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SCIENTIFIC ARTICLE

Synovial fold of the posterior shoulder joint capsule

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Abstract
Purpose The purpose of the study is to describe, based on shoulder MRI and MR arthrography with arthroscopic correlation, a posterior joint capsule fold.
Materials and methods A retrospective review of 410 shoulder MRIs and direct MR arthrograms with arthroscopic correlation in positive cases (when available) was obtained with IRB approval and HIPPA compliance. The study was performed by three musculoskeletal radiologists. The criteria utilized to establish the diagnosis of posterior synovial fold included: (1) axial T1-weighted (T1W) on MR arthrography or axial T2* GRE-weighted on MRI demonstrating rounded thickening of the posterior shoulder joint capsule with a thickness at least 2 mm in diameter. (2) The posterior synovial fold extends in an oblique craniocaudal direction from the posterior–inferior joint capsule adjacent to the posterior–inferior glenoid labrum (7 o'clock) and continues superiorly away from the glenoid labrum to the posterior–superior joint capsule (11 o'clock).
Results Although uncommon, the posterior synovial fold was present in 2% (8/410) of studies reviewed and found predominantly in women (75%, 6/8). Four patients had arthroscopic confirmation of the posterior synovial fold. A higher percentage of posterior synovial folds were observed on shoulder MR arthrography (2.7%, 4/150) than on shoulder MRI (1.5%, 4/260).
Conclusion Although rare, the posterior synovial fold can be recognized and should not be confused with a posterior labral tear. Further investigation is needed to assess its histologic properties and its clinical significance.

Keywords Shoulder · MR arthrography · Synovial fold · MRI · Joint capsule

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Introduction

Normal anatomy and normal anatomic variants of the shoulder joint, including the glenohumeral ligaments, labrum, and joint capsule, have been widely described in the radiology literature (1–4). Thorough knowledge of the shoulder joint capsular and ligamentous anatomy is essential for accurate shoulder MRI and MR arthrography interpretation (5–7). Normal anatomic variants should be recognized to avoid patients undergoing unnecessary arthroscopic surgery.

We describe a thickening of the posterior shoulder joint capsule which can be seen with shoulder MRI and MR arthrography. To our knowledge, shoulder joint MRI or MR arthrographic imaging of a posterior synovial fold with arthroscopic correlation has not been described in the literature. By convention, the glenohumeral joint can be divided into anterior and posterior halves. Anterior is 12 to 6 o'clock and posterior is 6 to 12 o'clock. The posterior joint capsule fold, which extends from the posteroinferior joint (7 o'clock) to the posterior–superior joint capsule (11 o'clock) in an oblique craniocaudal direction, is in close proximity to the glenoid labrum.

Materials and methods

A retrospective review of 410 consecutive shoulder MRIs and MR arthrograms obtained during the period from November 2007 through April 2008 was made with IRB approval and HIPPA compliance. A total of 259 shoulder MRIs and 141 shoulder MR arthrogram studies were reviewed. Eight patients were found to have a posterior synovial fold. The images were viewed on a Matrix Fusion PACS workstation by musculoskeletal radiologists with 30 years and 1 year attending experience (authors 2, 3 respectively) and one musculoskeletal radiology fellow (author 1). The diagnosis of a posterior synovial fold was made by unblinded unanimous consensus.

The criteria utilized to establish the diagnosis of posterior synovial fold included: (1) axial T1-weighted (T1W) MR arthrogram (MRA) or axial T2* GRE on MRI demonstrating rounded thickening of the posterior shoulder joint capsule with a thickness of at least 2 mm. (2) On axial images, the posterior synovial fold extends in an oblique craniocaudal direction from the posterior–inferior joint capsule adjacent to the posterior–inferior glenoid labrum (7 o'clock) and continues superiorly away from the glenoid labrum to the posterior–superior joint capsule (11 o'clock).

