Positioning Guide for Cross-Sectional Musculoskeletal Imaging

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Fundamental Principles of Series Prescription

- Understand the central axis of anatomy
- Know the essential anatomic borders to include
- Prescribe at level of primary joint
- Long and short axis prescriptions at 90° from each other
- Maximal coverage using minimum # of slices
- Disregard whether your images will flip when prescribing proper angles. Images are easily reoriented in PACS.

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Ankle & Foot

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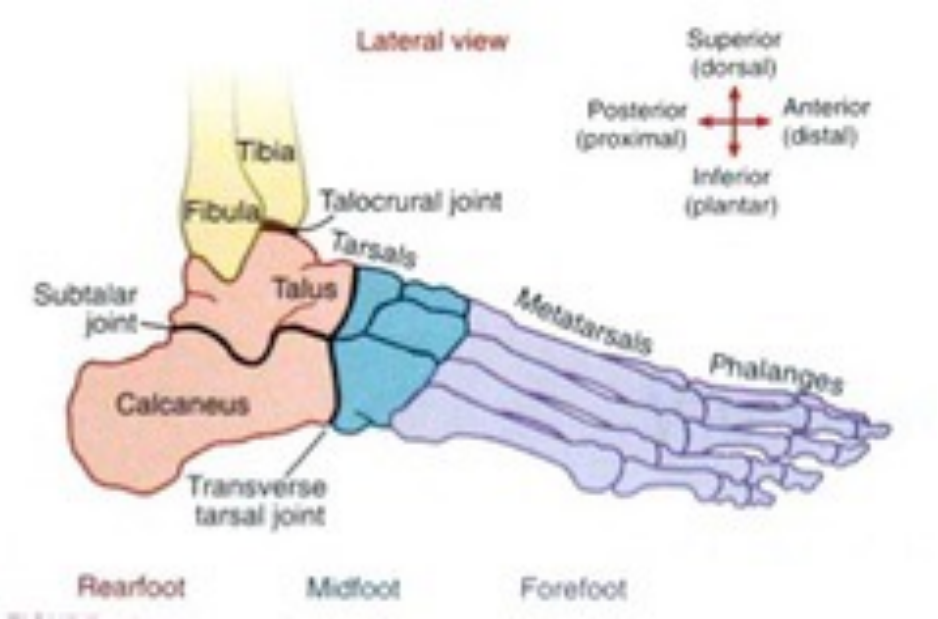
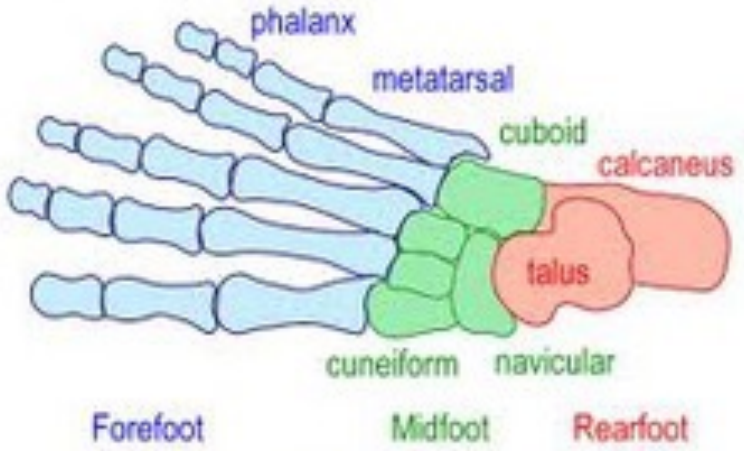
Definition of anatomic terms

- Forefoot - metatarsals, toes
- Midfoot - navicular, cuboid, cuneiforms
- Hindfoot - talus, calcaneus





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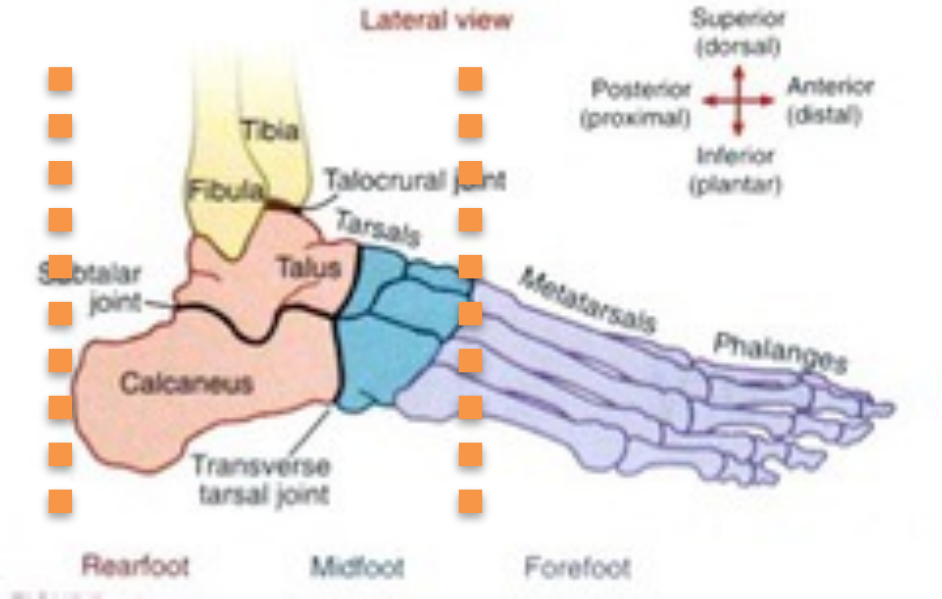
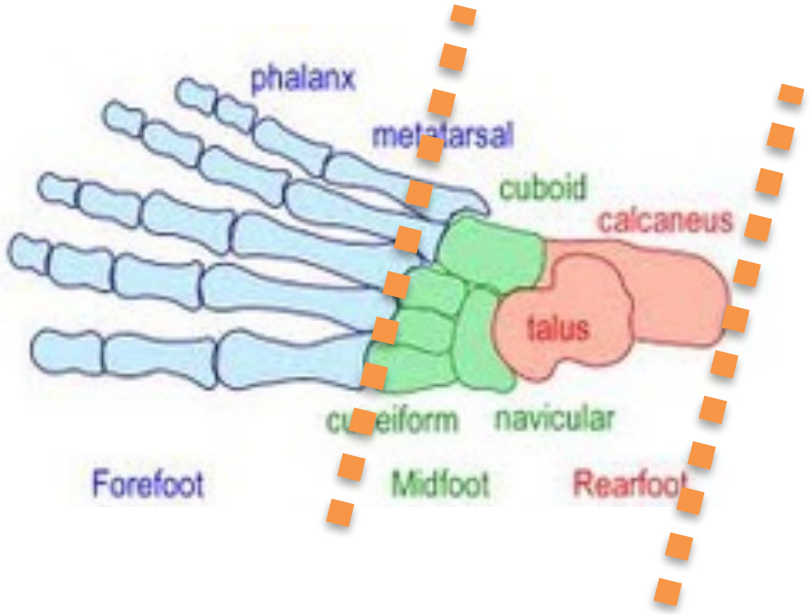
ANKLE/HINDFOOT coverage

- anatomy including and proximal to base of 5th metatarsal





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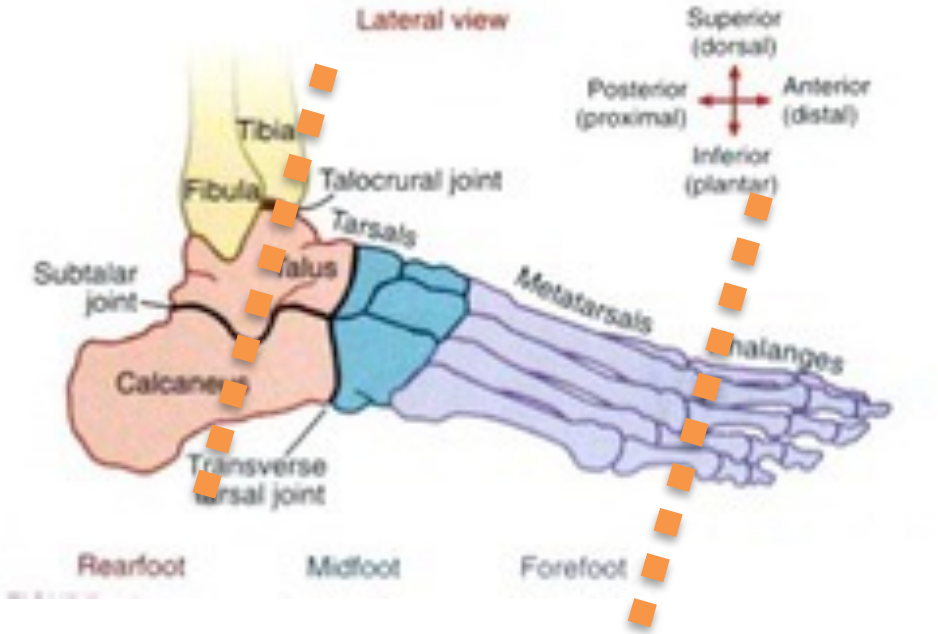
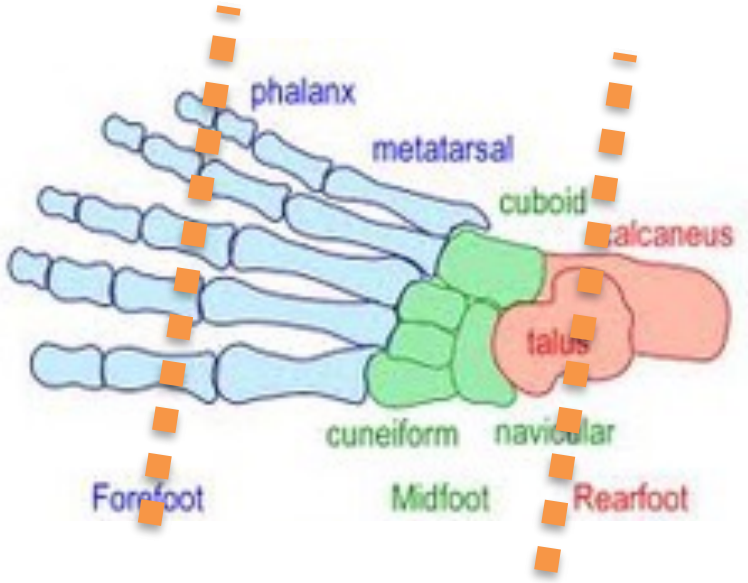
MID/FOREFOOT coverage

- Midfoot- anatomy between neck of calcaneus & metatarsal phalangeal joints





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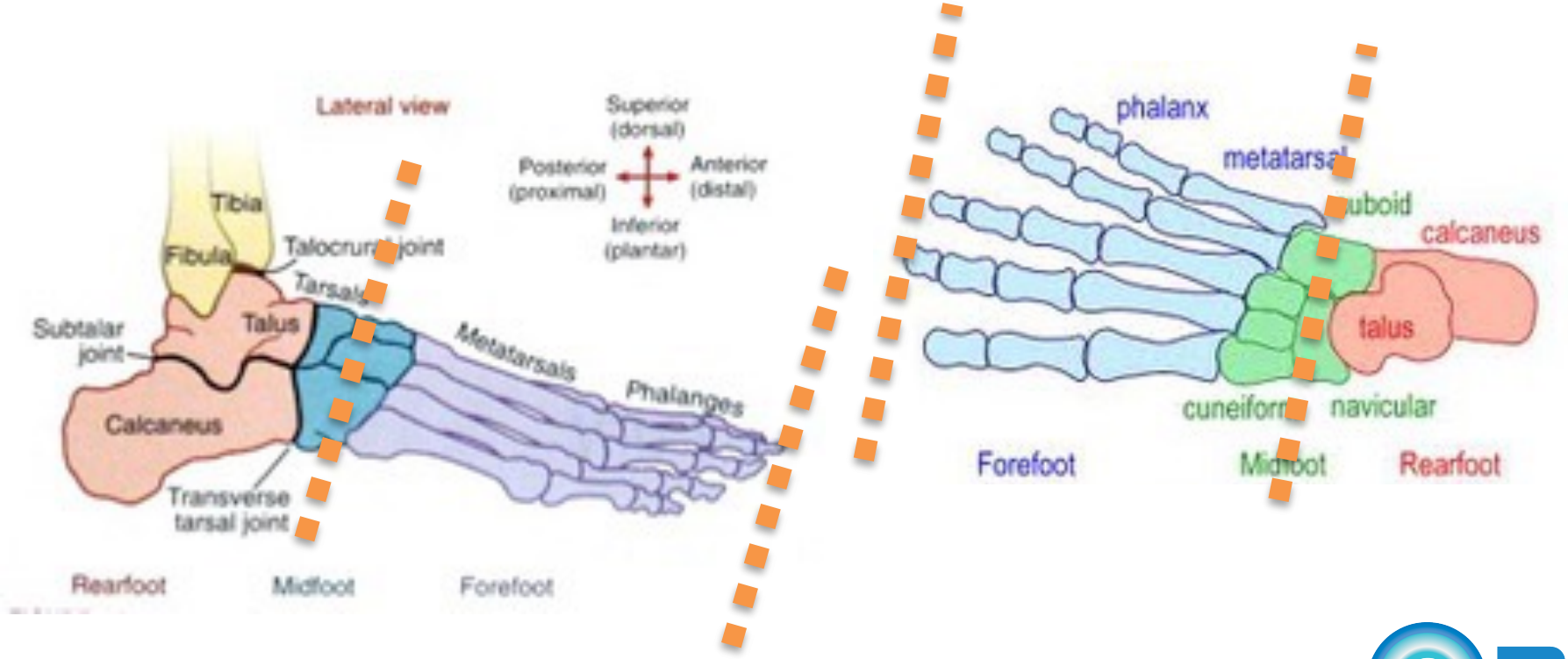
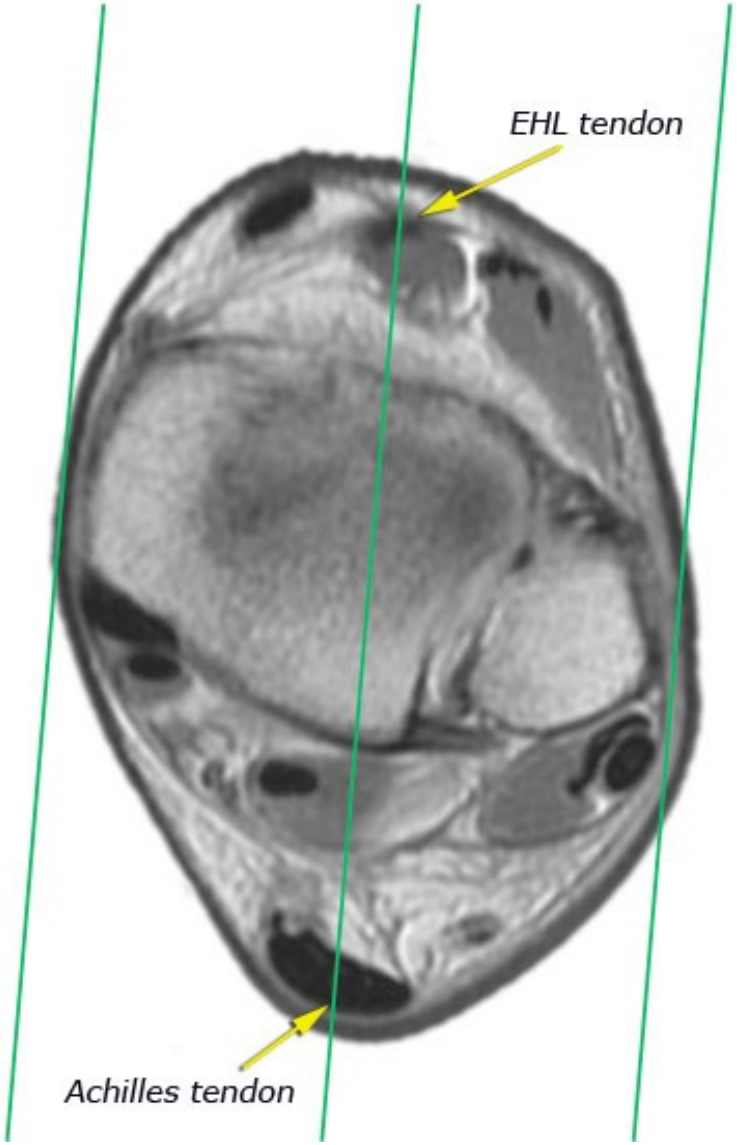
FOREFOOT/TOES coverage

- Forefoot - anatomy distal to base of 5th metatarsal



Ankle/Mid/Hindfoot



Sagittal

Prescribe at level of tibiotalar joint line, parallel to a line bisecting Achilles with Extensor Hallucis Longus (EHL) tendon or 2nd metatarsal (whichever is easier to identify)

