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ARTICLE

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Diagnosis of SLAP lesions with Grashey-view arthrography

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Abstract *Objective:* To examine the accuracy of Grashey views obtained during shoulder arthrography in the diagnosis of clinically relevant superior labrum anterior-posterior (SLAP) lesions. *Design and patients:* Grashey views obtained during diagnostic arthrography (conventional and MR) were used to examine the superior labrum. Twenty-eight of 118 shoulder arthrograms obtained during a 27-month period fulfilled study criteria and were correlated for accuracy using arthroscopically confirmed grade 2–4 SLAP lesions as the standard of reference. Arthrograms were graded using the consensus method. Prevalence, sensitivity, specificity, and accuracy were 21%, 50%, 86%, and 79%. The appearance of the superior labrum on the Grashey view was compared subjectively with MR arthrography. Sources of errors were analyzed. *Conclusion:* Grashey views obtained during shoulder arthrography can diagnose clinically relevant SLAP lesions with moderately high specificity, moderate accuracy, and limited sensitivity. Findings on the Grashey view closely resemble those seen on coronal oblique MR arthrography. Grashey views should be considered in patients undergoing shoulder arthrography.

Keywords Arthrography · MR arthrography · Shoulder, SLAP lesion · Superior labrum

Introduction

The current imaging test of choice for diagnosis of superior labrum anterior-posterior (SLAP) lesions is MR arthrography, which shows high overall accuracy [1, 2, 3]. Some patients, however, are unable to undergo MR imaging due to contraindications such as the presence of mechanical implants or large habitus while other patients are unable to remain motionless during MR imaging. For these patients, options for imaging of the superior labrum include ultrasonography and CT arthrography [4, 5, 6, 7, 8]. Ultrasonography requires a technically proficient examiner who may not be readily available and CT arthrography has not been validated in large population studies. Neither examination is in widespread clinical use.

We noted during fluoroscopically guided injection of the shoulder for MR arthrography some cases in which the appearance of the superior labrum on Grashey views mimicked the appearance of SLAP lesions seen on coronal oblique MR arthrography. This observation led us to wonder whether the Grashey view can be used to diagnose SLAP lesions, especially in patients who are unable to undergo or satisfactorily complete MR arthrography.

Materials and methods

Subject selection

One hundred and eighteen cases of shoulder arthrography between June 29, 1999 and September 27, 2001 were found by examination of the departmental musculoskeletal fluoroscopy procedure logbook. The respective arthrography reports, clinical records, and arthrography films were reviewed to exclude technically inadequate examinations (2), postoperative joints (4), injections performed for therapy or suspected infection (9), air arthrography (6), and cases in which no Grashey views were obtained (3). Of the remaining 94 subjects, 66 had no arthroscopy performed by the time of our review, which occurred 9 months after the last shoulder injection in

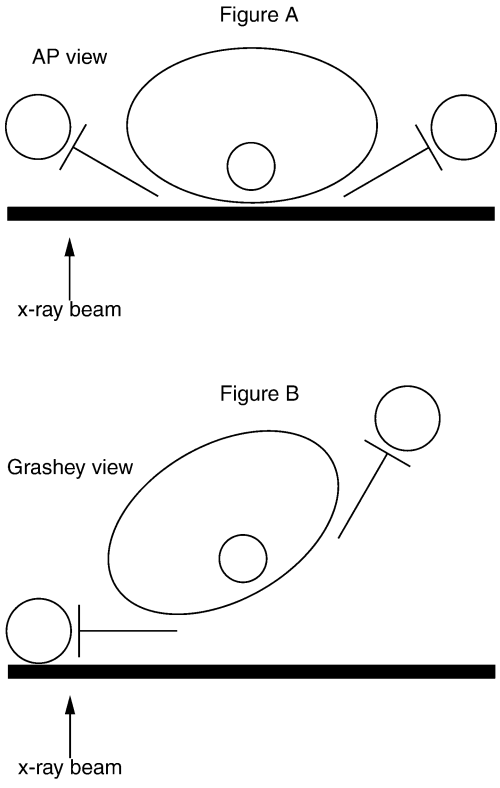

Fig. 1A, B Line drawing demonstrating patient positioning for the Grashey view shoulder arthrogram. **A** AP view with the patient flat on the fluoroscopy table. Note the oblique position of the glenoid rim with respect to the X-ray beam. **B** Grashey view. The entire torso is rotated to elevate the contralateral shoulder up toward the fluoroscopy camera, placing the shoulder of interest in an ipsilateral posterior oblique position. The glenoid rim is now tangential to the X-ray beam. This position profiles the superior labrum. The patient is also asked to rotate the head away from the shoulder of interest to prevent overlap of the chin with the shoulder (not shown)

the study. Of the remaining 28 subjects, five underwent conventional arthrography only due to claustrophobia or other contraindications to MR imaging, while 23 underwent subsequent MR or CT arthrography. Our institutional review board approved the study.

