Skagit RADIOLOGY INCORPORATED PROFESSIONAL SERVICES	**MSK: MR Protocols**		
	Reviewed: Updated	Date: 12/1/2025	
	Revised: Dr. Knott	Date: 12/1/2025	

Joint-based protocols:

MSK 1: Shoulder MRI

MSK 1A: Shoulder MR arthrogram

MSK 1AB: Shoulder MR arthrogram (instability protocol)

MSK 2: Elbow MRI

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MSK 3: Wrist MRI

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MSK 5: Pelvis and hip MRI

MSK 5A: Hip MR arthrogram

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MSK 8: Forefoot MRI

MSK 8M: Pre- and post-contrast foot MRI (Morton's neuroma protocol)

Non-joint-based protocols:

MSK 9: Pre- and post-contrast upper extremity, lower extremity, *or* pelvis MRI (tumor/mass, infection protocol)

MSK10: MR neurography

MSK11: Upper extremity *or* lower extremity MRI without contrast (long bone evaluation)

MSK12: Thoracic spine, lumbar spine, and pelvis MRI without contrast (bone marrow survey)

MSK13: Pre- and post-contrast hand MRI (arthritis protocol)

MSK14: Chest MRI without contrast (pectoralis protocol)

MSK15: Pelvic MRI without contrast (athletic pubalgia/sports hernia protocol)

MSK16: Chest and Body Wall MRI (Mass protocol)

MSK17: Sternum MRI

MSK 18: Sternoclavicular Joint MRI

MSK 19: Scapula MRI

Technical note: minimum matrix numbers for any sequences should be in general around 256 (avoid matrices of 192 or less in square FOV's)

MSK 1: Shoulder MRI

Indications: shoulder pain, internal derangement, rotator cuff tears, proximal long head of the biceps pathology, acromioclavicular joint pain or dislocation

Sequences: shoulder in *external* rotation.

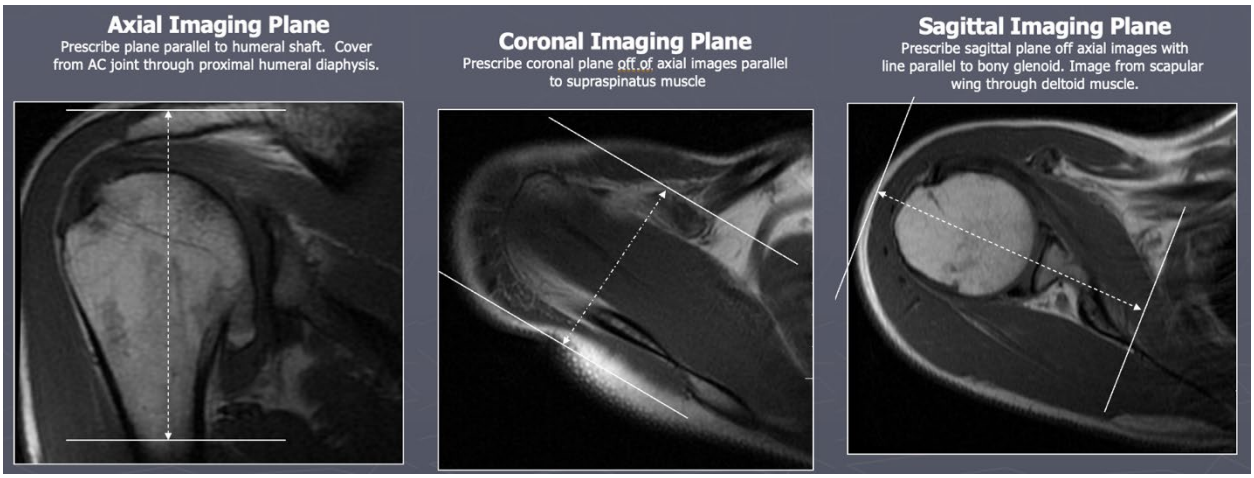
- *Oblique coronal T2 FSE with fat saturation* [3.0 mm thick, 0.6 mm gap]
- Oblique sagittal T1 SE
- Oblique sagittal T2 FSE with fat saturation
- Axial T2 FSE with fat saturation

For pre- and post-contrast exams, add the following:

- *Non-contrast* oblique coronal T1 SE with fat saturation.
- *Post-contrast*: oblique coronal, oblique sagittal, axial T1 SE with fat saturation.

Positioning:

- Axial = Plane parallel to the humeral shaft. Cover AC joint through proximal humeral diaphysis
- Coronal = parallel to the long axis of supraspinatus from the axial plane. Should be perpendicular to the glenoid.
- Sagittal = based off axial images with line parallel to the scapular wing through the deltoid



Comments:

- Good for diagnosing rotator cuff tears; less effective for labral pathology.
- T2 FSE with fat saturation: adjust TE to 40 msec (+/-5 msec).

MSK 1A: Shoulder MR arthrogram

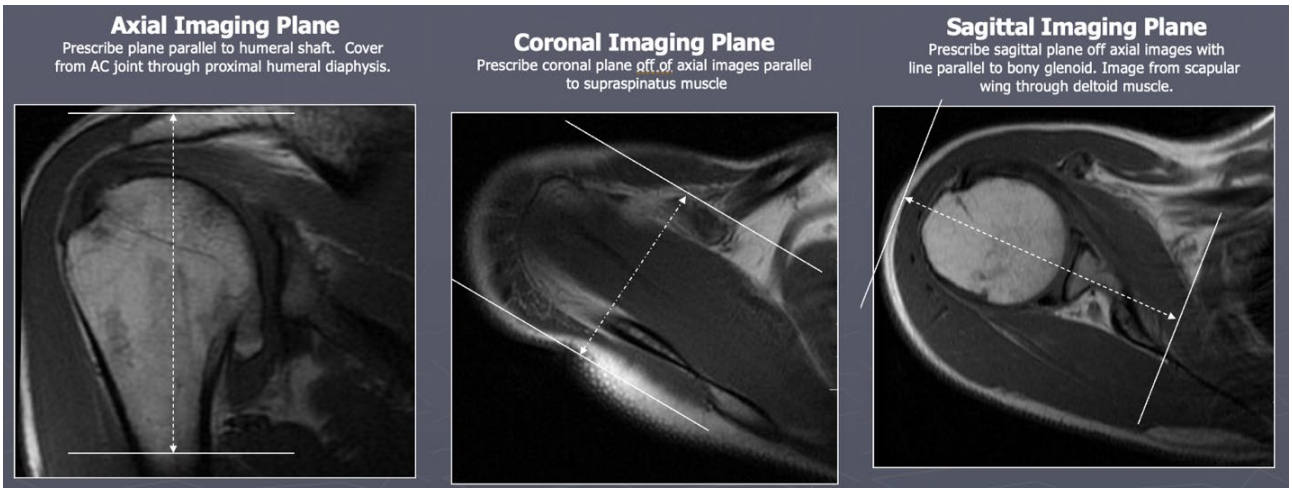
Indications: postoperative patients, rotator cuff tears, labral pathology, prior shoulder dislocation with Bankart lesion evaluation

Sequences: shoulder in *external* rotation

- Axial T1 SE with fat saturation
- Oblique coronal T1 SE with fat saturation
- *Oblique coronal T2 FSE with fat saturation* [3.0 mm thick, 0.6 mm gap]
- Oblique sagittal T1 SE with fat saturation
- Oblique sagittal T1 SE
- Oblique sagittal T2 FSE with fat saturation

Positioning:

- Axial = Plane parallel to the humeral shaft. Cover AC joint through proximal humeral diaphysis
- Coronal = parallel to the long axis of supraspinatus from the axial plane. Should be perpendicular to the glenoid.
- Sagittal = based off axial images with line parallel to the scapular wing through the deltoid



Comments:

- Good for both rotator cuff and labral pathology.
- T2 FSE with fat saturation: adjust TE to 40 msec (+/-5 msec).

MSK 1A: Shoulder MR arthrogram

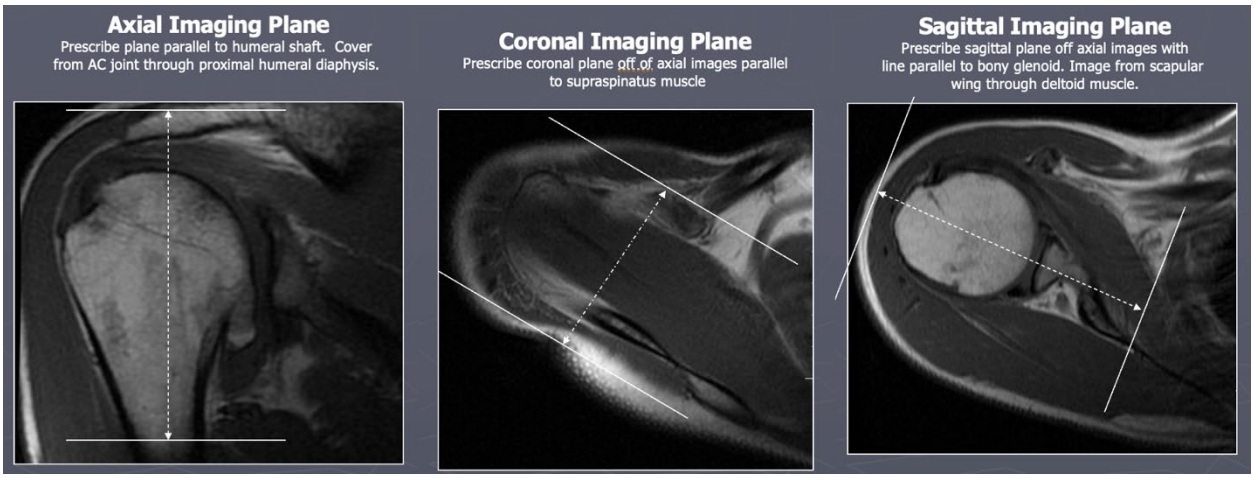
Indications: postoperative patients, rotator cuff tears, labral pathology.

Sequences: shoulder in *external* rotation

- Axial T1 SE with fat saturation
- Oblique coronal T1 SE with fat saturation
- *Oblique coronal T2 FSE with fat saturation* [3.0 mm thick, 0.6 mm gap]
- Oblique sagittal T1 SE with fat saturation
- Oblique sagittal T1 SE
- Oblique sagittal T2 FSE with fat saturation

Positioning:

- Axial = Plane parallel to the humeral shaft. Cover AC joint through proximal humeral diaphysis
- Coronal = parallel to the long axis of supraspinatus from the axial plane. Should be perpendicular to the glenoid.
- Sagittal = based off axial images with line parallel to the scapular wing through the deltoid



Comments:

- Good for both rotator cuff and labral pathology.
- T2 FSE with fat saturation: adjust TE to 40 msec (+/-5 msec).

MSK 1AB: Shoulder MR arthrogram (instability protocol)

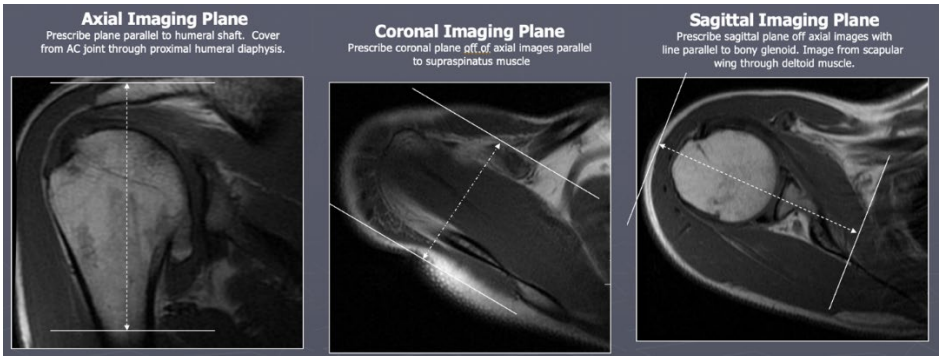
Indications: antero-inferior labral pathology, shoulder dislocation/instability.

Sequences: shoulder in *external* rotation

- Axial T1 SE with fat saturation
- Oblique coronal T1 SE with fat saturation
- *Oblique coronal T2 FSE with fat saturation* [3.0 mm thick, 0.6 mm gap]
- Oblique sagittal T1 SE with fat saturation
- Oblique sagittal T1 SE
- Oblique sagittal T2 FSE with fat saturation
- ABER T1 SE with fat saturation (Do NOT routinely perform. Should only be performed if ABER view is specifically requested by an orthopedic surgeon).

Positioning:

- Axial = Plane parallel to the humeral shaft. Cover AC joint through proximal humeral diaphysis
- Coronal = parallel to the long axis of supraspinatus from the axial plane. Should be perpendicular to the glenoid.
- Sagittal = based off axial images with line parallel to the scapular wing through the deltoid



Comments:

- Added sequence with shoulder in **Ab**duction **E**xternal **R**otation puts traction on the anteroinferior labrum and inferior glenohumeral ligament, diagnosing pathology resulting from anterior shoulder dislocations.
- Added benefit of assessing articular-surface rotator cuff tendon tears.
- T2 FSE with fat saturation: adjust TE to 40 msec (+/-5 msec).

MSK 2: Elbow MRI

Indications: pain, internal derangement, distal biceps or triceps tear, common extensor or common flexor tendon injury, medial or lateral epicondylitis.

Sequences: elbow supinated at side or overhead while prone.

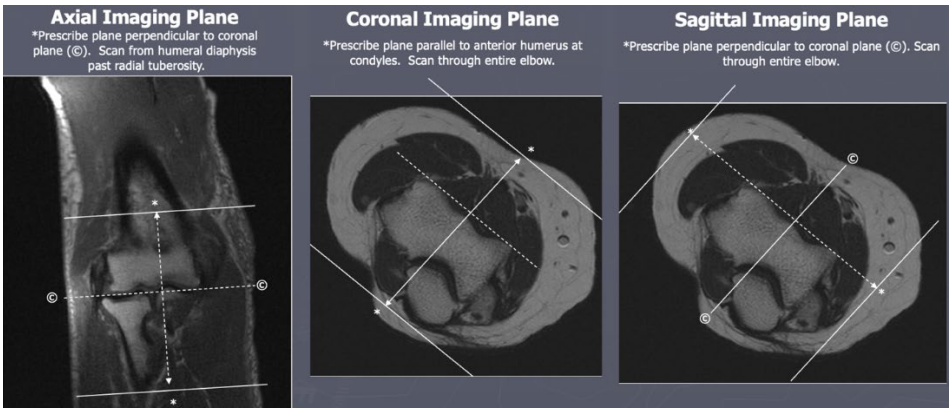
- Coronal T1 SE
- Coronal PD FSE
- *Coronal T2 FSE with fat saturation* [384 x 269 matrix, 3.0 mm thickness, 0.6 mm gap]
- Axial T1 SE
- Axial T2 FSE with fat saturation
- Sagittal T2 FSE with fat saturation

For pre- and post-contrast exams, add the following:

- *Non-contrast* coronal T1 SE with fat saturation.
- *Post-contrast*: coronal, sagittal, axial T1 SE with fat saturation.

Positioning:

- Coronal = parallel to the anterior humerus at the condyle. Scan through entire elbow (distally through the radial tuberosity)
- Axial = plane perpendicular through the humerus distal articular surface through the capitellum and trochlea based off the coronal images
- Sagittal = plane perpendicular to the coronal plane based off axial images



Comments:

- Make sure that axial sequences go distally enough to encompass the biceps tendon insertion onto the radius.
- T2 FSE with fat saturation: adjust TE to 40 msec (+/-5 msec).

MSK 2A: Elbow MR arthrogram

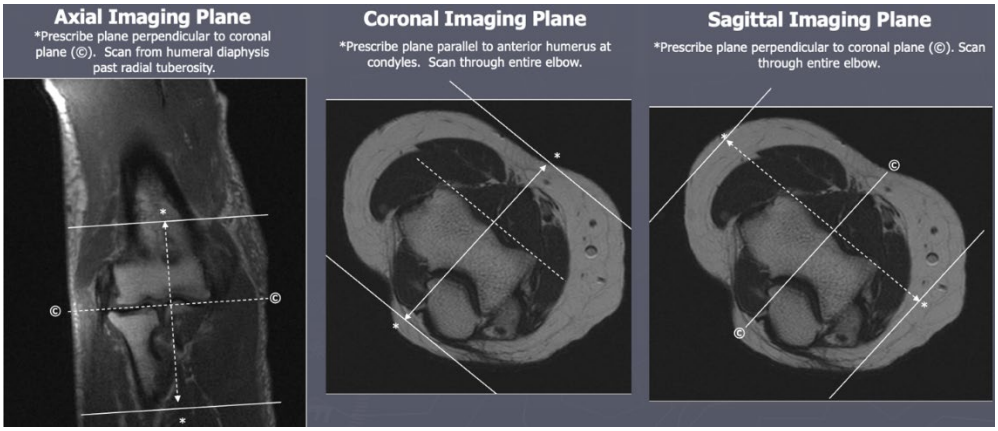
Indications: pain, internal derangement, osteochondral defect, radial or ulnar collateral ligament tear, post operative patient with evaluation for repeat ligament tear.

Sequences: elbow supinated at side or overhead while prone.

