



# Indirect MR Arthrography: Is It Helpful?

A review of the techniques, recent literature, normal anatomy, and common image findings

Authors: David Young, DO (PGY5), Yoon Cho, DO (PGY 5), Gregory Herting, DO (PGY 2)

Faculty Advisor: Donald Von Borstel, DO

Department of Musculoskeletal Radiology at Oklahoma State University Medical Center, Tulsa, OK



## Objectives

- Understand the proper techniques of indirect arthrography
- Review of recent literature of indirect MR arthrography when compared to direct MR arthrography and non-contrast MRI

## Introduction

Indirect arthrography is the use of intravenously injected gadolinium contrast for enhancement of a joint space. Synovial joints have increased vascularity and absence of basement membranes allowing contrast diffusion.

Indirect arthrography is performed by injecting intravenous gadolinium followed by active or passive exercise of the joint being imaged for approximately 10 minutes. Next, depending on the joint being imaged, there are various amounts of time delay depending on the joint. T1 weighted images with fat suppression are often obtained because the amount of contrast within the joint is low. Similar to direct arthrography, T2 weighted images are obtained primarily to visualize extra-articular disease.

Biphasic indirect arthrography technique takes advantage of the fact that gadolinium-based agents are vascular, and direct enhancement of pathologic processes can be seen. An initial T1 weighted image is obtained immediately after contrast administration, aka the vascular image. Delayed fat suppression T1-weighted images obtained, and exercise is not required.

A global Pubmed search was performed for labral pathology comparing direct arthrography, indirect arthrography, and non-contrast MRI. A total of 4 studies were found with sensitivity and specificity results reported.

## Literature Review Summary

Review Article	Direct MRA patients	Indirect MRA patients	Noncontrast MRI patients
#1	19	19	—
#2	—	80	80
#3	—	91	91
#4	1963	159	1402
<b>Total</b>	<b>1982</b>	<b>349</b>	<b>1573</b>

Imaging Techniques	Sensitivity	Specificity*
Direct MR Arthrography	80.4%	90.7%
Indirect MR Arthrography	83.3%	67.4%
Noncontrast MRI	64.7%	86.8%

\*Study #3 with no available specificity data

### Advantages and Disadvantages of Indirect Arthrography vs. Conventional MRI

Advantages	Disadvantages
<ul style="list-style-type: none"> <li>Higher sensitivity of detecting labral tears<sup>2,8</sup></li> <li>Does not require invasive procedure, fluoroscopy, or patient discomfort that accompanies traditional direct arthrography</li> </ul>	<ul style="list-style-type: none"> <li>Patient requires contrast with inherent potential risk (albeit low) of allergic reaction or nephrogenic systemic fibrosis</li> <li>Extra cost to patient</li> <li>Longer exam time and requires Radiologist procedure</li> </ul>

### Advantages and Disadvantages of Indirect vs. Direct Arthrography

Advantages <sup>1</sup>	Disadvantages <sup>1</sup>
<ul style="list-style-type: none"> <li>No fluoroscopic guidance required</li> <li>No articular injection</li> <li>Imaging can be offered after hours or offsite</li> <li>No need to immediately image after contrast administration if using traditional arthrography (as opposed to biphasic which will be discussed later)</li> </ul>	<ul style="list-style-type: none"> <li>Normal physiologic enhancement may mask pathologic enhancement</li> <li>Inability to detect non-anatomical communications between fluid-containing spaces, as they will all enhance simultaneously</li> <li>Joints are not distended causing structures such as the glenoid labrum to be poorly seen</li> </ul>

## Indirect Arthrography Examples

### Glenoid Labrum

- Normal labrum on MRI
  - The normal labrum shows low-signal intensity on all pulse sequences due to lack of mobile protons in the dense fibrocartilage. On cross sectional imaging, the normal labrum is most commonly triangular, but can also be round, cleaved, notched, flat, or even absent.

