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Original Article

Assessment of factors that could affect the success of US-guided contrast injection for hip MR arthrography

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Abstract

Background: To retrospectively evaluate the association between possible influencing factors and failed first attempts to inject a contrast agent intra-articularly under ultrasound (US)-guidance for direct magnetic resonance (MR) arthrography of the hip joint.
Methods: Ninety consecutive patients (38 women and 52 men; mean age, 42 years) undergoing US-guided hip MR arthrography (3 bilaterally) were retrospectively included in this study. The potential influencing factors were sex, age, body mass index (BMI), side of injection, target site, trajectory of the needle, additional use of needle tip rotation, failed first-attempt, and capsule elongation at the site of needle insertion.
Results: First-attempt failure was significantly associated with reduced capsule elongation at the target site and no additional use of needle tip rotation (OR 10.708; 95% CI 1.847−62.059; OR 3.518; 95% CI 1.120−11.047). Capsule elongation (sufficient for needle bevel insertion) was significantly larger at the femoral head-neck junction (5.2 ± 1.5 mm) than at the femoral head (2.9 ± 1.3 mm) ($p < 0.001$).
Conclusion: Less capsular elongation of the femoral head and no additional use of needle tip rotation to reduce the difficulty in contrast material delivery can increase the first-attempt failure rate in patients undergoing US-guided hip arthrography.

Keywords: Arthrography; Hip; Magnetic resonance image; Ultrasonography; Ultrasound-guided

1. Introduction

Magnetic resonance (MR) arthrography of the native hip is a well-proven and useful technique for the diagnosis of intra-articular lesions, especially lesions of the acetabular labrum.[1,2] As the number of intra-articular contrast injections increase, hip injection efficacy increases.

Various injection techniques have been described for MR imaging-guided arthrography targeting the femoral head or head-neck junction.[3−5] The use of US guidance is less common than the use of conventional fluoroscopic guidance. However, fluoroscopy is unable to visualize soft tissue structures (such as the femoral neurovascular bundle and distended hip capsule) and inflammatory reactions such as intra-articular effusion. Compared with the most commonly described fluoroscopy guidance technique, the most popular alternative (i.e., injection of a contrast agent into the hip joint under US-guidance) permits direct visualization of intra-articular needle placement and adjacent vascular structures, and involves no exposure to radiation[3−7] Nevertheless, failed injection attempts have occasionally been reported in patients undergoing US-guided hip arthrography.[8]

The advantages of knowing the factors influencing failed attempts at US-guided injection are two-fold. First, the operator can choose the more appropriate technique before injection. Second, avoiding failure reduces the procedure time and discomfort of the patient. Recently, Kantarci et al.[8] reported no

Conflicts of interest: The authors declare that they have no conflicts of interest related to the subject matter or materials discussed in this article.

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difference in the rate of failed first attempts under US-guidance targeting the femoral head and the rate of failed first attempts targeting the femoral head-neck junction, but more contrast media extravasation was noted when the femoral head was targeted. However, the factors possibly associated with failed first attempts during direct hip MR arthrography have never been assessed. The purpose of our study was to retrospectively determine which of these factors are associated with failed attempts to inject contrast into the native hip joint.

2. Methods

The protocol of this retrospective study was approved by the Institutional Review Board for Human Investigation (TSGHIRB 2-102-05-031) and required full de-identification/anonymization of the patients' records.

2.1. Patients

From February 2010 to March 2013, a total of 105 consecutive patients were referred to our hospital for MR arthrography of the hip joint and included in this study. Joint effusion was not apparent on hip US in any patient before hip arthrography. Inclusion criteria were adult age and receipt of US-guided injection for MR arthrography of the hip. Exclusion criteria were history of hip surgery or extra-articular pathology of the hip joint. Eleven patients with prior hip arthroscopy, 2 patients with communication between the hip joint and iliopsoas bursa, and 1 patient with osteochondroma-related posterior capsular rupture were excluded. One patient refused to take an MR examination because she was claustrophobic. Ninety patients (38 women, 52 men; mean age, 41 years; age range, 20–69 years) received US-guided injections for MR arthrography of the hip. Three patients underwent bilateral MR arthrography. A total of 93 native hips were enrolled in this study.

