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Magnetic resonance arthrography of the glenohumeral joint

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Background. *The purpose of this study was to estimate the value of native magnetic resonance imaging (MRI) and direct gadopentate (Gd-DTPA) magnetic resonance artrography (MRA) in diagnosing posttraumatic pathological changes of the glenohumeral joint.*

Patients and methods. *In 27 consecutive patients with clinically significant trauma in whom native MRI of the glenohumeral joint was not diagnostically conclusive direct MRA with paramagnetic contrast agent was accomplished. Following intraarticular injection of Gd-DTPA diluted in saline (concentration 0.2 mmol/l) T1W spin echo (SE) and gradient echo (GE) images were performed. Diagnostic results of native MRI and MRA were compared.*

Results. *MRA revealed 5 rotator cuff lesions, 7 labral lesions, 4 osteochondral injuries and a loose body which were not definitely proved by native MRI. All the pathological findings of MRA were confirmed operatively or arthroscopically.*

Conclusion. *Direct MRA with Gd-DTPA showed to be a more sensitive technique for the demonstration of clinically significant intraarticular posttraumatic changes than noncontrast MRI.*

Key words: magnetic resonance imaging; shoulder joint - injuries; rotator cuff

Introduction

Owing to multiplanar imaging capabilities, to superb contrast and to high spatial resolution MRI is able to demonstrate noninvasively joint anatomy. Consequently, this modality has become the method of choice for joint imaging. However, MRI diagnosis of different intraarticular pathologic conditions in anatomically complex joints, such as the glenohumeral joint, may be difficult. Therefore several techniques of MRA were evaluated. These include intraarticular use of saline or Gd-DTPA (direct arthrography) and the intravenous application of Gd-DTPA (indirect arthrography). An important advantage of direct arthrography is the joint capsule distension which enables the better visualisation of intraarticular anatomic structures especially in tight joints. According to some authors MRA of the shoulder joint may provide some information of diagnostic importance about the labrum, the joint capsule and the rotator cuff which are not possible without the use of Gd-DTPA.[1-5] Vast majority of centres still use noncontrast MRI as a routine diagnostic method.

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The purpose of this study was to estimate the value of native MRI and direct Gd-DTPA MRA in diagnosing posttraumatic pathological changes of the glenohumeral joint and eventually to include MRA in a routine diagnostic work up.

Patients and methods

On the basis of history and physical examination the clinical diagnosis of rotator cuff tears (n=18) and the lesions of the labum and the capsule (n=9) was made following significant trauma. In all of these patients native MRI was performed 0.5 -2 months following trauma. Magnetic resonance images were obtained using dedicated shoulder coil on 1.5 T scanner (Magnetom SP 63, Siemens, Erlangen, Germany). A SE sequence with T1-weighted (TR 450 ms, TE 15 ms), PD-weighted (TR 1900 ms, TE 20 ms) and T2-weighted (TR 1900 ms, TE 80 ms) images was performed using angled coronal plane, followed by a GE T1-weighted FISP 2D images (TR 40 ms, TE 10 ms, flip angle 40•) in an axial plane. In all the patients the MRI diagnosis was inconclusive (3 possible rotator cuff lesions, 2 suspect labral lesions and 2 possible osteochondral injuries). Due to persisting clinical symptoms MRA was indicated and accomplished 0,5 - 1 months after the first examination. The joint was punctured under fluoroscopic control using local anaesthesia. The proper position of the needle was controlled with 1-2 ml of non-ionic iodinated contrast material (Ultravist, Schering, Germany) and 10-15 ml of 2 mmol/1 Gd-DTPA solution in saline (Magnevist, Schering, Germany) was then injected until the capsule became distended. After the injection passive and active movements of the shoulder joint were carried out for several minutes to achieve the uniform distribution of Gd-DTPA solution. Coronal oblique and axial 5 mm thick consecutive slices were obtained using a SE T1-wieghted images (TR 450 ms, TE 15 ms), a GE FISP 2D images (TR 40 ms, TE 10 ms, flip angle 40°). A field of view was 16 cm with data acquisition matrix of 256 x 256. (MRA has been approved by the Republic's Ethics Committee).

The images were analysed in a qualitative fashion and the diagnostic results of native MRI and MRA were compared.

Results

Out of 27 cases MRI revealed equivocal pathological findings in 7 patients (26%). A diagnosis of possible full thickness rotator cuff lesion was made in 3 cases, of suspect labral injury in 2 cases and of osteochondral lesions in 2 cases. In the remainder of 21 (78 %) patients no pathological findings could be demonstrated (Table1).

