Original Report

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MR Arthrography of the Glenohumeral Joint: A Tailored Approach

OBJECTIVE. The purpose of this study was to anatomically confirm that anterior shoulder injection could result in penetration of the anterior stabilizing structures of the glenohumeral joint and to advocate the use of a tailored approach to MR arthrography based on presenting symptoms.

CONCLUSION. A tailored approach to MR arthrography may be a useful way to isolate expected pathology in the shoulder and limit confounding findings related to the performance of the procedure.

Although the role of MR arthrography of the glenohumeral joint has been debated in the literature, it is increasingly apparent that this is the study of choice for evaluation of the capsulolabral complex, undersurface of the rotator cuff, glenohumeral ligaments, rotator cuff interval, and possibly the postoperative shoulder [1–5]. The advantages of capsular distention are twofold. First, it allows distinction of individual structures by improved soft-tissue contrast and physical separation by the intraarticular contrast material. Second, it allows analysis of the distribution of contrast material in and around the joint. Both of these parameters are particularly important in the evaluation of anterior instability, a common indication for MR arthrography.

Despite the controversy over the designation of the primary stabilizers of the shoulder and their exact degree of contribution to joint stability, there is general agreement that many of these structures, including the capsulolabral complex, are concentrated around the anteroinferior aspect of the articulation. This is the exact region the needle traverses when performing a standard anterior approach for arthrography. Using this approach appears counterintuitive: It would seem desirable to avoid the potential area of abnormality during a diagnostic study in an effort to leave any pathologic lesion undisturbed.

It is this basic concept that led to our development of the tailored approach to MR arthorography. The purpose of this study was to anatomically confirm that anterior shoulder injection could result in penetration of the anterior stabilizing structures of the glenohumeral joint and to advocate the use of a tailored approach to MR arthrography based on presenting symptoms.

Materials and Methods

Six shoulders from six fresh frozen cadavers were harvested from four men and two women ranging in age at death from 53 to 75 years (mean age, 69 years). Specimens were brought to room temperature before imaging. The cadaveric specimens were placed in supine position on the fluoroscopy table with the proximal humerus in external rotation. An 18-gauge spinal needle was placed into the inferior third of the glenohumeral joint under fluoroscopic observation using a standard anterior approach [6, 7]. Intraarticular position was verified by a small test injection of 1 mL of iodinated contrast material, iohexol (Omnipaque; Nycomed Amersham, Princeton, NJ). A wire was threaded through the spinal needle and

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left in place, serving as a marker of the course of the spinal needle through the anterior soft tissues.

The cadaveric specimens were then placed in prone position with the proximal humerus in internal rotation. We examined the specimens fluoroscopically, elevating the shoulder until the beam was tangent to the glenohumeral joint and profiling the joint space. An 18-gauge spinal needle was placed into the glenohumeral joint through the posterior soft tissues. Care was taken to localize needle entry to the humeral side of the joint. Intraarticular position was again verified with 1 mL of iodinated contrast material. As with the anterior approach, a wire was threaded through the spinal needle and left in place in the posterior soft tissues to mark the course of the needle.

The cadaveric specimens were frozen for 48 hr at –60°C and sectioned at 3-mm intervals in the axial plane using a band saw. The anatomic sections were analyzed by the consensus of two musculoskeletal radiologists with particular attention to the structures traversed by the wires in both the anterior and posterior soft tissues.

Results

Analysis of the marker for the anterior approach in the cadaveric specimens showed the wire traversing the subscapularis muscle or tendon in all cases (n = 6). In two of six cases, the wire crossed the inferior glenohumeral ligament (Fig. 1). In two of six cases, the wire traversed the anteroinferior labrum (Fig. 2).

Analysis of the marker for the posterior approach in the cadaveric specimens showed the wire crossing the posterior inferior labrum in a single case. No anterior structures were violated.

Discussion

The concept of glenohumeral joint arthrography was introduced in the 1930s [6]. The diagnostic application of this procedure has evolved from its initial role in evaluation of capsular distortion, to the evaluation of the rotator cuff, and currently to the evaluation of the

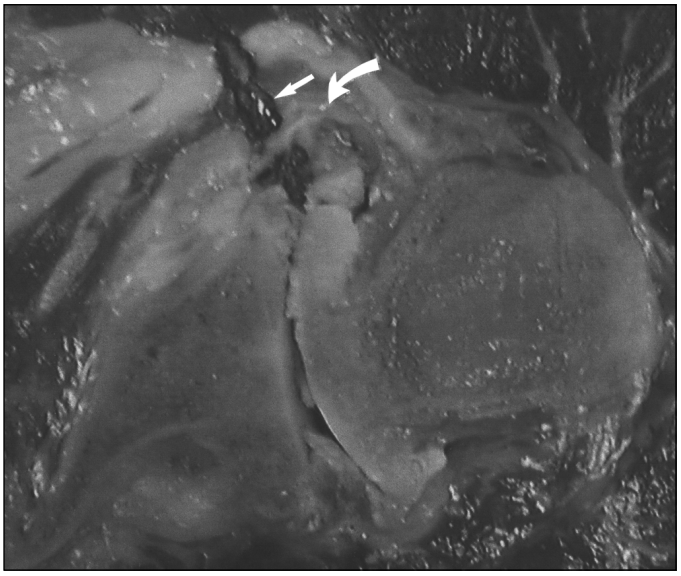

Fig. 1.—Photograph of axial anatomic section through inferior aspect of glenohumeral joint in cadaveric specimen. Wire (*straight arrow*) courses through anterior soft tissues, traversing anterior band of inferior glenohumeral ligament complex (*curved arrow*), and marks path of needle used in standard anterior approach for arthrography.