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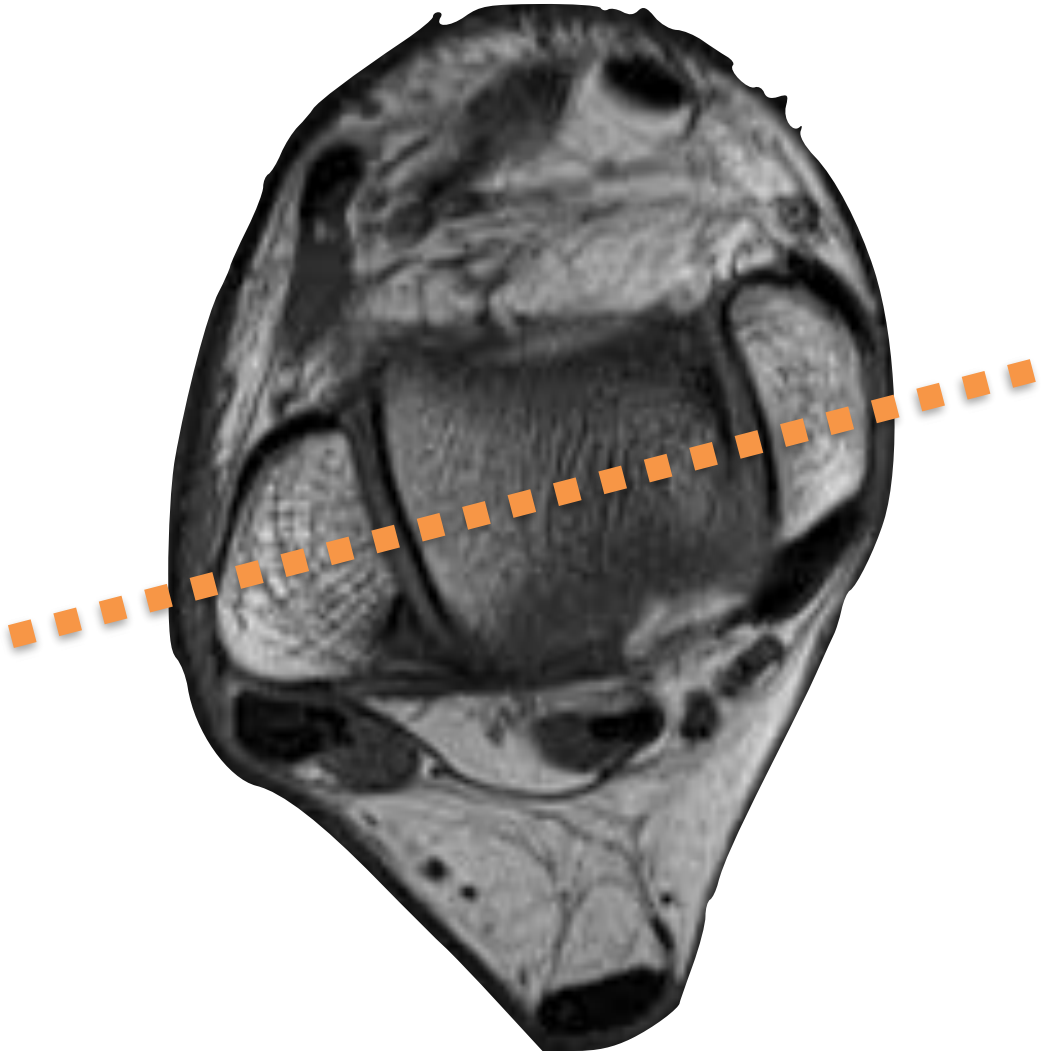

Coronal

Bisect malleoli at level of tibiotalar joint line. Talar dome should be en face

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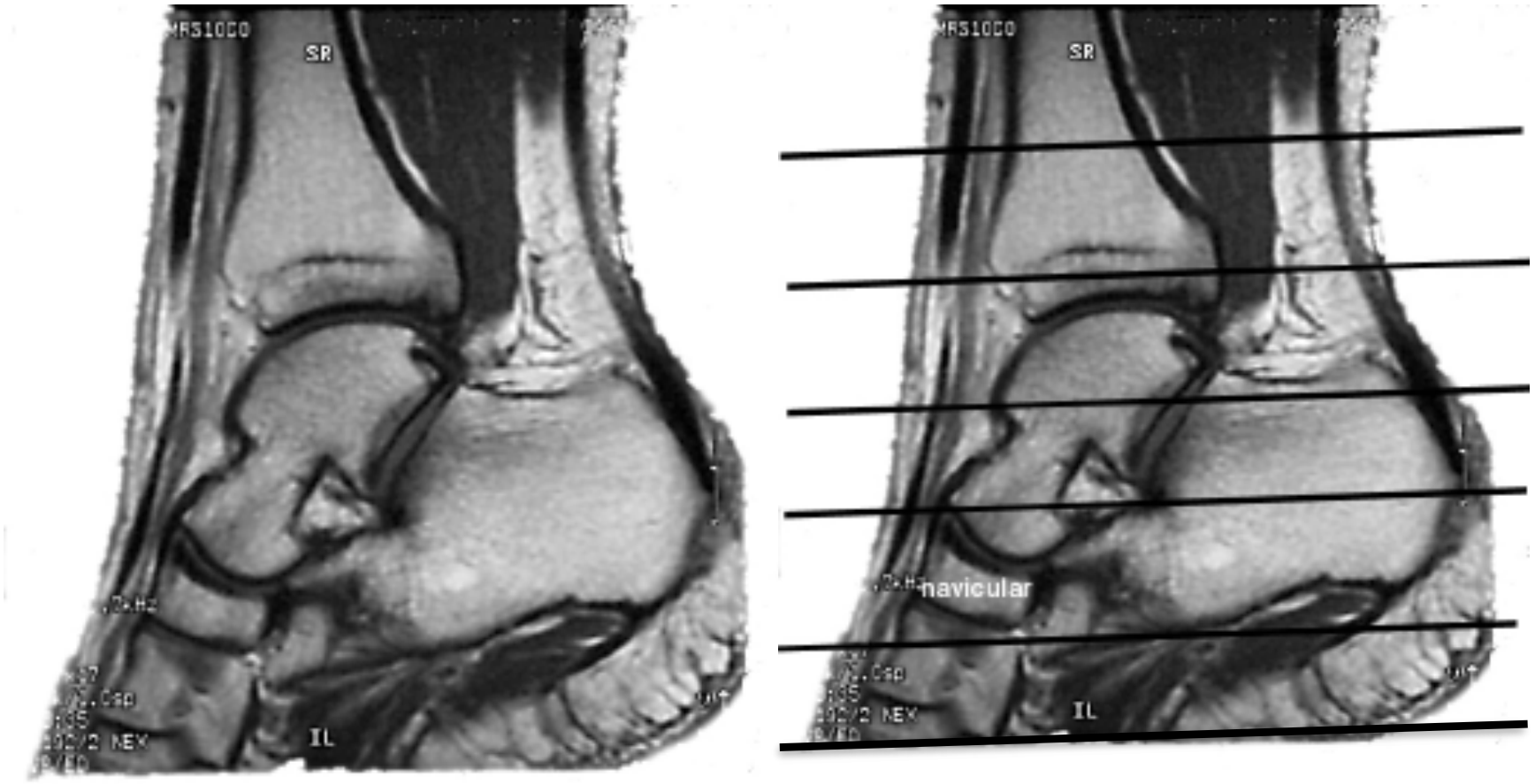

20-30° plantar flexion
Tangential to distal tibia

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Ankle MRI anatomic borders

Sagittal - include distal tibia though 5th metatarsal base.

* for Achilles, increase FOV to at least 20 cm to include its myotendinous junction. Add axials superiorly to cover entire tendon & MT jxn

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Mid/Forefoot/Toes

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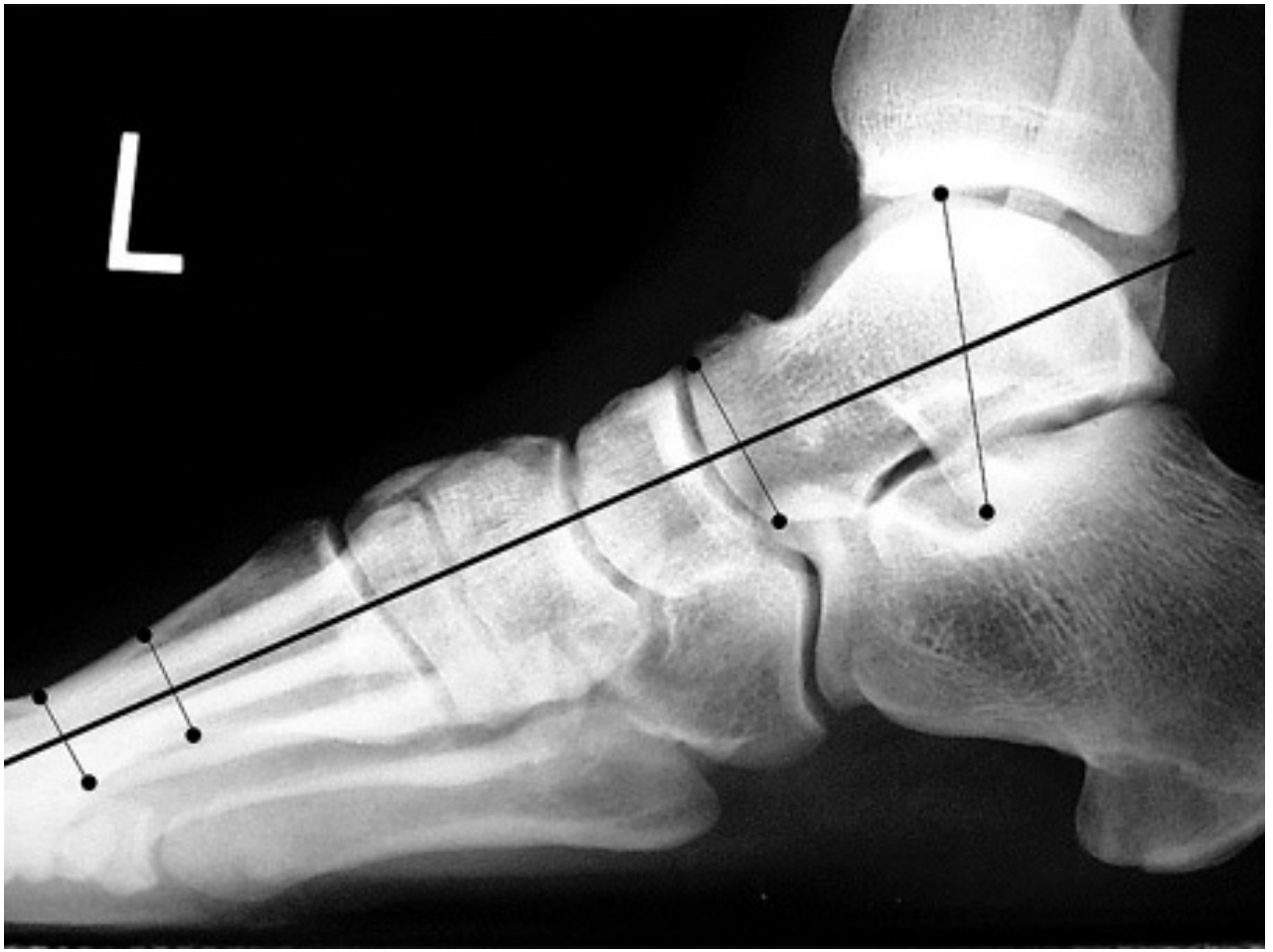

Long axis of foot

use 2nd metatarsal shaft as reference anatomy for all Rx

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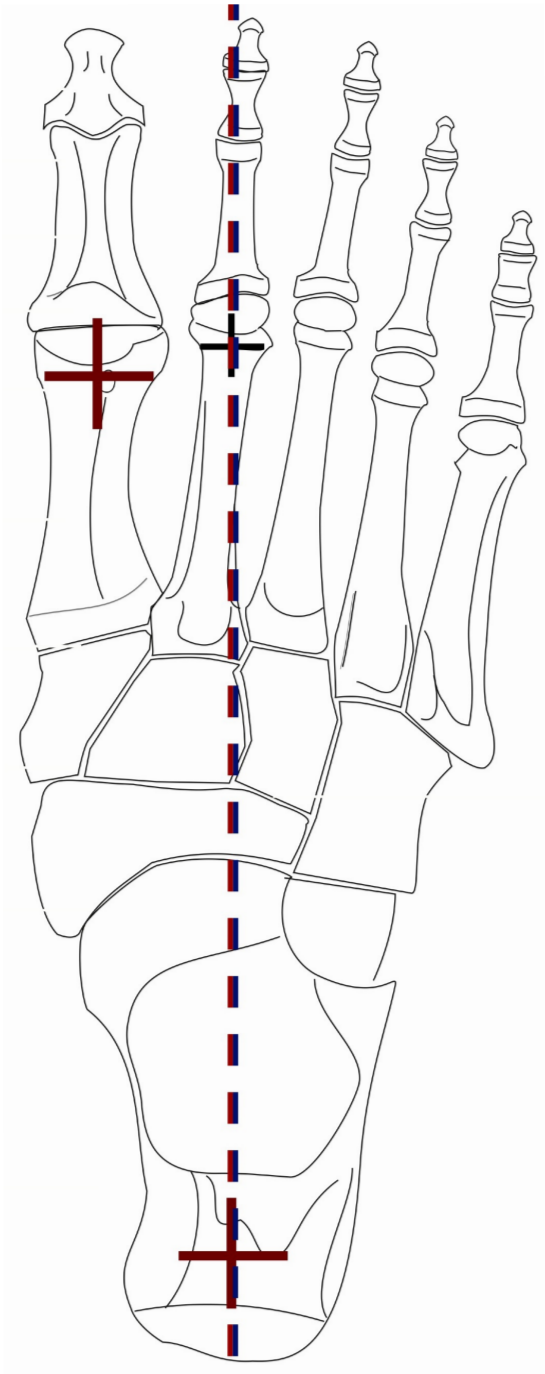

Central axis of foot

Achilles through 2nd metatarsal

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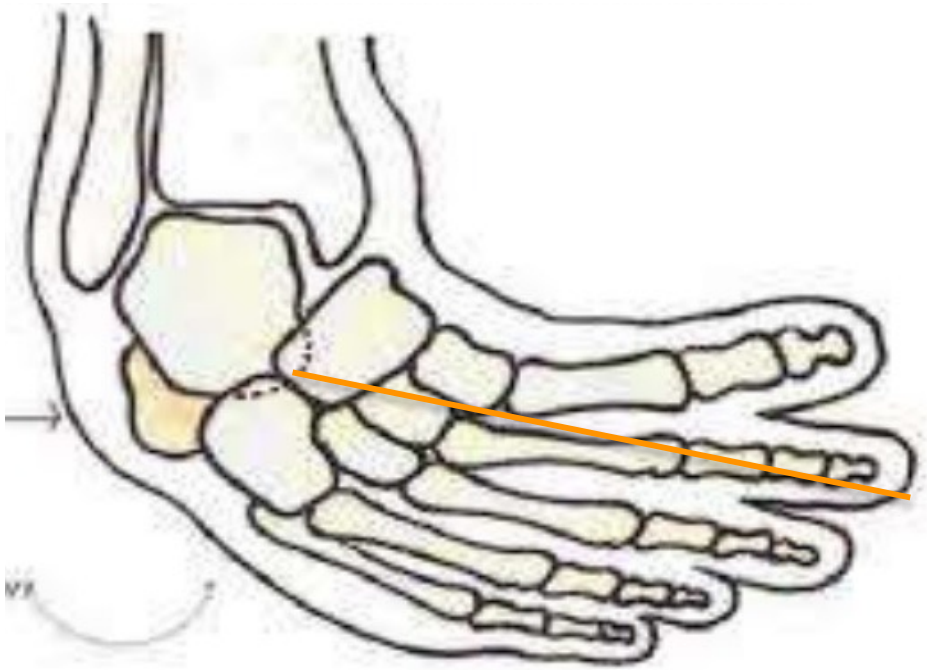