Shoulder arthrography

All examinations were performed as part of routine clinical care. The arm was placed in slight external rotation with the patient supine. The anterior shoulder was prepared sterilely and draped. One percent xylocaine local anesthesia was applied, followed by placement of a 22-gauge spinal needle into the anteroinferior glenohumeral joint. One milliliter of contrast was injected into the joint to confirm intra-articular needle position, followed by needle repositioning if necessary. The joint was filled to full capacity, up to a maximum of 30 ml. The needle was withdrawn. Internal rotation anteroposterior, Grashey (external rotation ipsilateral posterior oblique) and external rotation anteroposterior spot views were obtained using digital fluoroscopy. The Grashey view was obtained by rotating the patient's torso and shoulders together to achieve an ipsilateral posterior oblique position with respect to the table (Fig. 1). The patient was told to turn the contralateral shoulder toward the radiologist and to turn the head away from the shoulder undergoing examination to prevent the chin from overlapping the shoulder. This position shows the glenoid rim in profile with no overlap of the anterior and posterior rims of the glenoid fossa. Positioning was optimized under fluoroscopic control. Additional axillary and bicipital groove overhead radiographs were also obtained for patients who were not scheduled to undergo subsequent MR imaging.

MR arthrography was performed using a contrast mixture of Omniscan gadolinium contrast (Nycomed, Princeton, N.J.) (1:200 final dilution), 0.25% xylocaine, and iodinated contrast medium (Hypaque 15 or Omnipaque 75, final dilutions, Nycomed, Princeton, N.J.). Conventional arthrography was performed with the single-contrast technique using 0.5% xylocaine and Hypaque 30 or Omnipaque 150 (final dilutions). No complications were recorded for the study subjects using this technique.

Grading and arthroscopy correlation

Two musculoskeletal MR imaging-trained radiologists examined the Grashey view arthrograms in consensus. The superior labrum in each study was graded for the presence of a SLAP lesion by adapting criteria developed for MR arthrography [3]. A small or

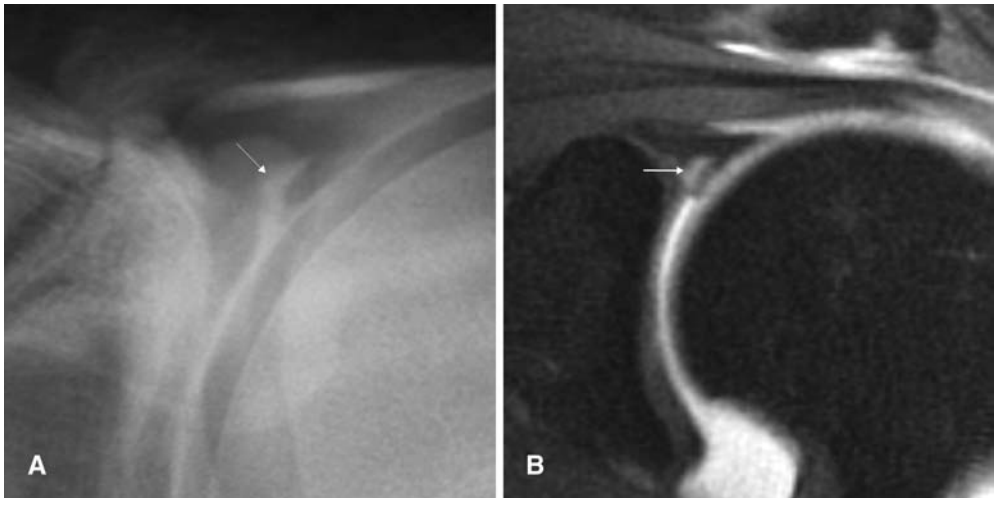

Fig. 2A, B True positive SLAP lesion resulting in a flap that contains 50% of the labrum. **A** Grashey view arthrogram shows extension of contrast into the substance of the superior labrum with a diagonal component extending from inferomedial to superolateral (*arrow*), well lateral to the expected location of the sublabral recess. Note the relatively thick line of contrast. **B** Corresponding T1-weighted fat-saturated MR arthrogram also shows a superior labral tear (*arrow*) with notable similarity to the Grashey view

