

Subchondral insufficiency fracture of the femoral head in males

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Abstract

Objective Subchondral insufficiency fracture of the femoral head (SIF) has been reported to be observed mainly in the elderly osteoporotic females and most of the studies on SIF have been made based on female patients. The purpose of this study is to document the clinical characteristics of SIF observed in male patients.

Patients and methods Between 2001 and 2011, we have diagnosed 39 consecutive SIF hips in our department, based on imaging studies and/or histologic examinations. Among them, 14 hips (35.8 %) were of male SIF patients. Their clinico-radiological characteristics were reviewed.

Results The age range in male SIF patients was 16–62 (ave. 44 years), while that in females was 22–84 (ave. 66 years) ($p < 0.001$). In male patients, 12 out of 14 hips (86 %) healed by non-surgical treatments, while 2 hips (14 %) underwent surgical treatments (one case: total hip arthroplasty, and one: anterior rotational osteotomy). On the other hand, in female patients 12 out of 25 (48 %) healed, while surgical treatments and/or progression of a collapse were observed in 13 hips (52 %) ($p < 0.05$). Both body mass index and bone mineral density showed no significant difference between male and female SIF patients.

Conclusions SIF in male is observed mainly in their 40s, and their prognosis seems to be good as compared to that in females.

Keywords Subchondral insufficiency fracture · Femoral head · Prognosis · Gender

Introduction

Subchondral insufficiency fractures of the femoral head (SIF) have been reported to occur mainly in osteoporotic elderly female patients [1–4]. Patients suffer from acute onset of hip pain without an obvious evidence of antecedent trauma. On T1-weighted MRI, a very low-intensity band in the subchondral area is a characteristic appearance, which tends to be irregular, disconnected and convex to the articular surface [2, 3]. This low-intensity band histologically corresponds to the fracture line and associated repair tissue [5]. Some cases of subchondral insufficiency fracture were managed by non-operative treatments, while others demonstrated disease progression until bone collapse which necessitated surgery [1–4]. The prognosis of SIF still remains unclear.

According to the English literature published between 1996 and 2000, approximately 29 cases of SIF were reported, which include 3 men and 26 women aged 61–88 (mean 72) years [1–6]. SIF was thus considered to be most commonly observed in elderly women, and clinical as well as radiographical studies have been reported mainly based on female SIF patients.

The purpose of this study is to investigate the clinical characteristics in male SIF patients and to compare them with those in females.

Patients and methods

The present study was approved by the institutional review board at the Kyushu University.

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Between April 2001 and March 2011, we have diagnosed 39 consecutive SIF hips in 38 patients in our department, where sequential imaging studies were available. The age range was 16–84 (ave. 58 years). In all the 39 hips, the diagnosis of SIF was made based on the following published criteria (1–5): (1) radiographs that are normal or show collapse of the femoral head and/or a linear patchy sclerotic area in the femoral head; (2) a bone marrow edema pattern in the femoral head and/or neck on MR images; (3) a subchondral low signal intensity band on T1-weighted MR images which is either serpiginous or parallel to the articular surface; (4) high signal intensity of the proximal lesion from the low-intensity band on the gadolinium-enhanced MR imaging; and (5) fractured bone trabeculae and associated fracture callus formation without any evidence of predisposing osteonecrosis on histology [5].

All patients were initially administered non-surgical treatments, which consisted of the avoidance of weight bearing for 2–8 weeks and use of anti-inflammatory drugs only when they had difficulty in sleeping. Thereafter, gradual weight bearing using crutches was allowed. During this period, bisphosphonate or drugs for osteoporosis were not used in any of the patients. Both the clinical assessment and the follow-up radiographs were obtained every month in all patients, in which the progression of collapse and severity of pain were evaluated. If the patients had an increase of hip pain due to the progression of a collapse, surgical treatments were considered. Patients with a history of any previous surgery or infection in the hip joint were excluded.

