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# Non-contrast MRI diagnosis of adhesive capsulitis of the shoulder

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ABSTRACT

*Purpose:* To investigate non-contrast MRI findings of clinical adhesive capsulitis.
*Methods:* 31 non-contrast, non-arthrographic, shoulder MRIs were evaluated for coracohumeral ligament thickness, rotator interval infiltration, and axillary recess thickening/edema.
*Results:* In detection of adhesive capsulitis, sensitivity is 76.7% and specificity is 53.3% for coracohumeral ligament thickening, sensitivity is 66.7% and specificity is 55.2% for coracohumeral ligament thickening and rotator interval infiltration, and sensitivity is 23.3% and specificity is 86.7% for coracohumeral ligament thickening, rotator interval infiltration, and axillary recess thickening/edema.
*Conclusions:* Adhesive capsulitis can be accurately diagnosed on non-contrast MRI shoulder examinations with appropriate clinical criteria without direct MR arthrography.



## 1. Introduction

Adhesive capsulitis is a common cause of pain, restricted range of motion, and referral to subspecialty orthopedic surgery and sports medicine clinics [1–5]. The orthopedic clinical exam for adhesive capsulitis shows high sensitivity and specificity for confident diagnosis of adhesive capsulitis and is the reference standard for diagnosis [6–10]. However, patients with adhesive capsulitis often suffer from concomitant shoulder pathologies including rotator cuff and glenohumeral lesions, leading to a more difficult physical examination and a more difficult diagnosis. In the latter scenario, patients are often referred for MRI. As such, routine noncontrast MRI may be less commonly considered as a reliable modality in confirming the diagnosis of adhesive capsulitis and may be more likely ordered to primarily exclude rotator cuff and glenohumeral lesions.

Several findings have been described with adhesive capsulitis based on arthroscopic [11–13], open surgical [14–16], and imaging experience [17–27] including thickening of the coracohumeral ligament, rotator interval infiltration of the subcoracoid fat, and thickening and edema at the axillary recess and inferior glenohumeral ligament. Direct and indirect MR arthrographic findings of adhesive capsulitis or frozen shoulder are well described [17–20] and include an imaging adaptation of the observations above. However, adhesive capsulitis most commonly occurs in patients age 45 to 60 years old, a population for whom direct and indirect MR arthrography is rarely ordered in our region. Several recent studies have been performed describing noncontrast MRI findings of adhesive capsulitis and their role in the diagnosis of clinical adhesive capsulitis [25–27]. Sofka et al. described noncontrast MRI findings with clinical stage of adhesive capsulitis [25]. Gondim Teixeira et al. described noncontrast MRI findings of adhesive capsulitis compared to indirect MR arthrogram findings with sensitivities and specificities based on single MR criterion [26]. Zhao et al. described the frequency of noncontrast MRI findings of adhesive capsulitis but without sensitivity or specificity calculations [27]. No published study to date has strictly evaluated routine noncontrast MRI shoulder examinations with sensitivities and specificities for specific MRI findings and constellations of MRI findings to accurately diagnosis adhesive capsulitis.

In our study, we sought to investigate specific noncontrast MRI findings as well as constellations of noncontrast MRI findings for confirmation of clinical adhesive capsulitis.

## 2. Materials and methods

Institutional review board approval at two institutions was obtained prior to the start of this study. Cases were recruited in a single orthopedic shoulder clinic at one institution, and the reviewers were from a separate institution. A retrospective review of records and images without informed consent was performed in accordance with Health Insurance Portability and Accountability Act. We performed a subspecialty

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orthopedic surgery/sports medicine clinic database search from January 2010 and December 2011 for patients discharged with a primary or isolated diagnosis of adhesive capsulitis or frozen shoulder and without a history of recent trauma or prior MRI. Then, the same investigators accrued an age- and gender-matched control group without a clinic discharge diagnosis of adhesive capsulitis, frozen shoulder, rotator cuff tear, glenoid labrum tear or glenohumeral arthritis and also lacking a recent trauma history or prior MRI at the time of clinic visit. All patients were examined in a subspeciality shoulder clinic by a single orthopedic subspecialist. Clinical diagnostic assessment included evaluation for clinical history of shoulder pain and clinical physician exam findings of restricted active and passive range of motion of the humerus with external rotation <90°, internal rotation <75°, flexion <90°, or abduction < 90°, which was then compared with the contralateral shoulder. From these two groups, 31 patients had a noncontrast MRI within one week after the clinic visit, and these were sorted into the subject and control groups. One patient with clinical suspicion of adhesive capsulitis was excluded due to the presence of a clear traumatic labral tear. MR imaging of the shoulder was performed using standard protocol on a 1.5 Tesla scanner with a dedicated shoulder receiver coil (Siemens Magnetom, Erlangen, Germany). Coronal oblique T1-weighted spin echo non-fat suppressed (FOV 16–18 cm, TE minimum, TR 400–800), coronal oblique T2-weighted fast spin echo (FSE) fat suppressed (FOV 16–18 cm, TE 30–45, TR > 1500), axial proton density weighted FSE fat suppressed (FOV 10 cm, TE 10-20, TR 3000), and sagittal oblique T2-weighted FSE non-fat suppressed (TE 110, TR > 2000) sequences were acquired as a part of all MRI exams. Images were obtained using a slice thickness of 3–4 mm with a 0.5 mm gap.Two fellowship trained musculoskeletal radiologists with 5 and 13 years experience were blinded and reviewed the MR examinations in on a P.A.C.S. (Picture Archiving and Communication System) workstation. The readers reviewed anonymized cases with a random study number independently. Maximal coracohumeral ligament thickness was measured on the non-fat suppressed sagittal oblique sequence, and thickness >2 mm was considered abnormal. Rotator interval infiltration of the subcoracoid fat was graded as none, mild, moderate, or severe using the non-fat suppressed sagittal oblique and the non-fat suppressed coronal oblique sequences. Mild infiltration of rotator interval fat was defined as replacement of <25% of the fat signal. Moderate infiltration was defined as 25%–50% replacement of fat signal, and severe infiltration was defined as replacement of >50% of the volume of normal fat signal in the interval (Fig. 1). The axillary recess was evaluated for thickening >2 mm at its most inferior point on the coronal fluid sensitive, fat suppressed sequences. Axillary recess pericapsular edema was also evaluated on the coronal fluid sensitive, fat suppressed sequences (Fig. 2).The sensitivity and specificity for detection of adhesive capsulitis was calculated based on presence of one, two, or three criteria, using orthopedic surgery physical examinations as the reference. The sensitivity and specificity for each reader and in consensus was performed. Frequencies of each of the criteria individually were also calculated. Mean thickness for the coracohumeral ligament in the two groups was calculated, and a two tailed Student's *t*-test was performed to determine