Ignore deformities.
Always use 2nd metatarsal shaft as the central axis of foot

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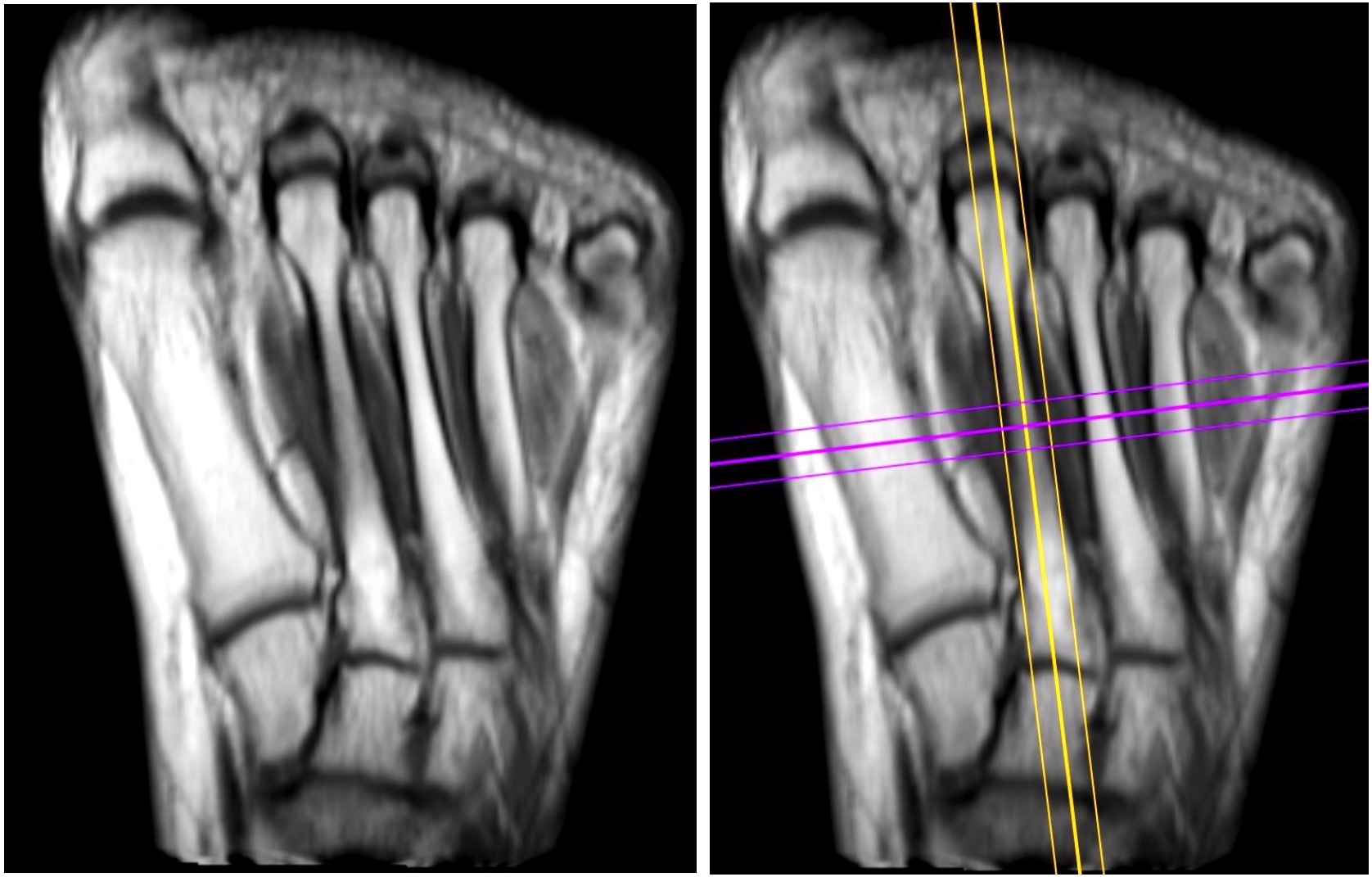

prescription of sagittal & short axis (transverse)

on long axis view- prescribe tangential to 2nd metatarsal shaft

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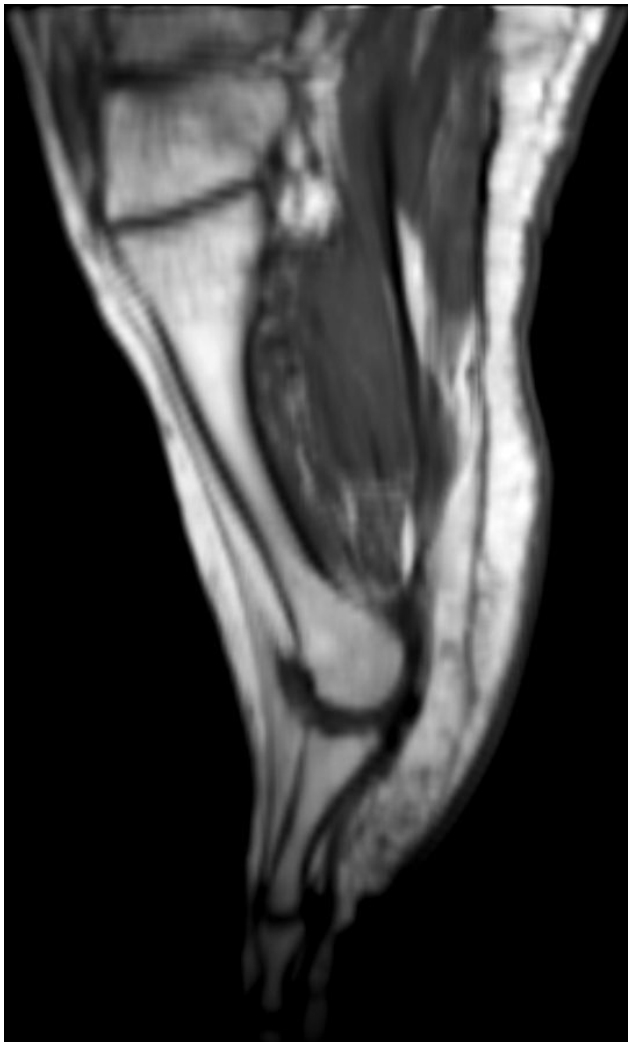

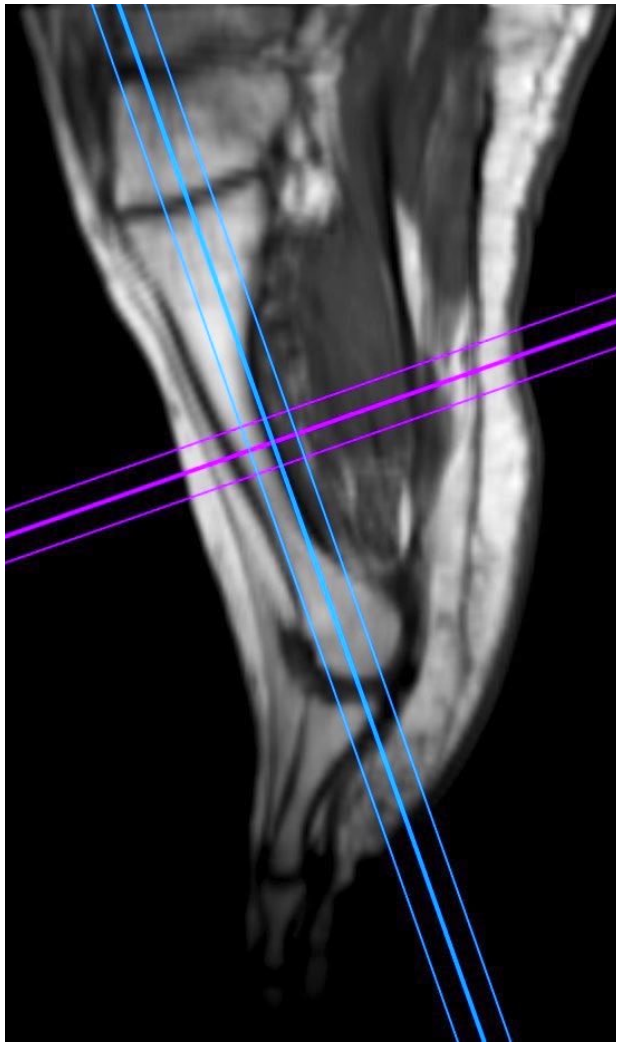

prescription of long axis & short axis (transverse)

on sagittal view- prescribe tangential to 2nd metatarsal

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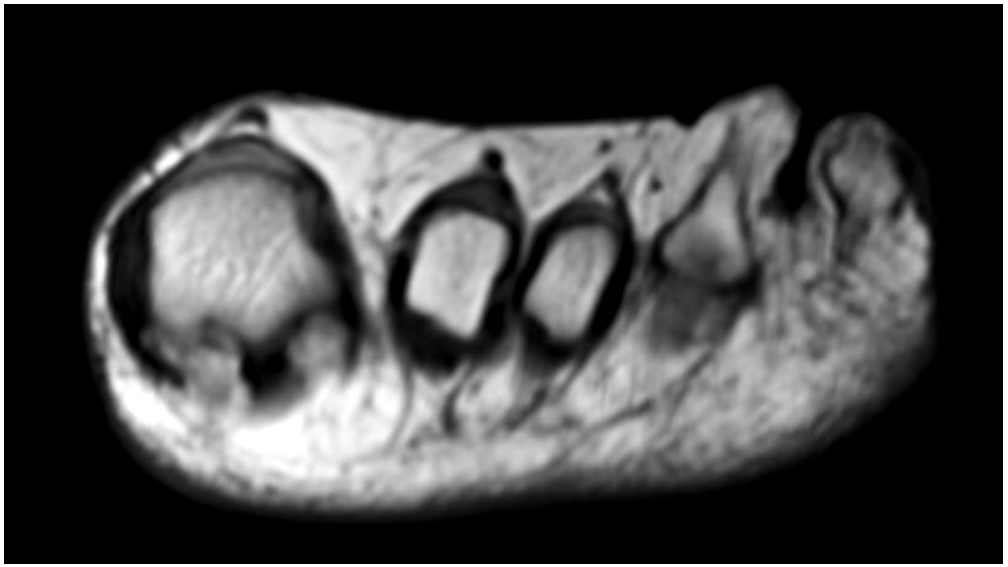

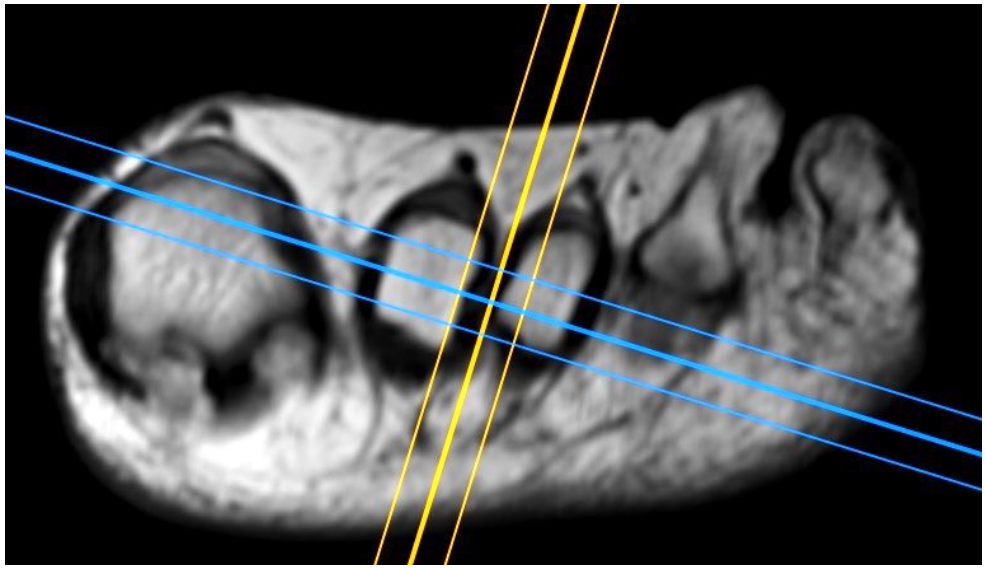

prescription of long axis & sagittals

on short axis view- prescribe tangential to 2nd interspace @ level of metatarsal phalangeal joint

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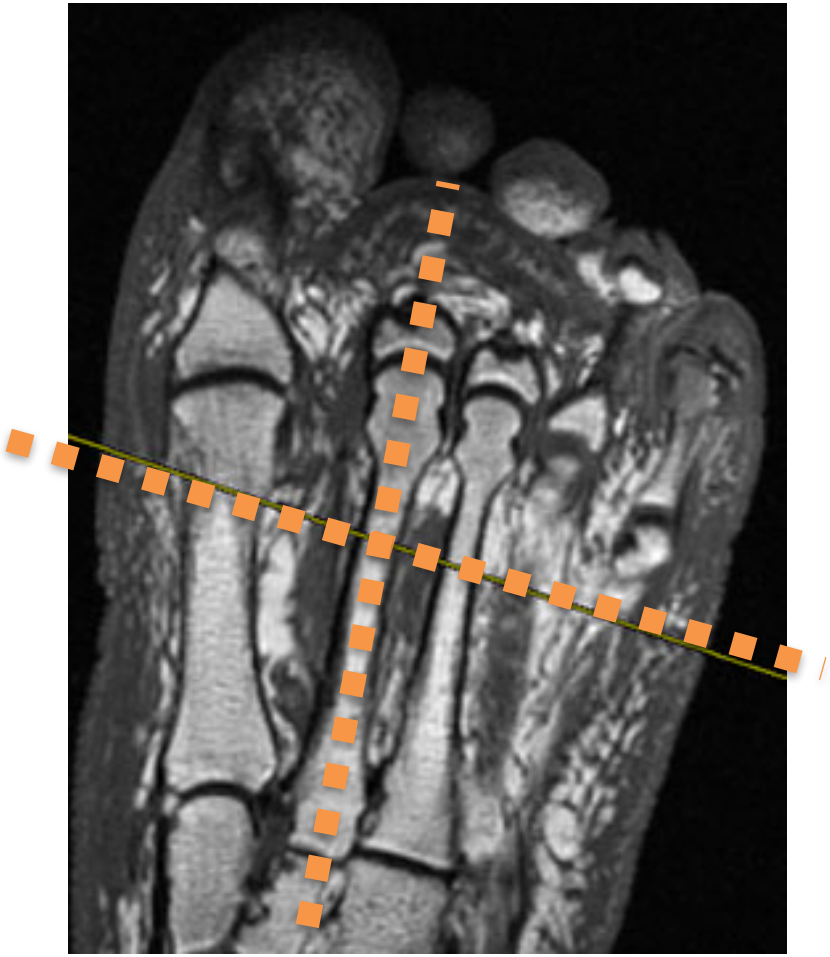
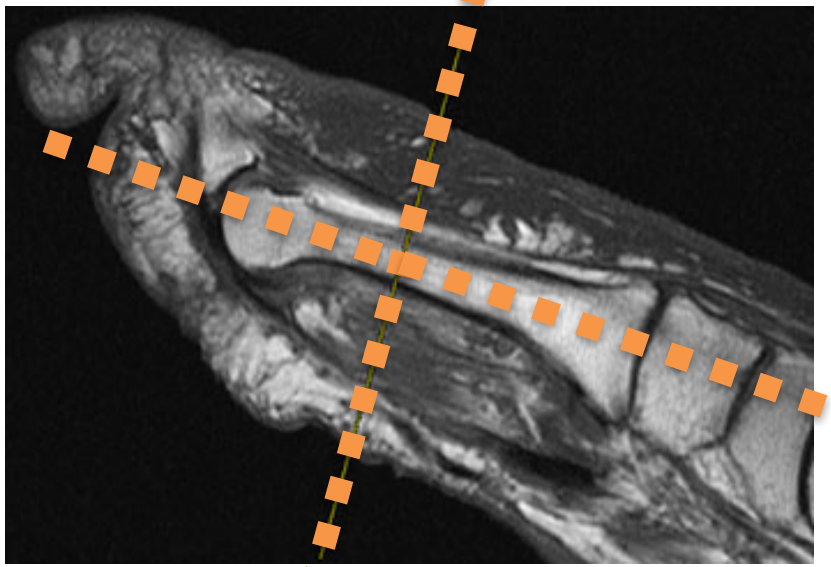
long axis



short axis



sagittal

Forefoot

Borders- include 5th metatarsal base through toes

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dedicated Midfoot exam

- Indications:
  - plantar fibroma
  - Lisfranc fracture
  - Charcot foot
- Use Forefoot protocol but center over area of interest (midfoot). Include anatomy distal to neck of calcaneus

