



Fate of subchondral fatigue fractures of femoral head in young adults differs from general outcome of fracture healing[☆]



Sang-Min Kim^b, Seung-Min Oh^b, Chang-Ho Cho^b, Seung-Jae Lim^a, Young-Wan Moon^a, Sang-Hee Choi^c, Youn-Soo Park^{a,*}

^a Department of Orthopaedic Surgery, Samsung Medical Center, Sungkyunkwan University School of Medicine, Seoul, South Korea

^b Department of Orthopaedic Surgery, Seoul Medical Center, Seoul, South Korea

^c Department of Radiology, Samsung Medical Center, Sungkyunkwan University School of Medicine, Seoul, South Korea

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ABSTRACT

Purpose: The purpose of this study is to report the clinical course of fatigue-type subchondral fractures of the femoral head in young healthy adults.

Materials/Methods: We retrospectively reviewed 28 consecutive patients (34 hips) who had a clear history of a sudden increase in physical activity without trauma on the hip and pelvis, and were diagnosed as having a fatigue-type subchondral fracture of the femoral head. The diagnosis was made primarily on the basis of sequential plain radiographs and magnetic resonance images.

Results: Of the 34 hips, 19 hips with no bony collapse experienced gradual disappearance of subjective pain a few months after onset, and there were no recurrences. Other 2 hips that showed bony collapse, but preserved the articular margin, also experienced no definite deterioration of collapse or arthritic change and did not need surgical intervention. In the remaining 13 hips with bony collapse and destroyed articular margin or arthritic change, hip pain gradually worsened necessitating surgery.

Conclusions: The current findings suggest that a subchondral fatigue fracture of the femoral head could show a different severity of subchondral injury over time. In the collapsed subchondral fatigue fractures, especially when combined with head incongruency, the hip pain was aggravated enough to require surgical intervention.

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Introduction

Although a subchondral stress fracture of the femoral head is a rarely encountered condition, a number of studies have reported the above disease entity in recent decades [1,3,4,7,11,16,17]. The majority of these reports, however, have focused on insufficiency-type stress fractures occurring in the elderly [1,4] or in young adults without any history of overexertion [5,16].

There have been few studies on clinical outcomes in patients with fatigue-type stress fractures of the femoral head since Visuri [12] described stress osteopathy of the femoral head in ten military recruits. These studies commonly emphasized that the fracture differed from osteonecrosis in terms of disease outcomes, although

the precise prognosis of a subchondral fracture of the femoral head was still unknown [5,9]. Lee et al. [6] concluded that collapsed fatigue fractures heal without progression of the collapse or destruction of the joint and clinical symptoms disappear, unlike collapsed osteonecrosis.

However, Yamamoto et al. [16] described that several overlaps in clinical imaging were often seen between insufficiency-type subchondral fractures and osteonecrosis, when the femoral head was collapsed. In cases of insufficiency-type fractures, some have been reported to undergo collapse necessitating surgery, and sometimes, to show rapid progression of the collapse, such as seen in rapidly progressive coxarthropathy [19,20]. In the knee joint, secondary arthropathy, which results from a subchondral insufficiency fracture, was reported [15]. In all of these 14 cases, operative intervention was performed due to progressive worsening of the pain.

Recently, we have observed sequential radiological changes of the femoral head with fatigue-type subchondral fractures over time. Although some hips with subchondral fractures were generally expected to make a gradual recovery, a considerable

[☆] This study was approved by the institutional review board at the Samsung Medical Center (Seoul, Korea).

* Corresponding author at: Department of Orthopedic Surgery, Samsung Medical Center, Sungkyunkwan University School of Medicine, 50 Irwon-dong, Gangnam-gu, Seoul, 135-710, South Korea.

E-mail address: ysp3504@skku.edu (Y.-S. Park).

number of hips with a collapsed femoral head have shown secondary arthritic changes, and their subjective symptoms have often been worsened to require operative treatment. Based on these experiences, we hypothesized that, if fatigue-type subchondral fractures were collapsed followed by a loss of head sphericity, their fate would progress unlike the general outcome of fracture healing. In this study, the authors evaluate the clinical course of fatigue-type subchondral fractures of the femoral head in healthy young patients with a history of overexertion.

Materials and methods

We retrospectively identified 1264 consecutive patients (1420 hips) under the age of 30 who visited the authors' hospital due to the hip pain, between October 2000 and August 2011. Details of their clinical data were extracted from patient charts and Picture Archiving and Communications System (PACS, General Electric, Milwaukee, WI). One radiologist (CHC) with a specialization in musculoskeletal disorder and two orthopedic surgeons (YSP and SMK) participated in their diagnostic process to confirm a diagnosis. Three investigators assessed the clinical course, simple radiographs and MRIs of all patients two times with an interval of 3 months. Of the 1264 patients, 28 (34 hips) were diagnosed with a subchondral fatigue fracture of the femoral head under unanimous decision of these three investigators. This study was approved by the institutional review board at the Samsung Medical Center (Seoul, Korea).

