The role of ultrasound in shoulder magnetic resonance arthrogram: a guide for injection but not only.

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Purpose

To evaluate the role of ultrasound scan (US) not only as a guide to injection in glenohumeral joint for direct magnetic resonance arthrogram (MRA), but also as a preliminary assessment of the shoulder, a real diagnostic moment considering request and clinic.

The Radiologist specialized in the musculoskeletal sub-discipline can indeed dispose of all the radiological means available in order to answer the clinical request: an integration with other techniques may also be decided (e.g. a TC to evaluate bony loss in glenoid fractures) or maybe US itself can be enough to answer the clinical request, eventually supported by a plain magnetic resonance.

The experience level of the radiologist improves the diagnostic accuracy of MRA of the shoulder making it somehow, like for US, an operator dependent examination.

The MSK Radiologist should be an active actor in the diagnostic path: US can be a help in this goal.
Methods and Materials

A number of 29 shoulder MRA taken during 2014 have been retrospectively evaluated: 20 patients (68.9%) underwent shoulder MRA because of instability with one or more episodes of dislocation, of these 18 (90%) were post-traumatic, 2 (10%) atraumatic; 4 patients never had humeral head dislocation but did have subjective and clinical signs of shoulder instability. Shoulder MRA has been requested to evaluate antero-superior instability or rotator cuff tear in 3 patients (10.3%). In 2 cases (6.9%) orthopedist sent the patients for an evaluation in persistent pain after surgical procedures where plain magnetic resonance wasn't satisfactory.

The mean age of the patients was 35.34 years (15-69 y); the prevalence of patients were males (23 patients - 79.3%). There were 9 patients with equal or more than 40 years of age, of these 6 didn't have instability problems. From this it's deducible that there is also a relationship between the age of the patient and the type of indication: more post-traumatic instability in younger patients and more rotator cuff pathology or post-surgery pain in older patients.

In all cases MRA has been preceded by US scans of the shoulder (Toshiba Aplio 500 with linear probes of 11 and 18 MHz) in order to assess pre-existing glenohumeral joint effusion, subacromial bursal effusion, rotator cuff tears, paralabral cysts, calcifications or other pathological findings.

Subsequently US has guided the glenohumeral joint injection of 10-20 ml of contrast agent performed with a 20 Gauge spinal needle, usually with an anterior approach - with arm in external rotation - and coaxial access of the needle. Ultrasound guided posterior approach, with lateral oblique access of the needle, has been used in the few cases of unsuccessful anterior approach or if anterior approach seemed to be less tolerated by the patient.

As a further advantage, US guidance avoids exposure to ionizing radiation, necessary with fluoroscopic guidance, thus avoiding the use of iodinated contrast material for X-ray visualization.

Also palpation directed intra-articular glenohumeral joint injection avoids X-rays but it has a lower accuracy compared to US guidance.

As in most centres a highly diluted solution with saline gadolinium-based contrast agent was used for articular injection. The articular use of diluted gadolinium contrast agent is in fact an off-label use, even if no adverse reactions have been shown so far. Single sets of ready to use contrast agent appropriately diluted and certified for articular use are commercially available (Magnevist 2mmol/lt - Bayer; Dotarem 0,0025 mmol/ml - Guerbet).
No anesthetic or epinephrine were used. Informed consent was obtained from all the patients.

Worth mentioning is that the optimal concentration on intra-articular gadolinium varies depending on MRI magnet strength from 1mmol Gd/L to 6 mmol Gd//L.

Right afterwards US has documented the correct capsular distention with posterior glenohumeral scans and/or with scans of the long head of the biceps tendon, even though distention of the sheath at this level is not always visualized immediately after injection (Fig.1). This sonographic confirmation also serves as a guarantee of a technically correct and effective procedure.

MRA has been taken in all cases within 20 minutes after contrast injection. The MRA has to be taken within an hour; the maximal contrast to noise ratio and joint distention of the glenohumeral joint occurs 15 minutes after injection of contrast.

