Case Report**Bilateral iliac stress fracture in a young male Military cadet: report of an unusual case****Christos Apergis¹, Georgios Bekas¹, Christos Zafeiris², Terpsithea Koureta³, Konstantinos Raptis³**

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Abstract

Stress fractures are common in highly active people, such as athletes or the military population and occur more frequently in the tibia and especially the tarsal and metatarsal bones. Concomitant bilateral presentation is rare and especially bilateral iliac bone stress fracture has never been reported in the current English literature. We present a case of a young Air Force cadet with acute onset of bilateral hip pain, while participating in the routine military training program. Clinical examination, radiologic evaluation and MRI established the diagnosis of bilateral iliac bone stress fracture. The patient followed conservative treatment with partial weight bearing using crutches and the symptoms disappeared after a 3 month period.

Keywords: Bilateral fractures, Iliac fractures, Stress fractures, Fractures in military population

Introduction

Stress fractures are common in military population. They were first reported in Prussian soldiers' metatarsals by Breithaupt in 1855 as "march fractures" and their radiographic characteristics were described by Stechow in 1897¹. Stress fractures occur generally due to bone fatigue and there is a clear distinction be made between fatigue and insufficiency fractures². A repetitive abnormal load upon a normal bone causes a fatigue fracture while a normal load upon a weak and structurally abnormal bone causes an insufficiency fracture. Although the military recruits - being usually young and in good general condition - are more susceptible to fatigue rather than insufficiency fractures, when diagnosed with a stress fracture it is nevertheless necessary to exclude other causes of bone fragility. Diagnosis may be difficult because the symptoms are non specific and radiographic signs are often absent or subtle³. Pelvis is one of the less frequent areas where the fatigue fractures are presented⁴. Moreover, bilateral stress fractures are extremely rare; in the current literature there have been reports for bilateral pedicle, pubic, ischial, femoral, tibial, fibular, calcaneal, scapular, ulnar and scaphoid fractures, but there is no report about an iliac one so far.

Case report

An 18-year-old male Greek Air Force cadet presented to the Emergency Department complaining of persistent pain in both hips 3 weeks after he started basic combat training in the Academy. The pain was not responding to medical treatment or rest. The patient did not report any acute trauma at that anatomic location and noted that his symptoms worsened during intense physical exercise. The patient underwent radiological investigation with plain radiographs of pelvis and bilateral hips that revealed a radiolucent line in the right iliac bone (Figure 1), whereas pelvic MRI revealed bilateral bone marrow edema and stress fractures in both iliac bones (Figures 2-3). Additional laboratory studies were obtained (Table 1) to exclude other causes of

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Figure 1. Initial pelvis AP X-ray showing a radiolucent line in the right iliac bone.

Figure 2. MRI coronal STIR views showing bilateral bone marrow edema and stress fractures in both iliac bones.

bone fragility. The biochemical markers of bone turnover and DXA scan in lumbar spine (Z-score: -0.5) and left hip (Z-score: -0.8) were normal (Tables 2,3), thus - adding to his free personal and family medical history - no reason for insufficiency fracture was found. Based on the clinical and imaging findings, the diagnosis of bilateral iliac bone stress fracture was established. The patient followed conservative treatment with ambulation with crutches for a 6 week period and progressive returning to physical exercise. At the latest follow - up 3 months after the diagnosis, the patient was free of pain and has returned to his previous level of activity in Academy without major restrictions.

Biochemical Marker	Value	Normal Range
Serum calcium	9,1 mg/dL	8,4-10,2 mg/dL
Serum phosphate	3,7 mg/dL	2,3-4,7 mg/dL
PTH	48 pg/ml	10-65 pg/mL
C-reactive protein (CRP)	1.01 ng/l	<10 ng/l
Total alkaline phosphatase (ALP)	86 U/L	56-119 U/L
25(OH)-Vitamin D	43.4 ng/ml	>30 ng/ml

Table 1. Patient's laboratory findings.

