CASE REPORT

Case Report

Multifocal Subchondral Stress Fractures of the Femoral Heads and Tibial Condyles in a Young Military Recruit

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Abstract

Background Subchondral stress fractures of the femoral head may be either of the insufficiency-type with poor quality bone or the fatigue-type with normal quality bone but subject to high repetitive stresses. Unlike osteonecrosis, multiple site involvement rarely has been reported for subchondral stress fractures. We describe a case of multifocal subchondral stress fractures involving femoral heads and medial tibial condyles bilaterally within 2 weeks.

Case Description A 27-year-old military recruit began having left knee pain after 2 weeks of basic training, without any injury. Subsequently, right knee, right hip, and left hip pain developed sequentially within 2 weeks. The diagnosis of multifocal subchondral stress fracture was confirmed by plain radiographs and MR images. Nonoperative treatment of the subchondral stress fractures of both medial tibial condyles and the left uncollapsed femoral head resulted in resolution of symptoms. The collapsed right femoral head was treated with a fibular strut allograft to restore congruity and healed without further collapse.

Literature Review There has been one case report in which an insufficiency-type subchondral stress fracture of the femoral head and medial femoral condyle occurred within a 2-year interval.

Clinical Relevance Because the incidence of bilateral subchondral stress fractures of the femoral head is low and multifocal involvement has not been reported, multifocal subchondral stress fractures can be confused with multifocal osteonecrosis. Our case shows that subchondral stress fractures can occur in multiple sites almost simultaneously.

Introduction

Subchondral stress fractures of the femoral head are classified as insufficiency-type in which the bone quality is poor and typically fractures with normal activity, and fatigue-type stress fractures in which the bone quality is normal but is subjected to repetitive high stresses [8]. The former type of fracture occurs not only in elderly patients with poor bone quality, but also in patients treated with corticosteroids for systemic lupus erythematosus [16], rheumatoid arthritis [9], and kidney or liver transplantation [5, 6]. The latter type of fracture occurs in healthy adults [7, 8, 13].

Because the clinical features and radiologic findings of subchondral stress fractures of the femoral head are similar to those for osteonecrosis or transient osteoporosis of the hip, it is difficult to distinguish between them [13, 14]. The most distinguishable features of osteonecrosis of the femoral head and subchondral stress fractures of the femoral head are MRI findings. With osteonecrosis of the femoral head, an abnormal signal intensity band, representing the outer margin of the necrotic area, exists outside

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the subchondral fracture line, and the bone marrow edema pattern is observed only outside the necrotic area. However, with subchondral stress fractures of the femoral head, no additional abnormal signal intensity band exists, and the bone marrow edema pattern extends to the subchondral area [13]. Kim et al. [7] suggest the clinical course and image findings of subchondral stress fractures of the femoral head closely resemble those for transient osteoporosis of the hip, and the only difference is the presence of the subchondral fracture line observed on MR images. Although the overall incidence of multifocal osteonecrosis is reportedly approximately 3% [2], polyarticular subchondral stress fractures have been documented in only one case report, which described the multiple occurrence of collapsed subchondral insufficiency fractures in the femoral head and medial femoral condyle with a 2-year interval [15]. We report the case of a young military recruit with subchondral stress fractures involving the femoral heads and tibial condyles bilaterally within a short interval. The patient agreed that information concerning his case could be published.

