

MSK MRI PROTOCOL OVERVIEW

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MSK MRI PROTOCOL OVERVIEW

SHOULDER (ROUTINE)

GENERAL COMMENTS

- Supraspinatus tendon is what you use to plan the coronal sequence for a routine shoulder
- Glenohumeral joint is what you use to plan the coronal and sagittal sequences for a post arthrogram shoulder

COIL

- Shoulder coil
- Large 4 channel flex coil for larger patient (make certain that coverage has enough signal for the AC joint)
- Body matrix coil for an extremely large patient

POSITIONING

- Supine
- Try to have shoulder neutral (external rotation is fine)
- Try to limit superior or inferior positioning of shoulder when compared to the chest (IF THE SHOULDER IS MARKEDLY ANGLED, YOU CAN ANGLE THE AXIAL IMAGES PERPENDICULAR TO THE GLENOHUMERAL JOINT)
- Try to place shoulder as close to isocenter in the bore of the magnet
- Place a sponge at the elbow and one supporting the hand and strap the arm in place

SEQUENCES, AND WHAT IS MOST IMPORTANT TO REPEAT

- Cor T2 FS is most important sequence to repeat if motion
- Axial PD FS is next most important sequence

1. AX T1
2. AX PD FS
3. COR T2 FS
4. COR T2
5. SAG T2 FS
6. SAG T2

SEQUENCES

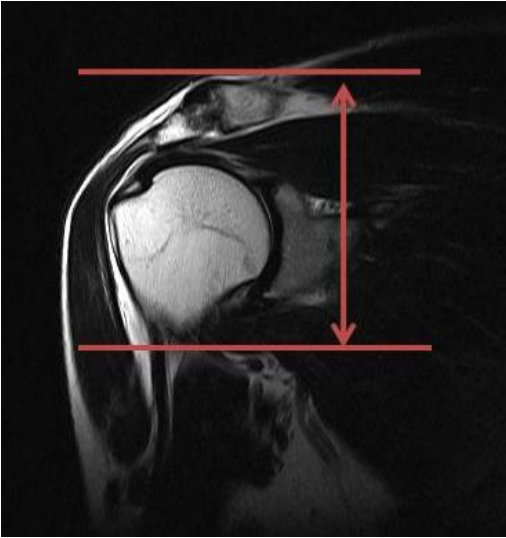
LOC

3 PLANE LOC

MSK MRI PROTOCOL OVERVIEW

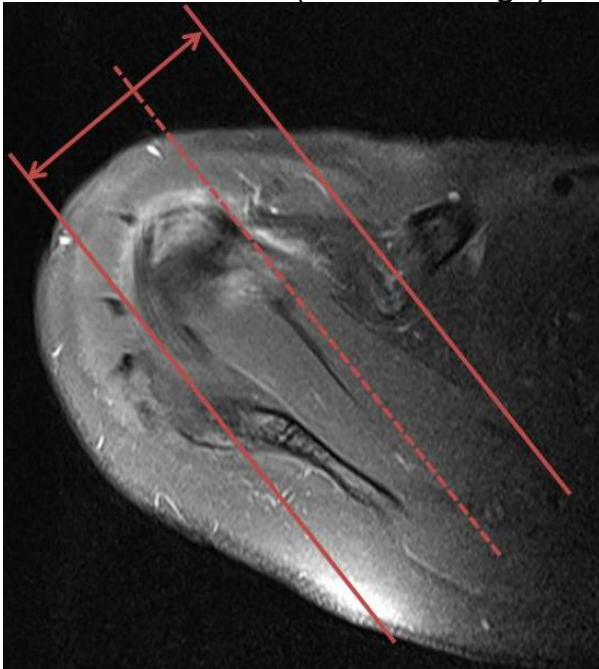
1. AXIAL T1 AND PD FS

- Use coronal LOC and plane is straight horizontal (IF THE SHOULDER IS MARKEDLY ANGLED, YOU CAN ANGLE THE AXIAL IMAGES PERPENDICULAR TO THE GLENOHUMERAL JOINT)
- Cover from top of AC joint down and try to cover to the inferior portion of the glenohumeral joint axillary pouch
- No Sat Band



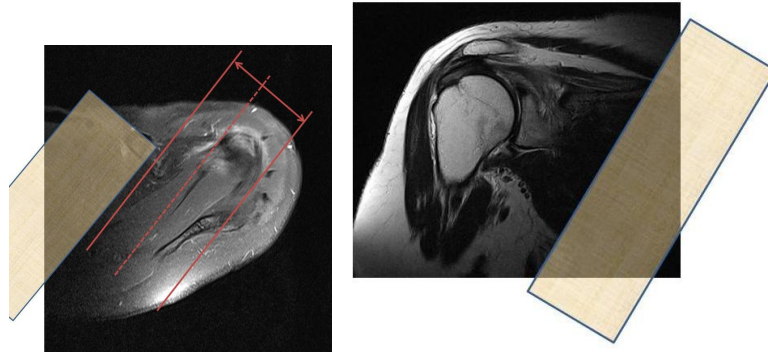
2. COR T2 AND T2 FS

- Use axial T1 or PD FS sequence to orient the plane along the supraspinatus tendon (first image)
- If the supraspinatus tendon is not well seen, you can either use the teres minor tendon (second image) or the glenohumeral joint



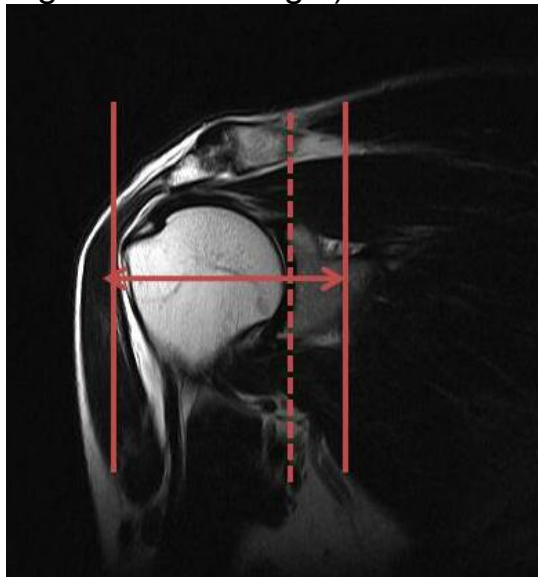
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- Cover from anterior portion of coracoid process to 1 slice posterior to the humeral head.
- Oblique Sat band over chest

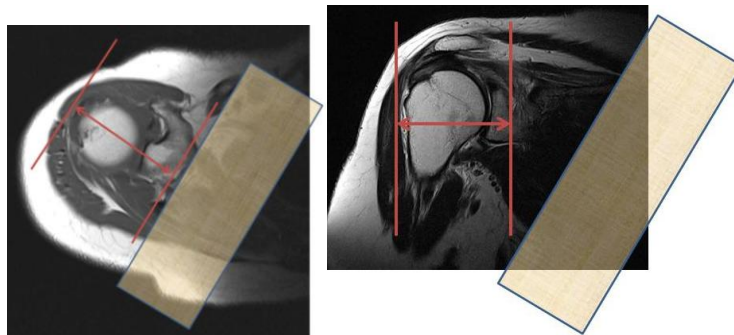


3. SAG T2 FS

- Perpendicular to Coronal sequence
- Angle approximately parallel to GH joint on the Cor T2 sequence (use Glenoid articulating surface to angle)



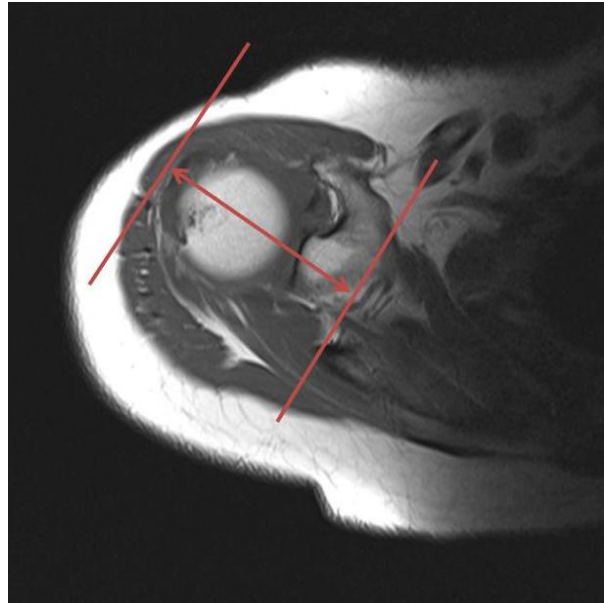
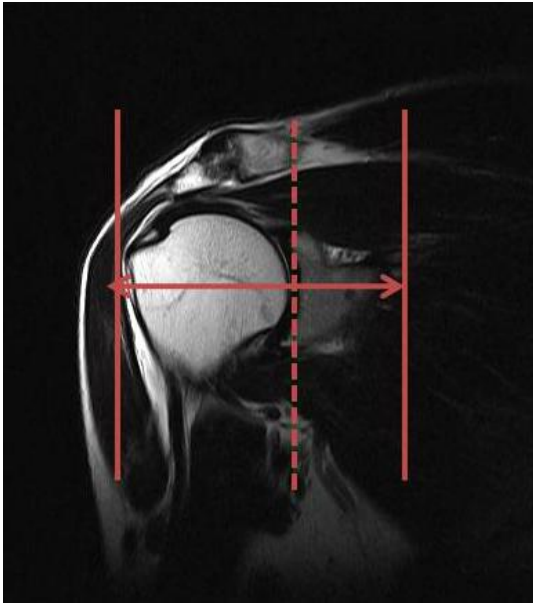
- Cover from 1 slice out of humeral head to as far medial as slices allow
- Oblique Sat band over chest



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4. SAG T2

- The slices are thicker than the SAG T2 FS (to cover more of the muscle bellies)
- Oblique Sat band over chest
- Cover from 1 slice out of humeral head to as far medial as the slices go (to approx. the medial portion of the coracoid process)



MSK MRI PROTOCOL OVERVIEW

SHOULDER + PROXIMAL BICEPS

GENERAL COMMENTS

- Covers shoulder and down to mid-to-distal humerus
- Can't use shoulder coil because it does not work with the body matrix coil

COIL

- Large 4 channel flex coil over shoulder
- Body matrix coil over upper arm, minimally overlapped with flex coil
- Use both coils at the same time only for the SAG T2

POSITIONING

- Supine
- Try to have shoulder neutral (external rotation is fine)
- Try to limit superior or inferior positioning of shoulder when compared to the chest
- Try to place shoulder as close to isocenter in the bore of the magnet
- Place a sponge at the elbow and one supporting the hand and strap the arm in place

SEQUENCE ORDER

SHOULDER

1. AX T1
2. AX PD FS
3. COR T2 FS
4. COR T2
5. SAG T2 FS

SHOULDER AND UPPER ARM

7. SAG T2

UPPER ARM

8. AX T1
9. STIR

SEQUENCES

LOC (BOTH COILS ON FOR LOC)

3 PLANE LOC

MSK MRI PROTOCOL OVERVIEW

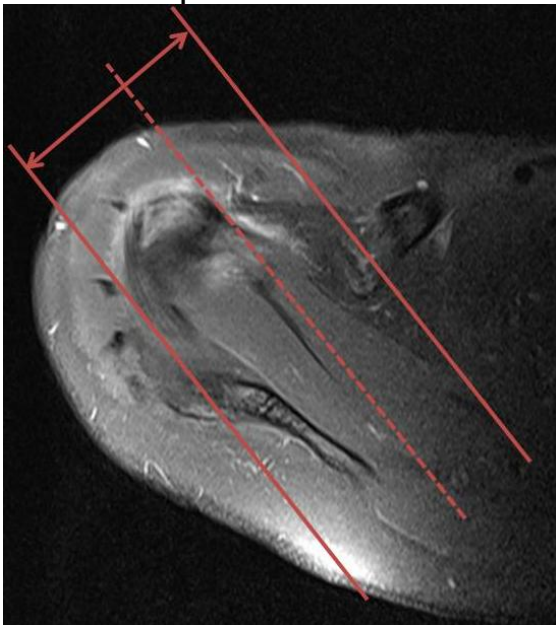
1. AXIAL T1 AND PD FS

- Use coronal LOC and axial plane is straight horizontal (don't angle)
- Cover from top of AC joint down and try to cover to the inferior portion of the glenohumeral joint axillary pouch
- No Sat Band

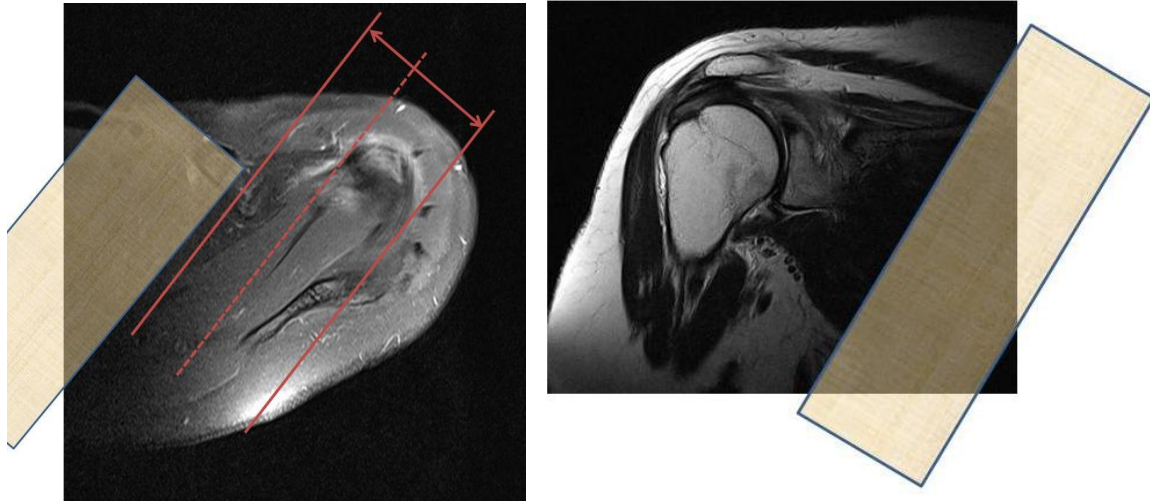


2. COR T2 AND T2 FS

- Use axial T1 or PD FS sequence to orient the plane along the supraspinatus tendon.
- If the supraspinatus tendon is not well seen, you can either use the teres minor tendon or the scapular body
- Cover from anterior portion of coracoid process to 1 slice posterior to the humeral head.
- Oblique Sat band over chest

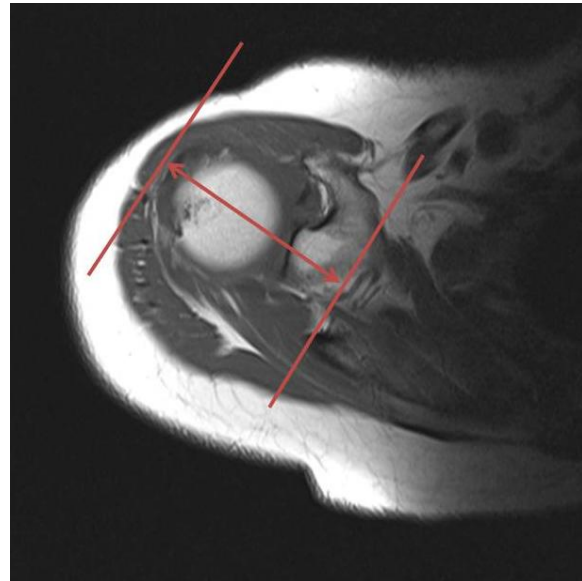
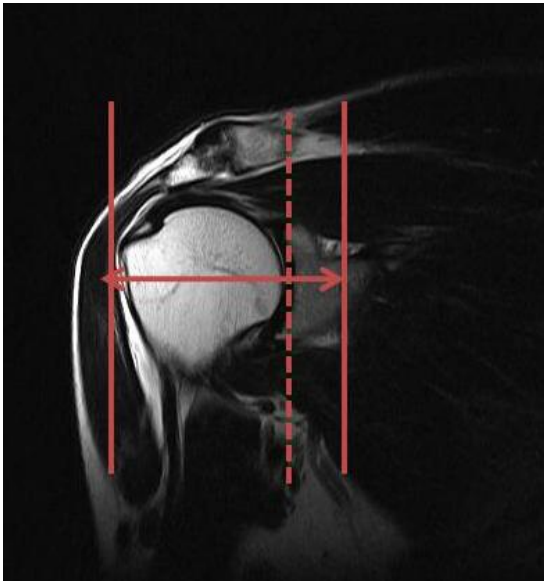


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3. SAG T2 FS

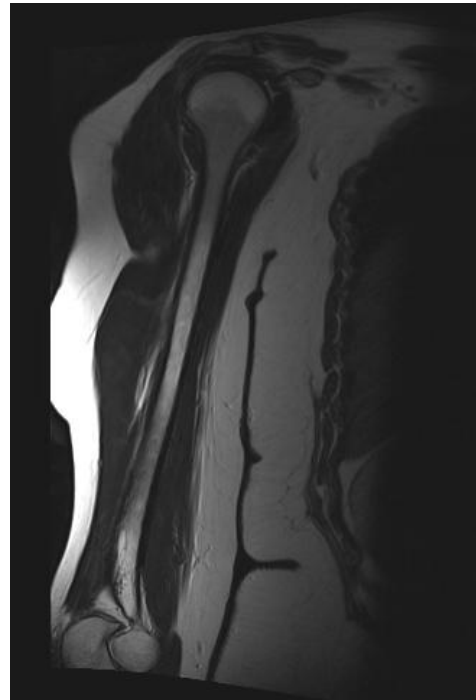
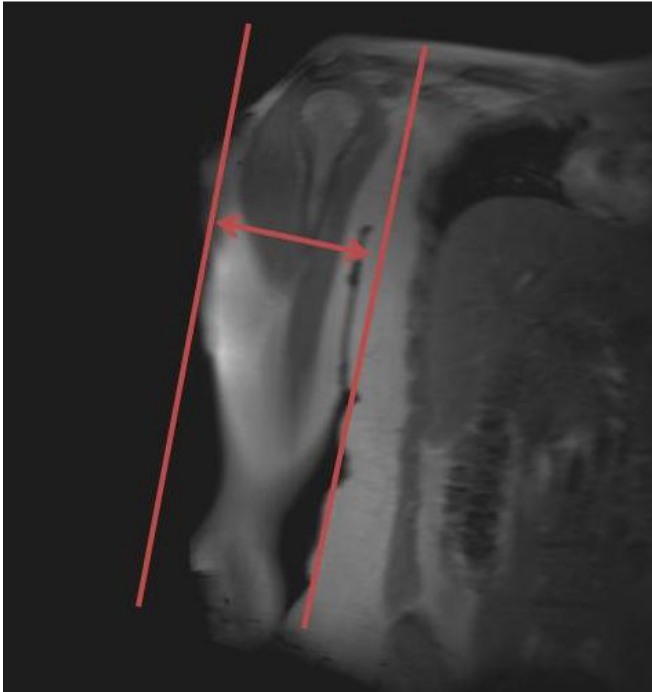
- Perpendicular to Coronal sequence
- Angle parallel to GH joint or humeral shaft on the Cor T2 sequence
- Cover from 1 slice out of humeral head to as far medial as slices allow
- Oblique Sat band over chest



MSK MRI PROTOCOL OVERVIEW

4. SAG T2

- The FOV is bigger, the slices are thicker, and there are more slices (to cover most of the muscles of the upper arm)
- Try and use same alignment as for the SAG T2 FS
- Oblique Sat band over chest



5. AXIAL T1

- Overlap 1-2 slices with Axials of Shoulder
- Cover down as far as slices allow
- Sat band above

6. AXIAL STIR

- Overlap 1-2 slices with Axials of Shoulder
- Cover down as far as slices allow
- Parallel Sat bands above and below

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ELBOW (ROUTINE)

COIL

- Use 4 Channel Flex coil
- Make sure the coil is centered at the olecranon

POSITIONING

- Supine (or if a large patient in the Superman position)
- Try to have elbow fully extended
- Try to have hand supinated (palm up and put sandbag on hand)
- Elevate elbow with a sponge to isocenter (if supine)
- Sponge and strap elbow in place

SEQUENCES, AND WHAT IS MOST IMPORTANT TO REPEAT

- Axial PD and COR STIR sequences are the most important to repeat

1. COR STIR
2. COR T1
3. AX PD
4. AX STIR
5. SAG PD FS

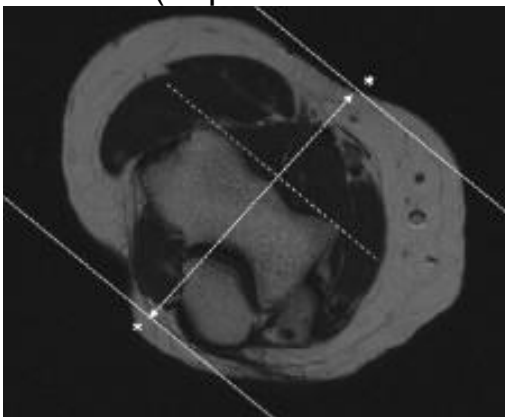
SEQUENCES

AX LOC

3 PLANE LOC

1. CORONAL T1 AND STIR SEQUENCES

- Use axial LOC to angle parallel to anterior portions of the capitellum and trochlea (or parallel to humeral epicondyles)



MSK MRI PROTOCOL OVERVIEW

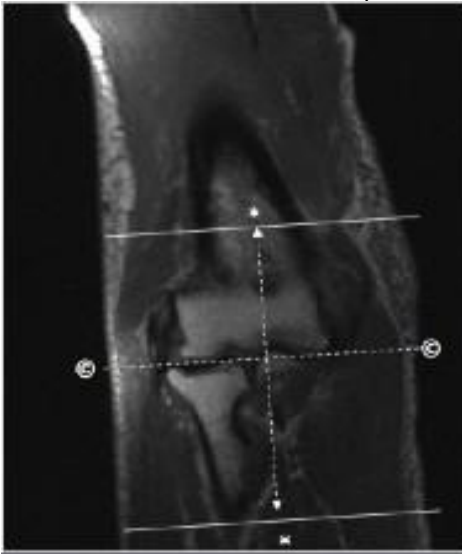
- Use sagittal LOC to angle parallel to humerus/radius/ulnar plane, but closer to plane of radius if minimally flexed (if markedly flexed elbow, then angle between anterior humerus and the radius)



- Cover from back of the olecranon to at least 1 slice anterior to radial head

2. AXIAL PD AND STIR SEQUENCES

- Perpendicular to Coronal
- Use COR T1 to angle parallel to elbow joint (parallel to capitellum and trochlea)
- Cover from 1 slice distal to radial tuberosity up as far as the slices go
- Parallel Sat Bands (above and below)



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3. SAGITTAL PD FS SEQUENCE

- Perpendicular to both Coronal and Axial sequences
- Cover 1 slice outside of both humeral epicondyles
- No Sat Band



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ELBOW + DISTAL BICEPS TENDON

GENERAL COMMENTS

- Larger FOV than normal elbow (to cover more of the muscle)
- Covers more anteriorly (covers biceps muscle)
- Need to cover 1 slice distal to radial tuberosity

COIL

- Use Body Matrix Coil (to cover higher)
- Make sure the coil covers from the radial tuberosity to as high on the humerus as the coil goes

POSITIONING

- Supine (or if a large patient in the Superman position)
- Try to have elbow fully extended
- Try to have hand supinated
- Elevate elbow with a sponge to isocenter (if supine)
- Sponge and strap elbow in place

SEQUENCES, AND WHAT IS MOST IMPORTANT TO REPEAT

- Axial PD and COR STIR sequences are the most important to repeat
- Then repeat SAG PD FS

1. COR STIR
2. COR T1
3. AX PD
4. AX STIR
5. SAG PD FS

- Reposition
6. FABS PD FS

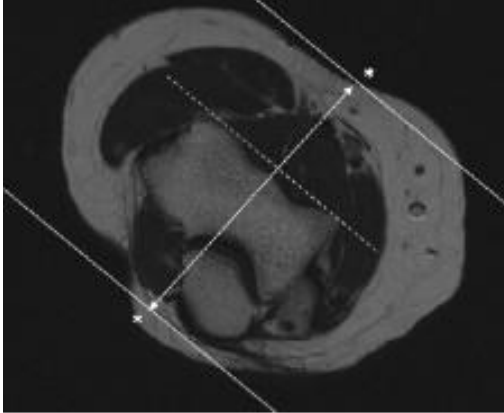
SEQUENCES

AX LOC
3 PLANE LOC

MSK MRI PROTOCOL OVERVIEW

1. CORONAL T1 AND STIR SEQUENCES

- Use axial LOC to angle parallel to anterior portions of the capitellum and trochlea (or parallel to humeral epicondyles)



- Use sagittal LOC to angle parallel to humerus/radius/ulna plane (if flexed then angle more parallel to humerus)
- Cover from anterior muscles back to at least mid-portion of olecranon
- No Sat Bands



2. AXIAL PD AND STIR SEQUENCES

- Perpendicular to Coronal
- Use COR T1 to angle parallel to elbow joint (parallel to capitellum and trochlea)
- Cover from 1 slice distal to radial tuberosity and up as far as the slices go
- Parallel Sat Bands
- Can do a second PD and STIR stack higher up biceps muscle if the abnormal muscle is not all covered (Or slightly thicker slices if the extra coverage is not that much)

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3. SAGITTAL PD FS SEQUENCE

- Perpendicular to both Coronal and Axial sequences
- Cover 1 slice outside of both humeral epicondyles

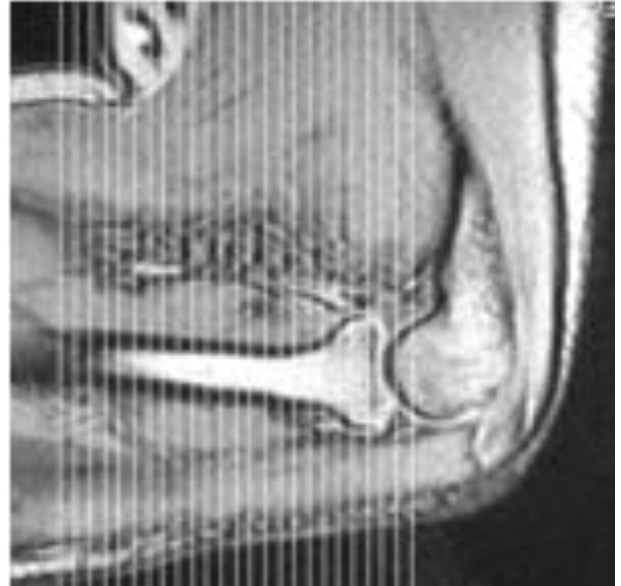
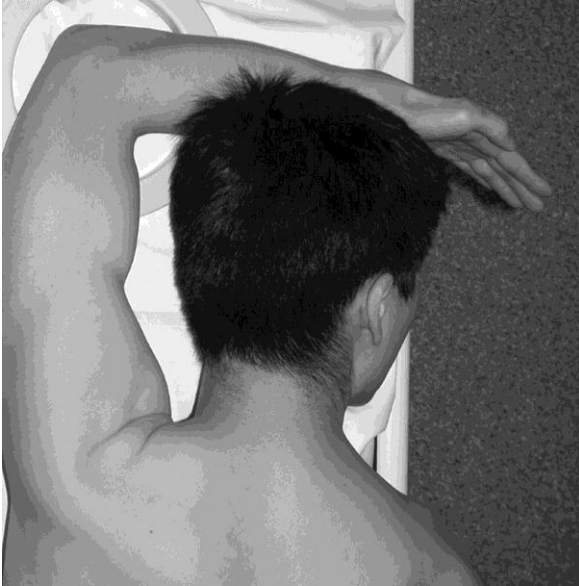


4. FABS PD FS SEQUENCE

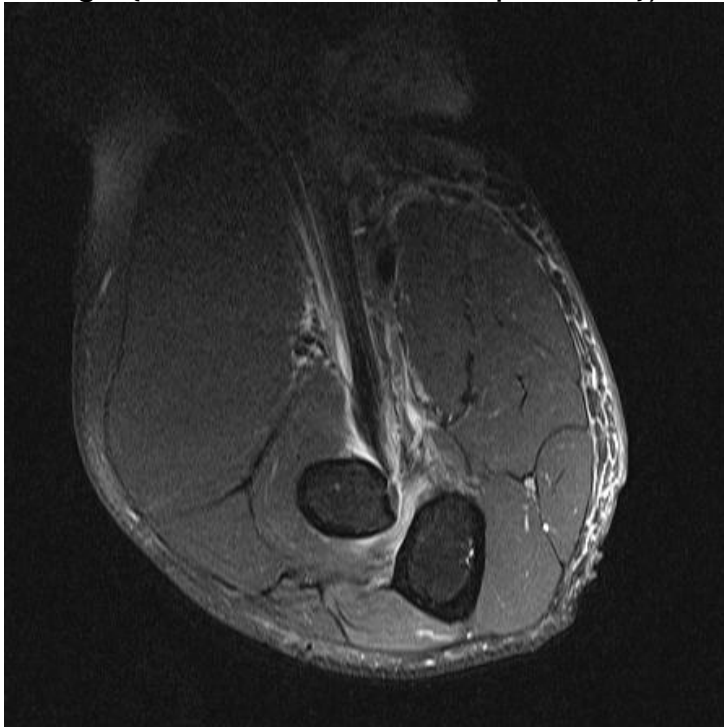
- Reposition with arm abducted over head, flexed to 90 degrees (try to limit hyperflexion), and supinated (thumb up)
- Use Body Matrix Coil and wrap around lower humerus, and make sure to cover the radial tuberosity, and cover up to approx. the mid humerus
- Axial LOC and then a 3 Plane LOC and get a good Sagittal LOC
- Angle Parallel to humeral shaft

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- Obtain slices from outside of radial tuberosity and up to but not including the humerus



- FABS Sequence (Try and have more signal in the upper arm than on this image {have coil cover more proximal})



MSK MRI PROTOCOL OVERVIEW

ELBOW + DISTAL TRICEPS TENDON

GENERAL COMMENTS

- Larger FOV than normal elbow
- Covers more posteriorly (covers triceps muscle)

COIL

- Use Body Matrix Coil
- Make sure the coil is centered above the olecranon

POSITIONING

- Supine (or if a large patient in the Superman position)
- Try to have elbow fully extended
- Try to have hand supinated
- Elevate elbow with a sponge to isocenter (if supine)
- Sponge and strap elbow in place

SEQUENCES, AND WHAT IS MOST IMPORTANT TO REPEAT

- Axial PD and STIR sequences are the most important to repeat
- Then repeat SAG PD FS

1. COR STIR
2. COR T1
3. AX PD
4. AX STIR
5. SAG PD FS

SEQUENCES

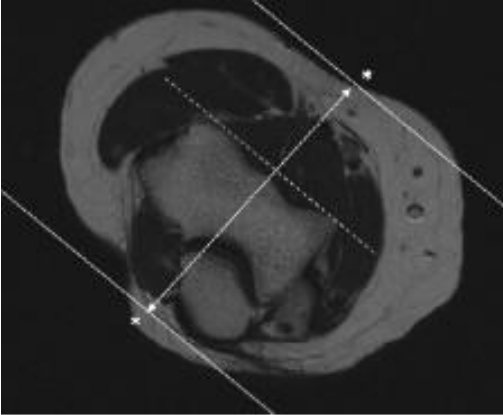
AX LOC

3 PLANE LOC

1. CORONAL T1 AND STIR SEQUENCES

- Use axial LOC to angle parallel to anterior portions of the capitellum and trochlea (or parallel to humeral epicondyles)

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- Use sagittal LOC to angle parallel to humerus/radius/ulna plane (if flexed then angle more parallel to humerus)
- Cover from 1 slice anterior to radial tuberosity back to cover triceps muscle
- No Sat Bands



2. AXIAL PD AND STIR SEQUENCES

- Perpendicular to Coronal
- Use COR T1 to angle parallel to elbow joint (parallel to capitellum and trochlea)
- Cover from mid-radial tuberosity up as far as the slices go
- Parallel Sat Bands
- Can do a second PD and STIR stack higher up biceps muscle if the abnormal muscle is not all covered (Or slightly thicker slices if the extra coverage is not that much)

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3. SAGITTAL PD FS SEQUENCE

- Perpendicular to both Coronal and Axial sequences
- Cover 1 slice outside of both humeral epicondyles



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WRIST (ROUTINE)

GENERAL COMMENTS

- Try to have every wrist pronated and in superman position
- Phase is Head to Foot for Coronals
- Phase is Right to Left for Axials

COIL

- Dedicated 8 Channel Wrist
- Small 4 Channel Flex for larger wrists

POSITIONING

- Superman position preferred
- Have wrist pronated

SEQUENCES, AND WHAT IS MOST IMPORTANT TO REPEAT

- The most important sequence to repeat is the COR MEDIC
- Repeat Axial STIR second if there is motion

1. COR STIR
2. COR T1
3. COR MEDIC
4. AX PD
5. AX STIR
6. SAG STIR

SEQUENCES

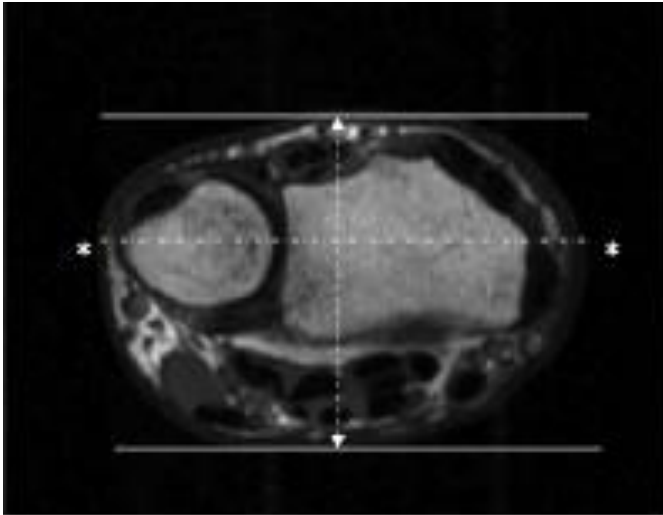
LOC

3 PLANE LOC

1. CORONAL STIR, T1, MEDIC T2
 - **PHASE IS HEAD TO FOOT**
 - Use axial LOC and angle parallel to anterior radial metaphysis (best fit) at the distal radioulnar joint (or approx parallel to proximal carpal row)
 - Use sagittal LOC and angle parallel to radius/lunate/capitate alignment (or just radius if wrist is flexed)

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- Cover through all of the bones, and try to cover the flexor and extensor tendons as well (increase slices instead of DIST Factor if feasible)
- Proximal Sat Band on COR STIR



2. AXIAL PD AND STIR SEQUENCES

- **PHASE IS RIGHT TO LEFT**
- Perpendicular to Coronal Sequences
- Use COR T1 and angle parallel to long axis of wrist (can use radius growth plate scar to angle, BLUE ARROW ON IMAGE).