- Coronal T1 SE with fat saturation
- *Coronal T2 FSE with fat saturation* [384 x 269 matrix, 3.0 mm thickness, 0.6 mm gap]
- Axial T1 SE
- Axial T2 FSE with fat saturation
- Sagittal T1 SE with fat saturation
- Sagittal T2 FSE with fat saturation

Positioning:

- Coronal = parallel to the anterior humerus at the condyle. Scan through entire elbow (distally through the radial tuberosity)
- Axial = plane perpendicular through the humerus distal articular surface through the capitellum and trochlea based off the coronal images
- Sagittal = plane perpendicular to the coronal plane based off axial images



Comments:

- Make sure that axial sequences go distally enough to encompass the biceps tendon insertion onto the radius.

- T2 FSE with fat saturation: adjust TE to 40 msec (+/-5 msec).

MSK 3: Wrist MRI

Indications: pain, occult scaphoid or carpal bone fractures, flexor or extensor tendon pain, carpal tunnel pain.

Sequences: wrist neutral at side or overhead while prone(preferred).

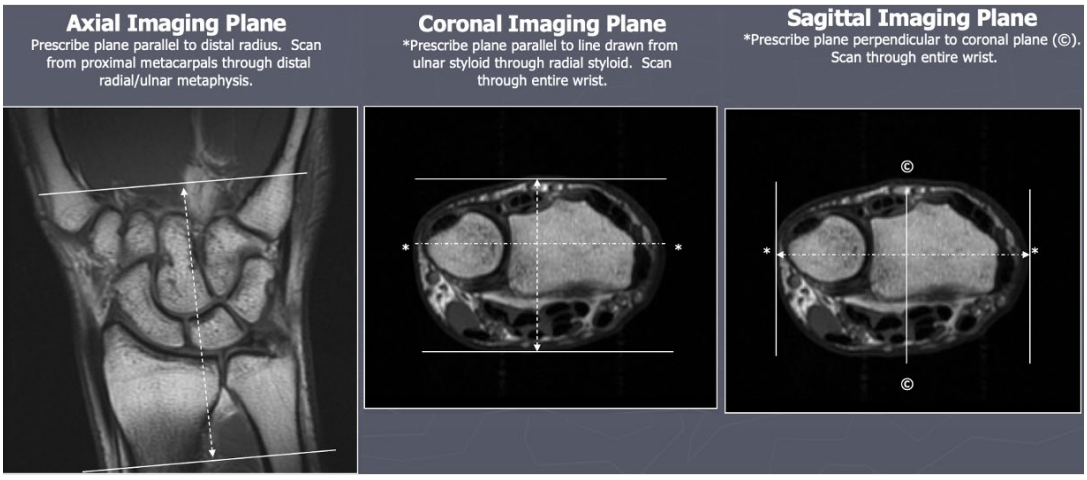
- Coronal T1 SE
- *Coronal T2 FSE with fat saturation* [384 x 210 matrix, 3.0 mm thickness, 0.3 mm gap]
- Axial T2 FSE with fat saturation
- Coronal 3-D GRE
- Sagittal T2 FSE with fat saturation

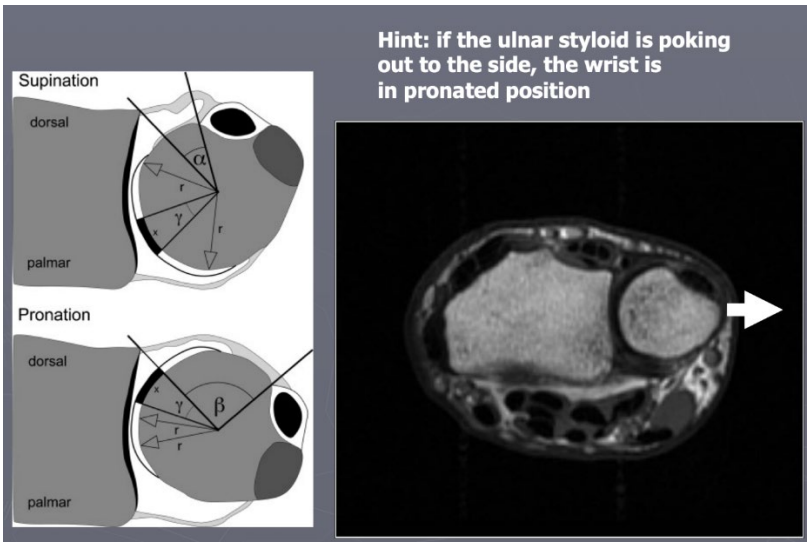
For pre- and post-contrast exams, add the following:

- *Non-contrast* coronal T1 SE with fat saturation.
- *Post-contrast*: coronal, sagittal, axial T1 SE with fat saturation.

Positioning:

- Axial = plane parallel to the distal radius, Scan from the distal radial / ulnar metaphysis to the base of the proximal metacarpals.
- Coronal = Plane parallel to the line through the radial and ulnar syloid. Accurate plan requires wrist to be in pronation
- Sagittal = plane perpendicular to the coronal plane





Comments:

- Reduced sensitivity for triangular fibrocartilage tears and ligamentous injury.
- T2 FSE with fat saturation: adjust TE to 40 msec (+/-5 msec).

MSK 3A: Wrist MR arthrogram

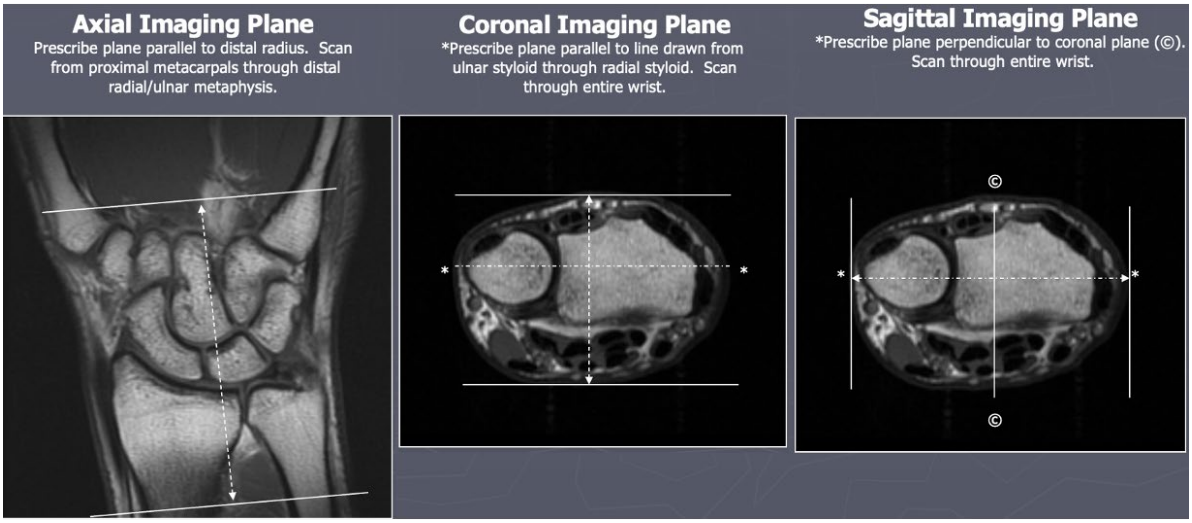
Indications: Scapholunate ligament tear, lunotriquetral ligament tear, triangular fibrocartilage complex tear.

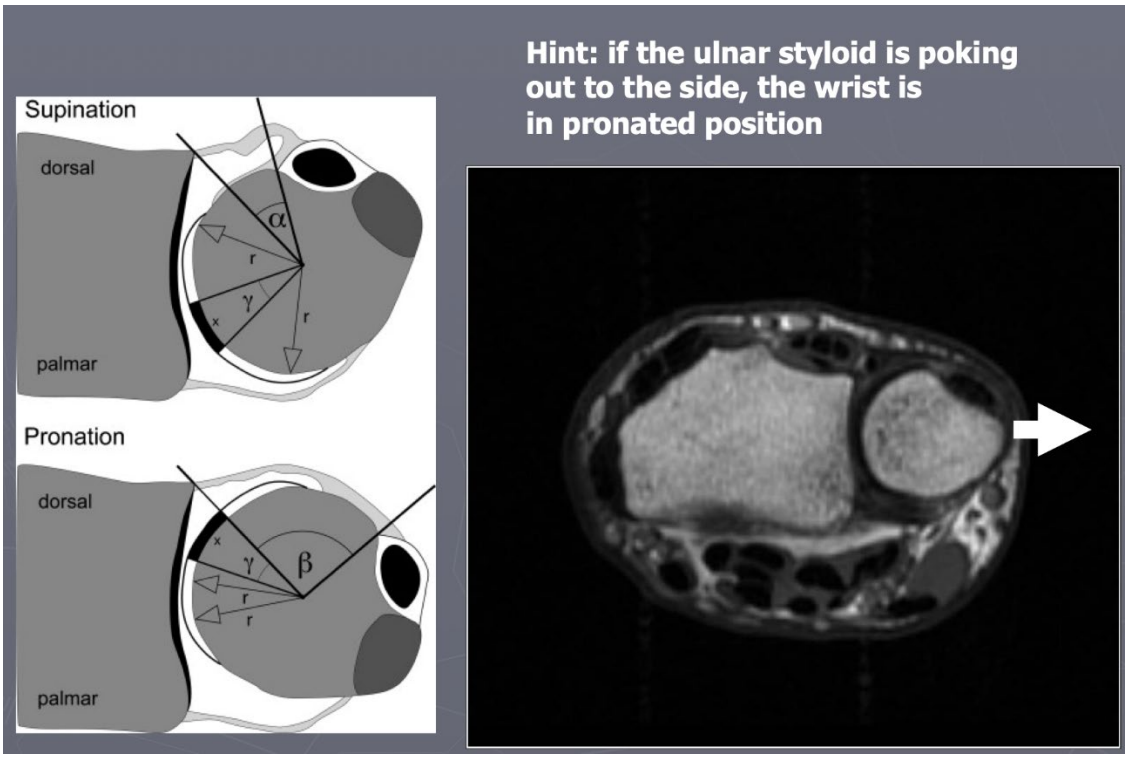
Sequences: wrist neutral at side or overhead while prone.

- Coronal T1 SE with fat saturation
- *Coronal T2 FSE with fat saturation* [384 x 210 matrix, 3.0 mm thickness, 0.3 mm gap]
- Axial T1 SE with fat saturation
- Axial T2 FSE with fat saturation
- Sagittal T1 SE with fat saturation
- Sagittal T1 SE

Positioning:

- Axial = plane parallel to the distal radius, Scan from the distal radial / ulnar metaphysis to the base of the proximal metacarpals.
- Coronal = Plane parallel to the line through the radial and ulnar syloid. Accurate plan requires wrist to be in pronation
- Sagittal = plane perpendicular to the coronal plane





Comments:

- More effective for evaluating the triangular fibrocartilage, as well as extrinsic and intrinsic carpal ligaments.
- T2 FSE with fat saturation: adjust TE to 40 msec (+/-5 msec).

MSK 4: Hand/finger MRI

Indications: General arthritis evaluation (rheumatoid, psoriatic, inflammatory). If pain localizes to finger, or wrist, prefer specific dedicated protocol.

Sequences: hand prone at side or overhead.

- Coronal T1 SE
- Coronal T2 FSE with fat saturation
- Axial PD FSE
- *Axial T2 FSE with fat saturation* [384 x 250 matrix, 3.0 mm thickness, 0.3 mm gap]
- Sagittal T1 SE
- Sagittal T2 STIR

For pre- and post-contrast exams, add the following:

- *Non-contrast* axial T1 SE with fat saturation.
- *Post-contrast*: coronal, sagittal, axial T1 SE with fat saturation.
- Positioning:
- Coronal: long axis plane aligned along the metacarpals, scan from the distal radioulnar joint through the distal phalanges.
- Axial: plane perpendicular to metacarpals and phalanges bone long axes, scan from the distal radioulnar joint through the distal phalanges.
- Sagittal: plane parallel to the long axis of the metacarpals and phalanges, scan through the entire hand from medial to lateral.
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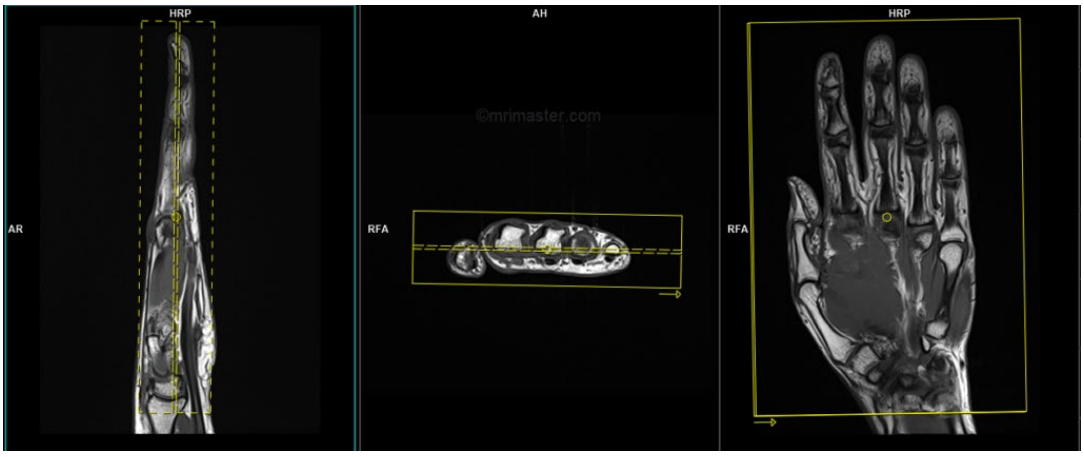
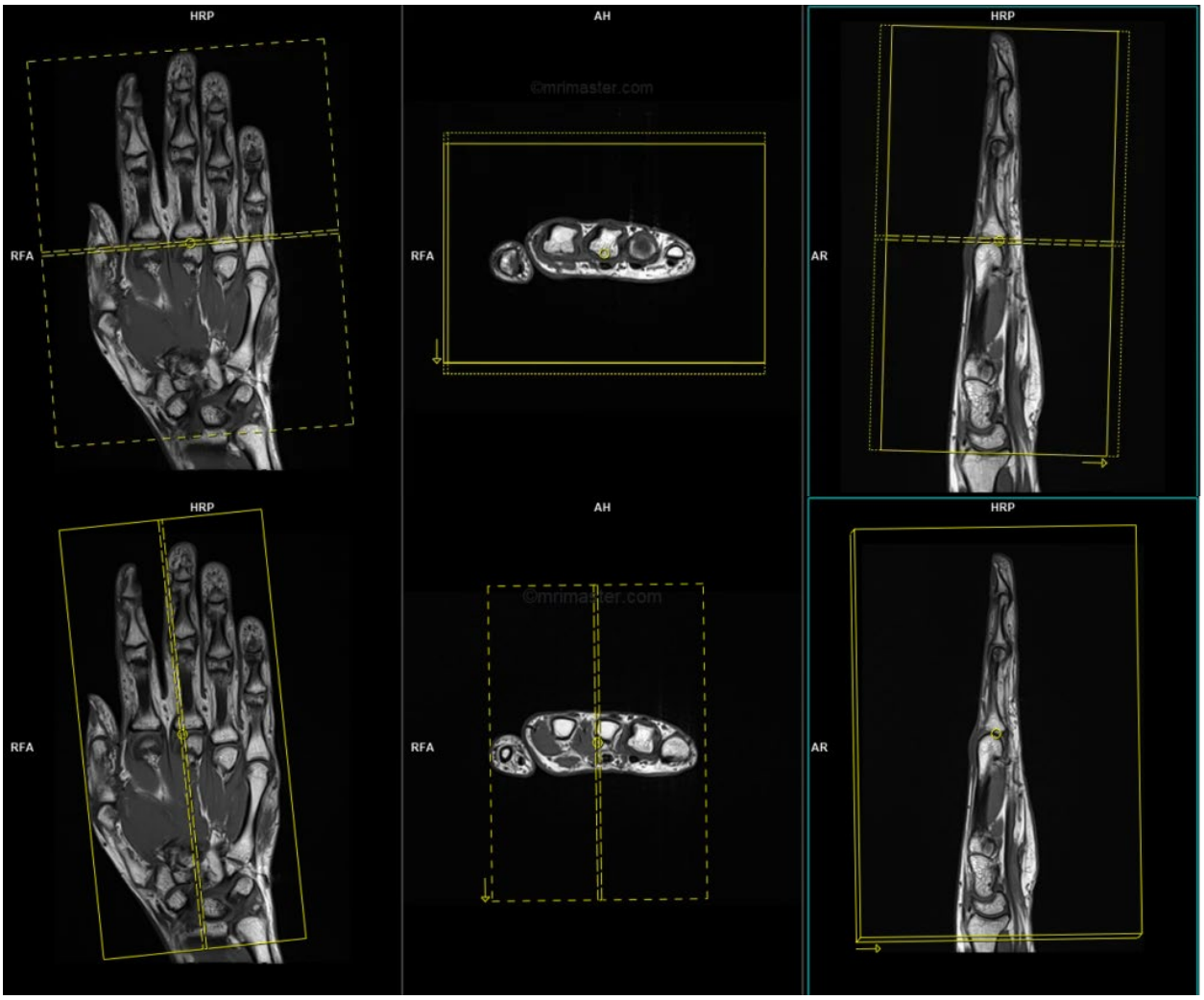


- 

Comments:

- Coronal and axial sequences should encompass adjacent digits for comparison
- Sagittal images can be done through the symptomatic finger(s) only.
- Slice thickness: 2-2.5 mm with minimal interslice gap.
- Axial T2 FSE with fat saturation: adjust TE to 40 msec (+/-5 msec).