The age at the onset of hip pain, bone mineral density (BMD) based on the lumbar spine or contralateral side of the femoral neck, the body mass index (BMI) and the period between the onset of hip pain and pain relief were documented. Antero-posterior and lateral radiographs in both hips were obtained every month after the onset of hip pain. MRI was obtained within 2–6 weeks after the onset of hip pain in all the 39 hips. In young patients (less than

30 years of age), both blood and hormonal examinations were performed.

The differences in age, BMI, BMD and period for the recovery were analyzed using Student's unpaired *t* test. Fisher's exact test was used to analyze the affected side and outcome. Differences with *p* values of less than 0.05 were considered to be statistically significant.

Results

All of the 39 hips were diagnosed and confirmed as SIF based on the previously published criteria [1–5]. Among the 39 SIF hips, 14 hips (35.8 %) were of male and 25 hips (64.2 %) of female SIF cases. The age range in male SIF patients was 16–62 (ave. 44 years), while that in females was 22–84 (ave. 66 years) ($p < 0.001$). In male SIF hips, the affected side was right in 3 and left in 11, while 13 in right and 12 in left in female patients. BMI in male patients was 23.5, while that in female patients was 23.8. As to BMD (*T*-score), no significant difference was noted between male (-1.62 SD) and female patients (-1.72 SD) (Table 1).

In male SIF patients, 12 out of 14 hips (86 %) healed by non-surgical treatments (Figs. 1, 2), while 2 hips (14 %) underwent surgical treatments (66 years old; total hip replacement, 16 years old; transtrochanteric anterior rotational osteotomy). On the other hand, in female patients 12 out of 25 hips (48 %) healed, while surgical treatments and/or progression of collapse was observed in 13 of 25 (52 %) ($p < 0.05$). Among these 13 hips, one patient denied having surgical treatments despite the progression of a collapse in the hip and following joint space narrowing. Three hips in female SIF cases showed rapid progression of a collapse such as seen in rapidly destructive coxarthrosis, but none of the hips in male cases showed such a rapid destruction. The period between the onset of pain and recovery was 4 months in male and 5.6 months in female patients (Table 1).

Table 1 Clinical characteristics of SIF cases

	Male	Female	<i>p</i>
Age (years; mean \pm SD)	44.1 \pm 12.7	66.3 \pm 13.9	<0.001
Side (Rt/Lt)	3/11	13/12	0.087
BMI (mean \pm SD)	23.5 \pm 1.0	23.8 \pm 0.7	0.410
BMD (<i>T</i> -score; mean \pm SD)	-1.62 ± 0.17	-1.72 ± 0.16	0.657
Prognosis			
Healed	12 (86 %)	12 (48 %)	0.039
Surgery or progression of a collapse	2 (14 %)	13 (52 %)	
Period for the recovery (months; mean \pm SD)	4.0 \pm 2.0	5.6 \pm 2.3	0.078

