Acta Orthop. Belg., 2010, 76, 838-843

CASE REPORT

Fatigue stress fractures of the pelvis : A rare cause of low back pain in female athletes

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Stress fracture of the pelvis represents one rare differential diagnosis among the manifold causes of low back pain in female athletes.
We report a case of fatigue stress fracture of the pelvis in a 24-year-old female athlete as an unusual differential diagnosis of low back pain that should be taken into consideration. According to the literature the incidence of low back pain in athletes ranges from 1% to 30% and is influenced by sport type, gender, training intensity, training frequency and technique. In some cases, no specific pain generator is found, which makes diagnosis and treatment difficult.
The frequency of the injury and the treatment options are discussed, based on published studies.

Keywords : insufficiency fracture ; fatigue fracture ; athlete ; low back pain.

INTRODUCTION

Stress fractures of the sacrum are an uncommon cause of low back pain (LBP) in athletes (*29, 31*). Reported rates of LBP in athletes range from 1% to 30% (*6,16,22,40*). They are influenced by sport type, gender, training intensity, training frequency and technique (*6,12,24*). In some cases, no specific pain generator is found, which makes diagnosis and treatment difficult. Thus, it is important to identify less common causes of LBP in athletes, such as stress fracture of the sacrum (*10,14,24*).

Stress fractures are reportedly observed in 2-4% of athletes (*25,33,38*). They are primarily seen in the tibia and femur as well as in the metatarsals (*39*). Fatigue stress fractures occur in a much younger patient population than insufficiency fractures ; the mean age typically reported is in the 20's and 30's (*28*). Long-distance running is the most frequently reported cause of sacral stress fractures in athletes (*2,23,33,39*) and seems to be more common in female athletes (*6,14,24*).

The female athlete triad of eating disorders, dys-/amenorrhea and osteopenia represents an increased risk for developing a stress fracture (*26*). However, the triad is not necessarily present in young female athletes who are diagnosed with sacral fractures (*39*).

We present the case of a 24-year-old female long-distance runner who sustained a fatigue stress fracture of the sacrum. Additionally, we reviewed the literature from 1988-2008 using MEDLINE to identify risk factors and treatment options for sacral stress fractures.

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No benefits or funds were received in support of this study

CASE REPORT

A 24-year-old woman reported ongoing pain in her lumbar spine and sacrum. The pain was mainly located around the right sacroiliac joint, without any radiation toward the legs. She was exercising twice a day (16 kilometer runs every day). Until her first presentation in our clinic, she did not have any significant clinical history. An adequate trauma could not be remembered : she reported increased training in preparation for the coming season.

The patient mentioned that she had suffered from bulimia years ago. Now she controlled her weight by exercising consistently. She denied any history of menstrual irregularities. Her family history was negative for metabolic bone disease.

Inspection revealed a young woman, with a body mass index of 21. Physical examination demonstrated pressure pain around the right sacroiliac joint, pain on hip extension, and rotational pain around her lumbar spine. Muscle tone, reflexes and sensory function were normal. There were no leg abnormalities, no pelvis or sacral obliquity and no radicular symptoms. She reported no static pain, but aggravation of pain while jumping. She reported that she could no longer perform any physical activity. At the first visit we obtained a radiograph of her lumbar spine and pelvis (fig 1), which did not show any visible fracture. The radiograph however showed an asymmetrical transitional anomaly (mega-transverse process on the left side)

A conservative therapy using non-steroidal anti-inflammatory drugs and physiotherapy was initiated. Due to persistent pain over a two-week period, the patient was referred to MRI and Technetium 99m bone scintigraphy. The bone scan revealed significant uptake on the right wing of the sacrum (fig 2).

The coronal T2-weighted MRI demonstrated a vertically oriented sacral fracture of the right wing (fig 3a, b). The sacroiliac joint was not affected.

The laboratory studies were normal concerning calcium, phosphorus, bone alkaline phosphatase, parathyroid hormone, and 25-hydroxyvitamin D.

Conservative treatment was started with partial weight-bearing on the right lower extremity for 6 weeks with appropriate physiotherapy. Then we initiated an increase in load, limited only by pain at the sacrum. Throughout rehabilitation, exercises with reduced load on the sacrum were advised.

