# Original Report

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# Femoral Head Osteochondral Lesions in Painful Hips of Athletes: MR Imaging Findings

**OBJECTIVE.** This study describes the MR imaging findings of focal osteochondral lesions found in the hips of 11 athletes with persistent pain and normal findings on radiographs.

**CONCLUSION.** Osteochondral lesions of the femoral head are seen on MR imaging as focal, medial areas of high T2-weighted and low T1-weighted signals and should be considered as a possible cause of persistent hip or groin pain in young, high-level athletes because the institution of appropriate treatment may help to prevent late degenerative sequelae.

Hip pain is a common presenting complaint of athletes. The onset of pain may coincide temporally with a traumatic injury. These patients generally have normal findings on radiographs at presentation. Those with persistent symptoms often require further diagnostic imaging with MR imaging. Frequent abnormalities found on MR imaging include labral tear or injury, stress fracture, and avascular necrosis [1]. We describe the clinical and radiographic features of 11 athletes found to have femoral head lesions similar in MR imaging appearance to osteochondral lesions in other locations, such as the knee and ankle.

## Materials and Methods

After the identification of an index case, we conducted a retrospective search of our institution's hip MR imaging database for the preceding 18 months. We excluded patients with findings of classic avascular necrosis, stress or insufficiency fracture, transient osteoporosis, evidence of osteomyelitis, labral abnormality, and metastasis. Three examinations revealed a small, focal area of decreased signal on T1-weighted and increased signal on T2-weighted sequences in the anterior–superior portion of one femoral head, similar to the abnormality identified in the index case. Subsequently, an additional seven patients were prospectively identified, either at the time of imaging at our institution or at the time of referral from outside institutions, bringing the total number of patients to 11.

Conventional radiographs of the hip were obtained in all patients and were uniformly found to show normal findings. MR protocol parameters varied, but all included axial and coronal imaging with T1-weighted images (TR/TE, 600/13) and fat-suppressed fast spin-echo T2-weighted images (3500/65), or (fast) short tau inversion recovery images (4000/35; inversion time, 150 msec). The conventional radiographs and MR images were reviewed by two musculoskeletal radiologists and one orthopedic surgeon.

Three patients underwent follow-up examinations with MR imaging using the same protocol between 2 months and 4 years after the initial detection of the lesion; the others are being followed up clinically and have not undergone further imaging.

## Results

The patient population consisted of nine males and two females, ranging from 15 to 41 years old, with an average age of 25 years. All of the patients presented to their referring clinicians with complaints of persistent groin pain. The duration of pain varied from patient to patient, ranging from 1 week to 6 months at initial presentation. All patients were avid athletes, either recreationally or at the collegiate or professional level. Three patients played soccer; four, basketball; and one, ice hockey.

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One patient was an avid water-skier; one, a competitive snow skier; and one, a competitive power-lifter. Neither of the female patients were, or had recently been, pregnant at the time of the onset of symptoms or at the time of their MR examinations. Four of the 11 patients recalled a discrete traumatic event preceding the onset of chronic hip pain.

The conventional radiographs revealed normal findings, as determined by the musculoskeletal radiologists and the orthopedic surgeon. The MR images were reviewed in consensus, and the findings were believed to be abnormal. In all 11 patients, the MR examination showed a focal area of decreased signal on T1-weighted images and increased signal on T2-weighted images in the anterior–superior portion of one femoral head, an appearance consistent with bone marrow edema or contusion. The area of signal abnormality was small in all cases, involving 10–25% of the femoral head, and was anteromedially located (Fig. 1). In no case did the area of signal abnormality extend across the midline, nor was any evidence of femoral head collapse present. Two patients had obvious irregularity of the overlying articular cartilage in association with bone marrow edema (Figs. 2 and 3). No other signal abnormalities were seen in the bones or soft tissues of the hips or pelvis. Specifically, no signal abnormalities suggestive of labral abnormalities were present.