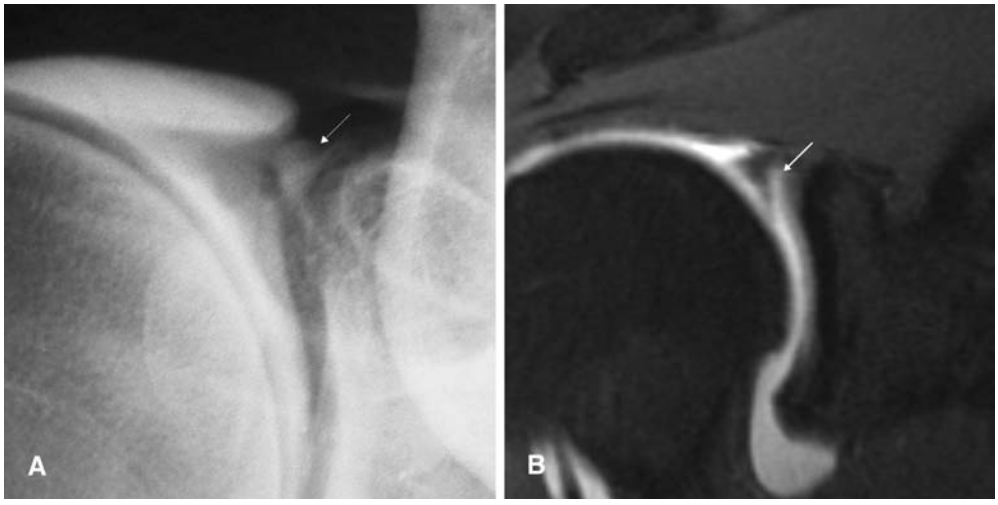

Fig. 3A, B True-positive tear of the anterosuperior labrum. **A** Grashey view demonstrates abnormal pooling of contrast in the superior labrum (*arrow*). **B** MR arthrogram shows a thick line of contrast within the superior labrum (*arrow*)

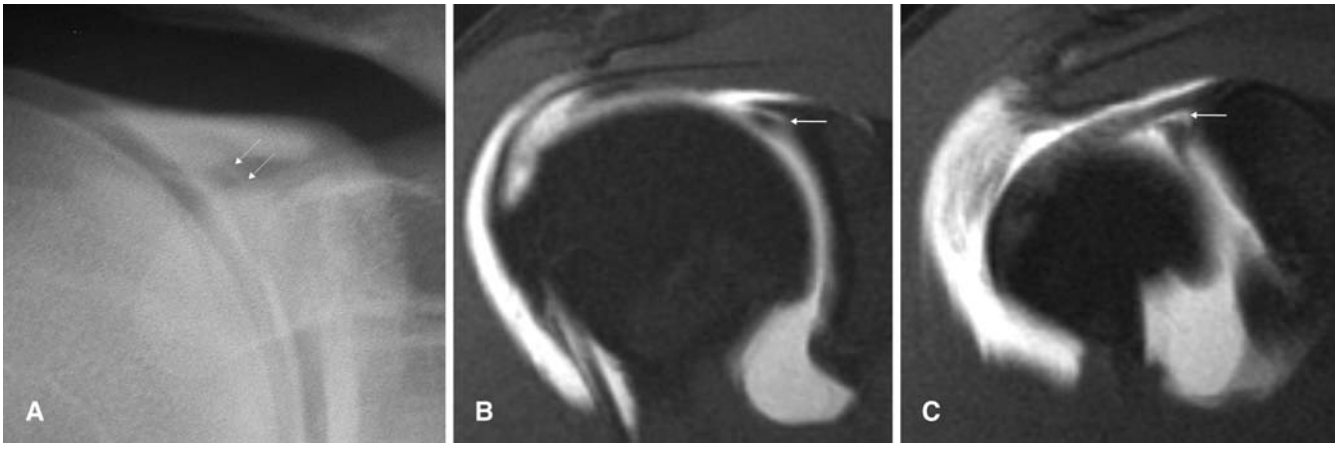

Fig. 4A–C True-positive grade 3 SLAP lesion. **A** Grashey view shows a faint line of contrast running in diagonal orientation typical of SLAP lesions (*arrows*). **B** MR arthrogram of the posterior superior labrum shows the lesion more clearly than the Grashey view (*arrow*), but the appearance is otherwise similar to the Grashey view. **C** MR arthrogram of the anterior superior labrum shows normal contrast between the inferior border of the long head of biceps tendon and the superior labrum (*arrow*). The contrast is oriented superomedial to inferolateral as opposed to superolateral to inferomedial as in superior labral tears

frayed labrum, horizontal or complex extension of contrast into the superior labrum, and vertical extension of contrast into the superior labrum distinct from the labral-hyaline cartilage attachment were used as criteria for a SLAP lesion. No bucket-handle tears were noted on the arthrograms. Readers were masked to the MR arthrography, clinical, and arthroscopy data. These results were correlated with the arthroscopy results, using grade 2–4 SLAP lesions as the standard of reference for clinically relevant SLAP lesions. Grade 1 SLAP lesions were treated as normal as they are not likely to be clinically important [1]. Six grade 2–4 and six grade 1 lesions were seen at arthroscopy. Prevalence, sensitivity, specificity, positive and negative predictive values, and accuracy were calculated. The arthrography images were subsequently analyzed for sources of potential error.

Results

Prevalence of grade 2–4 SLAP lesions was 21%. Three of six tears and 19 of 22 normal cases were diagnosed correctly using the Grashey view, yielding 50% sensitivity, 86% specificity, and 79% accuracy. Three false positive cases and three false negative cases were diagnosed, leading to 50% positive and 86% negative predictive values.

Two of the three true positive cases were easily seen on the Grashey views (Figs. 2, 3) as contrast collections extending into the superior labrum in a vertical direction. The third true positive case also showed contrast in the superior labrum, but the contrast was only faintly seen (Fig. 4). All three cases showed excellent correlation with coronal oblique MR arthrography, although one case was easier to see on the MR arthrogram (Fig. 4).

