**Efficacy of ultrasound guide to perform hip arthro-MRI**

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Purpose

Our purpose was to verify the usefulness and effectiveness of the ultrasound guide while performing arthrography with Magnetic Resonance (arthro-MR) of the hip, in order to avoid exposure to ionizing radiation and use of iodinated contrast medium, which are required when using fluoroscopic or CT guide.

In recent years a new hip pathology has been defined, known as femoro-acetabular impingement (FAI), which quickly has drawn the attention of orthopaedists and radiologists [1]. The diagnosis of this pathology is based on clinical-semiological signs, dedicated x-ray examinations [2] and, above all, on magnetic resonance arthrography [3,4]. Arthro-MR evaluates the pathological hip after intra-articular (IA) injection of paramagnetic contrast medium.

This examination is essential because only the intra-articular contrast medium allows adequate visualization of the diagnostic elements required to plan the arthroscopic treatment of the disease, i.e. acetabular labrum and opposing femoro-acetabular chondral surfaces.

In most centres that perform these examinations and in several studies of scientific literature, the injection of paramagnetic contrast medium in intra-articular location is performed with fluoroscopic or CT guidance [5]. With these guides, however, the method is fairly complex, relatively time consuming, requires use of intra-articular iodinated contrast medium and, above all, determines X-ray exposure both for the operator and the patient.

In our hospital over the last 10 years we performed, together with our Rheumatology colleagues, about 15,000 ultrasound guided intra-articular hip injections of hyaluronic acid, anaesthetics or steroids for the treatment of osteoarthritis [6]. We decided to use a similar technique to perform hip arthro-MR in patients with FAI.
Methods and Materials

Over a period of 18 months (September 2009-May 2012) in our hospital we performed **150 arthro-MR of the hip** on 150 patients (81 men and 69 women) with clinical and radiological signs of FAI.

All patients were examined with the standard ultrasound technique, with the subject in the supine position and the hip in neutral or slight extra-rotation. The scanning approach was anterior, longitudinal parasagittal and lateral to the femoral vessels.

As we know, the colour Doppler imaging allows easy viewing of the femoral vessels which must be avoided by the path of the needle. The ultrasound probe is centred on the femoral epiphysis and oriented along the femoral neck, including the femoral head and the hyperechoic articular capsule in the field of view.

The joint capsule was easily visualized between the hypoechoic iliopsoas muscle and the osteochondral femoral profile (Fig.1). The injection technique was the same we designed and used for hip intra-articular therapy with hyaluronic acid [7]. We used the same ultrasound device, the same multi-frequency convex probe (2.5-5 MHz), with an inserted biopsy device, and the same needle (20-21 G, 9-11 cm/3.5-4.3 inches in length).

Considering that the volumes to be injected were greater (10-20 ml of contrast medium according to the articular compliance) compared to that used in IA hyaluronic acid therapy, we decided to use, in addition to the classic **antero-superior injective approach** (Fig.2), with the needle directed towards the femoral head, also the antero-inferior (Fig.3), with the needle path in caudal-cranial direction, in order to reach the area of passage between femoral head and neck. This in order to introduce the contrast medium in a broader joint recess and to assess whether this approach could reduce the discomfort of the patient due to the rapid capsular distention.

The injection technique required a nursing unit and two radiologists, one at the ultrasound probe and the other to the administration of the injection.

**Through the ultrasound real-time visualization we correctly recognized the needle progression and / or the position of needle tip below the hyperechoic capsule** (Fig.4).

We had the proof of the correct progression of contrast medium into the joint in different ways. First, we noticed a slow or absent resistance to injection, even more evident with the use of prefilled luer-lock syringes. Secondly, we used the real-time ultrasound visualization: **gadolinium is hypo-anechoic** and, while it filled the joint, **we saw a progressive capsular distention with an effusion-like pattern** (Fig.5). Finally, we used power Doppler imaging to detect flow signals generated by the slow flowing of contrast medium inside the joint (Fig. 6).
We did not use any local anaesthetic before and during injection. We stopped the injection when the patient reported a troublesome discomfort due to the rapid filling of the joint.
Images for this section:

**Fig. 1:** Ultrasound anatomy of the hip.

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**Fig. 2:** Ultrasound-guided antero-superior approach for the intra-articular injection of the hip.