MRA examinations were taken with Esaote E-scan XQ 0,2 T with SE-T1 weighted sequences in the three planes plus a coronal GE-Stir acquisition with 4 mm slice thickness. The whole examination was conducted with arm in neutral position and concluded with two further SE-T1 acquisitions in the axial plane, one in internal rotation and one in external rotation.
Fig. 1: posterior scan of glenohumeral joint after injection documenting capsular distention

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Results

In 5 cases (17.2%) sonograms showed findings useful for interpreting and reporting such as articular or bursal effusion. Articular effusion can be detected prior to injection with US posterior scan of glenohumeral joint (fig.2). This finding - besides having a clinical value itself - also tells us that a lesser amount of contrast agent is necessary for an adequate capsular distention (fig.3) in order to obtain diagnostic MRA images (fig.4). It may also be useful to demonstrate subacromial bursal effusion prior to injection, especially in cases where capsular tear is suspected (fig.5-6).

In 2 cases (6.9%) US has documented the correct capsular injection of contrast agent (fig.7) that was not confirmed by MRA images (fig.8), where spreading of contrast agent was appreciated anteriorly, outside the gleno-humeral capsule (fig.9). Particularly, in one case, the contrast agent injected with posterior glenohumeral approach passed through the articulation and went off the capsule in the anterior planes. Contrast agent passage from inside to outside the articulation indirectly demonstrates a capsular lesion. This diagnostic element could be missed if a correct capsular injection is not documented and a capsular lesion could be mistaken with an erroneous articular injection.

In one case US alone answered the diagnostic request of evaluation of the rotator cuff after surgery (fig.10) demonstrating a complete tear of the supraspinatus tendon.

In 1 case (3.4%) US documented a small calcification in the periarticular soft tissues, right inferiorly and laterally to the coracoid process (fig.11), that was related to the patient's symptoms and varied the clinical orientation. In this case an X-ray was also taken to complete the diagnostic evaluation (fig.12).

In all cases US can demonstrate whether contrast agent is inside the articulation or not before undergoing magnetic resonance.
Images for this section:

**Fig. 1:** posterior scan of glenohumeral joint after injection documenting capsular distention

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**Fig. 2:** US glenohumeral posterior scan: articular effusion prior to contrast injection.

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Fig. 3: US glenohumeral posterior scan:

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**Fig. 4:** MRA axial plan (same patient fig.2-3) showing a SLAP tear.

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Fig. 5: US: subacromial bursal effusion.

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Fig. 6: MRA (Same patient fig.5): subacromial bursal effusion.

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**Fig. 7:** US documents correct capsular distention with a posterior scan of glenohumeral joint.

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Fig. 8: MRA of the same patient (fig7): no capsular distention is seen.

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Fig. 9: MRA (same patient fig.7-8): contrast agent spreads in anterior planes out of the capsule.

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**Fig. 10**: US shows complete tear of rotator cuff.

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**Fig. 11:** US shows small calcification near coracoid process.

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Fig. 12: Same calcification (fig.11) documented with x-ray image.

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Conclusion

From the reported experience - even considering the limited number of patients - it comes out how ultrasounds, used not only as a guide for articular injection, can play an important role in the clinical evaluation and in the diagnostic path of the patient coming for shoulder MRA.

For the radiologist specialized in the musculoskeletal sub-discipline, it can be worth taking the time, as a routine, for an ultrasound examination of the shoulder before starting the articular injection. Prior US scans allow to be sure not to miss elements that could be eventually erased or modified by the contrast agent injection pinpointing elements useful in the reporting. Furthermore this will give the radiologist a chance to visit the patient, focusing and evaluating the clinical request thus verifying its appropriateness, a matter that should never be taken for granted. US scans right after contrast injection confirm the capsular distention as a guarantee of a correct procedure.
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