Some of the true negative cases also showed contrast in the region of the superior labrum that could be mistaken for a tear, although most of the true negative cases were confidently called normal by the readers. One case demonstrated normal contrast outlining of the inferior

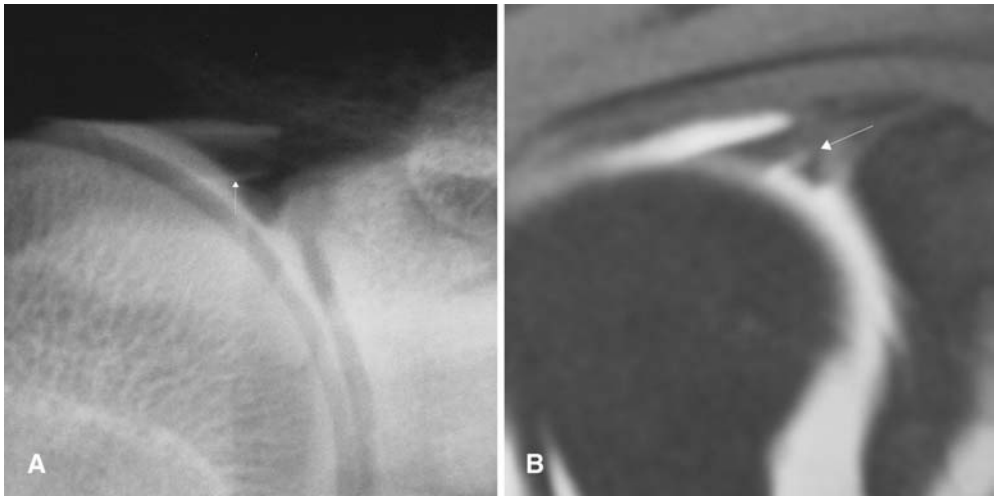

Fig. 5A, B True negative normal superior labrum with horizontal contrast outlining the biceps-labral complex. **A** Grashey view shows a thin line of contrast outlining the long head of biceps tendon (*arrow*) in a superomedial to inferolateral orientation. This appearance should not be confused with a SLAP lesion. **B** MR arthrogram illustrates contrast in the recess formed by the long head of biceps tendon and superior labrum at the biceps-labral complex (*arrow*), matching the appearance on the Grashey view

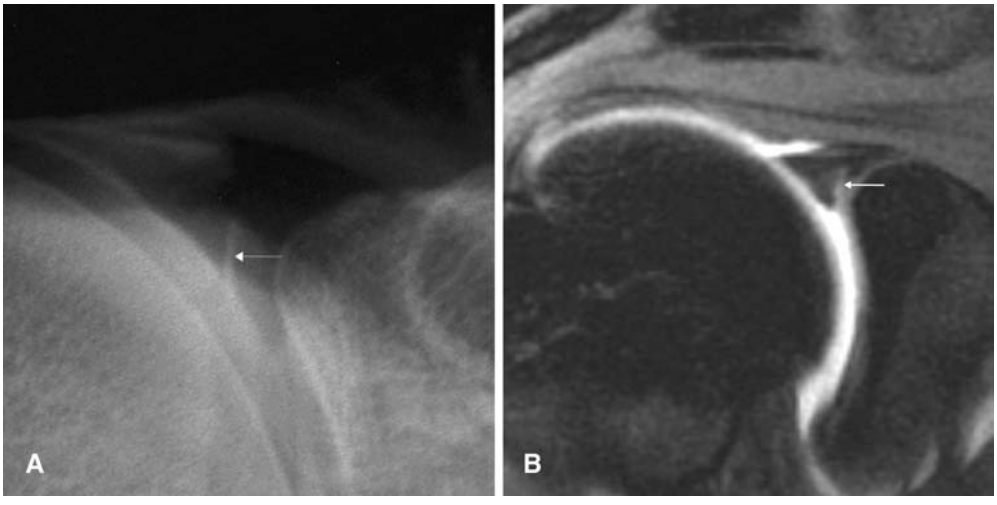

Fig. 6A, B True negative normal superior labrum with sublabral recess. **A** Grashey view shows a thin line of contrast extending into the sublabral recess vertically (*arrow*). The recess is approximately the same distance from the superior glenoid rim cortex as the contrast outlining the glenoid articular cartilage. No globular or diagonal component is present, unlike the SLAP lesions shown in Figs. 2, 3, 4. **B** MR arthrogram illustrates the sublabral recess (*arrow*) bordered by a normal superior labrum laterally and glenoid articular cartilage medially