MRI Shoulder/MR shoulder arthrography imaging

Images were acquired on GE Signa 1.5T MR system utilizing a phased array shoulder coil with the shoulder in the neutral position with respect to internal and external rotation. Shoulder MRI was performed utilizing gradient recalled echo (GRE) axial T2* (TR 450, TE 15, flip angle 17°), oblique coronal proton density (PD) (TR 1825, TE 24) and T2W fat suppression (FS) fast spin echo (FSE) (TR 3775, TE 85), oblique sagittal T1W (TR 400, TE 10) spin echo (SE), and PD FS FSE (TR 2050, TE 35), oblique axial PD FS FSE (TR 2225, TE 24). Shoulder MR arthrography was performed utilizing axial T1W SE (TR 384, TE 10) and GRE T2* (TR 417, TE 15, flip angle 17°), oblique sagittal T1W SE (TR 400, TE 10), oblique coronal T1W SE (TR 400, TE 10), T1W FS SE (TR 4000, TE 10), T2W FS FSE (TR 4000, TE 85), oblique axial T2* GRE (TR 417, TE 15, flip angle 17°), and abduction-external rotation (ABER) T1W FSE (TR 350, TE 10). The routine axial images were oriented perpendicular to main magnet field (B_0). Additional oblique axial images were obtained perpendicular to the craniocaudal axis of the glenoid from the 12 to 6 o'clock directions. Images were acquired utilizing a field of view (FOV) of 16.0×16.0 cm. Matrix size ranged from 160×160 through 256×256 and slice thickness ranged from 3.0 mm to 5.0 mm with spacing ranging from 0.5–1.8 mm. Direct MR arthrography was performed utilizing a standard anterior approach. MR arthrography was performed after injecting a mixture of lidocaine 1% 2 ml, Ultravist-300 2–5 ml, and Magnevist diluted in normal saline (Magnevist 2 ml in 250 ml normal saline) 7–9 ml and the total injected average volume was approximately 12 ml.

Arthroscopy

Arthroscopic imaging correlation was available in four of the eight patients (MR arthrography—three patients and MRI—

Table 1 Patients with a posterior synovial fold on MRI/MR arthrography

Study type	Clinical information	Additional MRI/MR arthrography findings	Surgical arthroscopy findings (images and report available)
MR arthrography	29 F. Trauma with clicking and pain shoulder pain. Rhomboid muscle and scapular pain external to glenohumeral joint	Suspicion for a posterosuperior labral tear	N/A
MR arthrography	34 F. Shoulder pain after direct trauma to shoulder. Instability	Suspicion for posterior labral tear	Increased capacity joint. Posterior synovial fold. The labrum was intact
MRI	30 F. With 5 days shoulder pain after lifting	Tendinosis of supraspinatus tendon, mild subacromial bursitis, mild joint effusion, no tear of the labrum	N/A
MR arthrography	17 M. Shoulder pain	Fraying of the undersurface of the infraspinatous tendon	Posterior synovial fold. Partial tear of the infraspinatous tendon
MR arthrography	28 M. Chronic shoulder pain	Irregular anterior–inferior and superior labrum	SLAP I. Anterior–inferior labral tear/ degeneration. Posterior synovial fold
MRI	16 F. Shoulder pain after trauma with anterior instability	Anterior labral tear, and suspicion for superior labral tear	Posterior synovial fold. Anterior and anteroinferor labral tear. Increased capacity of shoulder joint
MRI	54 F. With several months of shoulder pain after snow shoveling	AC joint osteoarthritis. Partial thickness supraspinatus tear	N/A
MRI	19 F. Pain. Autoimmune disease	No labral tear. No additional finding	N/A

