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A Simple Technique for Shoulder Arthrography

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Purpose: To present a systematic approach to teaching a technique for arthrography of the shoulder. Using an adhesive marker-plate with radiopaque coordinates, precise sites for puncture can be identified and the need for fluoroscopic guidance obviated.
Material and Methods: Forty-six glenohumeral arthrograms were performed in 45 patients; in 1 case involving examination of both shoulders. The stages of the technique are described in detail, as are the fundamental aspects of achieving an effective glenohumeral injection. Pain intensity was measured in all patients using a verbal description scale.
Results: Shoulder arthrography was successful in all cases. Average time taken for the procedure was 7 min, with no difference in the respective times required by an experienced radiologist and a resident. The procedure was well tolerated by most patients, with slight discomfort being observed in a very few cases.
Conclusion: The arthrographic technique used in this study is simple, safe, rapid, and reproducible, and has the advantage of precise localization of the site for puncture without need for fluoroscopic guidance. The procedure described in this study can be of help in teaching residents and can reduce the learning curve for radiologists with no experience in arthrographic methods. It also reduces the time of exposure to fluoroscopy.

Key words: Arthrography; joint; shoulder

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Several methods of shoulder arthrography have been described since OBERHOLZER first described his technique in 1933 (3, 6, 8, 9, 11, 12). The anterior approach is commonly employed for insertion of the needle under fluoroscopic guidance. It is important to bear in mind that the articular space contains the glenohumeral joint, but that it also extends as far as the anatomical neck of the humeral head, and that more of the articular surface of the humeral head is exposed when the shoulder is in external rotation (6). Consequently, several areas may be selected when determining the puncture site. The method considered to be standard (12) uses the glenohumeral joint at the junction of the middle and lower thirds. In a recent work (3), a modified anterior approach was used for shoulder arthrography: through the rotator cuff interval lying between the supraspinatus muscle and the subscapularis muscle and basically comprising the upper third of the humeral head, another puncture area is located at the junction of the middle and lower thirds of the medial humeral head (6). Currently, shoulder arthrography is performed as the first phase of a diagnostic process that includes computed tomography (CT) or magnetic resonance imaging (MRI) (4, 7, 10). An accurate and atraumatic shoulder arthrography technique is essential, especially when the examination is followed by MRI (6). Problematic aspects associated with this technique, which is usually carried out under fluoroscopic control, are the dose of radiation received by the patient and the length of time needed to carry out the procedure. Intra-articular insertion of the needle under fluoroscopic control needs a period of time that has obvious repercussions on the dose of radiation to both patient and examiner (1). These aspects are minimized when the procedure is carried out by an experienced radiologist. The key to successful shoulder arthrography is the use of a systematic method that permits precise determination of the puncture site. This is essential for easy teaching of the technique and also for learning by

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residents and radiologists with little or no experience in arthrography. In this study, a simple reproducible method is described for shoulder arthrography, by which an adhesive marker-plate with radiopaque coordinates enables intra-articular insertion of the needle without the need for fluoroscopic guidance.

Material and Methods

Forty-six shoulder arthrographies were performed in 45 patients (26 M and 19 F, age range 20–75 years, mean 41 years) sent for MR arthrography. Examination of both shoulders was performed in one patient. The patients were examined for glenohumeral instability ($n=25$), suspicion of a tear in the rotator cuff ($n=12$), and chronic shoulder pain ($n=8$). The study was approved by the Institutional Review Board. All patients were given detailed information about the procedure and informed consent was obtained. They all underwent US examination of the shoulder before MR arthrography, and in 28 cases the distance from the skin to the cortex of the medial humeral head or from the skin to the glenohumeral articular space was determined in order to select the correct length of spinal needle to be used in the arthrographic procedure. Twenty-nine of the 46 shoulder arthrographic examinations were performed by a radiologist with 15 years' experience in shoulder arthrography; after prior demonstration of the technique, the 17 remaining procedures were carried out by a resident under the constant supervision of the experienced radiologist throughout the performance of all procedures. The stages for performance of the arthrographic procedure are described below.