2.2. Imaging and probe placement techniques

US-guidance was provided using a scanner (Nemio XG; Toshiba, Tokyo, Japan) with a 3–4 MHz transducer (PLF-308P). The linear transducer was sterilized by CIDEX® OPA solution before injection. After cleaning the skin and transducer with alcohol, we slid the probe laterally through the femoral vessels to the most lateral edge of the superior acetabulum and placed it vertical to the most lateral edge of the superior acetabulum using a parasagittal approach. Under in-plane US-guidance, the needle was advanced toward the hip joint (Fig. 1) until the bone of the femoral head or head-neck junction was reached.

The patient's leg was placed in a neutral position, and the skin over the anterior hip was cleaned with alcohol. With regard to this leg position, we checked with the patients before injection to make sure they were comfortable. A 3.5-inch long 22-gauge spinal needle was used for all procedures. Ten ml of diluted (2 mmol/l) gadopentetate dimeglumine (Magnevist; Bayer Schering Pharma AG, Berlin, Germany) was injected according to a standard protocol.[7]

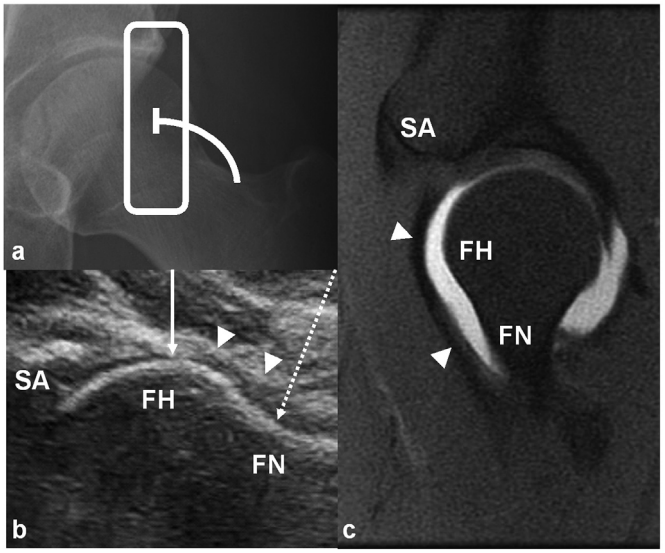

Fig. 1. A desirable probe position for US-guided hip joint injection as highlighted by the rectangle in (a). Major anatomical landmarks used for intra-articular injection on an ultrasonogram (b) and subsequent sagittal fat-saturated T1-weighted MR image (c). A parasagittal sonogram obtained at the anterior aspect of the hip joint and vertically along the most lateral edge of the superior acetabulum shows the femoral head (FH), femoral neck (FN), superior acetabulum (SA), and anterior hip joint capsule (arrowheads). The orientation of the needle for the US-guided technique is indicated by the long, white arrows (unbroken arrow: oblique trajectory of needle; dashed arrow: straight trajectory of needle).

When the procedure was performed under US guidance, a test injection of 2 ml of contrast agent was administered to confirm accurate needle placement, and was followed by intra-articular injection of approximately 8 ml of contrast agent into the hip joint using the end of the extension tube as a port. Needles encountered low resistance when in the joint space, and high resistance when embedded in articular cartilage. In the latter case, the needle was retracted just a few millimeters while injection pressure was maintained.[9] As soon as the tip of the needle reached the joint space, resistance immediately diminished. However, the maneuver of needle retraction sometimes failed to facilitate injection. Since August 2011, we used needle tip rotation, in addition, as described previously by Zwar et al.[10] We rotated the bevel of the needle counter-clockwise while continuing to test for resistance to injection of the contrast agent until no resistance was encountered. If rotation was ineffective, the needle tip would then be advanced or withdrawn or both very slightly, and then rotated in successive small steps before again attempting to inject. If the test injection was still difficult and there was no accumulation of contrast in the joint, the needle was withdrawn from the joint capsule and a second insertion was attempted under freehand US-guidance. Each injection attempt was recorded on different US images. A US-guided technique was considered successful if no accumulation of contrast agent was found during the early stages of injection around the needle tip and if, later, a sufficiently large volume of fluid had been instilled,