Working *"Around the Clock"* to Improve Shoulder MRI Patient Positioning

Jonathan Pierce MD, Tom Soker DO, Sahejmeet Guraya MD,
Navid Faraji MD, Richard Barger MD

University Hospitals
Cleveland | Ohio

Objective

- To evaluate the quality of shoulder MRI as it pertains to patient positioning at our institution before and after performing an educational intervention with MRI technologists in order to improve diagnostic image quality and interpretation of shoulder pathology.

- We hypothesize that the number of shoulder MRI's performed in external rotation will increase following targeted education of MRI technologists.
  - Potential benefits of standardized patient positioning:
    - Enable more accurate comparison between exams
    - Improved visualization of certain shoulder structures/pathologies

Background

Hospital Setting

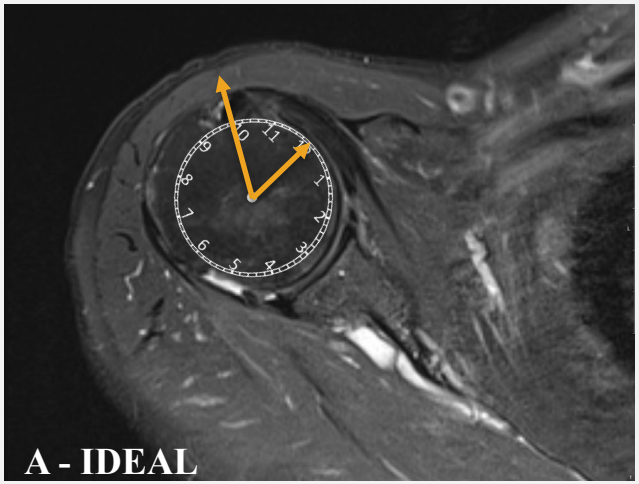
- Large healthcare system serving NE Ohio (18 hospitals, > 40 outpatient centers, 11 urgent care centers)
- Robust MSK MRI imaging practice

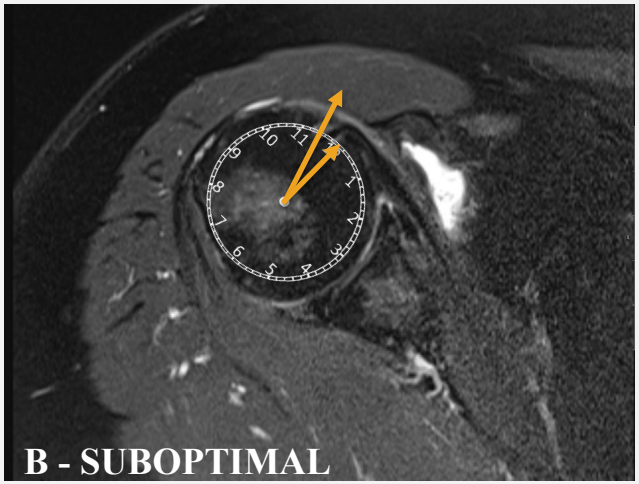
Shoulder Positioning

- The shoulder = one of the most common joints imaged with MRI
- Highly mobile joint; different positioning can emphasize/hide anatomic structures
- MRI technologists play a critical role in appropriately positioning the patient and ensuring high quality MRI imaging

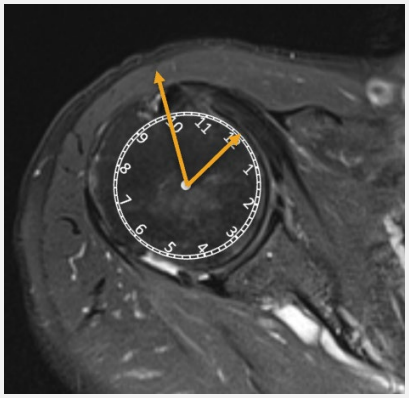
Grading Shoulder Positioning

- Clock face superimposed on the humeral head at the level of the bicipital groove; the bicipital groove assigned a clock position (ex: 9:00, 10:30, etc.)





