

CT-guided puncture for direct MR-arthrography of the shoulder: Description of possible techniques

Hauth E^{1*}, Cozub-Poetica C¹, Wieja G², Beer M³, and Jaeger H¹

¹ Radiologische Praxis, Ulm, Germany

² Orthopädische Praxis, Ulm, Germany

³ Department of Diagnostic and Interventional Radiology, University Hospital Ulm, Germany

Abstract

The following report describes the possible techniques of CT-guided puncture for direct magnetic resonance (MR) arthrography of the shoulder. CT-guided puncture can be regarded as an alternative technique to fluoroscopic- or ultrasound-guided puncture for MR-arthrography of the shoulder with high efficiency, low dose and extremely low complication rate.

Keywords: glenohumeral joint; CT-guided approach; technique; radiation dose; direct MR-arthrography

Introduction

Direct magnetic resonance (MR) arthrography of the shoulder with application of contrast medium in the joint space for distension of the joint capsule, is an established method for the determination or exclusion of intraarticular pathologies of the shoulder [1, 2]. Generally, the puncture of the glenohumeral joint is performed using fluoroscopic or ultrasound [3-8]. A computed tomography (CT)-guided puncture could be a viable alternative due to the unavailability of fluoroscopy devices or inexperience of the radiologist with fluoroscopic-guided puncture.

A potential advantage of CT-guided puncture over fluoroscopy-guided intervention is that the entire extent of the puncture channel and the surrounding soft tissues are visible. Accidental injury of the blood vessels and nerve structures, for example, in the axilla, is almost excluded due to the direct visualisation of the procedure. An advantage of CT-guided puncture over ultrasound guidance intervention is the better performance in obese or brawny patients.

Two approaches can be selected for CT-guided puncture of the shoulder joint. An anterior approach can be performed directly at the level of the coracoid process with approach via the rotator interval [10]. The advantage of this approach is that there are no muscular structures in the puncture channel. Additionally, the contact of the puncture needle with the anterior inferior labra is avoided [7]. When pathology is expected in the posterior shoulder joint area, the anterior approach should be selected [4, 5].

The posterior approach has the benefit of a comfortable and stable position of the patient, and that the patient

has no view of the intervention area. The risk of injury to the cartilage and tendon structures is lower than with the anterior approach [4, 5]. The posterior joint capsule of the glenohumeral joint is thinner and softer than the anterior capsule so that the puncture requires less force. In case when pathology is expected in the anterior shoulder joint area, the posterior approach should be selected.

Technique

The attending radiologist obtains informed consent of CT-guided puncture prior to the intervention. Depending on the approach to be utilized, the patient is positioned either supine or prone on the examination table of the CT scanner.

In cases with a planned anterior approach, the patient is placed in the supine position with external rotation of the shoulder to be punctured. The healthy shoulder is lifted using a 45-degree foam wedge, and a metal marker is placed lengthwise on the chest wall on the side of the shoulder to be examined (Figure 1a, b).

***Corresponding author:** Elke Hauth, MD., PhD., Radiologische Praxis, Parkstraße 10, 89073 Ulm, Germany. Tel.: +49 - 731-92044-0; Fax: +49 - 731-92044-18; Email: ehauth@t-online.de

Received 19 April 2016 Revised 30 May 2016 Accepted 8 June 2016 Published 16 June 2016

Citation: Hauth E, Cozub-Poetica C, Wieja G, Beer M, Jaeger H. CT-guided puncture for direct MR-arthrography of the shoulder: Description of possible techniques. J Radiol Imaging. 2016; 1(1):6-8. DOI: [10.14312/2399-8172.2016-2](https://doi.org/10.14312/2399-8172.2016-2)

Copyright: © 2016 Hauth E, et al. Published by NobleResearch Publishers. This is an open-access article distributed under the terms of the [Creative Commons Attribution License](https://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution and reproduction in any medium, provided the original author and source are credited.

Subsequently, a topogram of the glenohumeral joint and a transverse single scan are performed at the level of the coracoid process (rotator interval) (Figure 1b). Two distances are plotted in this single scan (Figure 1c): The distance between the metal marker and the skin above the shoulder joint space (Distance 1), and the distance between the skin and the medial side of the humeral head at the level of the anterior edge of the glenoid. The latter gives the calculated puncture depth (Distance 2). Then, the calculated puncture point is marked with a felt-tip pen and the shoulder to be punctured is disinfected according to the hygiene regulations for intraarticular punctures and injections [11].

1ml local anaesthetic (Mepivacaine hydrochloride, for example: Meaverin®-Actavis 0.5%) is infiltrated at the skin entry site. After using a single scan to check the position of the anesthetic needle in the skin, the puncture is performed at the same insertion site. We recommend using a 20G (0.9 x 75mm) spinal needle. The needle is advanced approximately 2/3 of the measured puncture depth. This is followed by a single scan and correction of the needle position, if required. Finally, the needle is advanced until light resistance of the shoulder joint capsule, which is then pierced (Figure 1d).