MRA confirmed rotator cuff lesions in all 3 cases with equivocal findings on MRI and proved 2 additional tears. In 3 of these patients the diagnosis of complete (Figure 1) and in 2 cases of partial rotator cuff rupture was made (Figure 2). Typical Bankart lesions were demonstrated in 7 patients using MRA, 2 of these were the cases with suspect labral lesions on native MRI (Figure 3). In patients with labral injuries 3 osteochondral (Sach - Hill) lesions of the posterolateral aspect of the humeral heads were revealed. MRA showed a loose body within the joint (Figure 4) which was not seen on native MRI (Table1). In all the patients pathological MRA findings were confirmed by the operative procedure or the shoulder artroscopy.

Discussion

MRI replaced the conventional arthrography in most institutions and has become a method of choice for depicting the posttraumatic joint pathological changes. Using different imaging

Table 1. MRI and MRA findings

Diagnostic modality	MRI				MRA			
Diagnosis	possible		definite		possible		definite	
	N	%	n	%	n	%	n	%
normal findings			**20**	**74**			**8**	**30**
pathological findings	**7**	**26**					**19**	**70**
rotator cuff lesions	3	11					5	19
labral lesions	2	7,5					7	26
osteochondral lesions	2	7,5					3	11
loose bodies			0				1	3
frozen shoulder			0				3	11

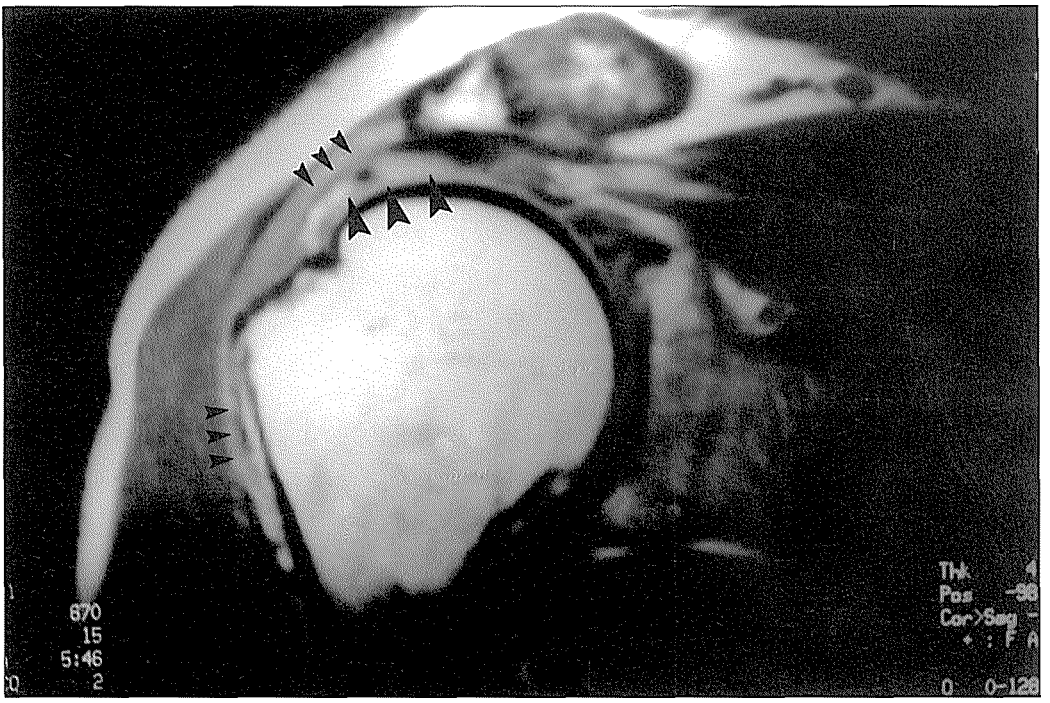

Figure 1. MRA, T1W spin echo image in an oblique coronal plane. Complete rotator cuff rupture is demonstrated with accumulation of paramagnetic contrast agent at the insertion of the m. supraspinatus terdon (big arrow heads). Leakage of contrast material into the subacromial-subdeltoid bursa is also revealed (small arrow heads).

protocols intra and paraarticular soft tissue structures can be demonstrated noninvasively with high contrast and spatial resolution in various planes. It has been proved that MRI shows high sensitivity and specificity for diagnosing the most of the clinically relevant pathological changes of the knee joint. Unfortunately the diagnostic results in some other anatomically tight joints, including glenohumeral, were not so good. In an attempt to increase the diagnostic accuracy of MRI several MRA methods were evaluated changing noninvasive native MRI in an invasive diagnostic procedure. The best results were achieved by the intraarticular application of gadopentate diluted in saline.[1-5]