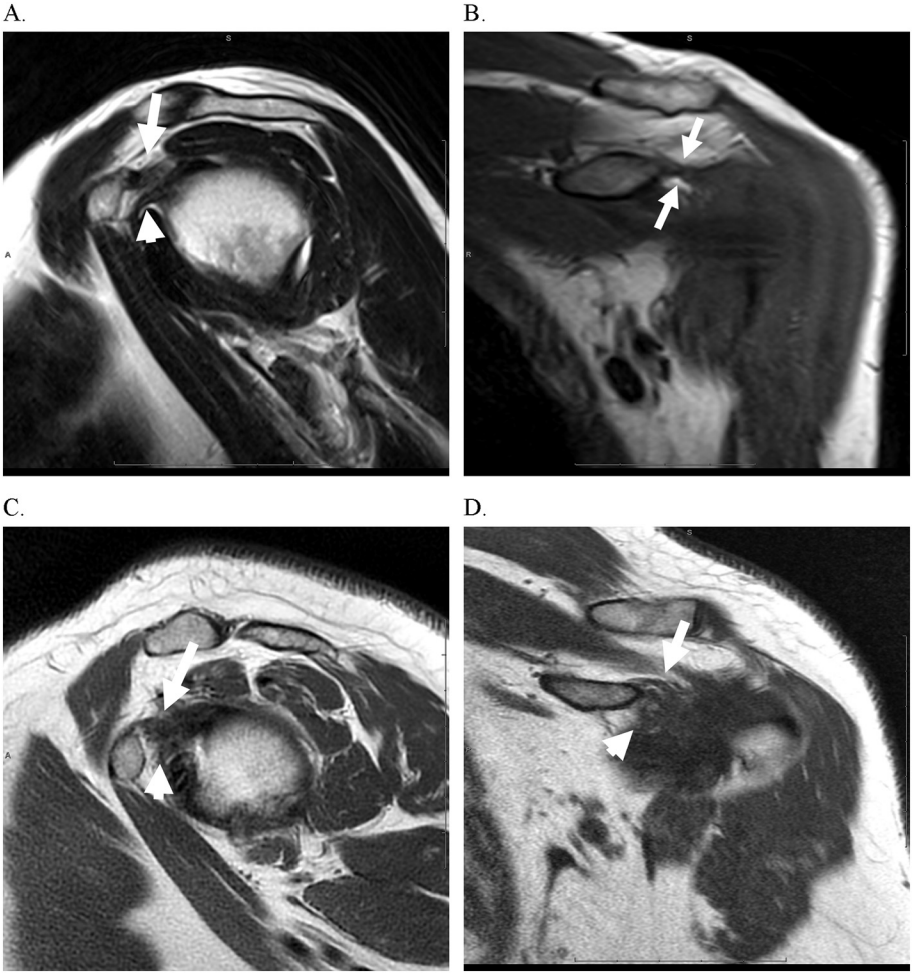


**Fig. 1.** A 62-year-old woman with clinical adhesive capsulitis. (A) Sagittal oblique T2-weighted fast spin echo non-fat suppressed and (B) coronal T1-weighted spin echo non-fat suppressed MR images show thickening of the coracohumeral ligament (white arrow) and moderate rotator interval infiltration of the subcoracoid fat (white arrow head). A 49-year-old woman with clinical adhesive capsulitis. (C) Sagittal oblique T2-weighted fast spin echo non-fat suppressed and (D) coronal T1-weighted spin echo non-fat suppressed MR images show marked thickening of the coracohumeral ligament (white arrow) and severe rotator interval infiltration of the subcoracoid fat (white arrow head).