Determination of the puncture site

Patients were placed in a supine position on the fluoroscopy table (Siregraph CF; Siemens Medical Systems, Erlangen, Germany) with the shoulder in external rotation. In cases where this position caused discomfort, or was impossible to achieve, the shoulder was placed in neutral rotation. Rigorous aseptic measures were applied and an adhesive marker-plate was placed on an area of skin over the humeral head and the glenohumeral joint in order to facilitate identification of the site for needle insertion (Fig. 1A). Previously, the device has been employed for wrist arthrography (1). The X-ray tube should be perpendicular to the area of interest. This is fundamental if the needle is to be advanced properly in the direction of the X-ray beam, and to ensure correct alignment to avoid parallel distortion and subsequent inaccurate needle placement. Next, a fluoroscopic spot image was obtained and the puncture site was determined. Puncture sites used were as follows: 1) Upper third of the medial humeral head; 2) lower third of the humeral head near to the middle third and the medial cortex of the humeral head; 3) area between the middle and lower thirds of the glenohumeral joint. The configuration of these areas is obtained by tracing a notional horizontal line from the center of the sclerotic line corresponding to the anatomical neck of the humeral head as far as the cortex of the humeral head (Fig. 1B). Once the glenohumeral joint is

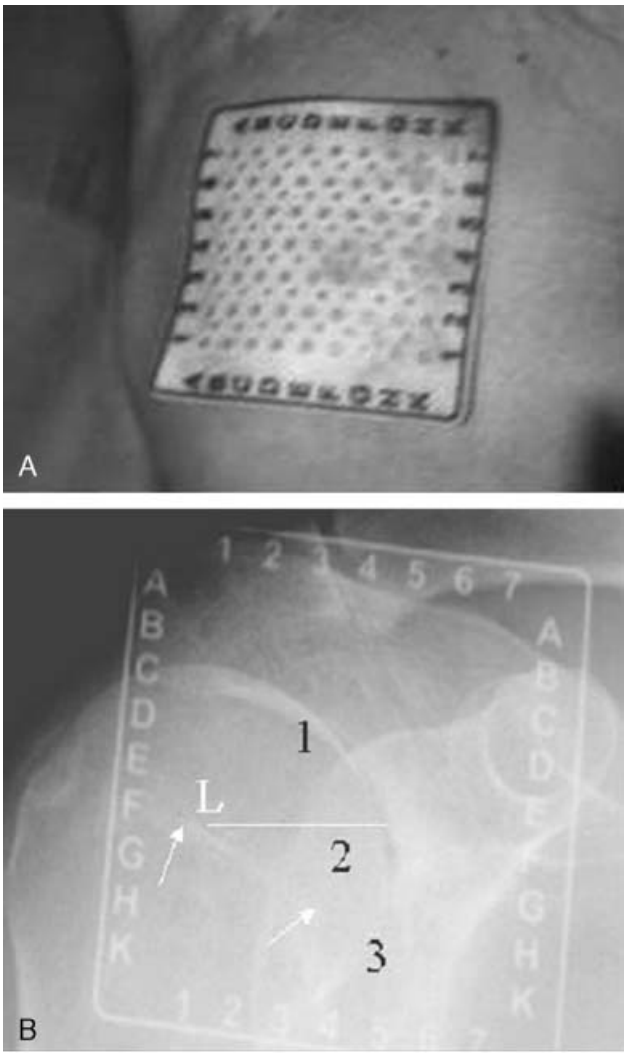

Fig. 1. A. Photograph showing adhesive marker-plate in place on the area of interest. B. Image showing the radiopaque coordinates and the possible sites for puncture. 1) Upper third of the articular space; 2) area of the lower third near to the middle third of the articular space; 3) area of the glenohumeral joint space between the middle third and the lower third. (L) Horizontal line from the center of the line from the anatomic neck (*arrows*) to the cortex of the medial humeral head.

selected, in order to avoid contact with the glenoid labrum it is important that the puncture site is close to the cortex of the medial humeral head. Puncture sites varied between the three sites described above. In selecting the puncture site, one must ensure that the coracoide process is not interimposed on the trajectory of the needle.