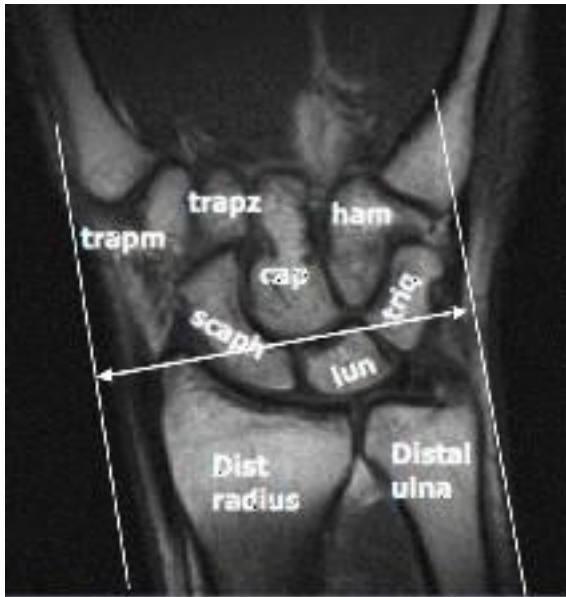


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- Cover through Distal Radioulnar Joint proximally and to the base of the metacarpals distally.
- Parallel Sat Bands on both

3. SAGITTAL STIR SEQUENCE

- Perpendicular to Coronal and Axial Sequences
- Cover from outside of Ulnar styloid and to outside of 1st CMC Joint
- Proximal Sat Band



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WRIST + DRUJ INSTABILITY

GENERAL COMMENTS

- Try to have every wrist pronated for the wrist sequences and supinated for the DRUJ sequence
- Phase is Head to Foot for Coronals
- Phase is Right to Left for Axials

COIL

- Dedicated 8 Channel Wrist
- Small 4 Channel Flex for larger wrists

POSITIONING

- Superman position preferred
- Have wrist pronated for first 6 sequences

SEQUENCES, AND WHAT IS MOST IMPORTANT TO REPEAT

- The most important sequence to repeat is the COR MEDIC
- Repeat Axial STIR second if motion

1. COR STIR
2. COR T1
3. COR MEDIC
4. AX PD
5. AX STIR
6. SAG STIR

Reposition wrist in Supination

7. AX PD

SEQUENCES

LOC

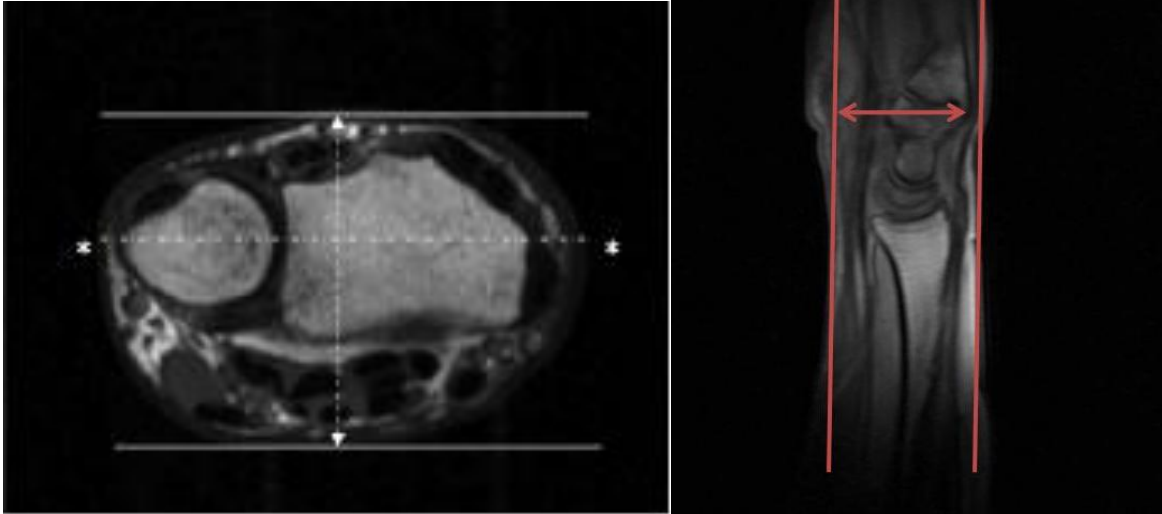
3 PLANE LOC

1. CORONAL STIR, T1, MEDIC T2

- **PHASE IS HEAD TO FOOT**
- Use axial LOC and angle parallel to anterior radial metaphysis (best fit) at the distal radioulnar joint (or approx parallel to proximal carpal row)

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- Use sagittal LOC and angle parallel to radius/lunate/capitate alignment (or just radius if wrist is flexed)
- Cover through all of the bones, and try to cover the flexor and extensor tendons as well
- Proximal Sat Band on COR STIR



2. AXIAL PD AND STIR SEQUENCES

- **PHASE IS RIGHT TO LEFT**
- Perpendicular to Coronal Sequences
- Use COR T1 and angle parallel to long axis of wrist (can use radius growth plate scar to angle, BLUE ARROW ON IMAGE).

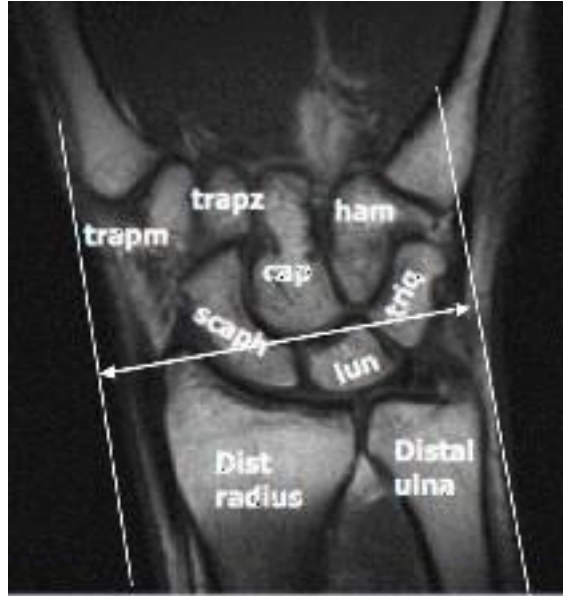


- Cover through Distal Radioulnar Joint proximally and to the base of the metacarpals distally.
- Parallel Sat Bands on both

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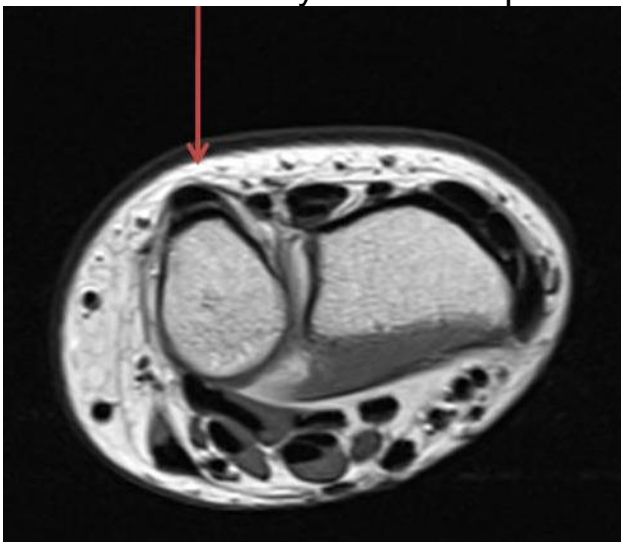
3. SAGITTAL STIR SEQUENCE

- Perpendicular to Coronal and Axial Sequences
- Cover from outside of Ulnar styloid and to outside of 1st CMC Joint
- Proximal Sat Band



4. SUPINATED AXIAL PD SEQUENCE

- Reposition wrist in SUPINATION
- Axial LOC
- 3 Plane LOC
- Run the same AX PD Sequence as before, and make sure to cover all of the DRUJ
- Takes approx. 8 minutes to localize and perform sequence
- The ulnar styloid should point to back of wrist (dorsally)



MSK MRI PROTOCOL OVERVIEW

THUMB

GENERAL COMMENTS

- Used for trauma and arthritis

COIL

- Small 4 Channel Flex Coil wrapped around hand, completely covering the thumb
- Center coil over 1st CMC Joint

POSITIONING

- Have thumb pressed to the hand (by wrapping thumb snugly to the hand)
- Thumb should be parallel to the other hand metacarpals
- Prone in a Superman position, if you can



SEQUENCES, AND WHAT IS MOST IMPORTANT TO REPEAT

- Most important to repeat is the COR MEDIC T2

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1. AX PD FS
2. AX T1
3. COR STIR
4. COR MEDIC T2
5. COR PD
6. SAG STIR
7. SAG PD

SEQUENCES

AXIAL LOC
3 PLANE LOC

1. AXIAL T1 AND PD FS SEQUENCE

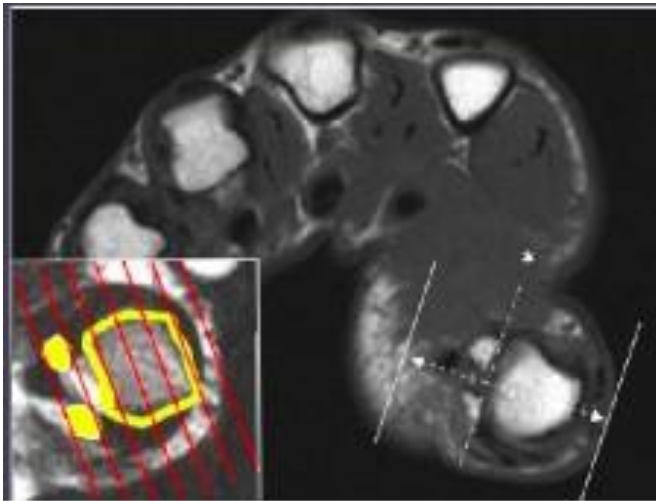
- Use SAGITTAL THUMB LOC (Coronal LOC for the rest of the hand), and angle perpendicular to the 1st Proximal Phalanx Shaft
- Cover from at least middle of distal phalanx proximally through trapezium distally
- Parallel Sat Bands



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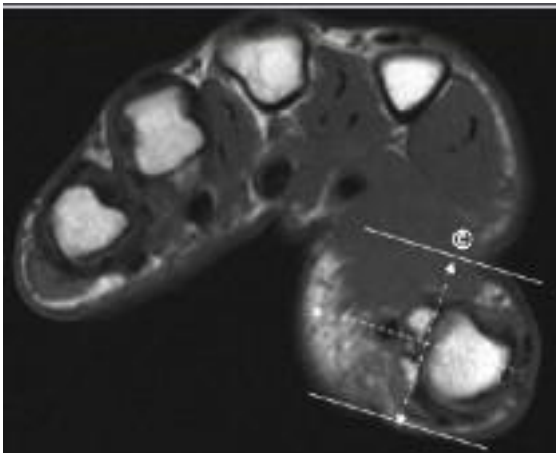
2. CORONAL STIR, PD, AND MEDIC T2 SEQUENCES

- Perpendicular to Axial PD FS sequence
- Use Axial PD FS or T1 and angle parallel to sesamoid plane of thumb
- Use sagittal LOC and cover from outside bones to at least to cover the thumb flexor tendon and entire 1st CMC joint
- Proximal Sat Band for STIR Sequence



3. SAGITTAL PD AND STIR SEQUENCES

- Perpendicular to Coronal and Axial sequences
- Cover from at least 1 slice out of both sides of the bones, and if extra slices then cover more of thenar muscles
- Proximal Sat Band for STIR Sequence



MSK MRI PROTOCOL OVERVIEW

HIP – HIGH RESOLUTION

GENERAL COMMENTS

- Used for younger people, where surgery is an option (< 40 y.o.)

COIL

- Body Matrix Coil is centered over both hips
- Large 4 channel flex coil is wrapped around affected hip (deep to Body Matrix Coil) If it is a LARGE PATIENT, then you can use a second body matrix coil to wrap around the affected hip (deep to the other body matrix coil), and increase FOV to 200.
- If both hips are needed, then standard Large flex coil over other hip
- Have top of flex coil 3 fingers below iliac crest
- **HAVE ONLY 4 CHANNEL FLEX COIL SELECTED WHEN PERFORMING HIGH RESOLUTION IMAGES**
- **HAVE ONLY BODY MATRIX COIL SELECTED WHEN IMAGING BOTH HIPs**

POSITIONING

- Patient supine
- Toes strapped together with sponges between knees to help femurs internally rotate
- Triangle under knees to also help femurs internally rotate
- Strap down Coils

SEQUENCES, AND WHAT IS MOST IMPORTANT TO REPEAT

- The most important sequences are the COR PD and SAG PD FS

Body Matrix Coil/Spine Array

1. COR STIR
2. COR T1
3. Axial STIR
4. AX T2

Flex Coil Only

5. COR PD
6. SAG PD FS
7. OBLIQUE AX PD FS

SEQUENCES

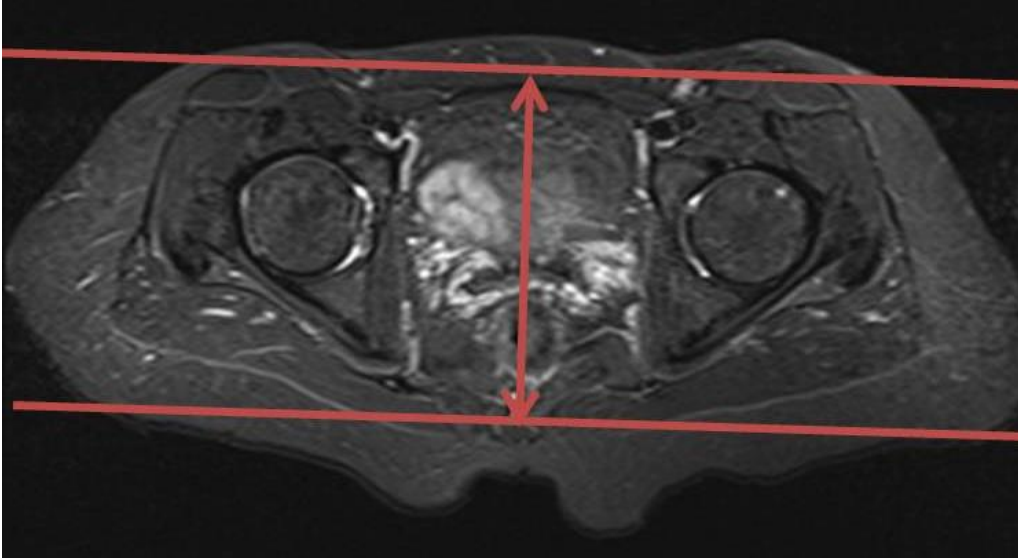
3 PLANE LOC FOR BODY MATRIX (USE COILS SEPARATELY)

3 PLANE LOC FOR 4 CHANNEL FLEX (USE COILS SEPARATELY)

MSK MRI PROTOCOL OVERVIEW

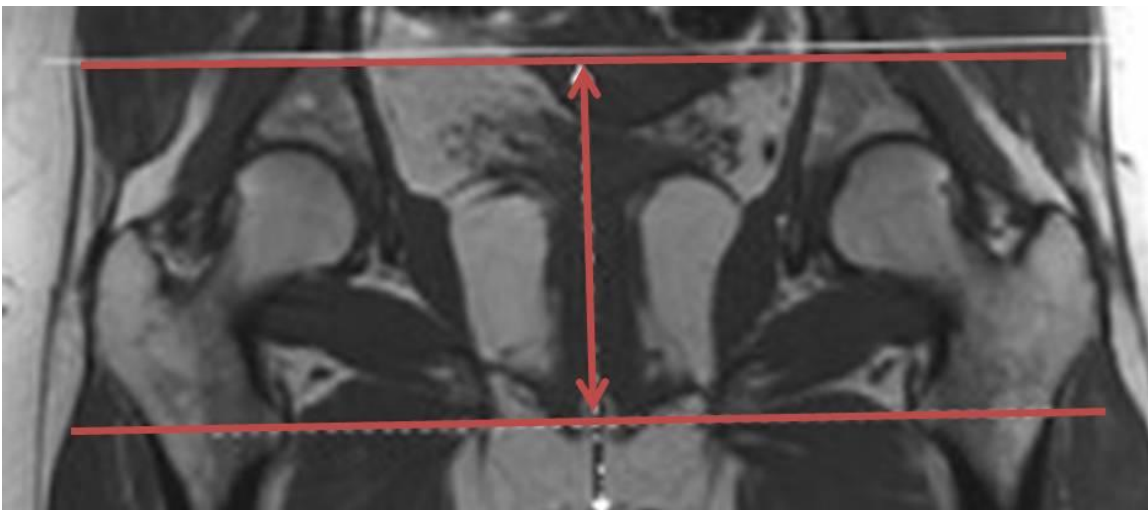
1. CORONAL T1 AND STIR SEQUENCES (BODY MATRIX COIL)

- Use Axial LOC and angle parallel through femoral heads
- Cover from back of ischial tuberosities to at least 2 slices anterior to acetabuli (preferably to cover pubic symphysis)
- Superior Sat bands for STIR and T1



2. AXIAL T2 SEQUENCE (BODY MATRIX COIL)

- Use COR T1 and angle parallel to femoral heads/acetabuli
- Cover from 2-4 slices above acetabuli down close to lesser trochanters
- Parallel Sat Bands

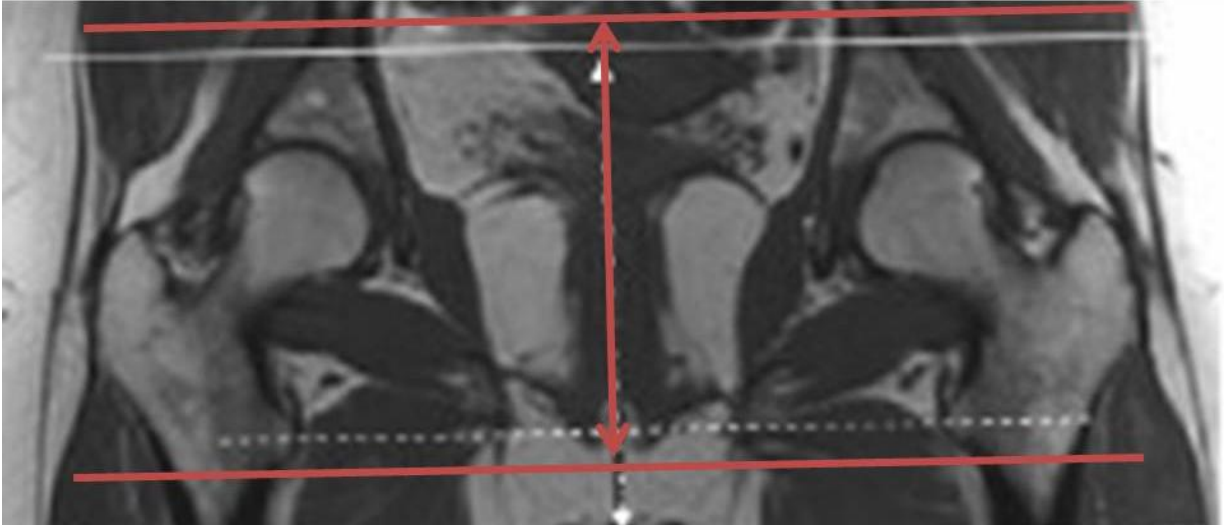


3. AXIAL STIR SEQUENCE (BODY MATRIX COIL)

- Angle the same as the AX T2
- Copy from AX T2

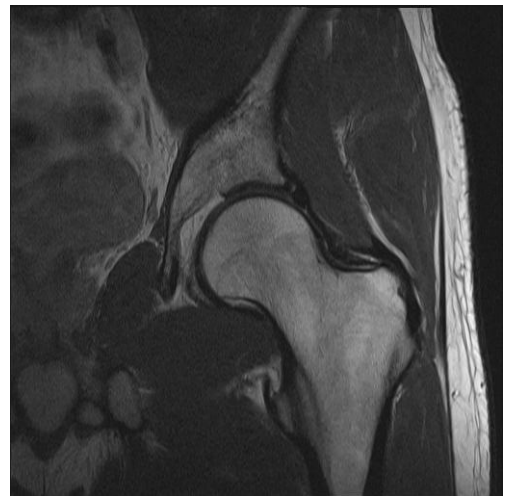
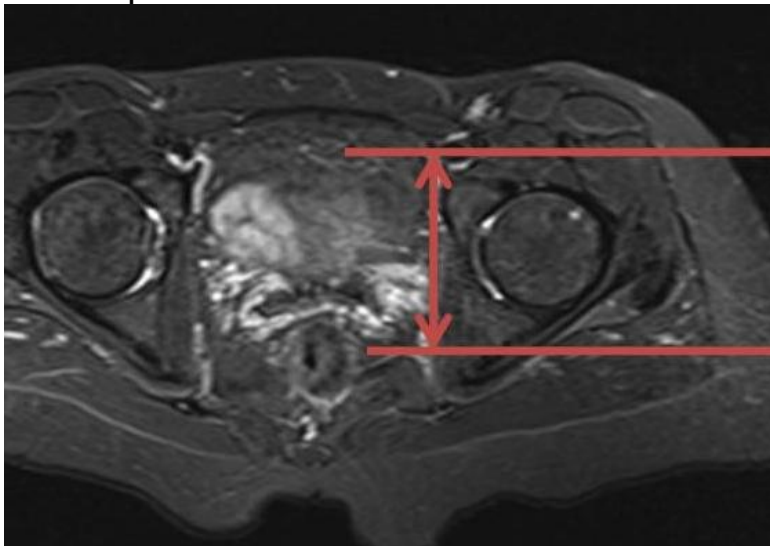
MSK MRI PROTOCOL OVERVIEW

- the 6 more slices on the STIR sequence (3 above and 3 below) means more coverage so you can cover the lesser trochanters
- Parallel Sat Bands



4. CORONAL PD SEQUENCE (FLEX COIL ONLY)

- FLUID WEIGHTED, SO FLUID IS BRIGHT
- Use Axial T2 and have plane parallel to both femoral heads
- Cover from 1 slice anterior to and 1 slice posterior to acetabulum
- Center at femoral head
- Superior Sat Band



5. SAGITTAL PD FS SEQUENCE (FLEX COIL ONLY)

- Perpendicular to COR PD
- Use COR PD and cover from outer cortex of the greater trochanter to the inner portion of the acetabulum
- Center at Femoral Head/Neck Junction

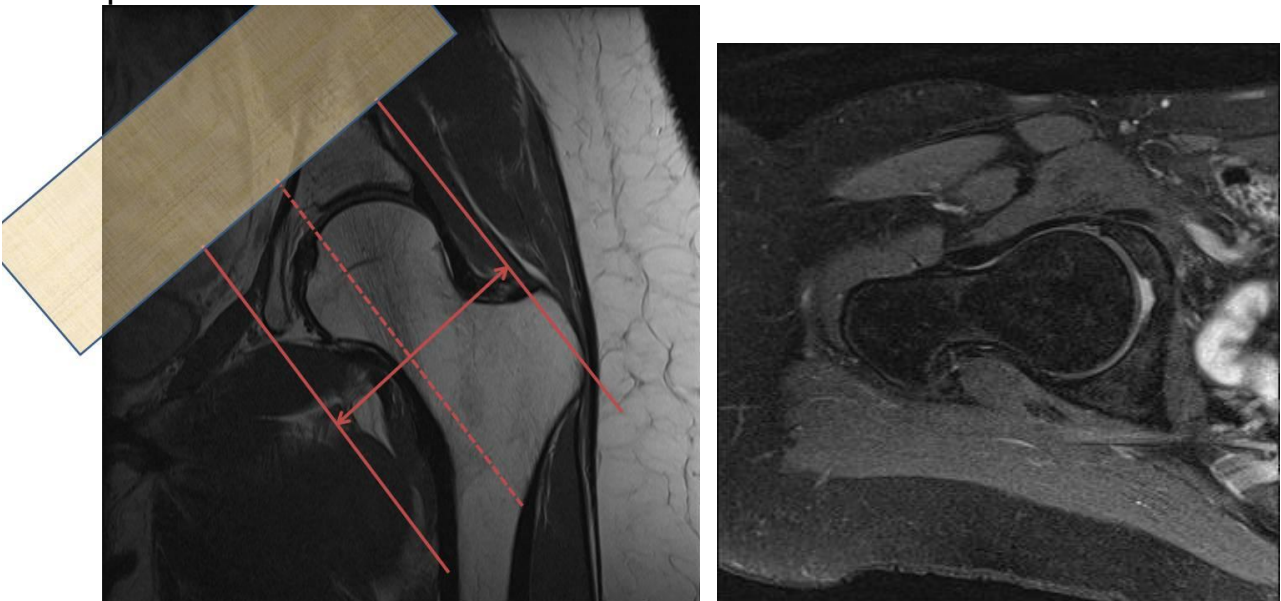
MSK MRI PROTOCOL OVERVIEW

- Superior Sat Band



6. OBLIQUE AXIAL PD FS (FLEX COIL ONLY)

- Use COR PD and angle parallel to femoral neck (use image with the longest medial/inferior femoral neck cortex). This angle is usually slightly more than you think (see image).
- Cover from 1 slice out of acetabulum superiorly to 1 slice out of acetabulum inferiorly
- Center at Femoral Head/Neck Junction
- Superior Sat Band



MSK MRI PROTOCOL OVERVIEW

HIP – AVN, OA, HIP FRACTURE

GENERAL COMMENTS

- Used for older people (> 40 y.o.)

COIL

- Body Matrix Coil is centered over both hips

POSITIONING

- Patient supine
- Toes strapped together with sponges between knees to help femurs internally rotate
- Triangle under knees to also help femurs internally rotate
- Strap down Coil

SEQUENCES, AND WHAT IS MOST IMPORTANT TO REPEAT

- The most important sequences are the COR STIR and SAG PD FS

1. COR STIR
2. COR T1
3. AX T2
4. AX STIR
5. SAG PD FS

SEQUENCES

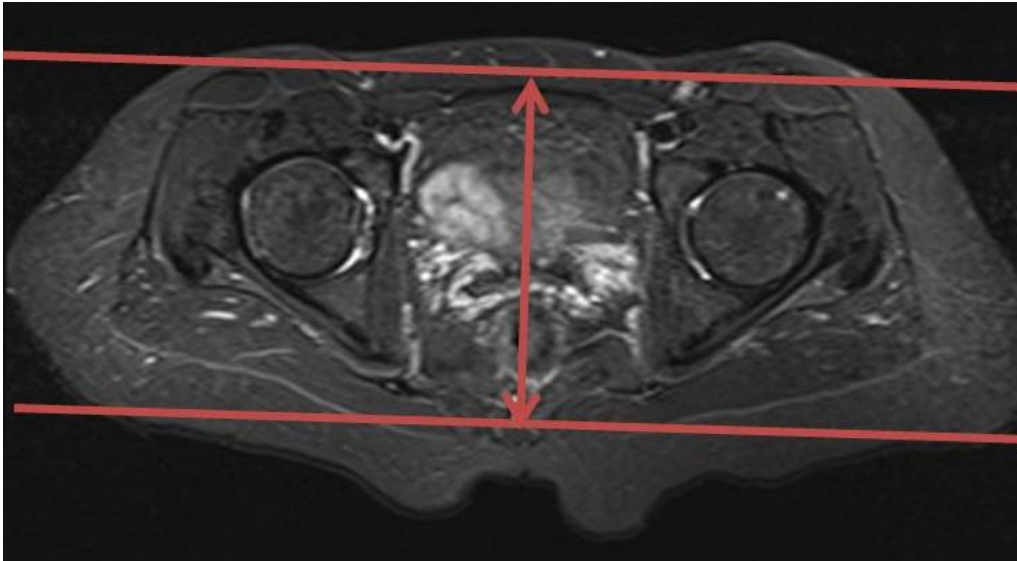
LOC

3 PLANE LOC

1. CORONAL T1 AND STIR SEQUENCES

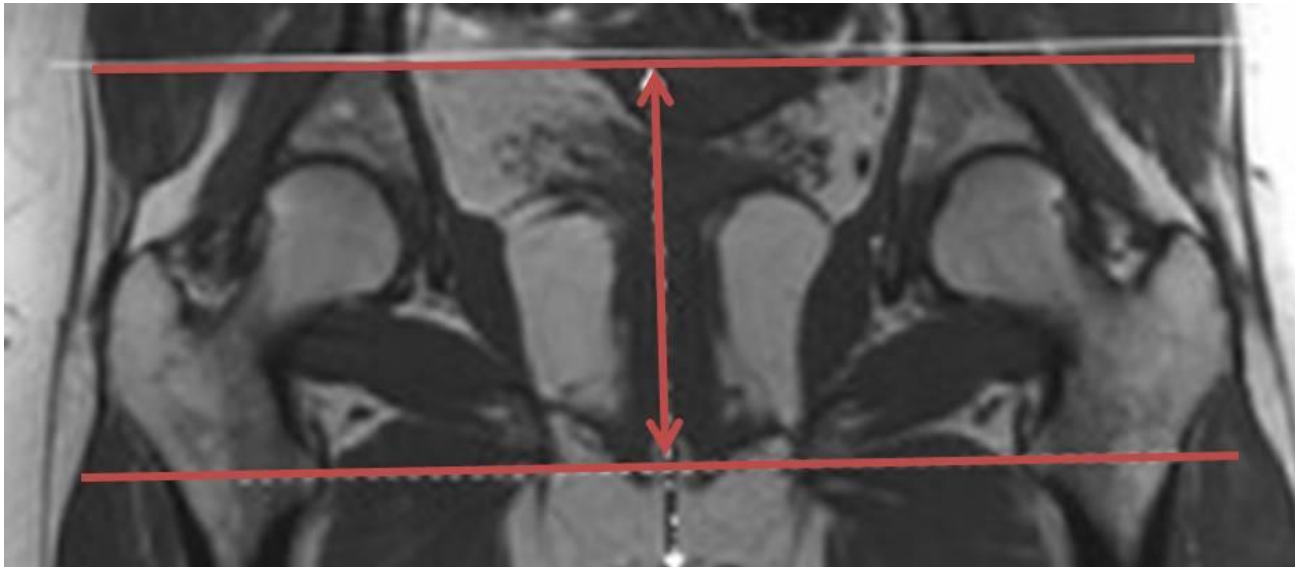
- Use Axial LOC and angle parallel through femoral heads
- Cover from back of ischial tuberosities to at least 2 slices anterior to acetabuli (preferably to cover pubic symphysis)
- Superior Sat bands for STIR and T1

