MR Arthrography of the Glenohumeral Joint: Modified Posterior Approach without Imaging Guidance[1]

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Institutional review board approval and informed consent were obtained. The purpose of the study was to prospectively perform magnetic resonance (MR) arthrography of the glenohumeral joint by using modified posterior approach without ultrasonographic or fluoroscopic guidance. A solution containing 0.1 mL of gadolinium chelate, 15 mL of saline, and 5 mL of 2% lidocaine was subsequently injected into the glenohumeral joint in 147 patients (81 men, 66 women; age range, 20–79 years). A 21-gauge needle was advanced along a trajectory connecting a skin mark 3–4 cm below and 2 cm medially to the posterolateral margin of the acromion and the coracoid process, as assessed with palpation, proceeding in posteroanterior direction. The joint was successfully entered at first attempt in 125 (85%) patients, at second attempt in 19 (13%), and at third attempt in three (2%). Contrast material–enhanced images were evaluated for presence, site, and maximal extent of contrast material extravasation; route of diffusion of the extravasation; compromised or noncompromised diagnostic quality; and presence of gas bubbles. Extravasation occurred in seven patients: at the interval between the teres minor muscle and infraspinatus muscle in five and within the infraspinatus muscle belly in two; extravasation had diffused along the teres minor muscle and infraspinatus muscle in five (71%) and along the teres minor muscle in two (29%). The mean extension of extravasation was 15 mm. Image quality was not compromised, and no gas bubbles were detected. The procedure was successful in all patients, with no complications.

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Magnetic resonance (MR) arthrography of the glenohumeral joint with direct intraarticular instillation of diluted gadolinium chelates is the preferred imaging modality for the evaluation of the glenoid labrum, glenohumeral ligaments, the undersurface of the rotator cuff tendons, and the postoperative shoulder (1,2). Because of the combined effects of increased soft-tissue contrast and distension of the capsule, MR arthrography shows greater diagnostic accuracy in the assessment of the glenohumeral joint, compared with non–contrast material–enhanced MR imaging (1,3–5).

The technique for joint puncture used with MR arthrography of the glenohumeral joint has its derivation in standard arthrography, as described in 1933 (6) and later simplified in 1975 (7). Different approaches of joint puncture have been described, the most frequent being the anterior, anteroinferior, and anterosuperior injection techniques (8).

There are only limited reports of the posterior approach to the glenohumeral joint, and all of these methods are fluoroscopically guided (1–3,8). When introduced through the posterior approach, a needle encounters fewer stabilizing structures of the joint, compared with an anterior approach (1). Moreover, with glenohumeral joint anterior instability, the posterior approach does not interfere with the anatomic structures being imaged (1). Also, if contrast material extravasation occurs, because of its posterior location there is little interference with the anatomic structures being studied (1).

The purpose of our study was to prospectively perform MR arthrography of the glenohumeral joint by using a modified posterior approach without ultrasonographic or fluoroscopic guidance.

Advance in Knowledge

- We describe a modified approach to inject contrast material for MR shoulder arthrography without fluoroscopic or ultrasonographic guidance.

Materials and Methods

Patients

From July 2004 through April 2005, MR arthrography of the glenohumeral joint was performed in 147 patients (81 men, 66 women; age range, 20–79 years; mean, 38 years) by two experienced musculoskeletal radiologists (O.A.C., R.M.), with more than 5 years of experience in musculoskeletal radiologic procedures. All patients underwent MR imaging before and after intraarticular injection of contrast material by using a 1.5-T MR imager (Signa; GE Medical Systems, Milwaukee, Wis) and a commercially available surface coil. The study was approved by the institutional review board, and informed consent was obtained from all patients. No author had any direct or indirect support from any company. Authors had complete control of all the data and the information submitted for publication.

MR Technique

The patients were initially placed supine with the arm at the side for standard MR imaging. The following pulse sequences were used: T2-weighted fast spin echo in transverse, coronal oblique, and sagittal oblique planes with frequency-selective fat saturation (repetition time msec/echo time msec, 3800/68; echo train length, 15; section thickness, 4 mm; spacing, 0.4 mm; field of view, 16 cm; matrix 320 × 192; number of signals acquired, four) and T1-weighted fast spin echo in the coronal oblique plane (650/15; echo train length, eight; section thickness, 3 mm; spacing, 0.3 mm; field of view, 16 cm; matrix 256 × 224; number of signals acquired, three).