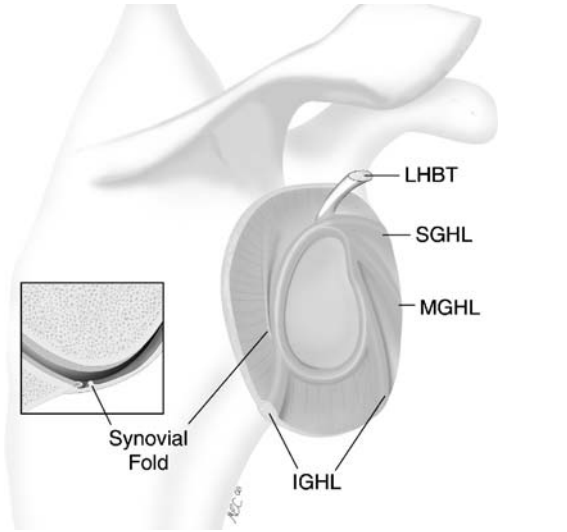

Fig. 1 Artistic rendition of a posterior synovial fold in oblique sagittal plane with an axial drawing. *LHBT* long head biceps tendon, *SGHL* superior glenohumeral ligament, *MGHL* middle glenohumeral ligament, *IGHL* inferior glenohumeral ligament

one patient). The arthroscopic images were reviewed retrospectively. MRI and MR arthrography images and reports were available to orthopaedic surgeons prior to arthroscopy. The posterior synovial fold was reported preoperatively in all surgical cases and the surgeons knew of the finding before surgery. The surgeons found a linear thickened synovial fold at the posterior wall of the joint capsule at arthroscopy. Four patients did not have surgical confirmation. Some patients had additional MR imaging abnormalities (Table 1). None of the four cases with a posterior synovial fold confirmed arthroscopically had a tear of the posterior glenoid labrum.

Results

In Table 1, clinical information, MRI, MR arthrography, and surgical arthroscopy findings are summarized. Demographics: the mean age of the patients was 28 years (range 16–54). Females represented 75% (6/8) of the patients and males represented 25% (2/8) of patients. In our shoulder MRI and MR arthrography population, 34% were female.

On shoulder MRI or MR arthrography, each positive case had a synovial fold in the posterior joint capsule which was vertically and obliquely oriented extending from the posterior–inferior shoulder joint, adjacent to the posterior–inferior glenoid labrum (7 o'clock position), to the posterior–superior shoulder joint (11 o'clock). The posterior synovial fold is illustrated in the artistic rendering (Fig. 1). The posterior synovial fold can be seen on axial MR arthrographic images

