Case Report

Femoral Neck Stress Fracture in Habitual Exercise Patient: A Case Report with Literature Reviews

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Background: Femoral neck stress fracture (FNSF) is considered rare, and, as a consequence, is easily misdiagnosed due to a lack of awareness. The initial presentation can be subtle, but serious sequelae, including avascular necrosis of the femoral head or non-union could occur without proper management.

Case Report: A left FNSF in a regularly exercising postmenopausal woman treated by in situ fixation with multiple cannulated screws is presented. Dual energy X-ray absorptiometry (DXA) scan revealed osteopenic bone marrow density (BMD) T-score. Subcutaneous denosumab injection was prescribed immediately following the operation according to World Health Organization (WHO) recommendation. Successful radiographic union was observed after three months without complications, and the patient was able to return to sports activities after six months.

Conclusion: An early and accurate diagnosis of FNSF is essential in returning to sport and preventing undesirable harmful consequences.

Keywords: Femoral neck, Stress fracture, Exercise, Athlete, Osteoporosis

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Femoral neck stress fracture (FNSF) is a rare condition, occurring in about 3% of all stress fractures[1]. Although the initial symptoms can be subtle and create minimal functional disturbance, serious sequelae can occur if the condition is misdiagnosed or if treatment is delayed[2-4]. Common clinical presentations include a poorly localized, gradual onset of pain with minimal limitation of range motion of the affected hip[2,5]. The overt fracture line from radiographic study can be seen only in one thirds of patients, and so misdiagnosis is easy[3,5,6]. In such case, without obvious radiologic abnormality, magnetic resonance imaging (MRI) is the second-line gold standard for diagnosing this condition[5]. Early detection and treatment of FNSF usually results in successful union and a low incidence of complications[7,8]. In contrast, delayed treatment can result in displacement, non-union, and avascular necrosis of the femoral head[7]. Additionally, the presence of underlying bone disease should be investigated and treated[5].

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Case Report

An active 61-year-old brown skin female with well controlled hypertension and dyslipidemia who was a regular runner, including participation in several marathon events in a year, presented with sudden pain in her left hip, which had begun one week previously while participating in a half-marathon running event. She denied any traumatic accident prior to or during the race event. She was able to finish the event, but only with difficulty and limping in her left leg. The pain persisted without improvement after receiving pain control medication and rest. Physical examination found she could walk, but with an antalgic gait in her left lower extremity. She could not identify the point of maximal tenderness and reported no pain during the leg rolling and Anvil tests. Active and gentle passive

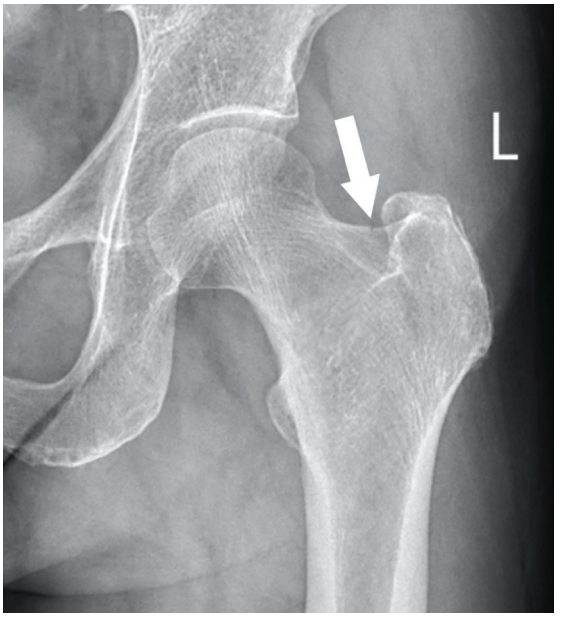

Figure 1. Plain radiograph showing cortical disruption at the lateral border of the neck of the left femur.

range of motion resulted in no pain in her left hip. She denied any recent abnormal changes in mood or eating behavior. She had reached menopause 12 years ago (at age of 49) without any gynecological problems.

Plain radiographs of both hips revealed a disrupted superior cortex of the left femoral neck without displacement, the medial cortex was intact (Figure 1). A FNSF was the most likely diagnosis. MRI was immediately requested and confirmed a non-displaced stress fracture of the left femoral neck (Figure 2).

Blood tests for calcium and phosphate level, vitamin D level, parathyroid hormone levels and dual energy X-ray absorptiometry (DXA) scan for bone mineral density (BMD) were requested. The blood profile revealed a normal range of calcium 9.1 mg/dL (8.6 to 10.2), phosphate 4.2 (2.5 to 4.5) and alkaline phosphatase 95 U/L (40 to 129), but decreased 25 hydroxy vitamin D 18.28 ng/mL (30 or more) (Electrochemiluminescence immunoassay, Cobas® e411, Roche Diagnostics, Mannheim, Germany), and a slightly high parathyroid hormone 67.62 pg/mL (15 to 65) (Electrochemiluminescence immunoassay, Cobas® e801, Roche Diagnostics, Mannheim, Germany). The DXA scan showed an osteopenic T-scores of –2.2 and –1.4 standard deviations in the lumbar spine and femoral neck area, respectively.

