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Rapid rehabilitation programme following sacral stress fracture in a long-distance running female athlete

Karsten Knobloch · Louisa Schreibmueller · Michael Jagodzinski · Johannes Zeichen · Christian Krettek

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Abstract Stress fractures occur in normal bone due to mechanical overload by cyclic stress increasing the osteoclastic activity, thus facilitating weakening leading to fracture of bones. Long-distance running may lead to stress fractures of the mid- and distal tibia and of the metatarsal bones. Stress fractures to the sacrum are rare. Certain factors for stress fractures in runners have been identified, such as leg–length inequality, a high longitudinal arch of the foot, forefoot varus, and menstrual irregularities in case of female athlete triad. We report on a 22-year-old female runner (usually training 140 km/week) suffering a sacral fatigue-type fracture. The female athlete triad with eating disorders, dysmenorrhea, and osteopenia was ruled out. Sexual hormone blood samples proofed normal values. The diagnosis was performed using magnetic resonance imaging 2 weeks after the onset of buttock pain. A conservative treatment regimen was initiated with strict physical rest for the first 2 weeks, and then gradual increase of physical activity with 60–90 min of daily cycling and moderate 2×60 min cross-training. After another 2 weeks time, daily 60–90 min of walking, Nordic pole walking, and moderate strength training two times a week was performed. At 7 weeks running was started, gradually increased to 90 km/week without any pain. A rapid rehabilitation programme after sacral stress fractures involving low impact physical activity, such as Walking and Nordic pole walking, is applicable to female athletes after ruling out the female athlete triad.

K. Knobloch (✉) · L. Schreibmueller · M. Jagodzinski · J. Zeichen · C. Krettek
Trauma Department, Medical School Hannover, Carl-Neuberg-Str. 1, 30625 Hannover, Germany
e-mail: kknobi@yahoo.com

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Introduction

Physical activity leads to a higher bone mineral density, especially among sporting events containing high workloads of the lower extremities [1]. Ideally, the stress on bone induced by physical activity should optimize the anatomic structure of the trabeculae by direct impact from weight bearing activity and indirectly by muscle pull [2]. However, stress fractures are a common overuse injury in athletes, especially in runners, but may remain unrecognized because the athletes treat themselves by resting until the symptoms resolve. The lower extremity is prone to stress fractures to the tibia, the most often commonly affected bone usually in its mid- and distal portion, followed by the metatarsal bones, the fibula, and the tarsal navicular bone [3]. Repetitive cyclic load may lead to overload of bone tissue, which might be deteriorated by a multiple number of issues, such as hormones, growth, and nutrition. Athletes, especially during adolescence place high physical demands on their bodies depending on the given sports activity, which might lead to stress fractures or avulsion fractures subsequent to repetitive microtrauma causing overload to the bone.

Although there is no close correlation between the weekly running mileage and the frequency of fractures, the mean running mileage in 31 athletes with recurrent stress fractures was 117 km/week [4]. Stress fractures of the pubic rami seem to be particularly common among long-distance running athletes. Regarding the menstrual cycle, 49% of stress fractures were among those

athletes with less than five menses per year, 39% of those with six to nine menses per year, and 29% with 10 to 13 menses per year [5]. Runners who had never used oral contraceptives were more than twice as likely to have had a stress fracture when compared with runners who had used oral contraceptives for more than 1 year. These data suggest that female distance runners who have a history of irregular or absent menses and who have never used oral contraceptives may be at an increased risk for developing a stress fracture.

Stress fractures to the sacrum are by far rarer with only a few total numbers of case reports in athletes. Isolated fatigue-type sacrum fractures have been reported mainly in runners [6]. In young athletes, sacral fractures of the fatigue-type should be considered among other reasons for low back pain, such as spondylolysis, lumbar Scheuermann's disease, scoliosis, disc herniation, fractures, and muscular stains [7]. We report on a 22-year-old female runner suffering a sacral fatigue-type fracture and a conservative treatment regimen with return to sport (running) within 7 weeks time.

Case report

A 22-year-old female runner suffered buttock pain on a visual analogue scale (VAS) of 10/10 without any preceding trauma. The pain was mainly located around the right sacroiliac joint, initially without any radiation towards the leg. She was running up to 140 km/week on streets and cross-country in an even distribution. She complained of severe buttock pain without any history of a fall or a strike; she could not anymore perform any physical activity at all. In physical exam she demonstrated tenderness on her right sacral region with moderate pain at the sacroiliac right joint. Pain aggravated while jumping. Lasegue test was negative, no sciatic pain or radiation in the lower leg in any lumbar or sacral dermatome was noted. Muscle tone, sensory function, and reflexes were normal. Both legs were same sized, no leg abnormalities, no scoliosis was apparent as well as no pelvic obliquity and no sacral torsion. No eating disorder was evident at physical examination and in her history. Furthermore, gynecological physical examination proofed regular menstruation and normal levels of sexual hormones without any signs of amenorrhea or dysmenorrhea.