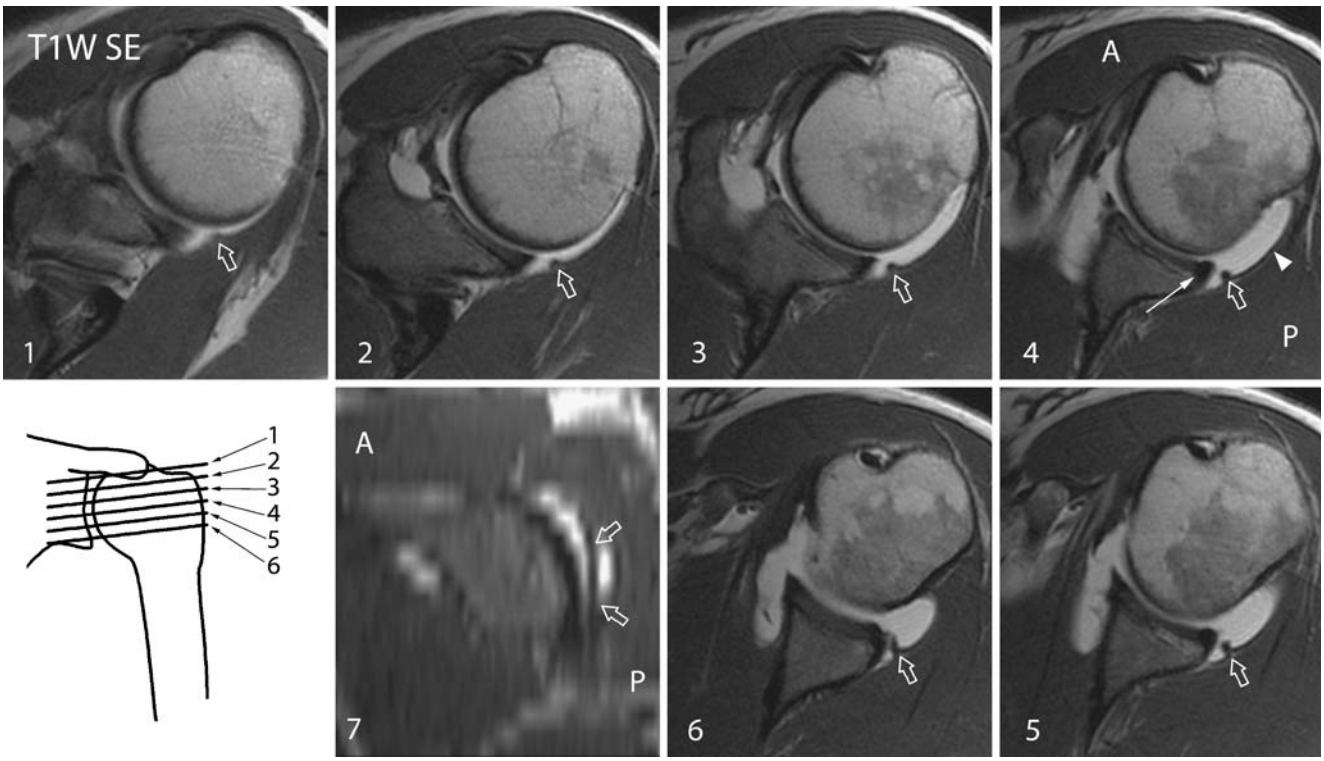

Fig. 2 MR arthrography. Axial T1W (SE, TR 500, TE 15). Patient A: 34-year-old female after direct trauma to the shoulder with shoulder instability. *Open arrow* posterior synovial shoulder fold. *Long white arrow* normal posterior glenoid labrum. *White arrowhead* posterior joint capsule. *1–6* Axial T1W images from superior to inferior. *7* Oblique sagittal multi-planar reformatted image with *open arrow* pointing to the posterior synovial shoulder fold. Image on far lower left: coronal drawing with reference lines

(Figs. 2, 3, and 4). In three of eight cases, the fold was seen partially on the oblique sagittal images, but on the oblique coronal images the fold was difficult to see. On the oblique sagittal reconstructed image the synovial fold could be seen along its entire longitudinal axis in one image (Fig. 2, image #7).The arthroscopic images (Figs. 5 and 6) clearly demonstrate a synovial fold coursing from superior to inferior adjacent to the posterior glenoid labrum.

Discussion

In the shoulder, the synovial joint capsule extends from the bony glenoid medially to the humeral neck laterally. The anterior and posterior joint capsule insertions on the scapular glenoid and the superior, middle, and inferior glenohumeral ligaments (seen as thickenings of the internal joint capsule) have been well described in the literature (8–10). In addition, there have been several descriptions of additional shoulder joint ligaments in the orthopedic literature including the fasciculus obliquus (11) and a new ligament in the superior capsuloligamentous complex (12).

To our knowledge there are no published descriptions and images of a posterior shoulder joint synovial fold with arthroscopic correlation. The posterior synovial fold begins close to the posterior–inferior glenoid labrum (7 o'clock direction) and could be mistaken for a posterior–inferior labral tear on MRI or MR arthrography. The fold was best visualized in the axial plane. The posterior fold was visualized in the axial plane in all cases and the fold could be viewed in the sagittal and coronal planes in some but not all cases. It is important to recognize that the posterior synovial fold represents an area of synovial joint capsule thickening rather than a posterior labral tear. This is analogous to confusing the middle glenohumeral ligament for an anterior glenoid labral tear.