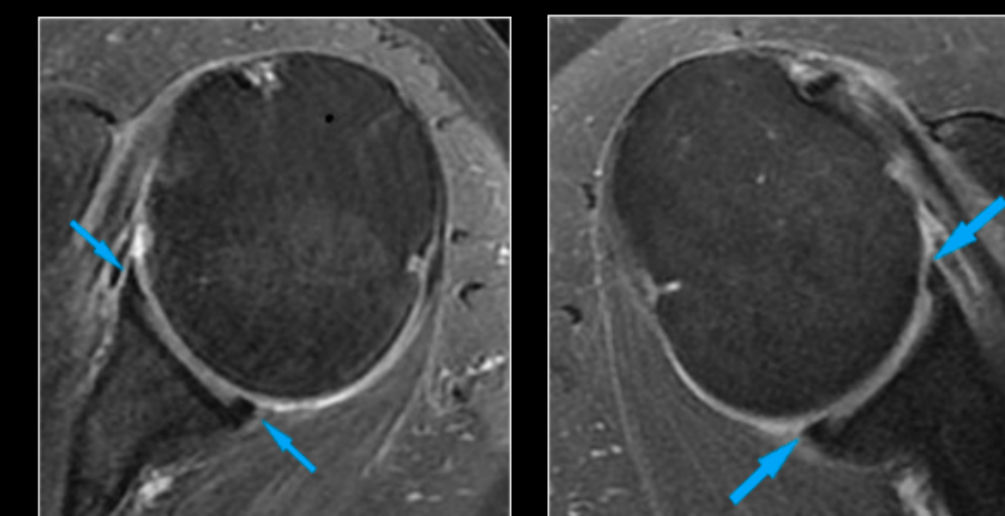


Figure 2. Indirect arthrogram T1 axial images show normal labrum (blue arrows), both triangular and flattened types. No evidence of tear visualized.

- Indirect Arthrographic MR findings
  - Labral injury will show undercutting linear enhancement, irregular intrasubstance enhancement, or degenerative blunting.

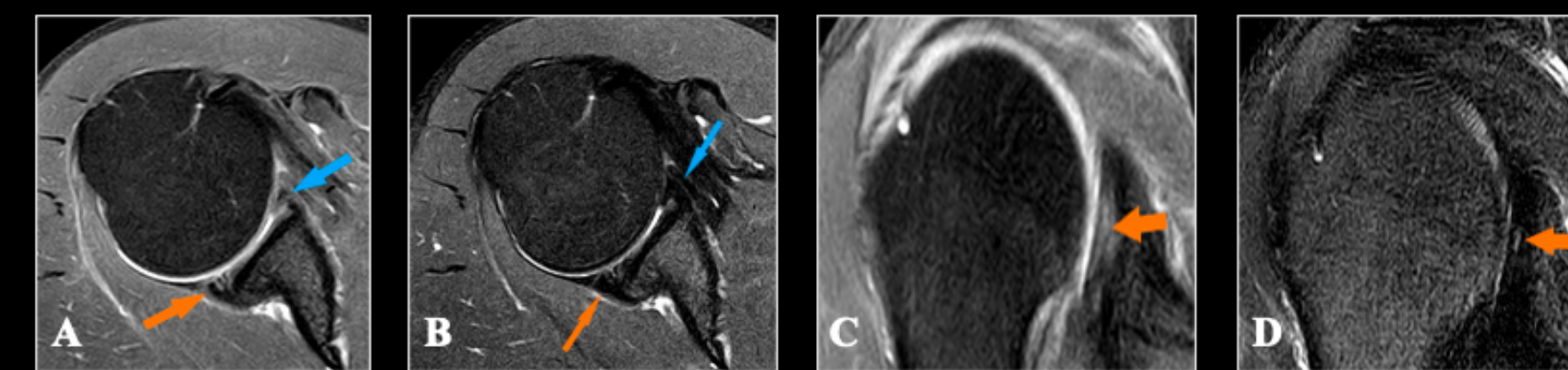


Figure 3. Indirect arthrogram T1 fat-suppressed axial and coronal images (A and C) showing both anterior (blue arrows) and posterior (orange arrows) labral tears; a finding even appreciated with inherent motion degradation of the image on the coronal image. Corresponding T2 fat suppressed axial and coronal images (B and D) show less well-defined signal of the labrum suggesting superior sensitivity of indirect arthrography in detecting labral tears.