IDEAL POSITIONING

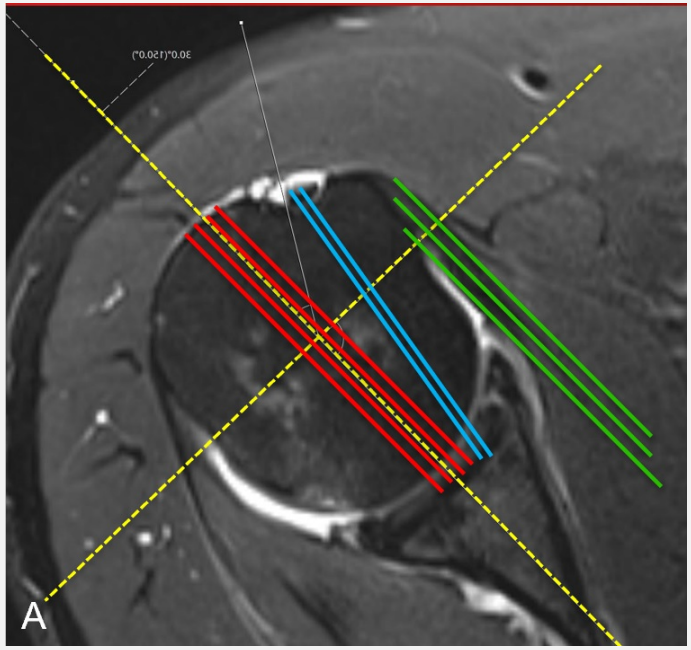


Shoulder: Mild External Rotation

Palm: Up

***Forearm:* Up, flat and NOT twisted/rotated**

On scout, biceps groove is @ 10:00 o'clock



Supraspinatus Tendon (Red)

- Straight and parallel to coronal plane
- All fibers en face in sagittal plane
- Easy assessment of location and extent of tearing

Subscapularis Tendon (Green)

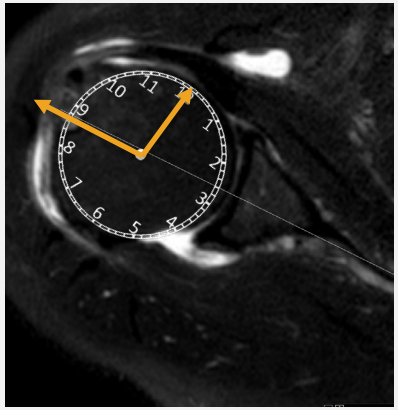
- Straight and parallel to coronal plane
- All fibers en face in sagittal plane
- Easy assessment of location and extent of tearing

Long Head Biceps Tendon (Blue)

- Straightened but mildly oblique to coronal and sagittal plane not as curved as excessive external rotation or internal rotation
- Balance of internal and external rotation optimally assessing position in groove