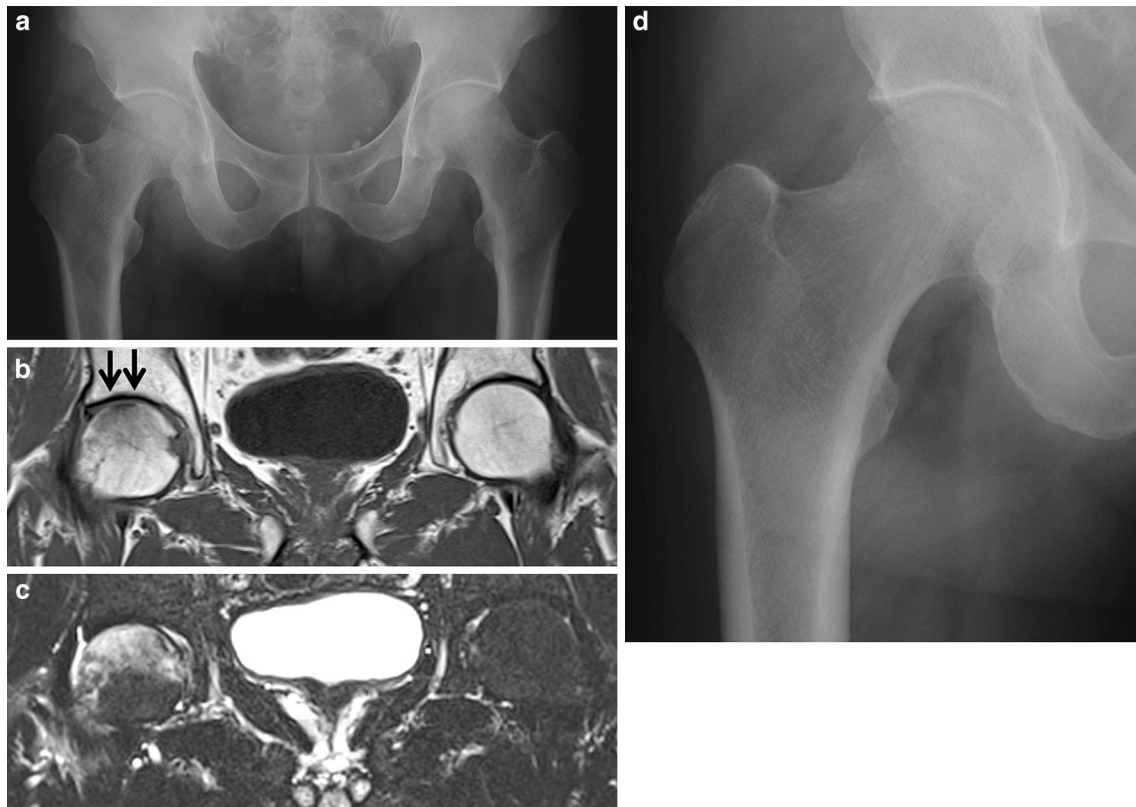


Fig. 1 **a** A 45-year-old man had a sudden onset of severe right hip pain. Radiograph obtained at the onset of hip pain shows no obvious changes. No evidence of osteoporosis or osteopenia is seen. MRIs show diffuse low intensity on T1 (**b**) and high intensity on STIR (**c**). In T1-weighted image, a very low-intensity band is seen just beneath

the articular cartilage (*arrows*), which is an evidence of SIF. **d** This patient was followed up by non-surgical therapy, including 2-month periods of two-crutch use and thereafter gradual increase of weight bearing. Five months later, he had no symptoms and radiograph showed no abnormalities

Both blood and hormonal examinations [calcium, ALP, PTH, 25(OH)vitamin D, and NTX in urine] were performed in 3 patients less than 30 years of age (16- and 21-year-old males and 21-year-old females), which revealed no conditions that predisposed the patients to osteoporosis, such as hyperparathyroidism or abnormalities in calcium or phosphate metabolism.

Histological examinations were performed in all the cases that underwent surgical treatments, including 2 males and 12 females, which all showed fractured bone trabeculae with associated fracture callus formation and granulation tissue. No evidence of predisposing osteonecrosis was observed in any of the patients [5].

Discussion

One of the important differential diagnoses in determining a subchondral insufficiency fracture of the femoral head may include osteonecrosis. Since a subchondral collapse is often observed in osteonecrosis, radiographic appearances have several overlaps between osteonecrosis and

subchondral insufficiency fracture [7]. In a subchondral insufficiency fracture, low-intensity band on the T1-weighted magnetic resonance images has been reported to correspond histologically to the fracture line and associated fracture repair tissue [5]. Therefore, the shape of the low-intensity band generally tends to be irregular, disconnected, and convex to the articular surface [1–5]. All the 39 hips in this study showed an irregular-shaped low-intensity band on the T1 MR images.

