

Evaluation of the Rotator-Cuff Tendon tears by MRI Arthrography of Should Joint

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Abstract:

To show the benefits and limitations of using abduction and external rotation (ABER) positions of the arm during MR arthrography of the shoulder in the evaluation of the rotator-cuff tendon, the capsulolabral complex and the shoulder joint after surgery.

47 patients complaining of either shoulder instability, chronic shoulder pain, pain of unknown cause or pain following shoulder surgery were studied using the direct MR arthrography technique in both the standard neutral position with the arm adducted as well as with the arm in the ABER position. A correlation was obtained between the MR arthrography findings and the surgical findings in 10 reports and clinical presentations of the examined patients.

Three patients [6%] were unable to perform ABER positioning. ABER oblique axial images were better than standard oblique coronal images in revealing undersurface tears of the rotator cuff particularly of the grade I type. Four tears were missed in standard images. Oblique axial images were better than standard axial images in demonstrating non-displaced anterior labral tears. One tear was missed and two tears were suspected in the standard

images. Oblique axial images were less sensitive than oblique coronal images in the diagnosis of superior labral tears. Two tears were missed in ABER images.

The ABER oblique axial MR arthrogram is a useful adjunct to the standard axial and oblique coronal MR arthrograms for assessment of capsulolabral abnormalities and rotator-cuff tendon tears despite some limitations.

INTRODUCTION

Magnetic resonance (MR) arthrography has proven more sensitive than conventional MR imaging for the diagnosis of glenoid labral abnormalities and rotator-cuff tears, particularly undersurface ones (*Chandnani V, Palmer WE, Miyazawa H.*) Recently, the use of abduction and external rotation (ABER) positioning of the arm during MR arthrography of the shoulder has resulted in a greater sensitivity of detecting of partial-thickness tears of the rotator-cuff tendons as well as some types of anterior labral tears (*Triman PF, Cvitanic*). In this article we prospectively studied patients with different shoulder diseases to show the benefits and limitations of using oblique axial sequences obtained with the arm in the ABER position during MR arthrography.

MATERIALS AND METHODS

At Al-Hussien Hospital from 2001 to 2003, 47 patients (35 male and 9 female, 18-61 years old, mean 30 years old) complained of shoulder instability, chronic shoulder pain, pain of unknown cause or pain following shoulder surgery were studied using the direct MR arthrography technique in both the standard neutral position with the arm adducted as well as with the arm in the ABER position. Three patients were unable to perform ABER positioning because of marked pain significant limitation of arm movement. All MR studies were performed using a 1.5 Tesla closet magnet [Magnetom Expert, Siemens Medical System]. MR arthrography was performed using a direct injection technique as follows: the patient was placed supine, and a 22-gauge needle was advanced under fluoroscopic guidance into the glenohumeral joint using an anterior approach. Next, 0.1 milliliter of gadopentetate diglumine [470 mg/ml] was diluted in 20 ml of saline. The diluted contrast medium was slowly injected into the joint until pressure occurred or the patient experienced pain, with an average total volume of approximately 15-20 ml. MR arthrography of the shoulder was initiated within 30 minutes after the intra-articular contrast injection. The patient was first examined with the arm adducted and in the neutral position. Using a standard shoulder surface coil, the following sequences were performed: A spin echo T1-weighted sequence with chemically selective fat saturation in axial, oblique coronal, and sagittal planes, using the following parameters, TR/TE = 400 - 680 msec/12 - 14 msec, 4 mm section thickness, 265 X 205 - 256 matrix, 1 mm intersection gap, and 16 cm FOV, and a fast spin-echo T2-weighted oblique coronal

sequence, with TR/TE = 3000/96 msec, 4 mm section thickness, 1 mm intersection gap, 256 X 256 matrix, and 16 cm FOV.

To obtain the ABER position the patient was instructed to place the hand of the affected arm behind his or her head or neck with the elbow is flexed.