Three patients underwent arthroscopy at the time of diagnosis. All were found to have cartilaginous defects in the anterior–superior femoral head, confirming the diagnosis of osteochondral lesions (Fig. 4). Three patients underwent at least one follow-up MR examination between 2 and 8 months after the initial

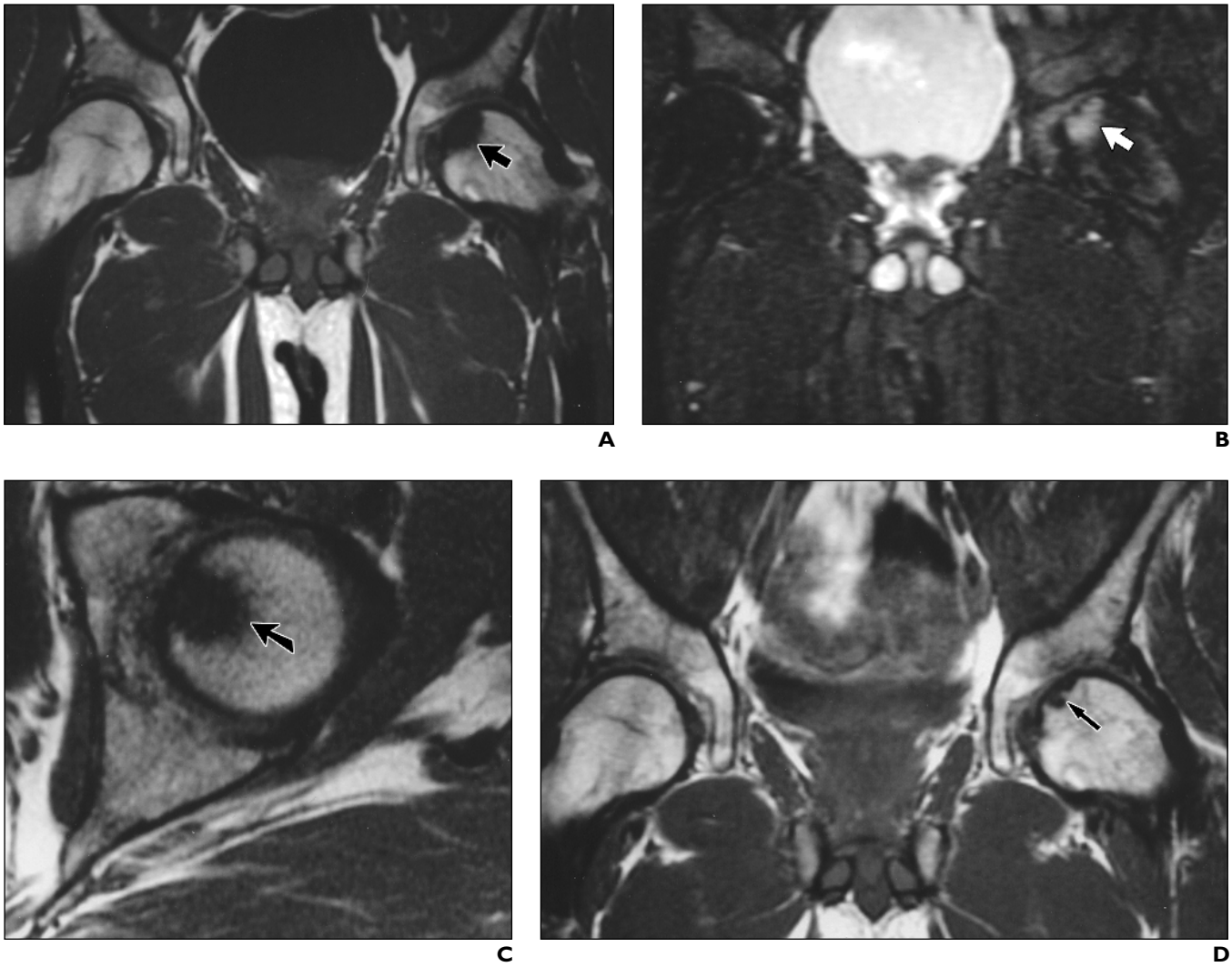



**Fig. 1.**—26-year-old male soccer player at time of presentation with 6-month history of left hip pain (**A**–**C**) and at 2-month follow-up (**D**–**G**).
**A,** Coronal T1-weighted image (TR/TE, 600/13) shows triangular-shaped area of decreased signal in 10–11 o'clock position (*arrow*).
**B,** Coronal T2-weighted image with fat suppression ($TR/TE_{eff}$, 3500/65) shows corresponding area of increased signal (*arrow*). Overlying cartilage is not seen well on this image.
**C,** Axial T1-weighted image (TR/TE, 600/13) shows medial location of this injury, as evidenced by decreased signal in marrow (*arrow*).
**D,** Coronal T1-weighted image (600/13) obtained at follow-up shows irregular contour in medial aspect of femoral head in location of previously seen triangular-shaped signal abnormality (*arrow*).
**(Fig. 1 continues on next page)**

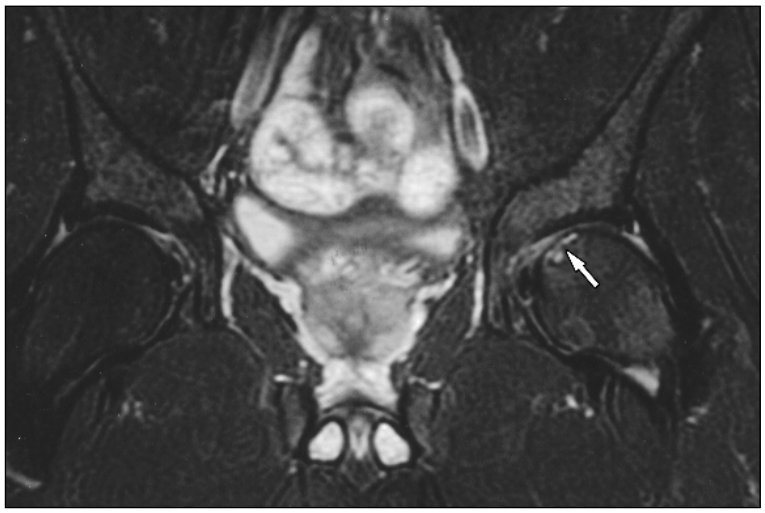
examination. In two of the three repeated examinations, the area of bone marrow edema had decreased in size in the interval. In the third, no change occurred in the size or appearance of the lesion over 4 years (Fig. 1).