Transient osteoporosis of hip is generally seen in pregnant women and middle-aged men [8]. It is characterized clinically by hip pain without any obvious antecedent trauma. The radiologic characteristics of the affected femoral head are focal loss of radiodensity, a diffuse homogeneous uptake on bone scintigraphy, and a bone marrow edema pattern on MR images [8–11]. All the SIF patients reported herein showed bone marrow edema on MRI, while definite radiographic evidence of local osteoporosis was not obvious in the femoral head. Recent studies suggest that a subchondral insufficiency fracture of the femoral head might have some relation to TOH, and the clinical appearances in male SIF also have some overlap

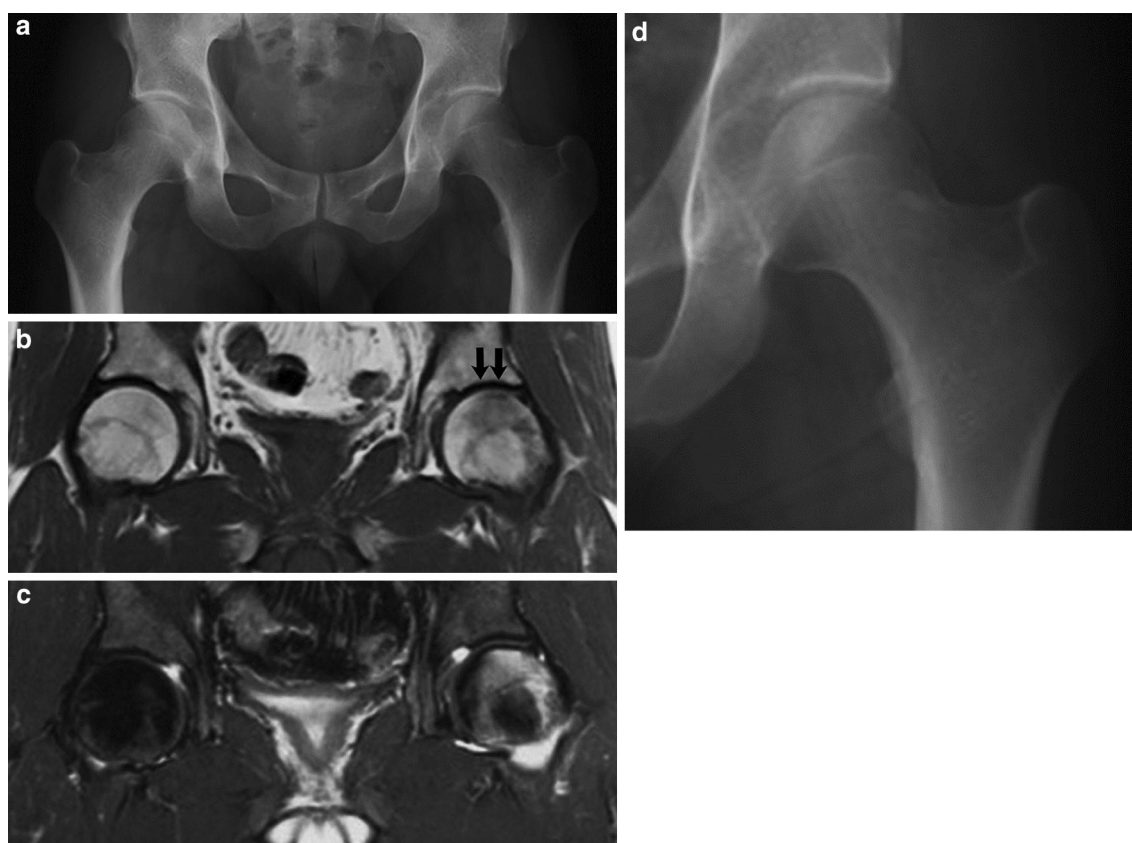


Fig. 2 **a** A 34-year-old man had a sudden onset of severe left hip pain. Radiograph obtained at the onset of hip pain shows no obvious changes. MRIs show diffuse low intensity on T1 (**b**) and high intensity on STIR (**c**). In T1-weighted image, a very low-intensity band is seen beneath the articular cartilage (*arrows*). **d** This patient

was followed up by the non-surgical therapy, including 2-month periods of two-crutch use with hospitalization and thereafter gradual increase of weight bearing. Three months later, the left hip pain disappeared and radiograph obtained 9 months after the onset showed no abnormalities

with those in TOH [10, 11]. Although the cases included in this study have not completely fulfilled the criteria of TOH based on the radiographic evidence of osteoporosis, we need more documented male SIF cases to clarify the relationship between TOH and SIF, especially in male cases.