Flexible phased array shoulder coil was wrapped around the axilla. Using a T1-weighted coronal localizer sequence, T1-weighted fat saturated oblique axial images (with TR/TE=350 - 500 msec/ 12 - 14 msec, 4 mm section thickness, 1 mm intersection gap, 265 X 205 - 256 matrix, and 16 cm FOV) were obtained parallel to the shaft of the humerus. The fat saturation technique was lacking in three of the patients studied.

ABER oblique axial images (ABER MR arthrography) were interpreted first for detection of shoulder abnormalities, followed by axial, oblique coronal and oblique sagittal images (standard MR arthrography). A correlation was obtained between MR arthrography findings and the available 10 surgical reports and clinical presentations of the examined patients. Eight shoulders were evaluated and repaired arthroscopically, and two shoulders had open repairs after diagnostic arthroscopy.

RESULTS

Of the 44 patients examined using MR arthrography in both standard and ABER MR arthrograms, 3 studies were excluded due to improper image localization and significant motion artifact of the remaining 41 patients, 22 patients had clinical evidence of shoulder instability, 11 had chronic shoulder pain or pain related to trauma during sports, and 8 had pain after shoulder surgery; 6 had Bankart repairs for recurrent

anterior shoulder instability and two had rotator-cuff tendon repairs for full-thickness tears.

Rotator-cuff tears

Two full-thickness tears were identified on both ABER and standard MR arthrograms. In one tear with a 1 cm tendon defect, standard oblique coronal images were better than oblique axial images in assessment of the size of the tendon defect. In the other nonretracted full-thickness tear, oblique axial images were better at identifying both the bursal and articular components of the tear, which was demon-

strated surgically (Fig.1). Ten partial-thickness rotator-cuff undersurface tears, associated with anterior and superior labrum tears, were seen on ABER oblique axial images, four [40%] of which could not be identified on standard oblique coronal images. Three of these were surgically found to represent grade-I tears involving less than 1/4 of the tendon thickness (Fig. 2). The other six rotator-cuff tears were identified on both standard and ABER MR arthrograms, however, the extension of the cuff tear into the cuff substance (flap tear) in two patients was identified only on the ABER MR arthrogram.



Fig1. Detection of the flap component of a full thickness rotator-cuff tendon tear with the ABER position in a 42-year-old woman who had chronic shoulder pain. (a) Standard oblique coronal FSE T2-weighted MR arthrogram show in an area with high signal intensity involving the full thickness of the anterior rotator cuff at its critical zone (arrow). Leakage of the contrast material into the subacromial subdeltoid bursa (arrowheads) is seen, denoting a complete non-retracted rotator-cuff tear. (b) ABER oblique axial T1-weighted MR arthrogram showing the undersurface retracted flap tear of the cuff tendon with contrast material filling the tendon (curved arrow) and a tear on the bursal side (straight arrow).

Labral ligamentous abnormalities

Anterior labral tears were seen on oblique axial images in 21 patients, in which standard axial images confidently show the displaced anterior labrum tears [n = 18],

while in the other three non-displaced anterior glenoid labrum tears (14%) two tears were suspected and one tear was completely missed (Fig.3).

