MR-GUIDED JOINT PUNCTURE AND REAL-TIME MR-ASSISTED CONTRAST MEDIA APPLICATION

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MR arthrography of the shoulder with diluted Gd-DTPA has proved to be an accurate method for evaluating the glenoid labrum, gleno-humeral ligaments and rotator cuff tears (1, 2). MR arthrography is typically performed by puncturing the shoulder joint under fluoroscopy and injecting Gd-DTPA diluted in physiological saline mixed with iodinated contrast material to confirm the intra-articular position of the needle. However, joint puncture under fluoroscopic control prolongs the examination time because the patient must be transferred to a fluoroscopic suite. In addition, in vitro and in vivo studies have shown that iodinated X-ray contrast media, depending on the concentration and amount, lower the signal intensity of low-osmolality Gd-DTPA solutions which may lead to diagnostic problems (3).

The aim of our study was to develop an MR-guided technique by which to confirm the intracapsular position of the needle tip during MR arthrography of the shoulder joint by visualizing the inflow of the contrast medium.

Material and Methods

Three unfixed human shoulder specimens were examined at room temperature on a 1.0 T MR unit (Gyroscan T10-NT, Philips) with a dedicated shoulder coil. Two MR-compatible markers were placed by palpation on the skin in a line parallel to the clavicle and coracoid process. On the basis of these markers, the entrance point and orientation for the needle puncture was determined with rapid localizer gradient-echo (GRE) sequences (TR/TE 8.9/3.9 ms, a 50°, matrix size 179/256, 1 acquisition, slice thickness 10 mm, gap 5 mm, imaging time 8 s). The joint punctures were performed by one radiologist with experience in shoulder arthrography. A 0.7-mm MR-compatible needle (E-Z-EM, Inc., Westbury, NY, USA) was used. It is a stainless steel alloy with a high nickel content, and is composed of nickel (49%), chrome (16%) and carbon (0.01%). The precise locali-zation of the needle in the shoulder joint was determined by rapid localizer GRE sequences in 2 orthogonal planes (axial and coronal). The artifactual widening of the needle shaft due to dephasing was measured from images on a work station. To confirm the intracapsular position of the needle tip, 10-15 ml of a diluted (2 mmol/l) Gd-DTPA-saline solution (Magnevist, Schering) was applied via a long connecting tube attached to the inserted needle. The inflow of the contrast medium into the shoulder joint was controlled during contrast media application viewing on real-time MR images on an LCD screen (1024x1024 RF-shielded liquid crystal monitor) installed directly above the magnet bore.

Real-time MR imaging was performed with the local-look technique (Philips): single shot TSE (TR/TE 500/74 ms, echospace 5 ms, FOV 300, slice thickness 10 mm) with an optional driven equilibrium reset pulse, 25 % rectangular FOV, matrix size 256, half scan with backfolding of surrounding tissue suppressed by orthogonal slice selection for excitation and refocusing RF pulses. Fluoroscopy rate was 2 frames/s.

Based on this technique MR-guided MR arthrography of the shoulder was performed in 46 patients (33m, 13 w; age range 16 – 42, mean 27 a).

Results

MR-compatible markers on the skin allowed the rapid and exact determination of the entrance point for the needle tip in the axial plane by estimation of the joint-space location in relation to the distance between markers. In addition, it was possible to estimate the depth of the needle puncture by means of the image scale (Fig. 1).

The fast GRE localizer allowed passive visualization: this means that the needle was localized and visualized by its susceptibility artifact which appeared as a signal loss of linear shape. The MR-compatible needle showed significant artifacts as the orientation of the needle shaft was perpendicular to the main magnetic field (B0). Magnetic field distortions, with spin dephasing and signal loss, artifactually increased the diameter of the 0.7-mm needle shaft to 3.8 mm (5.4-fold). Nevertheless the needle tip was easily recognized and it was possible to accurately localize the intra-articular needle-tip position in all specimens.

Using the long connecting tube attached to the inserted needle, we administered the contrast medium while watching its inflow into the joint on the LCD screen on the MR unit; this gave direct confirmation of the intracapsular position of the needle tip. Real-time MR imaging based on the local-look technique provided sufficient temporal resolution of contrast medium inflow and high contrast of intra-articular contrast medium to surrounding tissue.

Imaging time is increased if joint puncture is performed under MR guidance. However, no more than 3 GRE localizer sequen-ces were necessary in any of the cases for the correct positioning of the needle tip; these included the initial localizer sequence for demonstrating the skin markers. The ultra-short imaging time of the localizer sequences together with the joint puncture proce-dure (sterile conditions, local anaesthesia) did not prolong the MR examination time by more than 15 min. (mean: 9 min.). No complications were recorded.

Discussion

MR arthrography of the shoulder with Gd-DTPA has been shown to be valuable in detecting injuries of the glenoid labrum, glenohumeral ligaments and rotator cuff disorders (1, 2). The method combines the advantages of high contrast and adequate resolution as well as multiplanar imaging.

Needle insertion during MR arthrography is typically performed under radiographic fluoroscopy guidance. Needle position is verified by the injection of an iodinated contrast medium. However, two disadvantages result from this technique.

First, joint puncture under fluoroscopic control necessitates the initiation of the examination in a fluoroscopic suite from which the patient is then transferred to the MR unit. At institutions in which the fluoroscopic room is at some distance from the MR unit, the total examination time is significantly increased.

Second, in vitro studies indicate that iodinated contrast material lowers the signal intensity of low-osmolality Gd-DTPA solutions (3). This finding was supported by in vivo studies that demons-trated that even small amounts (15 % of total volume) of radiolo-gical contrast medium during T1-weighted SE-sequences led to a significant reduction (about 15 %) in the signal intensity of a 2-mmol Gd-DTPA solution. This could lead to diagnostic prob-lems. The MR-guided technique used in our study elimi-nates these problems. Real-time MR imaging of the contrast medium inflow into the joint cavity is helpful in verifying the intracap-sular position of the needle tip but is not absolutely necessary since the application of a small amount of Gd-DTPA (1 ml) is reliable to verify the intracapsular position of the needle tip.

In summary, MR-guided arthrography of the shoulder joint is an easily and quickly performed technique by which to control needle puncture and intraarticular contrast medium inflow in the MR unit and can replace conventional fluoroscopic. In principle, this technique is also possible in MR arthrography of other joints such as the ankle and the hip.

References

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