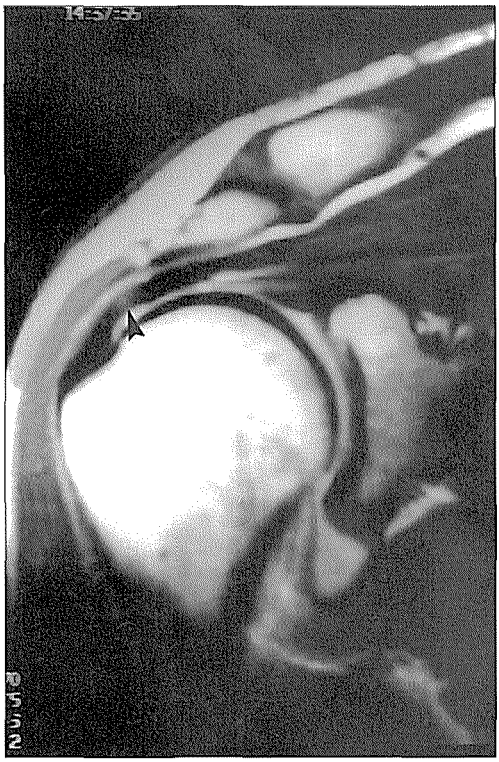

Figure 2. MRA, T1W spin echo image in an oblique coronal plane. Partial rotator cuff rupture. Small defect of the m. supraspinatus tendon is filled with paramagnetic contrast material (arrow head).

In our study native MRI revealed equivocal pathological changes only in 7 joints (26 %) out of 27 patients with significant clinical symptoms. In none of these MRI diagnosis was definite. There was a number of cases (n=20; 74 %) with normal findings in which the clinical symptoms could not be explained by MRI. On the other hand MRA proved to be much more accurate and revealed definite, clinically relevant pathological changes in 19 (70 %) of the shoulder joints resulting in an operative procedure which confirmed the MRA diagnosis.

Although the diagnostic results of MRA were much better than that of MRI in 8 (30 %) out of 27 cases with normal MRA findings clinical symptoms could not be substantiated by imaging features. It may be postulated that at least some of minor posttraumatic changes were spontaneously resolved in a period of several months following the initial trauma before MRA was accomplished, while some of them affected extraarticular anatomic structures not shown by MRA.

In all 3 cases with MRI diagnosis of possible full thickness rotator cuff tear MRA clearly demonstrated typical pathological findings, and proved 2 additional partial lesions not shown by MRI. MRI diagnosis was mainly based on T2-weighted SE images which revealed high signal intensity synovial fluid within the tendon of the supraspinatus muscle and an effusion within the subacromial - subdeltoid bursae. Using MRA in cases with complete tear the defect as well as the quality of neighbouring ends of the tendon were

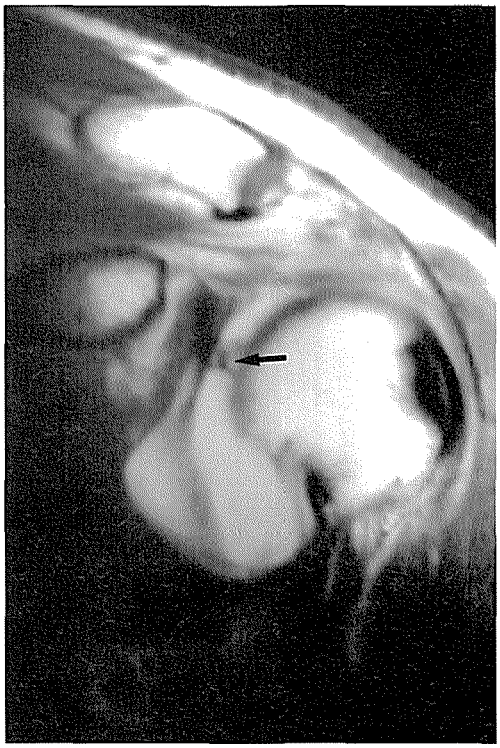

Figure 4. MRA, T1W spin echo image in an oblique coronal plane. Low signal intensity loose body is shown (arrow) surrounded by high signal intensity contrast material.