MSK MRI PROTOCOL OVERVIEW



2. AXIAL T2 SEQUENCE

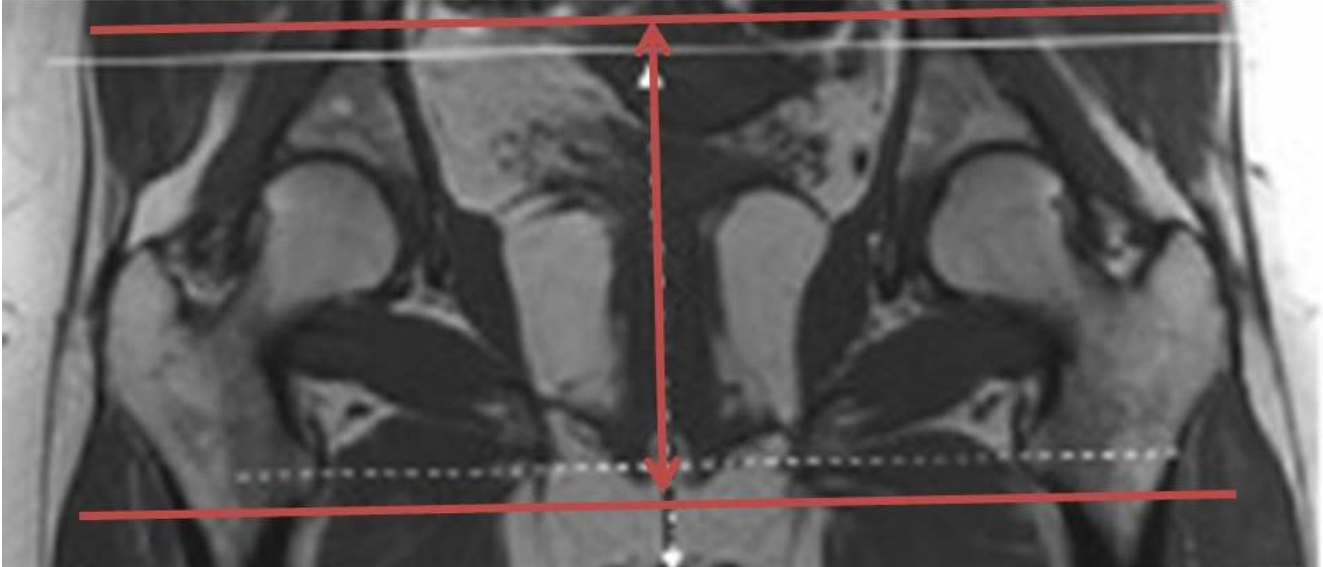
- Use COR T1 and angle parallel to femoral heads/acetabuli
- Cover from 2-4 slices above acetabuli down close to lesser trochanters
- Parallel Sat Bands



3. AXIAL STIR SEQUENCE

- Angle the same as the AX T2
- Copy from AX T2
- the 6 more slices on the STIR sequence (3 above and 3 below) means more coverage so you can cover the lesser trochanters
- Parallel Sat Bands

MSK MRI PROTOCOL OVERVIEW



4. SAGITTAL PD FS SEQUENCE

- Perpendicular to COR T1
- Use COR T1 and cover from outer cortex of the greater trochanter to the inner portion of the acetabulum
- Superior Sat Band



MSK MRI PROTOCOL OVERVIEW

PELVIS (ALL BONY PELVIS)

GENERAL COMMENTS

- Used for Occult pelvic fractures, Metastases, and Pathologic fractures

COIL

- Body Matrix Coil is centered over both hips
- Have top of coil at iliac crest

POSITIONING

- Patient supine
- Try not to rotate hips if concerned for a femoral neck fracture
- Strap down Coil

SEQUENCES, AND WHAT IS MOST IMPORTANT TO REPEAT

- The most important sequences to repeat are the COR STIR and T1

1. COR STIR
2. COR T1
3. AX T1
4. AX STIR
5. SAG STIR (2 STACKS)
6. AX IN AND OUT OF PHASE GRADIENT T1

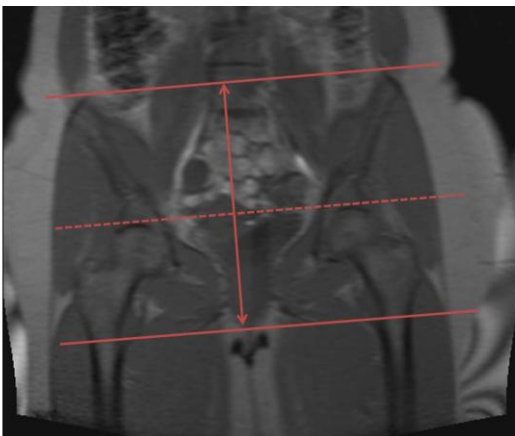
SEQUENCES

LOC

3 PLANE LOC

1. AXIAL T1, OPPOSED PHASE T1 AND STIR SEQUENCES

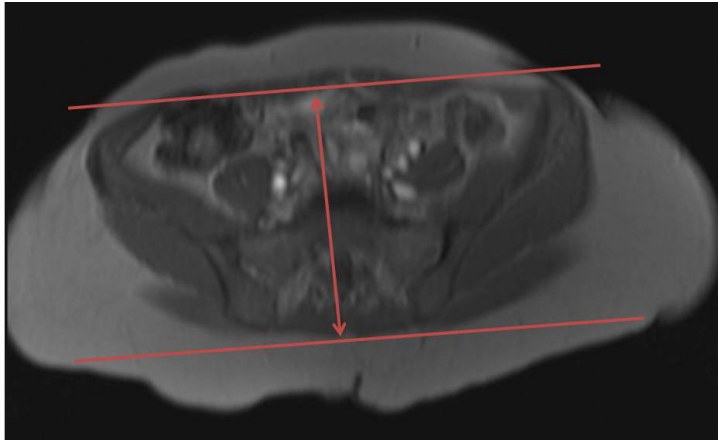
- Use COR LOC and angle parallel to femoral heads/acetabuli
- Cover from 1 slice above iliac crest to level of lesser trochanter
- Parallel Sat Bands



MSK MRI PROTOCOL OVERVIEW

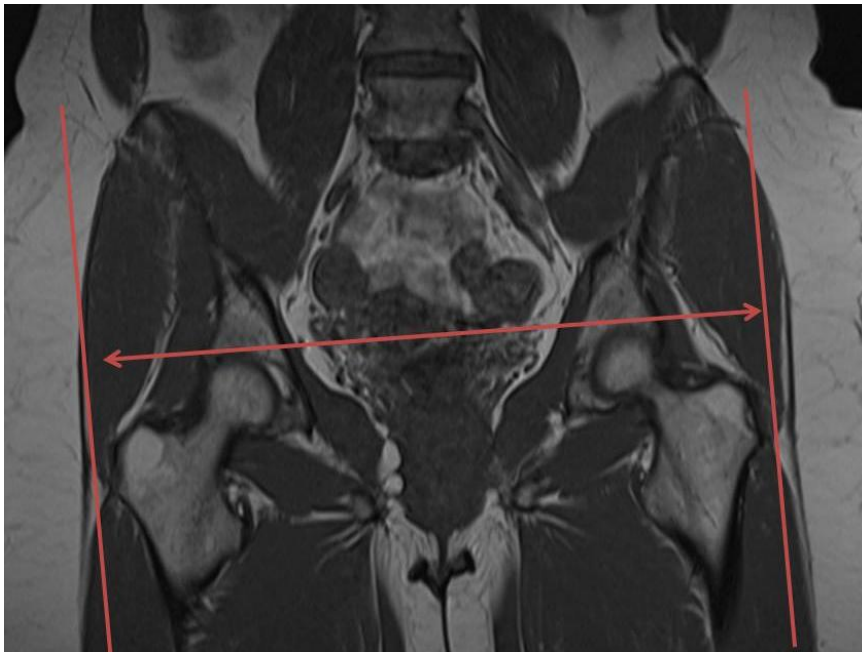
2. CORONAL T1 AND STIR SEQUENCES

- Use Axial T1 and angle parallel through femoral heads
- Cover entire bony pelvis (1 slice out of anterior ilium to 1 slice behind SI joints)
- Superior Sat bands for STIR and T1



3. SAGITTAL STIR SEQUENCE (2 STACKS)

- Perpendicular to COR T1
- Use COR T1 and cover from 1 slice out of both greater trochanters
- Superior Sat Band



MSK MRI PROTOCOL OVERVIEW

SACROILIAC JOINTS

GENERAL COMMENTS

- Different hospitals have slightly different ways of using coils

COIL

- Use Spine Array Posteriorly and have the Normalization Filter on (to reduce burn-out of image posteriorly)
- If you need more signal (large patient) or want to reduce acquisition time (IPAT) you can use both the Body Matrix Coil (strapped anteriorly over pelvis) and Spine Coil to reduce burn-out of image posteriorly

POSITIONING

- Supine

SEQUENCES, AND WHAT IS MOST IMPORTANT TO REPEAT

- The COR T1 is the most important to repeat

1. COR T1
2. COR STIR
3. AX STIR

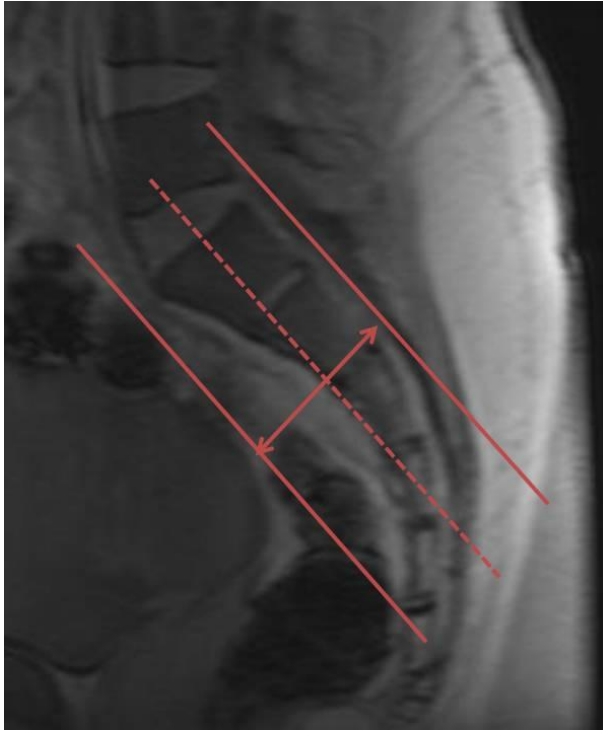
SEQUENCES

3 PLANE LOC

1. OBLIQUE CORONAL T1 AND STIR SEQUENCES

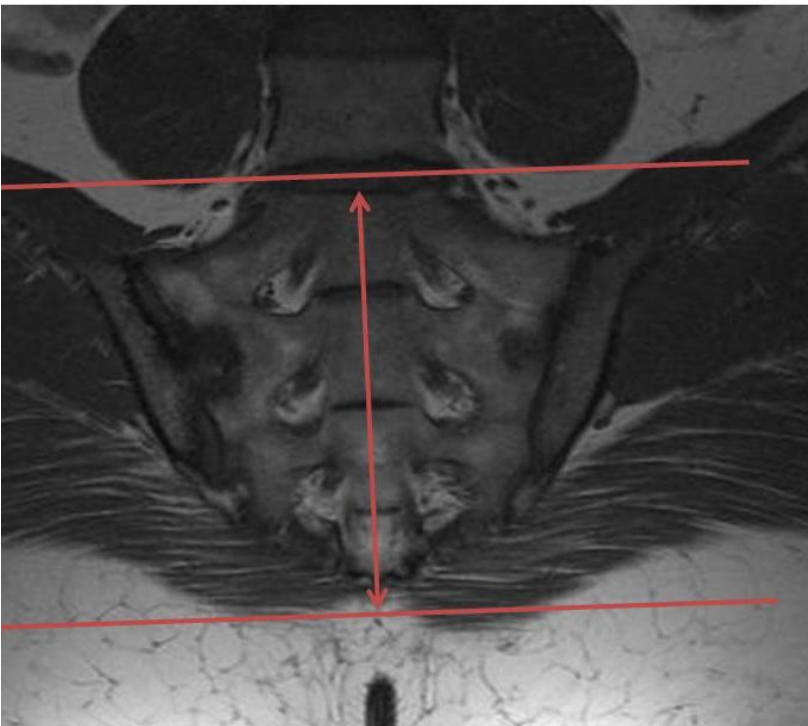
- Use Sagittal LOC and angle parallel to the length of the Sacrum (use the S2 posterior/superior cortex and center image at S2/S3 disc)
- Cover from 1 slice anterior and 1 slice posterior to the sacral bodies
- Superior Sat Band

MSK MRI PROTOCOL OVERVIEW



2. OBLIQUE AXIAL STIR SEQUENCE

- Perpendicular to the Coronal sequences
- Use COR T1 and cover through SI joints
- Superior Sat Band



MSK MRI PROTOCOL OVERVIEW

SACRUM/COCCYX AND SACROILIAC JOINTS

GENERAL COMMENTS

- Different hospitals have slightly different ways of using coils

COIL

- Use Spine Array Posteriorly and have the Normalization Filter on (to reduce burn-out of image posteriorly)
- If you need more signal (large patient) or want to reduce acquisition time (IPAT) you can use both the Body Matrix Coil (strapped anteriorly over pelvis) and Spine Coil to reduce burn-out of image posteriorly

POSITIONING

- Supine, centered over spine array

SEQUENCES, AND WHAT IS MOST IMPORTANT TO REPEAT

- The SAG T1 is the most important to repeat

1. COR T1
2. COR STIR
3. SAG T1
4. SAG STIR
5. AX STIR (2 STACKS)

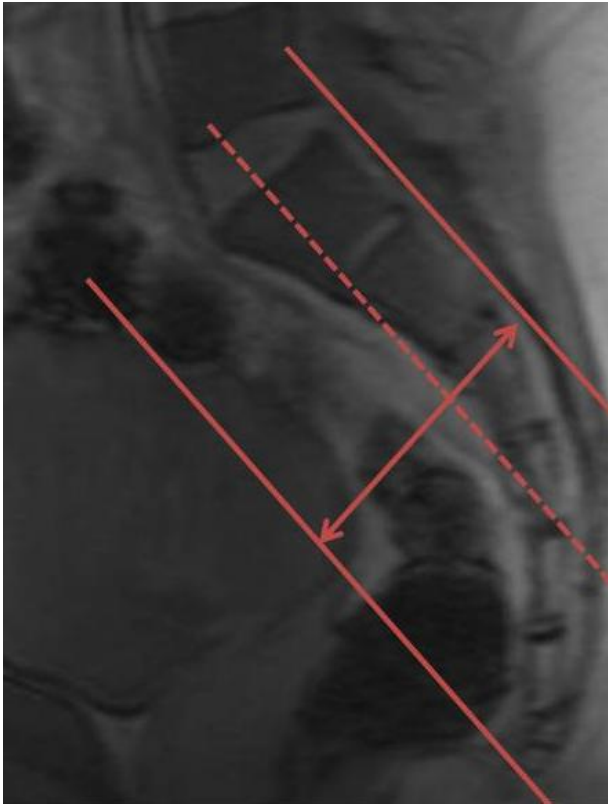
SEQUENCES

3 PLANE LOC

1. OBLIQUE CORONAL T1 AND STIR SEQUENCES

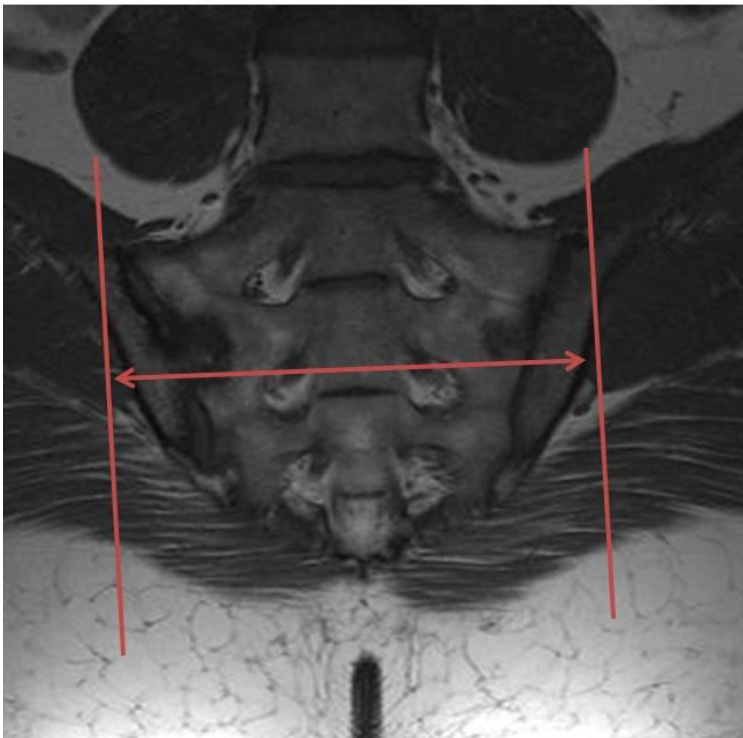
- Use Sagittal LOC and angle parallel to the length of the Sacrum (use the S2 posterior/superior cortex and center image at S2/S3 disc)
Cover from 1 slice anterior and 1 slice posterior to the sacral bodies and try to cover all of the coccyx
- Superior Sat Band

MSK MRI PROTOCOL OVERVIEW



2. SAGITTAL STIR AND T1 SEQUENCES

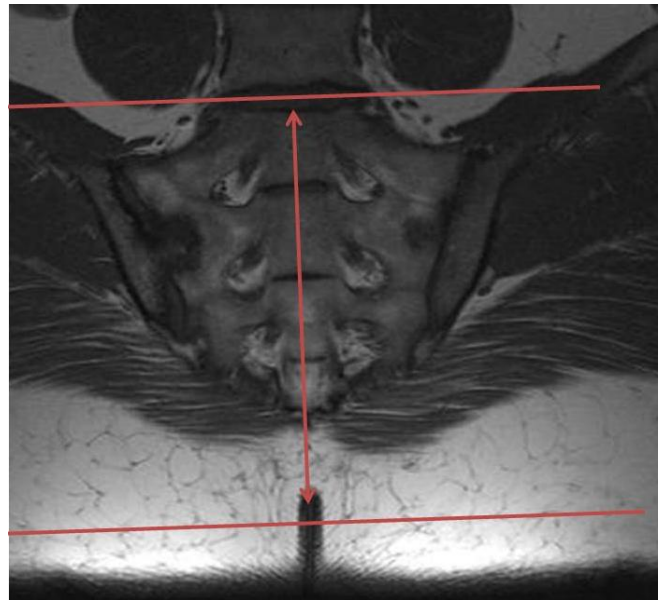
- Perpendicular to the Coronal sequences
- Use COR T1 and cover to 1 slice outside of both SI joints
- Superior Sat Band



MSK MRI PROTOCOL OVERVIEW

3. OBLIQUE AXIAL STIR SEQUENCE

- Perpendicular to the Coronal sequences
- Use SAG T1 and cover through sacrum and coccyx (you need 2 stacks, and angle perpendicular to sacrum for first stack and then lower sacrum/coccyx for second stack)
- Overlap stacks by 1 or 2 slices
- Superior Sat Band



MSK MRI PROTOCOL OVERVIEW

QUADRICEPS TENDON/MUSCLE

GENERAL COMMENTS

- The coronals and the first axials image both entire thighs
- The small FOV images are only on the affected side and cover the distal quadriceps muscles and tendon

COIL

- Use Peripheral Array, or if a tall patient use the Peripheral Array and Body Matrix Coil
- If no Peripheral Array, 2 Body matrix coils strapped over thighs
- Spine array coils on as well
- Signal should cover from above hips to tibial tuberosity

POSITIONING

- Supine
- Try to have toes pointing up, with a sponge between the feet for comfort
- Strap down snugly to prevent motion

SEQUENCES, AND WHAT IS MOST IMPORTANT TO REPEAT

- Sag T2 and small FOV axial T1 are the most important sequences to repeat

BOTH THIGHS

1. COR STIR
2. COR T1
3. AX T1 THICK (2 STACKS)
4. AX STIR THICK (2 STACKS)

AFFECTED SIDE

5. SAG T2
6. AX STIR THIN
7. AXIAL T1 THIN

SEQUENCES

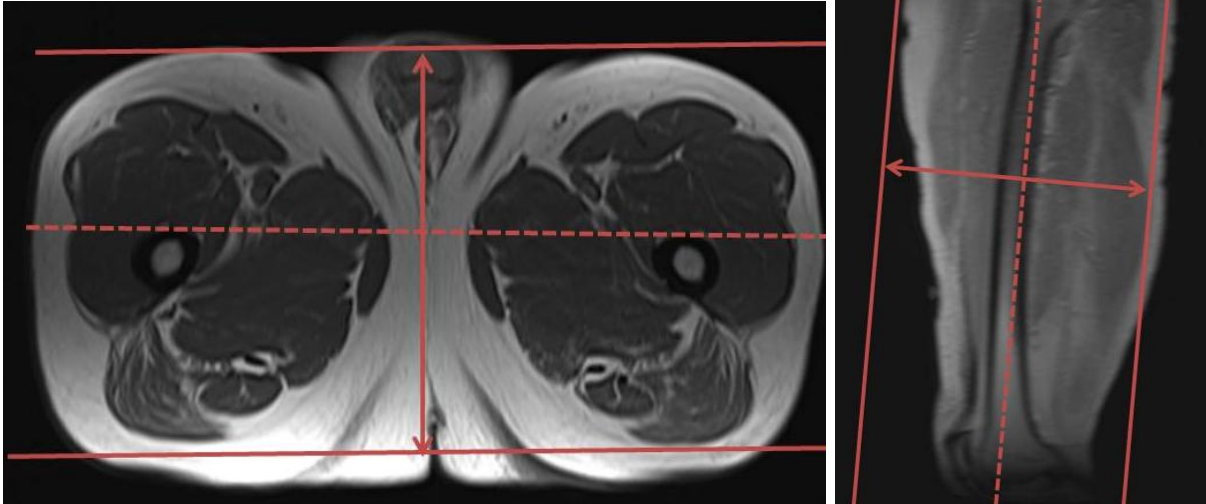
3 PLANE LOC (LARGE FOV)

1. CORONAL T1 AND STIR SEQUENCES

- Cover both Thighs from Anterior Inferior Iliac Spine (top of acetabulum) to Tibial Tuberosity (if the patient is tall, you can only cover to mid-patella)

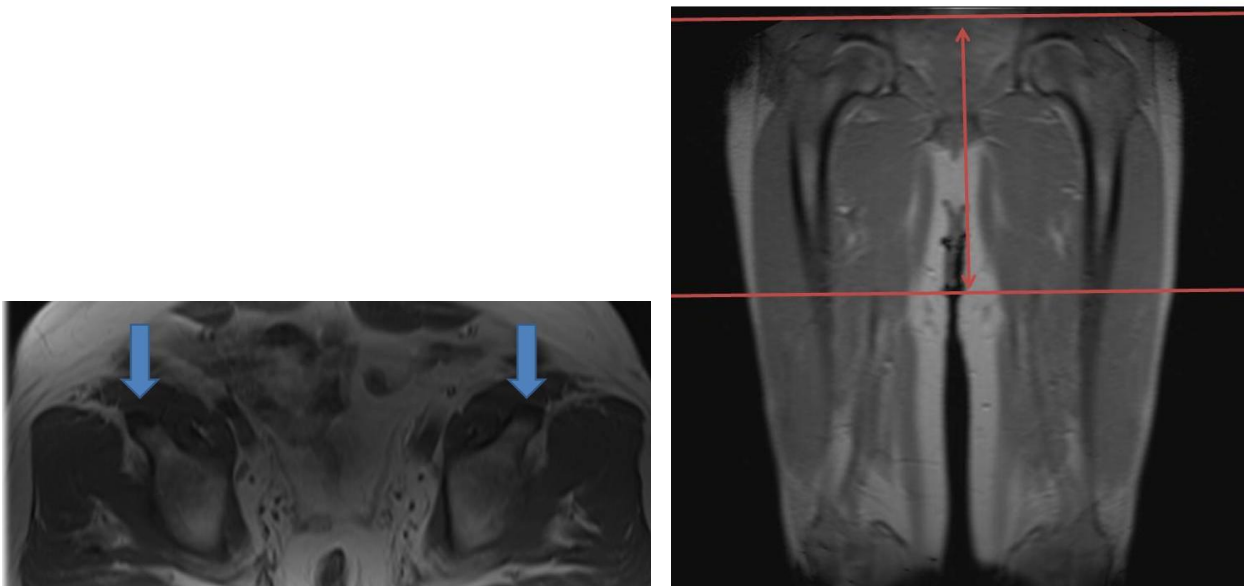
MSK MRI PROTOCOL OVERVIEW

- Use Localizers and angle parallel to the anterior femoral cortices in the axial plane and parallel to the femoral shaft in the sagittal plane
- Cover all of the thigh musculature anteriorly to as far back as the slices go
- Superior Sat Bands



2. AX T1 AND STIR SEQUENCES (UPPER STACK)

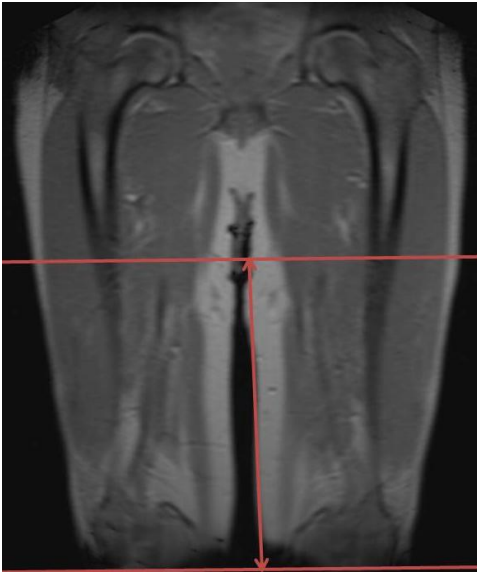
- 500 FOV to cover both thighs
- Best fit axial for both thighs
- Use COR T1 and cover from 2 slices above the superior acetabular rim down as far as the slices go (to cover anterior inferior iliac spine SEE BLUE ARROWS)
- Parallel Sat Bands



MSK MRI PROTOCOL OVERVIEW

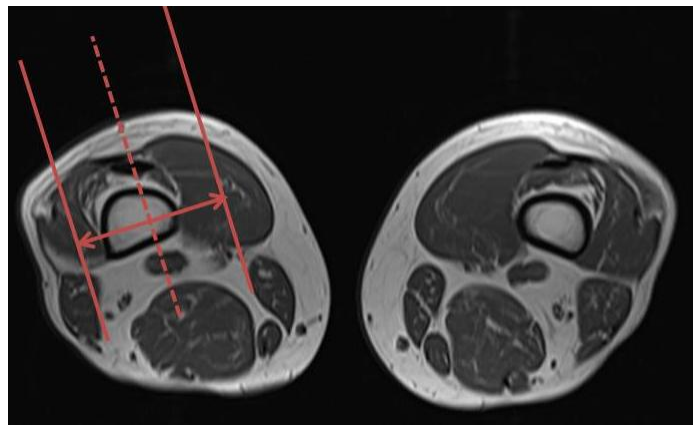
3. AX T1 AND STIR THICK SEQUENCES (LOWER STACK)

- Use 400 FOV as thighs are smaller lower down
- Overlap by 1 slice with the upper stacks and cover down to the tibial tuberosity (can increase slice thickness if needed)
- Parallel Sat Bands



4. SAGITTAL T2 SEQUENCE (affected side)

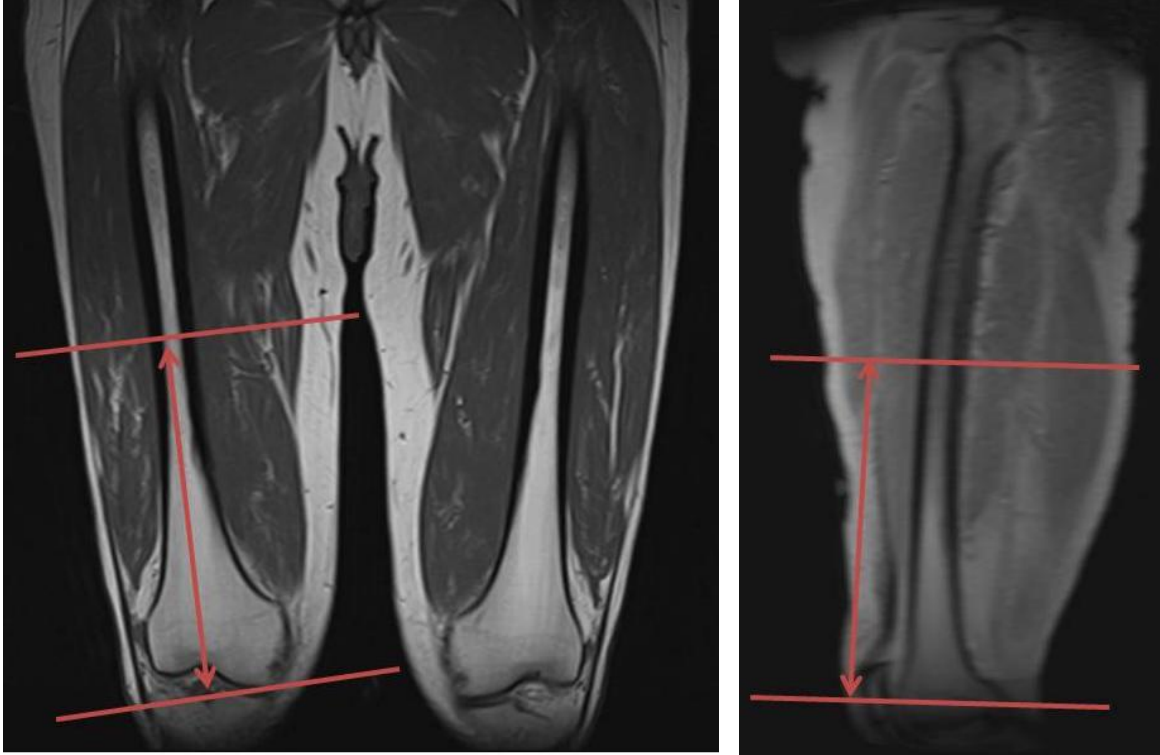
- Use Coronal T1 and angle parallel to the femoral shaft
- Cover from the tibial tuberosity up for the FOV
- Center slices at the midpoint of the Quadriceps tendon (on Axial T1 sequence) and cover medial and lateral as far as the slices go. Also, angle sagittals perpendicular to posterior femoral cortex.