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Knee

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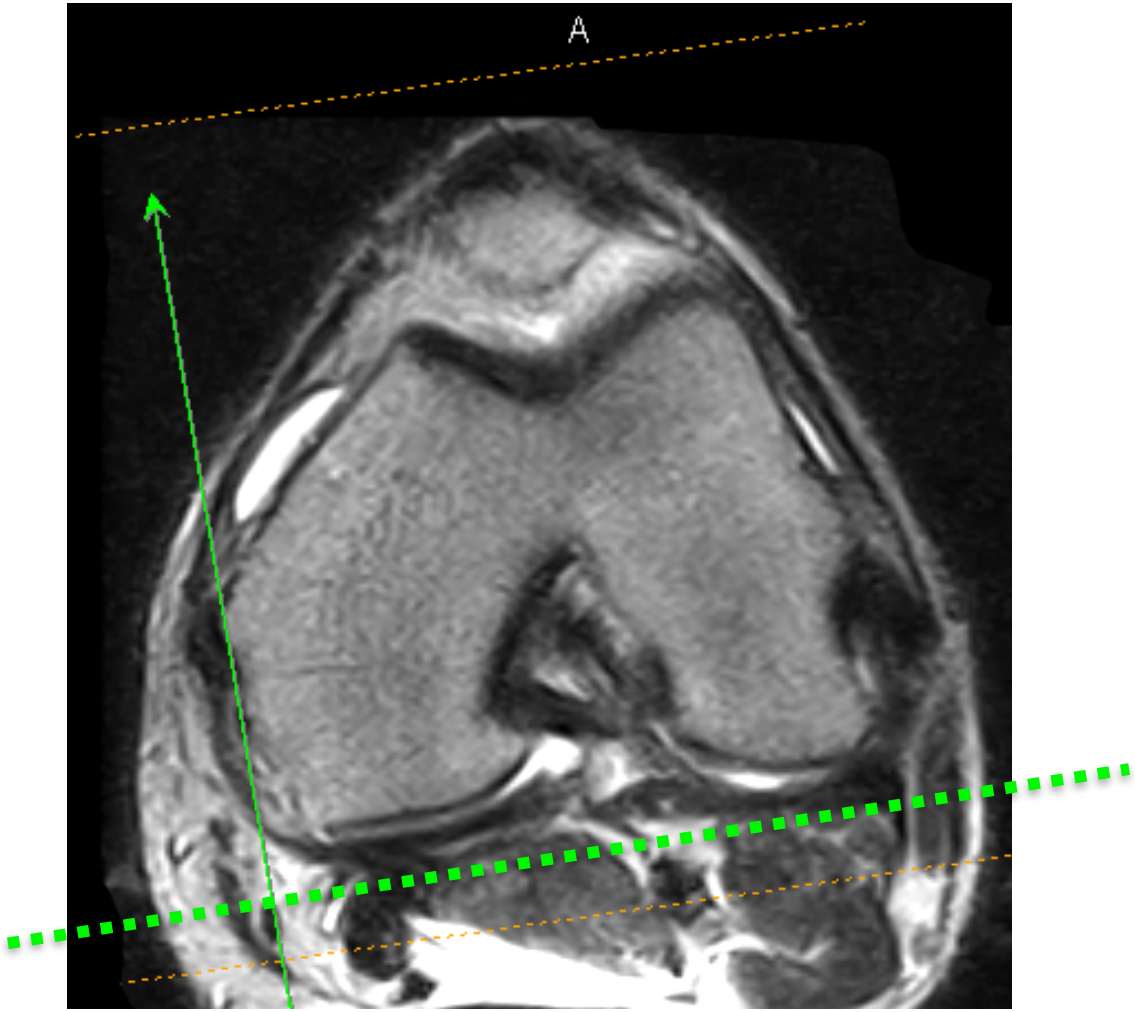
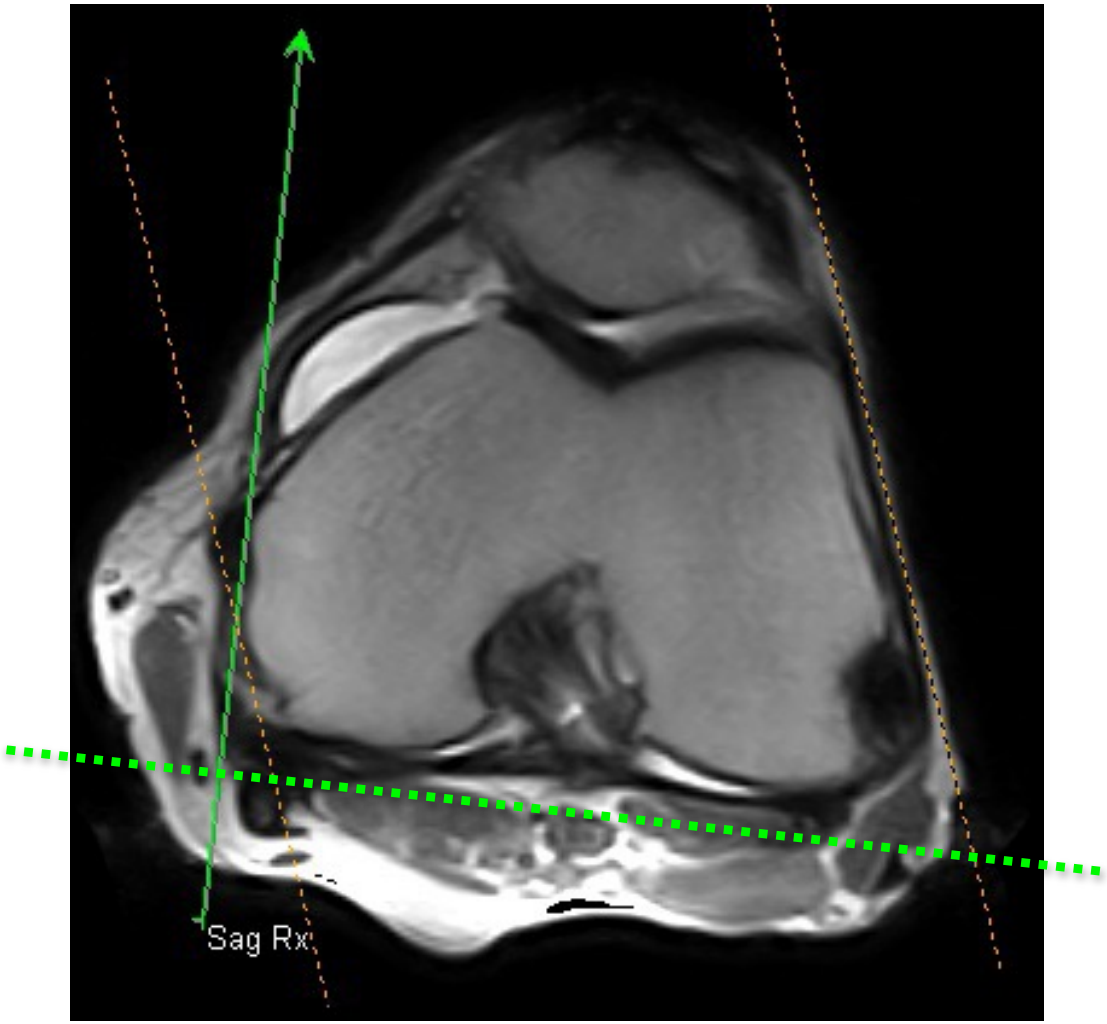


Knee Rx

tangential to posterior femoral condyles



Knee Rx - do NOT angle to ACL

Angle tangential to posterior femoral condyles (green lines are correct angle)
versus
tangential to ACL (dashed orange lines, incorrect angle)

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Knee Protocol

- Cor PD DIXON (or PD & fat sat PD)
- Sag PD & fat sat PD
- Axial fat sat PD

- for any hardware other than joint replacements, use the *post-op/ ACL protocol*
  - routine protocol **+ Sag STIR VAT**
  - Do *NOT* add VAT to PD's in knee (VAT blurs out cartilage)

- if patient has a mass, fracture, or anything that looks unusual **add an axial T1**

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Hip

Hip Protocol

- Small FOV protocol is designed to evaluate **FAI** (Femoral Acetabular Impingement), labral tear, internal derangement, AVN, tendon tear
- Do NOT use the FAI protocol to evaluate for fracture, mass, mets… use MRI Pelvis protocol.
- MRI Hip in elderly (>65 yrs) patients with recent trauma r/o hip fracture- Pelvis protocol should be used. Call Ortho rad to confirm.

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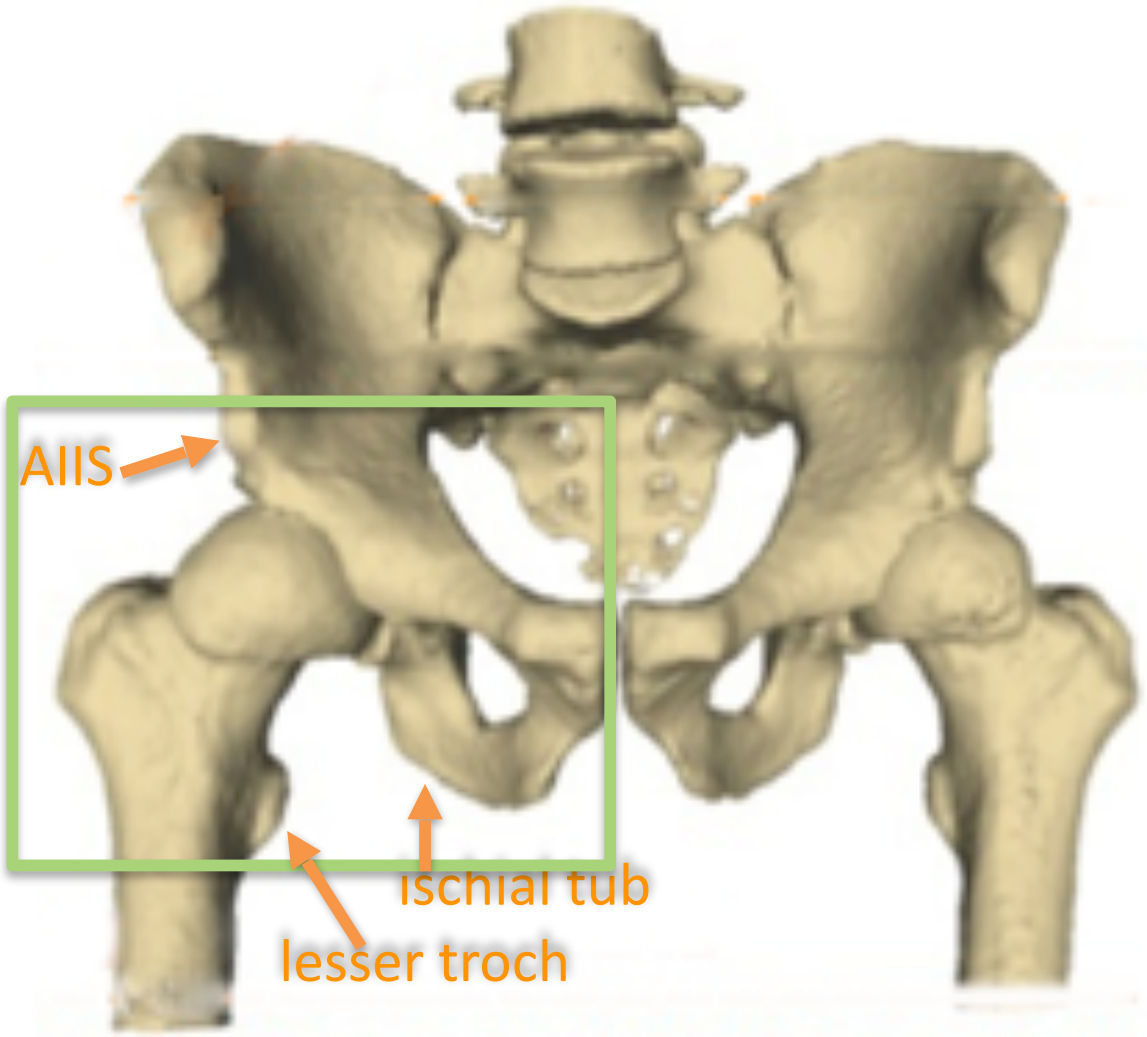

Anatomic borders to target for hip MRI

Superior to inferior: AIIS thru lesser trochanter

Medial to lateral: Greater trochanter thru ischial tuberosity

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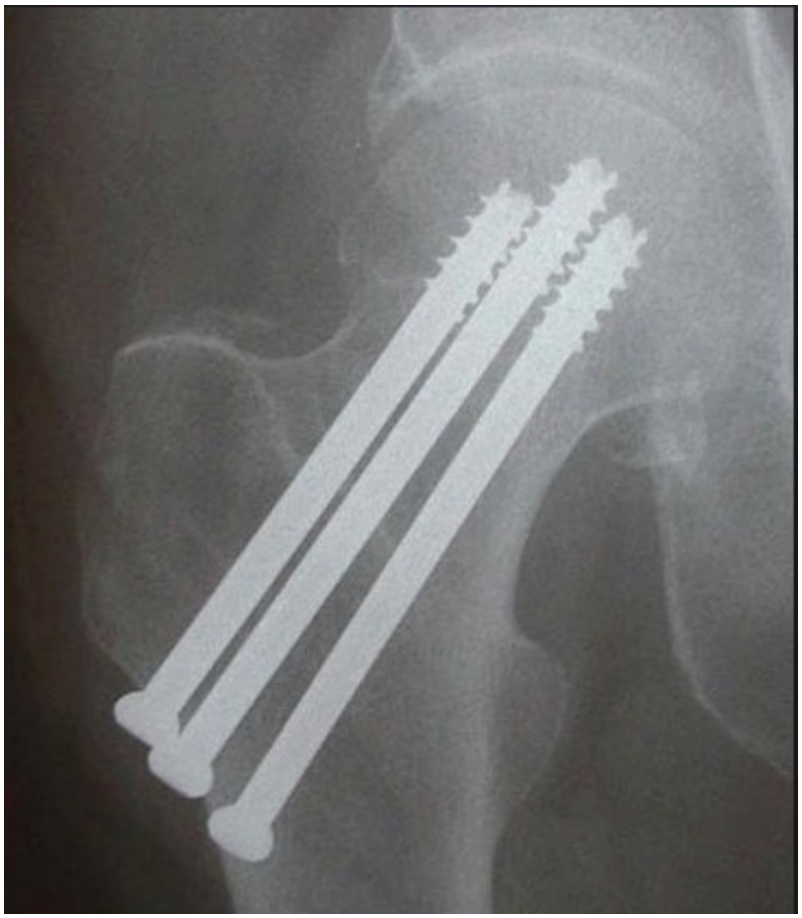

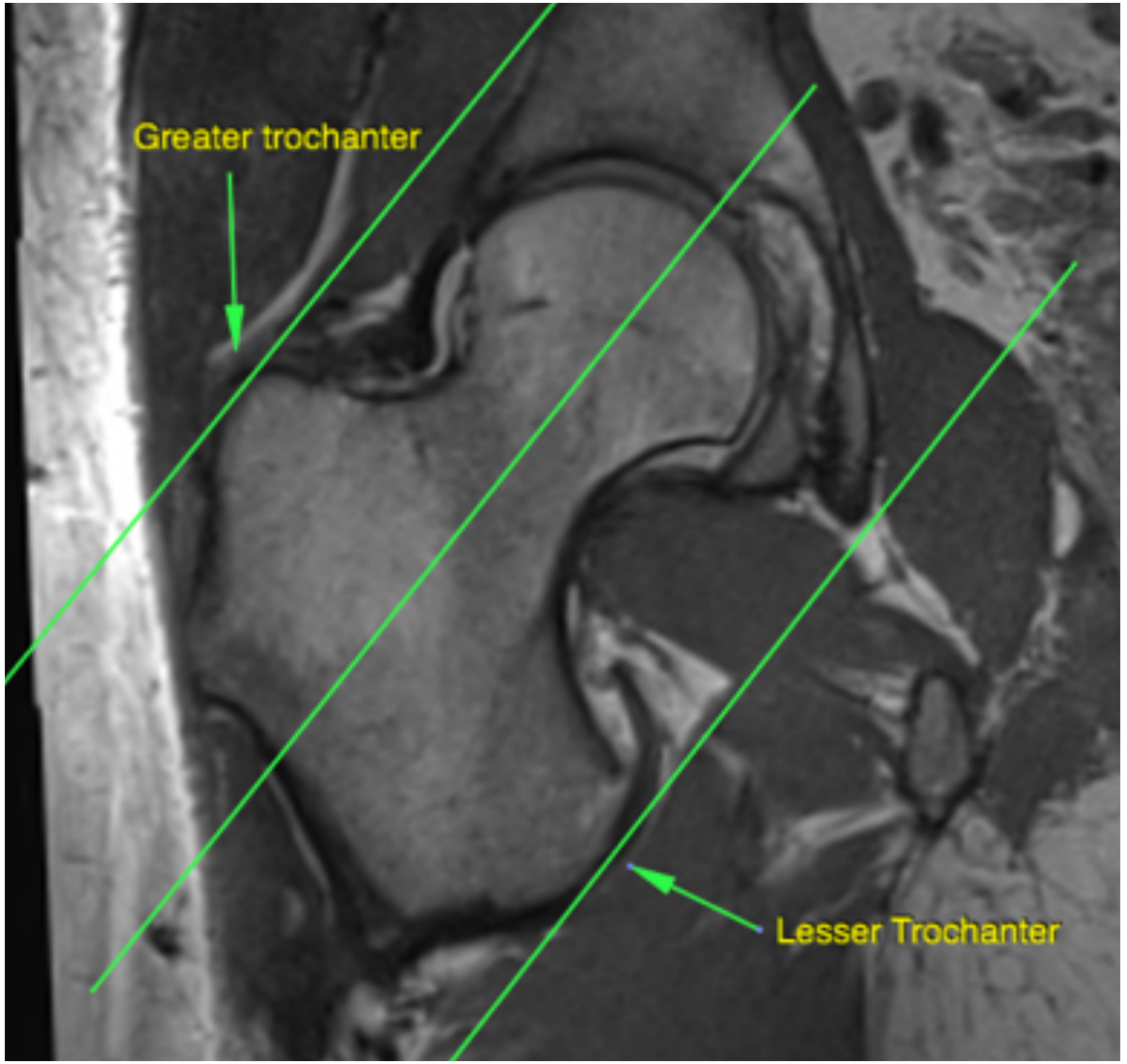

Oblique axial/sagittal

Rx parallel to long axis of femoral neck. Do not worry if steep Rx makes images flip.