MSK 4G: Thumb MRI without contrast (thumb injury protocol)

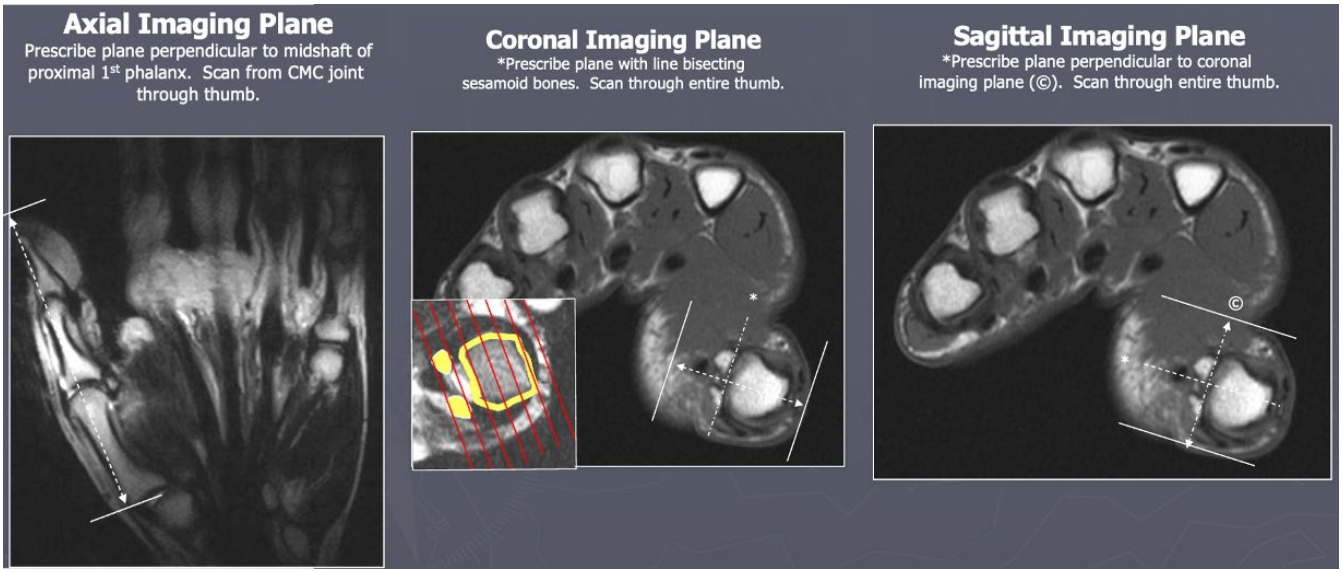
Indications: assess for ulnar collateral ligament injury/Stener lesion.

Sequences:

- Oblique coronal T1 SE
- *Oblique coronal T2 FSE with fat saturation* [384 x 250 matrix, 2.0 mm thickness]
- Axial T2 FSE with fat saturation
- Sagittal T2 FSE with fat saturation

Positioning:

- Axial = plane perpendicular to the mid shaft of the proximal phalanx. Scan from CMC joint through distal thumb tip
- Coronal = Plane parallel to a line which bisects the sesamoid bones
- Sagittal = plane perpendicular to the coronal plane



Comments:

- Limited study geared towards assessing the ulnar collateral ligament.
- Slice alignment is critical to this exam, please use the above guidance.
- Slice thickness: 2-2.5 mm with minimal interslice gap.
- T2 FSE with fat saturation: adjust 40 msec (+/-5 msec).

MSK 4F: Finger MRI (Finger injury or mass protocol)
Indications: specific finger pain, finger flexor or extensor ligament injury or tear, sagittal band or pulley tear, volar plate tear.
Sequences:

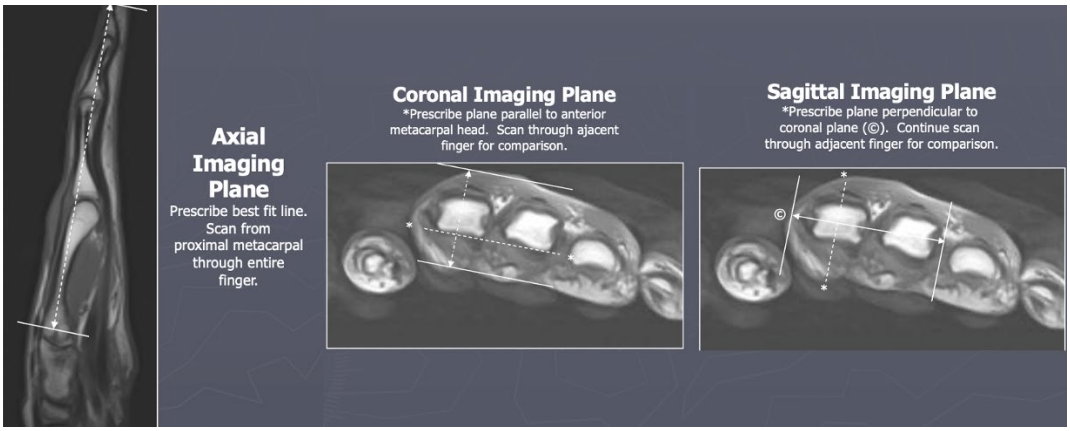
- Coronal T1 SE
- Coronal T2 FSE with fat saturation
- Axial PD FSE
- *Axial T2 FSE with fat saturation* [384 x 250 matrix, 3.0 mm thickness, 0.3 mm gap]
- Sagittal T1 SE
- Sagittal T2 STIR

For pre- and post-contrast exams, add the following:

- *Non-contrast* axial T1 SE with fat saturation.
- *Post-contrast*: coronal, sagittal, axial T1 SE with fat saturation.

Positioning:

- Scan from proximal metacarpal base through the end of the finger. For all sequences include the adjacent finger in the FOV for comparison
- Axial = best fit line (example below)
- Coronal = Plane parallel to the anterior metacarpal head.
- Sagittal = plane perpendicular to the coronal plane



Comments:

- Coronal and axial sequences should encompass adjacent digits for comparison
- Slice thickness: 2-2.5 mm with minimal interslice gap.
- Axial T2 FSE with fat saturation: adjust TE to 40 msec (+/-5 msec).

MSK 5: Pelvis and hip MRI

Indications: pain, internal derangement, avascular necrosis.

Sequences:

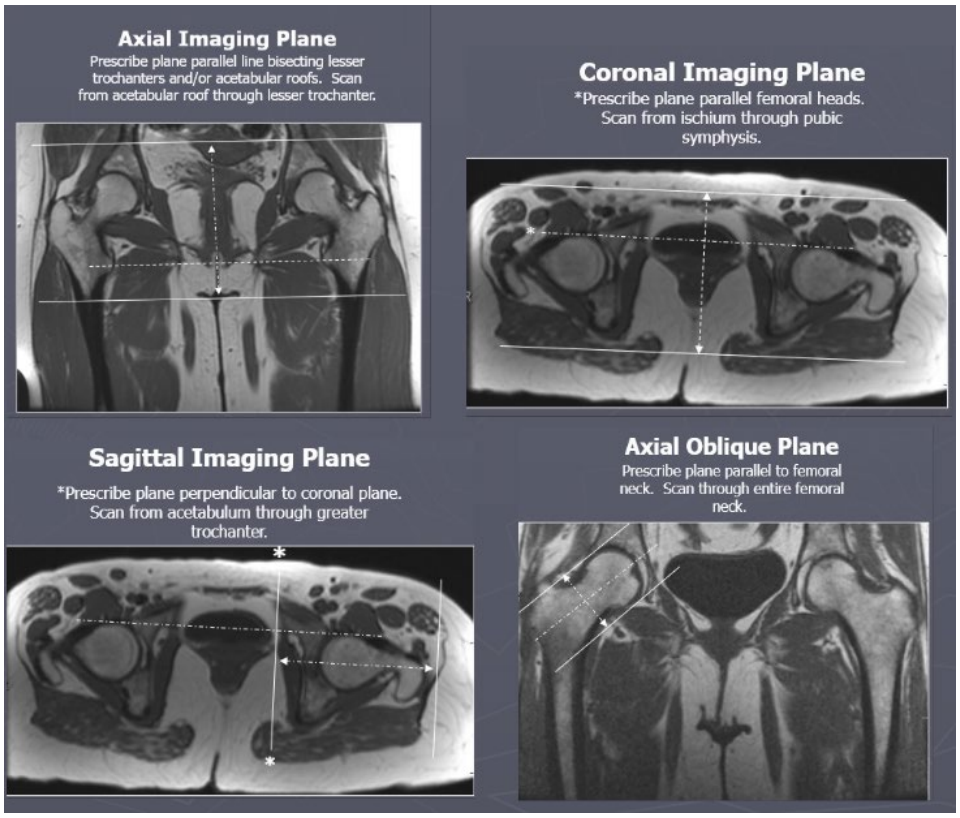
- Coronal T1 spin echo of bony pelvis
- Coronal STIR of bony pelvis
- *Coronal T2 FSE with fat saturation of affected hip* [3.5 mm thick, 0.35 mm gap]
- Axial T2 FSE with fat saturation of affected hip
- Sagittal T1 SE of affected hip
- Oblique axial T2 FSE with fat saturation of affected hip

For pre- and post-contrast exams, add the following:

- *Non-contrast* axial T1 SE with fat saturation.
- *Post-contrast*: coronal, sagittal, axial T1 SE with fat saturation.

Positioning:

- Axial = parallel line bisecting lower trochanters or acetabular roofs. Scan from acetabular roof through the lesser trochanter
- Coronal = plane parallel to femoral heads from the ischium through the pubic symphysis
- Sagittal = plane perpendicular to coronal plane. Scan from acetabulum through greater trochanter
- Axial oblique = plane parallel to the femoral neck. Scan through entire femoral neck



Comments:

- Oblique axial sequence is done parallel to the femoral neck, and is useful for diagnosing cam-type femoroacetabular impingement (FAI).
- T2 FSE with fat saturation: adjust TE to 40 msec (+/-5 msec).

MSK 5A: Hip MR arthrogram

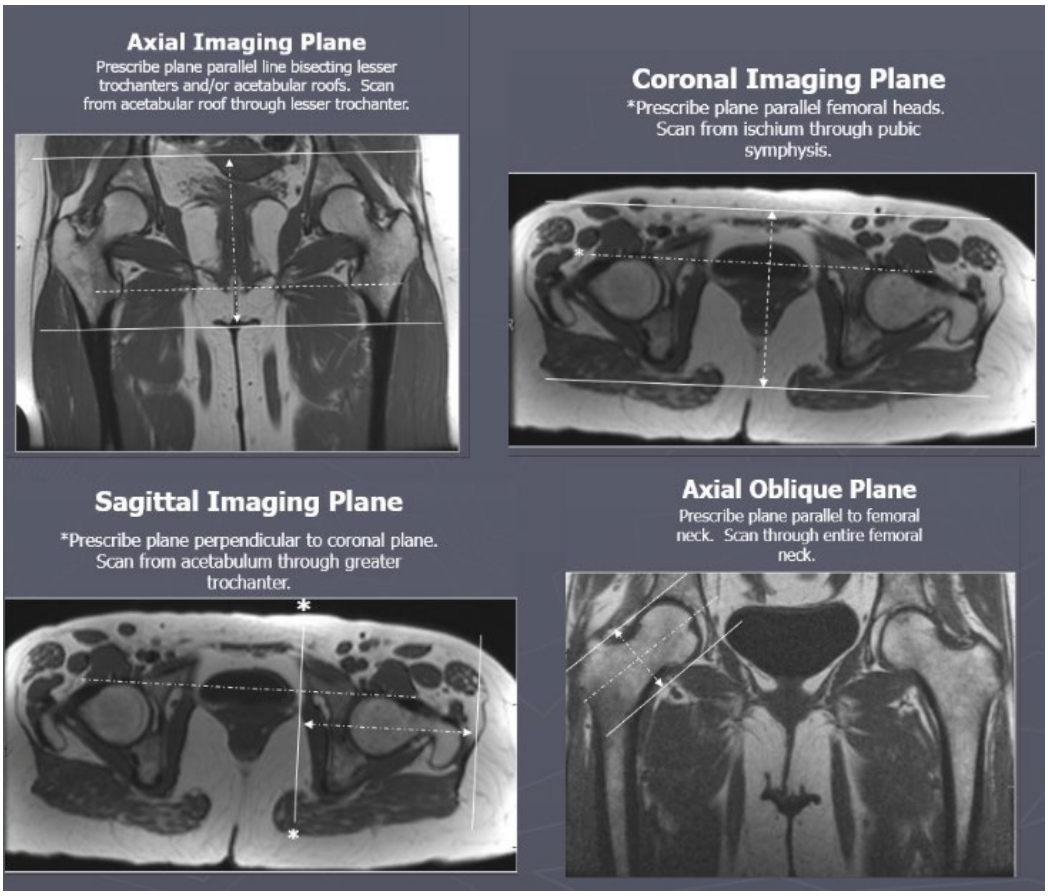
Indications: pain, labral pathology.

Sequences:

- Coronal STIR of bony pelvis
- *Coronal T1 SE with fat saturation of hip* [3.5 mm thick, 0.35 mm gap]
- Sagittal T1 SE with fat saturation of hip
- Sagittal T1 SE of hip
- Axial T2 FSE of hip with fat saturation of hip
- Oblique axial T1 SE with fat saturation of hip

Positioning:

- Axial = parallel line bisecting lower trochanters or acetabular roofs. Scan from acetabular roof through the lesser trochanter
- Coronal = plane parallel to femoral heads from the ischium through the pubic symphysis
- Sagittal = plane perpendicular to coronal plane. Scan from acetabulum through greater trochanter
- Axial oblique = plane parallel to the femoral neck. Scan through entire femoral neck



Comments:

- Oblique axial sequence is done parallel to the femoral neck, and is useful for diagnosing cam-type femoroacetabular impingement (FAI).
- T2 FSE with fat saturation: adjust TE to 40 msec (+/-5 msec).

MSK 5F: Pelvis and Hip MRI (Fracture protocol)

Indications: Outpatient hip pain following recent fall with negative x-rays and / or CT, recent fall, fracture evaluation, avascular necrosis evaluation.

Sequences:

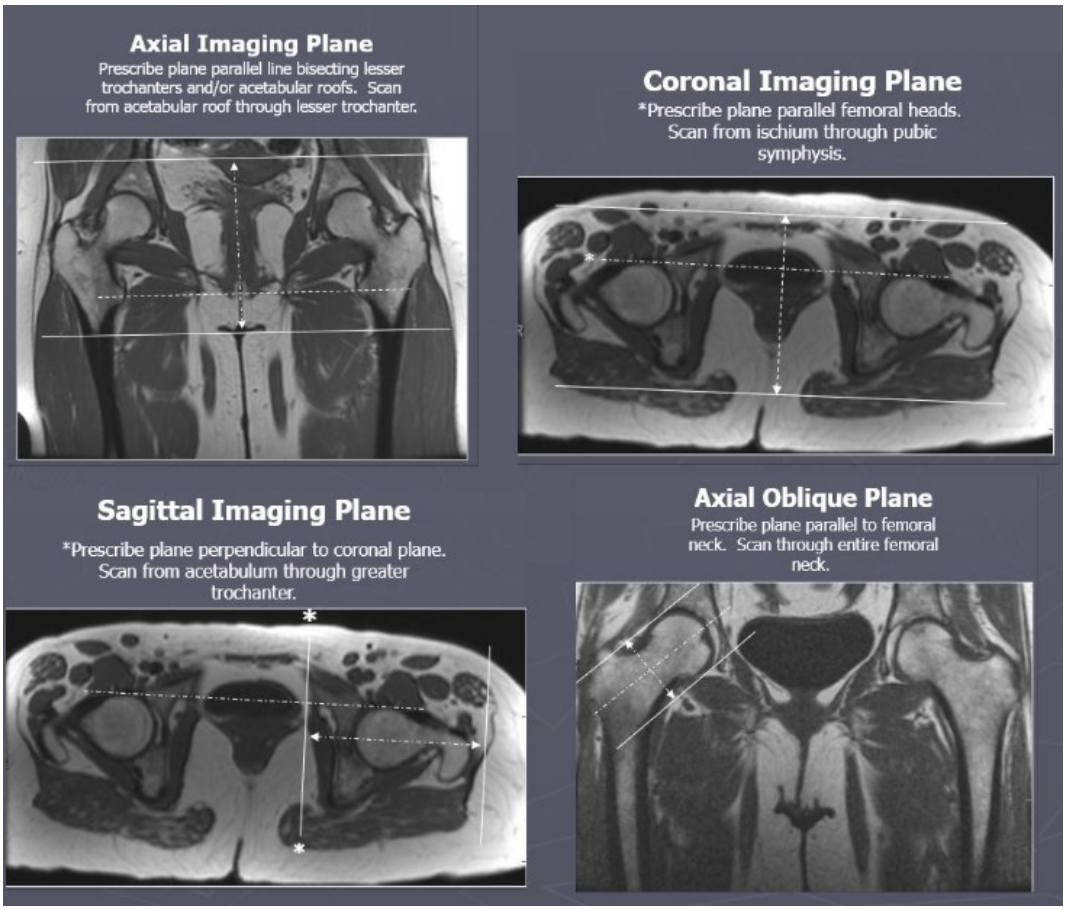
- Coronal T1 spin echo of bony pelvis
- Coronal STIR of bony pelvis
- *Coronal T2 FSE with fat saturation of affected hip* [3.5 mm thick, 0.35 mm gap]
- Axial T2 FSE with fat saturation of affected hip
- Sagittal T1 SE of affected hip
- Oblique axial T2 FSE with fat saturation of affected hip

For pre- and post-contrast exams (evaluation of pathologic fracture), add the following:

- *Non-contrast* axial T1 SE with fat saturation.
- *Post-contrast*: coronal, sagittal, axial T1 SE with fat saturation.