Figure 3. MRI axial STIR and coronal T1 showing bilateral bone marrow edema, more evident in the right iliac bone.

REGION	BMD (g/cm ²)	T - score	Z - score
Neck	0.992	-0.6	-0.9
Wards	0.771	-1.5	-1.9
Trochanter	0.807	-1.1	-1.2
Shaft	1.249	-	-
Total	1.007	-0.6	-0.8

Table 2. Left hip DEXA scan results (DPX-L Lunar).

REGION	BMD (g/cm ²)	T - score	Z - score
L1	0.950	-1.7	-1.6
L2	1.177	-0.5	-0.4
L3	1.219	-0.2	0.0
L4	1.098	-1.2	-1.0
L1-L2	1.067	-1.1	-1.0
L1-L3	1.120	-0.7	-0.6
L1-L4	1.114	-0.9	-0.8
L2-L3	1.198	-0.3	-0.2
L2-L4	1.160	-0.7	-0.5
L3-L4	1.153	-0.7	-0.6

Table 3. Lumbar spine DEXA scan results (DPX-L Lunar).

Discussion

Stress fractures are common in highly active people, like athletes and military population. Their incidence depends on the sex and is higher in females. Especially, in the military population, as our patient, the incidence varies between 0.8-6.8% for males and 2.6-21% for female recruits⁵⁻⁷. Interestingly, female recruits have a bone injury rate 1.5 to 5 times higher than males following the same training program⁶. Virtually, any bone can be affected, but the tibia (25-34%), tarsal (8-20%) and metatarsal bones (18-22%) are the most common sites of stress fractures in military population and runners followed by the pelvis (6-22%) and the femur (11-20%)^{2,4,6,7}. The iliac bone is an area rarely affected by this entity as they account only for 4% of pelvic bones' stress fractures according to studies in military recruits^{8,9}. Our literature research has yielded no similar cases of such a bilateral location of iliac bone in a young and healthy military personnel.

Apart from the military population, athletes are also prone to stress fractures as this entity account for more than 10% of all overuse injuries in sports⁴. Different skeletal areas are susceptible to stress fracture depending on particular sport or activity, so navicular fractures occur mainly in football players, basketball players and runners, femoral neck and pubic rami fractures affect distance runners and military recruits, whereas throwing athletes and baseball players suffer from olecranon stress fractures³. A high risk of stress fractures is observed in women affected by Female Athlete Triad. This syndrome consists of eating disorder, amenorrhea and osteoporosis.

The Triad's consequences affect mainly the cancellous bone than the cortical, so skeletal areas with high proportion of cancellous bone (pelvis, sacrum, femoral neck) are the most common sites of stress fractures in these athletes¹⁰.

The patient, whose the unusual case we report, is an 18 - year old male who followed a demanding training in the Air Force Academy which includes much running. The Air Force cadets are selected through thorough medical examination. The particular patient has a free medical history and all the laboratory and imaging results reveal no evidence of bone insufficiency, so his fractures are attributed to fatigue.

Diagnosis of stress fractures is a challenging procedure as the majority of them have an insidious onset, non specific symptoms and normal radiographic images, so they are often recognized as muscle strains or tendinopathies. The stress fractures are asymptomatic in military recruits at a high rate, up to 60%¹¹.

Plain radiographs are necessary as initial imaging because they have the advantage of being inexpensive, they are easily performed and are highly specific (88-96%) and may reveal or exclude other bone pathologies^{3,7,12}. However, this imaging modality has low sensitivity (12-56%), so it often fails to detect the fractures in the early post injury period, like these bilateral stress fractures of our patient⁷. Moran et al. reported that is required a time approximately from 2 weeks to 3 months between the initial symptoms and the appearance of a stress fracture in a plain radiograph¹³. As a result, this disadvantage leads to the need of other imaging exams and particularly nuclear scintigraphy, MRI, CT and ultrasonography.