* use straight axials for hip joint replacement

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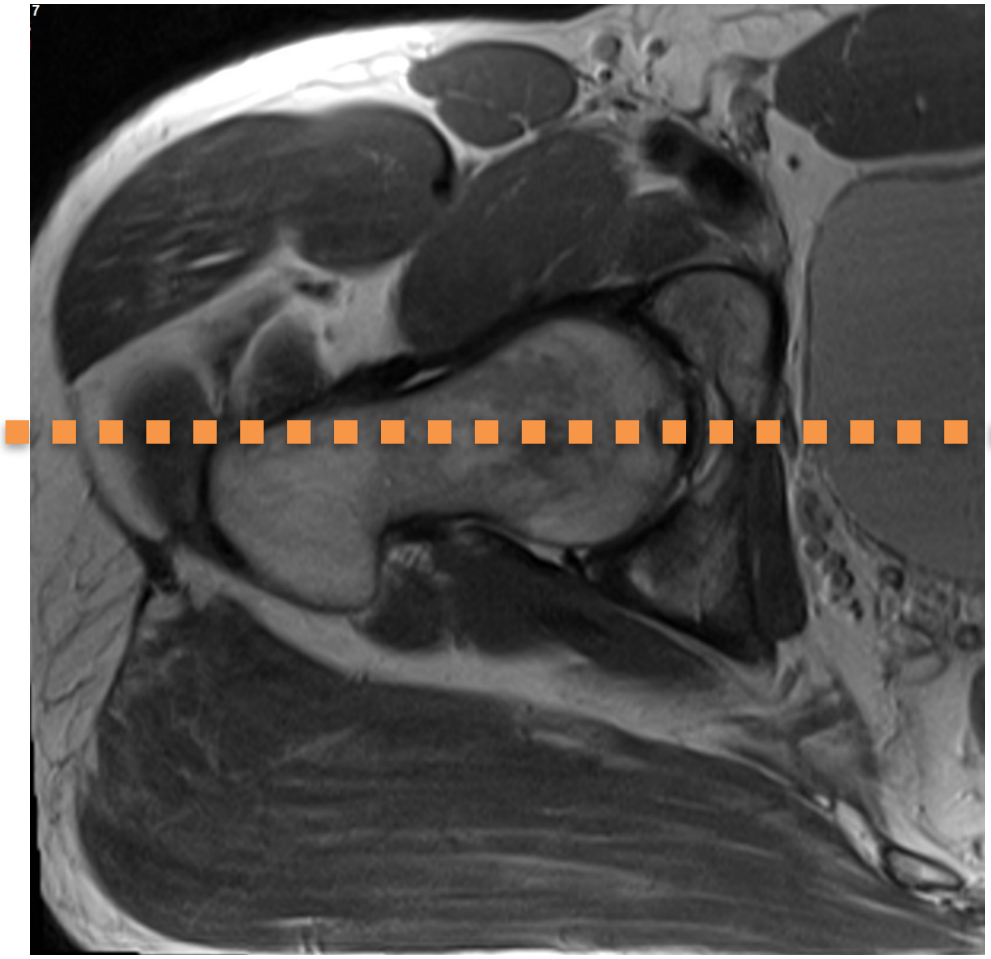

Coronal

Rx straight to pelvis; only angle if patient is tilted in scanner. Do not angle coronals to acetabulum or femur.

Include ischium through pubic symphysis

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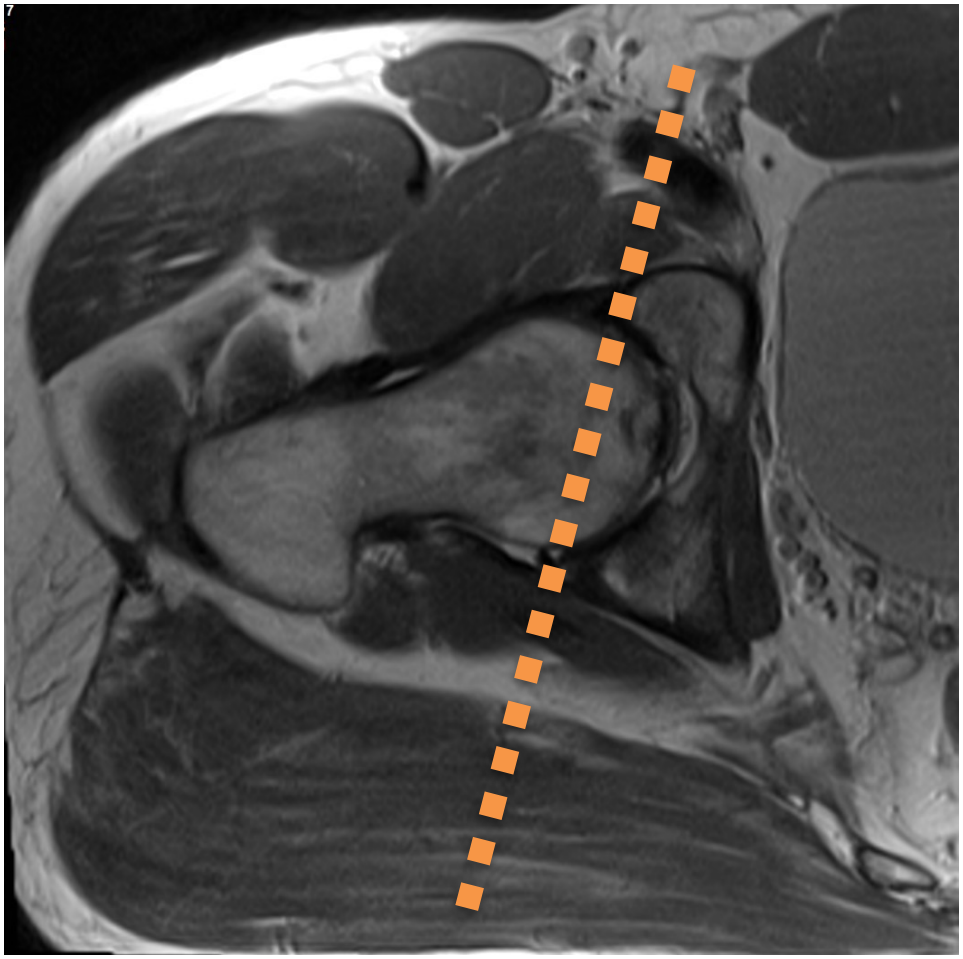

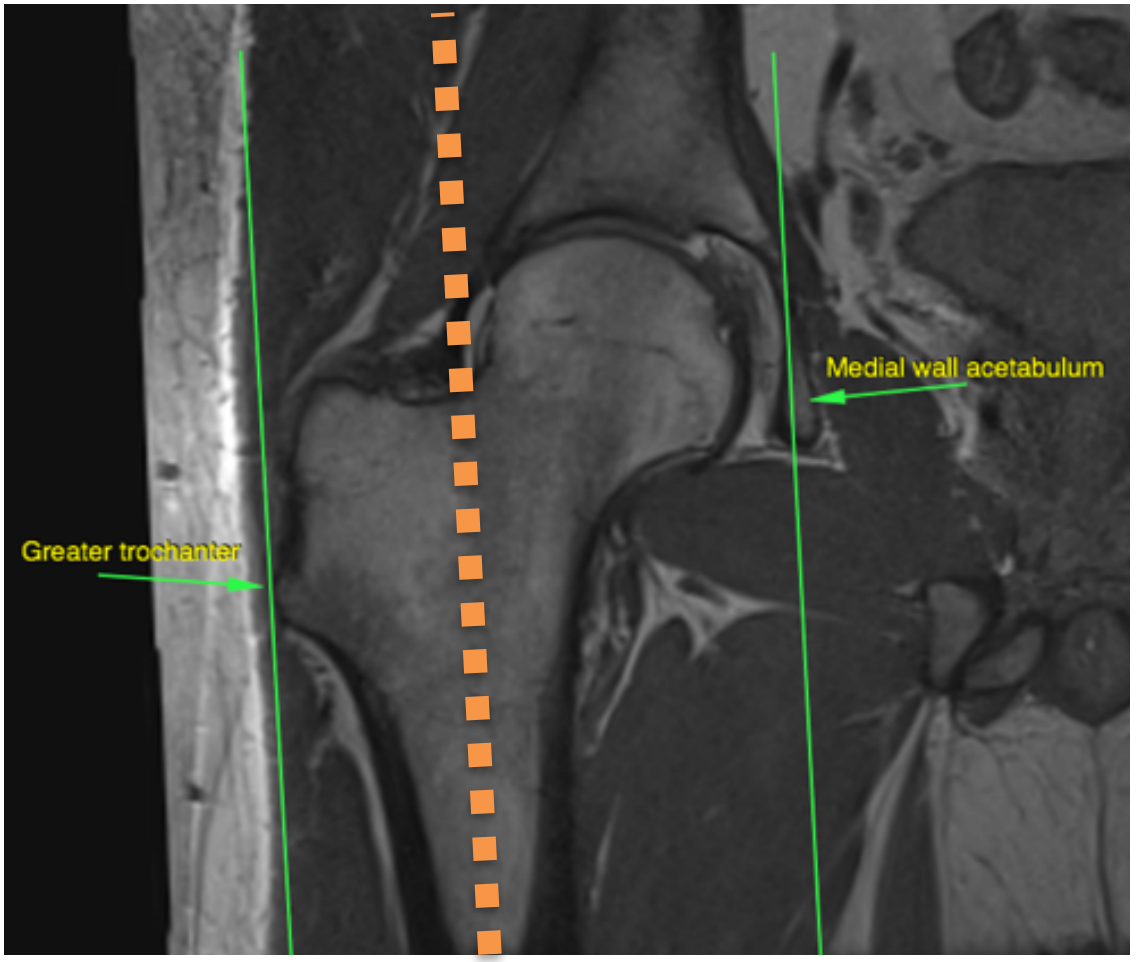

Sagittal Rx

Tangential to acetabular rim on Axial Rx
Parallel to femur on Coronal Rx
Include acetabulum through greater trochanter

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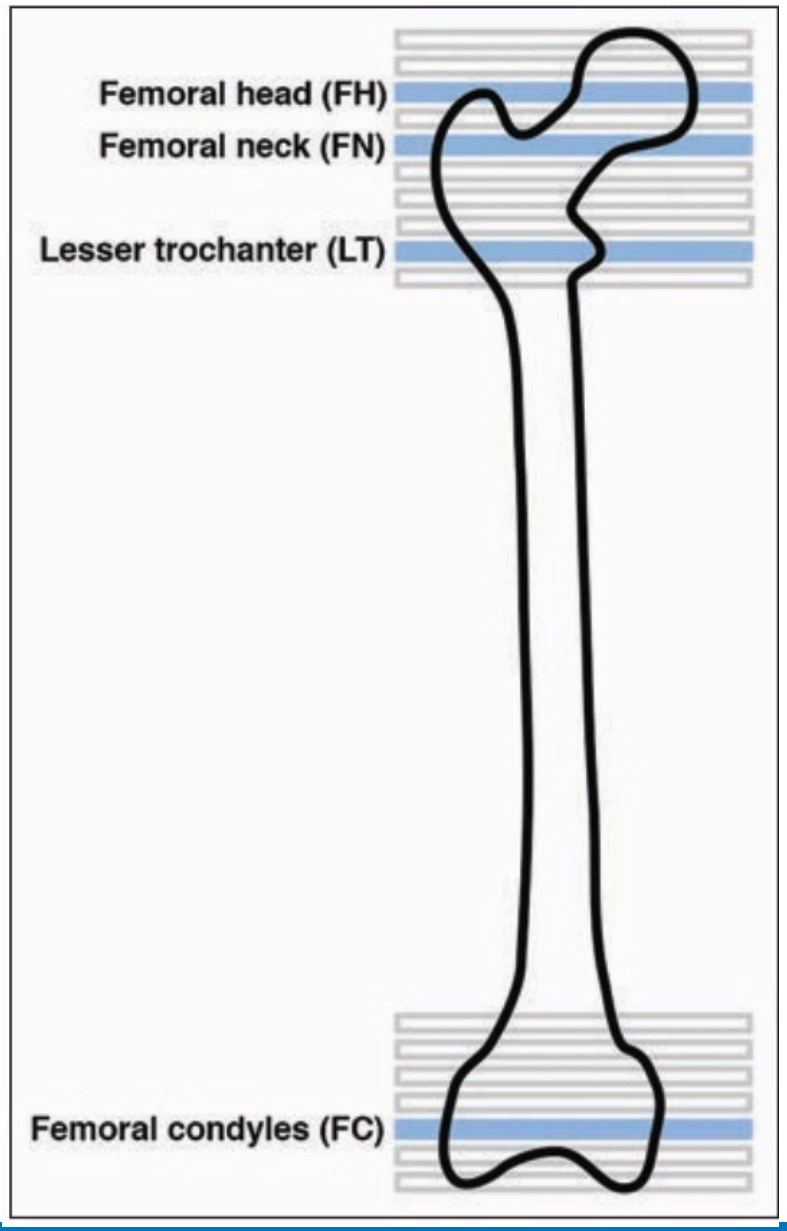
Hip Protocol
FAI with Femoral Version



Acquire two quick, 5mm straight axial HASTE sequences, one stack through the femoral neck and the other stack thru the femoral condyles of the knee.

Similar to CT Hip Preservation, it is essential that the patient does not rotate or move their hip or knee between the axial hip & axial knee sequences.

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Sports Hernia Protocol
aka
“athletic pubalgia”
for adductor tears

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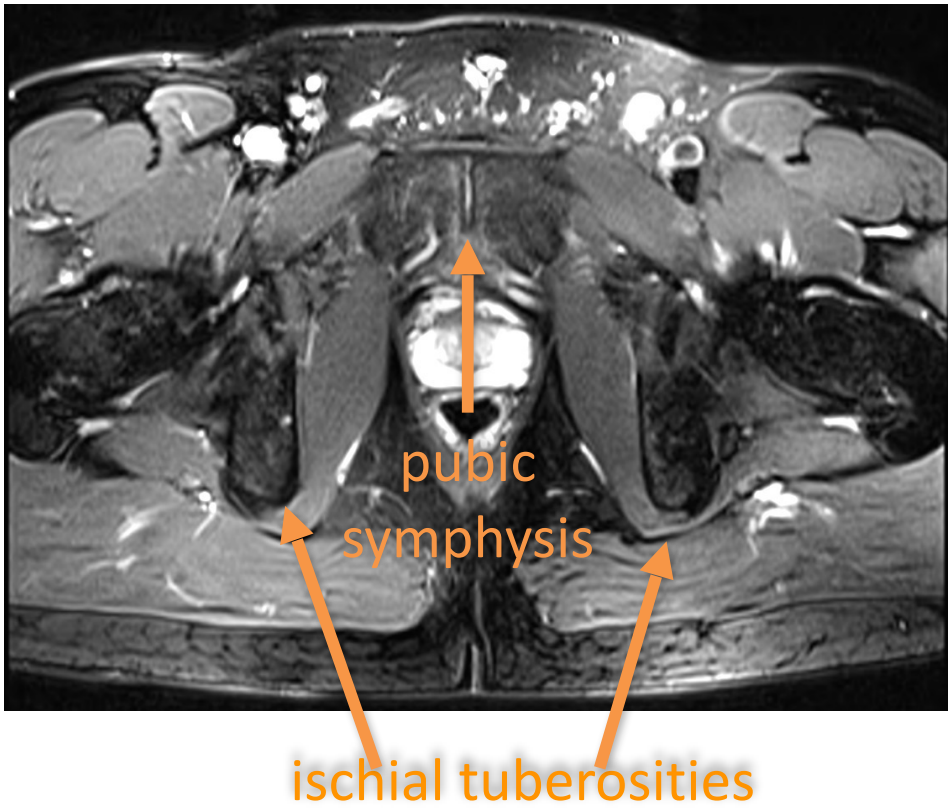
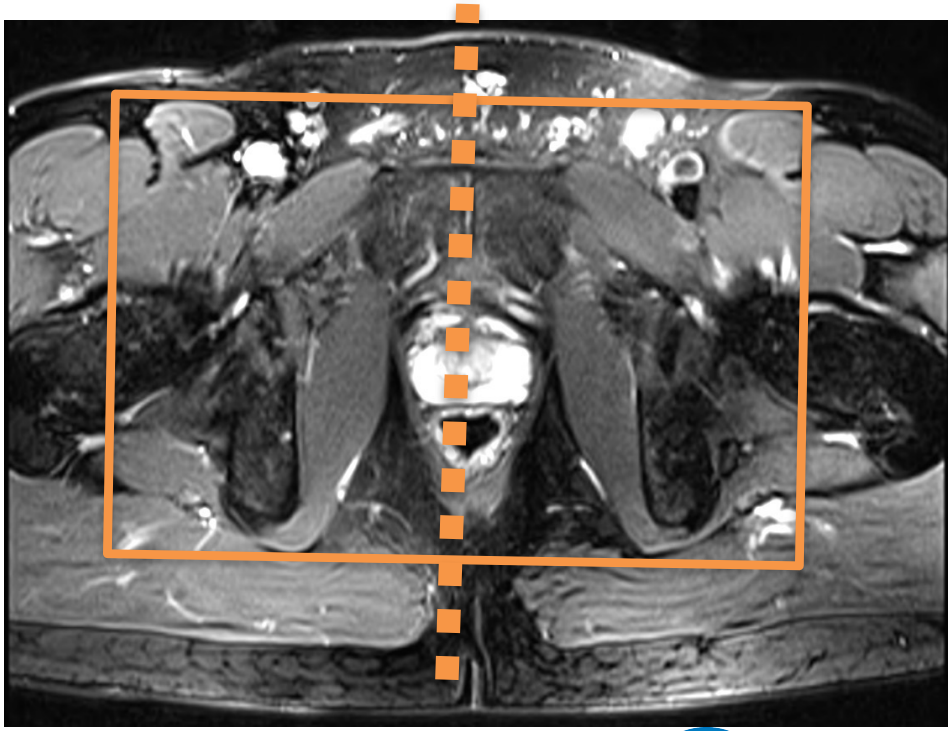
Sports Hernia