Positioning:

- Axial = parallel line bisecting lower trochanters or acetabular roofs. Scan from acetabular roof through the lesser trochanter
- Coronal = plane parallel to femoral heads from the ischium through the pubic symphysis
- Sagittal = plane perpendicular to coronal plane. Scan from acetabulum through greater trochanter
- Axial oblique = plane parallel to the femoral neck. Scan through entire femoral neck



Comments:

- Perform in any outpatient over 50 years old with history or indication of recent fall, hip fracture, rule out fracture, unable to weight bear
- Key difference is the sagittal T1 sequence which is used for fracture evaluation. Otherwise it is the standard hip MRI protocol.

MSK 5SI: Sacro-iliac joint MRI

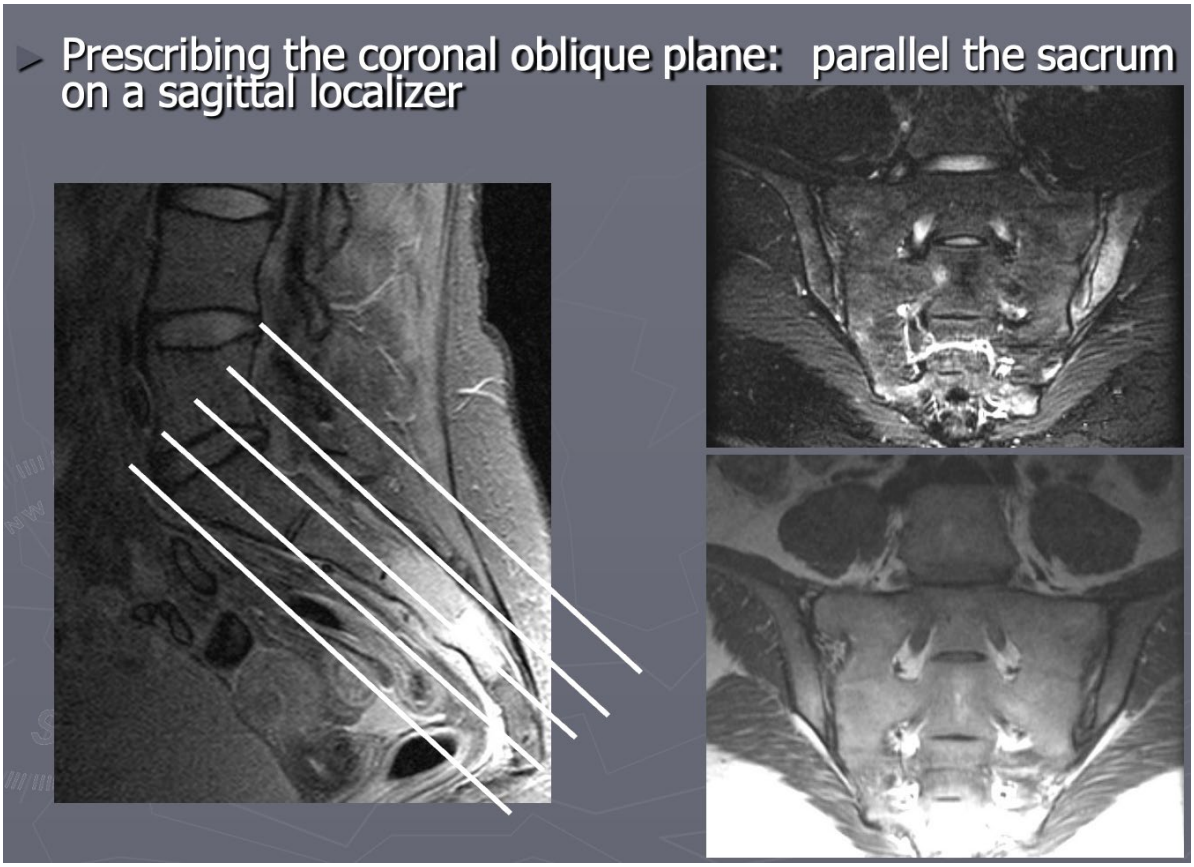
Indications**:** sacroiliitis, joint infection, sacral fracture, coccyx fracture

Sequences:

- Oblique coronal T1 SE through SI joints
- Oblique coronal STIR through SI joints
- Axial T1 SE
- Axial T2 STIR
- Oblique coronal 3D FLASH through SI joints
- Optional: post-Gd oblique coronal T1 SE with fat saturation
- Optional: post-Gd axial T1 SE with fat saturation

Positioning:

- Coronal oblique = parallel to the sacrum on the sagittal localizer
- Axial = perpendicular to the coronal sequence through the sacrum starting in the inferior half of the most caudal lumbar vertebra through the coccyx.
- Sagittal = perpendicular to axial, scan through at least 2 inches lateral of the sacroiliac joints bilaterally



Comments:

- Sacral or coccygeal fracture only.
- If indication is for mass or for multiple pelvic ring fractures, MRI pelvis is the preferred protocol
- 3D flash is for evaluation of the cartilage of the sacroiliac joints

MSK 5T: Pelvis MRI without contrast (trauma protocol)

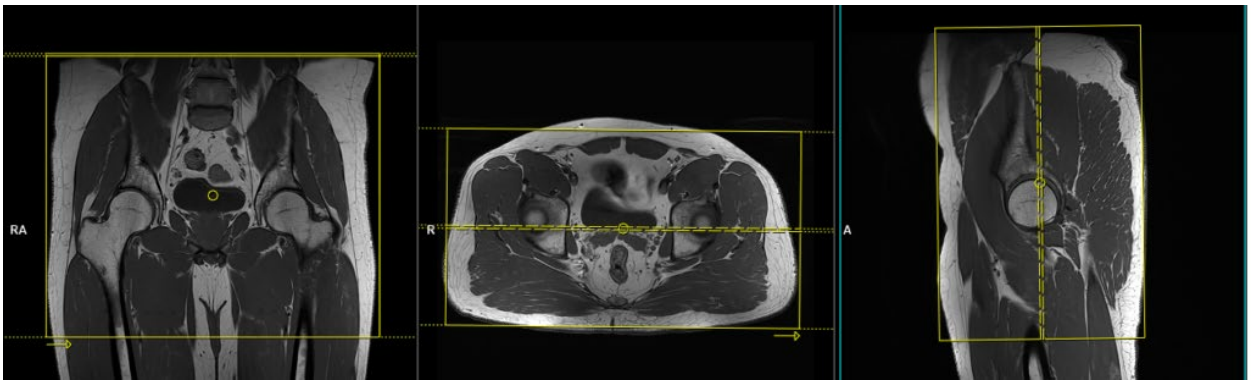
Indications: assess for pelvic ring, sacral, or hip fractures.

Sequences: include entire bony pelvis

- Coronal T1 SE
- Coronal STIR
- Axial T1 SE
- Axial STIR

Positioning:

- Coronal = large field of view extending from approximately 2 inches above the iliac crest to 2 inches below the pubic symphysis
- Axial = plane perpendicular to the coronal plane, aligned parallel to the femoral heads. Scan through the entire bony pelvis
- Sagittal = plane perpendicular to the axial plane parallel to a line drawn through the center of the pubic symphysis and sacral promontory.



Comments:

- Limited survey exam to assess for occult fractures Best for the *ER / inpatient setting* with indication to rule out fracture with a very abbreviated protocol. The dedicated hip protocol is better for outpatient exams as it allows for better evaluation of hip specific pathology which is more common in outpatients.

MSK 6: Knee MRI

Indications: pain, internal derangement.

Sequences:

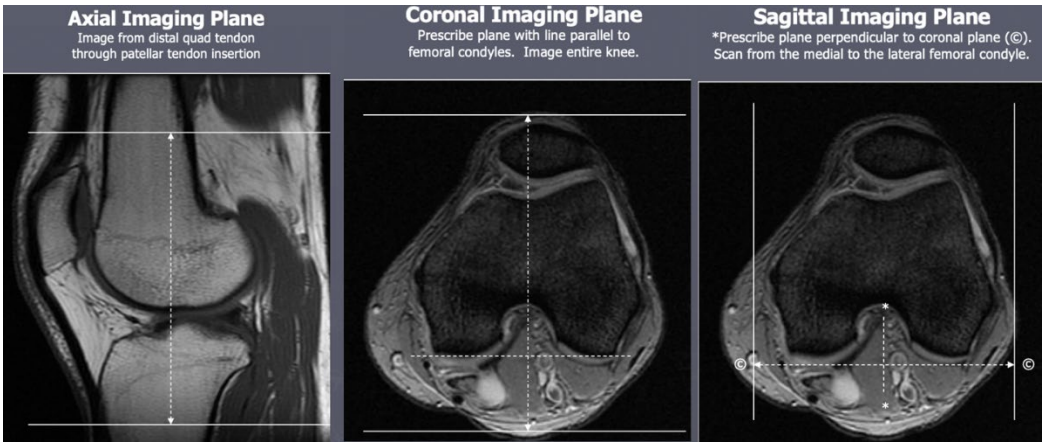
- Sagittal PD FSE
- Sagittal T2 FSE with fat saturation
- Axial PD FSE with fat saturation
- Coronal T1 SE
- Coronal PD FSE with fat saturation

For pre- and post-contrast exams, add the following:

- Non-contrast axial T1 SE with fat saturation.
- Post-contrast: coronal, sagittal, axial T1 SE with fat saturation.

Positioning:

- Axial = image from distal quadriceps tendon through the patellar tendon insertion
- Coronal = plane parallel to the posterior femoral condyles. Images should include the entire knee
- Sagittal = plane perpendicular to the coronal plane including from the medial to the lateral femoral condyles



- Comments:

- T2 FSE with fat saturation: adjust TE to 40 msec (+/-5 msec).
  Optional for Smith-Nephew hardware scans only: substitute 1st sequence for sagittal T2 FSE (no fat saturation) with 2 mm slice thickness, 0mm interslice gap, 512 x 256 matrix, 22 cm FOV, ETL 7, Bw 200, 1 NEX.

MSK 6A: Knee MR arthrogram

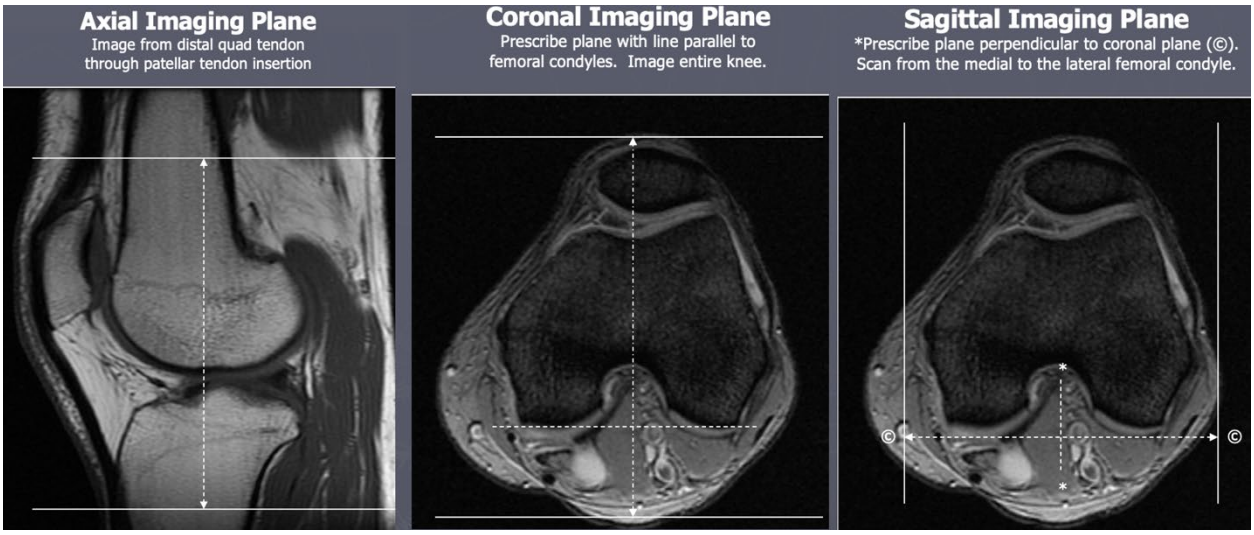
Indications: evaluating for meniscal retears in a postoperative knee.

Sequences:

- Sagittal T1 SE with fat saturation
- Sagittal PD FSE with fat saturation
- Coronal T1 SE
- Coronal T1 SE with fat saturation
- Coronal T2 FSE with fat saturation
- Axial PD FSE with fat saturation

Positioning:

- Axial = image from distal quadriceps tendon through the patellar tendon insertion
- Coronal = plane parallel to the posterior femoral condyles. Images should include the entire knee
- Sagittal = plane perpendicular to the coronal plane including from the medial to the lateral femoral condyles



Comments:

- Keep ACE wrap around knee during scan, to direct intra-articular contrast into regions around the menisci.
- T2 FSE with fat saturation: adjust TE to 40 msec (+/-5 msec)

MSK ConforMIS knee MRI (arthroplasty planning)

Indications: evaluating for knee implant design by ConforMIS

Sequences:

- Sagittal PD FSE with fat saturation
- Coronal PD FSE with fat saturation
- Sagittal 3D FLASH with fat saturation
- Coronal 3D FLASH with fat saturation

Comments:

Per manufacturer's guidelines, first 2 sequences are required, and the next 2 sequences are recommended.

MSK 6Z: Zimmer knee MRI (arthroplasty planning)

Indications: evaluating for knee implant design by Zimmer

Sequences:

- Axial T1 SE of ankle without fat saturation (TR 400-5000 msec, TE 2.0-100 msec)
- Sagittal 3D FLASH with fat saturation of knee
- Add: sagittal T2 FSE of knee (Smith-Nephew sequence, see notes).
- Coronal T1 SE of knee
- Axial T1 SE of hip (TR 20-5000 msec, TE 2.0-100 msec)

Comments:

- See manufacturer's publication for more sequence parameters.
- Smith-Nephew planning sequence: perform sagittal T2 FSE (no fat saturation) with 2 mm slice thickness and 0mm interslice gap, 512 x 256 matrix, 22 cm FOV, ETL 7, Bw 200, 1 NEX.

MSK 7: Ankle MRI

Indications: pain, internal derangement

Sequences:

- Sagittal T1 SE
- Sagittal T2 FSE with fat sat
- Axial PD FSE
- Axial T2 FSE with fat saturation [448 x 223 matrix, 3.0 mm thick, 0.3 mm gap]
- Coronal T2 FSE with fat saturation
- Coronal T1 SE

For pre- and post-contrast exams, add the following:

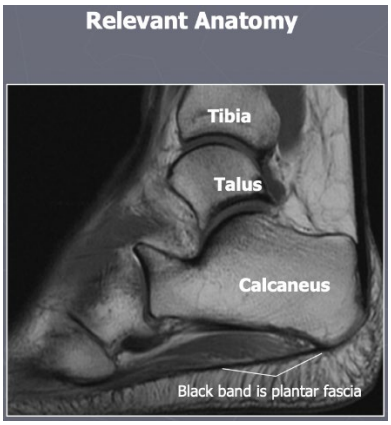
- Non-contrast axial T1 SE with fat saturation.
- Post-contrast: coronal, sagittal, axial T1 SE with fat saturation.

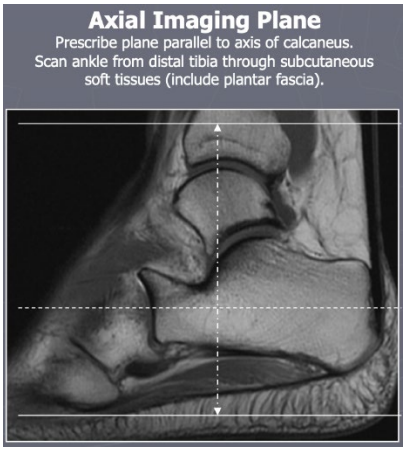
For plantar fascia evaluation (and whole foot imaging requested), add the following:

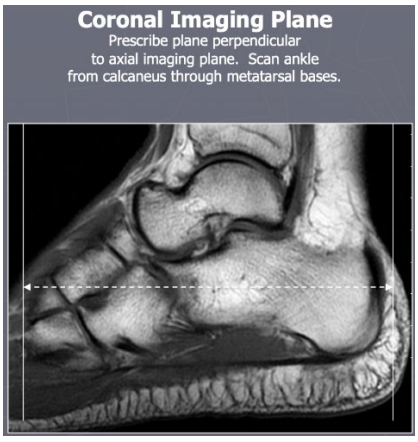
- Sagittal T2 FSE with fat saturation of forefoot.
- Axial T2 FSE with fat saturation of forefoot.