Injection Technique

The patient was seated in a chair, with the anterior chest wall facing the back of the chair. The arm of the shoulder undergoing the MR examination was placed in slight internal rotation to enlarge the posterior joint surface, with the elbow flexed 90° and held by the contralateral arm. The position of the posterolateral margin of the acromion and of the coracoid process was localized with palpation. The coracoid process is the bony protuberance that can be palpated beneath the skin sulcus separating the pectoralis major muscle and the deltoid muscle, lateral and below the middle third of the clavicle. A skin mark was made 3–4 cm below and 2 cm medially to the posterolateral margin of the acromion (Fig 1). This point corresponds to the transition between the teres minor muscle and the infraspinatus muscle (9). Sterile technique was used. The skin and soft tissues were anesthetized with 5 mL of 2% lidocaine (Xylocaine 2%; Astra Zeneca, Bosiglio, Italy) by using at first a 25-gauge needle and subsequently a 21-gauge needle (Fig 2).

A gadolinium-based solution was prepared by using 0.1 mL of gadoteridol (Prohance; Bracco, Milan, Italy), 15 mL of saline, and 5 mL of 2% lidocaine. A 21-gauge, 7-cm-long spinal needle was used to gain access to the joint. The 21-gauge spinal needle contains a stylet in order to reduce soft-tissue damage and to avoid plugging the needle with tissue. The needle was gently advanced horizontally, to avoid any caudal or cranial drift, along a posteroanterior trajectory connecting the aforementioned skin mark to the coracoid process until it contacted the humeral head cartilage and the underlying bone cortex and impacted the humeral head cartilage (Fig 3). The stylet was removed and the spinal needle was connected to a syringe containing 5 mL of 2% lidocaine. Gentle aspiration was performed to avoid bub-

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bles being retained in the needle. A test injection was administered by using 1–2 mL of an anesthetic agent (lidocaine [Xylocaine 2%]; Astra Zeneca, Bosiglio, Italy) (10). If the needle is in the joint space, low resistance will be encountered. If it is embedded in the articular cartilage, high resistance to injection will occur. In the latter case, the needle was retracted just a few millimeters while injection pressure was maintained. As soon as the tip of the needle reached the joint space, resistance immediately diminished. Ten to 15 mL of gadolinium-based solution were then injected in the joint space. At the end of the procedure, the patient was asked to move his or her shoulder for 1–2 minutes and was subsequently positioned in the MR imager. The mean time required to perform the procedure was 3 minutes (range, 2–4 minutes).

After intraarticular injection of the contrast material, MR arthrography was performed with the following pulse sequence: T1-weighted fast spin echo in coronal, transverse, and sagittal oblique planes with a frequency-selective fat saturation (650/15; echo train length, eight; section thickness, 3 mm; spacing, 0.3 mm; field of view, 16 cm; matrix 256 × 224; number of signals acquired, three) (Fig 4).

Complications such as pain, burning sensation, altered or reduced sensitivity, compromise of movements, early fatigue, fever, swelling, or bleeding at the puncture site were recorded by the radiologist (O.A.C.) who performed the procedure. Minor degrees of pain—mild enough not to require any analgesic medication and easily tolerated by the patients—were not considered complications and were not recorded. Any degree of pain that required analgesic medication or that was not easily tolerated was considered a complication and was recorded. Patients were contacted by the radiologist by telephone daily for 5 days. Moreover, they were asked to immediately contact the radiologist or the referring orthopedist by phone in case of any complication. The patients were evaluated by the referring orthopedist within 3 weeks after MR arthrography.

Assessment of the Procedure

The number of attempts required to enter the joint space and to inject the contrast material was recorded by the radiologist performing the procedure. The joint space was considered to have been entered when the needle contacted the humeral head cartilage and the pressure test was successful.