Needle insertion

After subcutaneous infiltration of 1 ml of the local anesthetic (2% mapivacaine) in the puncture site, a 22-gauge 1.5-inch (40 mm) or 22-gauge 3.5-inch (88 mm) spinal needle was used. The needle was advanced vertically in an anteroposterior direction, progressively and slowly, until it contacted the humeral head when area 1 or area 2 of the humeral head was selected or until a change in resistance was perceived when the glenohumeral joint was entered. Next, a fluoroscopic spot image was obtained to confirm the localization of the tip of the needle (Fig. 2A). Once it was considered that the needle was within the articular space, and after aspiration of joint effusion, a tube was connected between the needle and the syringe and a small test injection was performed (3, 6). If the needle is in the articular space there will be little resistance to the injection. If the needle is located in the hyaline cartilage an increase in resistance to the injection of anesthetic will be perceived, in which case the needle may be manipulated by rotating or by slightly moving it back (or the shoulder may be rotated internally) in order to facilitate intra-articular positioning of the needle (6, 8). At first, all punctures were performed using a long spinal needle. Subsequently, by means

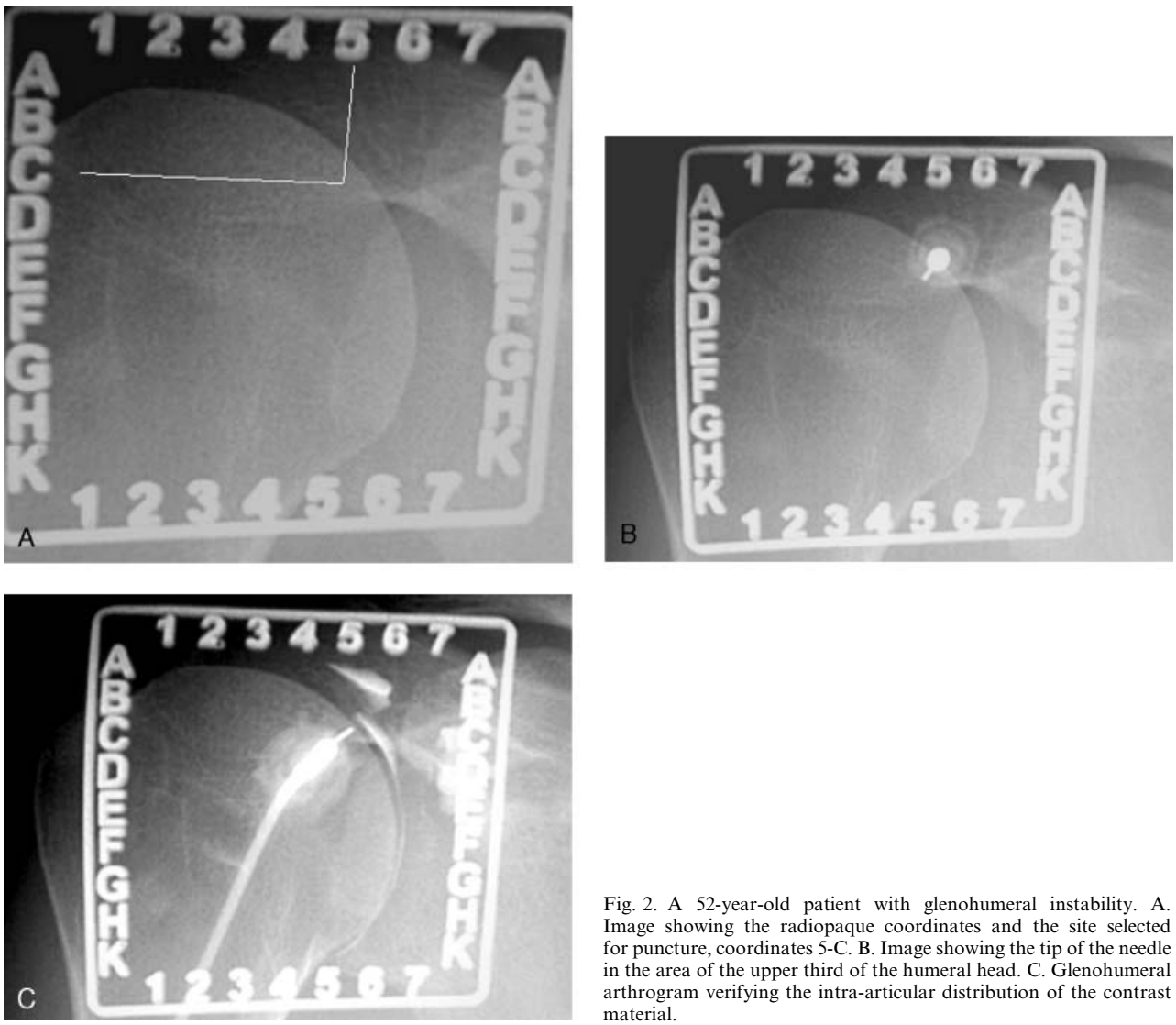

Fig. 2. A 52-year-old patient with glenohumeral instability. A. Image showing the radiopaque coordinates and the site selected for puncture, coordinates 5-C. B. Image showing the tip of the needle in the area of the upper third of the humeral head. C. Glenohumeral arthrogram verifying the intra-articular distribution of the contrast material.