## Discussion

Osteochondral lesions have been reported in the talus and knee and have a characteristic appearance on MR imaging [2]. We have recognized the appearance of such lesions in the hip and report on their MR imaging appearance and occurrence in elite athletes.

Osteochondral lesions of the talus and femoral condyles are thought to occur as a result of torsional impaction that causes microfractures of the subchondral bone and deformation of the overlying hyaline cartilage [3]. With enough impaction force, cartilage is deformed to the extent that it cannot return to its original shape on removal of pressure. Cartilage is known to have limited regenerative capacity, likely due to its avascularity, and when damaged, it undergoes chondrolysis, with the release of various enzymes and damage to the collagen fiber network. It is this process that is postulated to lead to the long-term degenerative sequelae sometimes seen in the knees or ankles of patients with previous osteochondral injury [4]. To prevent degenerative joint disease, prompt treatment of osteochondral lesions of the knee or talus is recommended [5, 6]. Arthroscopy, with removal of fragments and cartilage repair, is indicated in patients with gross cartilaginous disruption. For small disruptions or softening of the articular cartilage, it is recommended that the patient be removed from sports with weightbearing as tolerated for 6–12 weeks [7]. Despite treatment, many osteochondral lesions of the knee or ankle lead to degenerative sequelae and early osteoarthritis.