The prognosis of SIF depends on a number of variables including age, degree of osteopenia, activity, body weight, and extent of fracture, as well as initial treatment [1–4, 12]. Some cases of SIF have been reported to heal after non-surgical therapy, while other cases have been reported to undergo collapse necessitating surgery [1–4]. Why male SIF cases in this study have a good prognosis is not clear, but the younger age in male SIF cases may have some influences on the outcome. In addition, some SIF cases have been reported to show rapid progression of the collapse, such as seen in rapidly progressive arthrosis of the hip [6]. In this study, none of the male SIF cases showed rapid destruction of the hip joint.

The major limitation of this study was a small sample size and a retrospective observational design. Since SIF

is a relatively new concept, further large prospective studies are necessary. Secondly, in the present study, it is unclear why the outcome is different between the male and female cases. More detailed hormonal analysis as well as BMD measurements focusing on the subchondral area of the femoral head may be necessary. Thirdly, the relationship between SIF and TOH still needs to be clarified.

In conclusion, a subchondral insufficiency fracture of the femoral head in males is mainly observed in their 40s and the prognosis tends to be good as compared to that in female patients.

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Ethical standard Each author certifies that all investigations were conducted in conformity with the ethical principles of research.

References

1. Bangil M, Soubrier M, Dubost JJ, Rami S, Carcanagus Y, Ristori J, Burriere J (1996) Subchondral insufficiency fracture of the femoral head. *Rev Rhum Engl Ed* 63:859–861
2. Rafii M, Mitnick H, Klug J, Firooznia H (1997) Insufficiency fracture of the femoral head: MR imaging in three patients. *AJR* 168:159–163
3. Yamamoto T, Bullough PG (1999) Subchondral insufficiency fracture of the femoral head: a differential diagnosis in acute onset of coxarthrosis in the elderly. *Arthritis Rheum* 42:2719–2723
4. Hagino H, Okano T, Teshima R, Nishi T, Yamamoto K (1999) Insufficiency fracture of the femoral head in patients with severe osteoporosis: report of 2 cases. *Acta Orthop Scand* 70:87–89
5. Yamamoto T, Schneider R, Bullough PG (2000) Insufficiency subchondral fracture of the femoral head. *Am J Surg Pathol* 24:464–468
6. Yamamoto T, Bullough PG (2000) The role of subchondral insufficiency fracture in rapid destruction of the hip joint: a preliminary report. *Arthritis Rheum* 43:2423–2427
7. Ikemura S, Yamamoto T, Motomura G, Nakashima Y, Mawatari T, Iwamoto Y (2010) MRI evaluation of collapsed femoral heads in patients 60 years old or older: differentiation of subchondral insufficiency fracture from osteonecrosis of the femoral head. *Am J Roentgenol (AJR)* 195:63–68
8. Curtiss PH Jr, Kincaid WE (1959) Transitory demineralization of the hip in pregnancy. A report of three cases. *J Bone Joint Surg Am* 41:1327–1333
9. Potter H, Moran M, Schneider R, Bansal M, Sherman C, Markisz J (1992) Magnetic resonance imaging in diagnosis of transient osteoporosis of the hip. *Clin Orthop* 280:223–229
10. Miyanishi K, Yamamoto T, Nakashima Y, Shuto T, Jingushi S, Noguchi Y, Iwamoto Y (2001) Subchondral changes in transient osteoporosis of the hip. *Skeletal Radiol* 30:255–261
11. Vande Berg BC, Lecouvet FE, Koutaissoff S et al (2008) Bone marrow edema of the femoral head and transient osteoporosis of the hip. *Eur J Radiol* 67:68–77
12. Vande Berg BC, Malghem J, Goffin EJ, Duprez TP, Maldague BE (1994) Transient epiphyseal lesions in renal transplant recipients: presumed insufficiency stress fractures. *Radiology* 191:403–407