Anterior Capsular Structures and Labrum not obscured

SUBOPTIMAL: Excessive External Rotation

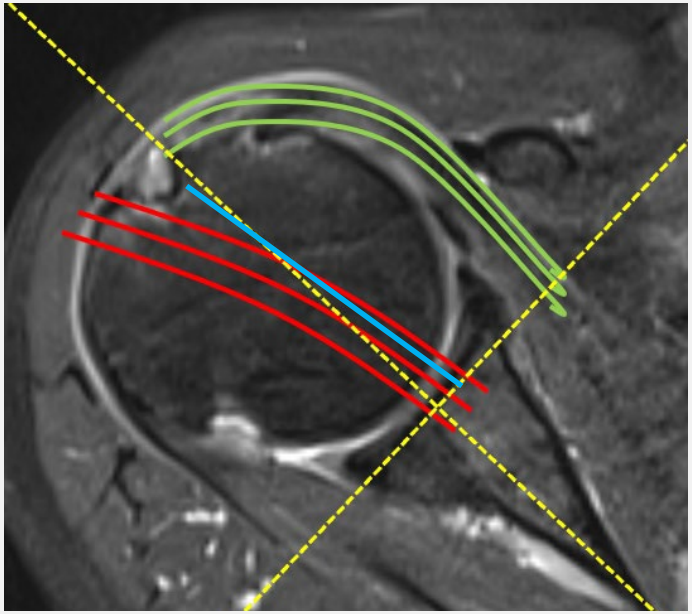


Shoulder: Excessive External Rotation

Palm: Up but not flat, twisted/rotated out

Forearm: Up but not flat and twisted/rotated out

On scout, biceps groove is between 8:00 - 10:00



Supraspinatus Tendon (Red)

- Straight to mildly curved posteriorly over greater tubercle
  - May have some volume averaging of tears

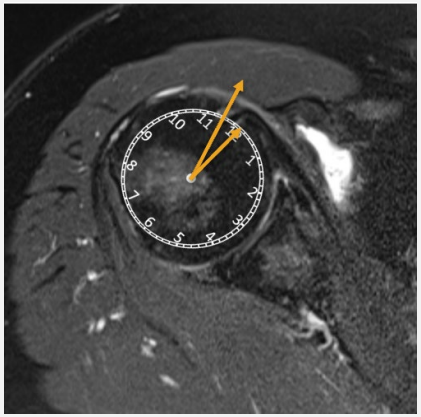
Subscapularis Tendon (Green)

- Significantly curved over lesser tubercle
- Significantly limited assessment
  - Volume averaging of tears
  - Difficult localization of tears

Long Head Biceps Tendon (Blue)

- Very straight
- Active reduction of dislocation/subluxation hiding pulley mechanism pathology (?) [cogwheel effect]

SUBOPTIMAL: Internal Rotation

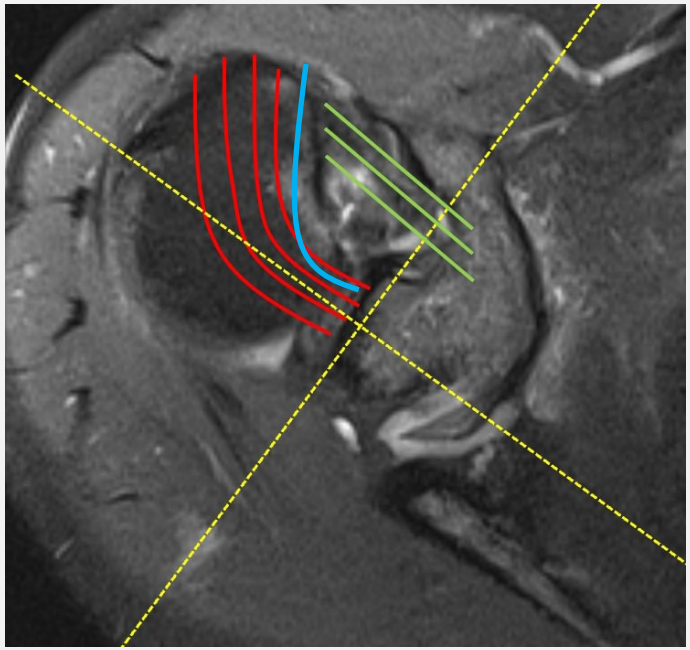


Shoulder: Internal Rotation

Palm: May be up but not flat twisted in, facing inward, or even palm down

Forearm: Up but not flat and twisted/rotated in, facing in, or twisted down

On scout, biceps groove is past 10:00 to 1:00



Supraspinatus Tendon (Red)

- Significantly draped obliquely over greater tubercle
- Very limited assessment due to obliquity in sagittal and coronal planes:
  - *Volume averaging of tears*
  - *Difficult assessment of location of tear*

Subscapularis Tendon (Green)

- Straight and foreshortened
- Limited assessment:
  - *Thickening/tendinosis*
  - *Obscuration of biceps subluxation/dislocation*
  - *Crowding with obscuration of anterior capsuloligamentous structures and labrum*