All patients mentioned a clear history of sudden physical overexertion during at least 1 month, without trauma on the hip or pelvis. They were healthy with no history of any associated disease or treatment with medication, and with no predisposing factors for osteonecrosis of the femoral head except smoking. Seven patients were smokers who had a mean 1.6-pack-year history (range, 0.4–3.2 pack-year) before the onset of hip pain. A blood examination revealed no abnormality in their hormonal, renal or liver functions. No evidence of infection, neuropathy, osteoporosis or inflammatory disease was noted.

Anteroposterior (AP) and frog-leg plain radiographs of both hips were obtained to identify the subchondral fracture line, bony collapse, and loss of sphericity. In subchondral fractures combined with arthritic change, the severity of the arthritic change was graded according to the modified Tönnis grading system [10]. The MR imaging criteria for subchondral fractures are described in previous reports [3,13,16,20]. The MRI findings were evaluated initially, focused on bone marrow edema, joint effusion, and loss of cartilage barrier. Low signal intensity bands on T1-images, high signal of the proximal segment on gadolinium or T2-images, and subchondral fracture lines were also investigated on MR images. Computed tomography was available for 6 hips.

Of the 28 patients, 26 were military recruits and 1 was a naval cadet, at the time of onset of hip pain. The remaining one was a Taekwondo player in a college of physical education. There were 27 males and 1 female, with a mean age of 21.4 years (range, 19–26 years). The right hip was affected in 18 hips and the left hip in 16. Both femoral heads were affected in 8 patients. The mean height of the patients was 175.2 cm (range, 163–184 cm), and the mean weight was 67.4 kg (range, 54–78 kg). The mean body mass index was 22.4 kg/m² (range, 19.3–26.2 kg/m²). The mean follow-up period was 57.4 months (range, 12–159 months). Subjective hip pain developed between 2 weeks and 1 month after physical overexertion began. Patients' symptoms occurred mainly after repetitive bending forward, forced long walks with heavy bags or martial arts. The mean duration period between the onset of the subjective symptoms and the time of diagnosis was 4.4 months (0.5–16 months). After a diagnosis was made in our clinic, all patients stopped their training or exercise program. Two patients

(3 hips) underwent operative intervention under a misdiagnosis of osteonecrosis of the femoral head before they visited our outpatient clinic.

Results

Plain radiographic findings

Of the 34 hips, 10 hips showed no apparent abnormalities on initial radiographs, while 24 hips showed a fracture line, bony collapse, demarcating sclerosis under the fracture line, loss of head sphericity, or arthritic change of the femoral head (Table 1). Of the 12 hips whose initial radiographs had shown no definite abnormalities, 3 hips progressed to collapse. The collapse of the femoral head was observed in 15 hips at the 1st visit to our clinic. Arthritic change of the hip joint had already been found in 3 hips.

MRI findings

Initial MRI findings of all hips are summarized in Table 2. Fracture lines were seen in all of 34 hips. In 2 of 34 hips, the contralateral side of the affected hip initially showed bony edema and joint effusion and afterwards, these findings disappeared. Of the 32 hips that showed a low signal band on T1-weighted images, the shape of the band was convex or parallel to the cartilage surface in 30 hips (Fig. 1), while the shape was concave in 2 hips. Nine hips that showed irregularity or discontinuity of the articular cartilage, showed various depressions of the subchondral bone lined with fibrocartilaginous tissue (Fig. 2).

The above-mentioned plain radiographic and magnetic resonance findings supporting the diagnosis of a subchondral fracture of the femoral head, could be categorized into four criteria over the course of time. Based on the current findings, a sequential staging system of subchondral fatigue fractures may be carefully presented below (Table 3).

In stage 0, the radiographic appearance is normal and MRI also shows only bony edema and joint effusion. In stage I, the simple radiographs have no apparent abnormal findings (stage Ia) or show crescent signs (Stage Ib, Fig. 3a), but the fracture line is evident on MRI images. Characteristic MRI findings, including a band-like low signal intensity lesion combined with the surrounding bone marrow edema can be seen on T1-weight images (Fig. 1). In stage II, the femoral head shows irregular shaped deformity due to the bony collapse on plain radiographs. Immediately after bony collapse, plain radiographs show preservation of the articular margin, combined with underlying demarcating sclerosis (Stage IIa, Fig. 3b), but with progression of subchondral collapse, the articular margin is depressed and radiolucent area is expanded (Stage IIb, Fig. 3c). With further progression, the subchondral bone is detached from the femoral head, and an oval-shaped bone defect is seen (Stage IIc, Figs. 3d and 4). In this stage, magnetic resonance images reveal irregularity or discontinuity of the articular cartilage and various depressions of the subchondral bone lined with

Table 1
Initial radiographic findings of 34 hips with the subchondral fatigue fracture of the femoral head.

	Number of hips (%)
Subchondral fracture line	24/34 (70.6)
Collapsed bony lesion	15/34 (44.1)
Demarcating sclerosis under fracture line	11/34 (32.4)
Loss of head sphericity (head incongruency)	13/34 (38.2)
Secondary arthritic change (such as bony spur or cyst)	3/34 (8.8)
Modified Tönnis grade 0 or I	2/34 (5.9)
Modified Tönnis grade II or III	1/34 (2.9)

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