MSK MRI PROTOCOL OVERVIEW

5. AX T1 AND STIR SEQUENCES (affected side)

- Small FOV for one thigh
- Perpendicular to the long axis of femoral shaft
- Cover from the mid-patella up as far as the slices go
- Parallel Sat Bands for T1 and Superior Sat band for STIR



MSK MRI PROTOCOL OVERVIEW

HAMSTRING TENDONS/MUSCLES

GENERAL COMMENTS

- Coronals and axials image both thighs
- Thin slices are the upper stacks (cover tendons better)

COIL

- Use Peripheral Array, or if a tall patient use the Peripheral Array and Body Matrix Coil
- If no Peripheral Array, 2 Body matrix coils strapped over thighs
- Spine array coils on as well
- Signal should cover from above hips to tibial tuberosity

POSITIONING

- Supine
- Try to have toes pointing up, with a sponge between the feet for comfort
- Strap down snugly to prevent motion

SEQUENCES, AND WHAT IS MOST IMPORTANT TO REPEAT

- Upper axial STIR is the most important sequence to repeat

1. COR STIR
2. COR T1
3. AX T1 THIN (UPPER STACK)
4. AX STIR THIN (UPPER STACK)
5. AX T1 THICK (LOWER STACK)
6. AX STIR THICK (LOWER STACK)
7. SAG T2 (AFFECTED SIDE)

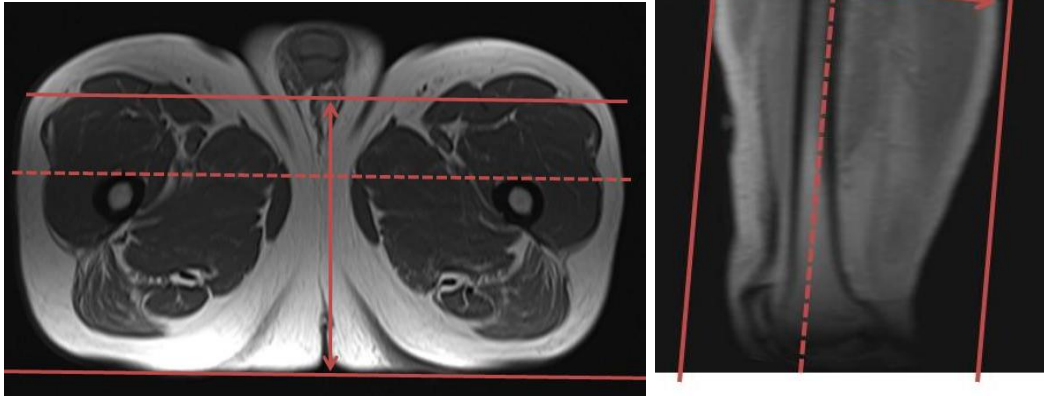
SEQUENCES

3 PLANE LOC (LARGE FOV)

1. CORONAL T1 AND STIR SEQUENCES

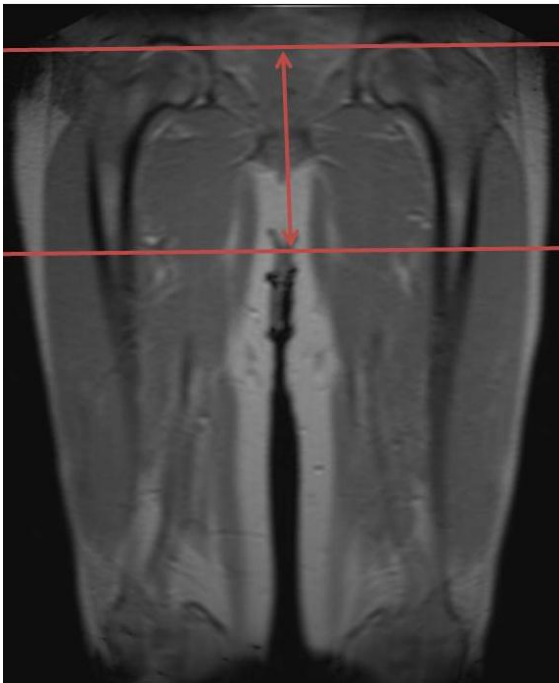
- Cover both Thighs from top of femoral heads to the Tibial Tuberosities
- Use Localizers and angle parallel to the Femoral Shafts in axial and sagittal planes
- Cover all of the hamstring musculature posteriorly to as far anterior as the slices go
- Superior Sat Bands

MSK MRI PROTOCOL OVERVIEW



2. AX T1 AND STIR THIN (UPPER STACK) SEQUENCES

- Use best fit axial for both thighs
- Use COR T1 and cover from the top of the femoral heads down as far as the slices go
- Parallel Sat Bands



MSK MRI PROTOCOL OVERVIEW

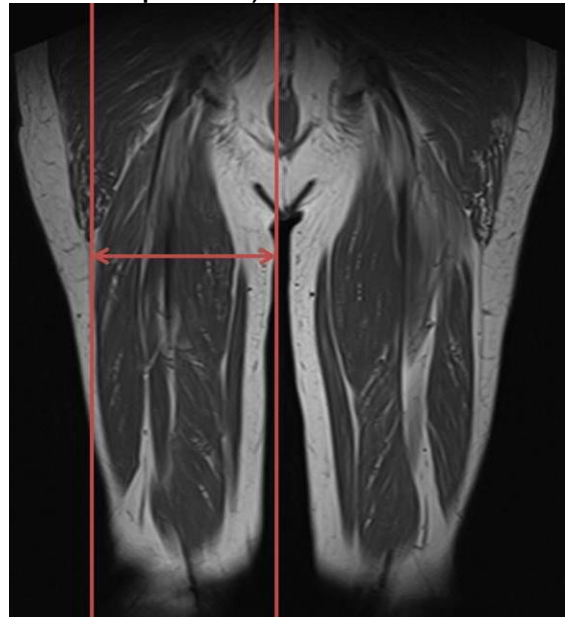
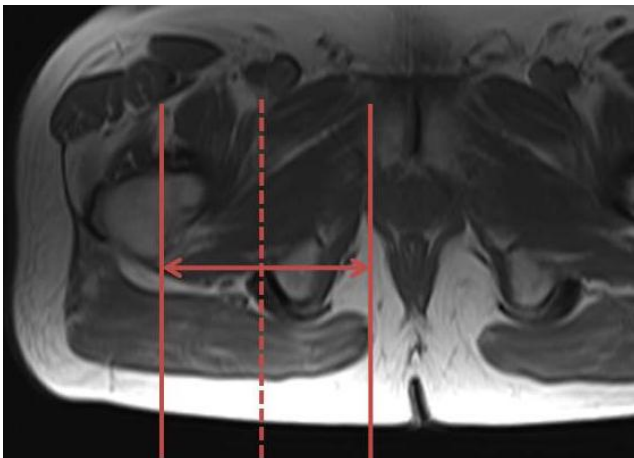
3. AX T1 AND STIR THICK (LOWER STACK) SEQUENCES

- Overlap by 1 slice with the upper stacks and cover down to the tibial tuberosity
- You can increase slices or gap to cover all the way down
- Parallel Sat Bands



4. SAGITTAL T2 SEQUENCE (AFFECTED SIDE)

- Use Coronal T1 and angle almost vertical
- Cover from the top of femoral head down for the FOV
- Center slices at the midpoint of hamstring tendons origins (just lateral to ischial tuberosity on Axial T1 sequence) but also try to cover all of the hamstring muscles laterally (see Cor T1 sequence)



MSK MRI PROTOCOL OVERVIEW

KNEE (ROUTINE)

GENERAL COMMENTS

- Only angle to the ACL in the coronal plane for the Sag PD FS sequence; do not angle in the axial plane
- Cover all of the patella on all sequences

COIL

- 15 Channel Knee Coil for Thin knees
- CP Extremity Coil for Larger knees
- Body coil for the Largest knees
- Center coil over the mid-point of the Patella (or Joint line)

POSITIONING

- Supine with knee fully extended
- Try to keep knee straight, but only if comfortable for the patient (limit internal and external rotation)

SEQUENCES, AND WHAT IS MOST IMPORTANT TO REPEAT

- Always repeat Sag and Cor PD if there is any motion

1. COR PD
2. COR STIR
3. SAG PD
4. SAG GRE T2
5. SAG PD FS TO ACL
6. AXIAL PD FS

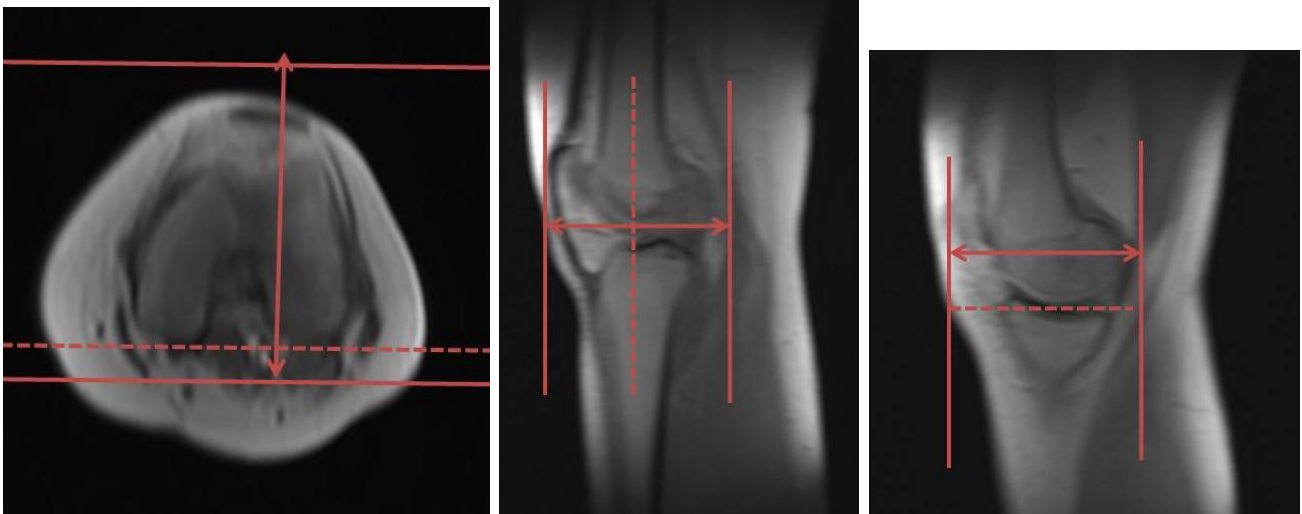
SEQUENCES

3 PLANE LOC

1. CORONAL PD AND STIR SEQUENCES

- Angle parallel to the posterior femoral condyles on the Axial scout
- Angle perpendicular to the tibial plateau on the Sagittal scout, or parallel to the tibial shaft if the tibial plateau is hard to assess
- Cover from the anterior cortex of the patella to as far back as possible (cover at least 1 slice posterior to femoral condyles and cover fibular head)
- Superior Sat Band on COR STIR

MSK MRI PROTOCOL OVERVIEW



2. SAGITTAL PD AND GRE T2

- Perpendicular to COR PD
- Angled perpendicular to Tibial Plateau on COR PD
- Cover at least 1 slice out of both menisci



3. SAGITTAL PD FS

- Angle to the lateral side of the ACL on the COR PD sequence (NOT ON THE AXIAL)
- Don't angle more than 7 degrees (it is usually less than you think)
- Superior Sat Band

MSK MRI PROTOCOL OVERVIEW



4. AXIAL PD FS

- Perpendicular to COR PD and SAG PD FS
- Cover from 2 Slices above the top of the Patella to the distal portion of the tibial tuberosity
- Parallel Sat Bands

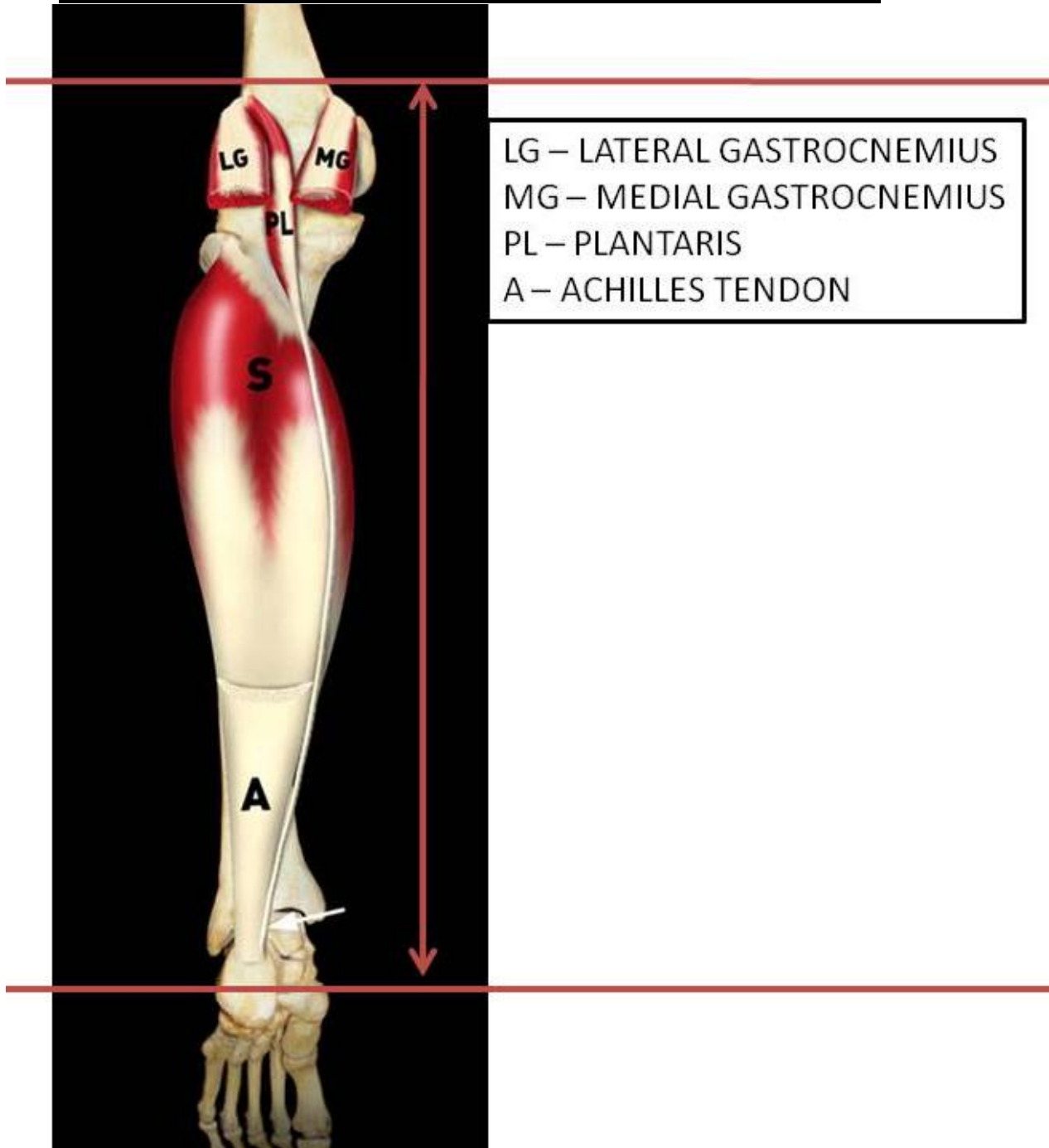


MSK MRI PROTOCOL OVERVIEW

CALF/TIBIA STRESS FRACTURE PROTOCOL

GENERAL COMMENTS

- The coronals image both calves
- The sagittal and axial images are only on the affected side
- You need to cover from above the Gastrocnemius tendons (femoral metaphysis) and attempt to go down to the Achilles insertion
- **FOR TALL PEOPLE, YOU DON'T HAVE TO COVER ALL THE WAY TO THE CALCANEUS ON THE SAG AND COR SEQUENCES**



MSK MRI PROTOCOL OVERVIEW

COIL

- Use Peripheral Array, or if a tall patient use the Peripheral Array and Body Matrix Coil
- If no Peripheral Array, 2 Body matrix coils strapped over calves
- Spine array coils on as well
- Signal should cover from distal femoral diaphysis to top of calcaneus

POSITIONING

- Supine
- Try to have toes pointing up, with a sponge between the feet for comfort
- Strap down snugly to prevent motion

SEQUENCES, AND WHAT IS MOST IMPORTANT TO REPEAT

- Axial STIR and PD are the most important sequences to repeat

BOTH CALVES

1. COR STIR
2. COR T1

AFFECTED SIDE

3. SAG T2
4. SAG T1
5. AXIAL PD (UPPER STACK)
6. AX STIR (UPPER STACK)
7. AXIAL PD (LOWER STACK)
8. AXIAL STIR (LOWER STACK)

SEQUENCES

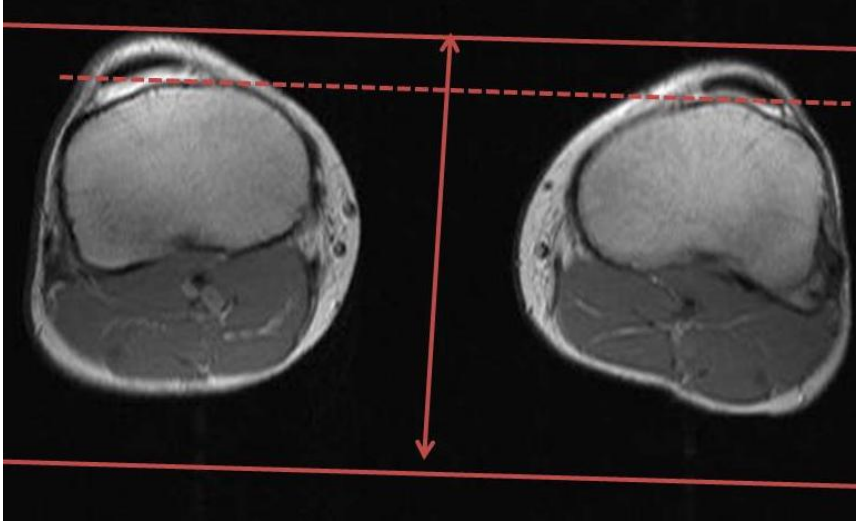
LOC

3 PLANE LOC (USING BOTH BODY COILS)

1. CORONAL T1 AND STIR SEQUENCES

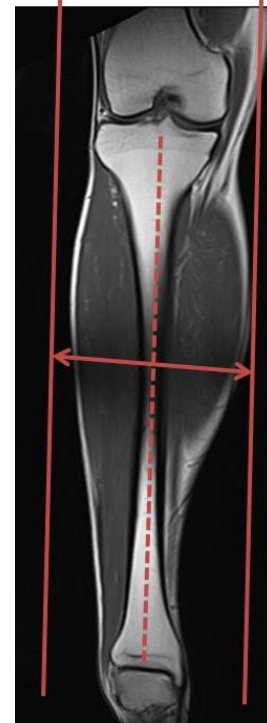
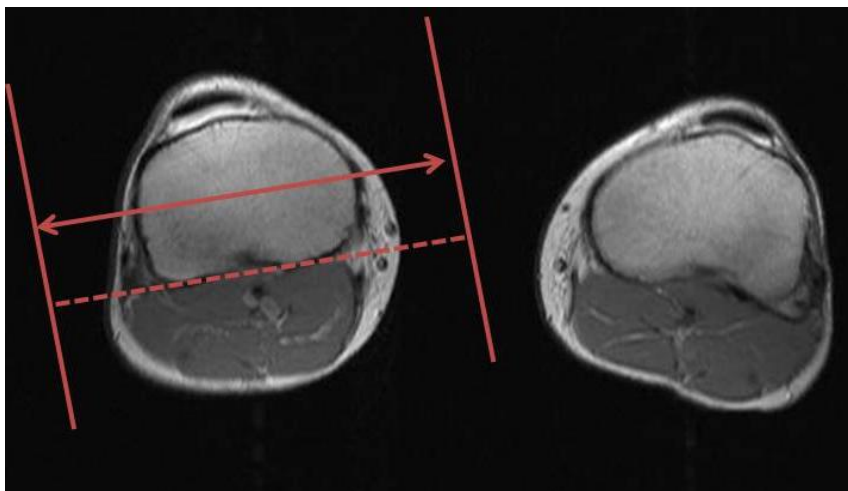
- Cover both calves from top of patellas down to try and cover the top of the calcanei
- Use Localizers and angle parallel to the anterior tibial cortices in the axial plane and parallel to the tibial shaft in the sagittal plane
- Cover all of the calf musculature posteriorly, and cover anteriorly through all of the anterior tibia
- Superior Sat Bands

MSK MRI PROTOCOL OVERVIEW



2. SAGITTAL T1 AND T2 SEQUENCES (AFFECTED SIDE)

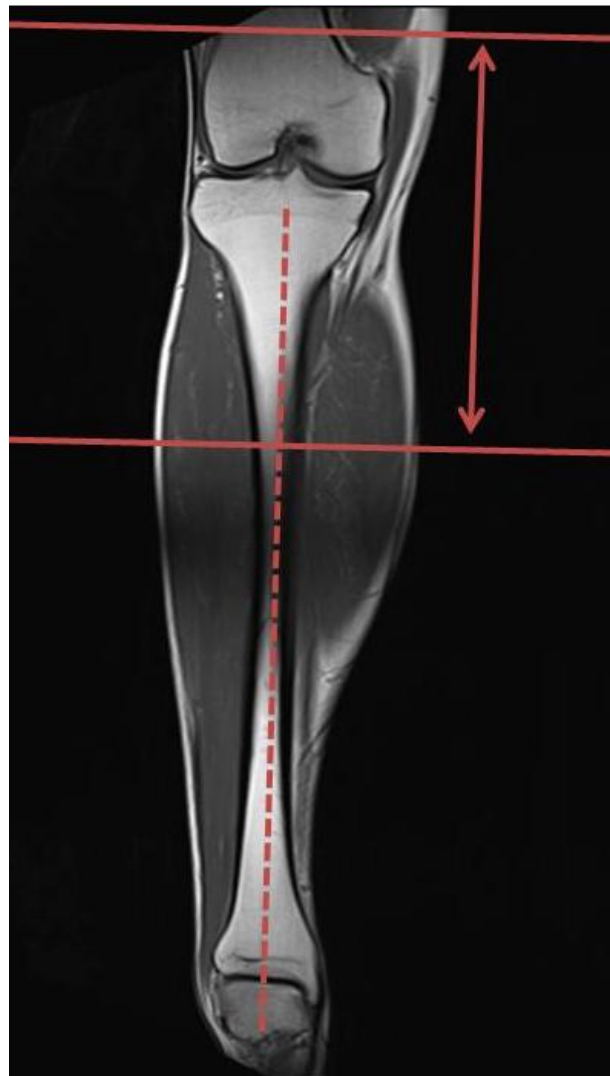
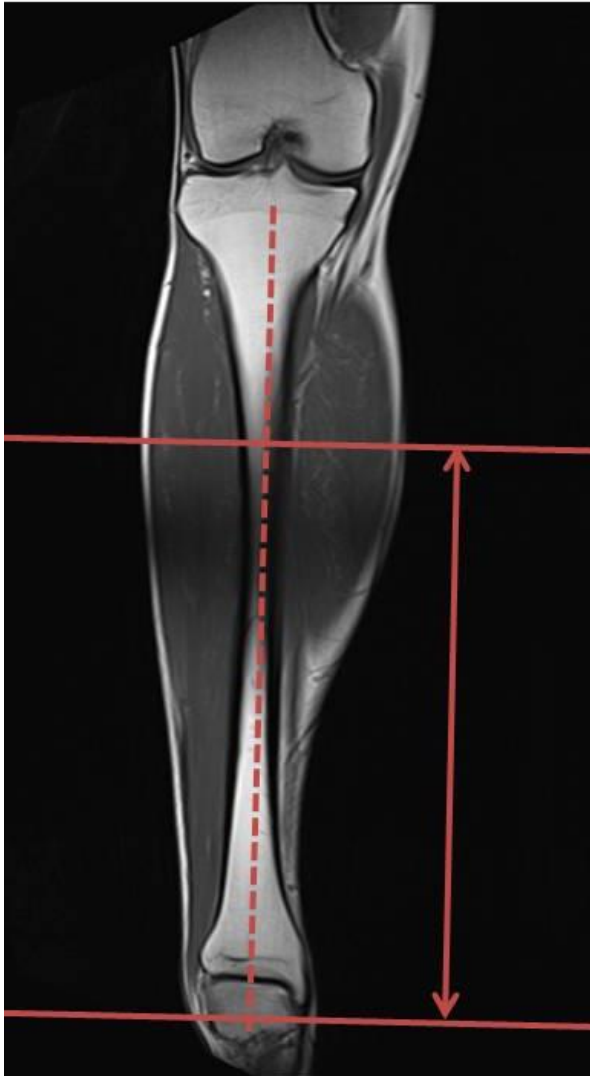
- Use Coronal T1 and angle parallel to the tibial shaft
- Cover from the top of the patella down to the top of the calcaneus
- Cover medial and lateral to the outside of the musculature
- Use Axial Loc and angle perpendicular to the back of tibial plateau



MSK MRI PROTOCOL OVERVIEW

3. AXIAL PD AND STIR SEQUENCES (AFFECTED SIDE)

- You have to do 2 stacks (the lower stack can be thicker slices if the patient is tall)
- Overlap stacks by 1 slice
- Perpendicular to the long axis of the tibial shaft
- Cover from the superior-patella to the top of the calcaneus
- Parallel Sat Bands for T1 and Superior Sat band for STIR



MSK MRI PROTOCOL OVERVIEW

ANKLE (ROUTINE)

GENERAL COMMENTS

- Have foot relaxed and use sponges to reduce motion artifact

COIL

- CP Extremity Coil
- Center coil at the malleoli

POSITIONING

- Supine with foot relaxed (approx. 90 degrees and toes pointing up)

SEQUENCES, AND WHAT IS MOST IMPORTANT TO REPEAT

- Always repeat Cor PD and Cor PD FS if there is any motion

1. COR PD
2. COR PD FS
3. SAG T1
4. SAG STIR
5. AXIAL PD
6. AXIAL STIR

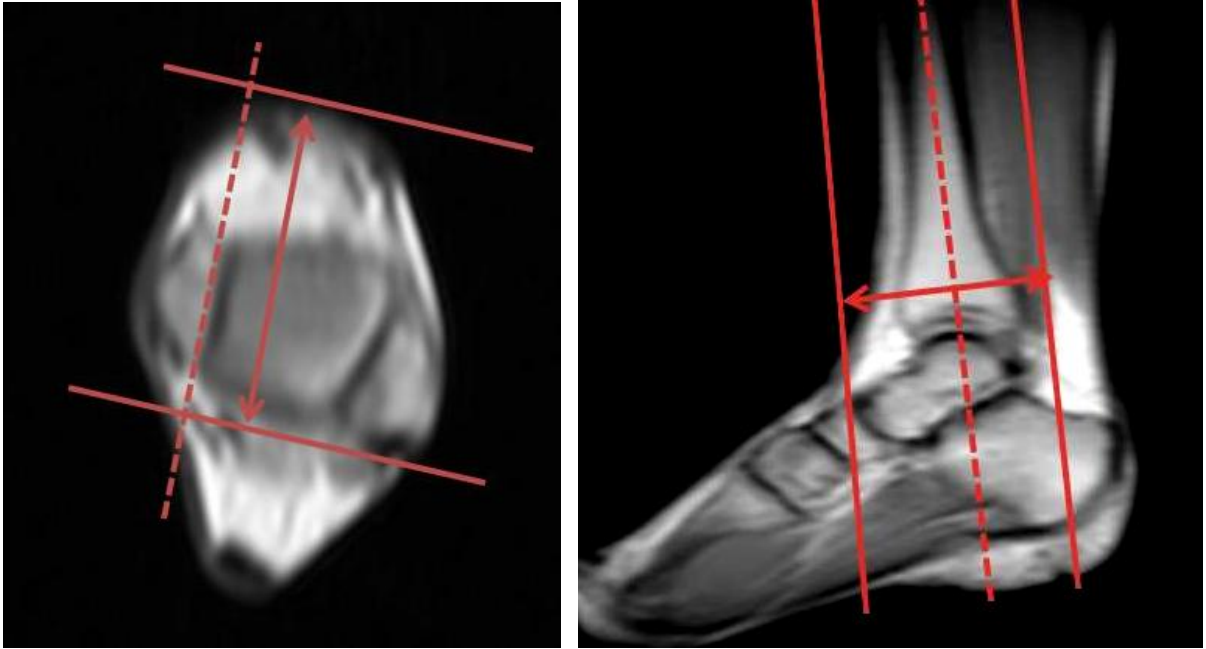
SEQUENCES

3 PLANE LOC

1. CORONAL PD AND PD FS SEQUENCES

- Use axial LOC and angle perpendicular to the inner cortex of the medial malleolus
- Use sagittal LOC and angle parallel to distal tibial shaft and cover from the talonavicular joint to at least 2 slices posterior to the talus
- The COR PD FS sequence is thicker and can cover more of the talonavicular joint anteriorly and plantar fascia posteriorly
- All of the plantar(inferior) soft tissues should be included in the FOV
- Superior Sat Band

MSK MRI PROTOCOL OVERVIEW



2. SAGITTAL STIR AND T1

- Perpendicular to COR PD
- Angled perpendicular to talar dome
- Cover at least 1 slice out of both malleoli
- All of the plantar soft tissues should be included in the FOV
- Superior Sat Band
-



MSK MRI PROTOCOL OVERVIEW

3. AXIAL PD AND STIR

- Perpendicular to COR PD and SAG STIR
- Cover from 3-4 Slices above the inferior margin of the tibiotalar joint (the joint is best seen posteriorly) down as far as the slices go
- Parallel Sat Bands



MSK MRI PROTOCOL OVERVIEW

ANKLE (FLEXOR AND PERONEAL TENDONS)

GENERAL COMMENTS

- Have patient prone and foot plantar flexed for better tendon evaluation
- Need more slices and Cor and Ax slices are thicker
- Coverage includes more of the proximal tendons

COIL

- Body Matrix Coil
- Cover more of the midfoot and calf than standard ankle

POSITIONING

- Prone with foot plantar flexed

SEQUENCES, AND WHAT IS MOST IMPORTANT TO REPEAT

- Always repeat Cor PD and Axial STIR if there is any motion

1. COR PD
2. COR PD FS
3. SAG T1
4. SAG STIR
5. AXIAL PD
6. AXIAL STIR

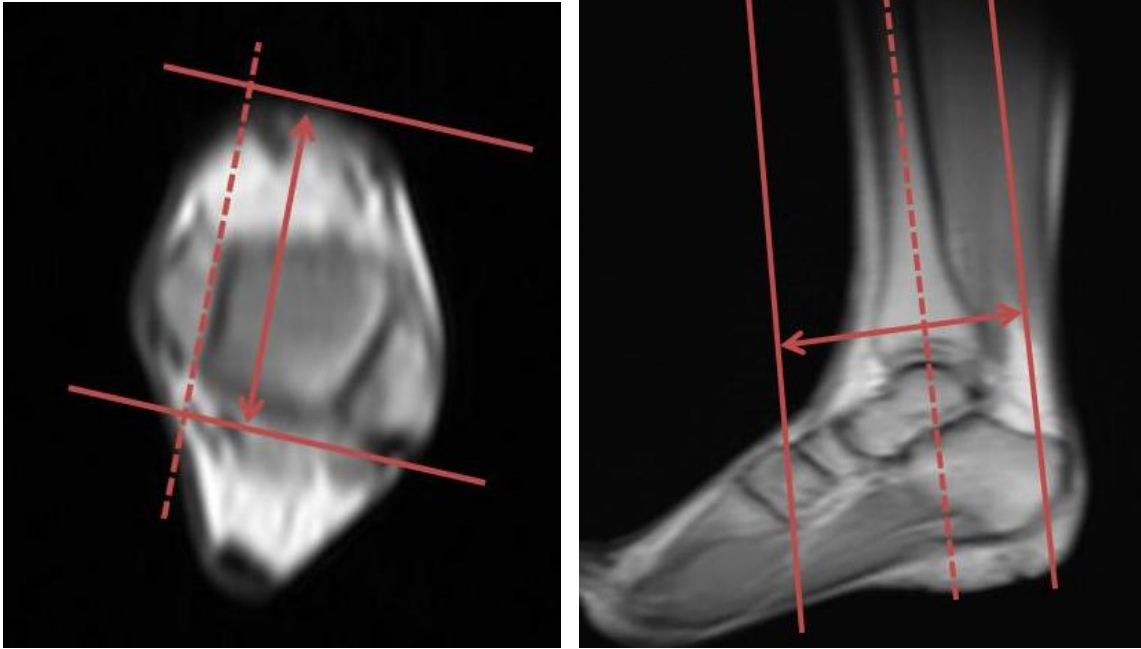
SEQUENCES

3 PLANE LOC

1. CORONAL PD AND PD FS SEQUENCES

- More slices and slices are thicker than standard ankle MR
- Use axial LOC and angle perpendicular to the inner cortex of the medial malleolus (should parallel posterior cortex of the talar dome)
- Use sagittal LOC and angle parallel to distal tibial shaft and cover from the navicular/cuneiform joint back to at least 3-4 slices posterior to the talus
- All of the plantar(inferior) soft tissues should be included in the FOV
- Superior Sat Band

MSK MRI PROTOCOL OVERVIEW



2. SAGITTAL STIR AND T1

- Perpendicular to COR PD
- Angled perpendicular to talar dome
- Cover at least 1 slice out of both malleoli
- All of the plantar soft tissues should be included in the FOV
- Superior Sat Band



MSK MRI PROTOCOL OVERVIEW

3. AXIAL PD AND STIR

- More slices and slices are thicker than standard ankle MR
- Perpendicular to COR PD and SAG STIR
- Cover from inferior cortex of the fifth metatarsal and cover up as far as possible (approx. five slices above the tibiotalar joint)
- Parallel Sat Bands



MSK MRI PROTOCOL OVERVIEW

ACHILLES TENDON

GENERAL COMMENTS

- Larger coverage of lower calf than previous

COIL

- Body Matrix Coil
- Cover the ankle and more of the calf

POSITIONING

- Prone with foot plantar flexed (Supine with plantar flexion if patient cannot tolerate prone positioning)
- Lift the other leg out of the way to prevent wrap

SEQUENCES, AND WHAT IS MOST IMPORTANT TO REPEAT

- Always repeat Axial T2 if there is any motion
1. AX T2
 2. AX STIR
 3. SAG STIR
 4. SAG T1

SEQUENCES

LOC

3 PLANE LOC

1. AXIAL T2 AND STIR SEQUENCES

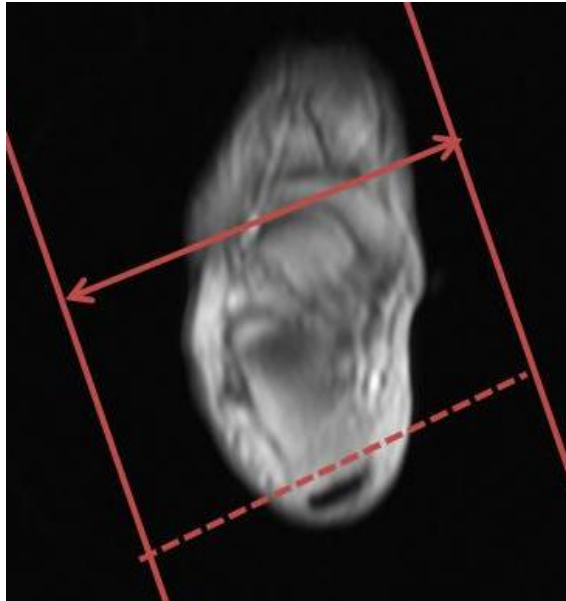
- Use Sagittal LOC and angle perpendicular to the achilles tendon
- Cover from distal most Achilles tendon (mid-portion of calcaneus) up as proximal as the slices go
- Parallel Sat Bands for T2 and Superior Sat band for STIR



MSK MRI PROTOCOL OVERVIEW

2. SAGITTAL STIR AND T1 SEQUENCES

- Perpendicular to Axial Sequences
- Superior Sat Band for STIR and T1
- Use Axial LOC and find the distal-most tendon and angle perpendicular to long axis of tendon
- Center in the mid-achilles tendon and use the slices given



MSK MRI PROTOCOL OVERVIEW

MORTON'S NEUROMA/FOREFOOT (WITH GAD)

GENERAL COMMENTS

- Have foot plantar flexed; to stop compression of the neuroma by the coil, which makes the neuroma difficult to visualize
- Have foot bare; no stocks or nylons
- Only do one foot at a time, as unable to give GAD again for 2nd foot