At the 6-month follow-up, the patient had no tenderness over the sacrum and a normal gait. Her athletic activities returned back to initial levels and she is still pursuing long-distance running.

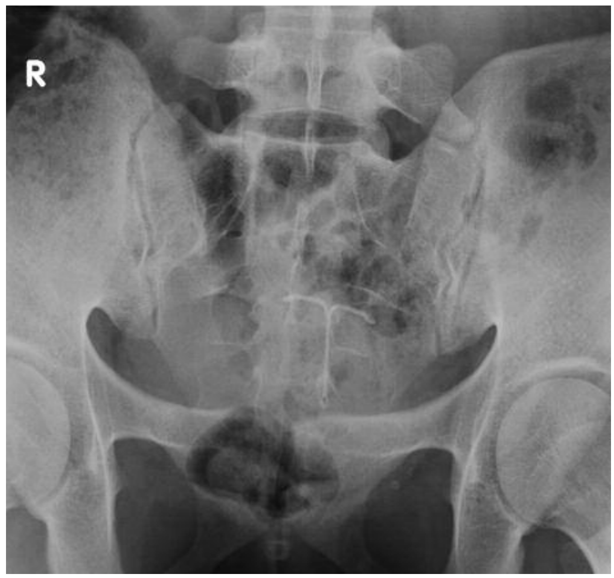

Fig. 1. — Plain anteriorposterior radiograph of the pelvis which fails to demonstrate the existing stress fracture of the right sacral wing. The superimposition of bowel gas and stool can make detection of sacral fractures extremely difficult.

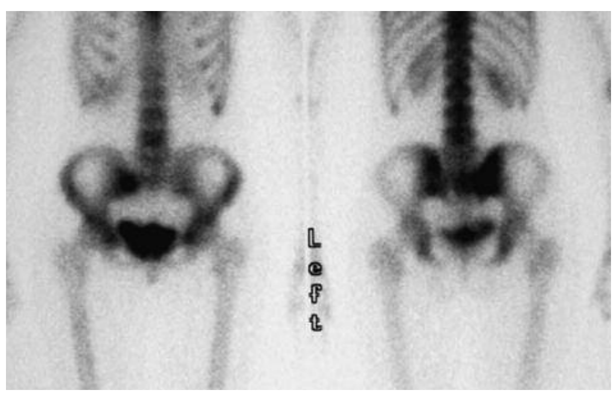

Fig. 2. — Technetium 99m bone scan showing typical uptake in the right sacral wing, corresponding with a sacral stress fracture.

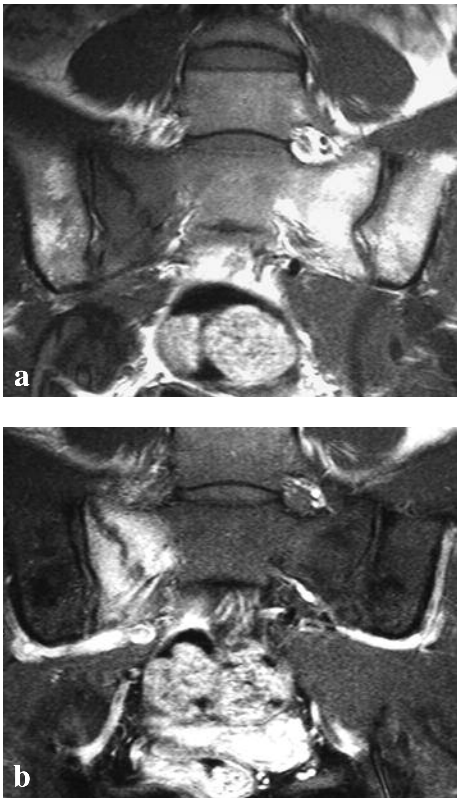

Fig. 3a and 3b. — Coronal T2-weighted MRI of the sacrum demonstrating the typical bone marrow oedema and the fracture line through the right sacral wing ; evidence of a fatigue stress fracture of the sacrum.