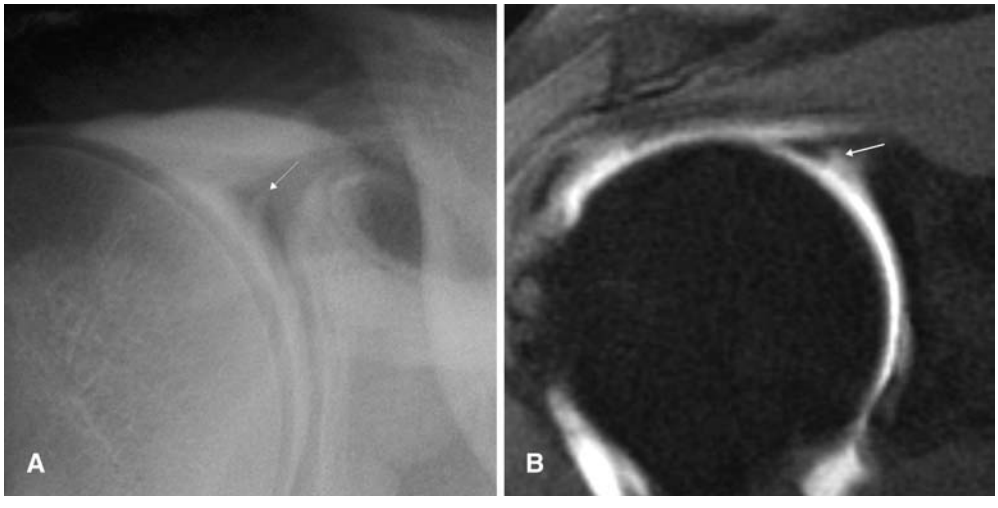

Fig. 7A, B True negative examination with fraying and no tear. **A** Grashey view shows a line of contrast with vertical orientation in the superior labrum (*arrow*). The thickness of the contrast is slightly greater than in the case with the normal labrum (Fig. 6). This case was thought to represent the sublabral recess only. **B** MR arthrogram shows globular imbibition of contrast into the inferior superior labrum (*arrow*). Arthroscopy revealed fraying of the superior and anterior labrum but no discrete tear

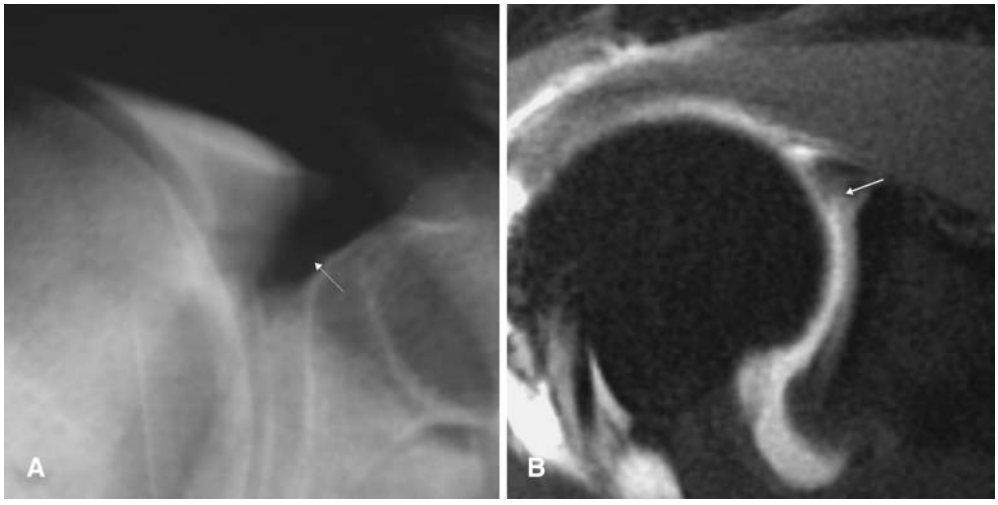

Fig. 8A, B True negative examination with frayed labrum and no discrete tear. **A** Grashey view shows no definite abnormality of the superior labrum (*arrow*). **B** MR arthrogram reveals minimal irregular increased signal in the inferior portion of the superior labrum (*arrow*), corresponding to fraying of the superior and anterior labrum

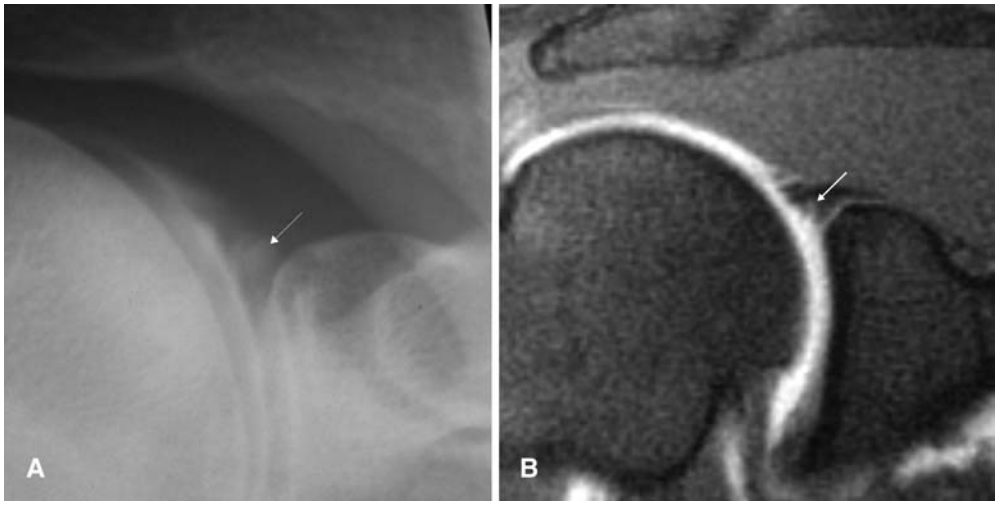

Fig. 9A, B False positive examination with contrast in the superior labrum region. **A** Grashey view shows globular contrast in the superior labrum (*arrow*) with no discrete line of contrast. This case was thought to represent a tear. **B** MR arthrogram shows a somewhat more linear configuration for the contrast in the superior labrum (*arrow*). Arthroscopy reports did not comment on the superior labrum; this case was presumed to represent a normal labrum for the purposes of the study