Case Report

A 27-year-old military recruit was referred for bilateral hip and knee pain. As a military recruit, he started basic military training 5 weeks before presentation. His basic training included fully-armed long-distance marching and martial arts. After 2 weeks of daily training, left knee pain began without injury. No abnormalities were detected on

the plain radiographs, and training on a reduced schedule was recommended. One week later, right knee pain developed followed by right hip pain and left hip pain sequentially within 5 days. His military training program finished immediately after the onset of left hip pain and the patient presented to our clinic for evaluation. Plain radiographs taken at the time of presentation (3 weeks after the onset of left knee pain) showed bilateral linear increased-density lesions in the subchondral area of the femoral heads (Fig. 1) and tibial plateaus (Fig. 2). The medial condyle of the left tibia and the anterosuperior portion of the right femoral head had already collapsed. MRI of the hip and knee revealed a serpentine low signal intensity line with surrounding bone marrow edema in the subchondral area of the femoral heads bilaterally and the medial tibial condyles bilaterally (Fig. 3). The serpentine low signal intensity line represents the subchondral fracture line which is not found in transient osteoporosis of the hip. The bone marrow edema pattern extended to the subchondral area, but there was no additional abnormal signal intensity band representing the reactive margin of the necrotic area, which is the characteristic finding of osteonecrosis of the femoral head. Based on these MRI findings, we diagnosed the patient with concurrent multifocal subchondral stress fractures of the medial condyle of the tibiae and both femoral heads. The patient's height was 161.8 cm and weight was 48.3 kg; his BMI indicated a lean body type (18.4 kg/m^2). The bone mineral density (BMD) was atypically low for his age ($\text{L1-L4} = 0.858 \text{ g/cm}^2$, $\text{T-score} = -2.7$, $\text{Z-score} = -1.9$; total femur = 0.744 g/cm^2 ,

Fig. 1A–B Preoperative (A) AP and (B) frog-leg lateral plain radiographs show linear increased-density lesions in the femoral head in both hips and the anterosuperior portion of the right femoral head already collapsed.

Fig. 2 A plain radiograph taken at the time of presentation shows linear increased-density lesions (arrowheads) in the subchondral area of the medial tibial condyle of both knees and depression of the medial plateau of the left knee.

T-score = -1.5 , Z-score = -1.3). However, laboratory tests revealed no abnormal findings in the complete blood count, electrolyte levels, renal function, liver function, calcium level, phosphate level, parathyroid hormone, and thyroid function. He had no history of steroid or immunosuppressive agent use. Medical history revealed that he had been treated for a somatoform disorder, hypochondria, and depression, and had a low level of outdoor physical activity for several years before he was recruited into the military. He had no regular physical activity and became almost housebound by gradual worsening of his psychological status.

We planned nonoperative treatment for the lesions of the left hip and both knees. Because collapse of the right femoral head was evident even on the plain radiograph, we treated it using a fibular strut allograft. Under fluoroscopic guidance, we created a core tract from the lateral cortex of the femur to the subchondral area of the anterosuperior portion of the femoral head using a 10-mm coring reamer. We then compacted the removed trabecular bone column into the subchondral area and inserted a fibular allograft along the core tract. With gentle tapping, we advanced the graft farther into the femoral head and elevated, although not completely, the collapsed subchondral area. We secured the distal end of the fibular allograft to the proximal femur using two Steinmann pins (Fig. 4).

The rehabilitation with a continuous passive motion device was started on the third postoperative day and we encouraged active muscle strengthening. Postoperatively, we restricted the patient to bed and did not allow weightbearing on both legs for 6 weeks to prevent collapse of the femoral heads and medial tibial condyles. After 6 weeks, we allowed tolerable weightbearing. Full weightbearing was permitted after 3 months. However, owing to his anxiety, the patient was reluctant to perform full weightbearing. He used walking assists for 4 months, and began full weightbearing at 4 months. At last followup at 2 years, he still had low physical activity and was receiving a psychiatric medication. Although it was difficult to check his clinical status, his parents reported that he could walk without support.

The increased-density lesions in the subchondral area of both medial tibial condyles and both femoral heads decreased gradually and disappeared completely at 3 and 5 months postoperatively, respectively. At last followup the elevated subchondral bone of the right femoral head was maintained, and no additional collapse occurred in any lesions. The implanted fibular allograft integrated into the host bone as observed on plain radiographs obtained 2 years after surgery (Fig. 5).