The MR imaging findings of the 11 patients in our series have the characteristic appearance of osteochondral lesions that are typically characterized by irregularity of the surface cartilage with abnormal bone marrow signal in the subchondral bone, often with an associated joint effusion. The medial location and focality of bone marrow edema in our series of patients



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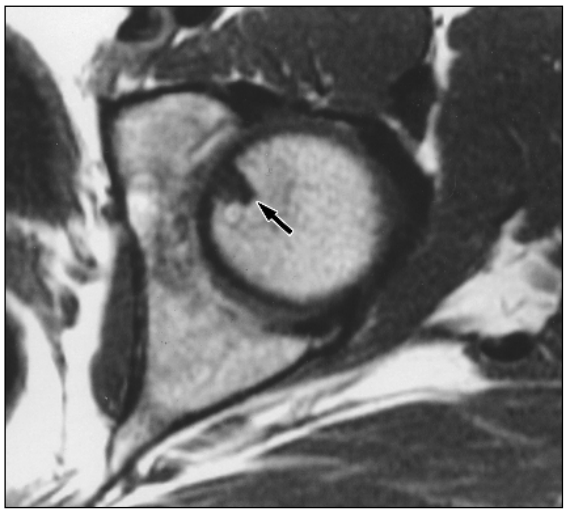

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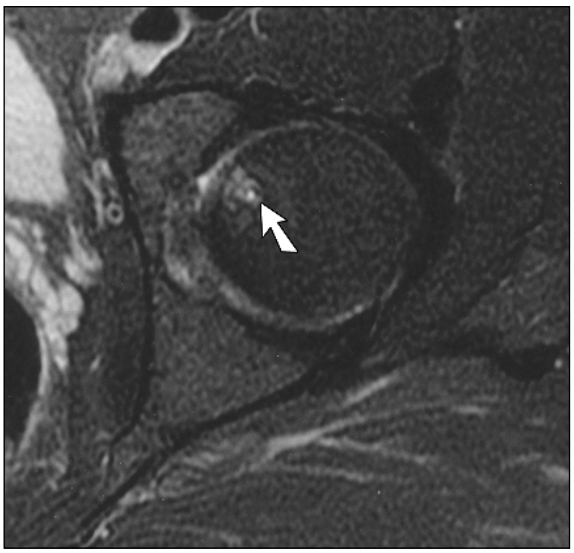

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**Fig. 1 (continued)**—26-year-old male soccer player at time of presentation with 6-month history of left hip pain (**A**–**C**) and at 2-month follow-up (**D**–**G**).
**E,** Corresponding coronal T2-weighted fat-suppressed image (TR/$TE_{eff}$, 3500/65) shows increased signal adjacent to region of curvilinear decreased signal in subarticular medial aspect of femoral head (*arrow*). Overlying cartilage may be thin in this location. Amount of edema has decreased in comparison with prior examination (**B**), but lesion is more organized.
**F,** Axial T1-weighted image (TR/TE, 600/13) shows decrease in bone marrow edema in comparison with prior study (**C**) (*arrow*).
**G,** Axial T2-weighted image with fat suppression (TR/$TE_{eff}$, 3500/65) shows decreased edema with focal area of high signal (*arrow*).