Initial therapy without any further imaging studies was performed with oral diclofenac 100 mg/d for 2 weeks; rest and a single injection with xylocaine and triamcinolone to the sacroiliac joint at the right side was performed by a general practitioner without fluoroscopy, which had no effect regarding the pain. Due to persistent pain beyond 2 weeks time, after diclofenac therapy was prescribed and also the injection had no effect, the patient was referred for further imaging studies to the MRI. In a sacrum magnetic resonance imaging (MRI) using the T2-weighted Turbo-Short Tau Inversion-Recovery (STIR)-technique signal changes in the massa lateralis of the right sacrum were evident (Fig. 1a, b). Within the signal changes, a tiny line from the apical border of the first sacral neuroforamen leading towards the massa lateralis was identified as a sacral stress fracture. The sacroiliac joint was without any signal irregularities.

Conservative treatment was started with strict physical rest for the first 2 weeks, and then gradual increase of physical activity with 60–90 min of daily cycling and two time 60 min cross-training a week. Diclofenac was not prescribed after confirmation of the sacral stress fracture as to not to delay bony healing [8, 9]. The

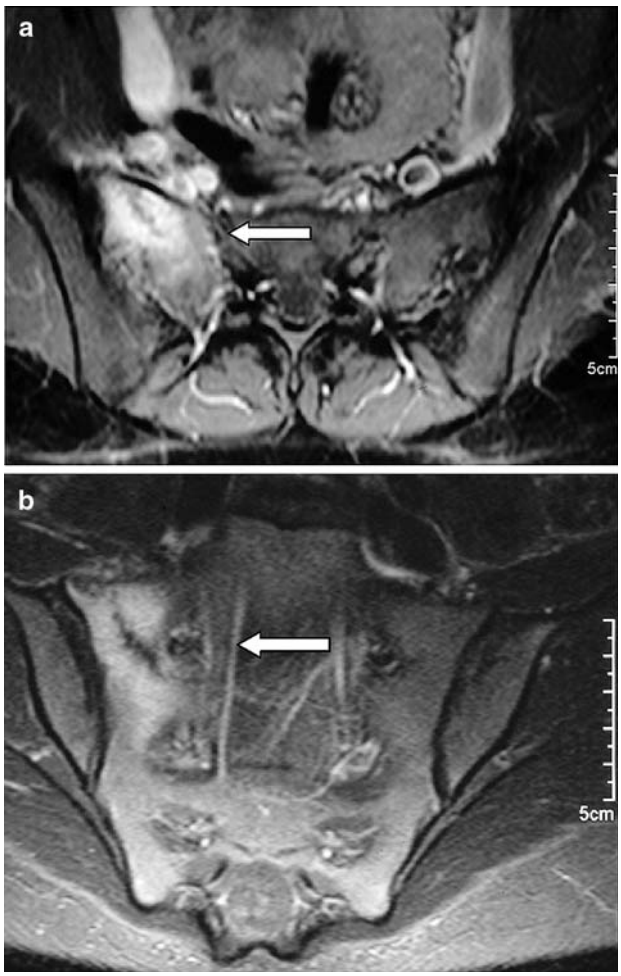

Fig. 1 Magnetic resonance imaging of the sacrum demonstrating a bone marrow odema at the right massa lateralis and a tiny fracture line as a sacrum stress fracture of the fatigue-type

rationale was to increase the load as much and soon as possible, only limited by pain at the sacrum. Exercises with known lower loads on the skeleton, such as walking and Nordic pole walking, was therefore advised to be complementarily performed throughout the rehab. After another 2 weeks time, daily 60–90 min of walking and Nordic pole walking and moderate strength training two times a week was initiated without any pain. Seven weeks after the onset of the pain, running was started on a daily basis with low intensity in extensive velocity, was gradually increased guided by any occurring pain to 90 km/week without any pain 8 weeks after the initial onset of the pain. In order to prevent future recurrent stress fractures, a modification of training with different load while running, Nordic pole walking, walking and modification of surfaces (grass, sand, forest grounds) was advised. Furthermore, the patient was recommended to start additional ball games [10] for variation issues. The running shoes were not changed because there was evidence that the running shoe fitting best is actually the best running shoe for the given athlete [11].

Discussion

"Olympic victors were those who did not squander there power by early and overtraining" (551 BC).