DISCUSSION

In most cases, the symptoms of low back pain are due to degenerative structural abnormalities such as degenerative disc disease, spondylolisthesis or sacroiliac joint dysfunction (*5*). Nevertheless, in rare cases no specific cause of pain is identified. Therefore, awareness of less common causes, such as fatigue stress fractures of the sacrum, is essential (*9,10,19*).

The sacrum is the keystone to the arch of the pelvis and its functions. It transfers the weight of the entire upper body to the pelvis (*1,34*). If the forces to the pelvis are too strong, stress fractures can develop. Those that suffer from fatigue stress fractures of the sacrum are typically women involved in long-distance running (fig 4) (*6,14,24*). In combination with the female athlete triad (negative energy balance, menstrual irregularity and reduced bone mineral mass) or other contributing factors such as lower bone density, low dietary calcium intake or hormonal irregularities, these factors suggests that women are more likely to sustain a fatigue fracture (*1,6*). Other non-gender-related predisposing factors for a fatigue stress fracture are leg-length discrepancies, weakened supporting

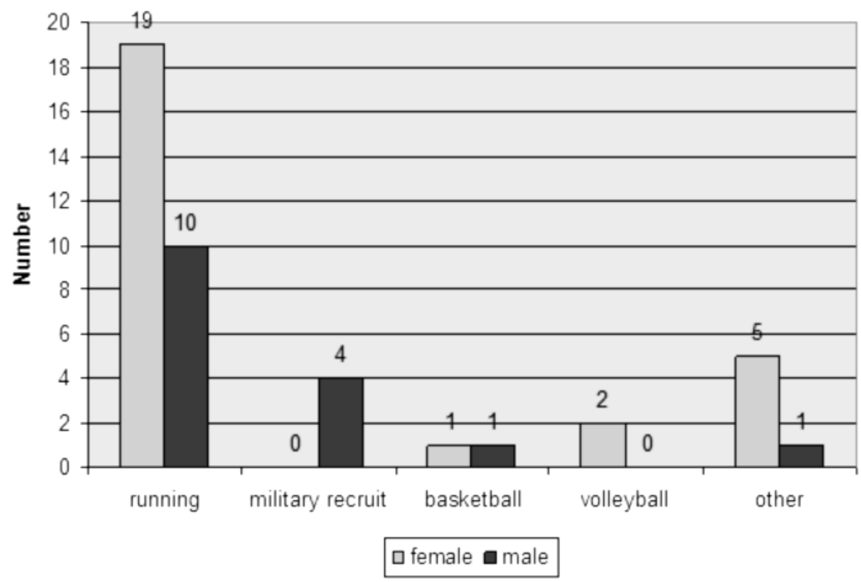

Fig. 4. — Diagram of gender distribution with regard to athletic activity in definitive cases. Taken from data in table I (*1,2,6-8,12-14,17-20,22,23,25,26,29,30,32,35-38,40*).

musculature, any recent increase in activity and biomechanical alterations (*41*).

Stress fractures may be divided in two further subgroups : insufficiency fractures and fatigue fractures (*1,28,34*). These fracture types can result from intrinsic and extrinsic factors. Intrinsic factors, such as hormonal dysfunction, can lead to weakness of the bone and decreased bone quality (*1*). Extrinsic factors would be synonymous to adequate trauma or repetitive microtrauma, which induce bone remodeling. Repetitive cyclic stress leads to enhanced rates of osteoclastic activity, linked to enhanced osteoblast activity and the development of new bone (*24,43*). Lack of rest and thus time for new bone to accumulate results in weakening of the bone and subsequent fracture (*43*). Thus, fatigue fractures occur when normal bone is subjected to abnormal stress (*28*). A consistent risk factor seems to be the rapid increase in level of activity (*24*), as in our reported case.