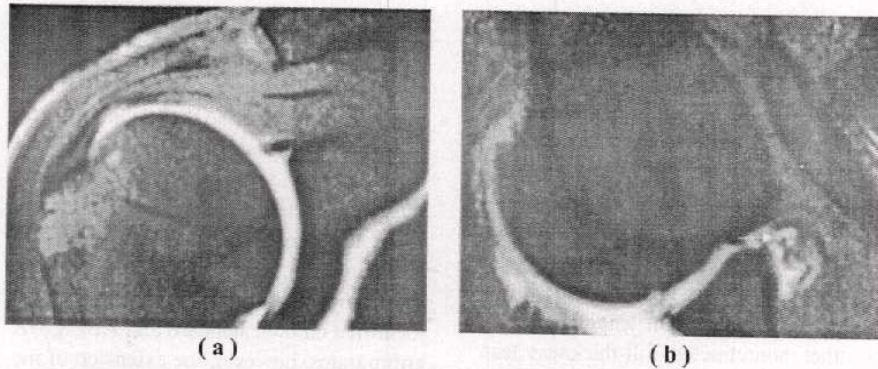


Fig 2. Detection of a superficial undersurface tear of the rotator cuff with the ABER position in a 19-year-old baseball player who had pain related to overhead motion of his arm. (a) Standard oblique coronal T1-weighted fat-saturated MR arthrogram showing no abnormality of the rotator-cuff tendon, (b) ABER T1-weighted MR fat-saturated MR arthrogram at the corresponding level of the rotator-cuff tendon in (a) revealing an undersurface tendon irregularity (arrow) enhanced with contrast material which was demonstrated by arthroscopy to represent a grade-I tendon-cuff tear.

Superior labrum tears were identified in 5 patients on standard oblique coronal images 12 was later demonstrated surgically, two of which were missed on ABER oblique axial images.

Of five anterior bony glenoid lesions associated with anterior shoulder dislocation (osseous Bankart), two lesions [40%] were missed on axial images and clearly visualized on oblique axial images. Three bony glenoid fractures were seen on both ABER and standard MR arthrograms, in which the ABER oblique axial MR arthrograms were better for visualizing the osseous fragment than the standard images.

Hill-Sachs lesions were seen in 16 patients on standard axial images, two [13%] of which were missed on oblique axial images.

The anterior capsule and the anterior band of the inferior glenohumeral ligament (AIGHL) were better identified in all patients on the oblique axial images than on the standard axial images. In one patient with clinical evidence of shoulder subluxation, the anterior capsulo-ligamentous complex was seen redundant only on oblique axial images with no labral abnormalities detected (Fig 4).

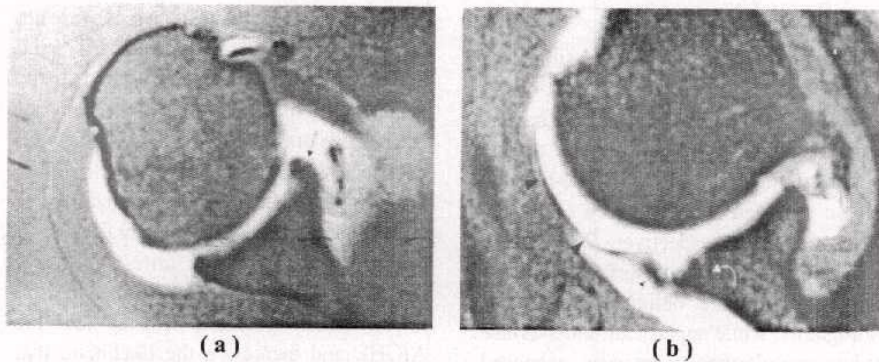


Fig 3. Detection of anterior labrum detachment with ABER position in a 28-year-old man who had an anterior traumatic shoulder dislocation. (a) Standard axial T1-weighted MR arthrogram: The anterior labrum (arrow) appears intact, (b) ABER oblique axial T1-weighted MR arthrogram clearly demonstrating the avulsed anterior labrum (arrow) displaced away from the underlying bony glenoid by the attached AIGHL (arrowheads). An anterior bony glenoid fissure fracture (curved arrow) is also seen on the oblique axial image.

Postoperative shoulders

The reconstructed capsule was better identified in oblique axial images in all cases. In one patient, loose anterior capsular re-attachment was better identified on

oblique axial images. In one repaired rotator cuff tendon, diffuse, high signal intensity was seen on standard oblique coronal images, while oblique axial images identified an undersurface flap tear of the cuff tendon.

