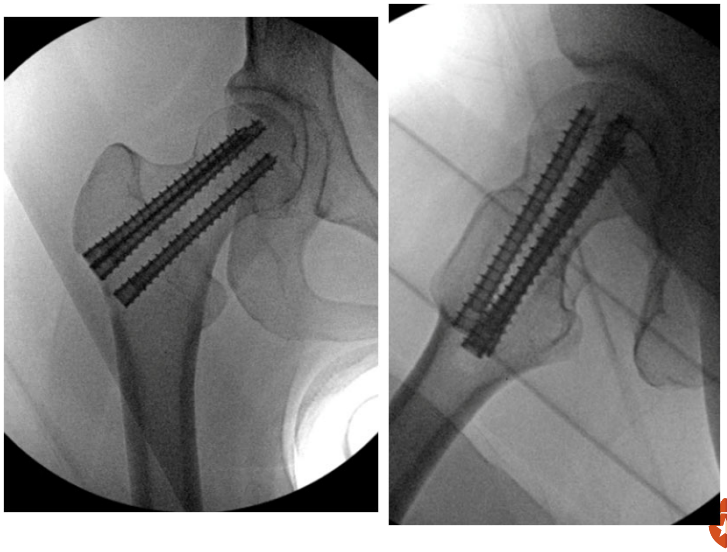

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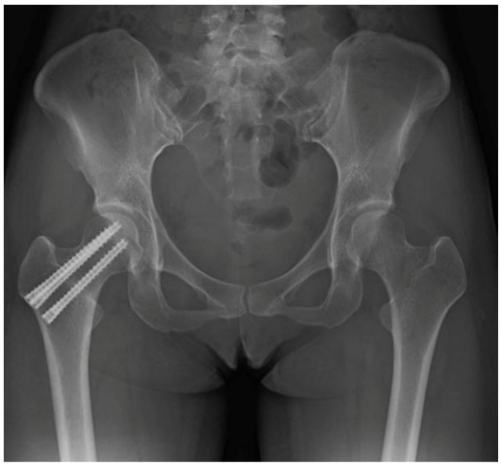
Case 1

- 33 yo Asian female
  - Does great post-op
  - 9 months later though…..
  - Left hip pain x1 month
    - (MRI on CD)



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Thank you!

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References

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