Long Head Biceps Tendon (Blue)

- Intracapsular portion foreshortened and oblique
- Limited assessment:
  - *Intracapsular tendonsis/tearing*
  - *Subscapularis tear obscuration in subluxation/dislocation*
  - *Passive reduction of subluxation/dislocation hiding underlying pulley mechanism pathology*

Phase 1 – Pre-intervention Assessment

Methods

(1) Database Query

- Imaging database (PACS) queried for Shoulder MRIs performed in the UH Health System during the month of November 2020.
- Exclusion criteria
  - Exams with insufficient sequences to assess (at least 1 axial, 1 sagittal, and 1 coronal)
  - Exams with significant motion between the sequences
  - Exams without humeral heads (certain arthroplasties, amputations, & tumor/infection destroyed)
- ***A total of 130 examinations were identified*** (1 excluded due to significant motion between sequences)

(2) Data Review

- Exams were reviewed independently by four radiologists
  - ***2 fellowship trained MSK radiologists*** (6 years and 14 years experience), ***1 PGY-3*** and ***1 PGY-4*** radiology resident
- All shoulders were oriented to face right; Line drawn through long axis of scapula at center of glenoid
- Clock positions determined relative to the center of the bicipital groove
- Supraspinatus (Axial and Coronal) and Subscapularis (Axial and Sagittal) were assessed for the quality of their position.
  - Ideally neither tendon is off plane
  - Intermediate was one or both slightly off plane
  - Not ideal was one or both significantly off plane

(3) Data Analysis

- Reader consensus on clock face and scores
- Averages with standard deviation across the four readers for each of the three positions scores
- Average of each score out of total number of cases

Phase 1 – Pre-intervention Assessment

Results

- All readers agreed that 9:00 and 11:00 to 1:00 were not ideal
- All readers agreed that 9:30 (subscapularis less ideal) and 10:30 (supraspinatus less ideal) were intermediate
- All readers agree that 10:00 was the ideal position
- Data
  - Pooled average of not ideal cases: 94 with standard deviation of 15.22
  - Pooled average of intermediate cases: 18 with standard deviation of 13.77
  - Pooled average of ideal cases: 18 with standard deviation of 2.83
  - Thus **72.31% of cases were not ideal**, 13.85% were intermediate ideal, and 13.85% were ideal

Next Steps

Phase 2 – Intervention

- Ideal shoulder positioning and its importance will be discussed with MRI technologists throughout the UH system via a series of brief live and recorded Zoom training sessions
- In-person demonstrations of ideal positioning will also be performed by MSK Radiologists in the MRI Suite
- *Proposed Methods for Improved Patient Positioning:*
  - Discussion and demonstration of ideal shoulder positioning with patient prior to beginning the MRI
  - Using weighted devices to keep the shoulder in external rotation (i.e., Sandbag on hand/forearm)
  - Monitoring patients to ensure they maintain external rotation

Phase 3 – Post-intervention Assessment

- Approximately 100 shoulder MRIs performed across the UH system will be evaluated by 4 independent radiologists following these training sessions
- Examinations will be graded based on the assignment of “ideal” positioning to exams with the bicipital groove at the 10:00 position
- Results will be compared to the pre-intervention data

Preliminary results anticipated by RSNA 2021 Annual Meeting*

References

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- Erickson S.J., Cox I.H., Hyde J.S., Carrera G.F., Strandt J.A., Estkowski L.D. Effect of tendon orientation on MR imaging signal intensity: a manifestation of the “magic angle” phenomenon. *Radiology* **1991**; 181:389–392
- Carroll K.W., Helms C.A. Magnetic resonance imaging of the shoulder: a review of potential sources of diagnostic errors. *Skeletal Radiol* **2002**; 31:373–383
- Davis, D.L.; Faddoul, D.; Almardawi, R. Practice Quality Improvement for Patient Positioning on Shoulder MRI to Reduce Potential Diagnostic Errors *J. Am. Coll. Radiol.* **2017** 14(8): 1058-1061