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Pictorial Essay: Pitfalls in Magnetic Resonance Imaging of the Shoulder

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Abstract

Numerous imaging pitfalls of normal variants due to imaging technique and artifacts can be seen on routine magnetic resonance imaging of the shoulder. Familiarity with these pitfalls is crucial to avoiding diagnostic errors. Understanding of the common causes of shoulder imaging artifacts will enable the radiologist to make rational changes in imaging technique to eliminate or reduce the effects of artifacts on magnetic resonance images. This pictorial essay highlights possible pitfalls that arise from imaging techniques, imaging artifacts, and normal variations, and how they may be recognized.

Résumé

De nombreux écarts par rapport aux variantes normales attribuables à la technique d'imagerie utilisée et aux artefacts sont observables dans les examens d'imagerie par résonance magnétique classique de l'épaule. Il est essentiel d'être au fait de ces écarts pour éviter les erreurs de diagnostic. En sachant reconnaître les causes courantes d'artefacts d'imagerie de l'épaule, le radiologiste peut apporter des changements rationnels à la technique d'imagerie afin d'éliminer ou de réduire les effets des artefacts sur les images obtenues par résonance magnétique. Cet article descriptif met en évidence les écarts attribuables aux techniques d'imagerie, aux artefacts et aux variations normales ainsi que les façons de les reconnaître.

Key Words: Diagnostic pitfalls; Imaging artifacts; Imaging pitfalls; Magnetic resonance artifacts; Magnetic resonance imaging; Normal variants; Shoulder joint

Magnetic resonance (MR) imaging is now increasingly being used in daily clinical practice for the assessment of various shoulder conditions, such as impingement and instability. Knowledge of common normal variants as well as imaging artifacts that mimic pathology is crucial for accurate analysis and interpretation of MR images. This pictorial essay aims to highlight possible diagnostic pitfalls that arise from imaging techniques, imaging artifacts, and normal variations, and how they may be recognized.

Pitfalls Due to Imaging Techniques

Vacuum Phenomenon

The externally rotated position of the arm during imaging is reported to cause this effect in up to 20% of cases, most frequently on gradient echo sequences [1]. Awareness of this artifact is important to avoid misdiagnosing intra-articular air as being from chondrocalcinosis or loose bodies. The vacuum phenomenon can be differentiated from pathology in several ways. First, correlation with radiographs is helpful for looking for intra-articular gas, articular cartilaginous calcification, and osteochondral loose bodies. Second, the vacuum phenomenon has a characteristic appearance and location. It appears as a round or linear signal void in the superior glenohumeral joint space, approximately at the level of the coracoid process, and is seen on 2 or 3 contiguous images. In contrast, chondrocalcinosis may have more extensive cartilage involvement, and intra-articular loose bodies will usually lie dependently in synovial recesses rather than at the superior aspect of articular surfaces. Third, the vacuum phenomenon is only present on gradient recalled echo images obtained with the arm in external rotation. True intra-articular abnormalities should not disappear merely because of positional variation.

MR Arthrography

MR arthrography entails the intra-articular injection of contrast material and is typically performed under

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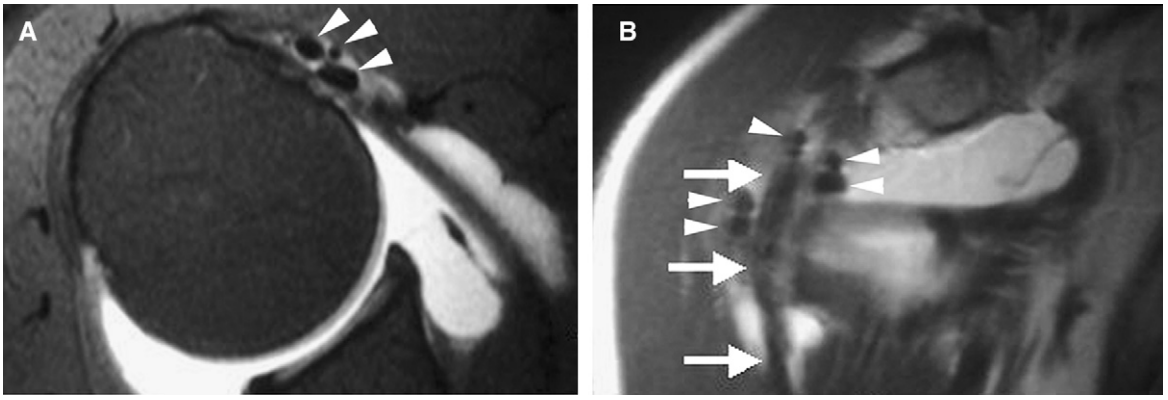