After a further single scan and check of the correct position (tip of the puncture needle at the medial side of the humerus head at the level of the anterior edge of the glenoid), 1 ml from a mixture of 4ml local anaesthetic and 1ml contrast medium containing iodine is injected (Iomeprol, for example: Imeron® 350) (Figure 1e). After a single scan to check the intraarticular dispersion of the iodine contrast medium, the gadolinium contrast medium (Gd-DOTA, ARTIREM® 0.0025 mmol/ml) is injected through an extension tube from a pre-filled syringe. Generally, 18ml are applied. Should there be an increase in the puncture pressure during the injection, only 15ml are injected. After removal of the puncture needle, a concluding CT single scan is made to document intraarticular dispersion of gadolinium contrast medium (Figure 1f).

The approach via the rotator interval can be restricted if an anatomically larger coracoid process is present immediately in front of the joint line, hindering the approach [6]. In this case, we recommend moving caudally until the coracoid process no longer hinders the approach to the shoulder joint space. The anterior approach to the glenohumeral joint should be performed as cranially as technically possible.

For the posterior approach, the patients are placed in supine position with external rotation of the shoulder to be punctured. The shoulder to be examined is lifted using a 45-degree foam wedge. The metal marker is placed dorsally lengthwise on the chest wall on the side of the shoulder to be examined (Figure 2a). We recommend using a 22G (0.7 x 75 mm) spinal needle for the posterior approach, because there is less resistance to the puncture in the posterior approach. Figure 2b shows the needle position in the posterior approach. Figure 2b shows the needle position for a posterior approach at the medial side of the humerus head at the level of the posterior edge of the glenoid. To our experience, the posterior approach is

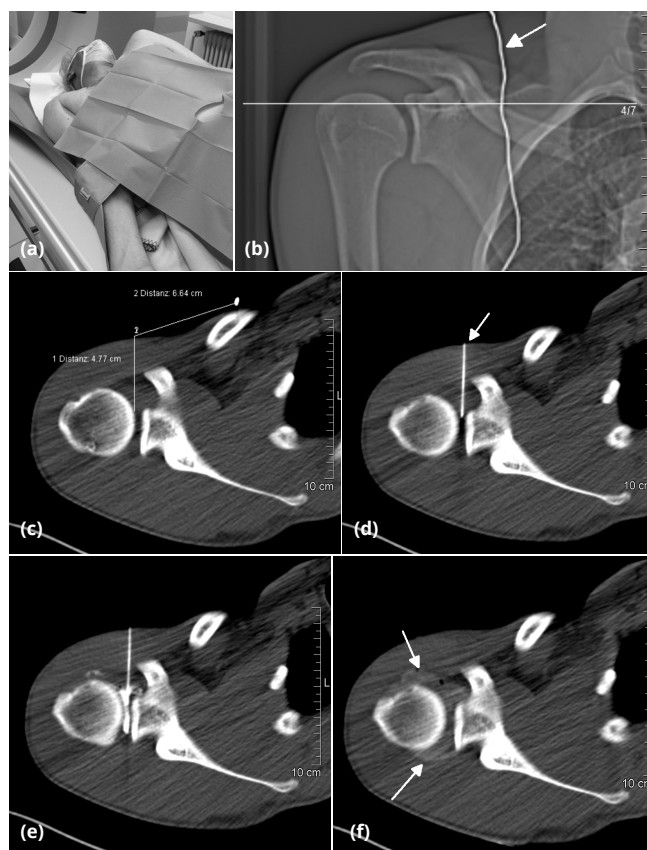


Figure 1 CT-guided puncture via the anterior approach (rotator interval): (a) For anterior approach the patient is positioned supine with a slight external rotation of the arm. The healthy shoulder is lifted using a foam wedge of 45 degrees; (b) CT topogram of the glenohumeral joint: Metal marker (arrow) ventrally on the chest wall on the side of the shoulder to be examined. Plotting of the transversal level for the CT scan at the level of the coracoid process; (c) CT single scan (biopsy modus): Plotting two distances: first, the distance between the metal marker and the skin above the shoulder joint space. The distance between the skin and the humeral side of the joint space at the level of the anterior edge of the glenoid; (d) CT single scan: Monitoring of the spinal needle (arrow) into the joint space. The needle tip in the joint space is directly distal to the anterior edge of the shoulder glenoid; (e) CT single scan: Monitoring after application of the iodine contrast medium: The contrast medium can be seen in the shoulder joint space; (f) CT single scan: Monitoring after removal following application of the gadolinium contrast medium: Dispersion of the contrast medium in the shoulder joint space and in the anterior and posterior recess of the glenohumeral joint with distension of the joint capsule (arrow).