A review of medical literature from 1988-2008 using MEDLINE produced 43 cases (*1,2,7-9,13-15,18-21,23,24,26,27,30,31,33,36-39,41*) with a fatigue stress

Table I. — Selected representative papers with characteristics of sacral fatigue stress fractures

Gender	Activity	Age (years)	Number of patients	Authors
M	running	31-32	2	Atwell *et al*. (*2*)
F	running	28	1	Bottomley *et al*. (*6*)
M	basketball	20	1	Crocket *et al*. (*7*)
M	running	26	1	Czarnecki *et al*. (*8*)
F	running	20-21	3	Eller *et al*. (*12*)
F	fitness	25	1	Featherstone *et al* (13)
F	running	35	1	Gerrard *et al*. (*14*)
F	running	14	1	Grier *et al*. (*17*)
F	running, gymnastic	15-16	2	Haasbeek *et al*. (*18*)
M	running	35-42	2	Holtzhausen *et al*. (*22*)
M	military recruit	18	1	Lechevalier *et al*. (*26*)
M	running	48	1	Major *et al*. ('97) (*29*)
M(*3*), F(*1*)	running	18-49	4	Major *et al*. ('00) (*30*)
F	running, volleyball	17-21	3	McFarland *et al*. (*32*)
M	running	40	1	Schils *et al*. (*35*)
M	military recruit	18-20	3	Volpin *et al*. (*40*)
F	running(6), soccer(1), basketball(1)	19-45	8	Johnson *et al*. (*23*)
F	running	26	1	Haun et al. (*20*)
F	volleyball	16	1	Shah et al. (*36*)
F	running, bicycling	20	1	Haller et al. (*19*)
F	hockey player	20	1	Slipman et al. (*38*)
M	tennis player	46	1	Silva et al. (*37*)
M	running	36	1	Alsobrook et al. (*1*)
F	running	22	1	Knobloch et al. (*25*)

Table II. — Multiple forms of low back pain at physical examination
(Data from Denis *et al* (*10*), Boissonnault *et al*. (*4*), Lin *et al* (*28*) and Alsobrook *et al* (*1*))

Paramedian joint or sacroiliac pain	Vague sacral pain +/- radicular symptoms
Sacral soreness	Vague lower back, hip or buttock pain
Palpable pain with pressure over the sacrum	Leg length discrepancy
Uni- or bilateral sacral pain	Painful hopping test on affected side
Lumbar range of motion may be painful	Sciatic signs may be positive

fracture of the pelvis. Characteristics of these fractures are given in table I by reference to selected representative papers.

Usually patients do not present with pathognomonic symptoms. The physical examination discloses various types of low-back pain (table II) (*1,5,11,29*).

General imaging of an athlete with low back pain starts with a series of plain anterioposterior and lateral radiographs. Due to bone geometry, soft tissue formation and overlying bowel gas, plain radiographs usually will not reveal a sacral stress fracture (*33*). Furthermore, these fractures rarely produce a visible callus (*31*). In some cases, radiographs show a transitional anomaly such as a mega transverse process articulating with the sacrum ; this may influence stress transmission from L5 to S1, particularly if the transitional anomaly is asymmetrical, as in the patient reported here (*3*).

Radioisotope bone scan is a very sensitive diagnostic tool ; it shows increased focal uptake over a sacral wing in athletes with a fatigue fracture (*1*). However, it can also be misinterpreted as sacroiliac joint dysfunction, sacroiliitis or malignancy because of a similar bone scan pattern, especially if the diagnosis does not match the clinical symptoms (*43*).

MRI of the pelvis is a sensitive tool which has the advantage of demonstrating oedema, which regularly occurs around acute fractures sites (*33*). CT imaging is an excellent technique for documenting the presence of sacral stress fractures ; it carries the added benefit of documenting the location and extent of the fracture (*17*). However, the CT findings are subtle and can be overlooked if not considered in the context of a differential diagnosis (*5*).

Techniques such as magnetic resonance imaging (MRI), computed tomography (CT) or bone scintigraphy are more effective when used to demonstrate a suspected fatigue stress fracture of the sacrum. MRI and CT in combination can reveal the characteristic lucency and thickening in the cortical bone, as well as focal sclerosis in the cancellous bone (*30*). Obviously, multiple diagnostic tools are necessary to achieve the right diagnosis.