- Sagittal & Coronal: prescribe tangential to pubic symphysis
- include pubic symphysis anteriorly, ischial tuberosities laterally & posteriorly





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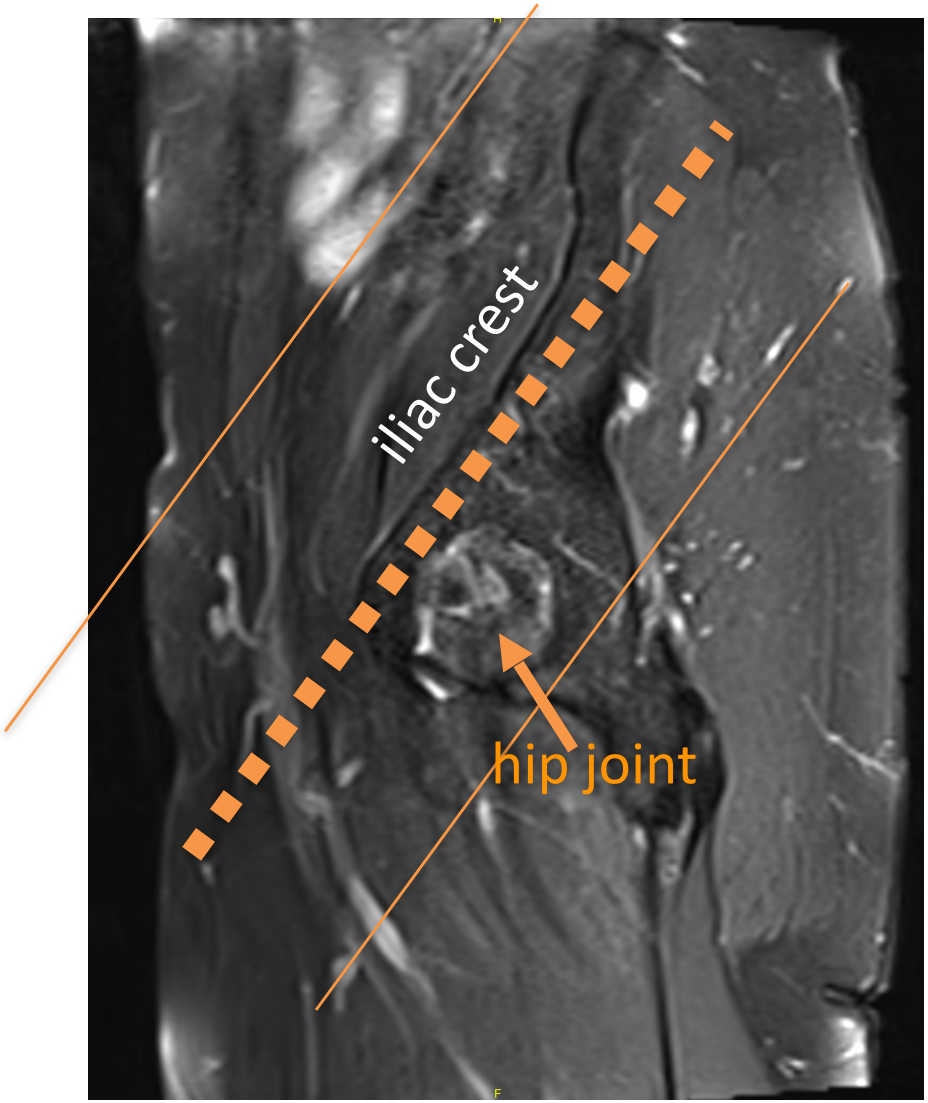

Oblique axial

Prescribe off Sag thru hip joint, parallel to anterior iliac crest
be sure to scan across pubic symphysis at midline

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Sports Hernia Protocol

- Cor T1
- Cor STIR
- Axial PD fat sat
- Sag PD fat sat
- Oblique axial PD
- Oblique axial PD FS

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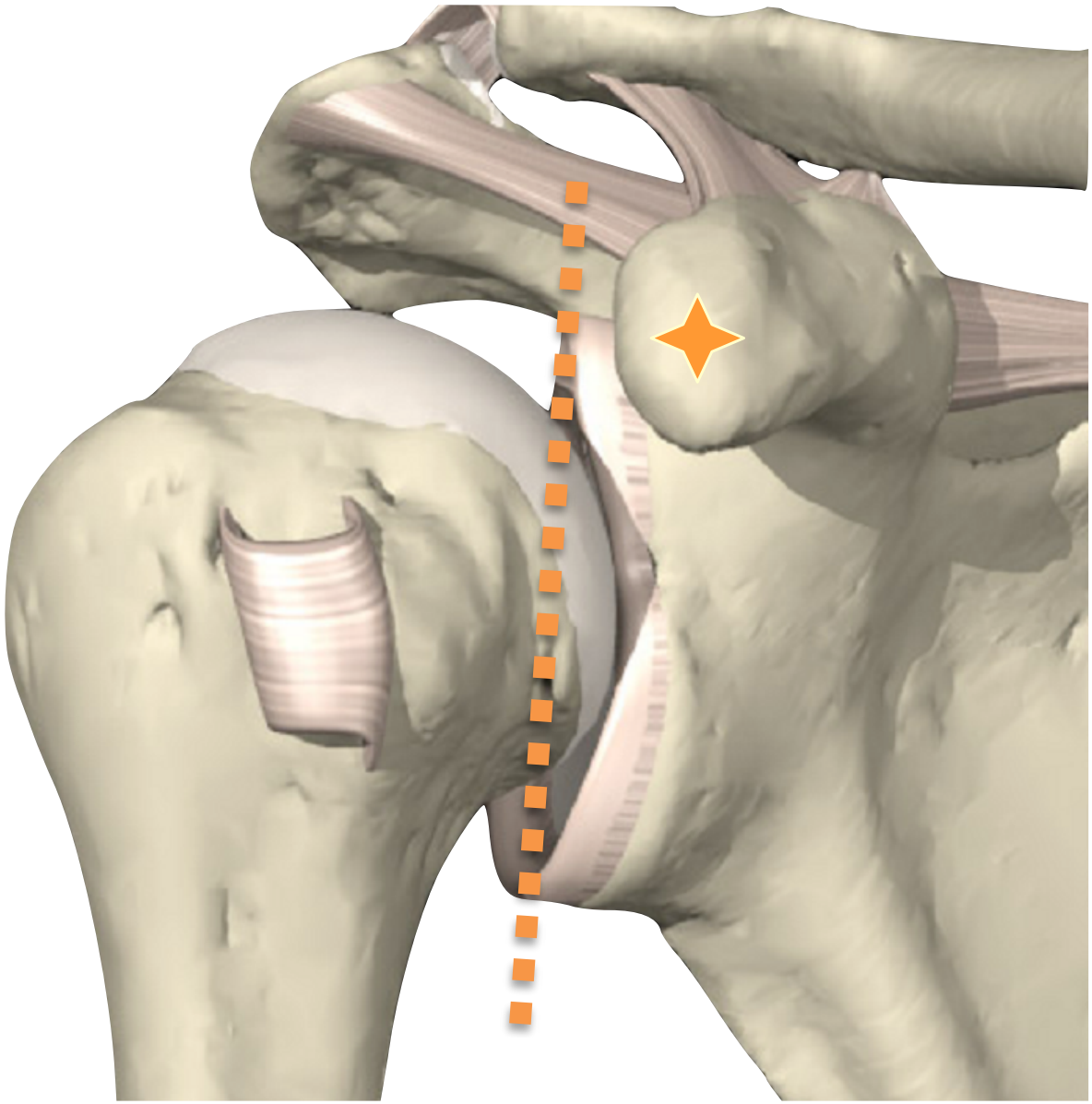
Shoulder



Central axis of shoulder - glenohumeral joint

- use coracoid process to help orient which direction is anterior

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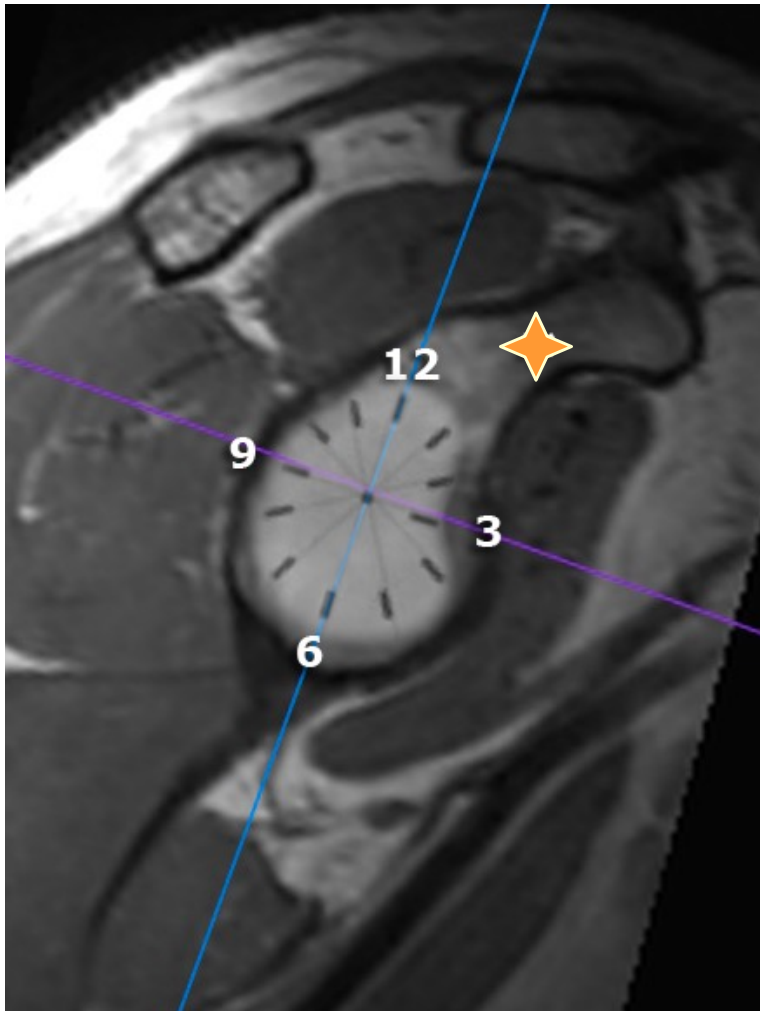

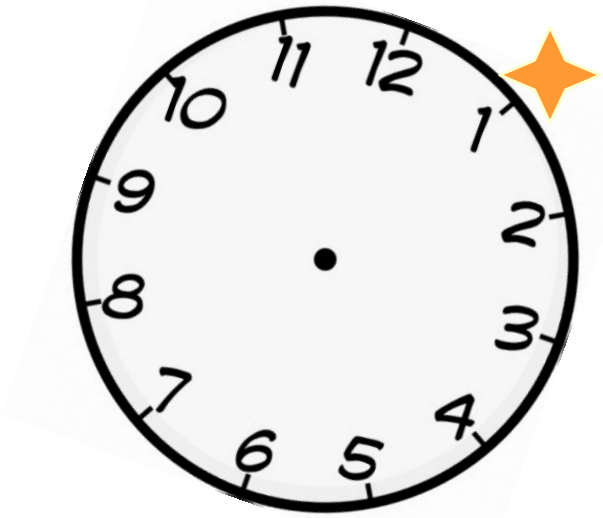

Glenoid clockface

coracoid = 1:00

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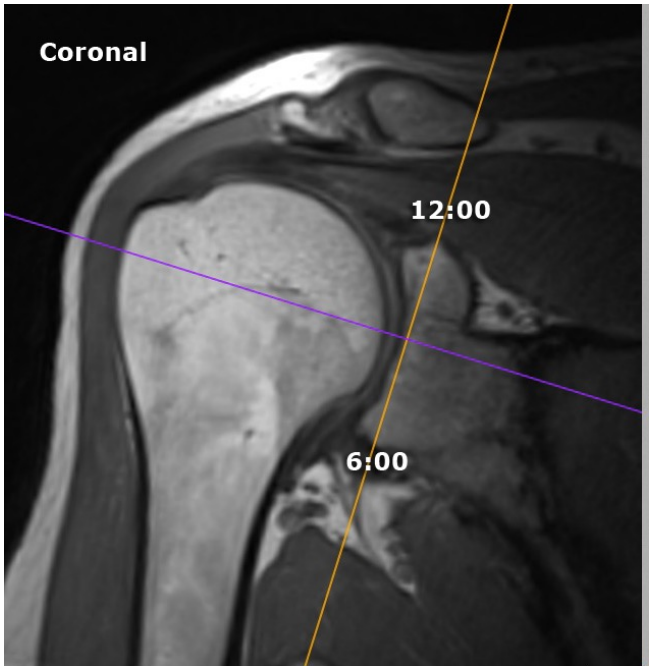
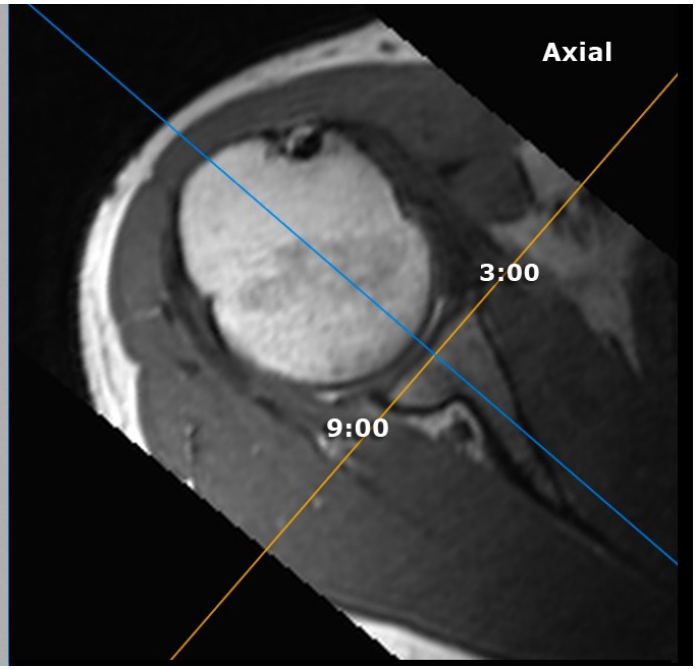
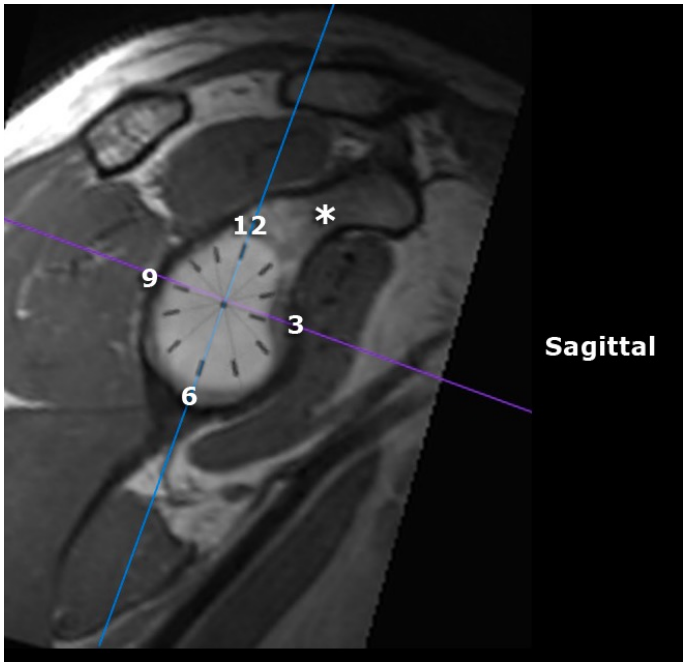
Shoulder Clockface Rx