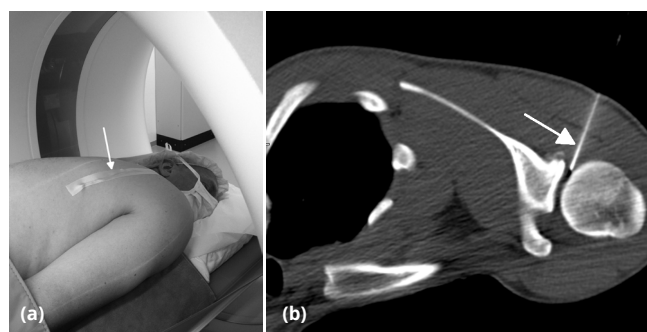


Figure 2 CT-guided puncture via the posterior approach: (a) For the posterior approach the patient is positioned prone. The shoulder to be punctured is raised with a foam wedge in external rotation of the arm to 45 degrees. A metal marker (arrow) is placed dorsally lengthwise on the chest wall on the side of the shoulder to be examined; (b) CT single scan: Monitoring of the position of the spinal needle (arrow). The needle tip is directly at the posterior edge of the glenoid.

easier to perform. The technique in regards to checking needle position and confirming intraarticular position is the same as for anterior approach.

Using the described approach, we present the results of our last 100 interventions. All of them were successfully performed. A multislice CT-scanner with an iterative reconstruction algorithm and a specific intervention program for a low dose technique to reduce the radiation dose was used applying single scans with a reduced current of 60mAs. The dose-length product (DLP) of the interventions was on average 30.3 mGycm (16-56 mGycm). In order to calculate the effective dose the DLP was multiplied by the conversion factor for the thorax, 0.014 [12]. The average effective dosage in the patient group was 0.42mSv (0.22-0.78 mSv).

An advantage of the CT single scan technology over CT fluoroscopy might be the fact that the radiation dose for the radiologists can be reduced to zero, as they are able to leave the examination room during the individual scans. The average intervention time from the topogram to the final CT-scan was 13.6 min (Range: 9-26 min). Through further optimization of the puncture procedure and with greater experience in CT-guided puncture, the number of CT single scans can be further reduced, which can also reduce the radiation dose for the patient as well as the intervention time.

The interventions were well tolerated by the patients. After injection of the gadolinium contrast medium, discomfort or pain was experienced by the majority of patients most likely caused by the distention of the capsule or the irritation of the synovia. No late severe complications, such as bleeding or infections were observed. We recommend a short follow-up of the patients for one hour after MR-arthrography.

Conclusions

CT-guided puncture can be regarded as an alternative technique to fluoroscopic- or ultrasound-guided puncture for MR-arthrography of the shoulder with high efficiency, low dose and no minor or major complications.

Conflicts of interest

The authors declare no conflicts of interest.

References

- [1] Arbeitsgemeinschaft (AG) muskuloskeletale Radiologie der Deutschen Röntgengesellschaft (DRG). Indikationen zur direkten CT- und MR-Arthrographie 2013. <http://www.ag-msk.drg.de/de-DE/334/stellungnahmen-und-empfehlungen>
- [2] Jacobson JA, Lin J, Jamadar DA, Hayes CW. Aids to successful shoulder arthrography performed with a fluoroscopically guided anterior approach. *Radiographics*. 2003; 23(2):373-378.
- [3] Ng AW, Hung EH, Griffith JF, Tong CS, Cho CC. Comparison of ultrasound versus fluoroscopic guided rotator cuff interval approach for MR arthrography. *Clin Imaging*. 2013; 37(3):548-553.
- [4] Chung CB, Corrente L, Resnick D. MR arthrography of the shoulder. *Magn Reson Imaging Clin N Am*. 2004; 12(1):25-38.
- [5] Chung CB, Dwek JR, Feng S, Resnick D. MR arthrography of the glenohumeral joint: a tailored approach. *AJR Am J Roentgenol*. 2001; 177(1):217-219.
- [6] Dépelteau H, Bureau NJ, Cardinal E, Aubin B, Brassard P. Arthrography of the shoulder: a simple fluoroscopically guided approach for targeting the rotator cuff interval. *AJR Am J Roentgenol*. 2004; 182(2):329-332.
- [7] Rhee RB, Chan KK, Lieu JG, Kim BS, Steinbach LS. MR and CT arthrography of the shoulder. *Semin Musculoskelet Radiol*. 2012; 16(1):3-14.

- [8] Rutten MJ, Collins JM, Maresch BJ, Smeets JH, Janssen CM, et al. Glenohumeral joint injection: a comparative study of ultrasound and fluoroscopically guided techniques before MR arthrography. *Eur Radiol*. 2009; 19(3):722-730.
- [9] Binkert CA, Verdun FR, Zanetti M, Pfirrmann CW, Hodler J. CT arthrography of the glenohumeral joint: CT fluoroscopy versus conventional CT and fluoroscopy--comparison of image-guidance techniques. *Radiology*. 2003; 229(1):153-158.
- [10] Mulligan ME. CT-guided shoulder arthrography at the rotator cuff interval. *AJR Am J Roentgenol*. 2008; 191(2):W58-61.
- [11] Intraartikuläre Punktionen und Injektionen: Hygienemaßnahmen. 2008; AWMF-Leitlinienregister Nr. 0029/006. Available on 15 December 2015 <http://www.awmf.org/leitlinien/detail/ll/029-006.html>
- [12] Deak PD, Smal Y, Kalender WA. Multisection CT protocols: sex- and age-specific conversion factors used to determine effective dose from dose-length product. *Radiology* 2010; 257(1):158-166.