Discussion

Bilateral subchondral stress fractures of the femoral head are rare. There are a few case reports of insufficiency-type fractures [1, 5, 14], and two reported cases of fatigue-type fractures in two studies [7, 13]. The features of subchondral stress fractures are different compared with osteonecrosis, in which bilateral involvement of the femoral head is common, and even multiple site involvement is not rare.

There is only one case report of the multiple occurrence of collapsed subchondral insufficiency fractures in the femoral head and medial femoral condyle with a 2-year interval [15]. However, polyarticular involvement of subchondral stress fractures in our patient occurred in the femoral heads and tibial condyles bilaterally almost concurrently, with a short interval during military training after recruitment. A sudden increase in the physical activity during military training is one of the common features of fatigue-type subchondral stress fractures in young adults [7, 8, 13]. The BMD of our patient reflected poor bone quality compared with others of the same age group. This might be attributable to his low outdoor physical activity level, which led him to be more susceptible to polyarticular subchondral stress fractures. This case has both aspects of fatigue-type and insufficiency-type fractures.

Subchondral stress fractures of the knee have been reported as insufficiency-type fractures and typically

Fig. 3A–C (A) T1- and (B) T2-weighted signal intensity MR images of the hip and (C) T1-weighted signal intensity MR images of both knees show a subchondral fracture (arrows) and the bone marrow

edema pattern (asterisks) extending to the subchondral area without additional abnormal signal intensity band, representing the reactive margin of the necrotic area.

Fig. 4 A postoperative radiograph shows restored femoral head congruity and the fibular allograft, which is secured within the core by two Steinmann pins that cross both cortices of the fibula and the lateral femoral cortex.

involve the medial proximal tibial condyle. These fractures are manifested by spontaneous onset of severe and localized pain in the tibia rather than the knee [3]. Because clinical signs and plain radiographic findings of subchondral stress fractures are similar to bone marrow edema syndrome and osteonecrosis, these three entities should be included in the main differential diagnosis among the most frequent nontraumatic disorders of the knee. MRI is usually adequate to discriminate between these three entities. The MR images of subchondral stress fractures and bone marrow edema syndrome have a common finding of alteration in signal intensity in the marrow space with ill-defined low signal intensity on T1-weighted images and high signal intensity on T2-weighted images, which represents medullary edema and hemorrhage, whereas the MR images of subchondral stress fractures show band-like areas of very low signal intensity in the medullary space, which usually extend to the cortex. The MR images of osteonecrosis of

Fig. 5A–B On plain radiographs taken 2 years after surgery, (A) the implanted fibular allograft is well integrated into the host bone and there is no progression of the femoral head collapse, and (B) the linear increased-density lesions in the subchondral area disappeared completely in the medial tibial plateau bilaterally indispensable.

the knee show a discrete area of low signal intensity on T1- and T2-weighted images in the subchondral region of the affected femoral condyle or tibial plateau, surrounded by bone marrow edema changes [11].

The differential diagnosis of subchondral stress fractures with osteonecrosis of the femoral head is critical because the clinical course and treatment strategies are different in

each case [1, 4–9, 13, 14, 16]. Osteonecrosis occurs most commonly in the hip and greater than 50% of patients have bilateral osteonecrosis [2]. Multifocal involvement of osteonecrosis also has been reported in approximately 3% of these patients [2, 10, 12, 17]. Because the incidence of bilateral subchondral stress fractures of the femoral head is rare and multifocal involvement has not been reported, multifocal subchondral stress fractures can be easily confused with multifocal osteonecrosis. Our case shows that multifocal involvement of subchondral stress fractures in a young adult is a possibility. We treated subchondral stress fractures of both medial tibial condyles and the left uncollapsed femoral head nonoperatively. We treated the right collapsed femoral head with a fibular strut allograft to restore congruity, which healed without progression of the collapse, and the clinical symptoms improved.

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