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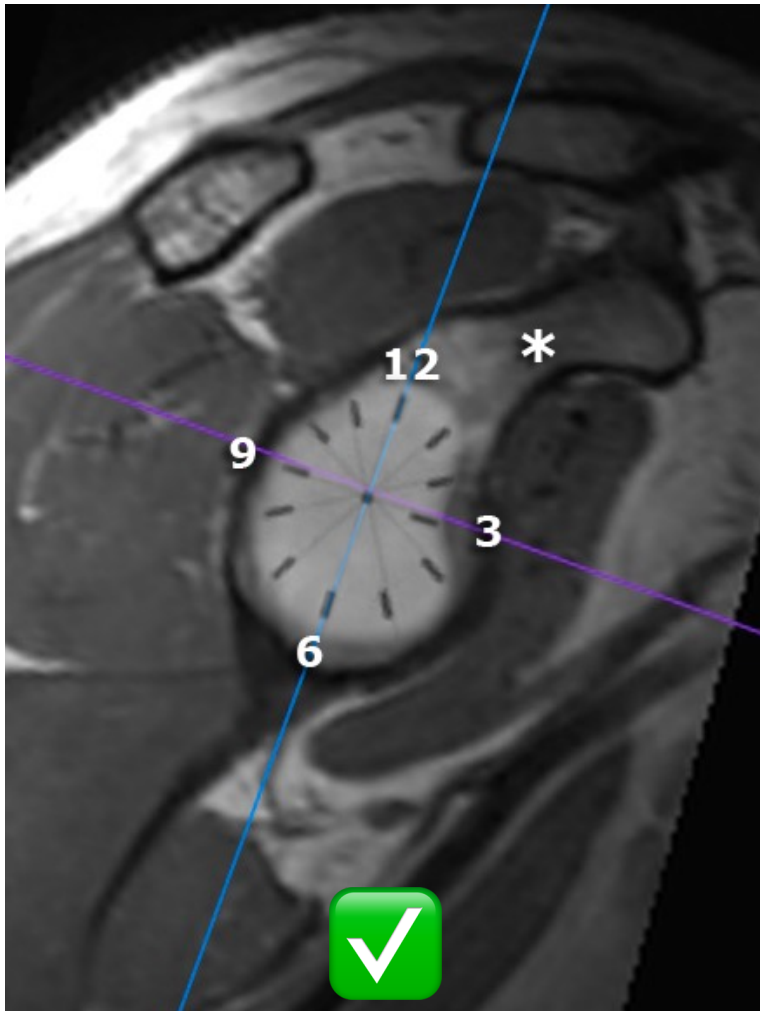
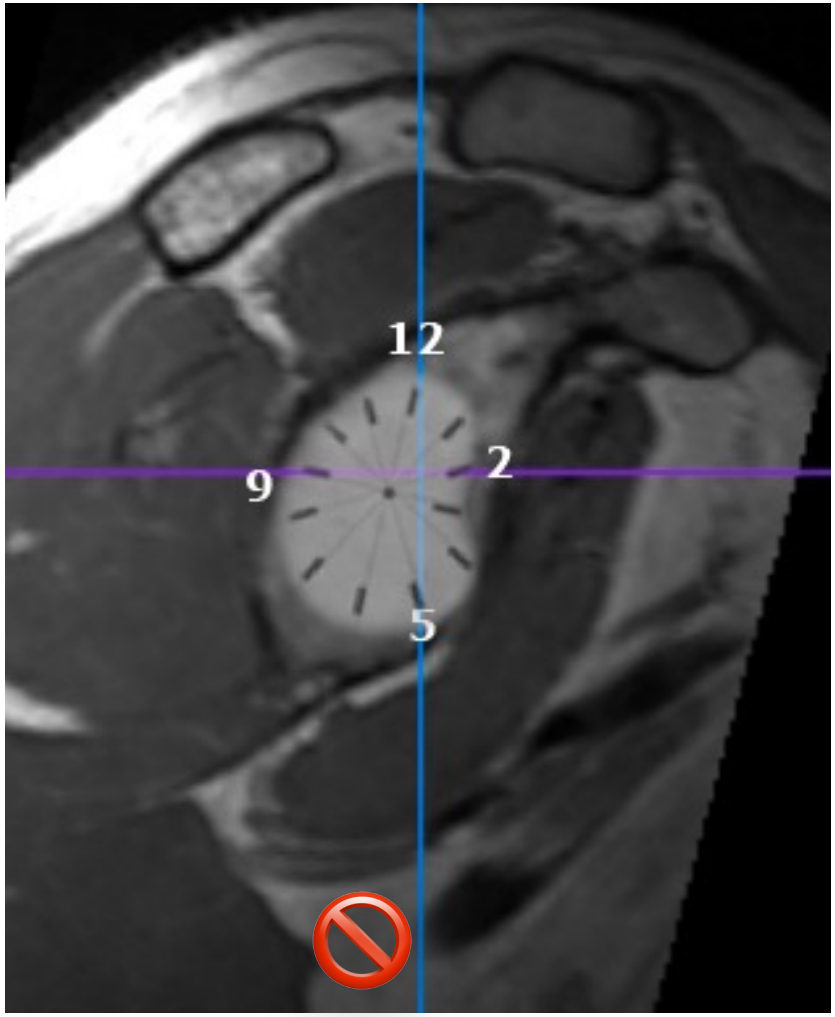


correct



incorrect

Glenoid clockface Rx vs straight Rx

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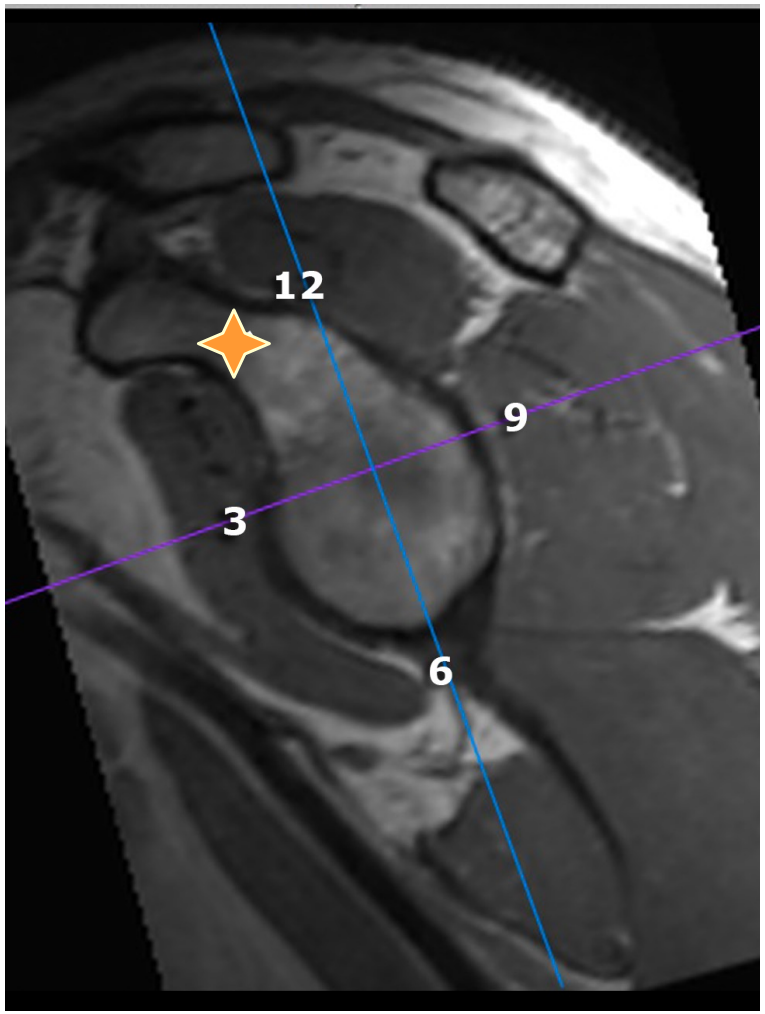

clock face flips between left & right shoulders; coracoid is always 1:00

Glenoid clock face

coracoid = 1:00

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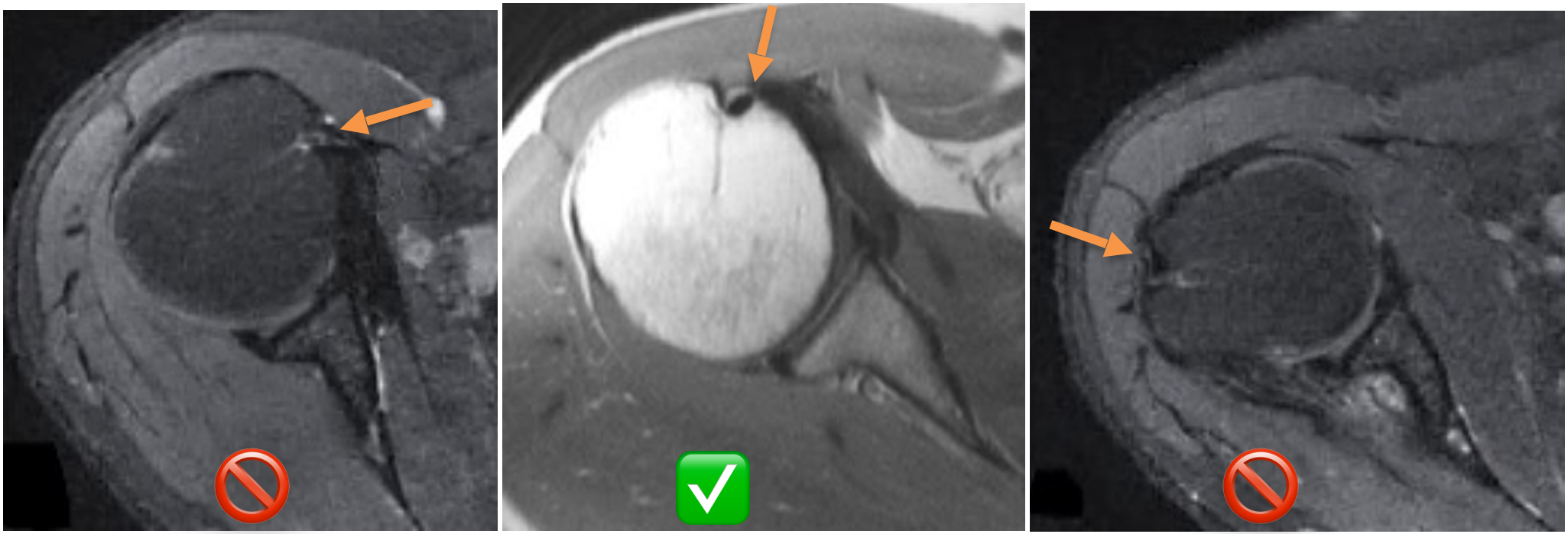

Position arm in neutral or mild external rotation, with thumb up.
Do not internally or over externally rotate.

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Shoulder Protocol

- Cor PD DIXON (or Cor PD + PD fat sat)
- Axial PD fat sat
- Sag T1 *(image medially thru scapular Y)*
- Sag PD fat sat

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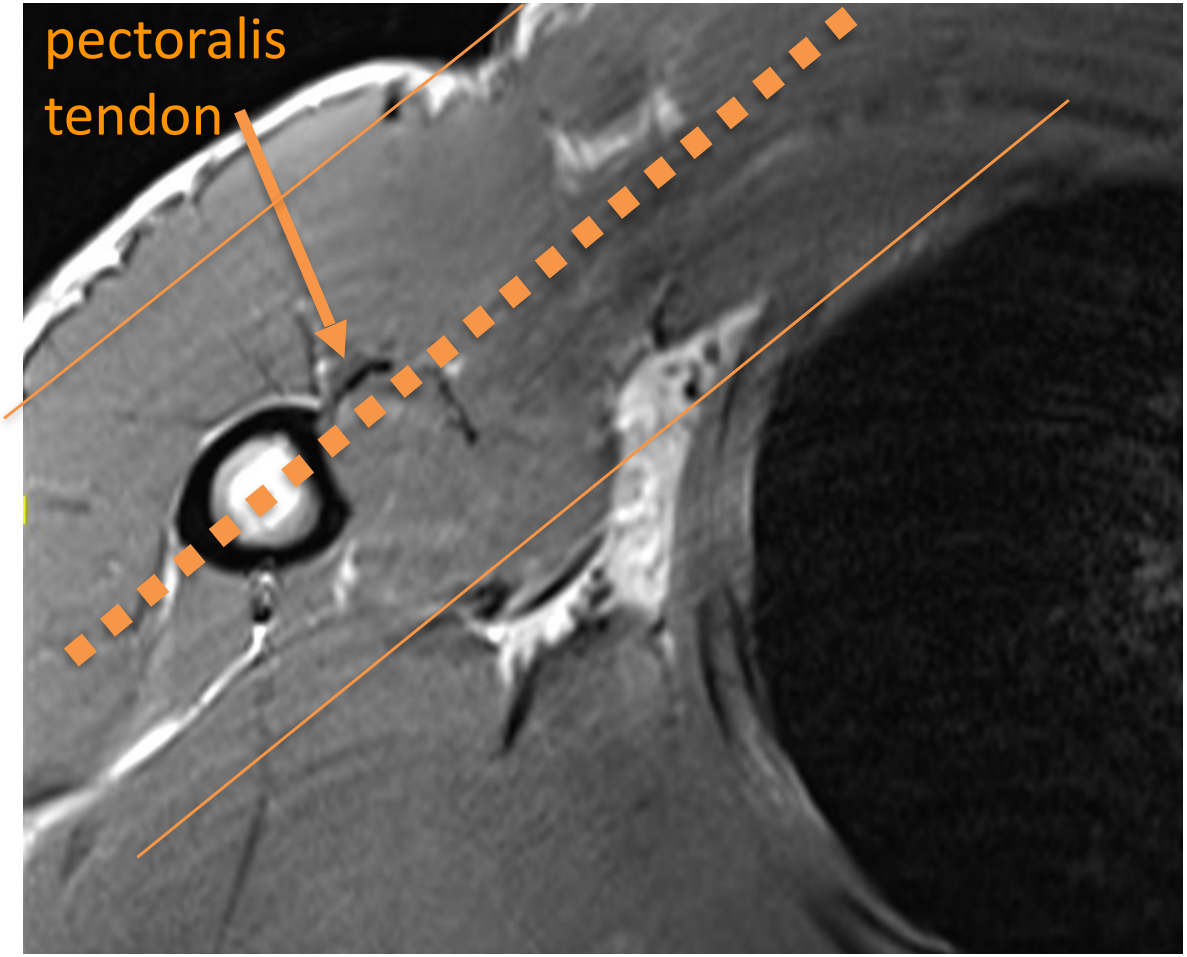
Pectoralis



Oblique coronal

Prescribe off an axial image, parallel to the pectoralis muscle

* The humeral attachment of the pectoralis tendon MUST be included on all series

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Pectoralis protocol

- Axial PD
- Axial STIR
- Oblique coronal PD
- Oblique coronal STIR

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Elbow

always include entire radial tuberosity

(distal biceps insertion)

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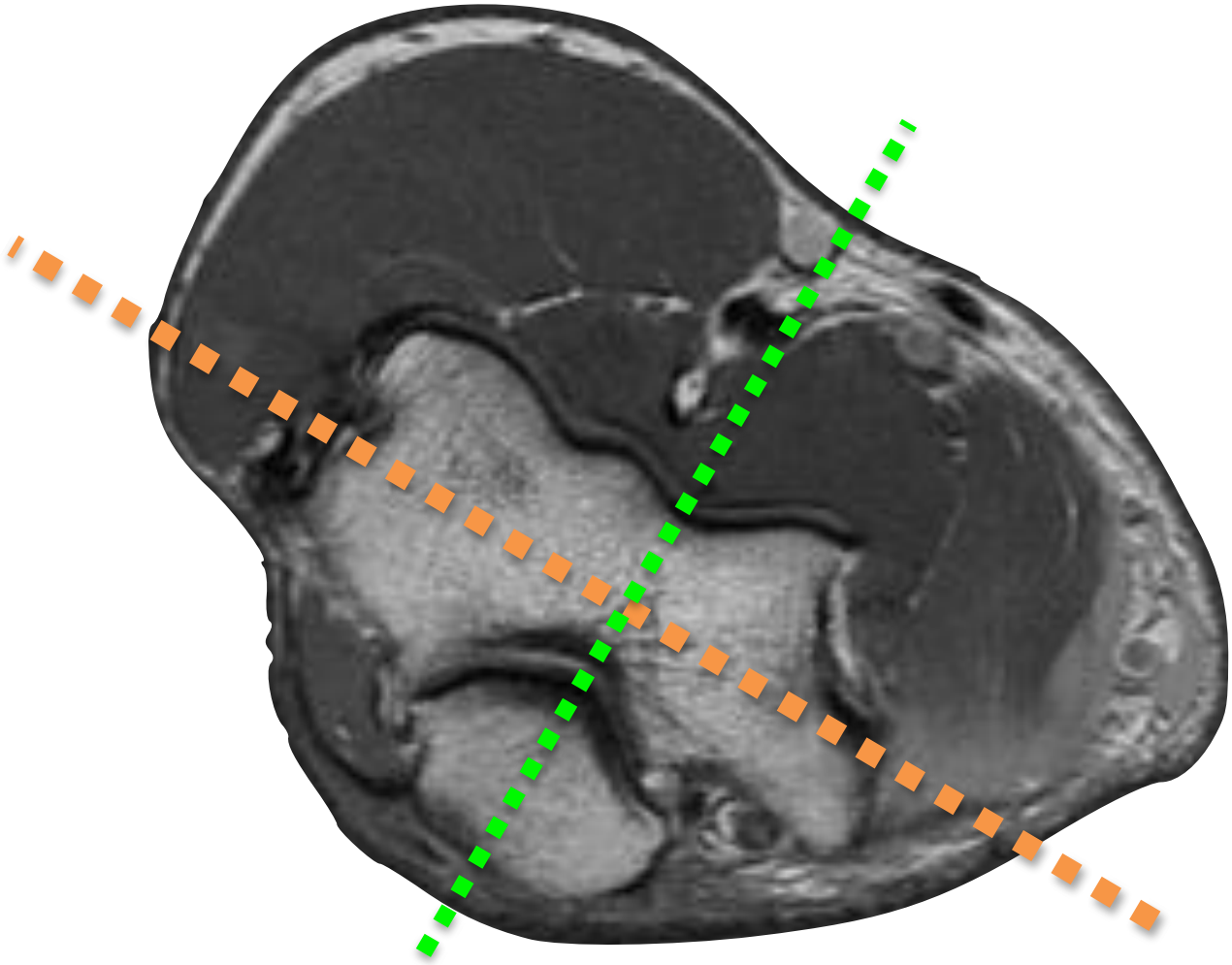