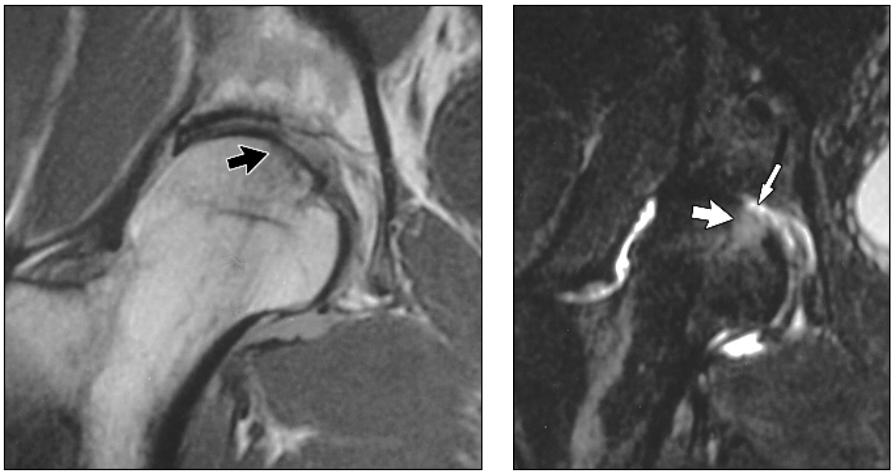

**Fig. 2.**—28-year-old male skier with 3-month history of hip pain.
**A,** Coronal T1-weighted image (TR/TE, 600/13) shows decreased signal in subchondral bone at medial aspect of femoral head (*arrow*).
**B,** Corresponding coronal (fast) short tau inversion recovery image (4000/35; inversion time, 150 msec) reveals increased signal in subchondral bone (*thick arrow*), with visible cartilage loss shown by joint fluid filling location of cartilage defect (*thin arrow*).

are in marked contrast to the typical location of classic avascular necrosis, which can have a similar imaging appearance but usually occurs in a larger area, between the 10 o'clock and 2 o'clock positions [8]. Additionally, stability or a decrease in size of the lesion on follow-up MR examinations in several patients supports the diagnosis of osteochondral lesion because avascular necrosis tends to progress rather than regress or resolve spontaneously [9]. Further, the patient population in which these lesions were identified is unique in terms of its youth and avid participation in sports; these are not the type of individuals predisposed to develop classic avascular necrosis or transient osteoporosis of the hip. Idiopathic transient osteoporosis of the hip has been described in middle-aged men and pregnant or recently pregnant women without a history of trauma. The imaging characteristics of our patients are not compatible with those of transient osteoporosis of the hip, which would involve more of the femoral head. The history of high-level participation by all 11 patients in sports that place torsional and impaction forces on the hips is consistent with the diagnosis of osteochondral lesion. Finally, arthroscopic evaluation performed on three patients actually revealed the cartilaginous defect in every case.

Most of the patients in our series were teenagers or young adults, and all participated in sports at a high level. Several played soccer, a sport known to predispose individuals to early degenerative changes of the hip. A study of 286 former elite European soccer players by Lindberg et al. [10] showed that coxarthrosis was three times more common in retired soccer players than in age-matched controls (mean age, 55 years). Other groups have found increased rates of degenerative disease in the hips of former avid athletes and have postulated that repeated compression of cartilage and shock forces to joints may be responsible [11, 12].

We believe that the lesions seen in the hips of the athletes in our series may be the type of acute–subacute injuries that predispose such individuals to early degenerative changes of the hips. The mechanism of injury leading to osteochondral injury in the hip is as yet uncertain; however, we propose two possible theories. The first theory implicates transient subluxation with resultant shearing of cartilage and underlying marrow edema. Subluxation could result from the large rotational component of forces placed on the hip while passing or kicking the ball. Such a mechanism would also be expected to result in MR evidence of damage to the joint capsule and associated soft-tissue injuries such as hematoma or edema in muscles or fat. Although these findings were not present in the patients in our series, delayed imaging could have resulted in missing the findings of injury from such a mechanism. The other postulated mechanism for occurrence of osteochondral lesions in the hip is impaction force, such as the force in sudden stops or landing from jumps. This mechanism would be expected to lead to marrow changes on both sides of the joint, known as "kissing contusions." Also, evidence of soft-tissue changes would not necessarily be expected from such a mechanism because all the abnormal forces would be transmitted directly to the joint itself. No consensus has yet been reached as the true culprit mechanism for osteochondral lesions in the hip.

Many classification schemes have been proposed for the characterization of osteochondral injuries of the ankle and knee on the basis of findings on MR imaging or arthroscopy, with the thought that the long-term outcomes of the various types of lesions may differ [5, 6, 13, 14]. These schemes are generally based on the amount of cartilaginous disruption (irregularity, flap, or free fragment) and the degree of abnormality of the adjacent subchondral bone

