Diagnostic and Interventional Imaging (2016) xxx, xxx—xxx

ORIGINAL ARTICLE /*Musculoskeletal imaging*

Subchondral linear hyperintensity of the femoral head: MR imaging findings and associations with femoro-acetabular joint pathology

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KEYWORDS
Subchondral bone;
MR imaging;
Femoral head;
Subchondral insufficiency fracture;
Osteonecrosis

Abstract
Purpose: The goal of this study was to evaluate the associations between linear hyperintensity in the subchondral bone of the femoral head on T2-weighted MR imaging and structural bone lesions.
Material and methods: The MR imaging examinations of 63 patients (66 hips) that showed a bone marrow edema pattern (BMEP) of the hip were retrospectively evaluated (study group). The study group comprised 43 men and 20 women, with a mean age of 55.3 years ± 16.9 (SD) (range: 19—84 years). A control group of 61 patients (77 hips) without BMEP of the hip on MR imaging was created. The control group comprised 30 men and 31 women, with a mean age of 53.1 years ± 15.6 (SD) (range: 25—83 years). The presence of linear abnormalities of the subchondral bone on T2-weighted fat-saturated sequences (TR/TE = 4220—4340/42—45 ms) was evaluated and MR imaging findings were correlated with structural femoro-acetabular pathology (advanced chondropathy, osteonecrosis, subchondral insufficiency fractures and macroscopic fractures) and with pain duration.
Results: A linear hyperintensity in the subchondral bone on T2-weighted MR imaging was found in 43/66 hips with areas of BMEP (65.1%) and in 3/77 hips without BMEP (3.8%). Subchondral linear hyperintensity was seen in 15/16 (93.7%) hips with a subchondral insufficiency fracture. Among the 16 hips with an ARCO stage III osteonecrosis, 13 (76.9%) presented BMEP associated with a subchondral linear hyperintensity. BMEP was present in 6/8 hips with ARCO stage IV

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http://dx.doi.org/10.1016/j.diii.2016.06.006

Please cite this article in press as: Gondim Teixeira PA, et al. Subchondral linear hyperintensity of the femoral head: MR imaging findings and associations with femoro-acetabular joint pathology. Diagnostic and Interventional Imaging (2016), http://dx.doi.org/10.1016/j.diii.2016.06.006

osteonecrosis; however, only two hips (25%) exhibited subchondral linear hyperintensities. Finally, 77.7% of patients with subchondral linear hyperintensities presented with acute or subacute hip pain ($P < 0.0001$).

Conclusion: Femoral head subchondral linear hyperintensity on T2-weighted MR imaging is common and is associated with acute subchondral bone damage.

Subchondral bone plays an important role in intra-articular stress distribution, cartilage nutrition and ultimately joint homeostasis [1—5]. Signal abnormalities on T2-weighted fat-saturated spin-echo-magnetic resonance imaging (MRI) adjacent to subchondral bone have been found in association with diffuse speckled bone marrow edema pattern (BMEP) and various types of structural anomaly in the knee joint [6]. Subchondral linear signal abnormalities are distinct from BMEP zones and originate from the subchondral spongiosa [6,7]. This finding MRI was mainly associated with acute or subacute stress changes in subchondral bone (e.g. biomechanically important meniscal tears, direct trauma, ostechondral lesions). Subchondral linear changes can also appear in a more diffuse manner when associated with bone hyperemia and demineralization [7].

Subchondral linear changes can also be identified in clinical practice, and in images published in various articles on hip MRI (Fig. 1) [8—10]. Despite the potential interest of this finding, there are no studies that have evaluated the associations and clinical implications of subchondral linear abnormalities in the hip. Various pathologic processes may affect the femoral head subchondral bone, and subchondral signal abnormalities may have prognostic implications in conditions like osteoarthrosis, aseptic osteonecrosis and traumatic lesions [11,12]. Pathologic processes leading to structural bone abnormalities in the hip may result in significant patient morbidity and necessitate total hip replacement surgery [10,13—15]. As MRI is often used to evaluate femoro-acetabular joint derangements, data on the prevalence of subchondral bone signal abnormalities may be of clinical importance [16].

The goal of this study was to evaluate the associations between linear hyperintensity in the subchondral bone of the femoral head on T2-weighted MRI and structural bone lesions. We hypothesized that the presence of this finding in the femoral epiphysis might have clinical and prognostic significance.

Material and methods

Patients

A total of 957 unilateral or bilateral MRI examinations of the hip were performed in our institution from January 1st, 2012 to October 14th, 2014. Patients had been referred by orthopedists and rheumatologists for the evaluation of hip pain of degenerative, traumatic or inflammatory origin. A search in our database targeting BMEP related words was performed. The reports containing BMEP related words were reviewed individually by a radiologist (K.S.). The item ''BMEP'' was found in the reports of 138 studies. Images from the studies corresponding to the selected reports, and patient medical records, were retrospectively evaluated. Seventy-three patients were excluded according to the following exclusion criteria: their age was < 18 years, bone marrow edema was not located at the femoral head, they had metallic artifacts around the hip on MRI, or they had bone or soft-tissue tumors and history of hip surgery.

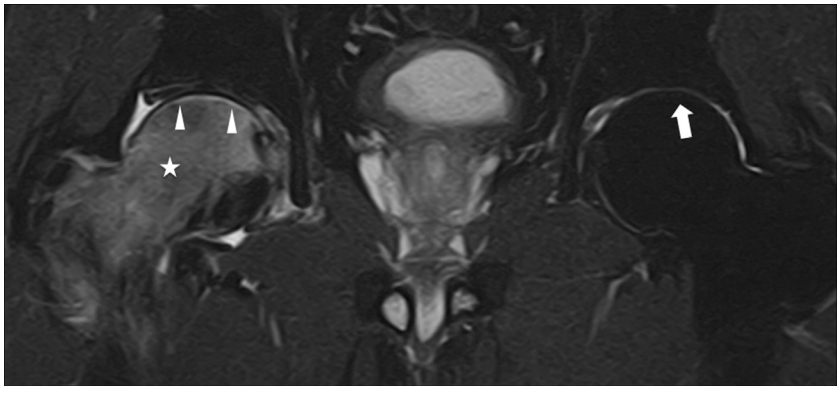

Figure 1. A 46-year-old man with a subchondral insufficiency fracture of the right femoral head. Fat-saturated T2-weighted MR image in the coronal image shows a large area of bone marrow edema (star) and a subchondral linear hyperintensity (arrowheads). Note that no subchondral linear abnormality is seen in the contralateral femoral head (arrow).

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