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Fig. 3: Needle paths of different injective approaches.

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Fig. 4: Real time ultrasound visualization of the needle while entering into the hip joint.

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Fig. 5: Ultrasound images acquired before and after gadolinium injection. Arrows: distended joint capsule.

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**Fig. 6:** Real time ultrasound and Power-doppler visualization of gadolinium while filling hip joint.

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Results

In all cases we correctly positioned contrast medium in intra-articular position, without significant extravasation that hampered the correct visualization of joint structures.

We had no benefit from the use of the antero-inferior injective approach. In fact we recognized with greater difficulty the needle tip, because in a deeper location (femoral neck) compared to that of the antero-superior approach (femoral head). Moreover the capsular distention during the injection was less evident in the lower joint recess compared to the upper one. For this reason, after the first injections, we always used the antero-superior injective approach.

The technique lasted about 10 minutes, considerably less than those with fluoroscopic or CT guidance, without use of radiation and iodinated intra-articular contrast medium to confirm the correct introduction of gadolinium into the joint.

The technique was always well tolerated, without adverse events, even at a distance of time.

Performed arthro-MR gave a correct anatomical evaluation of the acetabular labrum and femoro-acetabular articular osteochondral structures, clearly showing their pathological changes. The lesions revealed by MR examination had, in the operated cases, arthroscopic confirmation.
Conclusion

This study is further evidence of the efficacy and safety of ultrasound-guided IA injection of the hip. Although today some specialists still perform hip injections with a "blind" injective approach, the study of Leopold [8], regarding cadaveric hips, showed that a technique based only on anatomical landmarks neither by the anterior (40% of failure) or the lateral approach (20% of failures) could be considered safe and reliable for an effective diagnostic use.

Fluoroscopy, the most commonly used image guide until a few years ago, has some major drawbacks. First it needs ionizing radiation and iodinated contrast medium in articulation. Then it does not allow direct visualization of the joint capsule and vascular structures. The manipulation of the needle is greater and more complex than other methods and costs are relatively high. Costs increase even more if we use CT guide.

In recent years, mainly thanks to the growing use in Italy, the ultrasound guided injection technique has reached clinical and scientific validation, in consideration of its safety, efficacy and relative cheapness. Clinical results have shown that ultrasound is effective as fluoroscopy and CT in guiding therapeutic intra-articular injection of the hip [9]. This belief also originates from our decade of experience, developed by performing approximately 15,000 hip injections to inject hyaluronic acid, steroids, and anaesthetics [7]. In addition to its efficacy and safety, the ultrasound method, on the contrary of fluoroscopy, allows recognizing concomitant diseases, such as joint effusions, bursitis [10], synovial hypertrophy that can be treated by the same ultrasound guidance with drainage of joint effusion and use of IA steroids.

Our study has demonstrated the effectiveness of ultrasound guidance in the execution of hip arthro-MR for the diagnosis of FAI, indirectly confirming also the accuracy of this method for IA therapy with hyaluronic acid, considering that the injection volume (2-4 ml) is lower compared to that required to perform arthro-MR (10-20 ml). Gadolinium does not appear hyperechoic such as hyaluronic acid, but has a hypoechoic aspect, similar to joint effusion and progressively distends the joint capsule above the osteochondral femoral profile.

In conclusion, our experience suggests that ultrasound guidance must become the gold standard for the injection of contrast medium into the hip, especially in view of a significant increase in arthro-MR examinations related to the great development of arthroscopic treatment of femoro-acetabular impingement.

With this safe and effective technique we could avoid unnecessary and harmful radiation exposure to both patient and physician.
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