COIL

- CP Extremity Coil
- Try and center coil at the Metatarsal heads (ball of foot), but make sure toes are in coil to prevent inhomogeneous Fat Sat

POSITIONING

- Pt is prone and foot is plantar flexed
- Try not to put too much packing over the MTP joints, to prevent pushing/compressing a Morton's neuroma

SEQUENCES, AND WHAT IS MOST IMPORTANT TO REPEAT

- Always repeat Cor T1 (Short Axis) and Cor T1 FS + Gad if there is motion

1. AX (LONG AXIS) T2
2. COR (SHORT AXIS) STIR
3. COR (SHORT AXIS) T1
4. COR (SHORT AXIS) T1 FS
5. SAG STIR

POST GADOLINIUM

6. COR (SHORT AXIS) T1 FS
7. AX (LONG AXIS) T1 FS

SEQUENCES

LOC

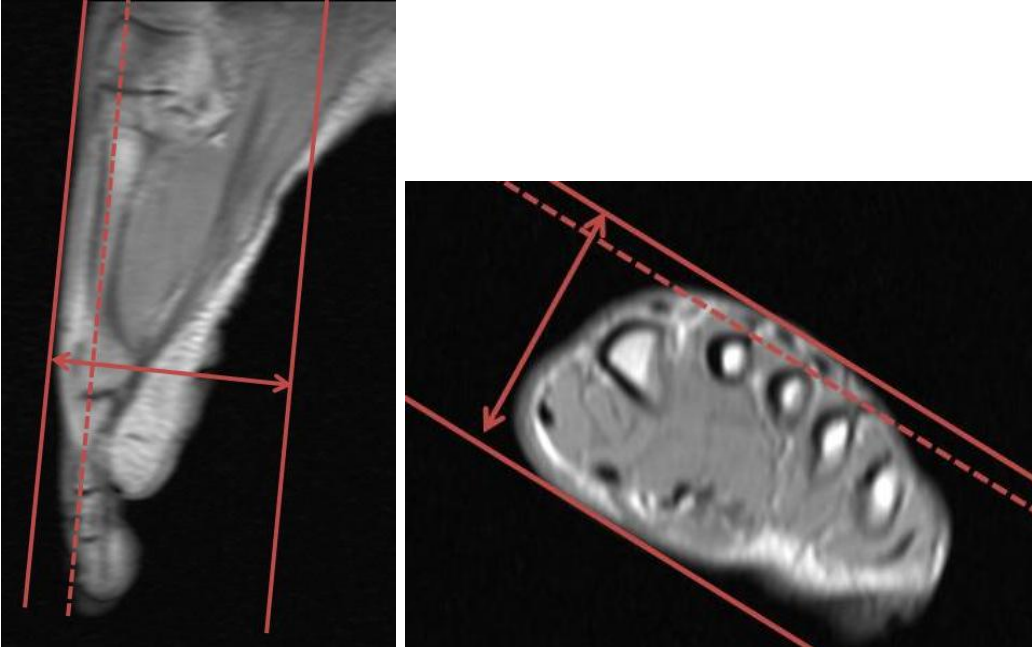
3 PLANE LOC

1. AX (LONG AXIS) T2 SEQUENCE

- Use Sag LOC and angle parallel to the shaft of either the 2nd or 3rd metatarsals (whichever is the least deformed) and at least cover the soft tissues superior and inferior to the MTP joints
- Cover all of the toes and as far proximal as the field of view allows

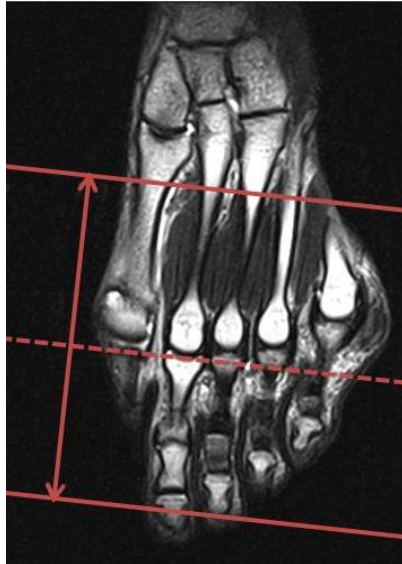
MSK MRI PROTOCOL OVERVIEW

- Use Axial LOC and angle parallel to the superior cortices of the 2nd and 3rd metatarsal necks
- Proximal Sat Band



2. COR (SHORT AXIS) STIR, T1, T1 FS SEQUENCES

- Perpendicular to AX (Long Axis) T2
- Angled parallel to 2nd MTP joint or perpendicular to 2nd metatarsal shaft
- Cover at least to mid-metatarsal shaft region, but try to cover out to the DIP joints if there is enough slices



3. SAGITTAL STIR SEQUENCE

- Perpendicular to AX T2 and COR T1
- Parallel to 2nd metatarsal shaft on Axial T2 sequence
- Cover from tips of the toes as far proximal as the FOV allows

MSK MRI PROTOCOL OVERVIEW

- Cover from medial margin of 1st MTP joint as far lateral as the slices go (try to cover all of the MTP joints)



4. CORONAL AND AXIAL T1 FS SEQUENCES

- After GADOLINIUM administration through an antecubital vein
- Copy parameters from previous sequences

MSK MRI PROTOCOL OVERVIEW

TEMPOROMANDIBULAR JOINTS PROTOCOL

GENERAL COMMENTS

- Both TMJ's are imaged
- (AT CLINIC ONLY, NOT AT HOSPITALS) Measure (mm's) maximal amount of mouth opening as well as the amount the patient could perform comfortably for the MRI with the mouth opener in place

COIL

- TMJ Coils, which are placed after the patient opens and closes the mouth so the TMJ's can be palpated and localized (anterior to the ears)
- Head coil if no TMJ coil

POSITIONING

- Supine with a Closed mouth, except for the last open mouth sequence
- Put in earplugs as headphones do not work with TMJ coils

SEQUENCES, AND WHAT IS MOST IMPORTANT TO REPEAT

- Always repeat SAG PD and open mouth Sag GRE if there is any motion

1. SAG OBL PD
2. SAG OBL STIR
3. COR PD
4. SAG FLASH GRE CLOSED
5. SAG FLASH GRE OPEN

IF DEDICATED TMJ COIL

6. SAG OBL MEDIC CLOSED

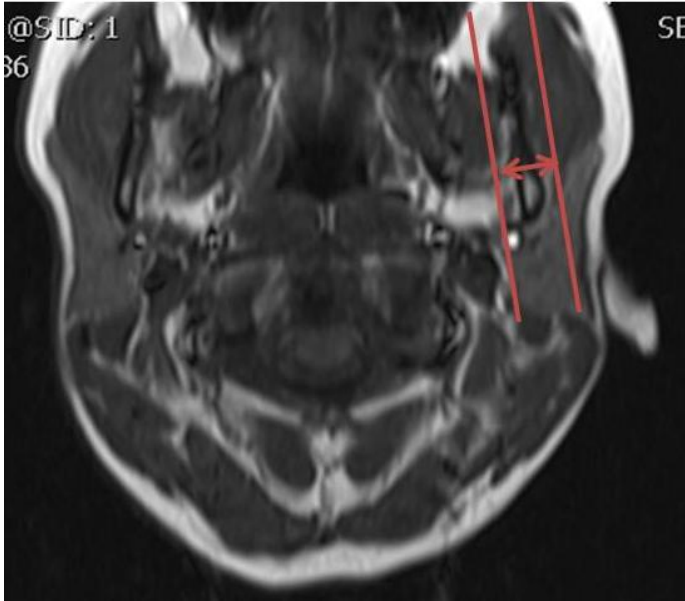
SEQUENCES

AXIAL, CORONAL AND OBLIQUE SAGITTAL LOCALIZERS

1. SAGITTAL OBLIQUE PD, STIR, AND MEDIC SEQUENCES

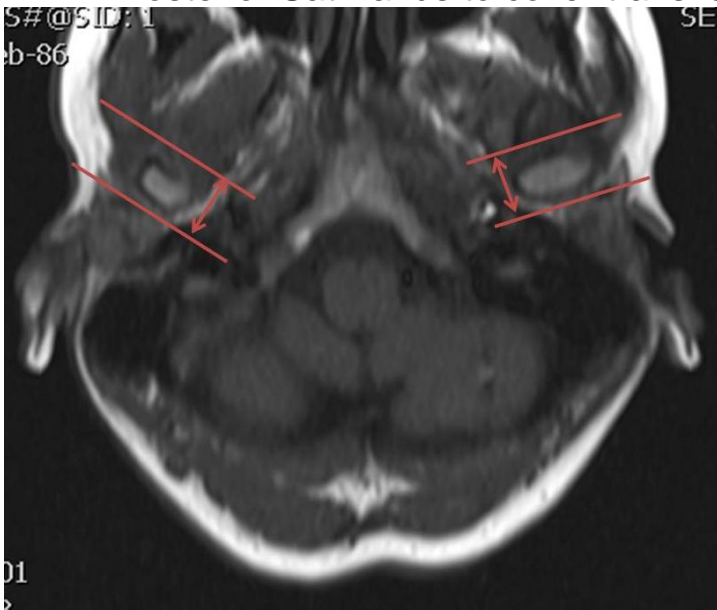
- Use Axial LOC and angle parallel to the mandibular rami and perpendicular to the long axis of the mandibular condyles
- Posterior Sat Bands to cover transverse sinuses for PD and STIR sequences
- Don't angle on the Coronal LOC, but use it to cover through the entire joint (medial to lateral)

MSK MRI PROTOCOL OVERVIEW



2. CORONAL PD SEQUENCE

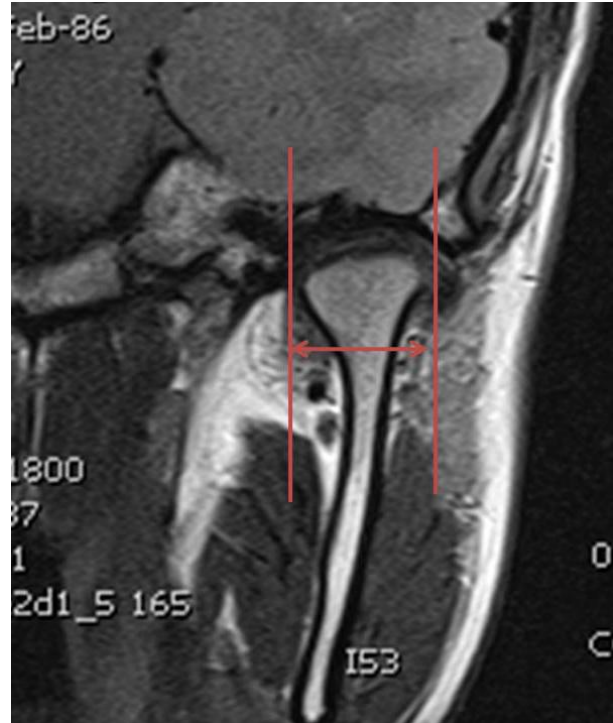
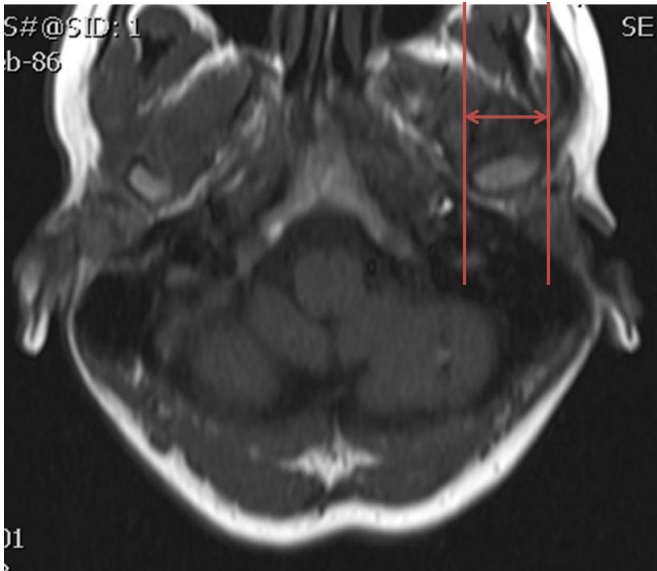
- Perpendicular to Sag Obl PD on both sides
- Use Sag Obl PD and cover the whole joint (anteroposterior) and angle plane parallel to back of mandibular condyle
- The sequence performs one joint first and then the other
- Posterior Sat Bands to cover transverse sinuses



MSK MRI PROTOCOL OVERVIEW

3. SAGITTAL FLASH GRE OPEN AND CLOSED SEQUENCES

- Copy from Sag Obl PD for position, but don't oblique sequence, and perform as a straight sagittal (because of change in position of the joints during mouth opening)
- Set up off of the coronals, and make sure the condyles are completely covered
- Perform closed sequence, then place mouthpiece and quickly image with the mouth open
- Posterior Sat Bands to cover transverse sinuses



MSK MRI PROTOCOL OVERVIEW

SPONDYLOARTHROPATHY PROTOCOL

GENERAL COMMENTS

- The protocol images the entire spine and the SI joints
- Obtain only cervicothoracic and thoracolumbar spine sequences (not 3 separate C,T and L sequences)
- Perform the SI joints last
- Spend the time to localize properly before imaging

1. CERVICAL, THORACIC, AND LUMBAR SPINE

COIL

- Use Neck Array and Spine Array for spine sequences

POSITIONING

- Supine, centered over the spine array

SEQUENCE ORDER

LOCALIZERS

- Use Complete Spine LOC

CERVICOTHORACIC SEQUENCES

1. SAG T1
2. SAG STIR

THORACOLUMBAR SEQUENCES

3. SAG T1
4. SAG STIR

SEQUENCES

CORONAL LOC

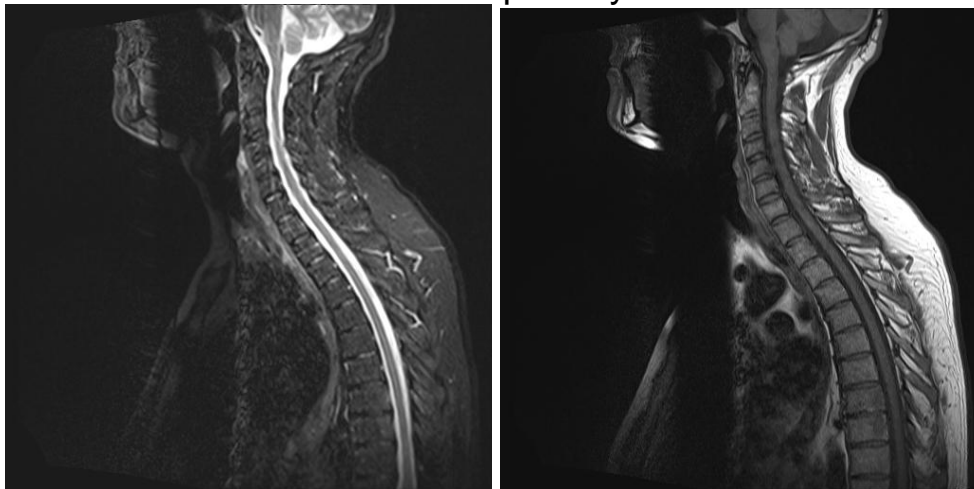
- Angle parallel to the entire spine if the patient is not scoliotic (use best fit for both sequences if there is scoliosis)

MSK MRI PROTOCOL OVERVIEW



1. SAGITTAL T1 AND STIR SEQUENCES

- Use Coronal LOC of the whole spine and put center slice in the middle of the vertebral bodies and try to cover all of the vertebral bodies laterally (if the patient is scoliotic you may have to do two side-by-side sequences and overlap by 1 slice)
- The thoracic spine is narrower than the lumbar spine, so you can cover some of the costotransverse joints
- Only put on the spine coils you are using for the sequence
- Anterior Sat Band for respiratory motion

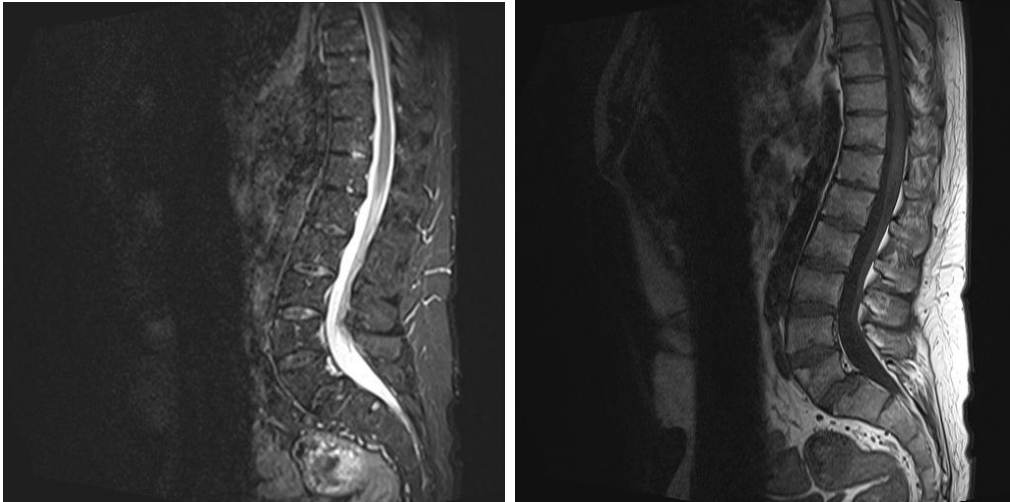


2. SAGITTAL T1 AND STIR SEQUENCES

- Use Coronal LOC and center slices and try to cover all of the vertebral bodies

MSK MRI PROTOCOL OVERVIEW

- The lower vertebral bodies will likely not be imaged, as they are wider
- This FOV should overlap with the upper sequences FOV
- Only put on the spine coils you are using for the sequence
- Anterior Sat Band for bowel motion



MAKE SURE YOU OVERLAP THE CT AND TL SEQUENCES

2. SACROILIAC JOINTS

GENERAL COMMENTS

- Different hospitals have slightly different ways of using coils

COIL

- Use Spine Array Posteriorly and have the Normalization Filter on (to reduce burn-out of image posteriorly)
- If you need more signal (large patient) or want to reduce acquisition time (IPAT) you can use both the Body Matrix Coil (strapped anteriorly over pelvis) and Spine Coil to reduce burn-out of image posteriorly

SEQUENCES, AND WHAT IS MOST IMPORTANT TO REPEAT

- The COR T1 is the most important to repeat

4. COR T1
5. COR STIR
6. AX STIR

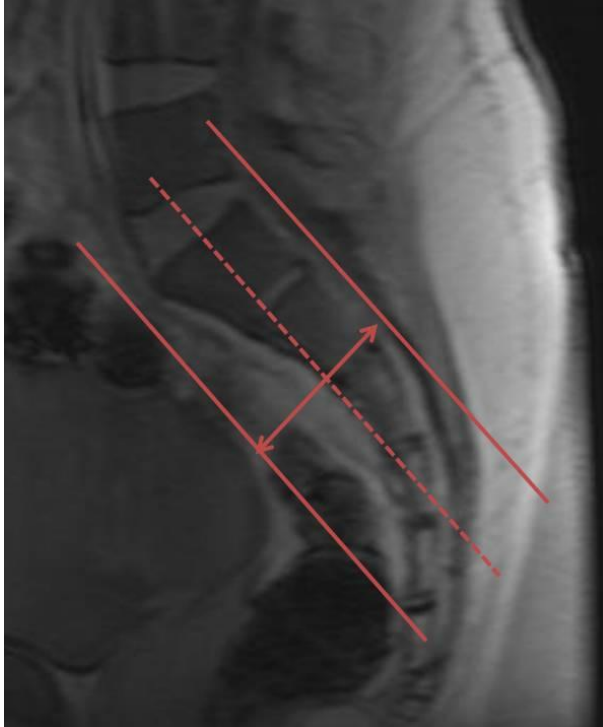
SEQUENCES

3 PLANE LOC

MSK MRI PROTOCOL OVERVIEW

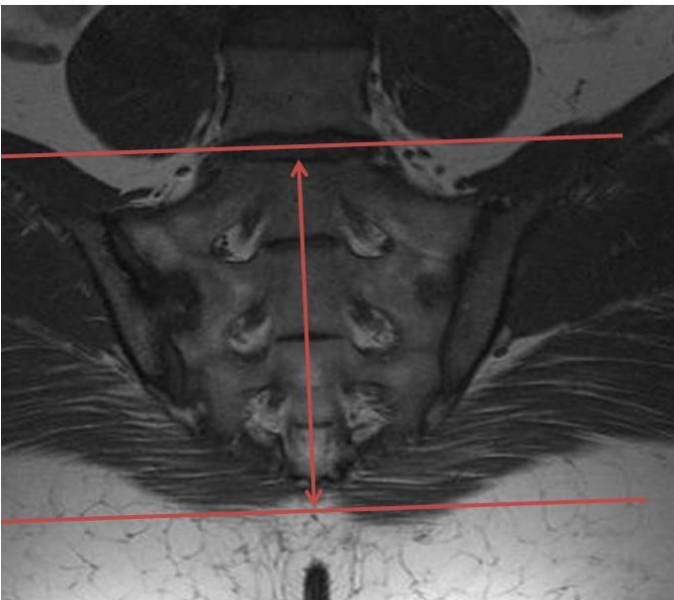
1. OBLIQUE CORONAL T1 AND STIR SEQUENCES

- Use Sagittal LOC and angle parallel to the length of the Sacrum (use the S2 posterior/superior cortex and center image at S2/S3 disc)
- Cover from 1 slice anterior and 1 slice posterior to the sacral bodies
- Superior Sat Band



2. OBLIQUE AXIAL STIR SEQUENCE

- Perpendicular to the Coronal sequences
- Use COR T1 and cover through SI joints
- Superior Sat Band



MSK MRI PROTOCOL OVERVIEW

SHOULDER ARTHROGRAM (POST ONLY)

GENERAL COMMENTS

- The Glenohumeral joint is what you use to plan the coronal and sagittal sequences for a post arthrogram shoulder
- Axial and Cor T1 FS are higher resolution than Sag T1 FS

COIL

- Shoulder coil
- Large 4 channel flex for a larger patient (make certain that coverage has enough signal for the AC joint)
- Body matrix coil for an extremely large patient

POSITIONING

- Supine
- Try to have shoulder neutral (external rotation is fine)
- Try to limit superior or inferior positioning of shoulder when compared to the chest
- Try to place shoulder as close to isocenter in the bore of the magnet
- Place a sponge at the elbow and one supporting the hand and strap the arm in place

SEQUENCES, AND WHAT IS MOST IMPORTANT TO REPEAT

- Cor T1 FS is most important sequence to repeat if motion
- Axial T1 FS is the next most important sequence

1. AX T1 FS
2. COR T1 FS
3. COR T2 FS
4. SAG T1 FS
5. SAG T2
6. AX T1 (INTERNAL ROTATION)
7. (OPTION) ABER T1 FS

SEQUENCES

LOC

3 PLANE LOC

1. AXIAL T1 FS

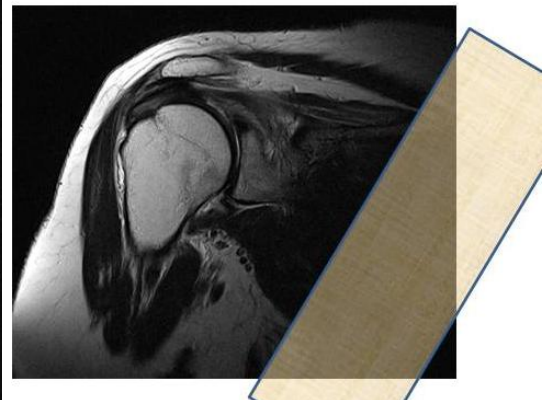
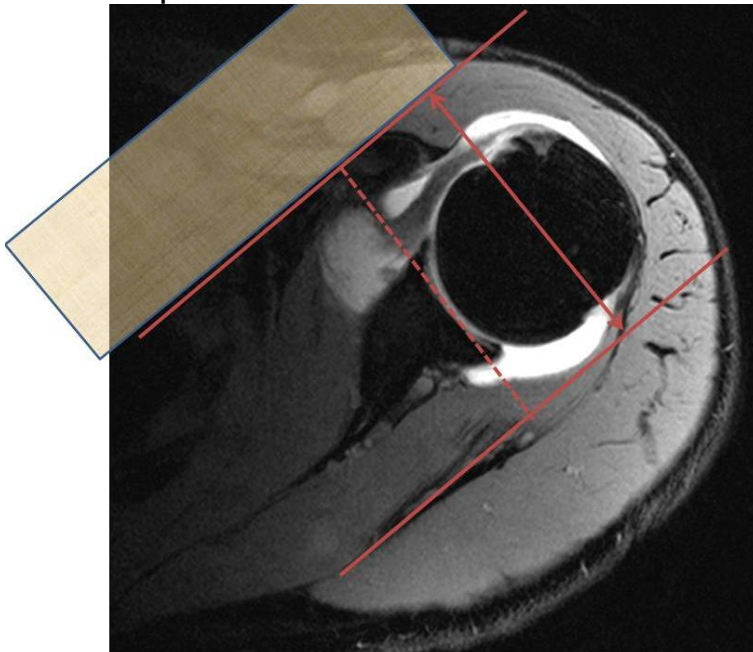
MSK MRI PROTOCOL OVERVIEW

- Use coronal LOC and plane is straight horizontal (don't angle)
- Cover the entire glenohumeral joint (look at contrast on LOC), and cover to the inferior portion of the axillary pouch (and through AC joint if you have enough slices)
- Oblique Sat Band over chest



2. COR T1 FS AND T2 FS

- Use axial T1 FS sequence to orient the plane perpendicular to the glenohumeral joint
- Cover from anterior portion of coracoid process (subscapularis recess) to cover posterior glenohumeral joint recess
- Oblique Sat band over chest

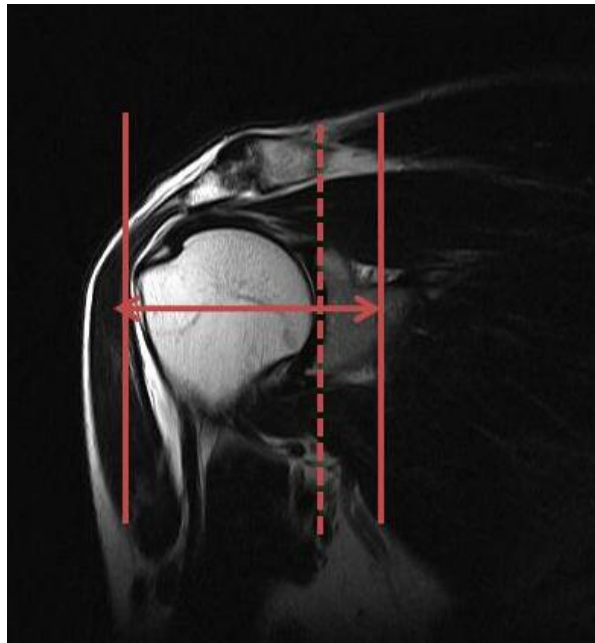
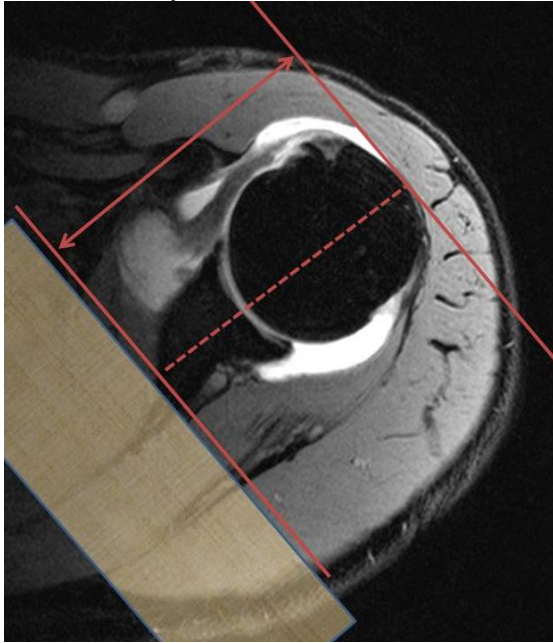


3. SAG T1 FS

- Perpendicular to Coronal sequence

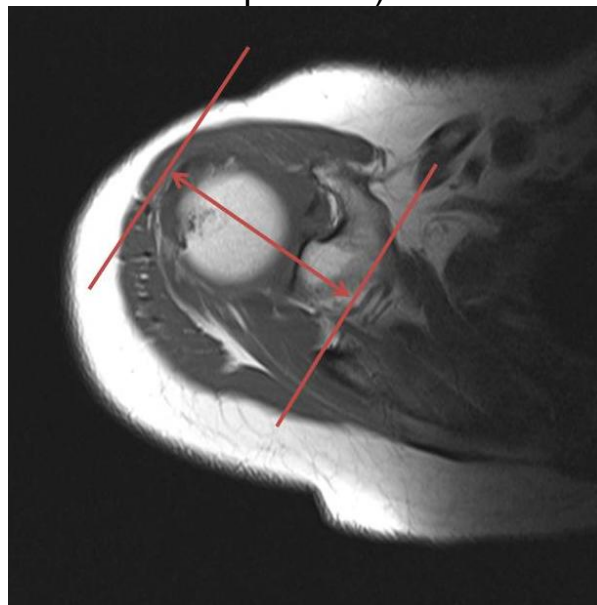
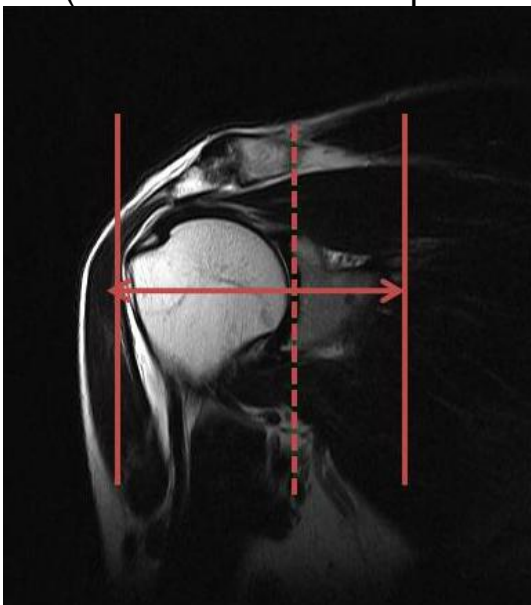
MSK MRI PROTOCOL OVERVIEW

- Angle approximately parallel to GH joint on the Cor T1 FS sequence (use Glenoid articulating surface to angle)
- Cover from 1 slice out of humeral head to as far medial as slices allow
- Oblique Sat band over chest



4. SAG T2

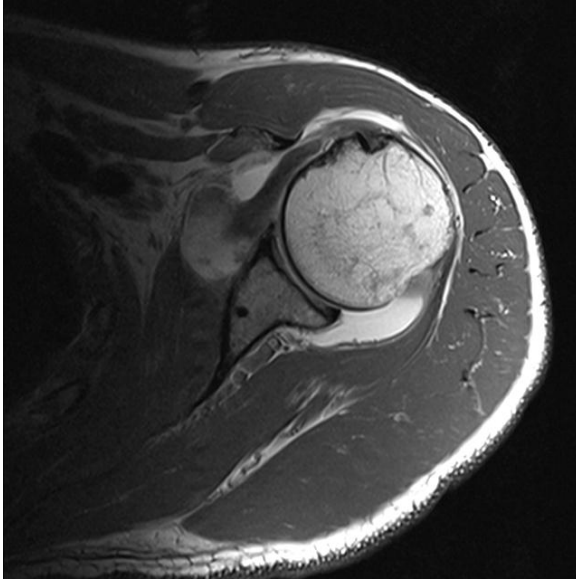
- The slices are thicker than the SAG T2 FS (to cover more of the muscle bellies)
- Oblique Sat band over chest
- Cover from 1 slice out of humeral head to as far medial as the slices go (Cover to the medial portion of the coracoid process)



MSK MRI PROTOCOL OVERVIEW

5. AX T1 (INTERNAL ROTATION)

- Go in and loosen shoulder so the patient can internally rotate, and then re-tighten straps and run sequence
- Copy parameters from Ax T1 FS (this sequence has more slices and a larger gap, so there is more coverage to account for any inadvertent change in position during internal rotation)



6. ABDUCTION EXTERNAL ROTATION (ABER) T1 FS (OPTIONAL)

- Takes about 9 minutes to reposition, strap down, re-localize and run the sequence
- Used for anterior glenohumeral dislocations, because you can assess the anteroinferior glenoid labrum better (creates traction on the labrum through tensing the anterior inferior GH ligament)
- Abduct shoulder, flex elbow, and have patients hand placed under the patients neck to reduce motion and increase comfort
- If patient has too much pain, you can image with the hand above the head with the elbow flexed
- Strap 4 Channel Flex Coil or Body Coil around proximal humerus, centered over axilla with good signal at the glenohumeral joint