border of the long head biceps tendon as it attaches to the superior labrum (Fig. 5) and another case showed normal extension of contrast into the sublabral recess (Fig. 6). Both these cases were interpreted correctly and both showed close correlation with the MR arthrography findings. A third case showed contrast that was thought to represent the sublabral recess (Fig. 7) but was shown at arthroscopy to represent labral fraying without a tear. Another case of labral fraying without tear showed minimal vague contrast in the superior labrum on the Grashey view (Fig. 8). The MR arthrograms in both these cases showed a somewhat globular pattern of increased signal.

The three false positive cases all showed abnormality on both the Grashey view and on subsequent CT or MR arthrography. One case with vague, poorly defined contrast within the superior labrum was graded a tear, but the arthroscopy notes did not mention the superior labrum (Fig. 9). This case was judged as a false positive, although it is possible that a tear was present and not noted, because such an omission is rare in our experience in reviewing arthroscopy reports for imaging correlation. A second false positive case showed globular contrast in the superior labrum (Fig. 10), which correlated with degenerative fraying without a tear. The last false positive case (Fig. 11) demonstrated a faint diagonal line of contrast similar to that seen in a true positive case (Fig. 4), with much more pronounced but similar findings on MR arthrography. This case represented labral fraying only, although the MR arthrography findings would be entirely consistent with a tear.

One false negative case in retrospect showed a faint line of diagonal contrast that was initially missed on the Grashey view due to perceptual or judgmental error (Fig. 12). This case had MR arthrography findings that correlated with the Grashey view. The second false negative case was extremely poorly windowed (Fig. 13). Retrospective analysis of this case did reveal grossly

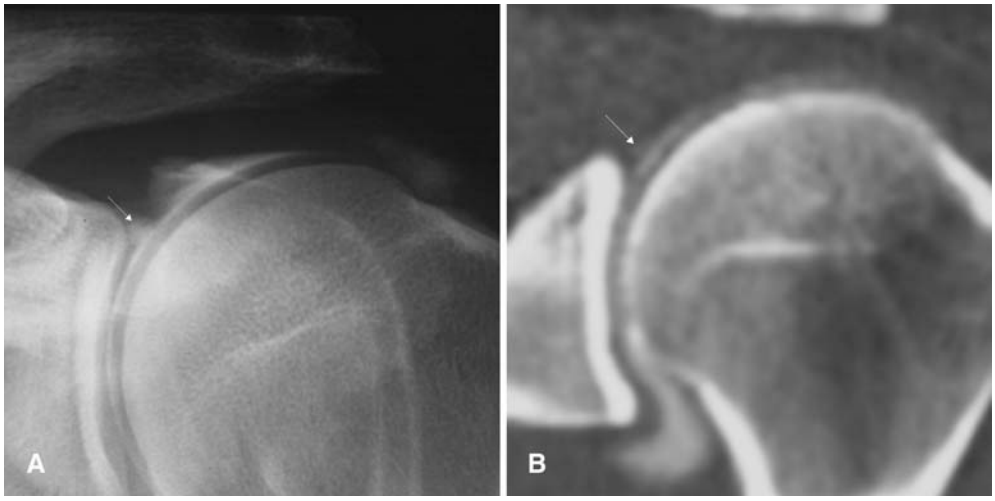

Fig. 10A, B False positive examination with superior labral fibrillation only. **A** Grashey view shows globular contrast within the inferior portion of the superior labrum (*arrow*). Note the contrast outlining the normal course of the long head of the biceps tendon over the humeral head. This case was graded as a tear. **B** CT arthrogram performed due to severe claustrophobia precluding MR imaging shows minimal contrast in the superior labrum on the coronal oblique reformatted image (*arrow*). Only diffuse fibrillation was found at arthroscopy