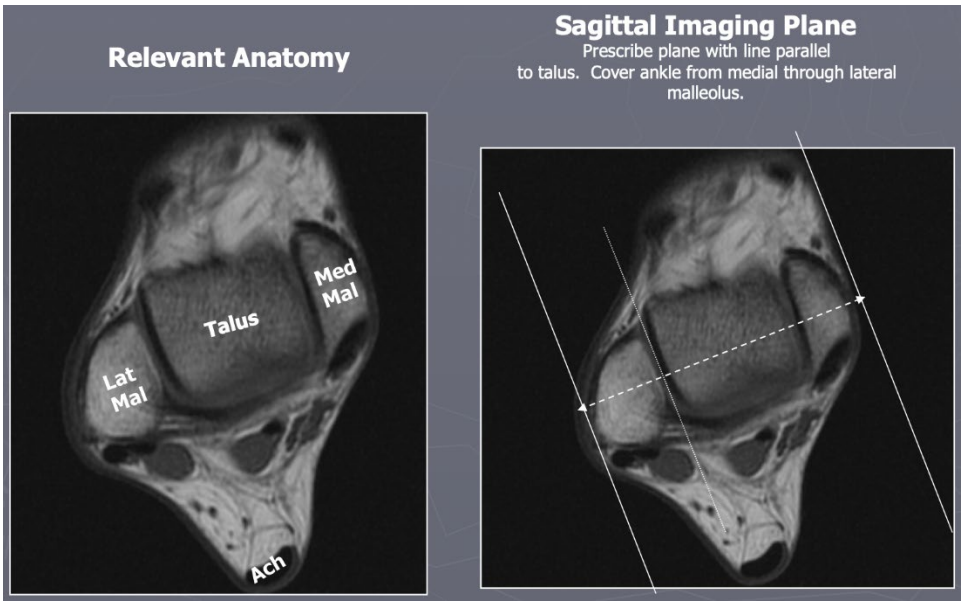
Positioning:

- Axial = plane parallel to the long axis of the calcaneus. Scan from the distal tibia through the subcutaneous soft tissues of the heel including the plantar fascia
- Coronal = plane perpendicular to the coronal plane, scan from the posterior calcaneus through the metatarsal bases. Include the subcutaneous fat superficial to the Achilles tendon.
- Sagittal = plane parallel to the dome of the talus. Image from the medial malleolus of the tibial through the lateral malleolus.
- Axial Oblique = plane based off sagittal sequence. Plane along the peroneal tendons at the inferior lateral malleolus. Scan from 1 cm posterior to the lateral malleolus to the peroneus brevis insertion at the 5th metatarsal tuberosity


Relevant Anatomy
Tibia
Talus
Calcaneus
Black band is plantar fascia


Axial Imaging Plane
Prescribe plane parallel to axis of calcaneus.
Scan ankle from distal tibia through subcutaneous
soft tissues (include plantar fascia).


Coronal Imaging Plane
Prescribe plane perpendicular
to axial imaging plane. Scan ankle
from calcaneus through metatarsal bases.



Comments:

- If region of interest is localized to the midfoot, extend field of view more anteriorly as needed.
- When whole foot imaging is requested (and region of clinical concern cannot be localized to either hindfoot or forefoot): perform MSK 7 and 8 concurrently but with separate sequences. Do not use larger FOV to encompass whole foot and ankle. Goal is to localize pain and symptoms to either a forefoot, midfoot, or hindfoot exam.
- T2 FSE with fat saturation: adjust TE to 40 msec (+/-5 msec)

MSK 7A: Ankle MR arthrogram

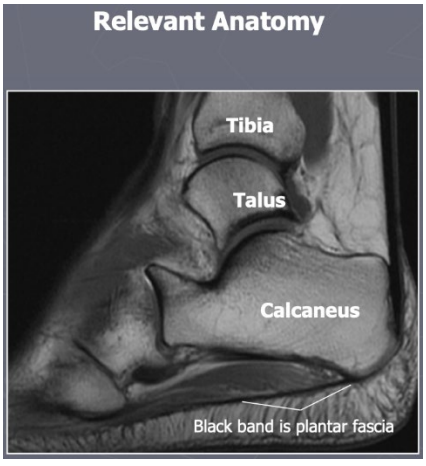
Indications: assess for intra-articular bodies, ligamentous injuries.

Sequences:

- Sagittal T1 SE
- Sagittal T1 SE with fat saturation
- Axial T1 FSE with fat saturation
- Axial T2 FSE with fat saturation [448 x 223 matrix, 3.0 mm thick, 0.3 mm gap]
- Coronal T1 SE with fat saturation
- Coronal T2 FSE with fat saturation

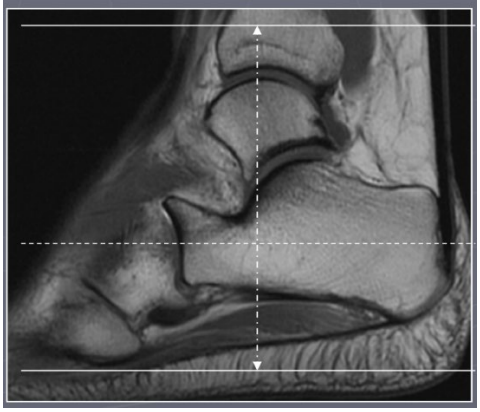
Positioning:

- Axial = plane parallel to the long axis of the calcaneus. Scan from the distal tibia through the subcutaneous soft tissues of the heel including the plantar fascia
- Coronal = plane perpendicular to the coronal plane, scan from the posterior calcaneus through the metatarsal bases. Include the subcutaneous fat superficial to the Achilles tendon.
- Sagittal = plane parallel to the dome of the talus. Image from the medial malleolus of the tibial through the lateral malleolus.
- Axial Oblique = plane based off sagittal sequence. Plane along the peroneal tendons at the inferior lateral malleolus. Scan from 1 cm posterior to the lateral malleolus to the peroneus brevis insertion at the 5th metatarsal tuberosity



Axial Imaging Plane

Prescribe plane parallel to axis of calcaneus.
Scan ankle from distal tibia through subcutaneous soft tissues (include plantar fascia).



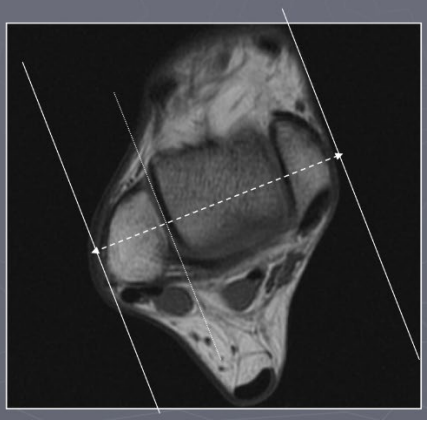
Coronal Imaging Plane

Prescribe plane perpendicular to axial imaging plane. Scan ankle from calcaneus through metatarsal bases.

Relevant Anatomy

Sagittal Imaging Plane

Prescribe plane with line parallel to talus. Cover ankle from medial through lateral malleolus.



Comments:

- Contrast injection into the tibiotalar joint capsule.
- T2 fast spin echo with fat saturation: adjust TE to 40 msec (+/-5 msec).

MSK 8: Forefoot MRI

Indications: pain, internal derangement.

Sequences:

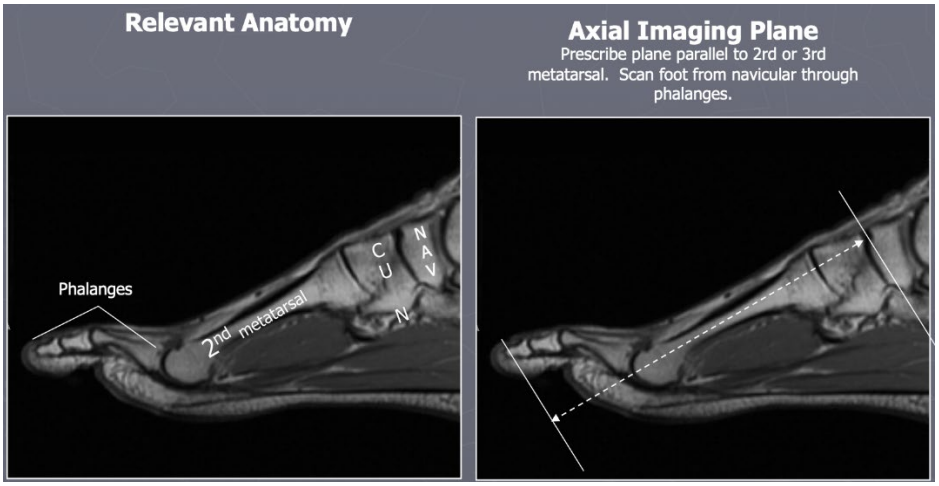
- Sagittal T1 SE
- Sagittal T2 FSE with fat saturation [320 x 192 matrix, 2.5 mm thick, 0.25 mm gap]
- Long-axis T1 SE
- Long-axis STIR T2
- Short-axis T1 SE
- Short-axis T2 FSE with fat saturation

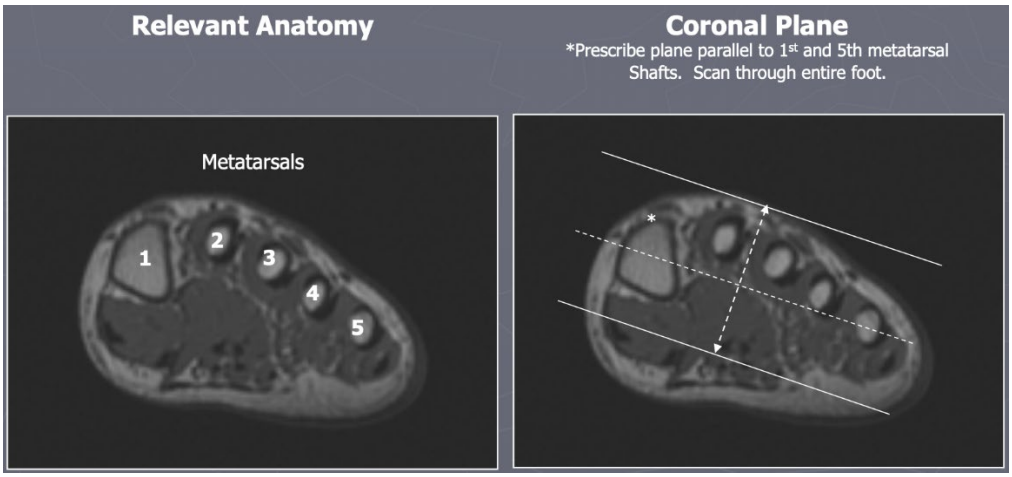
For pre- and post-contrast exams, add the following:

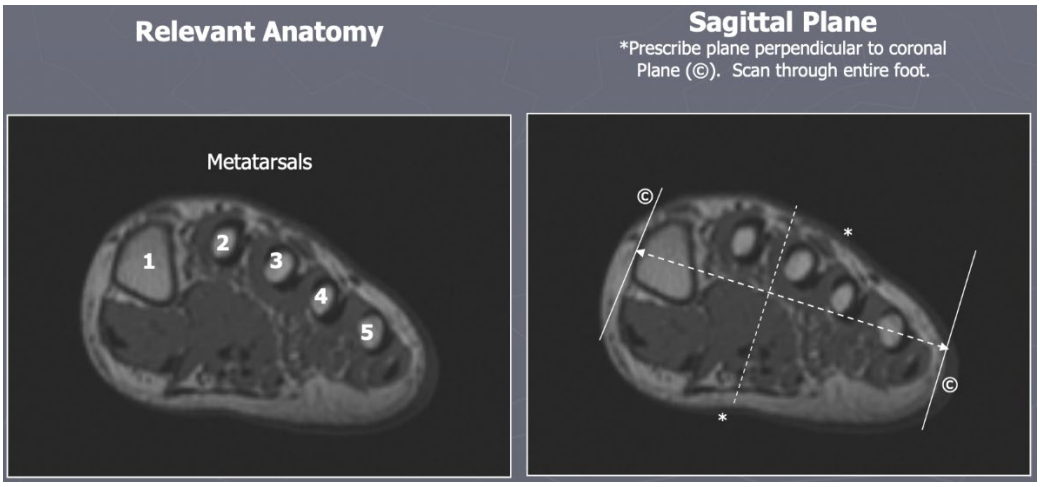
- Non-contrast short-axis T1 SE with fat saturation.
- Post-contrast: short axis, long-axis, sagittal T1 SE with fat saturation.

Positioning:

- Short Axis or Coronal = plane parallel to the 2nd or 3rd metatarsal shaft. Include from the navicular bone through the phalanges
- Long Axis or Axial = parallel to the 1st and 5th metatarsal shafts. Include from the distal phalanges to the navicular and cuboid bones
- Sagittal = plane perpendicular to the coronal plane. Include from the distal phalanges to the navicular bone.







Comments:

- Long-axis sequences are performed parallel to the metatarsal shafts. Short axis images are done perpendicular to the metatarsals.
- When whole foot imaging is requested (and region of clinical concern cannot be localized to either hindfoot or forefoot): perform MSK 7 and 8 concurrently but with separate sequences. Do not use larger FOV to encompass whole foot and ankle. Goal is to localize pain and symptoms to either a forefoot, midfoot, or hindfoot exam.
- T2 FSE with fat saturation: adjust TE to 40 msec (+/-5 msec).

MSK 8M: Forefoot MRI pre- and post-contrast (Morton's neuroma protocol)

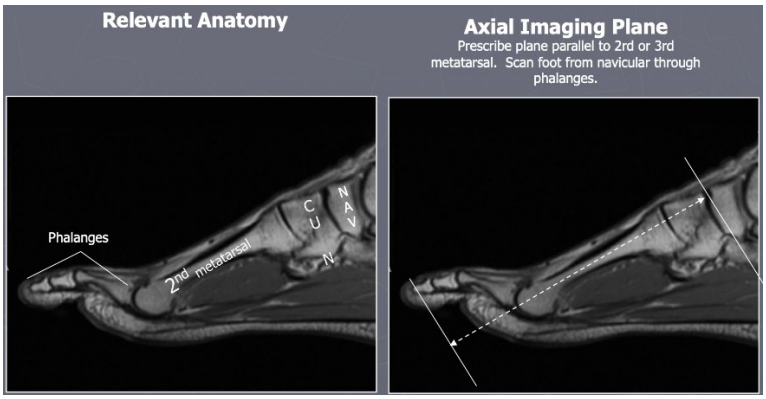
Indications: assess for Morton's neuroma.

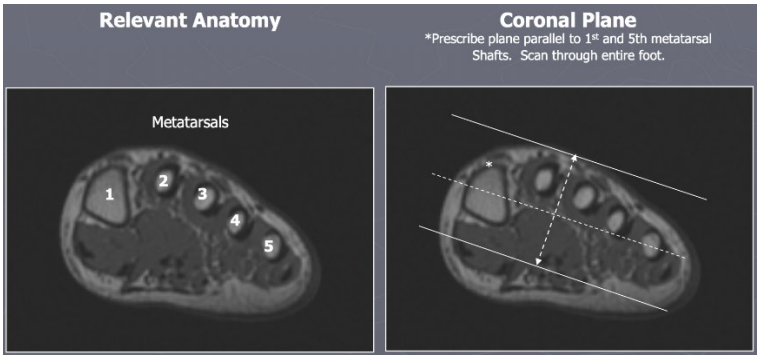
Sequences: place fiducial over symptomatic site

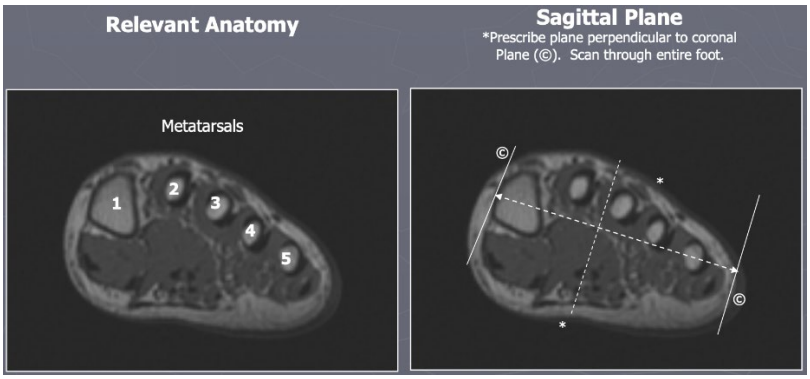
- Long-axis T1 SE
- Long-axis T2 FSE with fat saturation
- Short-axis T1 SE
- Short-axis T2 FSE with fat saturation
- Short-axis T1 SE with fat saturation
- Post-Gd short-axis T1 SE with fat saturation [320 x 192 matrix, 2.5 mm thick, 0.25 mm gap]

Positioning:

- Short Axis or Coronal = plane parallel to the 2nd or 3rd metatarsal shaft. Include from the navicular bone through the phalanges
- Long Axis or Axial = parallel to the 1st and 5th metatarsal shafts. Include from the distal phalanges to the navicular and cuboid bones
- Sagittal = plane perpendicular to the coronal plane. Include from the distal phalanges to the navicular bone.







