

## Computed tomography findings of subchondral insufficiency fractures of the femoral head



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### ABSTRACT

**Objectives:** The objective of this study was to describe the appearance of Subchondral insufficiency fracture (SIF) by computed tomography (CT).

**Methods:** Images of 52 consecutive patients diagnosed with SIF were retrospectively reviewed. CT was available for five patients (7 cases).

**Results:** Corresponding to a low-intensity band on MR images, a radiolucent or sclerotic band was observed on CT images.

**Conclusion:** The present study is the first to report CT findings of SIF. A radiolucent or sclerotic band was observed on CT images. The results of the present study provide useful information for diagnosis of SIF.

### 1. Introduction

Subchondral insufficiency fracture (SIF) of the femoral head has been reclassified as a cause of acute hip pain.<sup>1–3</sup> Affected patients typically complain of acute hip pain with no obvious antecedent trauma.<sup>1,4–6</sup> Radiographs obtained at the onset of hip pain show femoral head collapse or no obvious findings in the majority of cases. T1-weighted magnetic resonance (MR) images reveal low-intensity bands in the subchondral area of the femoral head, which tend to be irregular, disconnected, and convex to the articular surface.<sup>1,3,7</sup> These low-intensity bands have been histologically shown to correspond to the fracture line of the associated repaired tissue.<sup>4,8</sup> The low-intensity band is surrounded by a bone marrow edema pattern, which is observed as a homogenous and ill-delimited low-signal intensity area on T1-weighted MR images and high-signal intensity on T2-weighted MR images.<sup>9</sup>

Few studies have reported modalities other than MR imaging (MRI) for diagnosis of SIF. Of these, Miyanishi et al reported one case with transient osteoporosis of the hip, which had a subchondral fracture line of the femoral head on computed tomography (CT).<sup>10</sup> However, the imaging appearance of SIF on CT has not been described in detail. Therefore, the aim of the current study was to describe the appearance of SIF on CT.

### 2. Methods

#### 2.1. Patients

The protocol of the present retrospective study was approved by the local institutional review board. The medical records of 52 consecutive patients diagnosed with SIF between June 2007 and April 2014 at our institution were retrospectively reviewed. CT scans were available for five patients (two males and three females; mean age 57.2 years; age range, 23–81 years), which involved two bilateral cases. Of the five patients (seven cases), one had a history of corticosteroid therapy for asthma and one had a history of uterine cancer.

A diagnosis of SIF was based on the following published criteria<sup>1,8,11</sup>: (1) hip pain with no apparent history of trauma; (2) radiographic findings that were normal or showed collapse of the femoral head, joint space narrowing, and/or linear patchy sclerotic areas in the superior portion of the femoral head; (3) a bone marrow edema pattern in the femoral head and/or neck on MR images; and (4) a subchondral low-signal intensity band on T1-weighted MR images that was serpiginous or paralleled the articular surface.

All patients were initially managed by conservative treatment, which consisted of rest and avoidance of weight-bearing activities for 6–8 weeks. Radiographically, the presence of a subchondral fracture,