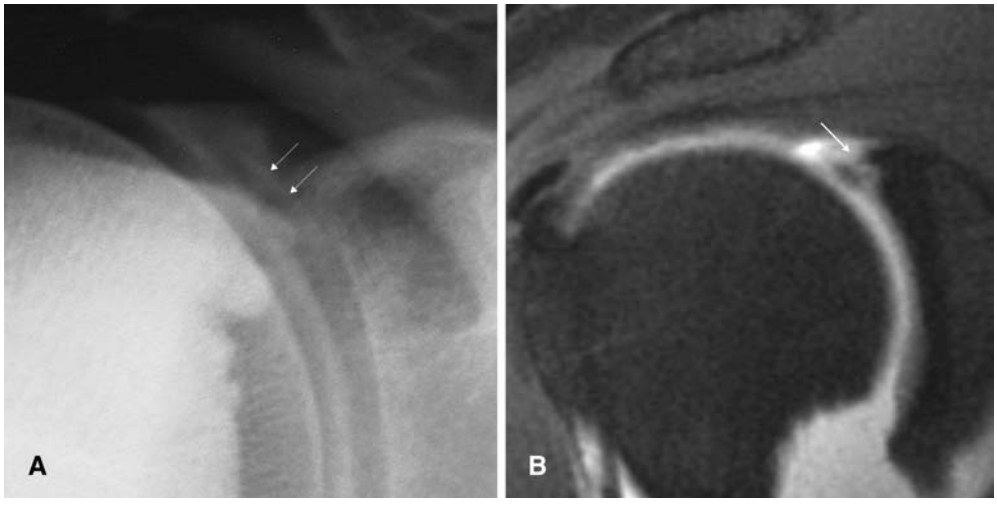

Fig. 11A, B False positive examination mimicking a tear. **A** Grashey view shows characteristic diagonal contrast within the superior labrum thought to represent a tear (*arrows*). **B** MR arthrogram shows irregular, linearly arranged contrast within the superior labrum (*arrow*) corresponding to the Grashey view. Arthroscopy revealed fraying with a sublabral hiatus but no tear

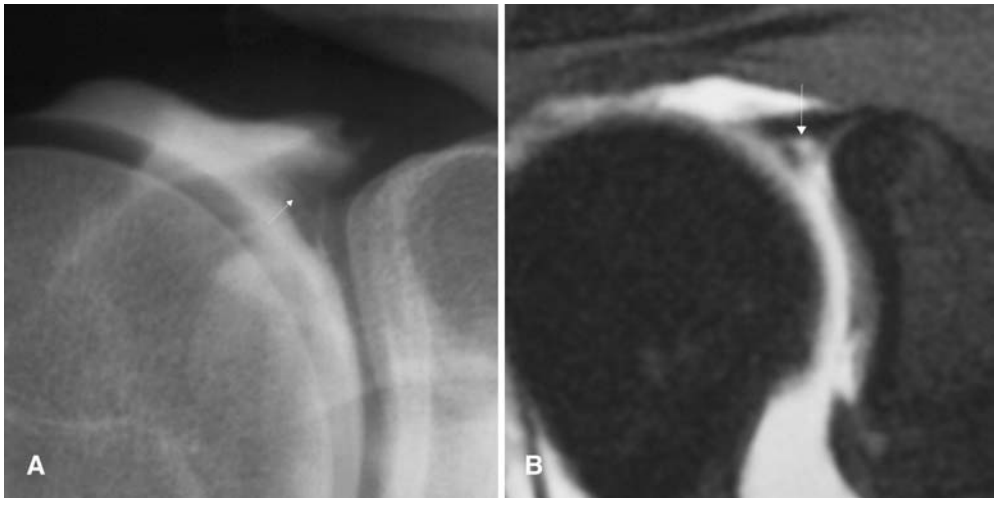

Fig. 12A, B False negative examination due to perceptual error. **A** Grashey view was interpreted as negative. Retrospective review shows a very subtle thin line of contrast in the superior labrum (*arrow*). **B** MR arthrogram shows a superior labral defect filled with contrast (*arrow*) inferior to the long head of the biceps tendon, which corresponded to a grade 2 SLAP lesion at arthroscopy