Contrast-enhanced images were evaluated for presence or absence of contrast material extravasation, site of contrast material extravasation (defined as the site of maximal deposition of the contrast material), route of diffusion of the extravasated contrast material (along the infraspinatus or the teres minor muscle), maximal extent of contrast material extravasation (in any plane, expressed in centimeters), compromised (coating and/or poor visualization of structures and/or needle artifacts) or noncompromised diagnostic quality, and presence or absence of gas bubbles

Figure 1

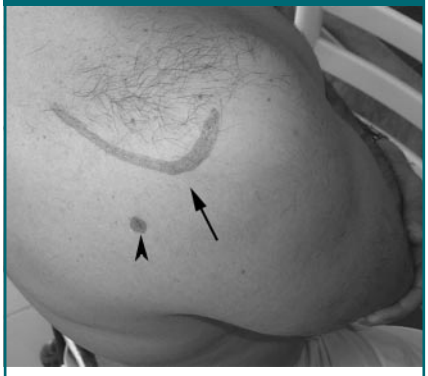

Figure 1: A skin mark (arrowhead) is made 3–4 cm below and 2 cm medially to the posterolateral margin of the acromion. The posterior margin of the acromion and its posterolateral margin (arrow) have been marked.

Figure 2

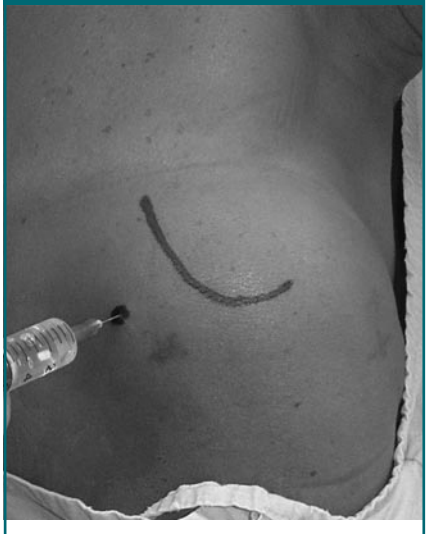

Figure 2: Lidocaine is injected into soft tissues beneath the skin mark. (Different patient than in Fig 1.)

Figure 3

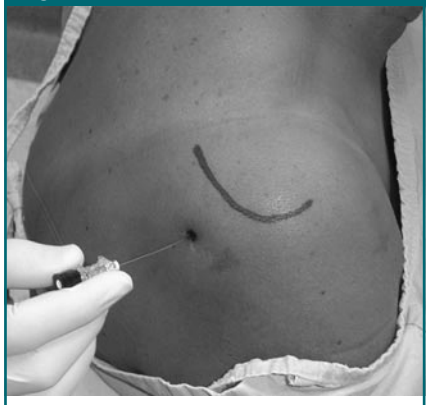

Figure 3: Spinal needle enters the joint space by following a posteromedial direction connecting the skin mark and the coracoid process, which was located with palpation. (Same patient as in Fig 2.)

Figure 4

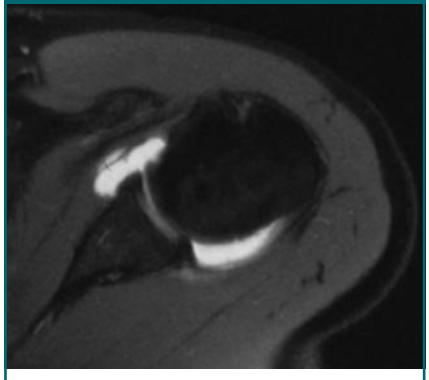

Figure 4: Transverse fat-suppressed T1-weighted fast spin-echo MR image (650/15) shows no contrast material extravasation. The joint is distended by diluted contrast material.

(ovoid-shaped signal intensity losses in a nondependent position within the joint) (3). Hematoma, sensory loss over the lateral aspect of the shoulder, reduction of the range of motion after the procedure, and early fatigue in the examined side were specifically sought as complications.

Figure 5

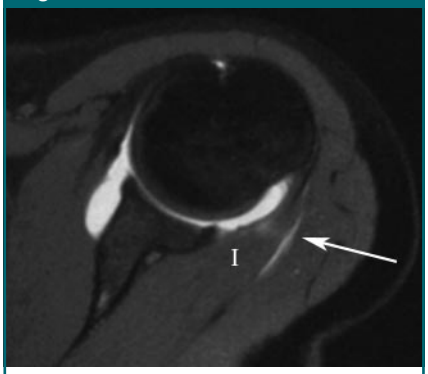

Figure 5: Transverse fat-suppressed T1-weighted fast spin-echo image (650/15) shows contrast material extravasation (arrow) from glenohumeral joint through and around infraspinatus muscle *(I)*. This is not a pathologic finding but a manifestation of the injection technique.