of US examination, when the skin-to-articular-space distance was <3 cm, a short spinal needle was employed, and when this distance was $\geqslant 3$ cm a long spinal needle was employed.

Injection of contrast material

Once a positive test injection with local anesthetic has been achieved, almost always indicating successful positioning of the needle in the articular space, a small quantity of contrast material must be injected in order to verify the correct placement of the needle (Fig. 2B and C). Between 2 ml and 4 ml of gadopentate dimeglumine (Magnevist; Schering, Berlin, Germany) was diluted in a 100 ml mixture containing 50 ml of sterile saline and 50 ml of iopramide (Ultravist 330; Schering, Berlin, Germany). It is essential to ensure that no air is introduced in order to avoid artifacts in MRI. The solution was slowly injected until the joint capsule was appropriately distended, with an average total volume of approximately 14 ml of injected material (range 9–20 ml). After the needle is removed, two or three layers of gauze must always be placed over the puncture site and secured with adhesive tape, which also serves to compress. On completing the arthrographic examination, pain intensity was measured in all patients using a 6-point verbal description scale (0=no pain, 1=mild, 2=discomforting, 3=distressing, 4=intense, 5=excruciating). Next, the MRI examination was performed less than 45 min after the glenohumeral injection to avoid absorption of contrast material and loss of capsular distention. Good quality images were obtained in all cases.

Total radiologist times were recorded for each procedure, i.e. from positioning of the adhesive marker-plate on the shoulder to withdrawal of the needle.