central axis of joint

bisects epicondyles

FABS position - use PD sequence to evaluate distal biceps tendon

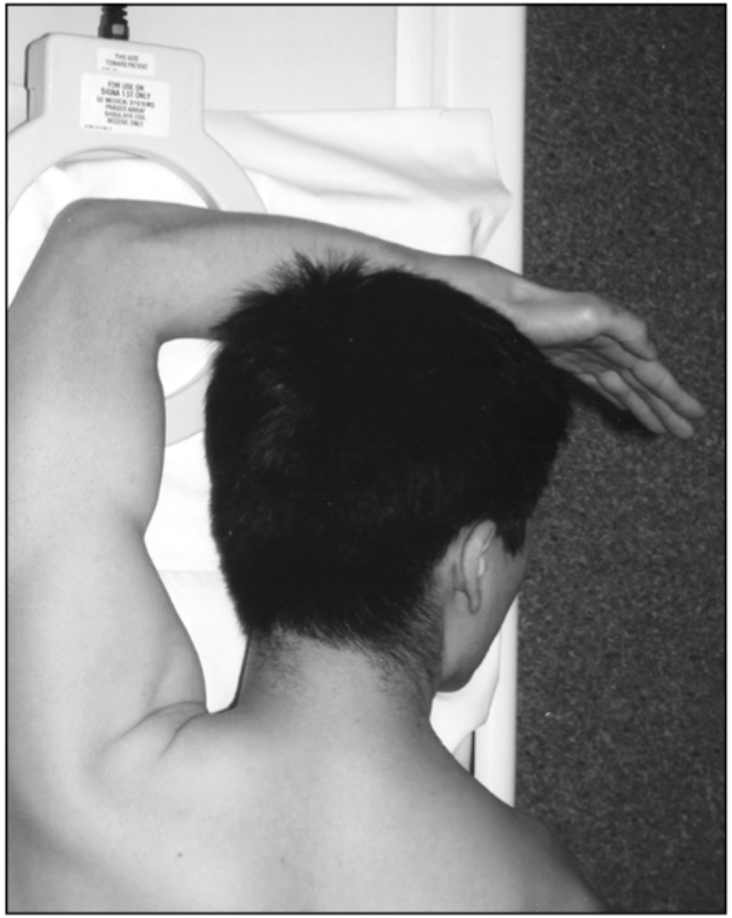

Fig. 1.—Photograph shows patient positioning for flexed abducted supinated view: patient is positioned prone on MRI table with elbow in flexed abducted supinated view position. Notice position of arm, flexed at elbow and abducted at shoulder with supinated forearm, thumb up.

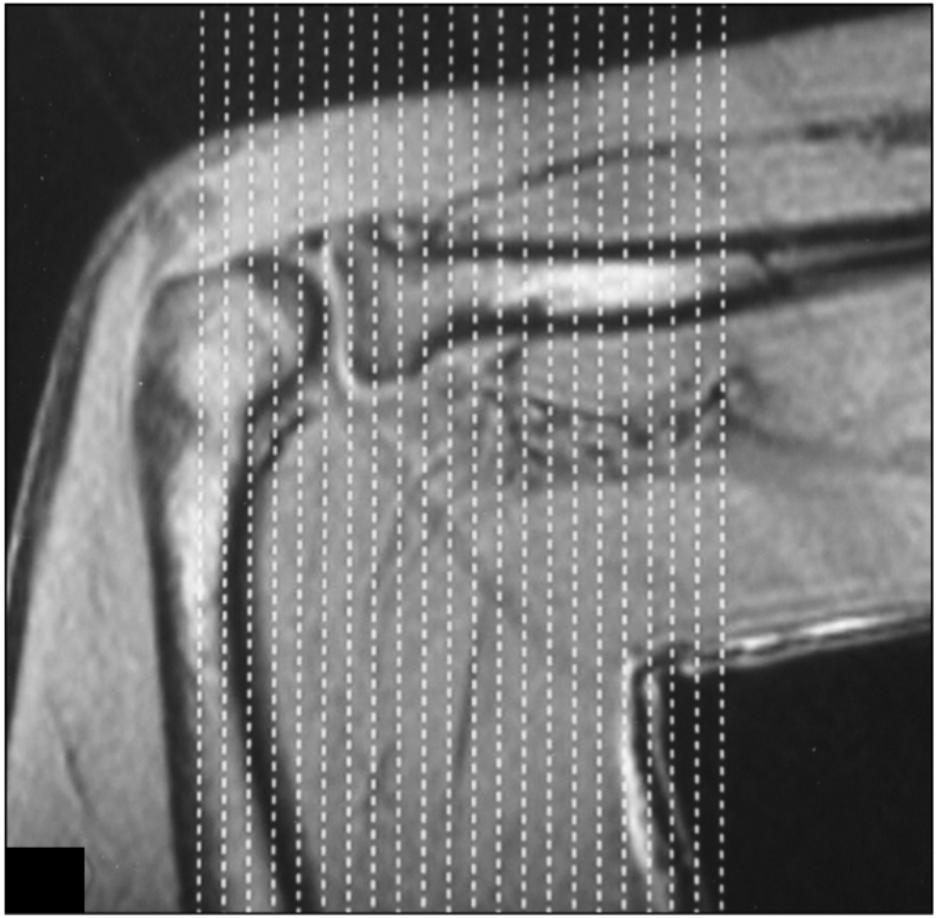

Fig. 2.—Localizer MR image with lines shows slice positioning for flexed abducted supinated view. Notice sections, sagittal to long axis of body but coronal to anatomy at elbow. Ideal angulation is planned along distal biceps brachii tendon, but often, as here, this structure is not clearly visible on localizer images. In this case, sections nearly perpendicular to radius provide reasonable and reproducible imaging plane.

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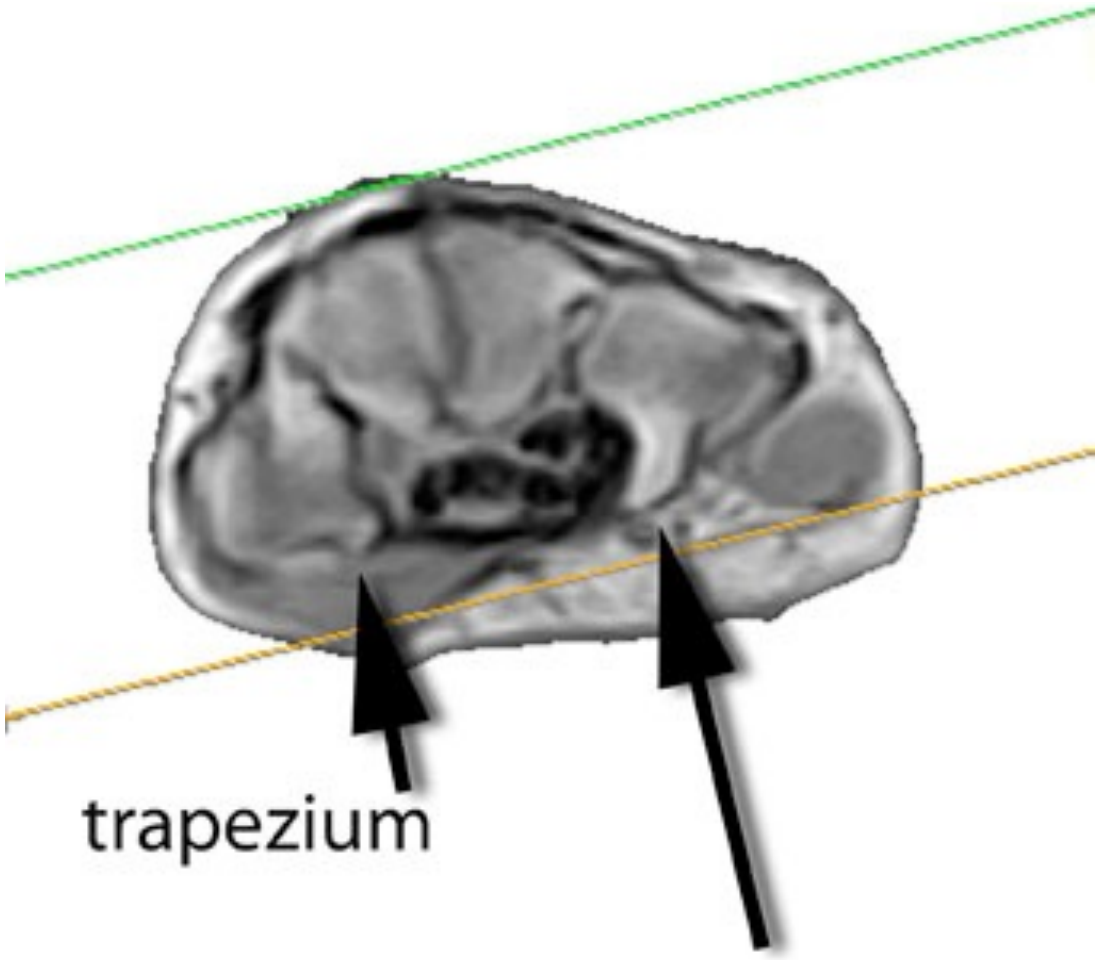
Wrist



Wrist

always include DRUJ

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Long Axis (oblique axial/sagittal) MPR thru Scaphoid

- Use for all CT wrists att: scaphoid

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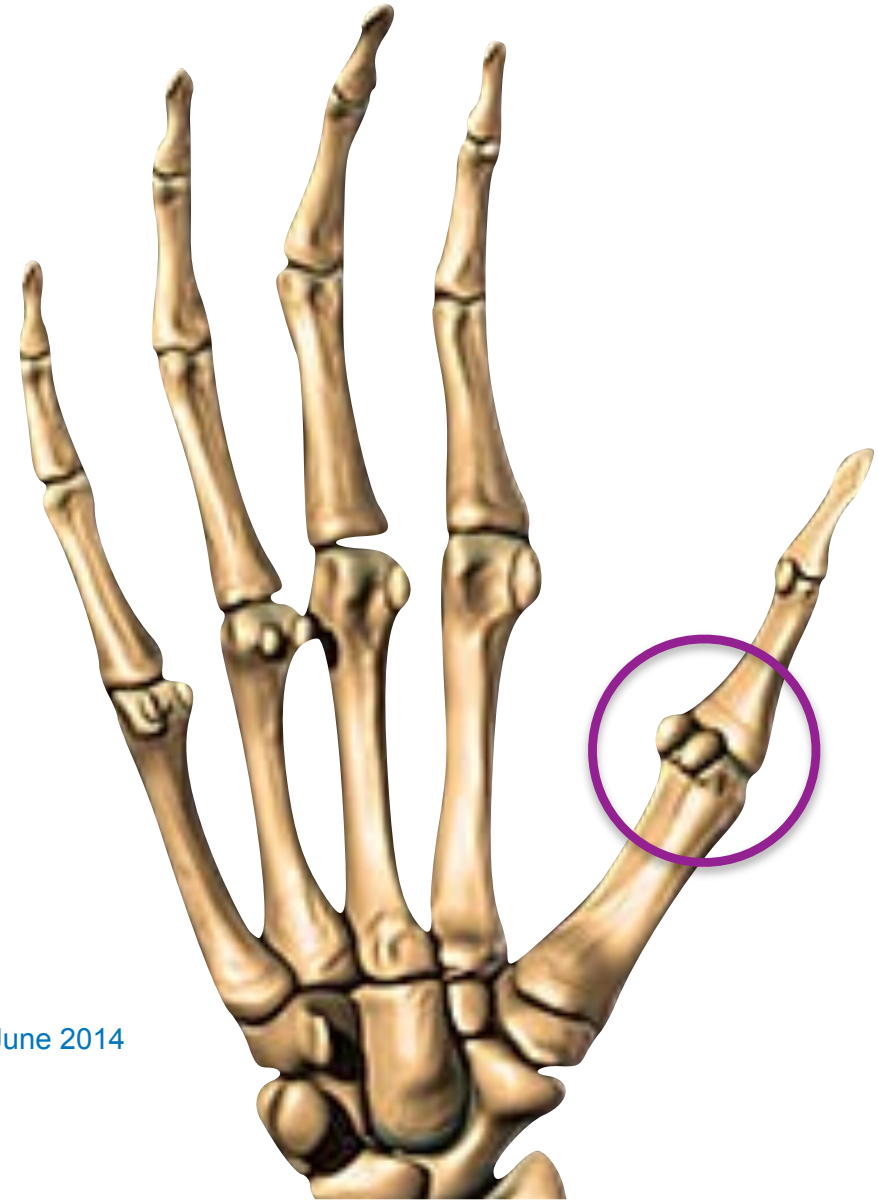
Thumb



E Chu, D Resnick.
MRI Web Clinic — June 2014

Center of axis: thumb MCP sesamoid bones

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Center of axis: thumb MCP sesamoid bones

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MSK Protocol Guidelines

- If fat sat is inhomogeneous (eg- off isocenter AOI) use STIR
- Masses & bone lesions - always include a T1 sequence
- For infection, use T1 and STIR sequences in all 3 planes. Use contrast for infxn above the ankle.
- When using contrast to evaluate a mass, always do pre- & post-gadolinium axial fat sat T1. For masses, include at least one T1 and one T2 fat sat sequence.
- Do not repeat DIXON, use faster PD/PS FS or T1/STIR sequences
- PD parameters: TR 3500-4500/TE 35-45; TF 7-11
- STIR: TE 50-60; TI: 160 @ 1.5T; 220 @ 3T

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Long bone protocol

- only image affected extremity
- always compose the Coronal & Sagittals if more than one acquisition
- Coronal T1
- Coronal STIR
- Sagittal DIXON PD or (T1 + T2 fat sat)
- Axial T1
- Axial STIR

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Metal Artifact - MRI

- Knee- all hardware except joint replacement (“post-op/ACL”)
  - routine protocol with fat saturation (do *not* use PD VAT)
  - add Sag STIR VAT
- Offensive metal artifact
  - Use STIR instead of fat sat when fat suppression is inhomogeneous
  - Use high kHz
- use PD instead of T2*
- use VAT for significant artifact (other than knee PD’s)
- only use SEMAC when evaluating a prosthesis

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Metal Artifact - MRI Knee

- Specifically in the knee, do NOT replace PD sequences with PD VATs if the patient has an intact native joint since VATs blur out cartilage pathology

- The following 3 protocols are appropriate 99% of the time in patients with metal in their knee:

  1) Total knee arthroplasty - use the TKA protocol

  2) Unicompartment knee arthroplasty- use the Hemiarthroplasty protocol

  3) For ALL other knees with hardware, use the “post-op/ACL” protocol (routine + Sagittal STIR VAT).

- If you think an exam would benefit from MARS sequences, add VATs *after* running the post-op/ACL protocol.

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Metal Protocol - CT

- Turn off CareDose
- Pitch 0.8
- kVP 140
- mAs - increase a lot
- Minimize photon attenuation from contralateral anatomy whenever possible (eg- when scanning a RT TKA , always bend the LT knee out of way)
- Use iMAR on soft tissue window axials only. Do not use iMAR on bone window data.
- Add transparent metal 3Ds when there is metal hardware

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CT MSK Protocol

- ST algorithm data in axial plane
- Bone algorithm data MPRs in all 3 planes
  - Hip- use oblique axial MPRs
  - Wrist- add MPR thru long axis of scaphoid for exams attn: scaphoid
- 3D VRTs
- Always position anatomy to minimize #slices needed (eg - position wrist/hand coronal to scanner with hand over head, elbow flexed & thumb up)
- CT without and with contrast is never indicated; do with only

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CT MSK Protocol - slice thickness

- MPRs for CT scans of joints should always be < 3 mm
  Please follow general guidelines below. If you feel the anatomy/ pathology you are imaging would be better seen with even thinner slices, then please feel free to do so.

- Shoulder- 2.0 mm
- Elbow- 2.0 mm
- Wrist- 1.5 mm
- Hand- 1.5 mm

- Hip- 2.5 mm
- Knee- 2.5 mm
- Ankle- 2.0 mm
- Foot- 2.0 mm

- Long Bones- 2.5mm

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