There are different treatment philosophies to manage a fatigue stress fracture of the sacrum (*1*). Nevertheless, standard guidelines are missing. There are suggestions that range from non-weight-bearing rest to painless walking (*18,23*), followed by gradual increase in the level of activity (*13,15, 19,26,35*), to preferential early rehabilitation such as light-weight-bearing exercise (*19,33,43*). Every variety of treatment in between has been attempted, with varying levels of success (*1*). Several patients described in previous reports returned to their base level of activity after 4-6 weeks (*33*). These inconsistent strategies imply uncertainty concerning treatment due to the rarity of this injury. Notably, stress fractures typically heal with rest (*23,36-38*).

Thus, from the medical viewpoint, it is necessary to establish the correct diagnosis to implement an appropriate treatment.

REFERENCES

1. **Alsobrook J, Simons SM.** Sacral stress fractures in a marathon runner. *Cur Sports Med Rep* 2007 ; 6 : 39-42.
2. **Atwell EA, Jackson D.** Stress fractures of the sacrum in runners. *Am J Sports Med* 1991 ; 19 : 531-533.
3. **Batt ME, Skattum N, Chong BK, Tanji JL.** Posterior element pain in an adolescent schoolgirl. *Br J Sports Med* 1996 ; 30 : 356-358.
4. **Blake SP, Connors AM.** Sacral insufficiency fractures. *Br J Radiol* 2004 ; 77 : 891-896.
5. **Boissonnault WG, Thein-Nissenbaum JM.** Differential diagnosis of a sacral stress fracture. *J Orthop Sports Phys Ther* 2002 ; 32 : 613-621.