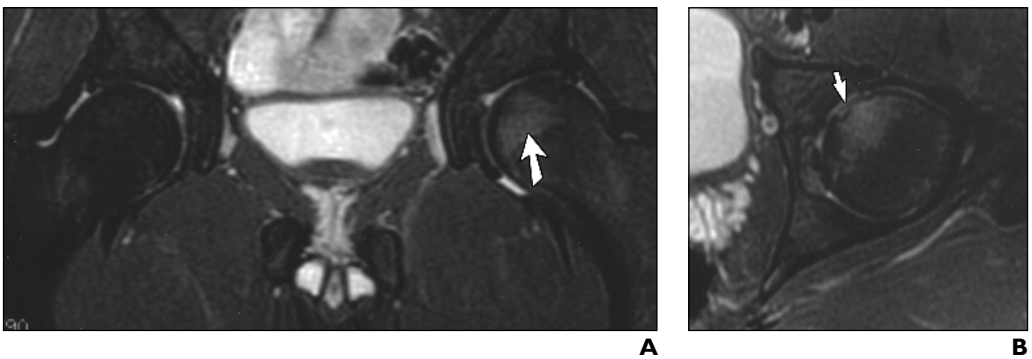

**Fig. 3.**—21-year-old male soccer player with acute hip pain.
**A,** Coronal T2-weighted fat-suppressed image ($TR/TE_{eff}$, 3500/65) shows area of increased signal consistent with bone marrow edema in medial aspect of femoral head (*arrow*).
**B,** Corresponding axial T2-weighted fat-suppressed image (3500/65) shows irregularity along articular surface compatible with small osteochondral lesion (*arrow*). Bone marrow edema is evident.

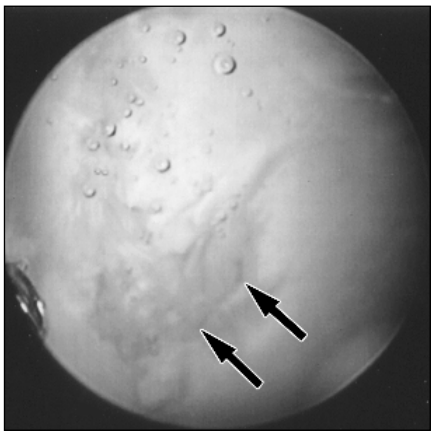

**Fig. 4.**—25-year-old male soccer player with 1-month history of hip pain. Image taken at time of arthroscopy shows large, irregular defect in femoral head articular cartilage (*arrows*). This defect is located over anteromedial aspect of femoral head.

(depression, frank indentation, or fracture). An MR classification scheme for osteochondral lesions of the femoral heads has not yet been developed. The development of a classification scheme would require a compilation of a large series of patients with MR imaging abnormalities. Unfortunately, our study is limited by a small number of patients and a lack of follow-up imaging or arthroscopy in several cases. Our findings, however, suggest that a population worthy of further examination would be avid athletes participating in a sport, such as soccer, which has been shown to predispose participants to the development of early degenerative changes of the hip.

Our overall understanding of radiographically occult osteochondral lesions has been greatly advanced over the past several years, as the use of MR imaging in patients with normal findings on radiographs has become more widespread and as improved sequences have allowed better determination of the condition of the articular cartilage [13–15]. Although osteochondral lesion is not a new diagnosis, our recognition of femoral head osteochondral lesions on MR imaging is likely reflective of the fact that MR imaging is now performed more frequently in patients with a symptomatic hip and normal radiographic findings. Also, whereas arthroscopy remains the gold standard for evaluation of cartilaginous injury, MR imaging is extremely helpful because of its ability to detect associated lesions in the subchondral bone and in the evaluation of joints in which arthroscopy is technically more difficult, such as the ankle or hip. Given the current widespread use of MR imaging for the evaluation of patients with knee or ankle pain, the diagnosis of osteochondral injuries of the talus or femoral condyles has become commonplace; however, the diagnosis by MR imaging of such lesions in the femoral heads has not, to our knowledge, been previously described. We believe that the MR imaging findings of the 11 patients in our series represent osteochondral lesions similar to those previously described in the talus and femoral condyles. Further, we believe that the lesions seen in the patients in our series may be at least partial contributors to the early onset of hip degenerative change previously described in elite athletes.

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