A stress fracture of the left femoral neck resulting from postmenopausal osteopenia of the bone combined with vitamin D deficiency was the most likely diagnosis. Other metabolic bone diseases, e.g., subtle osteomalacia with pseudo fracture was a differential diagnosis based on the low vitamin

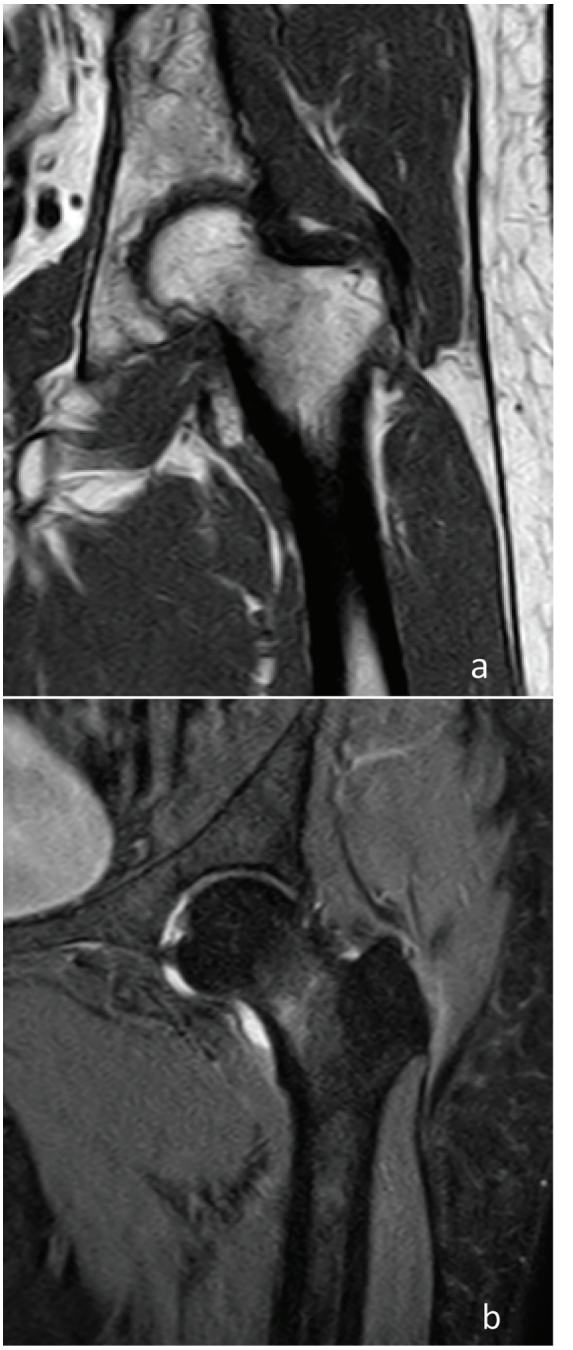

Figure 2. MRI of this patient. (a) Hypointense fracture line was observed in T1 sequence. (b) The T2 sequence indicated marrow edema and a suspected stress fracture of the neck of the left femur.

Table 1. Preoperative and 6 months after received calcium and vitamin D supplementation blood profile

	Reference range	Preoperative	6 months follow-up
Na (mg/dL)	8.6 to 10.2	9.1	9.5
P (mg/dL)	2.5 to 4.5	4.2	2.8
25-dihydroxy vitamin D (ng/mL)	≥30	18.28	19.71
Parathyroid hormone (pg/mL)	15.0 to 65.0	67.62	66

Na=sodium; P=phosphorus

Figure 3. Union was observed radiographically 3 months after multiple cannulated screws fixation.

D level. Since her pain arose while running a half-marathon and without significant trauma, sports related injuries was also suspected.

In situ fixation of the left femoral neck was scheduled immediately after the diagnosis was confirmed. Internal fixation with percutaneous multiple cannulated screws was successfully performed, achieving good alignment and fixation configuration. Partial weight-bearing ambulation with axillary crutches was prescribed for three months. According to the World Health Organization (WHO) recommendation, osteoporosis treatment should be initiated immediately after surgery. After discussing the risks and benefits with the patient, she decided to receive subcutaneous injection of denosumab (60 mg) every six months. Daily calcium and vitamin D supplements were prescribed as well.

Once the clinical union without any symptoms and radiographic union was observed at three months after the operation (Figure 3), the crutches were discontinued. She was allowed jogging and light exercise. After six months, she could participate in mini-marathon events. Her follow-up blood profile showed that the vitamin D level increased to 19.71 ng/mL and that the parathyroid hormone decreased to 66 pg/mL (Table 1).

Discussion

Sports related hip pain is common, especially in running athlete[9]. Although the causes are commonly from soft tissue injury, stress fracture is one of the crucial differential diagnosis[9]. Although rare, the incidence of FNSF is higher among female athletes in the age range of 16 to 56 years[1]. The association with female gender is postulated to be related to abnormal bony physiology in the female athlete triads[1,5]. Decreased BMD has also been found to increase FNSF risk. Long standing sub-maximal repetitive loading of the affected bone together with poor bone quality have been found to be part of the pathophysiology of FNSF. Accordingly, the most reported causal sports are marathon running, gymnastics, and ballet dancing[4,8].