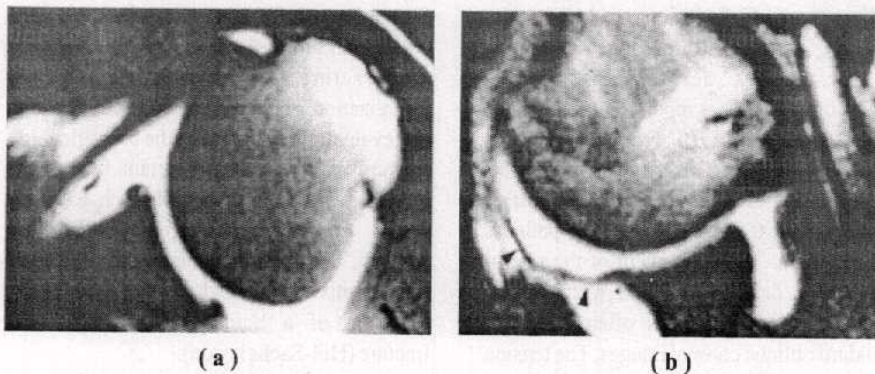


Fig 4. Detection of redundancy of the anterior capsule with the ABER position in a 24-year-old man who had atraumatic anterior shoulder subluxation. (a) Standard axial T1-weighted MR arthrogram showing no capsulolabral abnormality, (b) ABER oblique axial T1-weighted MR arthrogram revealing a redundant anterior capsulo-ligamentous complex (arrowheads), which could explain the patient's clinical condition. The anterior labrum (arrow) is intact.

DISCUSSION

Partial rotator cuff tears are classified into three grades according to the extent of the tear along the tendon substance. Grade-I tears involve less than 1/4 of the tendon thickness, while grade-II and grade-III tears involve less than and more than 1/2 of the tendon thickness, respectively. (Ellman H.) In this study, grade-I undersurface tears were missed on standard oblique coronal MR arthrograms, while superficial undersurface tendon irregularities, were seen enhanced with the contrast material on the oblique axial images. Moreover, the flap component of some undersurface tears was only identified on ABER MR arthrograms. Tirman and colleagues (Tirman PF) found that the adducted shoulder causes effacement of the fraying and tears of the undersurface of the tendon due to the underlying humeral head, while in the ABER position, the tendon is kinked, and allow depiction of the undersurface tear without effacement by the humeral head. Increased recognition of partial tears of the undersurface in sports medicine (Liu SH) makes the accurate delineation of these lesions on MR images relevant, because arthroscopic debridement alone or with acromioplasty, open arthrotomy, or both is reported by some to be beneficial (Fukuda H). The detection of an intrasubstance extension of a partial-thickness tear of the rotator cuff (flap tear) is also of surgical importance for the patient's management. The assessment of the size of the tendon defect associated with the full thickness tendon tears is often better on standard oblique coronal images. The tension on the torn portion of the rotator cuff exerted in the adduction position results in a shift of position relative to the adjacent untorn portion (Tirman PH.) ABER MR arthrography was also helpful for clearly

identifying some labral tears which were not completely identified on standard axial images. ABER positioning resulted in the displacement of the apparently intact anterior labrum. Cvitanic and colleagues (Cvitanic O) described the mechanism by which ABER positioning enhances the visualization of some non-detached anterior labral tears. A tensile force on the anterior labral ligamentous complex is exerted with the arm in the ABER position; drawing taut the AIGHL and increasing the likelihood that small tears or detachment of the AGL labrum will be seen. IGHL is best seen on oblique axial images (Kwak Sm.) Oblique axial images identified redundant anterior capsulo-ligamentous structures, which could explain the patient's complaint of mild anterior subluxation of his or her shoulder.

ABER MR arthrography could be helpful in the evaluation of atraumatic shoulder instability. ABER MR arthrography also significantly enhanced the visualization of anterior bony glenoid fractures associated with anterior shoulder dislocation. A significant distraction of the bony fragment from the remaining bony glenoid was carried out, which allowed contrast material to fill the fracture gap and enhanced the visualization of the fracture. The detection and evaluation of the size of the bony glenoid fracture or defect are important factors in management of patients with such lesions, which are not uncommon (Ltoi E.). In contrast, oblique axial images were found less sensitive than standard axial imaged in detection of a humeral head impaction fracture (Hill-Sachs lesion).