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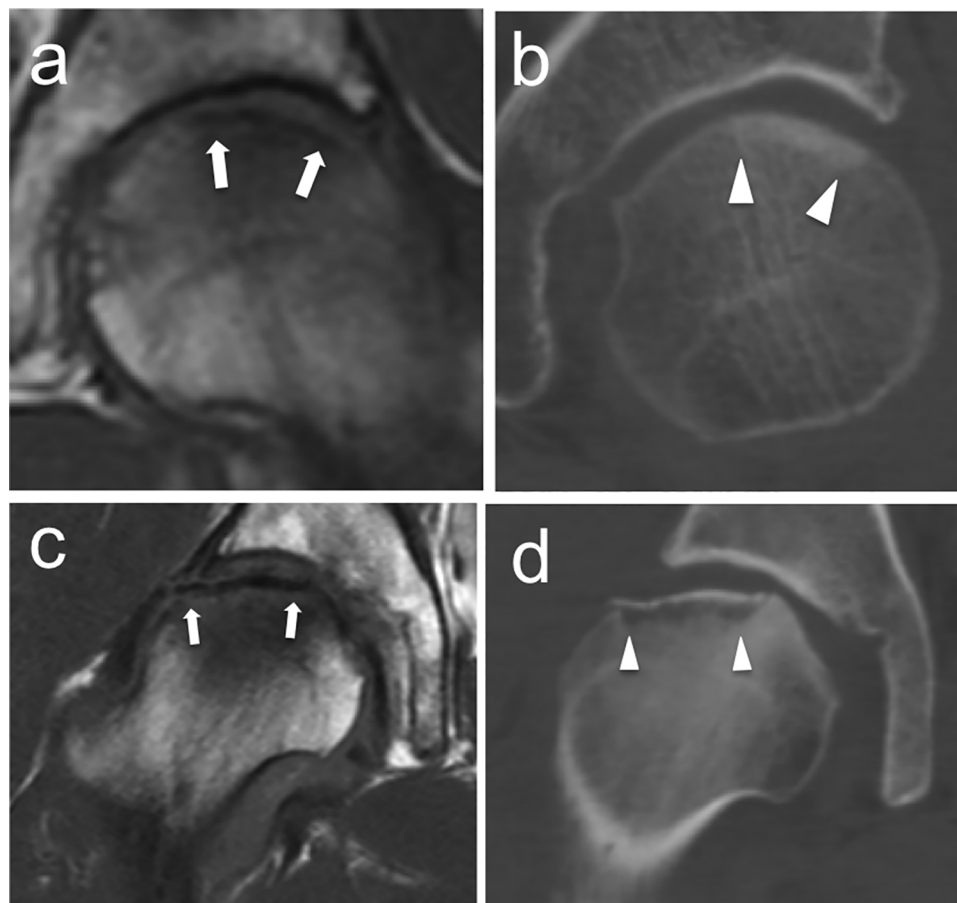
**Table 1**  
Clinical characteristics and CT findings of the femoral head.

Case No.	Sex	Age	MRI (weeks) <sup>b</sup>	CT (weeks) <sup>c</sup>	Clinical Outcome	Collapse	Radiolucent band	Sclerotic band
1 <sup>a</sup>	Male	47	6.8	7.6	Conservative	–	–	+
2 <sup>a</sup>	Male	47	6.8	7.6	Conservative	–	–	+
3	Female	74	8.8	15.6	THA	+	+	–
4 <sup>a</sup>	Male	23	7.2	8.8	ARO	+	+	–
5 <sup>a</sup>	Male	23	7.2	8.8	ARO	+	+	–
6	Female	81	2.8	6.8	THA	+	+	–
7	Female	61	2.0	3.2	Conservative	–	–	+

<sup>a</sup> Bilateral case.

<sup>b</sup> From onset to MRI.

<sup>c</sup> From onset to CT. THA, total hip arthroplasty; ARO, anterior rotational osteotomy of the femoral head.



**Fig. 1.** A 47-year-old male (Case 2 in Table 1): (a) T1-weighted MR image on coronal slice shows a low-signal intensity band (arrows). (b) CT (coronal slice) shows a sclerotic band corresponding to the band on the MR image (arrowheads). A 23-year-old male (Case 4 in Table 1): (c) T1-weighted MR image on coronal slice shows a low-signal intensity band (arrows), (d) CT (coronal slice) shows a radiolucent band corresponding to the band on the MR image (arrowheads) and collapse of the femoral head. No sclerotic band is observed.

patchy sclerosis, progression of collapse, and osteoarthritic change (joint space narrowing) were investigated on both the anteroposterior and lateral views, where progression of collapse was an indication of surgical treatment. For patients who did not undergo surgery, follow-up MRI was performed at approximately 6 or 12 months after the first visit.

**2.2. MRI**

MRI was performed using a 1.5-T or 3.0-T MR system. T1-weighted MR images (repetition time/echo time = 400–675/8–19 msec, field of view = 35–68 cm, matrix = 220–512 × 256–512, slice thickness = 3–5 mm) in the coronal plane were available for all patients. The hip position was neutral during MRI; namely, flexion, extension, abduction, adduction, internal rotation, and external rotation were each zero degrees.

**2.3. CT scans**

All CT images were obtained using a 64-detector-row CT scanner (Aquilion; Toshiba Medical Systems Corporation, Tokyo, Japan) with a 648 × 648 matrix, 2-mm section thickness, and field of view of 320 mm. Coronal CT slices were observed by two subspecialized hip joint surgeons with 4 and 7 years of experience, respectively. CT findings were compared with MR images.

**2.4. Histopathological findings**

For patients receiving total hip arthroplasty, a diagnosis of a subchondral insufficiency fracture was based on histopathological findings. Macroscopically, a linear fracture with a whitish-gray appearance paralleling the subchondral bone endplate was observed. Microscopically, the whitish-gray area consisted of irregularly arranged fracture calli and granulation tissue. It should be noted that small areas

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