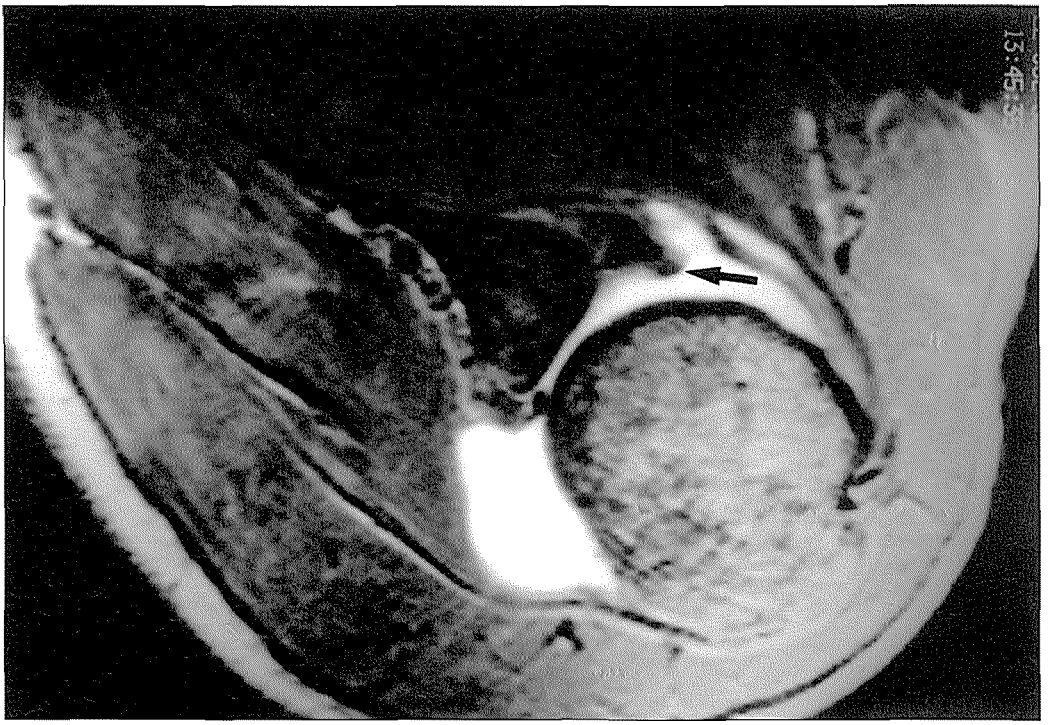

Figure 3. MRA, T1W gradient echo image in an axial plane. Bankart lesion is clearly demonstrated surrounded by high signal intensity solution of Gd-DTPA due to excellent capsular distension.

clearly outlined by the high signal intensity contrast agents on T1-weighted SE images (Figure 1). Leaking of the contrast agent into the subacromial and subdeltoid bursae was also demonstrated. In two joints with partial tear a small defect of the tendon was filled with high signal intensity gadopentate (Figure 2). There are several reasons for the superior diagnostic results of MRA. Firstly, the joint capsule distension resulted in better filling of the thorn tendon and in leaking of contrast agent out of the joint cavity.[3,4,6] Secondly, higher contrast resolution was achieved with the solution of gadopentate in comparison to synovial fluid in native MRI.[1,2,7] Thirdly, the spatial resolution on T1-weighted SE images in MRA was higher than on T2-weighted images which were diagnostic in MRI.[8,9]

Even greater differences between both examinations were documented in labral lesions. Only 2 possible labral lesions were shown by MRI, mainly using GE T1-weighted FISP 2D images. MRA proved each of these lesions and confirmed additional 5 Bankart lesions. Capsular distension with contrast accumulation within the capsulolabral lesions was the main reason for the better demonstration with MRA (Figure 3). MRI revealed 2 Sach-Hill lesions as high signal intensity areas on T2-weighted SE images and low signal intensity on T1-weighted SE images. The diagnosis of 3 osteochondral lesions with MRA was mainly based on the contrast accumulation within the defect of the humeral head.

Low signal intensity loose body representing cortical bone fragment was clearly demonstrated within a distended joint due to the surrounding high signal intensity gadopentate only using MRA (Figure 4).

In 3 cases the diminished capacity of the joint cavity with reduced bursae and the same

leakage of the contrast agent out of the glenohumeral joint indicated the frozen shoulder. Native MRI was not able to demonstrate these typical findings

There were no cases with pathological MRI findings which were not confirmed by MRA.

No adverse reactions to contrast agents or a complication due to intraarticular injection could be registrated.

In conclusion, in this study MRA proved to be more accurate than native MRI in diagnosing clinically relevant posttraumatic intraarticular changes of the glenohumeral joint. The results indicate that MRA may be used as a safe and reliable routine diagnostic procedure.

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