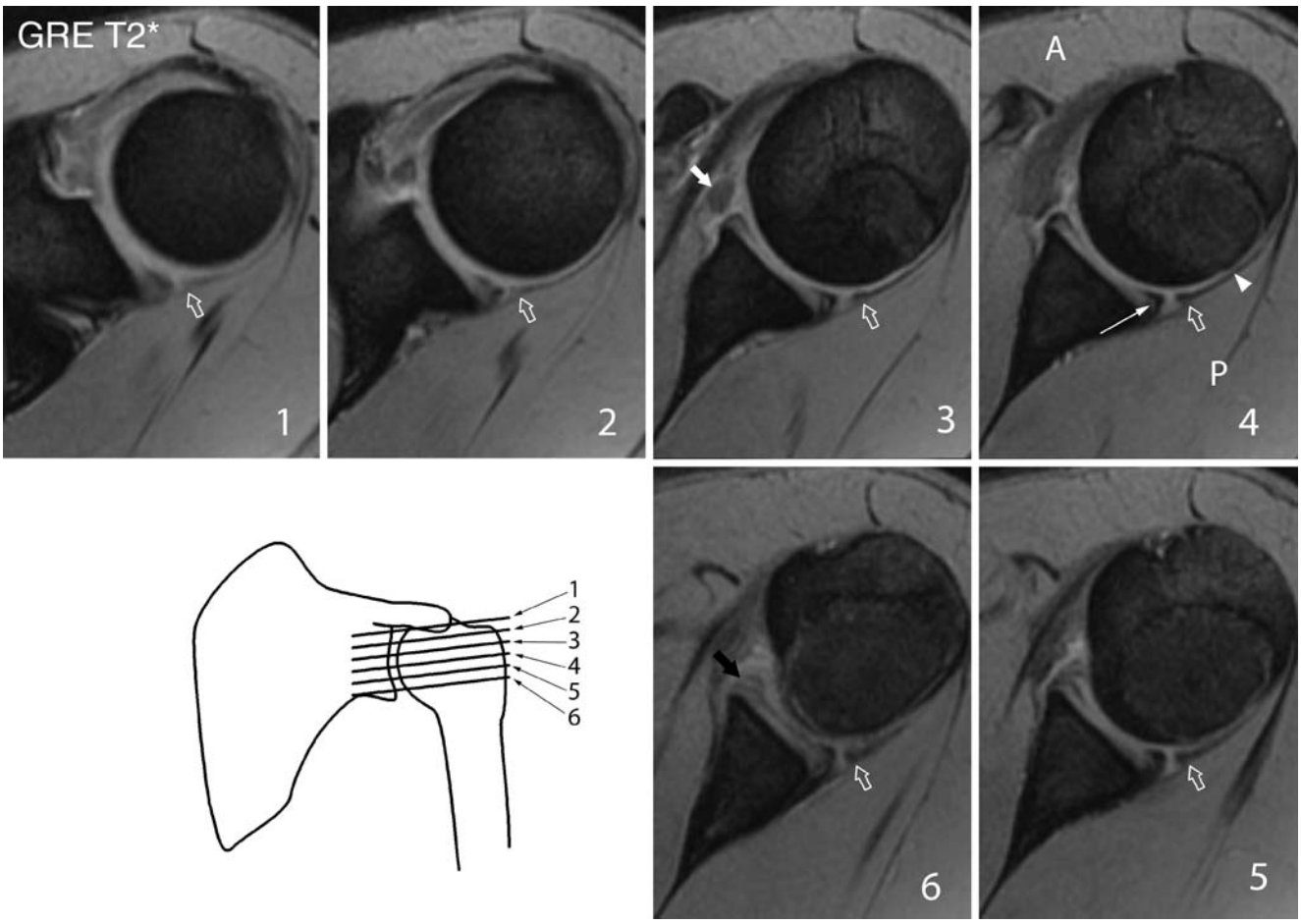

Fig. 3 Shoulder MRI. Axial GRE T2* (TR 467, TE 15, flip angle 17°) Patient B: 16-year-old female with shoulder pain after trauma with anterior instability. *Open arrow* posterior synovial shoulder fold. *Long white arrow* normal posterior glenoid labrum. *White arrowhead* posterior shoulder joint capsule. *1–6* Axial T2* images from superior to inferior. Incidentally noted: *white arrow head* prominent middle glenohumeral ligament. *Black arrowhead* anterior–inferior glenoid labral tear. Image on far lower left: coronal drawing with reference lines