Results

The 46 glenohumeral arthrographic examinations performed on the 45 patients were carried out successfully. The positioning of the arm during the arthrographic examination was: in exterior rotation in 29 procedures (63%) and in neutral rotation in 17 (37%). The areas corresponding to the selected puncture sites were as follows: the upper third of the humeral head was used in 16 (34.7%) glenohumeral injections, the lower third in 15 (32.6%), and the glenohumeral joint in 15 (32.6%). The punctures performed in the upper third of the medial humeral head were carried out using a short spinal needle in 6 arthrographic examinations and a long spinal needle in 10; punctures in the lower third involved the use of a short spinal needle in 8 cases and a long spinal needle in 7; punctures in the glenohumeral articular space involved the use of a short spinal needle in 3 cases and a long spinal needle in 12 cases. In the arthrographic procedures performed, the spot images obtained occupied a total time for fluoroscopy of less than 30 ms in each patient. Average total radiologist time was 7 min (range 5–10 min). No differences were observed in arthrographic procedure times between the experienced radiologist and the resident. On the verbal pain scale employed in 26 arthrographic procedures (56.5%), the patients indicated point 0 (no pain) and in the remaining 20 procedures (43.5%) the patients indicated point 1 (mild). The level of pain experienced by patients was similar regardless of whether the procedure was carried out by the resident or by the experienced radiologist. In all procedures, the intra-articular positioning of the needle was successfully achieved at the first attempt. The procedure was well tolerated by most patients, with slight discomfort being observed in a very few cases. No complications were observed.

Discussion

Shoulder arthrography is commonly performed in conjunction with CT or, now more frequently, with MRI (4, 7, 10). Various procedures have been described for obtaining glenohumeral arthrograms (3, 6, 8, 9, 11, 12). Most radiologists prefer to use the anterior approach for performing the intra-articular injection, though some authors (2, 5) prefer the posterior approach, especially in patients with suspicion of anterior instability, because this procedure avoids iatrogenic injury and the potential interpretative errors in diagnosis. However, it has been considered that similar results can be obtained from a fluoroscopically guided anterior approach (6).

There are several essential factors in achieving successful arthrographic examination of the shoulder via the anterior approach (3, 6): supine positioning of the patient with the shoulder in external rotation; selection of the puncture site close to the cortex of the medial humeral head; insertion of the needle parallel to the fluoroscopy beam; a positive anesthetic test injection; avoidance of capsular distention by overinjection of contrast material (15 ml is the recommended volume); and confirmation of intra-articular needle placement with iodinated contrast material. In concordance with other authors (3, 6), as an aberrant injection of iodinated contrast material could mask the area and

make further visualization difficult, we prefer to make test injections with a local anesthetic; this almost invariably ensures intra-articular positioning of the needle. Although we consider that the US examination is not essential for selection of the spinal needle, the distance from the skin to the cortex of the medial femoral head or from the skin to the glenohumeral articular space is determined in the examination commonly carried out in patients who are candidates for MR arthrography. We have observed that in most patients short spinal needles can be used in both the upper third and the lower third of the medial humeral head. In these puncture sites, long spinal needles should be used only in shoulders with voluminous soft parts. The short needles are easier to use than the long ones and possible movements of the needle, once inserted, are prevented as almost the entire needle is then inside soft parts. However, we do recommend the use of long spinal needles for puncture of the glenohumeral articular space.

Shoulder arthrography is usually performed under fluoroscopic guidance. In the present study, fluoroscopic spot images were obtained for confirmation purposes during the procedure. In most cases (82%), only three fluoroscopic spot images were required. This prevents irradiation of the radiologist and reduces radiation exposure to the patient. The site of the intra-articular puncture was determined without difficulty by use of the adhesive marker-plate without the need for fluoroscopic guidance. The adhesive marker-plate is sterile and single-use and will shortly be commercialized.

When an arthrographic technique is systematic, it can be performed effectively while minimizing injury to the articular structures (6). The findings observed in this present study indicate that the technique employed is safe. No difference was observed in procedure performance time by the experienced radiologist and the time taken by the resident, or in the levels of pain experienced by patients in procedures carried out by one or the other. The technique of shoulder arthrography is typically learned during radiology residency (6). The technique described in this study can be of help in teaching residents as it is basically very easy to learn and to perform.

In conclusion, the technique for shoulder arthrography described is simple, rapid, and reproducible. It facilitates the teaching/learning of the procedure and can reduce the learning curve for radiologists with no experience in arthrographic methods.

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