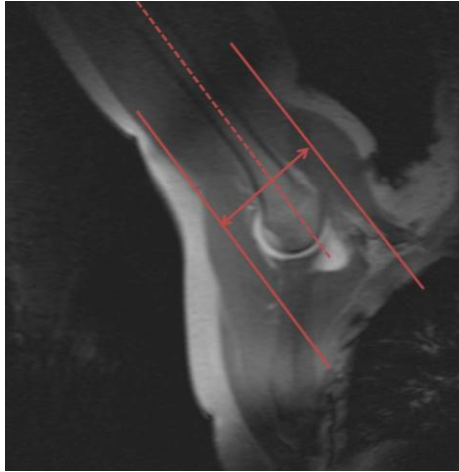
a) Coronal LOC to find shoulder and humeral shaft

b) 3 Plane LOC centered at glenohumeral joint

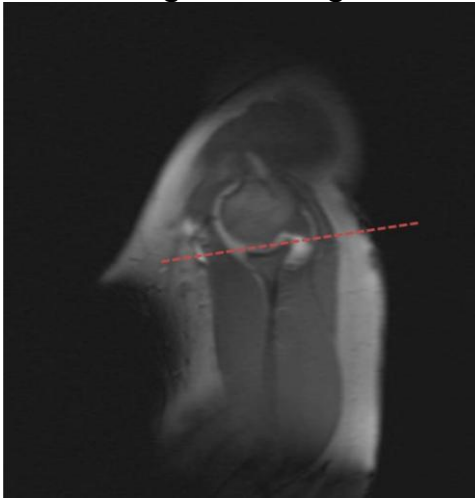
c) OBLIQUE AXIAL T1 FS

1. Use Cor LOC and the plane is parallel to the humeral shaft, and make sure to cover through the entire joint

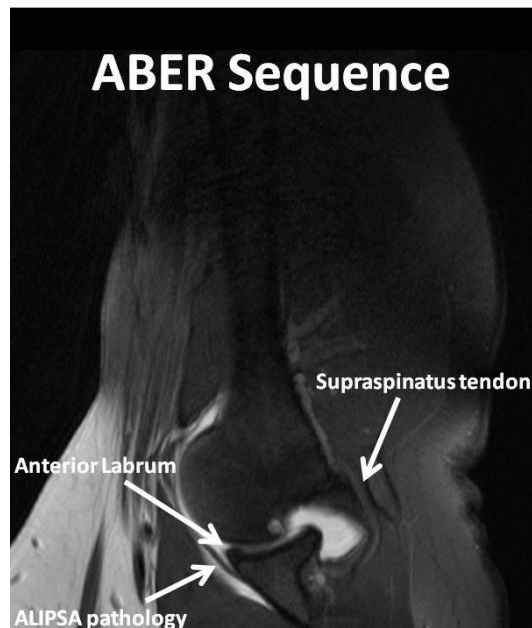
MSK MRI PROTOCOL OVERVIEW



2. Use Sag LOC and angle to the glenohumeral joint



3. Should see biceps tendon on top slice and you should cover through the labrum on the inferior-most slices



MSK MRI PROTOCOL OVERVIEW

SCAPULA

GENERAL COMMENTS

- Used for trauma, snapping scapula syndrome, pain around scapula

COIL

- Body Matrix Coil anteriorly, centered over pectoralis muscle and covers out to mid-humeral head
- Spine array on posteriorly

POSITIONING

- Supine, with arms to the sides
- Try and limit a drooping shoulder or a high-riding shoulder
- Strap down coil to reduce motion

SEQUENCES, AND WHAT IS MOST IMPORTANT TO REPEAT

- Axial T1 if motion

1. COR STIR
2. SAG T2
3. SAG T1
4. AX T1
5. AX STIR

SEQUENCES

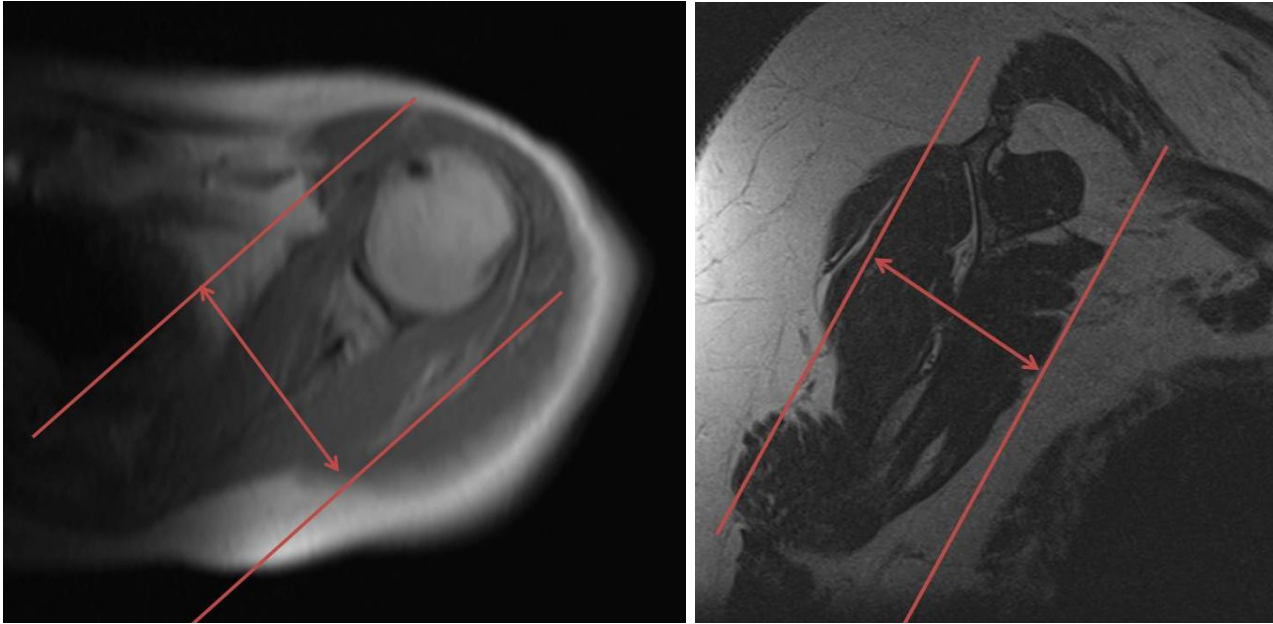
LOC

3 PLANE LOC

1. CORONAL STIR SEQUENCE

- Use Axial LOC and angle parallel to the scapular body, and cover from anterior portion of coracoid process to 3 slices posterior to humeral head (try to cover the adjacent muscles anteriorly and posteriorly)
- Use Sag LOC and angle parallel to the body of the scapula

MSK MRI PROTOCOL OVERVIEW



2. SAG T2 AND T1 SEQUENCES

- Perpendicular to Coronal STIR
- Use Coronal STIR and angle parallel to glenoid articulating surface, and cover from outside of humeral head to 2 slices medial to medial margin of scapula

3. AXIAL T1 AND STIR SEQUENCES

- Perpendicular to Sagittal and Coronal sequences
- Cover from top of acromion to 3 slices inferior to inferior angle of the scapula (Sagittal T2 would help with planning coverage)

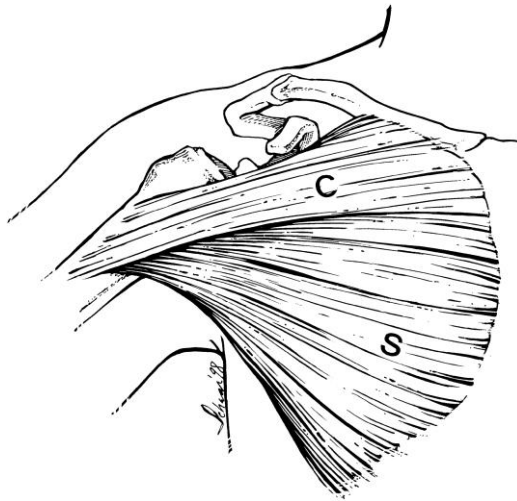


MSK MRI PROTOCOL OVERVIEW

PECTORALIS MAJOR

GENERAL COMMENTS

- Used for trauma and covers both tendon and myotendinous tears
- Try to reduce respiratory motion (diaphragmatic breathing rather than chest wall excursions, or try prone imaging)
- **Tell them to breath by pushing out their stomach and exhale by pushing in their stomach (limits chest movement)**



COIL

- Body Matrix Coil strapped anteriorly
- IF THERE IS EXTRA COIL THEN WRAP IT AROUND THE SHOULDER AND DO NOT PUT IT OVER THE OTHER PECTORALIS (TO REDUCE WRAP)
 - o Coil should cover sternum and out to cover shoulder
 - o Coil should cover from above clavicle down to mid humerus
- Have patient in neutral to externally rotated shoulder position, but if painful then put shoulder in any comfortable position to limit motion (strap hand down with sponges to limit hand movement)

POSITIONING

- Supine, with arms to the sides or prone to reduce motion
- Try and limit a drooping shoulder or a high-riding shoulder

SEQUENCES, AND WHAT IS MOST IMPORTANT TO REPEAT

- Repeat Axial PD FS (small FOV) if motion artifact

ENTIRE UNILATERAL PECTORALIS

1. COR HASTE T2 (BREATH-HOLD)

MSK MRI PROTOCOL OVERVIEW

2. AXIAL GRE T1 (BREATH-HOLD)
3. AXIAL STIR (BREATH-HOLD)

SMALL FOV OF TENDON

4. AXIAL PD FS
5. AXIAL T1
6. COR STIR
7. SAG T2

SEQUENCES

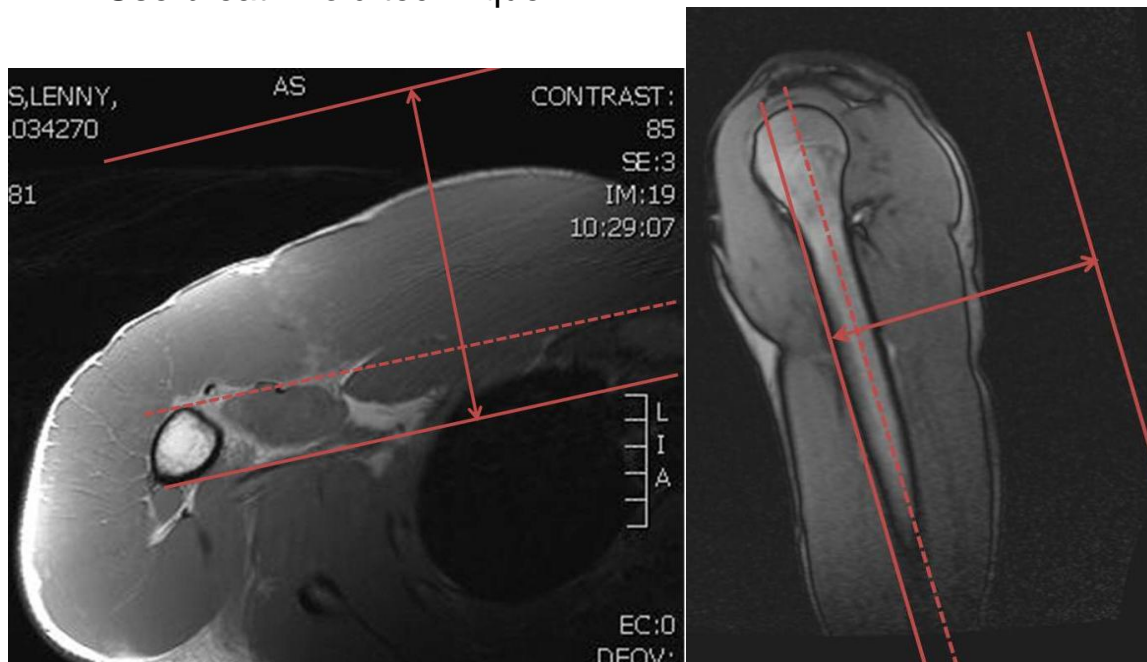
3 PLANE LOC

SAG LOC – SHOULD COVER HUMERAL SHAFT

AXIAL LOC – SHOULD COVER PROXIMAL HUMERAL SHAFT

1. CORONAL T2 SEQUENCE

- Use Axial LOC and angle parallel to the plane between the anterior humeral shaft and the anterior sternum
- FOV should be from midline to outer humeral shaft
- Cover from posterior humeral shaft to as far anterior as the slices go (during breath-holds the chest will expand)
- Use Sag LOC and angle to humeral shaft
- Use breath-hold technique



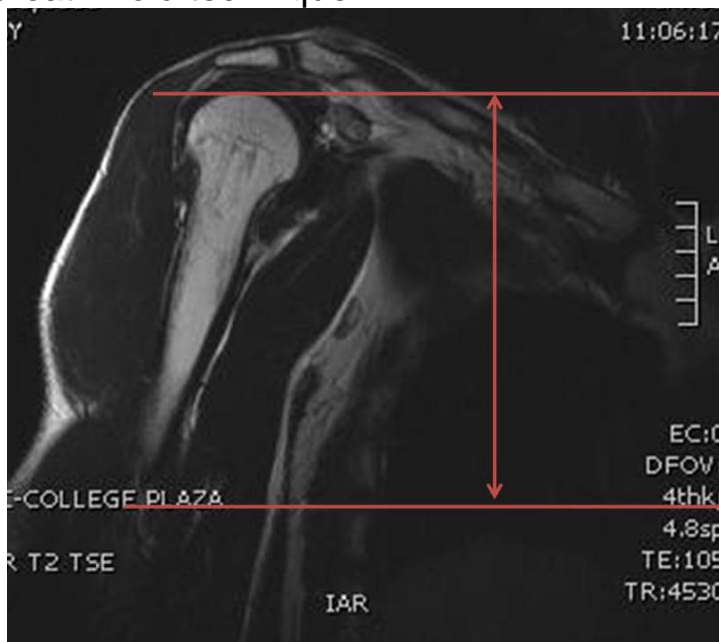
2. AXIAL GRE T1 AND STIR SEQUENCES

MSK MRI PROTOCOL OVERVIEW

- Plane is perpendicular to patients body and angled perpendicular to humeral shaft
- Use Cor T2 and cover from superior humeral head down to mid-humeral shaft (use where the deltoid muscle ends and the fat extends down to the humerus, SEE ARROW)



- FOV should be from midline to outer humeral shaft
- Make sure FOV covers all of anterior chest (due to chest expansion from deep breath)
- Use breath-hold technique



3. AXIAL PD FS AND T1 SMALL FOV SEQUENCES

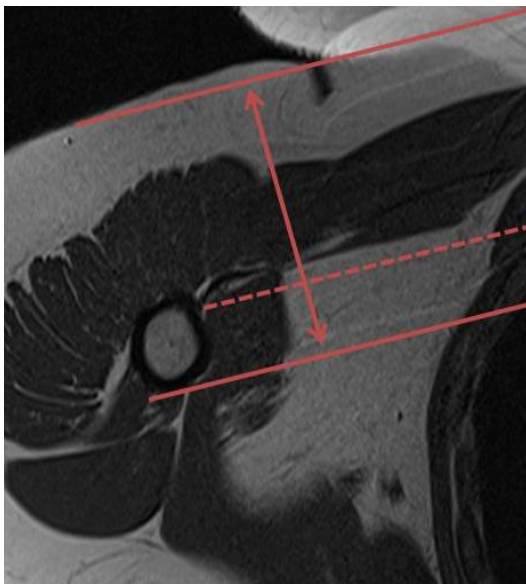
MSK MRI PROTOCOL OVERVIEW

- Use Cor T2 and have FOV cover from outer humeral shaft cortex to as far medial as the FOV covers
- **COVER FROM HUMERAL NECK DOWN MID-HUMERAL SHAFT**
- Sat Band over chest



4. CORONAL STIR SMALL FOV SEQUENCE

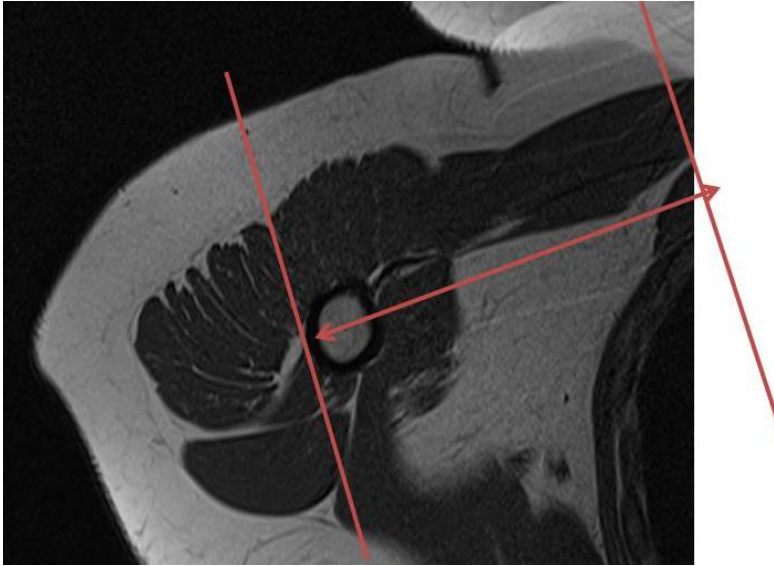
- Angle on Axial PD FS Sequence to the Pectoralis musculotendinous junction (guess on the plane of the muscle to angle)
- Have FOV cover from outer humeral shaft cortex to as far medial as the FOV covers (try to limit the amount of lung in the FOV)
- Cover from humeral neck down to inferior portion of deltoid tuberosity
- Sat Band over chest



MSK MRI PROTOCOL OVERVIEW

3. SAGITTAL T2 SMALL FOV SEQUENCE

- Perpendicular to axial and coronal sequences
- Cover from outside of humeral shaft to as far medial as the slices go
- Sat Band over chest



MSK MRI PROTOCOL OVERVIEW

STERNOCLAVICULAR JOINTS

GENERAL COMMENTS

- Used for trauma, arthritis, pain
- Try to reduce respiratory motion (diaphragmatic breathing rather than chest wall excursions or try prone imaging if skinny)

COIL

- Small 4 channel flex coil
- Strapped anteriorly
- Centered over SC joints and sternomanubrial joint

POSITIONING

- Supine

SEQUENCES, AND WHAT IS MOST IMPORTANT TO REPEAT

- Repeat COR T1 if motion
1. COR T1
 2. COR STIR
 3. AX T1
 4. AX STIR
 5. SAG T2

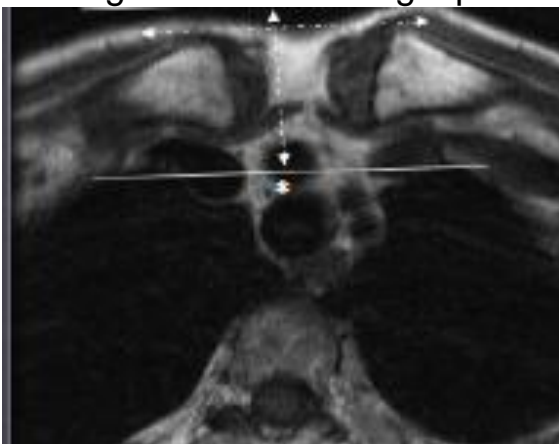
SEQUENCES

LOC

3 PLANE LOC

1. CORONAL T1 STIR SEQUENCES

- Use Axial LOC and angle parallel to both SC joints and cover from anterior skin surface to 1 slice posterior to the sc joints
- Use Sagittal LOC and angle parallel to manubrium



MSK MRI PROTOCOL OVERVIEW

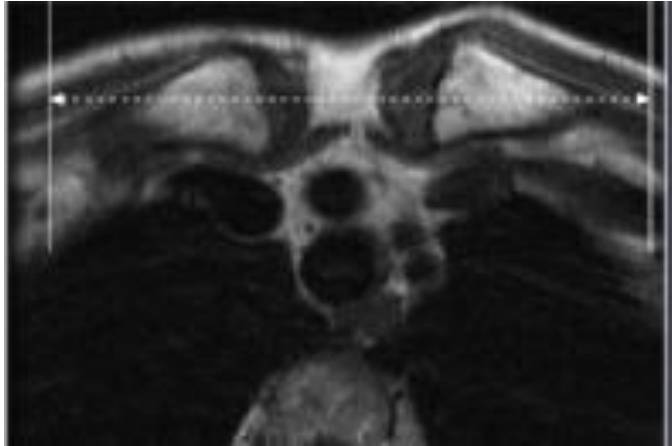
2. AXIAL T1 AND STIR SEQUENCES

- Use Cor T1 and angle perpendicular to long axis of the manubrium/sternum
- Cover from 2 slices above to as low down as the slices go



3. SAGITTAL T2 SEQUENCE

- Perpendicular to Axial and Coronal sequences
- Cover through both clavicular heads



MSK MRI PROTOCOL OVERVIEW

ELBOW ARTHROGRAM (PRE AND POST)

COIL

- Use 4 Channel Flex coil
- Make sure the coil is centered at the olecranon

POSITIONING

- Supine (or if a large patient in the Superman position)
- Try to have elbow fully extended
- Try to have hand supinated (palm up and put sandbag on hand)
- Elevate elbow with a sponge to isocenter (if supine)
- Sponge and strap elbow in place

SEQUENCES, AND WHAT IS MOST IMPORTANT TO REPEAT

- Axial PD and COR STIR sequences are the most important to repeat
- Sag T1 FS is most important to repeat post arthrogram

PRE-ARTHROGRAM

1. COR STIR
2. COR T1
3. AX PD
4. AX STIR
5. SAG PD FS

POST-ARTHROGRAM

6. COR T1 FS
7. SAG T1 FS
8. AX T1 FS

SEQUENCES

PRE-ARTHROGRAM SEQUENCES

LOC

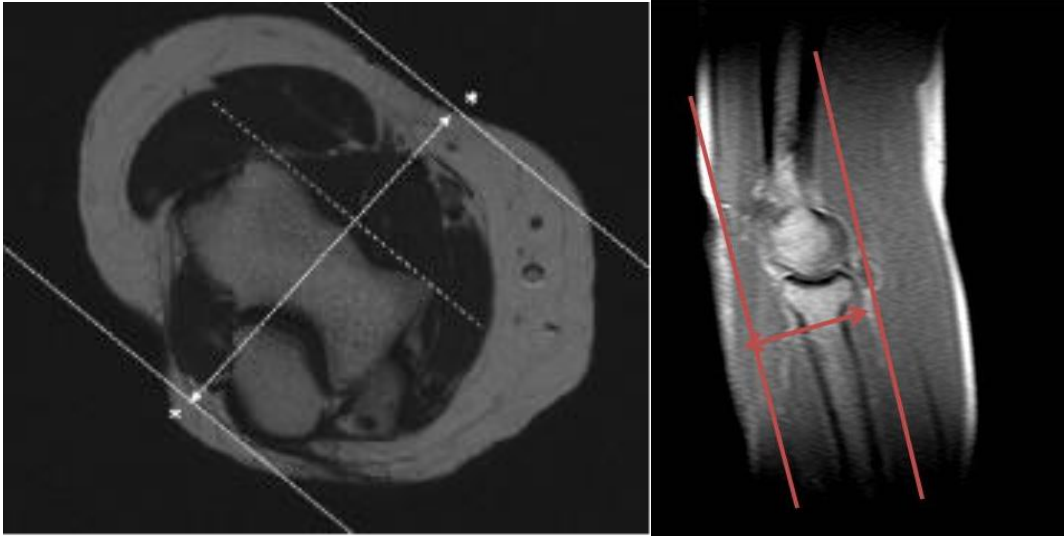
3 PLANE LOC

1. CORONAL T1 AND STIR SEQUENCES

- Use axial LOC to angle parallel to anterior portions of the capitellum and trochlea (or parallel to humeral epicondyles)

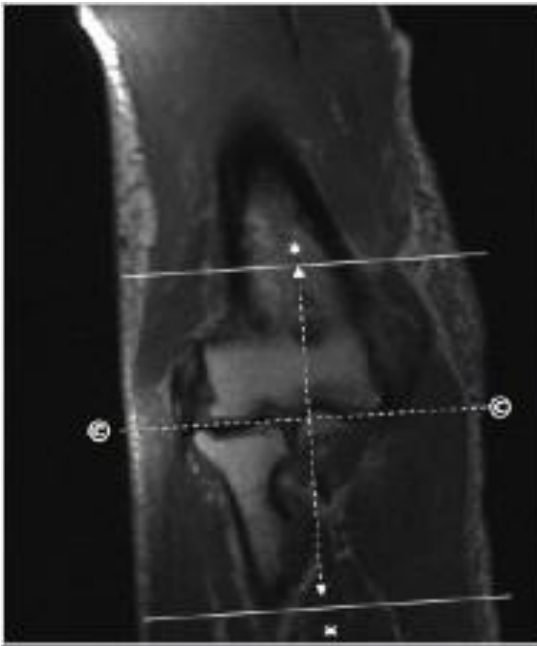
MSK MRI PROTOCOL OVERVIEW

- Use sagittal LOC to angle parallel to humerus/radius/ulnar plane, but closer to plane of radius if minimally flexed (if markedly flexed elbow, then angle between anterior humerus and the radius)
- Cover from back of the olecranon to at least 1 slice anterior to radial head
- No Sat Bands



2. AXIAL PD AND STIR SEQUENCES

- Perpendicular to Coronal
- Use COR T1 to angle parallel to elbow joint (parallel to capitellum and trochlea)
- Cover from 1 slice distal to radial tuberosity up as far as the slices go
- Parallel Sat Bands



MSK MRI PROTOCOL OVERVIEW

3. SAGITTAL PD FS SEQUENCE

- Perpendicular to both Coronal and Axial sequences
- Cover 1 slice outside of both humeral epicondyles



POST-ARTHROGRAM SEQUENCES

AX LOC 3 PLANE LOC

4. CORONAL T1 FS SEQUENCE

- Same planning and FOV as pre-arthrogram
- Cover all of the Gadolinium in the Joint

5. SAG T1 FS SEQUENCE

- Same planning and FOV as pre-arthrogram
- Cover all of the Gadolinium in the Joint

6. AXIAL T1 FS SEQUENCE

- Same planning and FOV as pre-arthrogram
- Cover all of the Gadolinium in the Joint

MSK MRI PROTOCOL OVERVIEW

WRIST ARTHROGRAM (PRE AND POST)

GENERAL COMMENTS

- Try to have every wrist pronated and in superman position
- Phase is Head to Foot for Coronals
- Phase is Right to Left for Axials

COIL

- Dedicated 8 Channel Wrist
- Small 4 Channel Flex for larger wrists

POSITIONING

- Superman position preferred, but can be supine if wrist is pronated
- Have wrist pronated

SEQUENCES, AND WHATS MOST IMPORTANT TO REPEAT IF SUBOPTIMAL

- The most important sequence to repeat is the COR MEDIC
- Repeat Axial STIR second if motion

PRE-ARTHROGRAM

1. COR STIR
2. COR T1
3. COR MEDIC
4. AX PD
5. AX STIR
6. SAG STIR

POST-ARTHROGRAM

7. COR GRE T1 FS
8. COR T1
9. SAG T1 FS
10. AX T1 FS

SEQUENCES

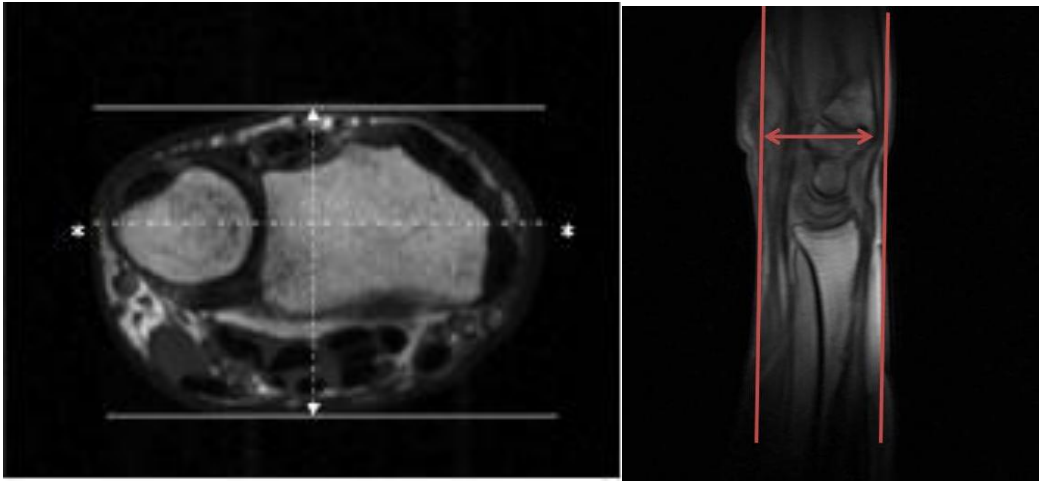
PRE-ARTHROGRAM SEQUENCES

3 PLANE LOC

1. CORONAL STIR, T1, MEDIC T2

MSK MRI PROTOCOL OVERVIEW

- **PHASE IS HEAD TO FOOT**
- Use axial LOC and angle parallel to anterior radial metaphysis (best fit) at the distal radioulnar joint (or approx parallel to proximal carpal row)
- Use sagittal LOC and angle parallel to radius/lunate/capitate alignment (or just radius if wrist is flexed)
- Cover through all of the bones, and try to cover the flexor and extensor tendons as well
- Proximal Sat Band on COR STIR



2. AXIAL PD AND STIR SEQUENCES

- **PHASE IS RIGHT TO LEFT**
- Perpendicular to Coronal Sequences
- Use COR T1 and angle parallel to long axis of wrist (can use radius growth plate scar to angle, BLUE ARROW ON IMAGE).