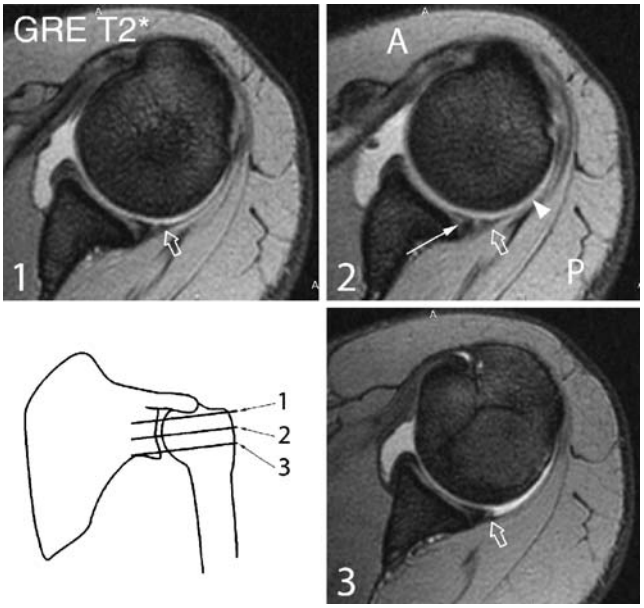

Fig. 4 Shoulder MR arthrography. Axial GRE T2* (TR 467, TE 15, flip angle 20°) Patient C: 17-year-old male with shoulder pain. *Open arrow* posterior synovial fold. *Long white arrow* normal posterior glenoid labrum. *White arrowhead* posterior joint capsule. *1–3* axial images from superior to inferior. Coronal reference line drawing

The prevalence of the posterior shoulder synovial fold in patients referred for shoulder MRI or MR arthrography was low (1.95%, 8/410). A higher percentage of posterior synovial folds were observed on shoulder MR arthrography (2.7%, 4/150) than on shoulder MRI (1.5%, 4/260). It may

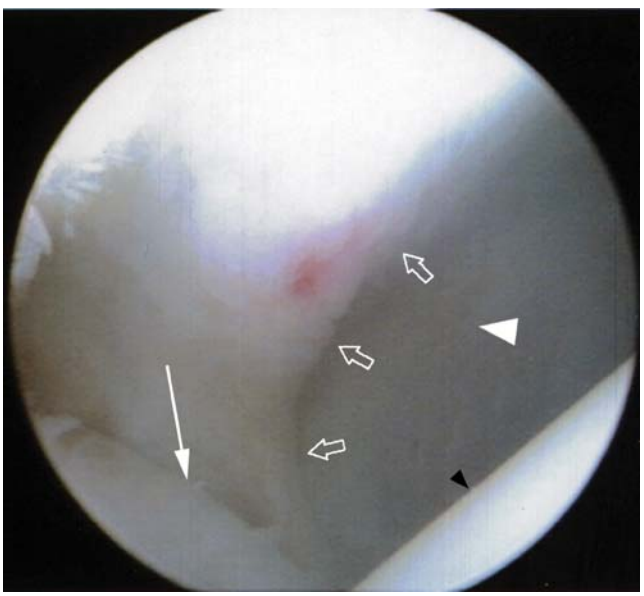

Fig. 5 Arthroscopic image (corresponding to Fig. 3). Patient B: 16-year-old female with shoulder pain after trauma with anterior instability. *Open arrows* posterior synovial shoulder fold. *Long white arrow* normal posterior glenoid labrum. *White arrowhead* posterior shoulder joint capsule. *Black arrowhead* humeral head