Figure 6

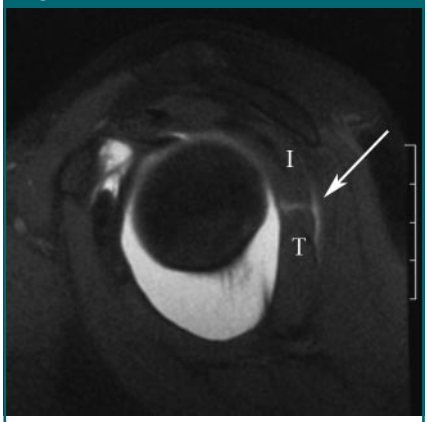

Figure 6: Sagittal oblique fat-suppressed T1-weighted fast spin-echo MR image (650/15) shows contrast material extravasation (arrow) from glenohumeral joint through infraspinatus muscle *(I)* and around infraspinatus and teres minor *(T)* muscles. This is not a pathologic finding but a manifestation of the injection technique. (Same patient as in Fig 5.)

Results

Gadolinium-enhanced MR arthrography of the glenohumeral joint was successfully performed in all 147 patients enrolled in the study. The joint was successfully entered on the first attempt in 125 (85%) of 147 patients, on the second attempt in 19 (13%) patients, and on third attempt in three (2%) patients. Contrast material extravasation occurred in seven (4.8%) of 147 patients. The site of contrast material extravasation was the interval between the teres minor and the infraspinatus muscle in five of seven patients and within the infraspinatus muscle belly in two of seven patients (Figs 5, 6). The routes of diffusion of the extravasated contrast material were along the teres minor muscle in two (29%) of seven patients and along the teres minor and infraspinatus muscles in five (71%) of seven patients. The mean maximal extension of contrast material extravasation was 15 mm (range, 5–25 mm). Extravasation did not result in compromised diagnostic image quality in any patient. Gas bubbles were not detected in any patients.

No complications were encountered. In particular, pain, burning sensations, altered or reduced sensitivity, compromise of movements, early fatigue, fever, swelling, or bleeding at the puncture site was not evident in any patient.

Discussion

Gadolinium-enhanced MR arthrography of the glenohumeral joint is an excellent method to image the shoulder. Because of the capsular distention and separation of individual intrarticular structures, as well as excellent contrast resolution, MR arthrography performs much better than conventional MR imaging of the same joint in the evaluation of rotator cuff abnormalities, glenohumeral instability, superior labrum anteroposterior (SLAP) lesions, rotator interval lesions, and abnormalities in the postoperative shoulder (1–3,11–13).

The anteroinferior portion of the glenohumeral joint contains important articular structures, including the anterior band of the inferior glenohumeral ligament and the anteroinferior portion of the labrum (1,13). If MR arthrography is performed with an anterior approach, these structures may be traversed by the needle, which might reduce the specificity of the detected abnormalities and potentially damage the glenohumeral joint (1,2). Moreover, even the experienced radiologist can encounter anterior extravasation of contrast material, which will complicate image analysis (1,10).

Because the posterior aspect of the joint contains fewer stabilizing structures and because of its more consistent anatomy, a posterior approach has been advocated by many (1,2,14). This approach does not increase the risk of the procedure (2). No injury has been reported as a complication of this approach, although some complications have been reported after arthroscopic procedures in which a posterior technique was used (2). These complications, including injury to the suprascapular and axillary nerves, may relate in part to the larger size of the arthroscopic instruments (2). Our palpation-guided posterior injection technique was not associated with any complication. The contact of the needle with the humeral head and the positive results of the test injection with lidocaine provide evidence of the correct position of the needle (8). This injection technique is easy and fast and does not require fluoroscopic monitoring.

In summary, we have described a modified technique to inject contrast material for MR arthrography of the glenohumeral joint that does not require fluoroscopic guidance, does not traverse the important anterior structures that require assessment, and was not associated with complications in our study.

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