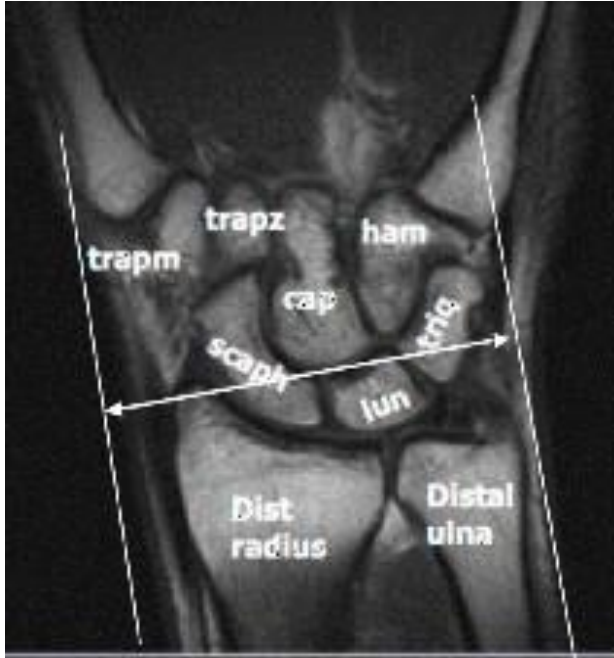


- Cover through Distal Radioulnar Joint proximally and to the base of the metacarpals distally.
- Parallel Sat Bands on both

MSK MRI PROTOCOL OVERVIEW

3. SAGITTAL STIR SEQUENCE

- Perpendicular to Coronal and Axial Sequences
- Cover from outside of Ulnar styloid and to outside of 1st CMC Joint
- Proximal Sat Band



POST-ARTHROGRAM SEQUENCES

3 PLANE LOC

4. CORONAL GRE T1 FS SEQUENCE

- Same planning as pre-arthrogram
- These are thinner slices than the Post COR T1 sequence (So cover all of the carpal bones and as much of the Gadolinium in the joint as the slices allow)

5. CORONAL T1 SEQUENCE

- Same planning as pre-arthrogram
- Cover all of the Gadolinium in the Joint

6. SAG T1 FS SEQUENCE

- Same planning as pre-arthrogram
- Cover all of the Gadolinium in the Joint

7. AXIAL T1 FS SEQUENCE

- Same planning as pre-arthrogram
- Cover all of the Gadolinium in the Joint

MSK MRI PROTOCOL OVERVIEW

HAND

GENERAL COMMENTS

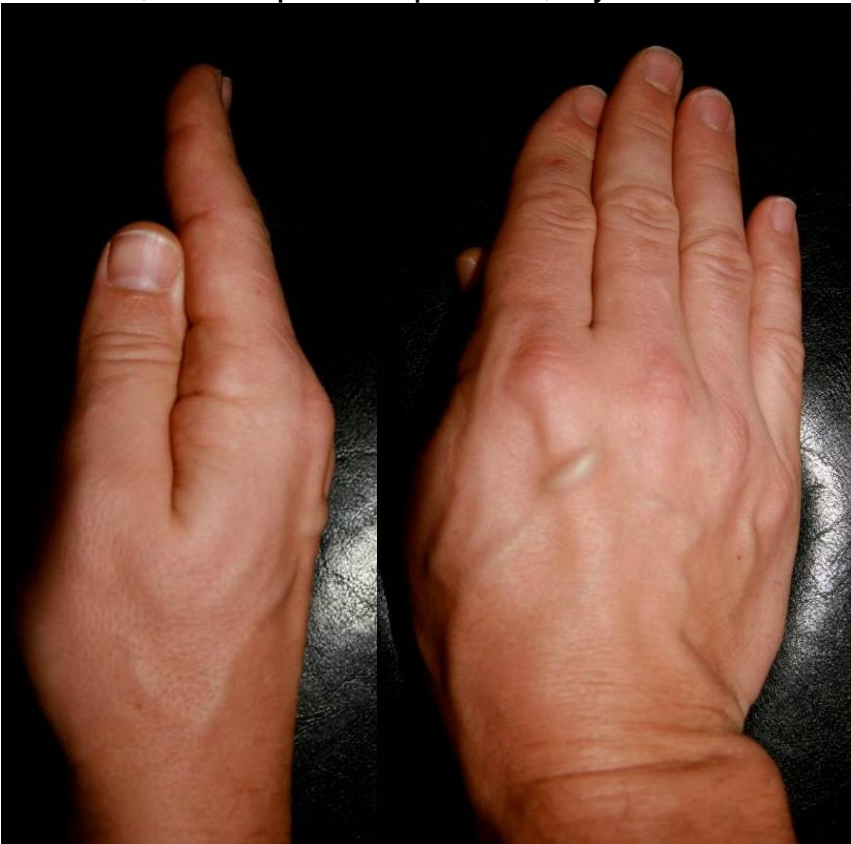
- Coronals and axials cover the whole hand and thumb
- Sagittal sequences cover finger of interest and an adjacent digit or use thicker slices and cover all of the digits if this is a “rule out pathology” history

COIL

- 4 Channel Flex Coil wrapped around the hand

POSITIONING

- Have thumb pressed to the hand (by wrapping thumb snugly to the hand), and this way the thumb can be imaged at the same time (the COR for the hand will be SAG for the thumb)
- Prone, in a Superman position, if you can



SEQUENCES, AND WHAT IS MOST IMPORTANT TO REPEAT

- The most important sequence to repeat is the COR MEDIC
- Repeat Axial STIR second if motion

MSK MRI PROTOCOL OVERVIEW

1. COR STIR
2. COR T1
3. COR MEDIC
4. AX STIR
5. AX PD
6. SAG STIR
7. SAG PD

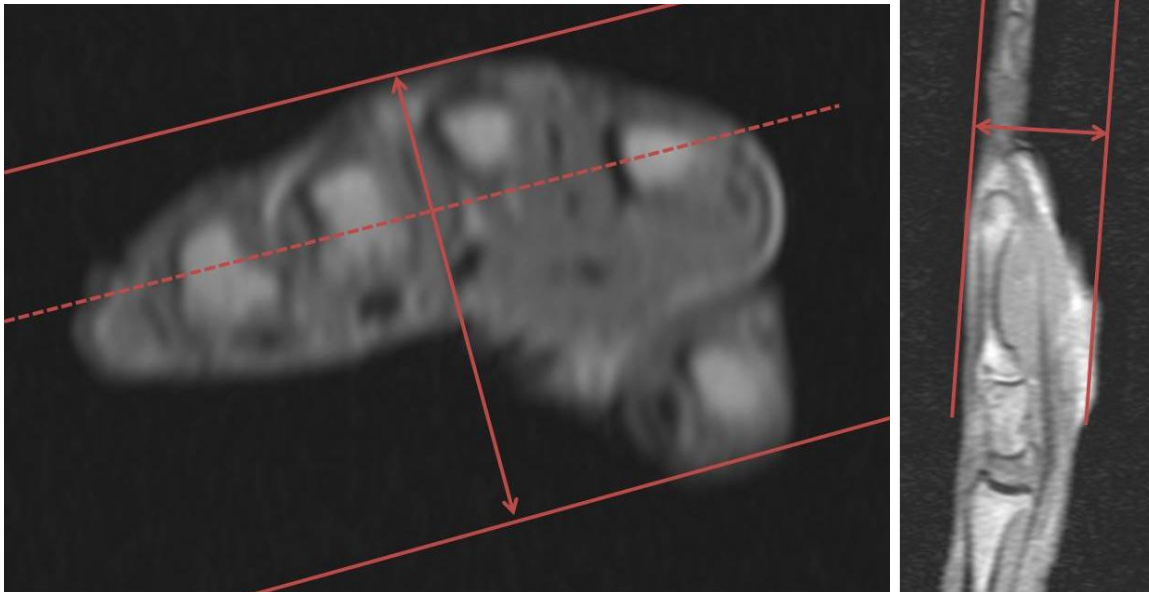
SEQUENCES

LOC

3 PLANE LOC

1. CORONAL STIR, T1, MEDIC T2

- Use Axial LOC and angle parallel to the 2nd-5th MCP joints, and try to cover through the majority of the thumb
- Use Sagittal LOC and angle parallel to 3rd digit and 3rd metacarpal
- Cover through all of the dorsal soft tissues and as far anterior as the slices go
- Have FOV from the finger tufts to the CMC Joints
- Proximal Sat Band on COR STIR

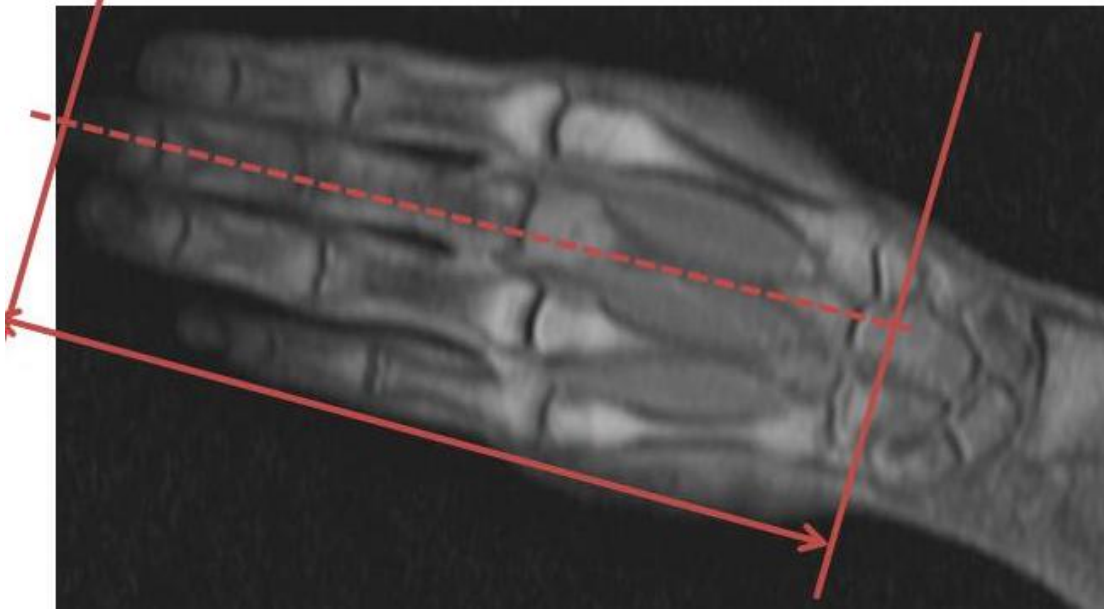


2. AXIAL STIR AND PD SEQUENCES

- Perpendicular to Coronal Sequences
- Use COR LOC and angle perpendicular to 3rd Digit

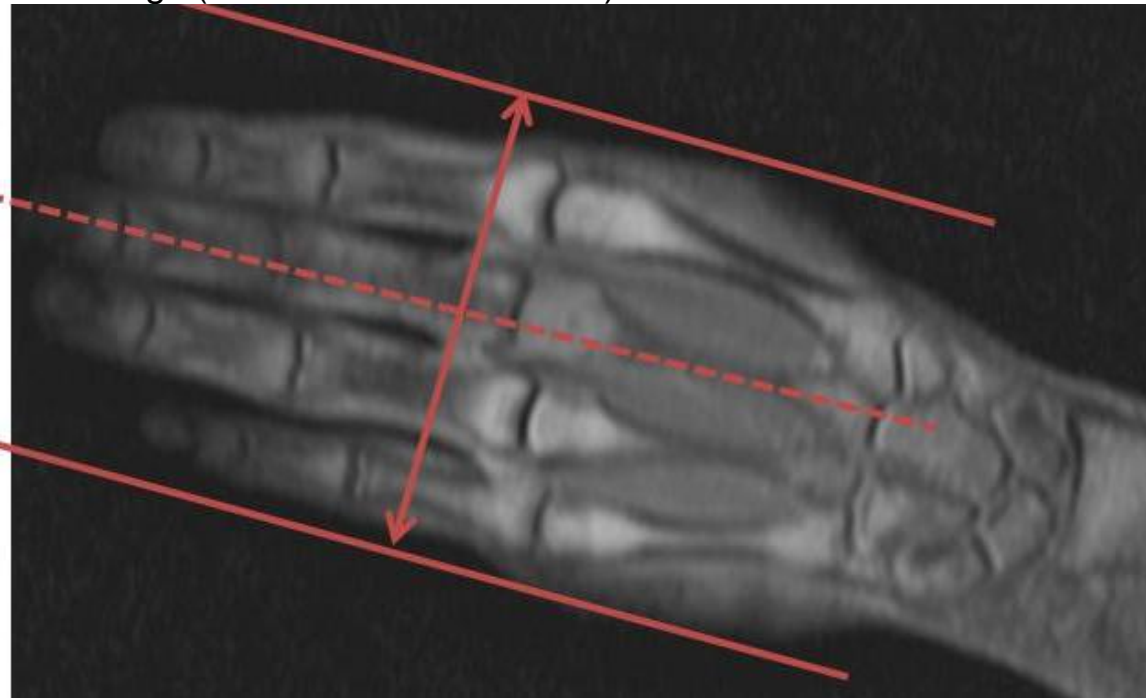
MSK MRI PROTOCOL OVERVIEW

- Cover from tip of finger to CMC joints
- Parallel Sat Bands on both



3. SAGITTAL STIR AND PD SEQUENCES

- Perpendicular to Coronal and Axial Sequences
- Cover through all of the digits if the patient has non-localizable pain or if they are looking for a generalized arthritis (USE THICKER SLICES)
- If a digit is symptomatic, then cover through that digit and an adjacent digit (USE THINNER SLICES)



MSK MRI PROTOCOL OVERVIEW

HIP ARTHROGRAM (PRE AND POST)

GENERAL COMMENTS

- **If there has been a recent MRI of the Hip and the radiologist wants only the post-arthrogram images**
 - o **ADD a COR T2 and SAG PD FS**
- Used for younger people, where surgery is an option (< 40 y.o.)
- The high resolution protocol pre can alter whether you perform the arthrogram, and should be done instead of the OA/AVN hip protocol

COIL

- Body Matrix Coil is centered over both hips
- Large 4 channel flex coil is wrapped around affected hip (deep to Body Matrix Coil) If it is a LARGE PATIENT, then you can use the BODY MATRIX COIL to wrap around the affected hip and increase FOV to 200
- If both hips are needed, then standard Large flex coil over other hip
- Top of flex coil 3 fingers below iliac crest
- **HAVE ONLY 4 CHANNEL FLEX COIL ON WHEN PERFORMING HIGH RESOLUTION IMAGES**
- **HAVE ONLY BODY MATRIX COIL AND SPINE ARRAY ON WHEN IMAGING BOTH HIPS**

POSITIONING

- Patient supine
- Toes strapped together with sponges between knees to help femurs internally rotate
- Triangle under knees to also help femurs internally rotate
- Strap down Coils

SEQUENCES, AND WHAT IS MOST IMPORTANT TO REPEAT

- The most important sequences are the COR PD and SAG PD FS pre-arthrogram and COR T1 FS post-arthrogram

PRE-ARTHROGRAM

Body Matrix Coil/Spine Array

1. COR STIR
2. COR T1
3. AX STIR
4. AX T2

MSK MRI PROTOCOL OVERVIEW

Change to Flex Coil

5. COR PD

6. SAG PD FS

7. OBLIQUE AX PD FS

POST-ARTHROGRAM

8. COR T1 FS

9. SAG T1 FS

10. AX T1 FS

11. OBLIQUE AXIAL T1

SEQUENCES

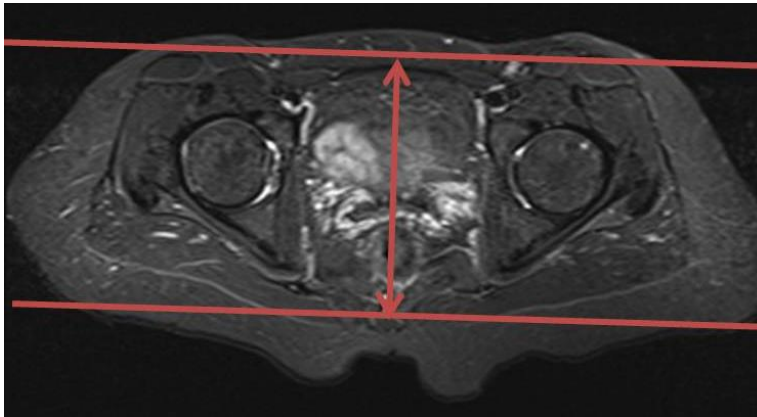
PRE-ARTHROGRAM SEQUENCES

3 PLANE LOC FOR BODY/SPINE MATRIX (USE COILS SEPARATELY)

3 PLANE LOC FOR 4 CHANNEL FLEX (USE COILS SEPARATELY)

1. CORONAL T1 AND STIR SEQUENCES

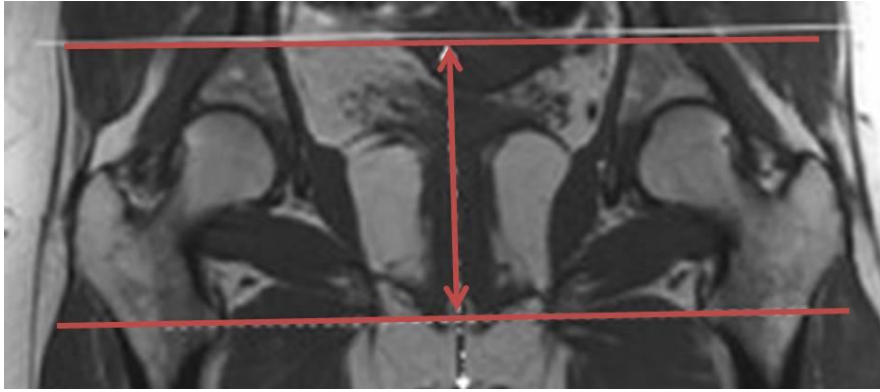
- Use Axial LOC and angle parallel through femoral heads
- Cover from back of ischial tuberosities to at least 2 slices anterior to acetabuli (preferably to cover pubic symphysis)
- Superior Sat bands for STIR and T1



2. AXIAL T2 SEQUENCE

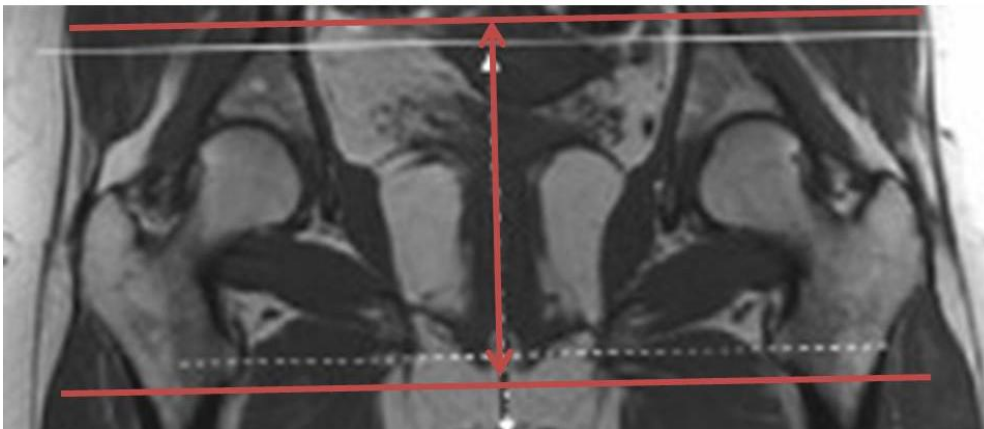
- Use COR T1 and angle parallel to femoral heads/acetabuli
- Cover from 2-4 slices above acetabuli down close to lesser trochanters
- Parallel Sat Bands

MSK MRI PROTOCOL OVERVIEW



3. AXIAL STIR SEQUENCE

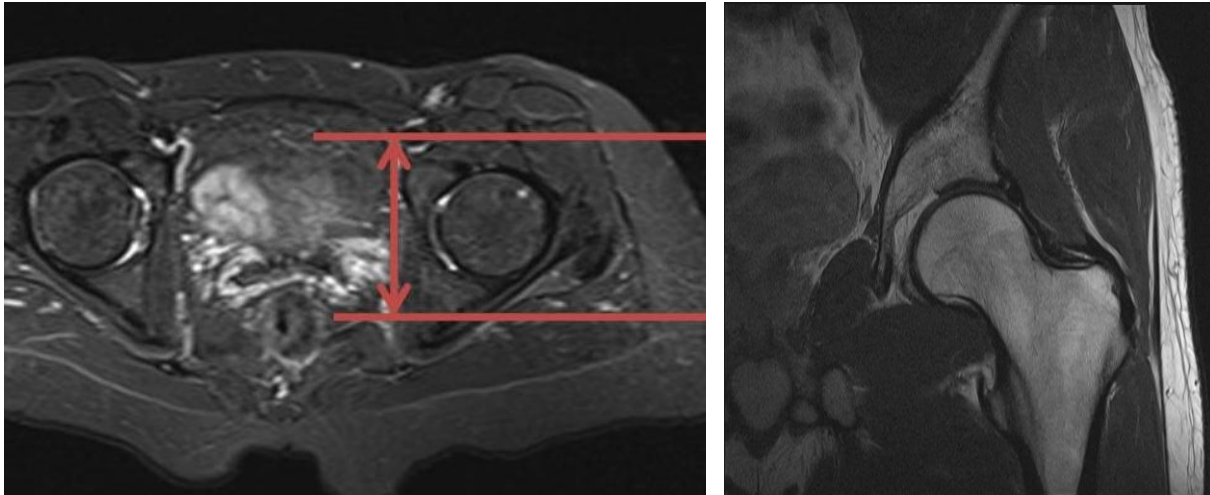
- Angle the same as the AX T2
- Copy from AX T2
- the 6 more slices on the STIR sequence (3 above and 3 below) means more coverage so you can cover the lesser trochanters
- Parallel Sat Bands



4. CORONAL PD SEQUENCE (FLUID WEIGHTED, SO FLUID IS BRIGHT)

- Use Axial T2 and have plane parallel to both femoral heads
- Cover from 1 slice anterior to and 1 slice posterior to acetabulum
- Center at femoral head
- Superior Sat Band

MSK MRI PROTOCOL OVERVIEW



5. SAGITTAL PD FS SEQUENCE

- Perpendicular to COR PD
- Use COR PD and cover from outer cortex of the greater trochanter to the inner portion of the acetabulum
- Center at Femoral Head/Neck Junction
- Superior Sat Band

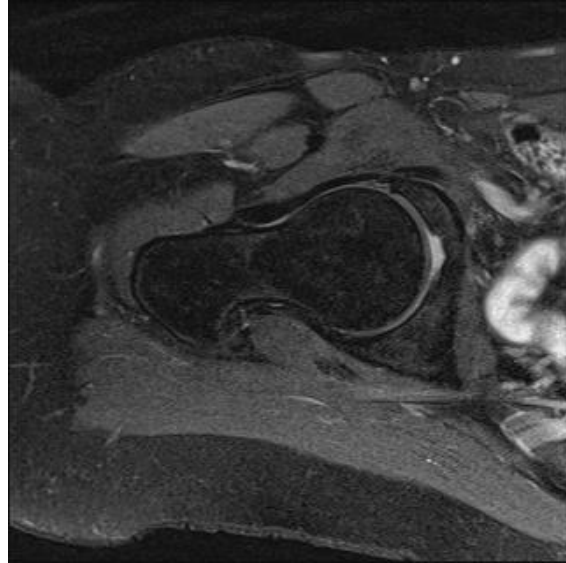


6. OBLIQUE AXIAL PD FS

- Use COR PD and angle parallel to femoral neck (use image with the longest medial/inferior femoral neck cortex). This angle is usually slightly more than you think (see image).
- Cover from 1 slice out of acetabulum superiorly to 1 slice out of acetabulum inferiorly
- Center at Femoral Head/Neck Junction

MSK MRI PROTOCOL OVERVIEW

- Superior Sat Band

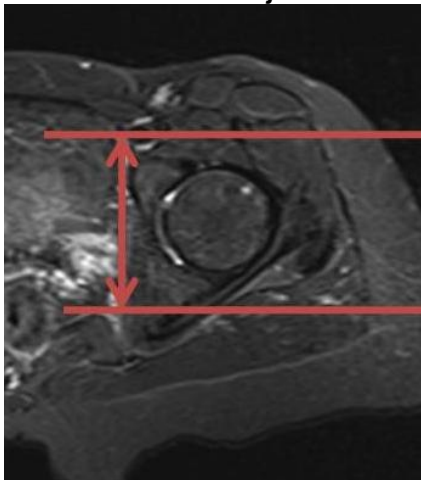


POST-ARTHROGRAM SEQUENCES

USE ONLY 4 CHANNEL FLEX OR BODY COIL WRAPPED AROUND THE AFFECTED SIDE

7. CORONAL T1 FS

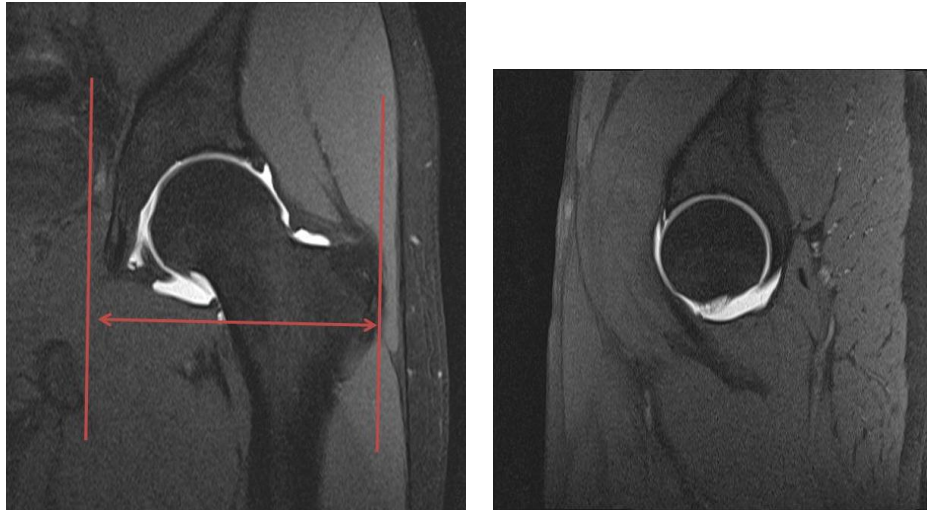
- Use Axial LOC and angle parallel through femoral heads; use your best guess, because you will not see the other hip (as coil is on one side)
- Cover from 2 slices outside of acetabulum anteriorly and 2 slices posteriorly
- Center at head/neck junction



MSK MRI PROTOCOL OVERVIEW

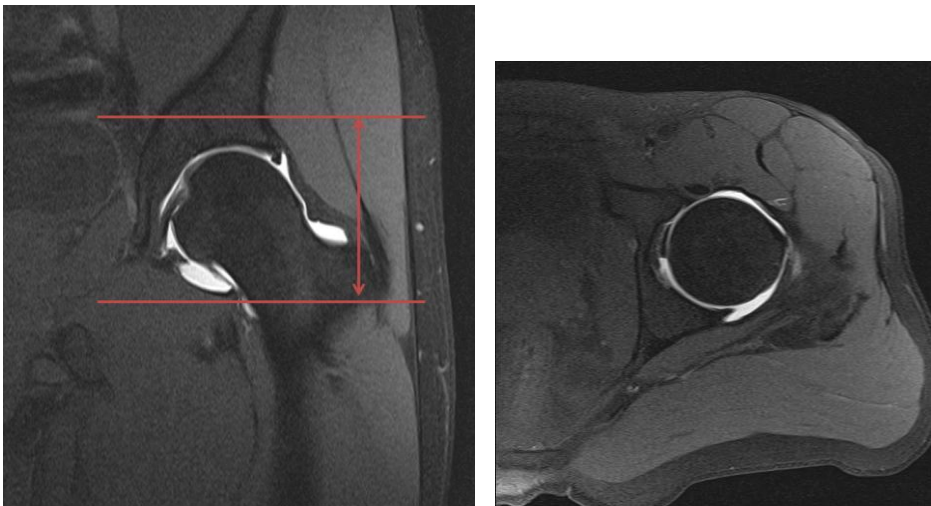
8. SAGITTAL T1 FS

- Perpendicular to COR T1 FS
- Use COR T1 FS or axial LOC and cover from mid-femoral neck (cover all of the Gadolinium) to the inner portion of the acetabulum
- Center at Femoral Head/Neck Junction
- Superior Sat Band
-



9. AXIAL T1 FS

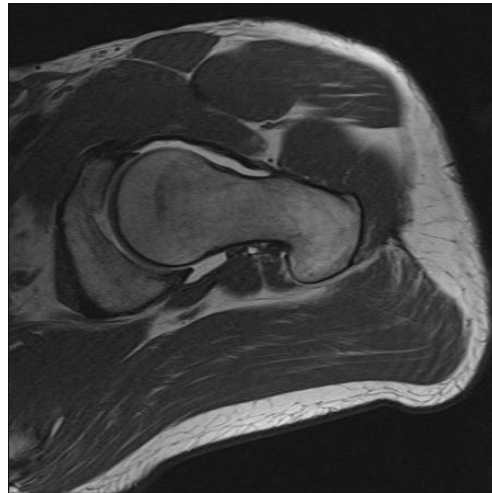
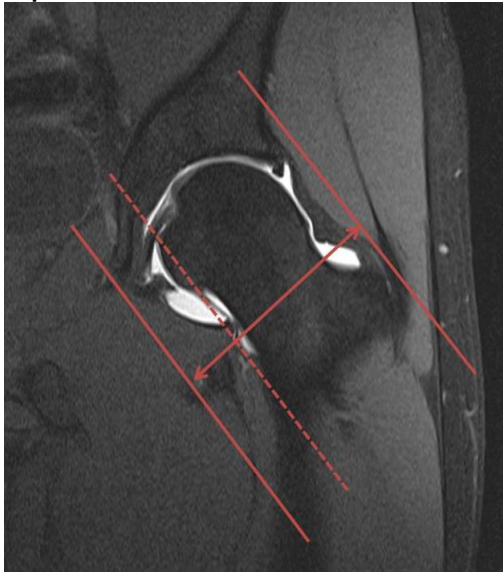
- Same angulation as you would do for the AX STIR and AX T2 sequences
- Use COR T1 FS and angle parallel to both femoral heads (this is an estimation, because other hip is not in LOC).
- Cover from 2 slices out of labrum superiorly to 2 slices out of acetabulum inferiorly (Cover all of the gadolinium)
-



MSK MRI PROTOCOL OVERVIEW

10. OBLIQUE AXIAL T1

- Use COR T1 FS and angle parallel to femoral neck (use image with the longest medial/inferior femoral neck cortex). This angle is usually slightly more than you think (see image).
- Cover from 2 slices out of acetabulum superiorly to 2 slices out of acetabulum inferiorly (Cover gadolinium in the joint)
- Center at Femoral Head/Neck Junction
- Superior Sat Band



MSK MRI PROTOCOL OVERVIEW

LUMBOSACRAL PLEXUS

GENERAL COMMENTS

- Screening study for nerve lesions or piriformis syndrome

COIL

- 2 Linked Body Matrix Coils, covering from mid-lumbar spine to mid thigh
- Spine array coils are also on
- Strap down Coils

POSITIONING

- Patient supine

SEQUENCES, AND WHAT IS MOST IMPORTANT TO REPEAT

- The most important sequences to repeat are the Axial STIR sequences

1. COR STIR
2. COR T1
3. AX T1 (2 STACKS)
4. AX STIR (2 STACKS)
5. SAG PD (AFFECTED SIDE)

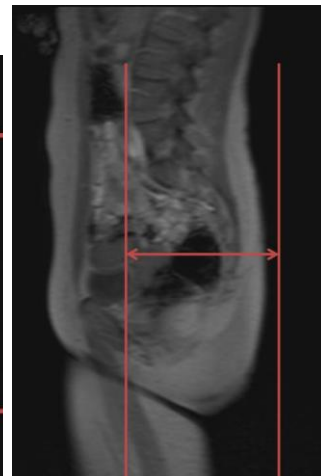
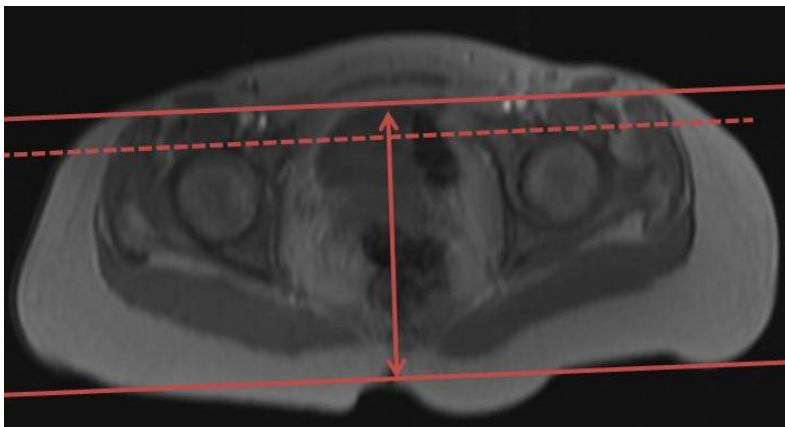
SEQUENCES

UPPER LOC

LOWER LOC

1. CORONAL T1 AND STIR SEQUENCES

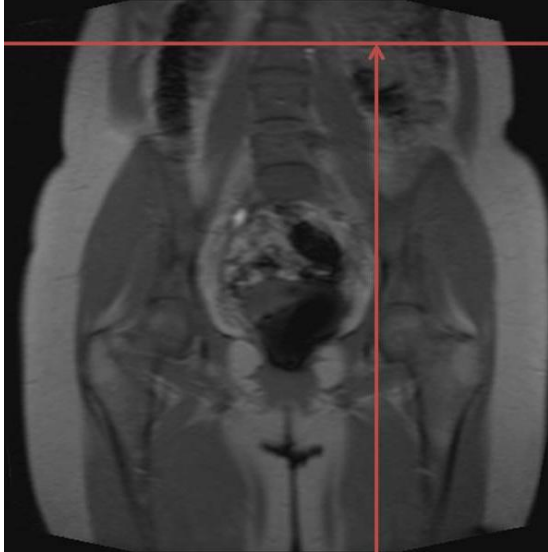
- Use Axial LOC and angle parallel through femoral heads, and cover posterior through gluteus maximus and anterior as far as slices go (at least the middle of the L3 vertebral body)
- FOV covers from the mid-L3 vertebral body to the mid-thigh
- Superior Sat Band for T1



MSK MRI PROTOCOL OVERVIEW

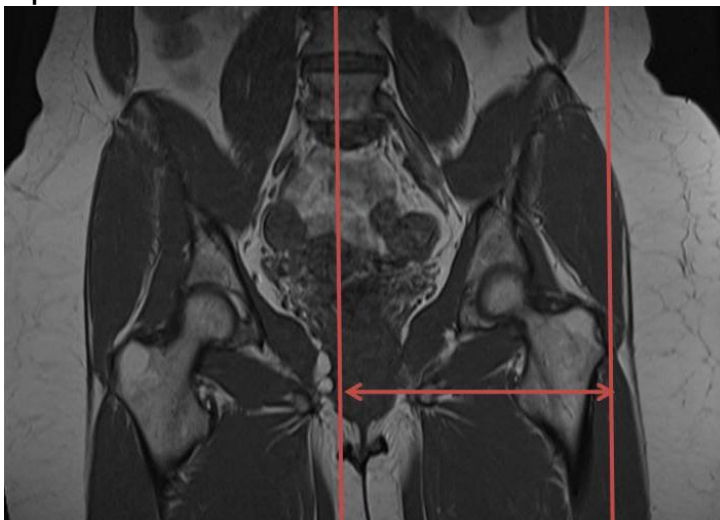
2. AXIAL T1 AND STIR SEQUENCES (2 STACKS)

- Use COR LOC and angle perpendicular to the patients body
- Cover from mid L3 vertebral body to mid thigh
- Overlap the 2 stacks by 1 slice for both the axial T1 and STIR sequences
- Superior Sat Band for T1



3. SAGITTAL PD SEQUENCE (AFFECTED SIDE)

- Perpendicular to COR T1
- Use COR T1 and cover from 1 slice out of the greater trochanter to the middle of the sacrum
- FOV covers from mid L3 to as far down as the FOV goes
- Superior Sat Band



MSK MRI PROTOCOL OVERVIEW

SPORTS HERNIA/ PUBALGIA/ OSTEITIS PUBIS

GENERAL COMMENTS

- Used for younger people, where there is a concern for a sports hernia, inguinal hernia, osteitis pubis and adductor tendon tears
- This protocol is made up of portions of the hip OA/AVN protocol, except for a few extra sequences and thicker Sag PD FS sequences

COIL

- Body Matrix Coil is centered over both hips
- Top of flex coil 3 fingers below iliac crest