Comments:

- Long-axis sequences are performed parallel to the metatarsal shafts. Shortaxis images are done perpendicular to the metatarsals.
- Perform scan with patients prone; flip short-axis images when sending to PACS.

MSK 9: Pre- and post-contrast long bone MRI (tumor/mass, or infection protocol)

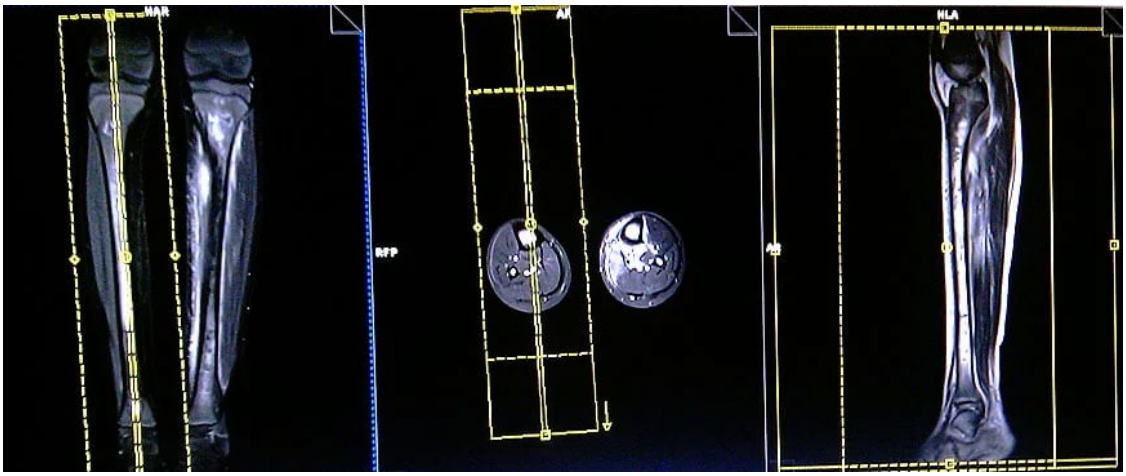
Indications: osseous or soft tissue lesion, palpable or seen on other studies.

Sequences: place fiducial over mass if palpable

- Coronal T1 SE
- Coronal STIR
- Axial T1 SE
- Axial T2 FSE with fat saturation
- Sagittal T1 SE with fat saturation
- Sagittal STIR
- Axial 2D FLASH in- and out-of-phase
- Axial Diffusion and ADC (b = 50, 400, 800)
- Coronal pre-Gd 3D VIBE with fat saturation.
- Coronal post-Gd 3D VIBE with fat saturation (axial, sag reformats)

Positioning

- Coronal = Image the entire requested bone in a plane parallel to the long axis of bone shaft.
- Sagittal = Image perpendicular to the coronal plane. For Humerus, should be perpendicular to a line through the medial and lateral epicondyles at the elbow. For femur should be along the long axis, ensuring appropriate angulation posterior to anterior. For forearm or lower leg, should be perpendicular to a plane from the medial and lateral cortex of the tibia or though a line bisecting the radius and ulna of the forearm.
- Axial = image perpendicular to the shaft of the long bone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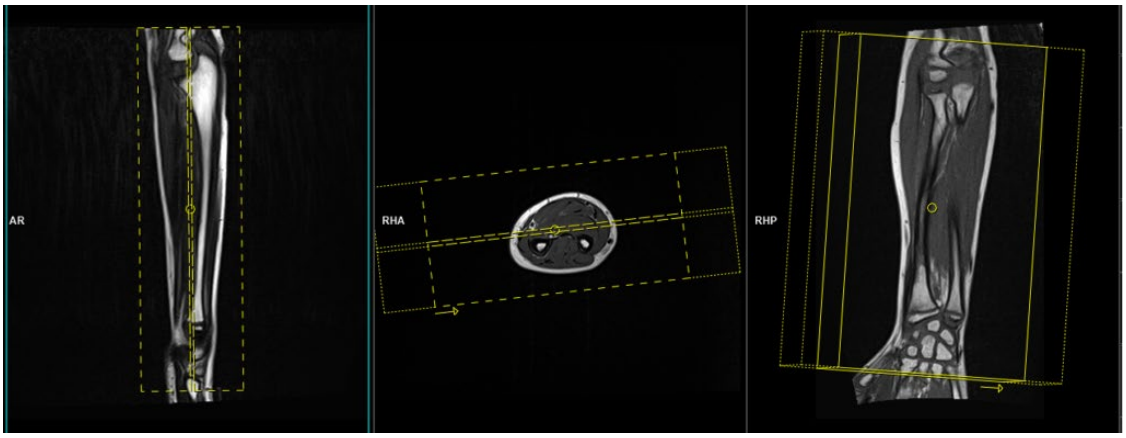
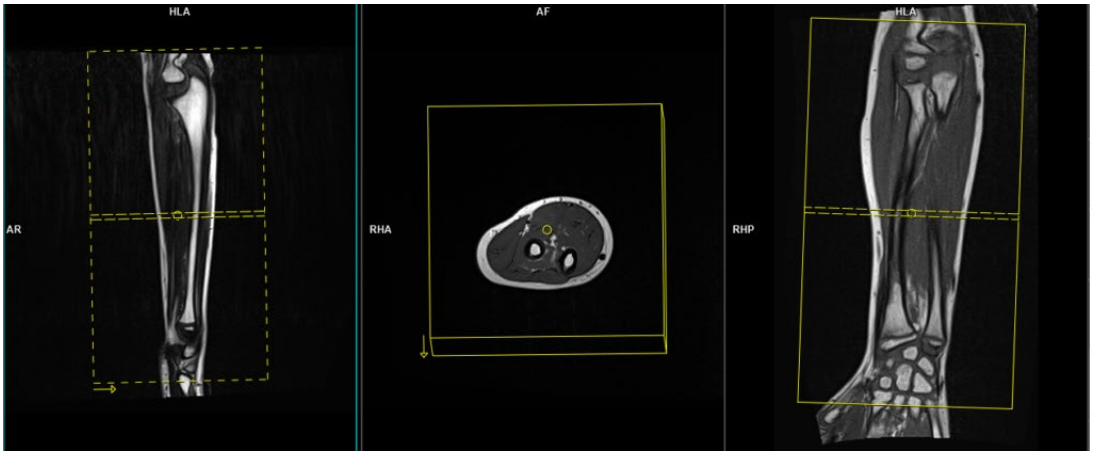
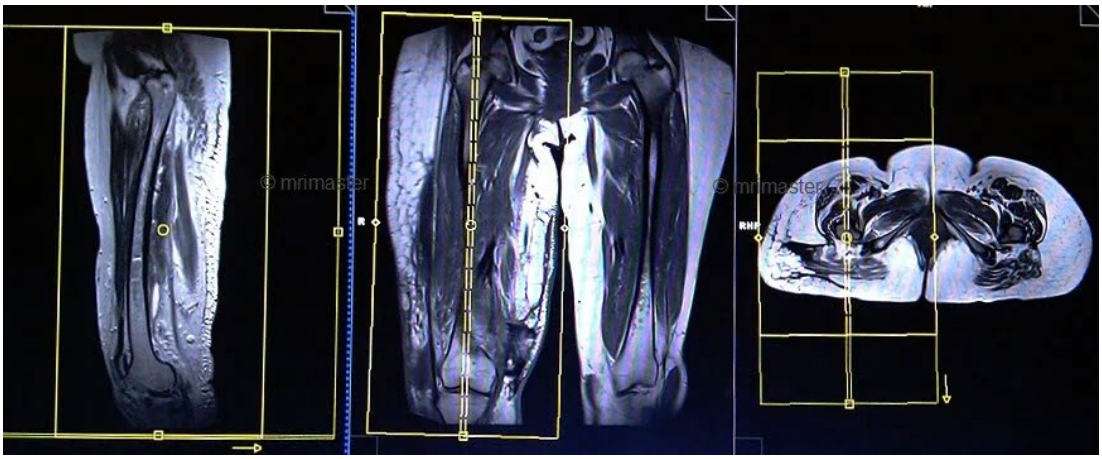
AF
HLA
RFP
AR


AR
RHA
RHP


HLA
AF
HLA
AR
RHA
RHP



Comments:

- On coronal and sagittal images, include entire long bone of concern. May include contralateral leg/thigh on coronal for comparison.
- On axial images, restrict slices to the actual lesion or site of concern. For T2 FSE with fat saturation: adjust TE to 40-50 msec.
- In- and out-of-phase imaging, DWI/ADC: restrict usage to examinations performed for characterization of intra-osseous lesion.
- For studies attempting to diagnose a bone lesion, check PACS to see if there is a diagnostic quality plain film of the lesion in question. If not, consult with interpreting radiologist about sending the patient to obtain plain films in department following MRI scan.

MSK10: MR neurography

Indications: evaluation of peripheral nerve disease.

Sequences:

- Axial T1 SE (4 mm thick)
- Axial T2 SPAIR (2 mm thick)
- Coronal T1 SE (4 mm thick)
- Coronal T2 or STIR 3D SPACE (1-2 mm thick)
- Coronal T2 fast spin echo with fat saturation (3 mm thick)
- Sagittal T2 fast spin echo with fat saturation (3 mm thick)

Comments:

- Field of view: ranges from 10-12 cm (wrist) up to 14-16 cm for knee or thigh). • Matrix ranges from 256 x 256 for smaller FOV, up to 512 x 512 for larger FOV.
- For small FOV, no interslice gap. For larger FOV such as sciatic nerves, can have interslice gap for improved coverage of axial scans.

MSK11: Upper or lower extremity MRI without contrast (long bone evaluation)

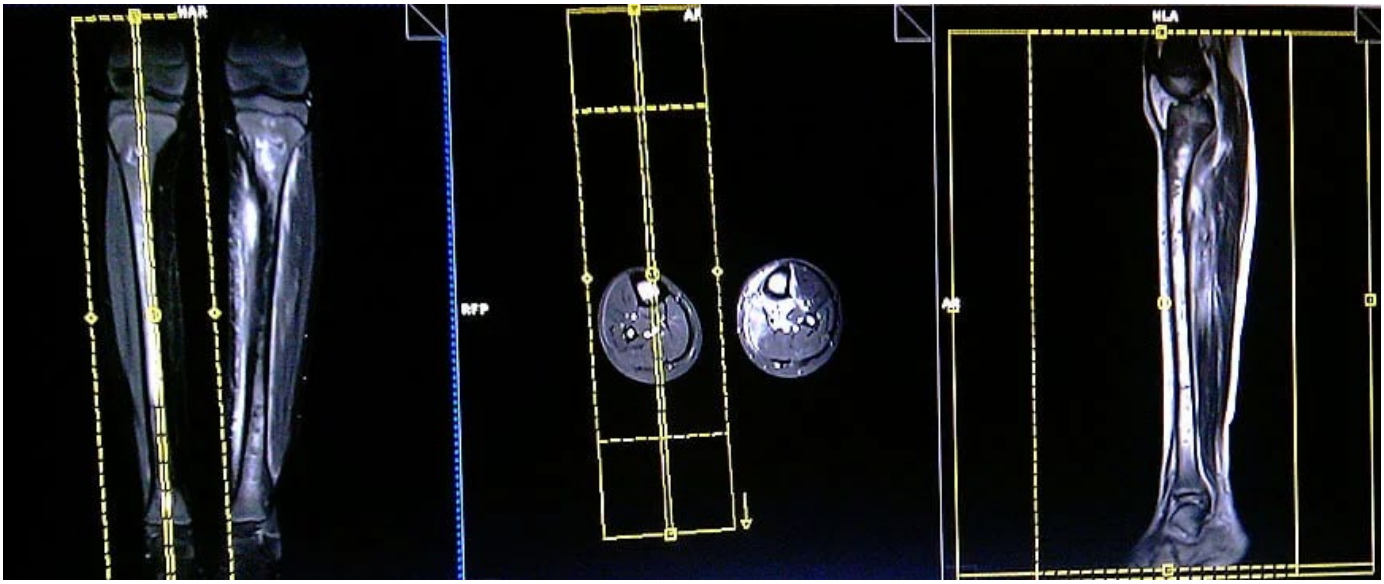
Indications: non-specific pain; tibial stress fractures.

Sequences: place fiducial over site of concern

- Coronal T1 SE
- Coronal STIR
- Sagittal T1 SE
- Sagittal STIR
- Axial T1 SE
- Axial T2 FSE with fat saturation Comments:
- On coronal and sagittal images, include entire long bone of concern. May include contralateral leg/thigh on coronal for comparison.
- On axial images, restrict the slices to the actual lesion or site of concern. May include contralateral leg/thigh at tech's or rad's discretion.
- Typically done for humerus, femur, leg, or forearm

Positioning:

- Coronal = Image the entire requested bone in a plane parallel to the long axis of bone shaft.
- Sagittal = Image perpendicular to the coronal plane. For Humerus, should be perpendicular to a line through the medial and lateral epicondyles at the elbow. For femur should be along the long axis, ensuring appropriate angulation posterior to anterior. For forearm or lower leg, should be perpendicular to a plane from the medial and lateral cortex of the tibia or though a line bisecting the radius and ulna of the forearm.
- Axial = image perpendicular to the shaft of the long bone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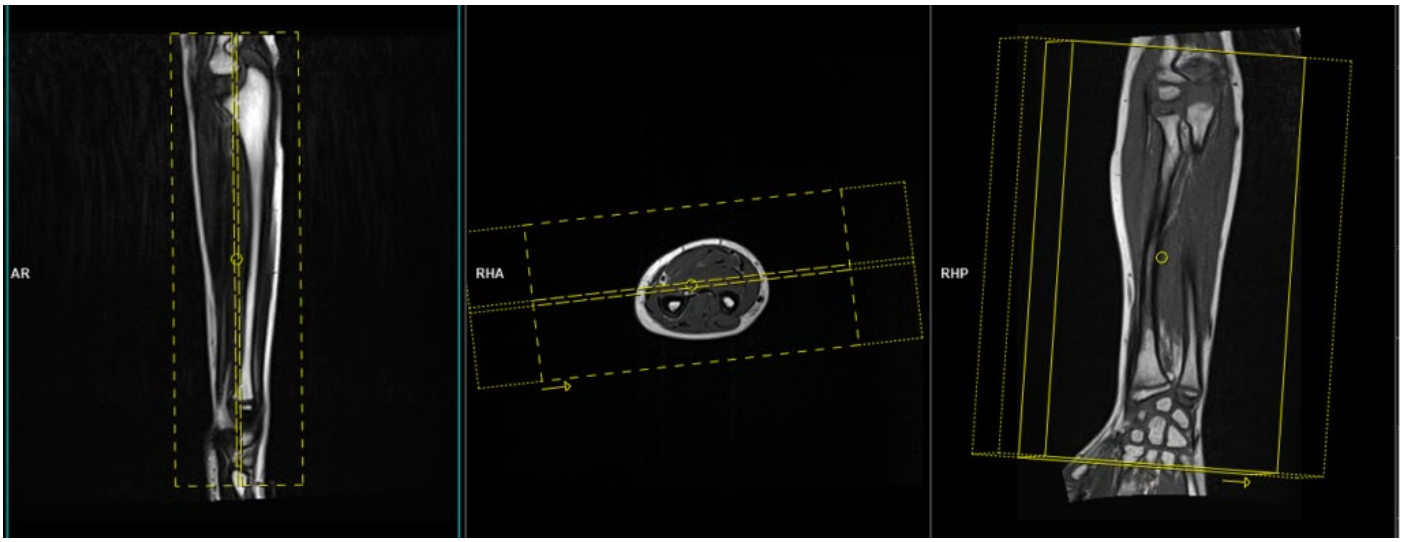
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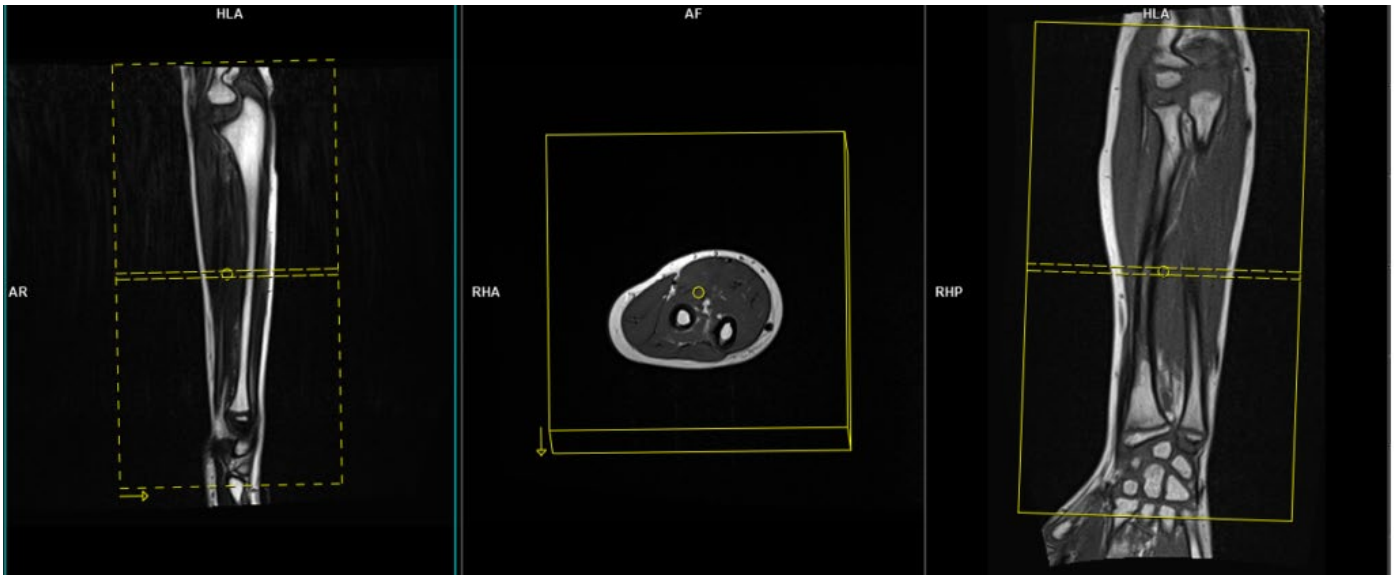
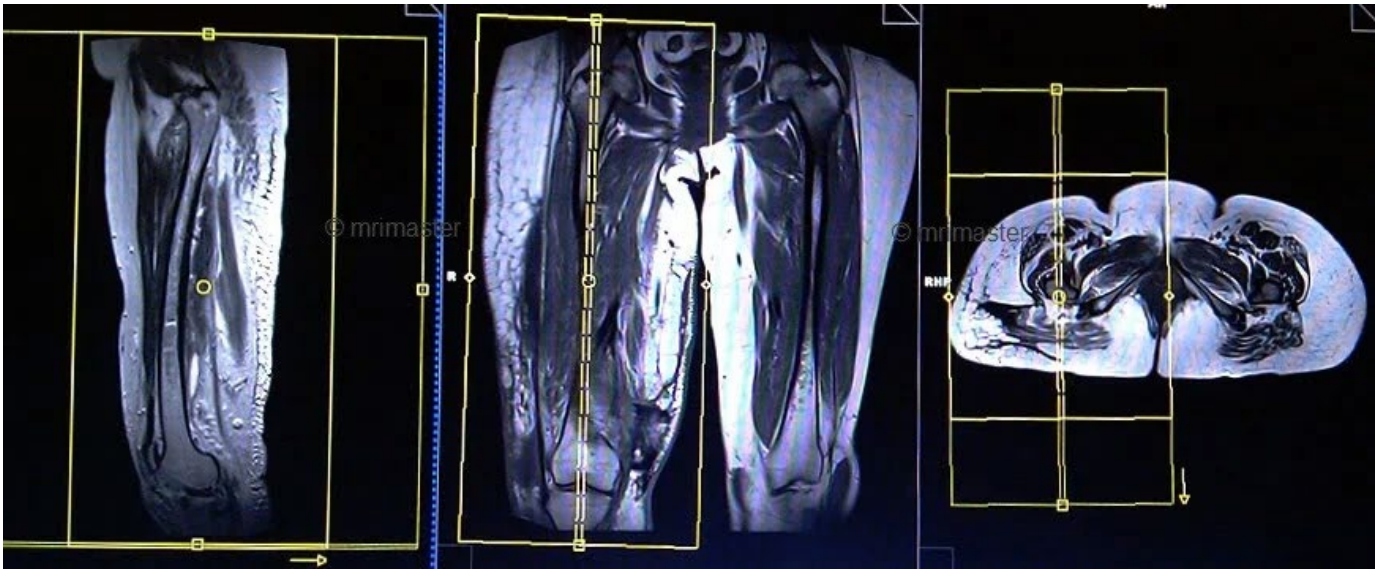




Comments:

- Fiducial placement is critical for stress fracture exams as findings can be extremely subtle
- On coronal and sagittal images, include entire long bone of concern. May include contralateral leg/thigh on coronal for comparison.
- On axial images, restrict the slices to the actual lesion or site of concern. May include contralateral leg/thigh only if bilateral symptoms.
- Typically done for humerus, femur, leg, or forearm

MSK12: Thoracic spine, lumbar spine, and pelvis MRI (bone marrow survey)

Indications: assess extent of bone marrow metastases, typically for multiple myeloma.

Sequences:

- place skin marker over upper T-spine for determining levels.
- Large FOV sagittal T1 SE through C-, T-, and L-spine
- Large FOV sagittal STIR through C-, T-, and L-spine • Large FOV coronal T1 SE through entire thorax
- Large FOV coronal STIR through entire thorax
- Coronal T1 SE through bony pelvis and femurs • Coronal STIR through bony pelvis and femurs

Comments:

- On sagittal spine sequences, divide spine into 2 scans if needed.
- Can recommend whole body PET-CT as an alternative means of assessing myelomatous involvement. Bredella et al. AJR 2005; 184: 1199-1204.

MSK13: Pre- and post-contrast hand MRI (arthritis protocol)

Indications: characterize and follow-up inflammatory arthritides in the hands and wrists.

Sequences: if doing both hands/wrists, position hands and wrists together in prayer position, with skin marker over the dorsum of the right hand as reference. Patient should be in lateral decubitus position. Use knee or extremity coil.

- Axial T1 spin echo
- Axial T2 FSE with fat sat (TE 40 msec +/- 5 msec)
- Coronal T1 spin echo • Coronal T2 FSE with fat sat (TE 40 msec +/- 5 msec)
- Post-Gadolinium axial T1 spin echo with fat saturation
- Post-Gadolinium coronal T1 spin echo with fat saturation Comments: • Use 3 mm slice thickness for all sequences.
- Rectangular FOV of around 130-140 mm: adjust as necessary to include entire carpal region; fingertips can be excluded if necessary.

Comments:

- Proper labeling of Left and Right sided images is essential for this exam as it can be very confusing for interpretation especially if all images are sent to both exam jackets.
- Use 3 mm slice thickness for all sequences.
- Rectangular FOV of around 130-140 mm: adjust as necessary to include entire carpal region; fingertips can be excluded if necessary.
- Schoellnast et al. AJR 2006; 187: 351-357. David Rubin, personal communication.

MSK14: Non-contrast chest MRI (pectoralis protocol)

Indications: characterize pectoralis major muscle/tendon injuries.

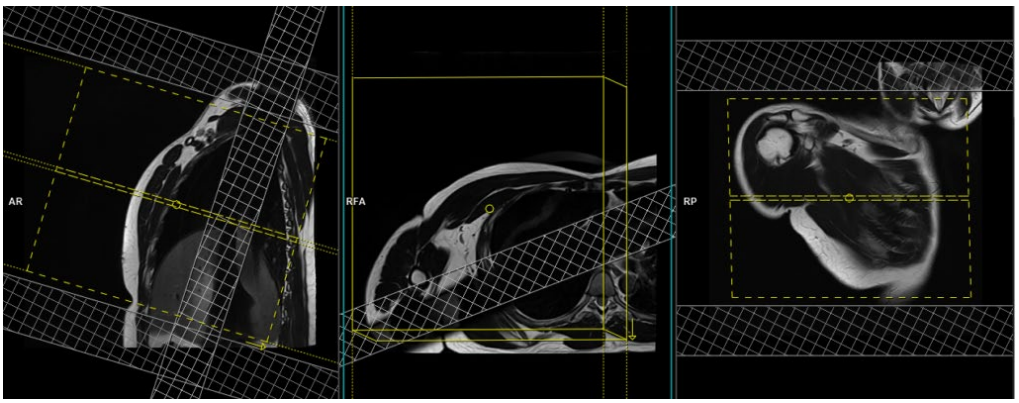
Sequences: use coronal localizer to set axial scan landmarks.

- Axial T1 spin echo
- Axial T2 FSE with fat sat (TE 40 msec +/- 5 msec)
- Oblique coronal T1 spin echo • Oblique coronal STIR • Axial T2 FSE with fat sat (TE 40 msec +/- 5 msec)
- Oblique coronal T2 FSE with fat sat (TE 40 msec +/- 5 msec)
- Oblique sagittal T2 FSE with fat sat (TE 40 msec +/- 5 msec)

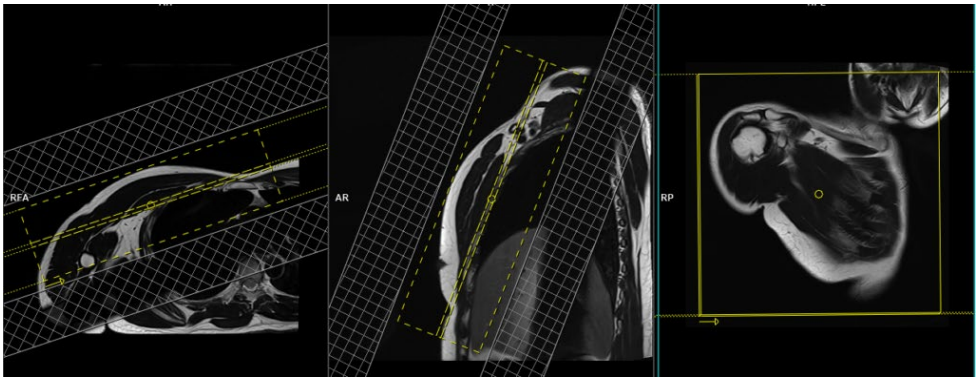
Positioning:

- If possible, position patient supine to minimize respiratory motion.
- Axials: scan from lower edge of humeral head down to the deltoid tuberosity of the humeral shaft, using coronal localizers.
- Oblique coronal sequences: set parallel to course of pectoralis major tendon from axial images.
- Use 5-inch surface coil centered over the axilla.
- 32 x 42 cm FOV for initial 4 sequences, 5 mm slice thickness with 0.5 mm gap for axials, 3 mm slice thickness with 0.3 mm gap for oblique coronals.
- 18 x 21 cm FOV for last 3 sequences centered around pectoralis major tendon insertion on humeral shaft.

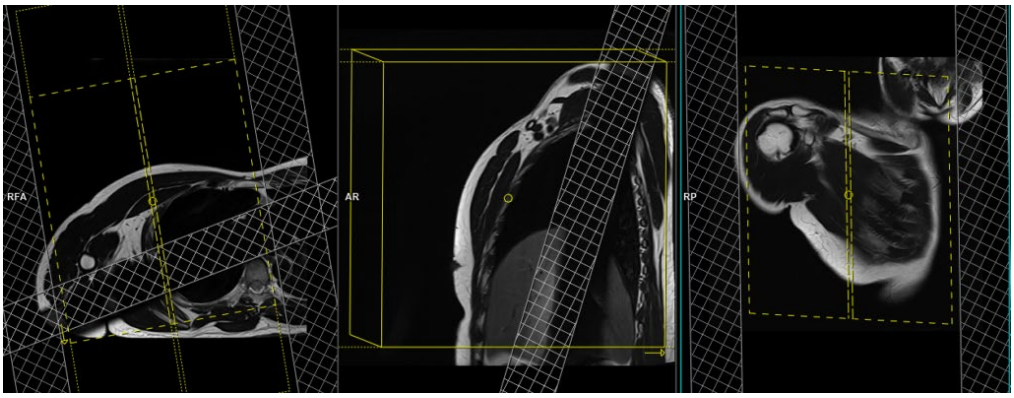
Oblique coronal



Oblique sagittal



Axial



MSK15: Non-contrast pelvic MRI (athletic pubalgia/sports hernia protocol)

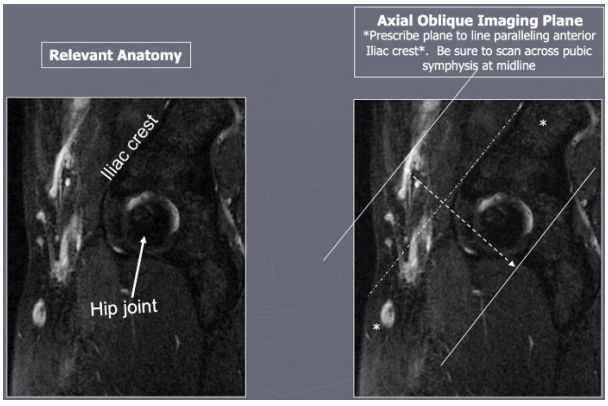
Indications: pubic symphysis region pain, osteitis pubis,core muscle injury, athletic pubalgia, sports hernia, groin strain.

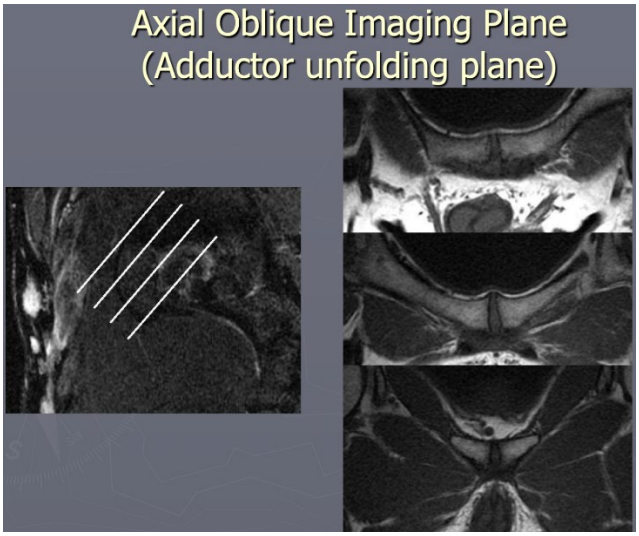
- Sequences:
- Coronal T1 spin echo through bony pelvis.
- Coronal STIR through bony pelvis.
- Axial T2 FSE with fat sat through pelvis (TE 40 msec +/- 5 msec)
- Sagittal T2 FSE with fat sat (TE 40 msec +/- 5 msec): small FOV.
- Oblique axial PD FSE: small FOV.
- Oblique axial T2 FSE with fat sat (TE 40 msec +/- 5 msec): small FOV.

Positioning:

- Large FOV Coronal = large field of view extending from approximately 2 inches above the iliac crest to 2 inches below the pubic symphysis
- Large FOV Axial = plane perpendicular to the coronal plane, aligned parallel to the femoral heads. Scan through the entire bony pelvis

- Small FOV Sagittal = plane perpendicular to large FOV coronal plane. Scan from medial wall of one acetabulum to the medial wall of the other acetabulum.
- Small FOV Axial oblique = plane parallel to the anterior iliac crest across the entire pubic symphysis from the medial wall of one acetabulum to the medial wall of the contralateral acetabulum.





Comments:

- Patients should empty bladders immediately prior to scan.
- For Small FOV sequences only:
    - Use 5-inch surface coil centered over symphysis.
    - Oblique axial plane: use sagittal image near hip joint to set plane parallel to arcuate line.
    - 4 mm slice thickness with 0 skip.
    - 20 x 20 cm FOV, with 256 x 256 matrix.
- Reference: Omar et al. Radiographics 2008; 28: 1415-1438.

MSK16: Chest and Body Wall MRI (Body wall mass protocol)

Indications: characterize a soft tissue mass on the chest or abdominal wall.

Sequences: use coronal localizer to set axial scan landmarks.

- Axial T1 spin echo
- Axial T2 FSE with fat sat (TE 40 msec +/- 5 msec)
- Coronal T1 spin echo
- Coronal T2 FSE with fat sat (TE 40 msec +/- 5 msec)
- Coronal pre-Gd 3D VIBE with fat saturation.
- Coronal post-Gd 3D VIBE with fat saturation (axial, sag reformats)

If known musculoskeletal malignancy (i.e. chest wall sarcoma) post surgical excision (i.e. for surveillance indication) add:

- Axial 2D FLASH in- and out-of-phase
- Axial Diffusion and ADC (b = 50, 400, 800)

Positioning:

- If mass is anterior, try to position patient prone, if tolerable, to minimize motion

Comments:

- Place fiducial on mass or bracket the mass if palable

MSK17: Sternum MRI

Indications: sternal pain, sternum bone lesion.

Sequences: use coronal localizer to set axial scan landmarks.