MR arthrography is a useful technique in the diagnosis of superior labrum anterior-to-posterior (SLAP) lesions of the shoulder (Bencardino JT). Oblique axial MR

arthrograms were less sensitive than standard coronal MR arthrograms for detection of SLAP lesions. In their MR arthrography study, Kwak et al (*Kwak SM*) compared neutral, external rotation and ABER positions of the glenohumeral joint in the assessment of the joint capsule, the biceps labral complex and the gleno-humeral ligaments, and found that the oblique coronal sequence with the arm in external rotation is the position of choice to delineate the biceps labral complex. However, ABER MR arthrography was helpful in detecting superficial undersurface tears of the rotator cuff associated with superior labral lesions.

Patients with shoulder surgery have a high incidence of postoperative complaints. Reportedly 26% of postoperative patients have complaint-requiring re-evaluation of the shoulder (*Wolfgang GI*) MR diagnosis of a partial thickness tear in a shoulder previously operated upon is difficult. Despite careful scrutiny, it may be difficult to differentiate a healing tendon response from a partial tear (*Magee TH*) In this study, ABER positioning was found beneficial for characterizing abnormal signal intensity involving the rotator cuff after surgery. Oblique axial images were also found to be useful in assessing of the site of capsular re-attachment and suture tightness. In conclusion, despite its limitations in the diagnosis of superior labral lesions and Hill-Sachs lesions, and the increased total time of the MR arthrography study, the ABER oblique axial sequence is a useful adjunct to the standard axial and oblique coronal sequences with the MR arthrography technique for the evaluation of rotator-cuff tendon, the capsulolabral complex and the shoulder joint after surgery.

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تقييم تمزقات أوتار مفصل الكتف بالرنين المغناطيسي مع حقن الصبغة بالمفصل

الهدف من هذه الدراسة وهذا البحث :

هو تشخيص تمزقات أوتار الكتف بالرنين المغناطيسي بعد حقن الصبغة بمفصل الكتف في حالات الأم الكتف البذمية والالام غير معلومة السبب بعد جراحات الكتف وبيان أفضل الأوضاع لإظهار اوتار الكتف.

احتوى هذا البحث على دراسة سبعة وأربعون (٤٧) مريضا (٣٥ ذكر، ٩ اناث) تتراوح أعمارهم بين (١٨ : ٦١) عاما بقسم الأشعة التشخيصية بمستشفى الحسين الجامعي بعمل فحص بالرنين المغناطيسي بعد الحقن بالصبغة في مفصل الكتف وتم التصوير في الوضع الروثيني المعتاد (الذراع ملاصق للكتف) تم في وضع (ABER) وعمل مقارنة بين نتائج الفحص وبيان التشخيص في الوضعين وتمت مطابقة النتائج مع المشاهدات والفحوص أثناء الجراحة لعشرة حالات من هذه الحالات .

وقد تبين من نتائج هذا البحث ان فحص مفصل الكتف بالصبغة بالرنين المغناطيسي في وضع (ABER) مبعاد الذراع عن الجسم ودوارنه للخارج أفضل في تشخيص تمزقات اوتار الكتف عن الوضع البادى المعتاد في التصوير والذراع ملاصقة للجسم خاصة في تشخيص التمزقات الجزئية وتمزقات الوتر الأمامى البسيطة.

ومن ذلك نستدل من هذا البحث أن التصوير والفحص في الوضع (ABER) المائل العمودى ايجابى في تشخيص هذه التمزقات و ذو حساسية فى بيان اصابات الكتف رغم عدم تمكننا فى تثبيت الذراع فى هذا الوضع فى ثلاثة مرضى نظرا للالام الشديدة لمحاولة تثبيت الذراع فى الوضع المراد التصوير فيه.