POSITIONING

- Patient supine
- Toes strapped together with sponges between the knees to help the femurs internally rotate
- Triangle under knees to also help femurs internally rotate
- Strap down Coils

SEQUENCES, AND WHAT IS MOST IMPORTANT TO REPEAT

- The most important sequences are the COR T1 and SAG PD FS

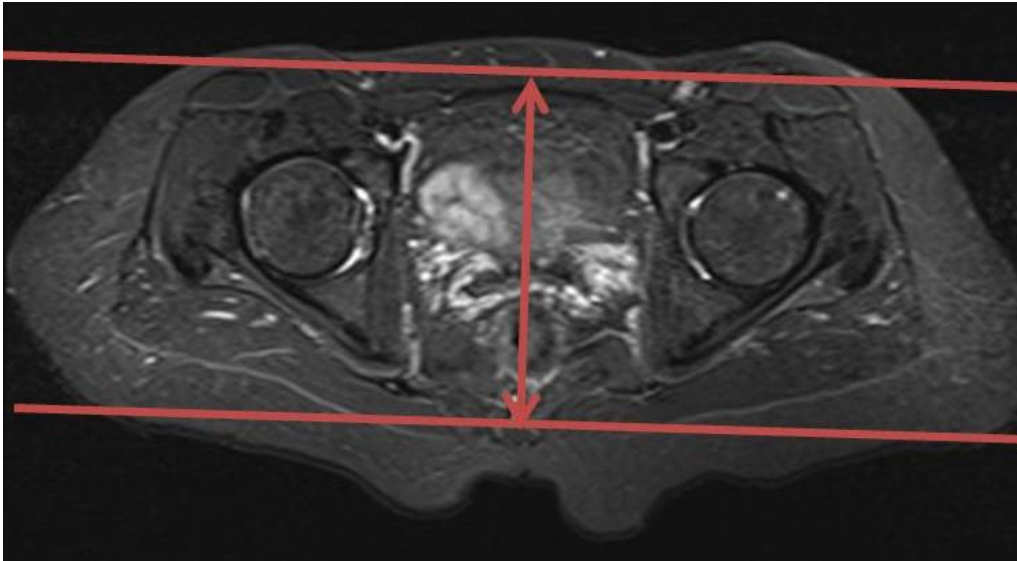
1. COR STIR
2. COR T1
3. SAG PD FS (PUBIS AND HIP ON SYMPTOMATIC SIDE; DO A SECOND SEQUENCE ON THE OTHER SIDE IF BOTH SIDES ARE SYMPTOMATIC)
4. AX T2
5. OBL AX STIR (PUBIS)
6. OBL AX PD (PUBIS)

SEQUENCES

1. CORONAL T1 AND STIR SEQUENCES

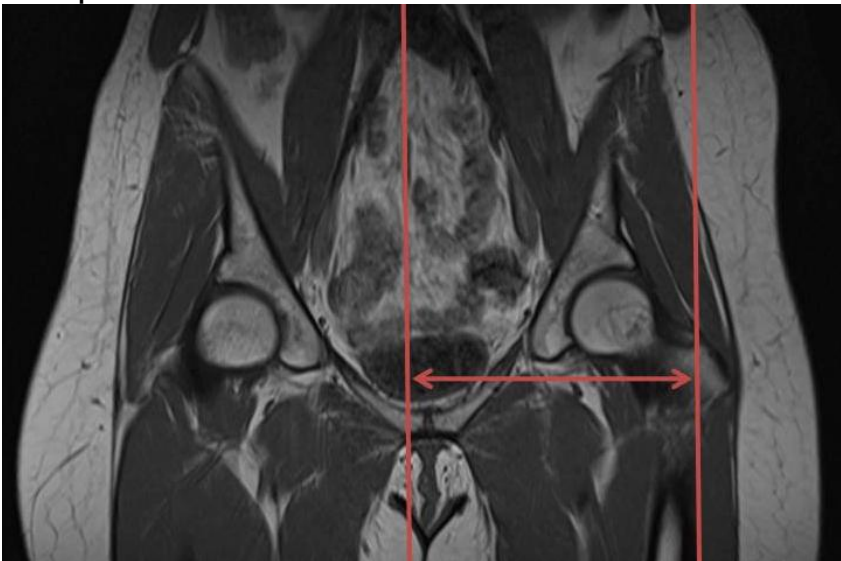
- Use Axial LOC and angle parallel through femoral heads
- Cover from at least 3 slices anterior to the pubic symphysis to as far back as the slices go
- Superior Sat bands for STIR and T1

MSK MRI PROTOCOL OVERVIEW



2. SAGITTAL PD FS SEQUENCE (AFFECTED SIDE)

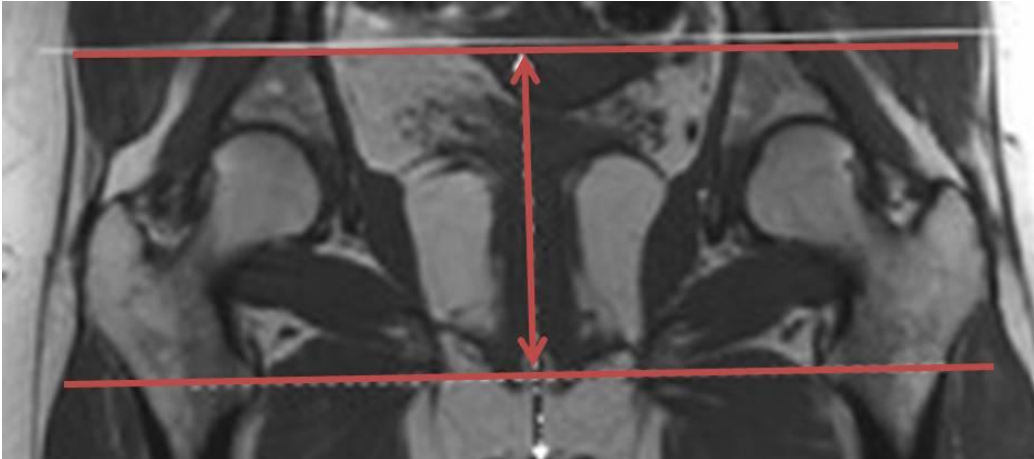
- Perpendicular to COR T1
- Use COR T1 and angle perpendicular to femoral heads/acetabuli
- Cover from the mid-femoral neck to 3 slices past the pubic symphysis (larger coverage than for a hip)
- If both sides are symptomatic, then perform a second sequence on the other side
- Superior Sat Band



3. AXIAL T2 SEQUENCE

- Use COR T1 and angle parallel to femoral heads/acetabuli
- Cover from 2-4 slices above acetabuli down close to lesser trochanters
- Parallel Sat Bands

MSK MRI PROTOCOL OVERVIEW



4. OBLIQUE AXIAL STIR AND PD SEQUENCES

- Use Sag PD FS and the imaging plane parallels the iliopubic cortex
- Cover from posterior hip joint to as far anterior as the slices go (should be at least 3 cm above the pubic symphysis)
- Superior Sat Band



MSK MRI PROTOCOL OVERVIEW

KNEE ARTHROGRAM (POST ONLY)

GENERAL COMMENTS

- Only used if there is a previous MRI that requested an arthrogram or an orthopedic surgeon specifically requests it
- If no MRI is directly available for comparison, you have to perform a standard knee MRI pre-arthrogram

COIL

- 15 Channel Knee Coil for Thin knees
- CP Extremity Coil for Larger knees
- Body coil for the Largest knees
- Center coil over the mid-point of the Patella

POSITIONING

- Supine with knee fully extended
- Try to keep knee straight, but only if comfortable for the patient (limit internal and external rotation)

SEQUENCES

1. COR T1 FS
2. COR T1
3. SAG T1 FS
4. AX T1 FS

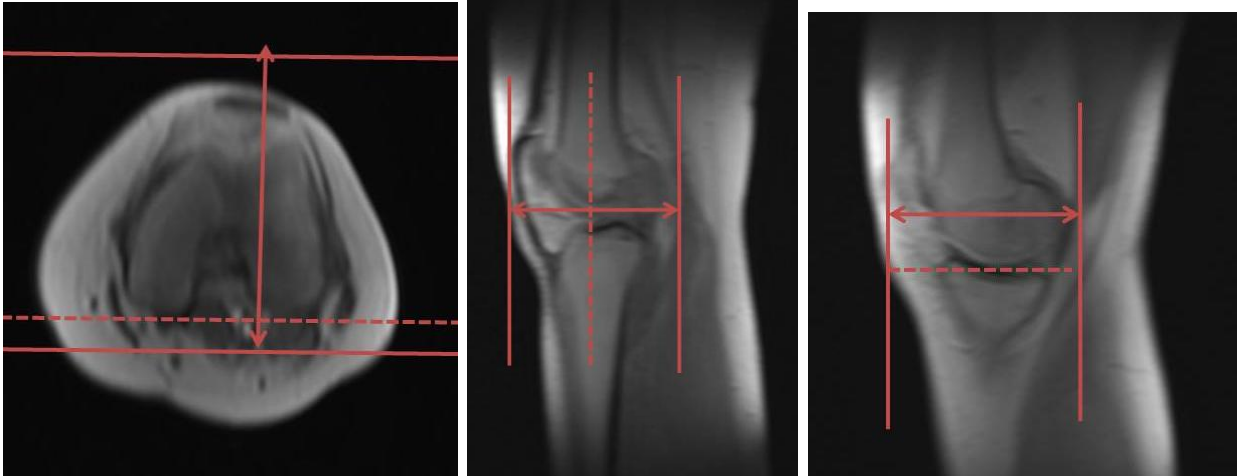
SEQUENCES

3 PLANE LOC

1. CORONAL T1 AND T1 FS SEQUENCES

- Angle parallel to the posterior femoral condyles on the Axial scout
- Angle perpendicular to the tibial plateau on the Sagittal scout, or parallel to the tibial shaft if the tibial plateau is hard to assess
- Cover from the anterior cortex of the patella to as far back as possible (cover the gadolinium in the joint)

MSK MRI PROTOCOL OVERVIEW



2. SAGITTAL T1 FS

- Perpendicular to COR T1
- Angled perpendicular to Tibial Plateau on COR T1
- Cover at least 1 slice out of both menisci and cover gadolinium in the joint



3. AXIAL T1 FS

- Perpendicular to COR T1 FS and SAG T1 FS
- Cover the entire suprapatellar pouch superiorly and down to the tibial plateau (cover all of the gadolinium)



MSK MRI PROTOCOL OVERVIEW

ANKLE ARTHROGRAM (PRE AND POST)

GENERAL COMMENTS

- Usually used for OCD's of talar dome; to check for loose fragments

COIL

- CP Extremity Coil
- Center coil at the malleoli

POSITIONING

- Supine with foot relaxed (approx. 90 degrees and toes pointing up)

SEQUENCES, AND WHAT IS MOST IMPORTANT TO REPEAT

- Always repeat Cor PD and Cor PD FS if there is any motion

PRE-ARTHROGRAM

1. COR PD
2. COR PD FS
3. SAG T1
4. SAG STIR
5. AXIAL PD
6. AXIAL STIR

POST-ARTHROGRAM

7. COR T1
8. SAG T1 FS
9. SAG T1
10. AX T1 FS

SEQUENCES

PRE-ARTHROGRAM SEQUENCES

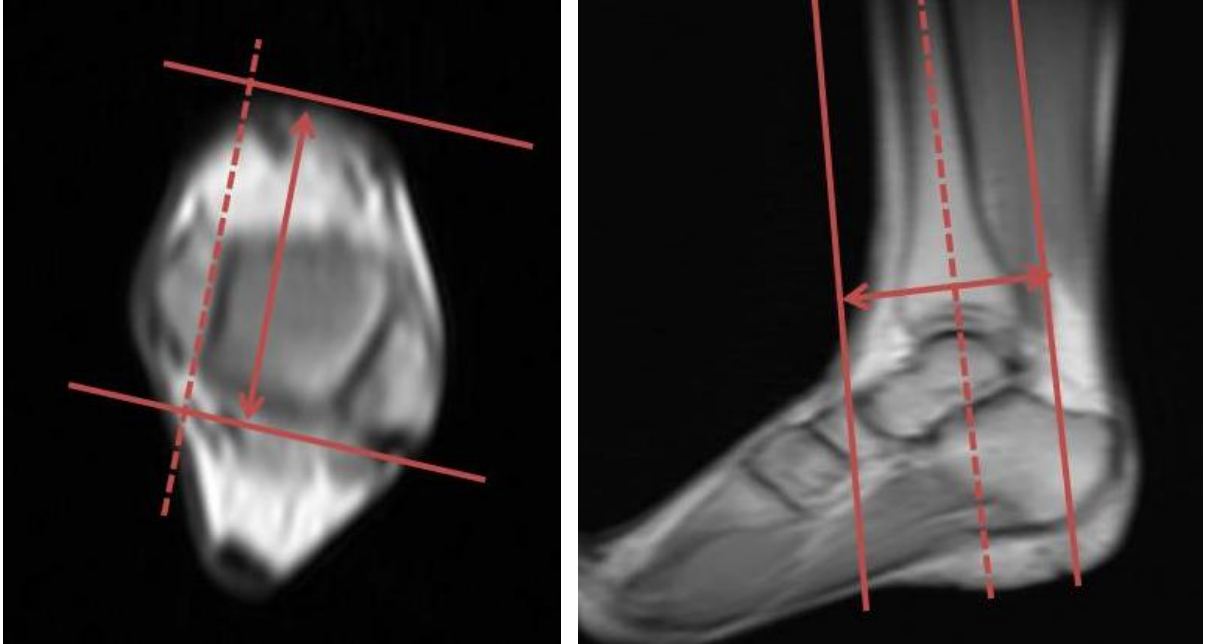
3 PLANE LOC

1. CORONAL PD AND PD FS SEQUENCES

- Use axial LOC and angle perpendicular to the inner cortex of the medial malleolus (should parallel posterior cortex of the talar dome)

MSK MRI PROTOCOL OVERVIEW

- Use sagittal LOC and angle parallel to distal tibial shaft and cover from the talonavicular joint back as far as possible (at least 2 slices posterior to the talus)
- All of the plantar(inferior) soft tissues should be included in the FOV
- Superior Sat Band



2. SAGITTAL STIR AND T1

- Perpendicular to COR PD
- Angled perpendicular to talar dome
- Cover at least 1 slice out of both malleoli
- All of the plantar soft tissues should be included in the FOV
- Superior Sat Band



MSK MRI PROTOCOL OVERVIEW

3. AXIAL PD AND STIR

- Perpendicular to COR PD and SAG STIR
- Cover from 3-4 Slices above the inferior margin of the tibiotalar joint (the joint is best seen posteriorly) down as far as the slices go
- Parallel Sat Bands



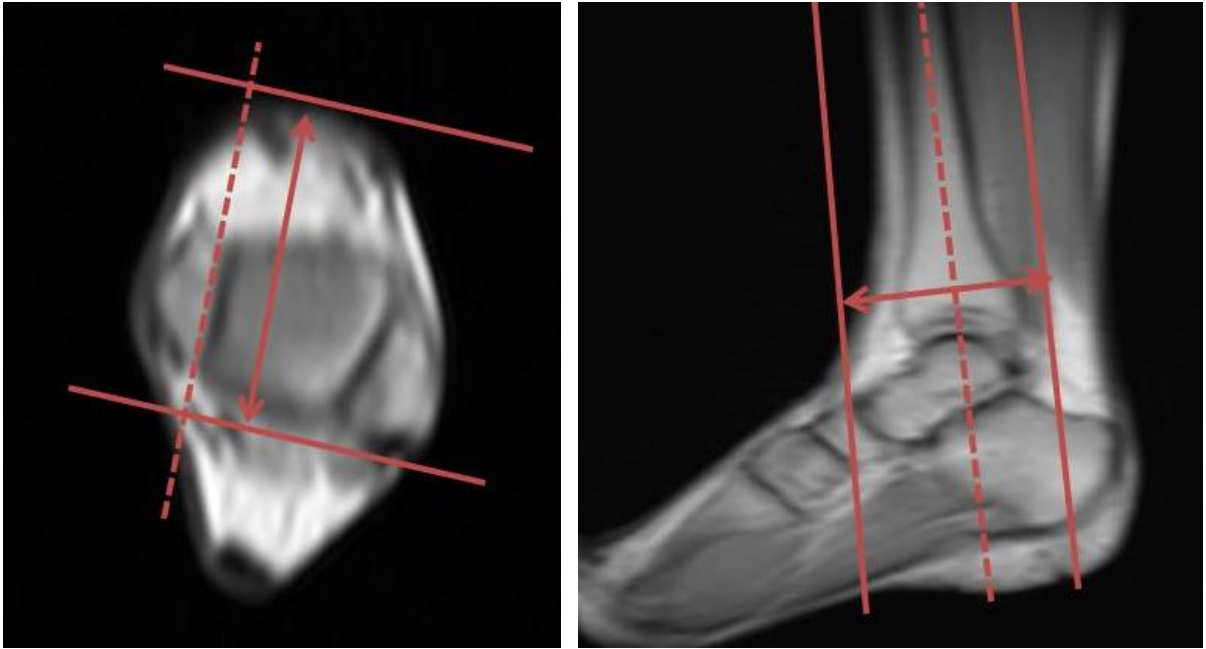
POST-ARTHROGRAM SEQUENCES

3 PLANE LOC

1. CORONAL T1 SEQUENCE

- Use axial LOC and angle perpendicular to the inner cortex of the medial malleolus (should parallel posterior cortex of the talar dome)
- Use sagittal LOC and angle parallel to the distal tibial shaft and cover from the anterior ankle joint recess to the posterior subtalar joint recess (cover all of the gadolinium in the joint)

MSK MRI PROTOCOL OVERVIEW



2. SAGITTAL T1 AND T1 FS SEQUENCES

- Perpendicular to COR T1 FS
- Angled perpendicular to talar dome
- Cover at least 1 slice out of both malleoli



3. AXIAL T1 FS SEQUENCE

- Perpendicular to COR T1 FS and SAG T1
- Cover from 3 Slices above the inferior margin of the tibiotalar joint down as far as the slices go (make sure to cover the posterior subtalar joint if it fills with gadolinium)

MSK MRI PROTOCOL OVERVIEW



MSK MRI PROTOCOL OVERVIEW

MIDFOOT/FOREFOOT

GENERAL COMMENTS

- Can perform supine with the toes sticking out of the extremity coil or plantar flexed in the extremity coil if you need the toes imaged
- Have foot bare; no stocks or nylons

COIL

- CP Extremity Coil

POSITIONING

- Prone and foot is plantar flexed (Preferred Method)
- Supine and toes sticking out of coil (Alternative Method)

SEQUENCES, AND WHAT IS MOST IMPORTANT TO REPEAT

- Always repeat AX T1 and AX STIR if there is motion

1. AX (LONG AXIS) T1
2. AX (LONG AXIS) STIR
3. COR (SHORT AXIS) STIR
4. COR (SHORT AXIS) T2
5. SAG STIR
6. SAG T1

SEQUENCES

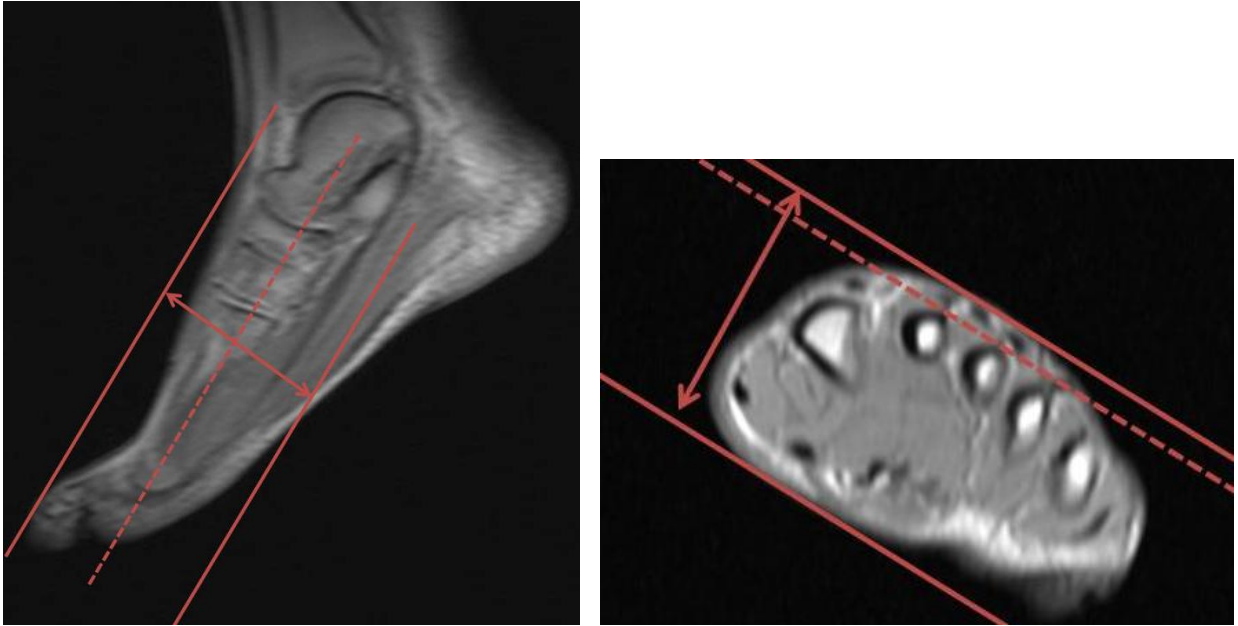
LOC

3 PLANE LOC

1. AX (LONG AXIS) T1 AND STIR SEQUENCES

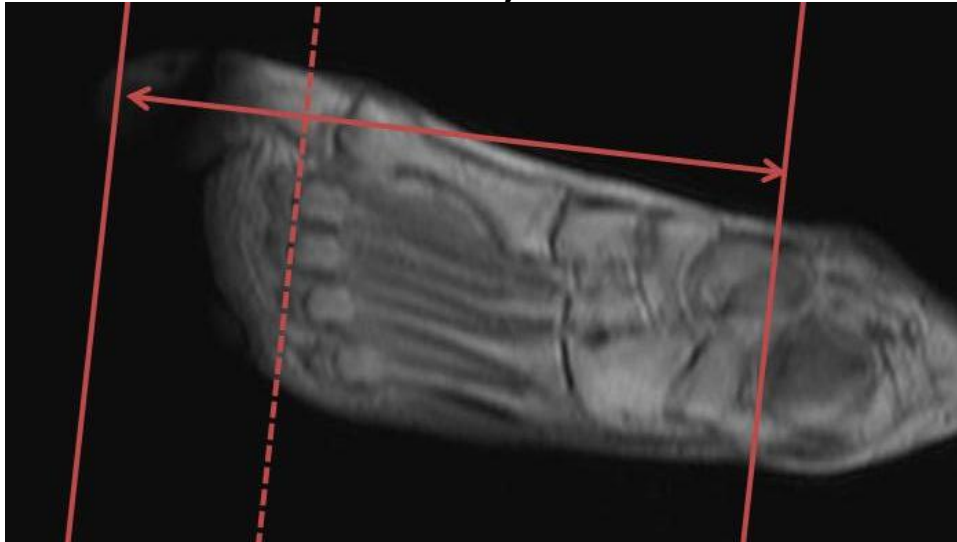
- Use Sag LOC and angle parallel to the shaft of either the 2nd or 3rd metatarsals (whichever is the least deformed) and at least cover the soft tissues superior and inferior to the MTP joints
- Cover all of the toes (if requested) and as far proximal as the field of view allows (SHOULD BE TO THE TALONAVICULAR JOINT)
- Use Axial LOC and angle parallel to the superior cortices of the 2nd and 3rd metatarsal necks
- Proximal Sat Band

MSK MRI PROTOCOL OVERVIEW



2. COR (SHORT AXIS) STIR AND T2 SEQUENCES

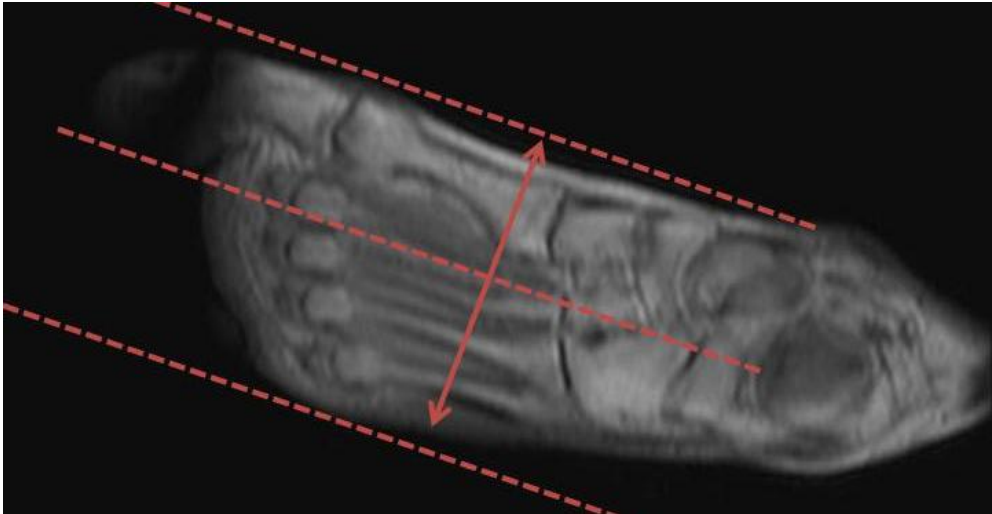
- Perpendicular to AX (Long Axis) T1
- Angled parallel to 2nd MTP joint or perpendicular to 2nd metatarsal shaft
- Cover at least to the talonavicular joint



3. SAGITTAL STIR AND T1 SEQUENCES

- Perpendicular to AX T1 and COR STIR
- Parallel to 2nd metatarsal shaft on Axial T1 sequence
- Cover from tips of the toes (if requested) as far proximal as the FOV allows
- Cover from medial margin of 1st MTP joint as far lateral as the slices go (tcover all of the MTP joints)

MSK MRI PROTOCOL OVERVIEW



MSK MRI PROTOCOL OVERVIEW

LIS FRANC INJURY

GENERAL COMMENTS

- Midfoot/forefoot protocol with an additional lis franc sequence
- Have foot bare; no stocks or nylons

COIL

- CP Extremity Coil

POSITIONING

- Prone and foot is plantar flexed (Preferred Method)
- Supine and toes sticking out of coil (Alternative Method)

SEQUENCES, AND WHAT IS MOST IMPORTANT TO REPEAT

- Always repeat AX T1 and AX STIR if there is motion

1. AX (LONG AXIS) T1
2. AX (LONG AXIS) STIR
3. COR (SHORT AXIS) STIR
4. COR (SHORT AXIS) T2
5. SAG STIR
6. SAG T1
7. THIN SLICE AX(LONG AXIS) PD FS

SEQUENCES

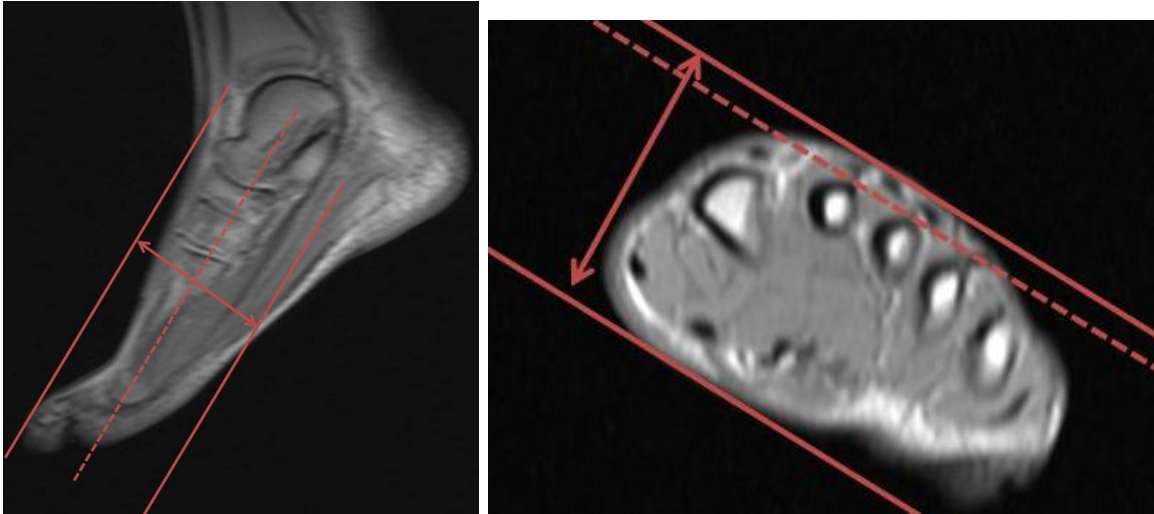
LOC

3 PLANE LOC

1. AX (LONG AXIS) T1 AND STIR SEQUENCES

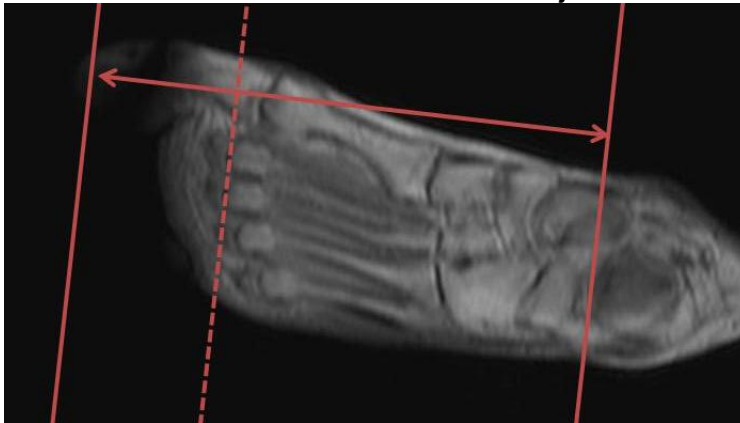
- Use Sag LOC and angle parallel to the shaft of either the 2nd or 3rd metatarsals (whichever is the least deformed) and at least cover the soft tissues superior and inferior to the MTP joints
- Cover all of the toes (if requested) and as far proximal as the field of view allows (SHOULD BE TO THE TALONAVICULAR JOINT)
- Use Axial LOC and angle parallel to the superior cortices of the 2nd and 3rd metatarsal necks
- Proximal Sat Band

MSK MRI PROTOCOL OVERVIEW



2. COR (SHORT AXIS) STIR AND T2 SEQUENCES

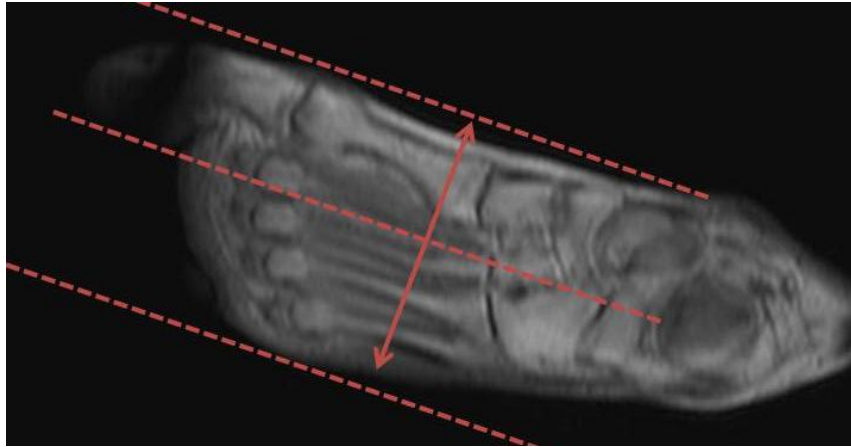
- Perpendicular to AX (Long Axis) T1
- Angled parallel to 2nd MTP joint or perpendicular to 2nd metatarsal shaft
- Cover at least to the talonavicular joint



3. SAGITTAL STIR AND T1 SEQUENCES

- Perpendicular to AX T1 and COR STIR
- Parallel to 2nd metatarsal shaft on Axial T1 sequence
- Cover from tips of the toes (if requested) as far proximal as the FOV allows
- Cover from medial margin of 1st MTP joint as far lateral as the slices go (tcover all of the MTP joints)

MSK MRI PROTOCOL OVERVIEW



4. AX (LONG AXIS) PD FS THIN SLICE SEQUENCES

- Use Sag T1 and angle parallel to the shaft of the 2nd metatarsal
- Use Cor T2 and angle parallel to the superior cortex of the 2nd metatarsal base
- Cover through the bases of the 1st and 2nd metatarsals



TECHNIQUES FOR REDUCING METAL ARTIFACT ON MR IMAGING

1. Increasing the turbo factor results in less artifact than with conventional spin echo (Increase echo train length to 6 on T1 and PD & at least 8 on STIR)
2. Use STIR instead of Fat Saturation sequences
3. Increase bandwidth (CAN GO UP TO 700)
4. Increase matrix in frequency encoding direction
5. Have phase encoding direction in most important orientation (Metal artifact is greatest in the frequency encoding direction)
6. Reduce echo spacing
7. Set the TE to at least 18 for T1 and PD sequences
8. No fat saturation on the pre and post gadolinium sequences