6. **Bono CM.** Low-back pain in athletes. *J Bone Joint Surgery* 2004 ; 86 : 382-396.
7. **Bottomley M.** Sacral stress fracture in a runner. *Br J Sports Med* 1990 ; 24 : 243-244.
8. **Crockett HC, Wright JM, Madsen MW *et al.*** Sacral stress fractures in an elite college basketball player after the use of a jumping machine. *Am J Sports Med* 1999 ; 27 : 526-528.
9. **Czarnecki DJ, Till EW, Minikel JL.** Unique sacral stress fracture in a runner [Letter]. *Am J Roentgenol* 1988 ; 151 : 1255.
10. **Delvaux K, Lysens R.** Lumbosacral pain in an athlete. *Am J Phys Med Rehabil* 2001 ; 80 : 388-391.
11. **Denis F, Davis S, Comfort T.** Sacral fractures : an important problem. Retrospectiv analysis of 236 cases. *Clin Orthop Relat Res* 1988 ; 227 : 67-81.
12. **Dreisinger TE, Nelson B.** Management of back pain in athletes. *Sports Med* 1996 ; 21 : 313-320.
13. **Eller DJ, Katz D, Bergman AG, Fredericson M, Beaullieu CF.** Sacral stress farctures in long-distance runners. *Clin J Sport Med* 1997 ; 7 : 222-225.
14. **Featherstone T.** Magnetic resonance imaging in the diagnosis of sacral stress fractures. *Br J Sports Med* 1999 ; 33 : 276-277.
15. **Gerrard DF, Doyle T.** Lumbosacral pain in an athlete. An unusual site for stress fracture. *Clin J Sport Med* 1988 ; 8 : 59-61.
16. **Granhed H, Morelli B.** Low back pain retired wrestlers and heavyweight lifters. *Am J Sports Med* 1988 ; 16 : 530-533.
17. **Grasland A.** Sacral insufficiency fractures, an easily overlooked cause of back pain in elderly women. *Arch Intern Med* 1996 ; 156 : 668-674.
18. **Grier D, Wardell S, Sarwark J, Poznanski AK.** Fatigue fractures of the sacrum in children : Two case reports and a review of the literature. *Skeletal Radiol* 1993 ; 22 : 515-518.
19. **Haasbeek JF, Green N.** Adolescent stress fracture of the sacrum : Two case reports. *J Pediatr Orthop* 1994 ; 14 : 336-338.
20. **Halller J, Kindynis P, Resnick D, Murray WT, Cervilla V.** Fatigue fracture of the sacrum : A case report. *J Can Assoc Radiol* 1989 ; 40 : 277-278.
21. **Haun DW, Kettner NW, Yochum TR, Green RL.** Sacral fatigue fracture in a female runner : a case report. *Manipulative Physiol Ther* 2007 ; 30 : 228-233.
22. **Hickey GJ, Fricker PA, McDonald WA.** Injuries to elit rowers over a 10-year period. *Med Sci Sports Exer* 1997 ; 29 : 1567-1572.
23. **Holtzhausen L, Noakes T.** Stress fractures of the sacrum in two distance runners. *Clin J Sports Med* 1992 ; 2 : 139-142.
24. **Johnson AW, Weiss CB Jr, Stento K, Wheeler DL.** Stress fracture of the sacrum. An atypical cause of low back pain in the female athlete. *Am J Sports Med* 2001 ; 29 : 498-508.
25. **Joy EA, Campbell D.** Stress fractures in the female athlete. *Curr Sports Med Rep* 2005 ; 4 : 323-328.
26. **Knobloch K, Schreibmueller L, Jagdzinski M, Zeichen J, Krettek C.** Rapid rehabilitation programme following sacral stress fracture in a long distance running female athlete. *Arch Orthop Trauma Surg* 2007 ; 127 : 809-813.
27. **Lechevalier D, Magnin J, Eulry F.** Truncated sciatica as the first manifestation of a fatique fracture of the sacrum in a young male. *Rev Rhum Engl Ed* 1996 ; 63 : 505.
28. **Lin JT, Lane, JM.** Sacral stress fractures. *J Women Health* 2003 ; 12 : 879-889.
29. **Lin JT, Lutz GE.** Postpartum sacral fracture presenting as lumbar radiculopathy. *Arch Phys Med Rehabil* 2004 : 85 : 1358-1361.
30. **Major NM, Helms CA.** Pelvic stress injuries : The relationship between osteitis pubis (symphysis pubis stress injury) and sacroiliac abnormalities in athletes. *Skeletal Radiol* 1997 ; 26 : 711-717.
31. **Major NM, Helms CA.** Sacral stress fractures in long-distance runners. *Am J Roentgenol* 2000 ; 174 : 727-729.
32. **Mammone JF.** MRI of occult sacral insufficiency fractures following radiotherapy. *Skeletal Radiol* 1995 ; 24 : 101-104.
33. **McFarland EG, Giangarra C.** Sacral stress fractures in athletes. *Clin Orthop Rel Res* 1996 ; 329 : 240-243
34. **Micheli LJ, Curtis C.** Stress fractures in the spine and sacrum. *Clin Sports Med* 2006 ; 25 : 75-88
35. **Miller C, Major N, Toth A.** Pelvic stress injuries in the athlete. *Sports Med* 2003 ; 33 : 1003-1012.
36. **Schils J, Hauzeur J.** Stress fracture of the sacrum. *Am J Sports Med* 1992 ; 20 : 769-770.
37. **Shah MK, Stewart GW.** Sacral stress fractures. An unusual cause of low back pain in an athlete. *Spine* 2002 ; 27 : E104-108.
38. **Silva RT, De Bortolli A, Laurino CFS, Aballa RJ, Cohen M.** Sacral stress fracture : an unusual cause of low back pain in an amateur tennis player. *Br J Sports Med* 2005 ; 40 : 460-461.
39. **Slipman CW, Gilchrist RV, Isaac Z, Lenrow DA, Chou LH.** Sacral stress fracture in a female field hockey player. *Am J Phys Med Rehabil* 2003 ; 82 : 893-896.
40. **Videman T, Sarna S, Battie MC *et al.*** The long-term effects of physical loading and exercise lifestyles on back-related symptoms, disability, and spinal pathology among men. *Spine* 1995 ; 20 : 699-709.
41. **Volpin G, Milgrom C, Goldsher D, Stein H.** Stress fractures of the sacrum following strenuous activity. *Clin Orthop Relat Res* 1989 ; 243 : 184-188.
42. **Weber m, Hasler P, Gerber H.** Insufficiency fractures of the sacrum. Twenty cases and review of the literature. *Spine* 1993 ; 16 : 2507-2512.
43. **Zaman FM, Frey ME, Slipman CW.** Sacral stress fractures. *Curr Sports Med Rep* 2006 ; 5 : 37-43.