Figure 1. Air bubbles adjacent to a dislocated long head of biceps tendon. (A) Axial fat suppressed T1-weighted magnetic resonance (MR) arthrographic image, showing several rounded hypointense areas (arrowheads) adjacent to the anterior aspect of the subscapularis tendon. (B) Coronal T1-weighed MR arthrographic image, showing the dislocated long head of biceps tendon (arrows) with adjacent air bubbles (arrowheads).

fluoroscopic guidance, before the transfer of the patient to the MR imaging scanner. Small air bubbles can inadvertently be introduced during contrast administration and be lodged within the glenohumeral joint as well as the long head of biceps tendon sheath. These air bubbles, if present along the long head of biceps tendon, may be seen as hypointense areas that mimic tenosynovitis or a tear (Figure 1) [2]. These focal hypointensities also may result in a false-positive diagnosis of loose bodies, particularly in the glenohumeral joint. Careful observation that these hypointensities are spherical in shape and consistently elevate to nondependent regions of the joint will help to differentiate them from loose bodies, which will gravitate to the dependent position. The susceptibility effects of these air bubbles result in thin hyperintense rim and blooming, particularly on gradient recalled echo images (Figure 2).

Wrong concentration of solution

It has been shown, through in vitro studies, that the optimal concentration of gadopentate dimeglumine (Gd-DTPA) to study the shoulder joint is 1.5-2 mmol/L [3]. Image degradation occurs if the injected Gd-DTPA solution is too concentrated or diluted. Use of a too-concentrated Gd-DTPA solution leads to an almost complete signal loss from the intra-articular fluid due to a rapid T2* shortening effect (Figure 3). If this artifact is recognized, then re-imaging of the joint should be performed after several hours, during which transynovial diffusion may dilute the intra-articular contrast [4]. The technique of preparing the injection, therefore, is important, with precise measurement of the exact volume of Gd-DTPA and diluting in an adequately large volume of normal saline solution. We recommend adding 0.5 mL Gd-DPTA to 100 mL of normal saline solution.

Extra-articular contrast extravasation

Extra-articular contrast extravasation can occur when the injected contrast volume exceeds the shoulder joint capacity, which normally ranges from 12-15 mL, or if excessive force is applied. In patients with adhesive capsulitis, when the shoulder joint capsule ruptures, extravasation of contrast

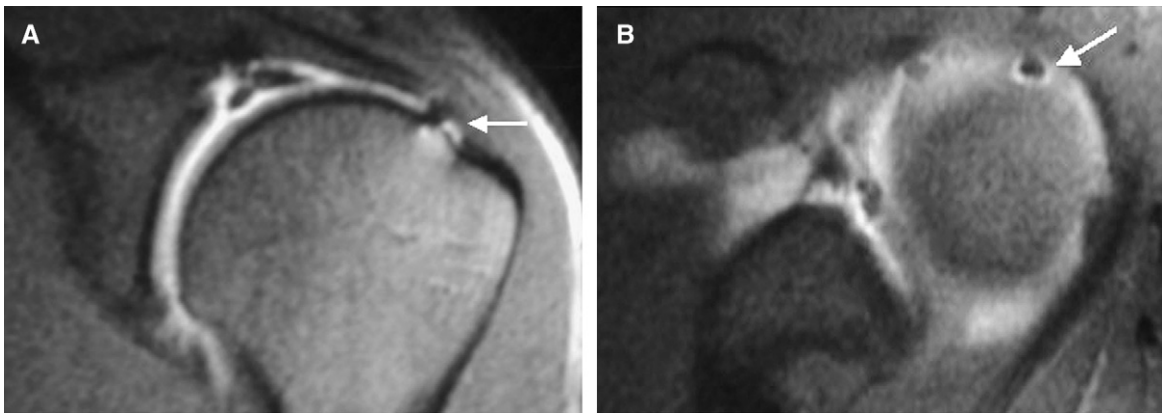

Figure 2. Susceptibility effects of air bubbles. (A) Coronal and (B) axial fat suppressed T1-weighted magnetic resonance arthrographic images, showing the injected air bubbles as focal rounded hypointense areas with adjacent thin hyperintense rims (arrows).