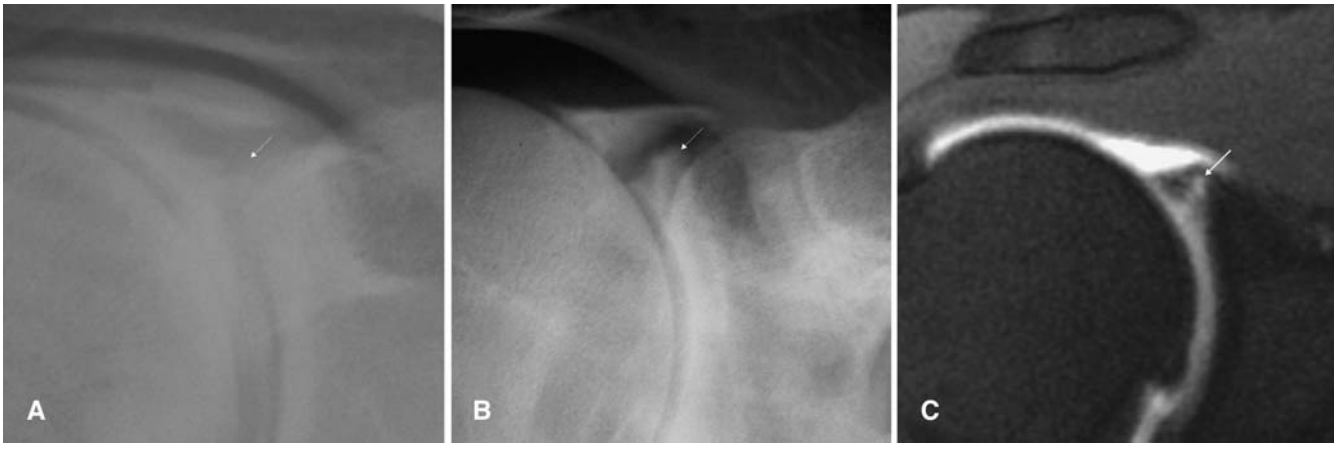

Fig. 13A–C False negative examination due to technical error. **A** Grashey view is poorly windowed. No discrete abnormality is present in the superior labrum (*arrow*). This view was the only one graded during the study and was read as negative. **B** AP view shows an irregular, slightly thickened line of contrast in the superior labrum (*arrow*). Note the improved visualization compared with the Grashey view. **C** MR arthrogram shows a superior labral tear (*arrow*) closely resembling the appearance of the conventional arthrogram (**B**)

positive findings on the anteroposterior (AP) view, which was filmed with optimal windowing. The findings on the AP view matched those seen on the MR arthrogram. The third false negative case was normal in appearance on both the Grashey view and MR arthrogram on retrospective review.

Discussion

Our arthrography service started obtaining Grashey views of the shoulder in our MR arthrography patients to better profile the rotator cuff tendons. We observed in several of these cases that the superior labrum appeared to be torn and matched findings on MR arthrography. This led to a retrospective study to evaluate the accuracy of the Grashey view for diagnosis of SLAP lesions. Our study shows that the Grashey view can examine the superior labrum using conventional arthrography with high specificity and moderate accuracy. The 50% sensitivity is problematic; however, if technical and perceptual errors had been corrected (Figs. 12, 13) the sensitivity could have been as high as 5/6 or 83%. This would lead to an overall accuracy of 86%, which is remarkably high given the single image that is required for diagnosis. We also believe that specificity can also be improved by recognizing that globular contrast in the superior labrum is likely to represent fraying only (Figs. 9, 10). In fact, the overall accuracy may be comparable to that of MR arthrography, as suggested by the remarkable resemblance of the Grashey view and MR arthrography images.

Several aspects of the arthrography technique that was used for the majority of our cases deserve discussion. First, most of the arthrography was performed as a preliminary step for MR imaging. This may have introduced selection bias, although the prevalence of SLAP tears in our study was not excessively high compared with what may be seen in a population that includes only patients who underwent arthroscopy after MR arthrography. Second, the cases were not performed to optimize the results of conventional arthrography. No exercise was performed before obtaining the arthrography images. The iodinated contrast was also dilute, although we believe that the concentration was adequate for single-contrast arthrography performed using digital fluoroscopy. It may be possible to see subtle labral tears more clearly with higher concentrations of iodinated contrast (Fig. 12) or with exercise. Third, all the images we evaluated were spot films obtained using the fluoroscope; no overhead films were obtained. Some image spatial resolution may have been sacrificed as a result, but we believe that optimal positioning would also be sacrificed if only overhead Grashey views were obtained. Fourth, the volume of injection we used was higher than that typically used for shoulder arthrography, as we regularly used over 20 ml. It is possible that this higher volume resulted in better filling of labral tears than typically seen with smaller volumes of injection. At any rate, we believe the higher volume probably did not materially affect the results. Lastly, no provocative maneuvers such as arm traction were utilized to enlarge potential tears of the labrum, although such maneuvers may in fact provide for better evaluation for labrum tears.

Some limitations of our study need to be addressed. No views other than the Grashey view were evaluated for the diagnosis of SLAP lesions, although it is clear that at least in some cases an AP view can show lesions as well (Fig. 13). The number of subjects was relatively small due to the reliance on arthroscopy as the standard of reference. It may be possible to achieve a larger sample size by using a different standard such as MR

arthrography, but we believe such a study would be less rigorous. A multi-institutional study could also provide a larger sample size, but differences in arthrography and arthroscopy techniques and accuracy would produce some variability in the data as well.

This brings us to the most relevant discussion: the potential role of Grashey view arthrography in the diagnosis of SLAP lesions. Our results are preliminary due to the relatively small sample size and limited sensitivity that was achieved, and our technique is not yet a routine alternative to MR arthrography. On the other hand, our study did show us errors that could be eliminated to improve both sensitivity and specificity, so that future interpretations using the same technique may be significantly more accurate. We believe on the basis of our results that the minimal extra effort required to obtain the Grashey view in patients undergoing MR arthrography provides a worthwhile opportunity to evaluate the superior labrum in patients who subsequently fail to complete the MR examination. The technique is an alternative to CT arthrography or ultrasonography in offices where MR scanners are not available, although comparative accuracy would need to be studied to assess which of these modalities is the best. If conventional arthrography is the only imaging test performed for the shoulder, we recommend obtaining the Grashey view since it will be the only view specifically designed to show the superior labrum, much as axillary views provide the only views of the anterior and posterior labrum.

Conclusion

Grashey view conventional arthrography showed high specificity and moderate accuracy in the diagnosis of SLAP lesions. Sensitivity was limited but may be improved with experience and optimization of technical parameters. The use of this view should be considered in patients undergoing arthrography, either alone or in combination with CT or MR arthrography.

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