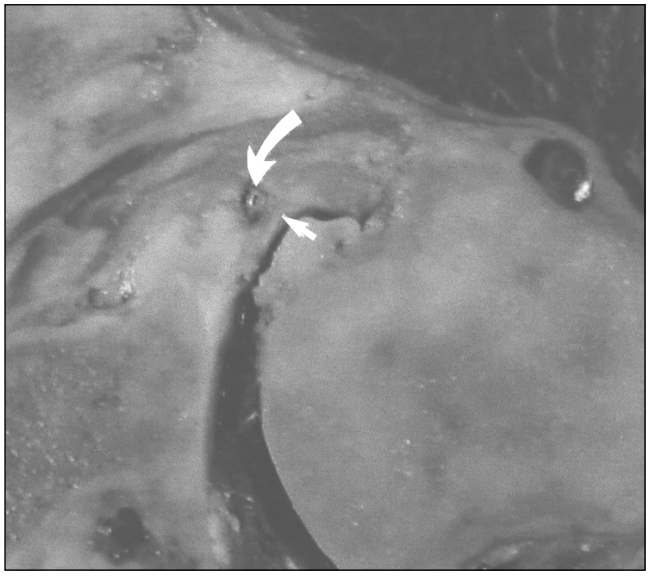

Fig. 2.—Photograph of axial anatomic section through glenohumeral joint in cadaveric specimen. Tip of wire (*curved arrow*) is seen in anterior labrum (*straight arrow*) and marks path of needle used in standard anterior approach for arthrography.

Fig. 3.—Photograph showing initial position of patient. Patient lies on side, facing operator, with symptomatic shoulder in nondependent position, internally rotated.

A

B

Fig. 4.—Photograph showing desired position of patient with corresponding spot fluoroscopic film.
A, Photograph shows patient turned forward toward prone position while glenohumeral joint is examined fluoroscopically.
B, Spot fluoroscopic film shows desired position of patient with joint space viewed in tangent to beam. Humeral side of inferior third of glenohumeral joint (*arrow*) is localized as needle entry site.

stabilizing structures of the glenohumeral joint when used in conjunction with MR imaging [6–8]. Despite this evolution in application, the technique for performing shoulder arthrography has changed little from that initially described and involves an anterior approach for needle placement regardless of the presenting history and symptoms.

The inherent instability of the glenohumeral joint with a tendency toward anterior instability is undisputed. An understanding of the anatomy of this articulation and its patterns of injury underlines the importance of the anterior structures in the shoulder. It is in the anterosuperior portion of the labrum that several normal variations in both signal intensity and morphology of the labrum can occur. It is in the anteroinferior portion of the labrum that capsular, ligamentous, labral, and osseous lesions can be specific indicators of mechanism of injury. As indicated in our study, the course of the needle in the anterior approach for arthrography clearly traverses these very structures. This could complicate interpretation of the study by introducing the possibility of distortion or disruption of the normal capsular confines and anatomic structures, making it difficult to distinguish true abnormality from complications of the injection.

The limitations of our study include the small specimen population. The use of an 18-gauge spinal needle for wire placement does not parallel clinical practice, but the use of a smaller gauge needle would not have accommodated the wire used to mark its course. Despite the larger gauge needle, the wire passing through the needle and left in the soft tissues approximates the actual caliber of a 20- or 22-gauge needle. Variations in patient positioning have been described in the literature, but our study used only a single position with no variation of obliquity or humeral position [9]. In addition, differences in tissue consistency in both the intact and sectioned cadaveric specimens could affect needle excursion as well as the appearance of the course of the wire. Despite this, the structures the wire traverses are identifiable.

Although the method of standard arthrography offers no major technical challenge, even the most seasoned radiologist can encounter complications, such as extraarticular contrast injection, capsular rupture with abnormal contrast collection, inadvertent injection of anterior structures (e.g., the subcoracoid bursa), subscapularis tendon, or a component of the anterior capsulolabral complex. Moreover, injury and postsurgical changes can add layers of complexity to a simple procedure, rendering it anything but simple.

In the case of the cadaveric specimens, we placed the shoulders in prone position, elevating the joint to an anterior oblique position to the table until the joint space was tangent to the beam. In the clinical setting, it is more practical to begin with the patient on his or her side, facing the operator, head resting on the arm, with the shoulder to be injected in the nondependent position (Fig. 3). A pillow or foam wedge is placed in front of the patient, the arm is internally rotated, and the patient is slowly rolled toward the prone position until the joint space is profiled (Fig. 4).

By tailoring the arthrographic approach, we are able to isolate expected abnormality and limit the introduction of confounding findings related to the performance of the procedure. If patients present with a history of anterior instability or anterior symptoms, a posterior approach for the arthrogram would be used. If patients present with posterior symptoms, such as pain with overhead throwing, an anterior approach would be used.

The technique differs only in patient position during the procedure, supine versus prone. There is neither added risk to the patient nor technical complexity for the operator. In actuality, the posterior anatomy is less variable and has fewer stabilizing structures than the anterior aspect of the joint. This is a basic concept, which makes intuitive sense.

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