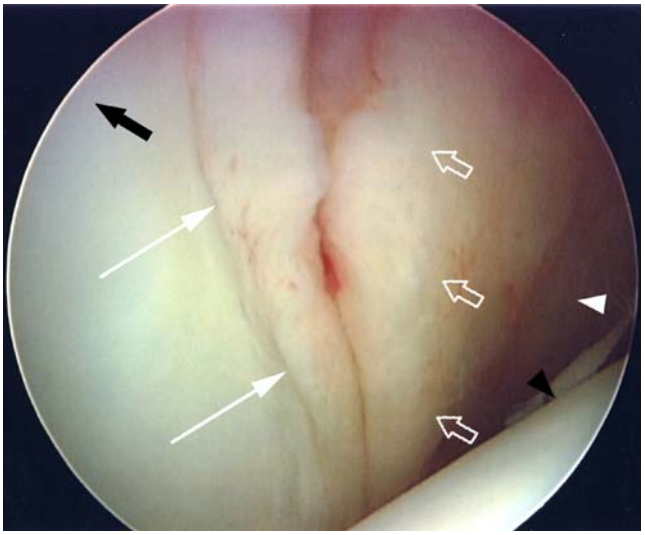

Fig. 6 Arthroscopic image (corresponding to Fig. 4). Patient C: 17-year-old male with shoulder pain. *Open arrows* posterior synovial shoulder fold. *Long white arrow* normal posterior glenoid labrum. *White arrowhead* posterior joint capsule. *Black arrowhead* humeral head. *Black arrow* glenoid bone

be that a posterior synovial fold in our patients is difficult to see on routine shoulder MRIs in the absence of significant internal joint fluid (13). In addition, most of the patients were women (75%, 6/8) and it is uncertain whether this is due to higher prevalence or small population size. Given the low prevalence of the posterior synovial fold, cadaveric and histologic correlation may be difficult and a study with more patients may be necessary to confirm that the finding is encountered predominantly in women.

Several arthroscopic portal placements have been described in the literature (14–17). During arthroscopy, in two of the four patients, a posterior shoulder portal was placed through the posterior synovial fold limiting its arthroscopic evaluation. Although portions of the posterior synovial fold could be seen with posterior portal placement, it could not be visualized as a complete intact structure making it difficult to see prospectively by the surgeon. In two of four patients, the surgeon modified the initial approach by using alternative portals first to examine the anterior labrum or rotator cuff. This also allowed for better direct visualization of the posterior synovial fold without perforation of the fold. Therefore, the detection of an intact posterior synovial fold could be limited by the standard posterior arthroscopic portals used to assess the shoulder joint. The surgeons were unsure of the clinical significance of the fold; however, one patient had significant improvement of symptoms after debridement of the posterior fold, but the patient also had a partial tear of the infraspinatus tendon that was not surgically altered during arthroscopy. A modified arthroscopic approach may be necessary to visualize an intact posterior synovial fold.

Future studies including histological examination of the posterior joint capsule in cadavers may elucidate the true nature of the posterior synovial fold. If the posterior synovial fold consists of abnormal tissue, it would suggest that it is an abnormal finding.

Our study includes the following limitations: the patient population with a posterior synovial fold is small. Four of the eight patients (50%, 4/8) did not have arthroscopic imaging confirmation of the fold. Two of the four surgically confirmed cases had anterior labral abnormalities. The lack of inter-observer data limits the study. It is uncertain if there is a relationship between labral tears and a posterior synovial fold. No pathologic correlation was obtained; therefore, a future cadaver study may clarify the histologic properties of the fold. Lastly, our patients were imaged in the neutral position. It is possible that the appearance of the posterior synovial fold may change with internal or external rotation, and in certain positions visualization of the fold may be enhanced or diminished (18). In one patient, during anterior arthroscopic examination in external rotation, the fold shifted behind the posterior glenoid labrum and was difficult to visualize, and in internal rotation, the fold appeared more prominent. Despite the limitations of the study, we believe the synovial fold of the posterior shoulder joint should be recognized and investigated further.

The synovial fold of the posterior shoulder joint capsule begins at posteroinferior joint close to the posterior–inferior glenoid labrum (7 o'clock position) and extends superolaterally away from the labrum to the posterior–superior aspect of the joint (11 o' clock position). Although rare, the posterior synovial fold can be recognized and should not be confused with a posterior labral tear. The etiology and relationship of the posterior fold to clinical symptomatology warrants further investigation. Its recognition on MRI may alter the arthroscopic diagnostic/surgical approach and management if it is clinically relevant.

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