Clinical presentations are usually non-specific with no direct traumatic events. A gradual onset and an ill-defined point of tenderness with subtle hip function disturbance aggravated by activities are commonly presented in most of the case[2,3,10]. Pain in the extreme hip range of motion with tenderness over the inguinal area, including the anterior thigh is the most common symptom[2,3,10]. These non-specific clinical presentation and physical examination findings together can lead a practitioner to overlook the possibility of this condition. A high level of suspicion awareness is crucial to detect this rare condition[5]. Plain radiograph, despite its low sensitivity, is the first line of investigation due to its cost-effectiveness and general availability[5,11]. However, two-thirds of FNSF patients show no abnormality in plain radiographs in that case. Therefore, further investigation is needed[3,11]. Currently, MRI is the most suitable

second-line investigation over bone scan with 100% sensitivity, specificity, and accuracy in detection of FNSF without radiation exposure[12]. Hypo-intense, ill-defined lesions in T1 with hyper-intense lesions in T2 weighted images indicating marrow edema are a common finding for this condition[3,6,11]. Although the present patient clinical and investigation were consistent with stress fracture, pseudofracture with subtle osteomalacia should be considered. However, this condition was less likely to be the diagnosis due to normal phosphate level without common presentation of pseudofracture on plain radiograph (marginal sclerosis with radiolucent line on medial side)[13].

Several authors have established a classification system for FNSF. Fullerton and Snowdy[14] classified FNSF into three groups based on fracture location and displacement. Type I is non-displaced tension side fracture, while type II is non-displaced compression side fracture. Displaced fracture is classified into type III. Later, type IV fracture described as atypical superiorly based incomplete tension-type fracture was added by Provencher et al[15]. After the invention of MRI, Shin and Gillingham[3] were able to subdivide the fracture into fracture without fracture line, less than 50% and more than 50% neck involvement.

Weight bearing activity should be prohibited and absolute bed rest should be prescribed after the diagnosis was made to prevent further displacement[5,14]. Conservative treatment with protected weight bearing can be safely prescribed for incomplete compression side (medial neck) fractures, while surgical fixation should be performed for tension side (lateral neck) and complete fracture[3,14]. As recommended by Fullerton and Snowdy, non-displaced tension side fracture as in the present patient can be treated with multiple pins or screws fixation[14] while complete and displaced fracture require more stable fixation such as dynamic hip screw with anti-rotational screw fixation. Non-weight bearing for six weeks followed by progressive weight bearing for an additional six weeks should be prescribed. Return to sports activity can be begin within one year postoperatively[14,16].

In addition to fracture management, investigation to identify underlying bony abnormality is mandatory[3,5]. Abnormal bony physiology can result in disequilibrium in the remodeling process, which increases the risk for FNSF[2,3]. Signs and symptoms of female athlete triad condition, and osteoporosis should also be noted. A female athlete can have one, two, or all three parts of the triad[1]. Blood profiles for calcium-phosphate homeostasis, including calcium level, phosphate level, alkaline phosphatase, vitamin D level, and parathyroid hormone levels should be evaluated[2,3]. Interestingly, even though the present patient might have received adequate sun exposure from her regular outdoor exercise, her slight vitamin D deficiency might result from risk factors such as hyperpigmentation and sunscreen usage[17,18]. BMD can be used to determine bone quality and the need for osteoporosis treatment[19]. Although the present patient was diagnosed as osteopenia by DXA scan, according to the WHO recommendations, patients with previous insufficiency fractures, even in the absence of bone mineral deficiencies, should be treated as osteoporosis to reduce the risk of future fractures as well as to reduce potential morbidity and mortality[20]. Antiresorptive agent such as bisphosphonate or denosumab should be prescribed along with adequate vitamin D and calcium supplementation.

Conclusion

FNSF is considered rare and could be easily missed or get a delayed diagnosis due to its subtle clinical presentation. A history of high physical activity level should raise the suspicion of this condition. MRI may be needed since only one-third of cases reveal explicit radiographic abnormality. Internal fixation is recommended to prevent fracture progression especially in tension side pathology. Underlying bone disease should be investigated and properly treated along with operative treatment. Early and accurate diagnosis of FNSF is essential for the patient to return to sport and prevent undesirable harmful consequences.

What is already known on this topic?

FNSF is considered rare and can be easily missed or delayed diagnosis. Early and accurate diagnosis of FNSF is essential in returning to sport and preventing undesirable harmful consequences.

What this study adds?

FNSF should be suspicion in high physical activity level patient with hip pain. Recently, running is one of the most popular and practiced sports worldwide. The number of runners has increased and so are the number of older participants. Therefore, the incidence of FNSF may also increase. Although rare, it should be recognized and managed promptly.

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Conflicts of interest

The authors declare no conflict of interest.

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