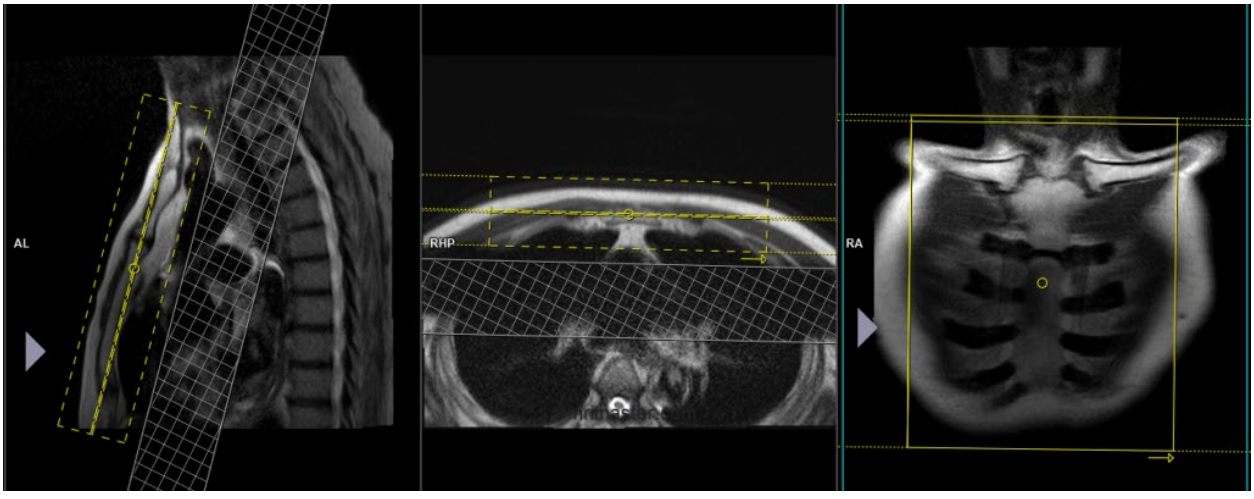
- Axial T1 spin echo
- Axial T2 FSE fat suppressed
- Coronal T1 spine echo
- Coronal T2 FSE fat suppressed
- Sagittal T2 FSE fat suppressed

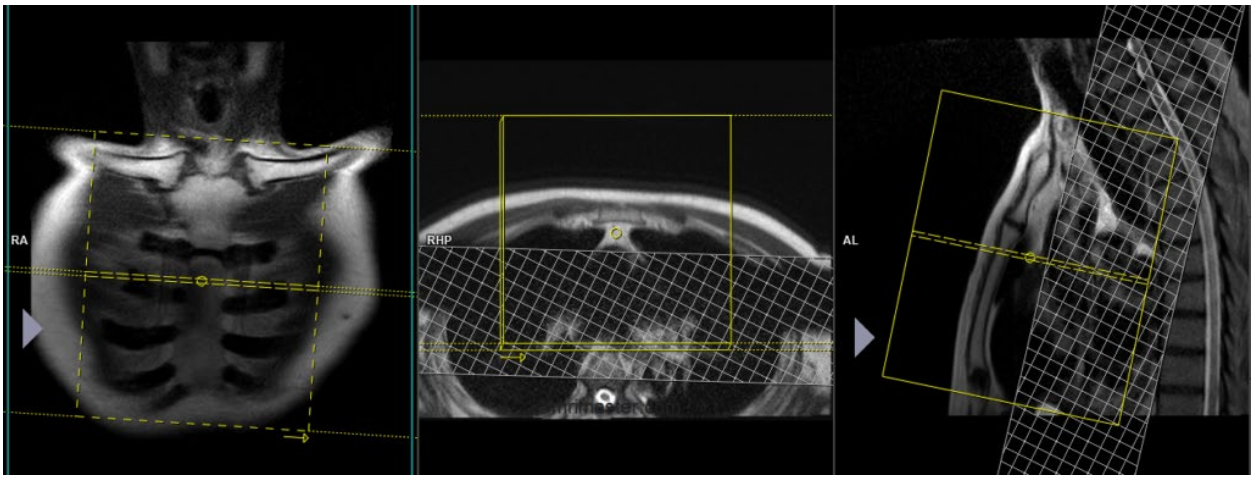
For pre- and post-contrast exams, add the following:

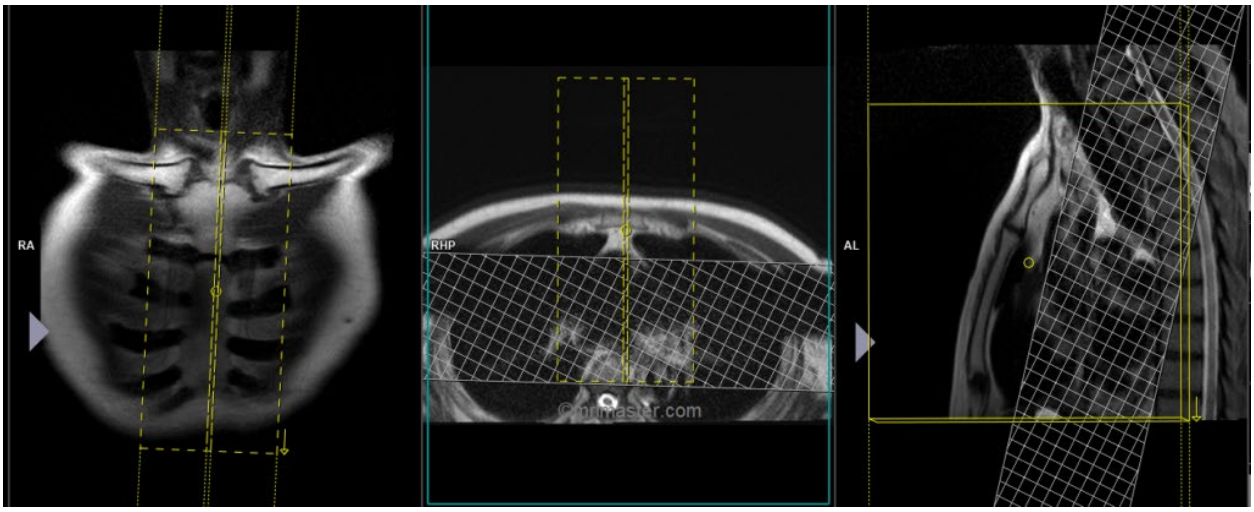
- Non-contrast axial T1 SE with fat saturation.
- Post-contrast: coronal, sagittal, axial T1 SE with fat saturation.

Positioning:

- Coronal = plan along the long axis of the central sternum. Scan at least 2 inches posterior to and anterior to the sternum
- Axial = plane perpendicular to the coronal sequence, aligned with the transverse axis of the sternum
- Sagittal = plane perpendicular to the axial sequence







Comments:

- Use a second two plane localizer aligned to the sternum to set a true coronal and axial relative to the sternum
- Prone if possible, if not possible, then please try respiratory triggered sequences

MSK18: Sternoclavicular joint MRI

Indications: sternoclavicular joint pain, inflammatory arthritis of SC joint.

Sequences: use coronal localizer to set axial scan landmarks.

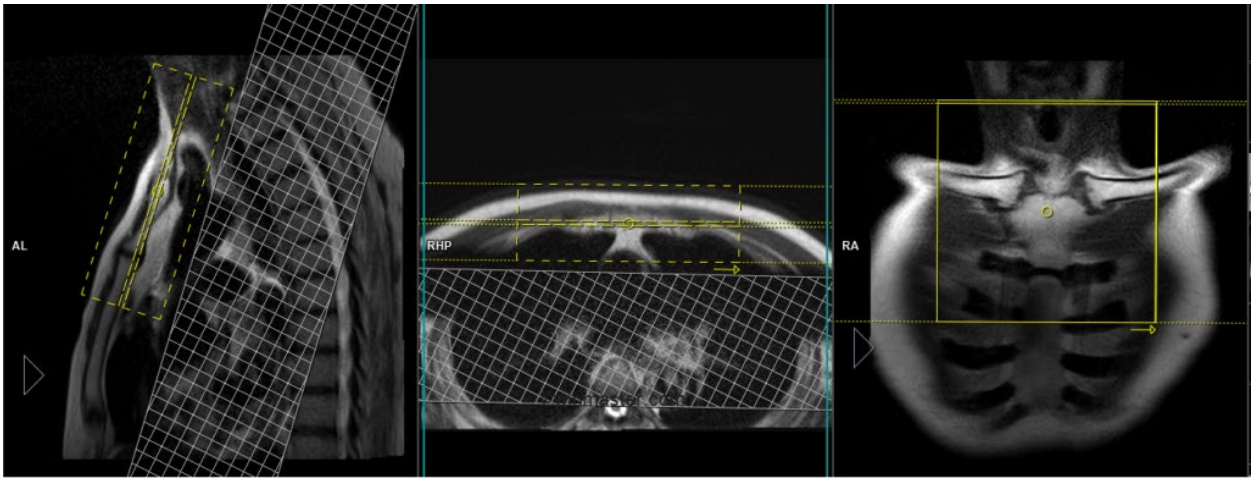
- Axial T1 spin echo
- Axial T2 FSE
- Coronal T1 spine echo
- Coronal T2 FSE
- Sagittal T2 FSE

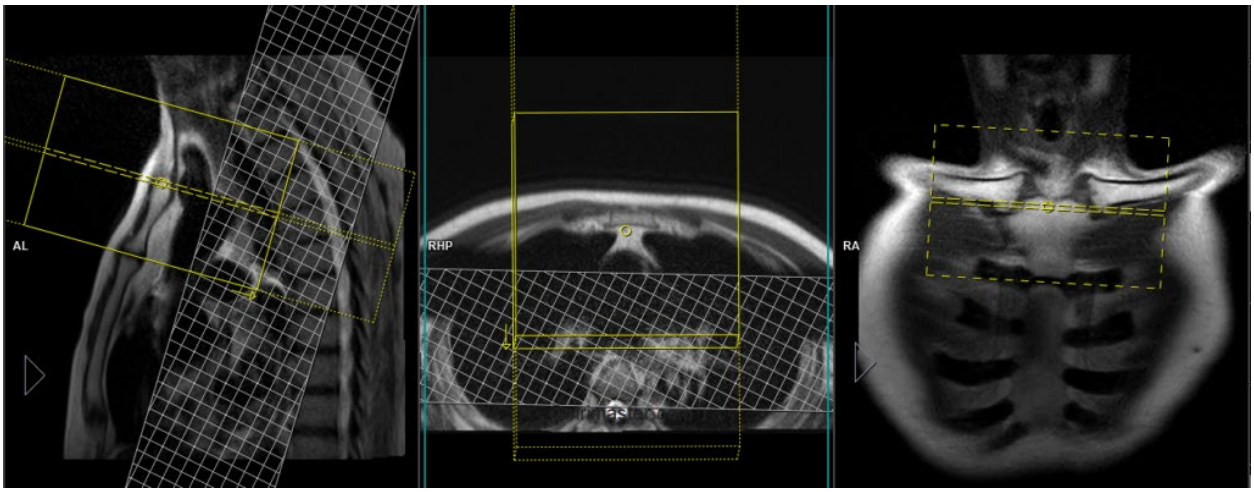
For pre- and post-contrast exams, add the following:

- Non-contrast axial T1 SE with fat saturation.
- Post-contrast: coronal, sagittal, axial T1 SE with fat saturation.

Positioning:

- Coronal = plan along the long axis of the manubrium. Scan 2 inches posterior to and anterior to the sternoclavicular joints
- Axial = plane perpendicular to the coronal sequence, aligned with the transverse axis of the superior manubrium
- Sagittal = plane perpendicular to the axial sequence





Comments:

- Use a second two plane localizer aligned to the manubrium (superior sternum) to set a true coronal and axial relative to the manubrium
- Prone if possible, if not possible, then please try respiratory triggered sequences

MSK19: Scapula MRI

Indications: scapular pain, scapula bone lesion, scapula fracture, scapula mass

Sequences: use coronal localizer to set axial scan landmarks.

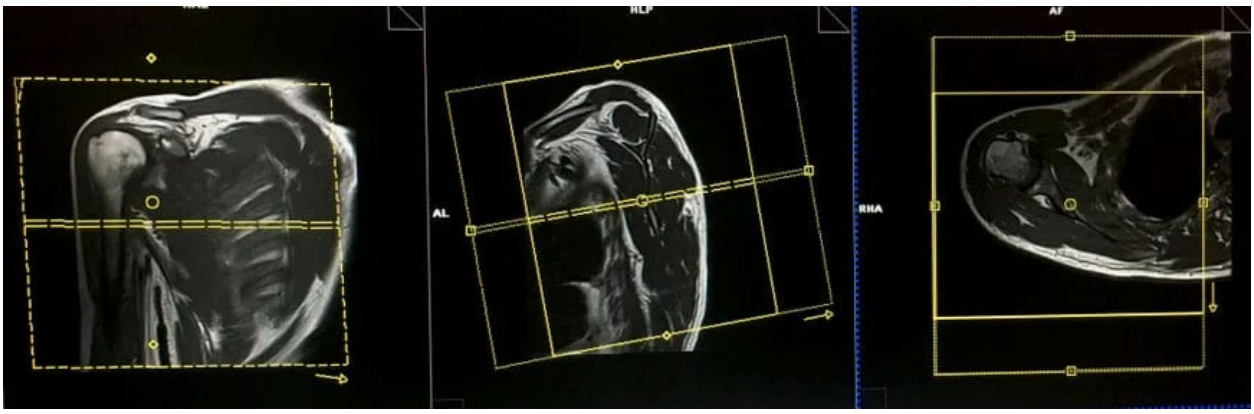
- Axial T1 spin echo
- Axial T2 FSE
- Coronal T1 spine echo
- Coronal T2 FSE
- Sagittal T2 FSE

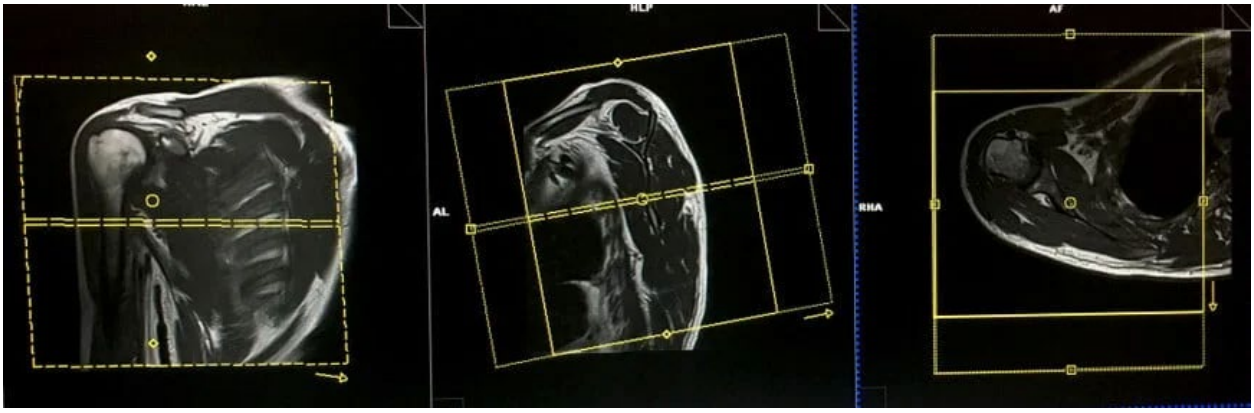
For pre- and post-contrast exams, add the following:

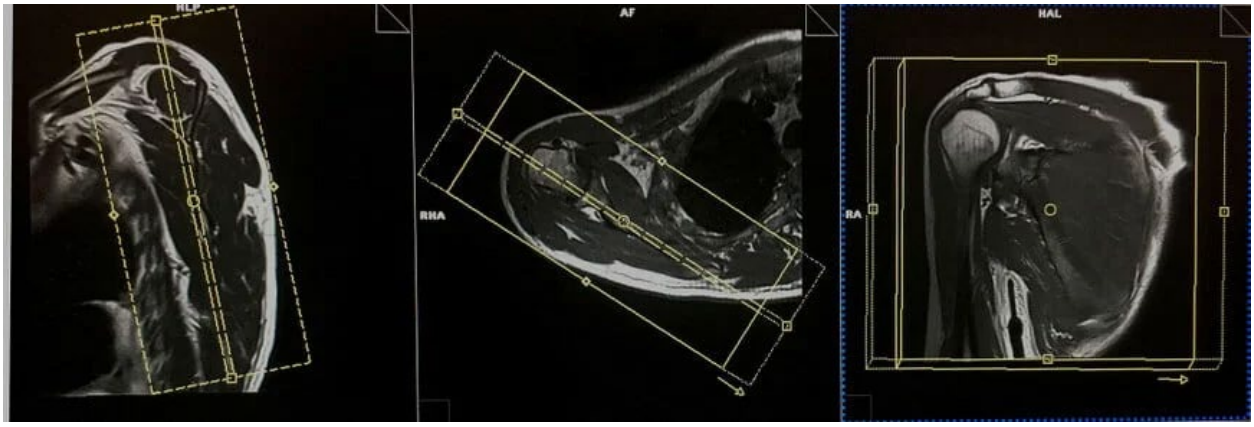
- Non-contrast axial T1 SE with fat saturation.
- Post-contrast: coronal, sagittal, axial T1 SE with fat saturation.

Positioning:

- Coronal = plan along the long axis of the scapular body. Include tissues deep rib margin through the superiofical skin
- Axial = plane perpendicular to the coronal sequence, aligned with the transverse axis of the scapula
- Sagittal = plane perpendicular to the axial sequence along the long craniocaudal axis of the scapular body







Comment:

- Patient positioned off center within bore so that scapula of interest is closer to center of body coil.