Nuclear scintigraphy (typically ^{99m}Tc-MDP) is a very frequently used tool in the diagnostic process of stress fractures due to its high sensitivity (50-100%)¹²⁻¹⁵. Nevertheless, it is positive also in a variety of different high - uptake conditions like tumor, inflammation, infection and bone metabolic disorders, thus its specificity (33-98%) is not absolutely satisfactory^{3,7,12,15}. Nuclear scintigraphy has the advantage of early detection of stress reactions and fractures as it may be positive within the first 6-72 hours¹³, except for patients with osteopenia where the low osteoblastic response to bone stress affects the radionuclide uptake¹⁴. However, this technique does not give detailed information about the morphology of the lesions, it needs 3 to 4 hours to be completed and the patient is exposed to high ionizing radiation^{3,7}. Additionally, it is an inappropriate exam for follow - up as high radiotracer uptake is observed for several months¹³.

MRI is considered the method of choice for early diagnosis of stress fractures as it has high sensitivity (68-100%) and specificity (85-100%) without presenting the disadvantages of nuclear scintigraphy since it is rapidly performed and has no ionizing radiation^{2,12-14}. It can also provide precise assessment of regional osseous morphology and surrounding soft tissues. MRI can depict the early

stages of bone stress reaction such as the periosteal and endosteal marrow edema. These radiological signs are the earliest evidence of stress injury and are depictable on MRI within approximately 3 days of the initial painful symptoms⁷. Particularly, the fast STIR and the fat - suppressed T2 sequences can demonstrate earlier and more confidently these aforementioned lesions^{13,14}.

In contrast to bone scan and MRI, CT has significantly lower sensitivity (32-69%) and almost equal specificity (88-100%)^{2,12,14}. It has the advantage of demonstrating more accurately particular stress fractures such as the pars interarticularis, tarsal navicular and the longitudinal ones of tibia. It is also useful both in the differential diagnosis between stress fractures and osteoid osteoma and in the evaluation of cortical abnormalities. However, CT cannot assess the bone turnover process, so its ability to reveal early signs of stress reactions is limited^{3,13,14}.

Ultrasonography is far from being the first choice to evaluate a bone injury, but its use is increasing. Today has limited use as it can only depict the superficial cortex of specific bones lying directly under the skin, such as the distal tibia and the feet. Further studies are needed to confirm its value and determine this technique as a widely accepted diagnostic tool in the management of stress fractures^{2,3,13}.

According to prognosis, stress fractures can be divided in low, medium and high-risk injuries². The low risk category includes fractures of first to fourth metatarsal shaft, calcaneus, cuboid, cuneiforms, fibula and medial cortical compression fractures of the femoral neck. These fractures have low rate of complications contrary to high-risk ones which usually demand surgical treatment and consist of proximal second metatarsal, navicular, talus body, anterior cortex of tibia, patella, lateral cortical tension fractures of the femoral neck, femoral head, pars interarticularis, and olecranon. Pelvis, like iliac fracture of our patient, along with femoral shaft, posteromedial tibia, medial malleolus and proximal fifth metatarsal are classified to medium - risk stress fractures sites^{2,4}.

The treatment of iliac stress fractures is usually conservative, with activity modification and progressive return to training activities¹⁶. Our patient was recommended only to ambulation with crutches and after a 3 months period had an uneventful recovery and returned to Academy training program. More treatment options are under study and these include the hyperbaric oxygen therapy, biphosphonates, growth factors, bone morphogenic proteins, recombinant parathyroid hormone, low - intensity pulsative ultrasonography and magnetic fields¹.

Conclusions

Lower extremity stress fractures among military recruits are common and related to significant morbidity, fiscal costs, and time lost from training. Despite their high incidence, their insidious onset and the usually lack of signs in the initial radiological examination make their diagnosis challenging.

The iliac bone is a rare site of stress fractures as well as the bilateral location in this Air Force cadet makes this case unique in the literature. MRI is thought to be the imaging modality of choice, as it is a reliable technique for early diagnosis and detailed anatomic evaluation of the fracture. The assessment of bone turnover is essential to distinguish a fatigue from an insufficiency fracture as it may change patient's treatment plan.

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