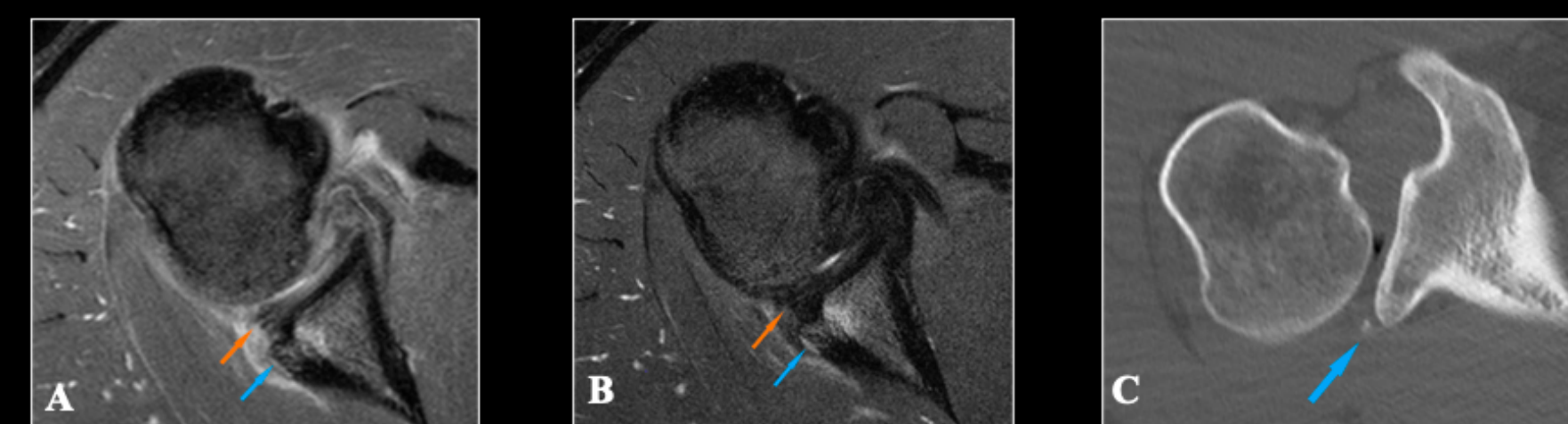


Figure 4. Indirect arthrogram T1 fat-saturated axial image (A) and T2 fat-saturated axial image (B) showing a posterior labral tear (orange arrows). Note the more defined irregular contrast enhancement and contour of the labrum on the T1-image compared to the T2-fat-saturated image. There is also irregular ossification of the posteroinferior aspect of the glenoid with adjacent marrow enhancement/edema (blue arrows). This finding, correlated with a CT exam (C), shows mineralization of the posterior band of the inferior glenohumeral ligament and is known as a "Bennett lesion" or "thrower's exostosis". This patient was a collegiate pitcher and presented with three months of non-localized shoulder pain when pitching. Incidental benign intra-articular gas noted on the CT image.

## Summary

- Our literature review showed indirect MR arthrography had the highest sensitivity and the lowest specificity in detecting glenoid labral tears when compared with non-contrast MRI and direct arthrography.
- Direct arthrography is currently the gold standard when suspicion for a glenoid labral tear is high.
- However, patient comfort, radiologist time/skill, and cost to the patient must be taken into account and indirect arthrography should be considered given the high sensitivity of detecting labral pathology.

## References

- Steinbach LS, William EP, and Mark ES. 2002. "Special Focus Session. MR Arthrography." Radiographics: A Review Publication of the Radiological Society of North America, Inc 22 (5): 1223-46.
- Peh WC, Cassar-Pullicino VN. Magnetic resonance arthrography: current status. Clin Radiol 1999; 54:575-587.
- Vahlensieck M, Peterfy C, Wischer T, Sommer T, Lang P, Schlipper U, Genant HK, and Schild HH. 1996. "Indirect MR Arthrography: Optimization and Clinical Applications." Radiology 200 (1): 249-54.
- Jung JY, Yoon YC, Yi SK, Yoo JC, and Choe BK. 2009. "Comparison Study of Indirect MR Arthrography and Direct MR Arthrography of the Shoulder." Skeletal Radiology 38 (7): 659-67.
- Dinauer PA, Flemming DJ, Murphy KP, and Doukas WC. 2007. "Diagnosis of Superior Labral Lesions: Comparison of Noncontrast MRI with Indirect MR Arthrography in Unexercised Shoulders." Skeletal Radiology 36 (3): 195-202.
- Fallahi F, Green N, Gadde S, Jeavons L, Armstrong P, and Jonker L. 2013. "Indirect Magnetic Resonance Arthrography of the Shoulder; a Reliable Diagnostic Tool for Investigation of Suspected Labral Pathology." Skeletal Radiology 42 (9): 1225-33.
- Symanski JS, Subhas N, Babb J, Nicholson J, and Gyftopoulos S. 2017. "Diagnosis of Superior Labrum Anterior-to-Posterior Tears by Using MR Imaging and MR Arthrography: A Systematic Review and Meta-Analysis." Radiology 285 (1): 101-13.
- Oh, DK et al. 2009. "Comparison of Indirect Isotropic MR Arthrography and Conventional MRI of Labral Lesions and Rotator Cuff Tears: A Prospective Study." American Journal of Radiology 192: 473-479.
- Magerkurth O, Jacobson JA, Girish G, Kalume Brigido M, Bedi A, and Fessell D. 2012. "Paralabral Cysts in the Hip Joint: Findings at MR Arthrography." Skeletal Radiology 41 (10): 1279-85.
- Petchprapa CN, Rybak LD, Dunham KS, Lattanzi R, and Recht MP. 2015. "Labral and Cartilage Abnormalities in Young Patients with Hip Pain: Accuracy of 3-Tesla Indirect MR Arthrography." Skeletal Radiology 44 (1): 97-105.