Stress fractures to the sacrum are rare with unknown prevalence and occurred mostly in females [12]. Currently two types of stress fractures are classified regarding their risk: High-risk stress fractures occur in the superolateral femoral neck, anterior tibial shaft, tarsal navicular, proximal fifth metatarsal, and talar neck leading often to prolonged and complicated recovery. Low-risk stress fractures occur in the lateral malleolus, calcaneus, 2nd through 4th metatarsals, and the femoral shaft usually heal within 4–6 weeks without any complications [13]. The undertreatment of high-risk stress fractures can lead to catastrophic bone failure and/or prolonged loss of playing time. Overtreatment of low-risk stress fractures can result in unnecessary deconditioning and unneeded loss of playing time.

A recent analysis from Australia [14] found only 2 of 11 athletes attending a university sports medicine center between 1996 and 2002 (18%) with navicular stress fractures receiving the literature-recommended treatment of at least 6 weeks' nonweightbearing cast immobilization. Of these 11 patients, only 6 (55%) returned to sports at their previous level. Only 3 patients with navicular stress fractures regained normal imaging appearance at follow-up.

Almost always running athletes are affected in cross-country, track, or marathon [15]. Apophysitis and avulsion fractures at the hip may affect younger runners and produce localised pain at muscle attachment sites [16]. Coaches, athletic trainers, and medical personnel who care for runners should advocate running regimens, surfaces, shoes, technique, and individualised conditioning programmes that minimise the risk of initial or recurrent hip injuries. Furthermore, based on a recent paper of Fredericson et al. [10], one should think about recommending ball sports as an alternative addition to running athletes. Fredericson et al. [10] found among 156 female and 118 elite male distance runners (18–44 years) using a questionnaire that in both men and women, playing basketball or soccer in youth correlated with a reduced stress fracture incidence later in life by almost 50%. In men, each year of additional soccer or basketball conferred a 13% decrease in stress fracture risk, which was the same among women with regular menses. In females with irregular menses, such as oligo-a amenorrhoe in the females athlete triad, the protective effect of soccer or basketball was absent. The more variation in sports a runner experiences, the better his bone is adjusted to the different workloads, decreasing the risk for occurring stress fractures.

Female athlete triad

Female runners are particularly susceptible to stress fractures [17], especially in the setting of the female athlete triad consisting of

- Amenorrhoea
- Osteoporosis
- Eating disorder

Although our patient did not fulfil the criteria for the female athlete triad, the triad is prevalent among especially long-distance running females, which should be ruled out in every female athlete presenting with a stress fracture. Female athletes should be especially asking about their eating habits ruling out the female athlete triad which consists of amenorrhea, osteoporosis/osteopenia, and disordered eating [18]. The potential impact of each, and the combination of these disorders, is detrimental to performance and health [19].

Diagnosis

Diagnosis for sacral stress fractures usually involves several imaging studies, as such plain radiographs may almost always reveal negative findings regarding sacral stress fractures, especially as symptoms usually precede

radiographic changes for weeks or months. Radiographic findings can include periosteal, endosteal or medullary novel bone formation and fracture lines [20]. The largest cohort published by Johnson with a total number of eight female athletes was examined with a high index of suspicion using a combination of plain radiographs, technetium-99 m bone scans, CT, and MRI. Typical MRI findings are diminished signal intensity within the fracture lines surrounded by a bone marrow oedema, which might be enhanced using fat suppression MRI techniques. A recent MRI [21] study among 26 NCAA asymptomatic male basketball players found after the season that in 6 of the 52 feet (12%) a signal indicating bone marrow edema in the metatarsals. The MRI depicts bone marrow edema in the feet before a fracture becomes evident. Identification of this edema may reveal stress changes, allowing early treatment and prevention of debilitating stress fractures [21].

Rapid rehabilitation programmes

Only conservative treatments without a detailed schedule or dose regimen have been reported in the literature for sacral stress fractures. The average time to becoming pain-free was 6.6 months in Johnson's cohort of eight female athletes, while it took 8 months to return to the same pre-injury activity level. Risk factor for recurrent pain was a rapid increase in the workload. Those with the best mineral bone density and the best overall diet were able to compete in sports 3 to 9 months earlier than the others. In our female athlete without eating disorders or dysmenorrhoea, she returned to running after 7 weeks with a weekly mileage of 90 km as soon as 8 weeks after the sacral stress fracture. Initial rest, followed by gradual increased physical activity with fewer loads on the skeleton, such as walking and Nordic pole walking, might enable our female athlete to increase her performance level starting as early as 2 weeks after rest might be one suggestion for the rapid return to sport in our case. Thus, early and rapid rehabilitation programmes seem to be possible in this setting, especially in case of a ruled out female athlete triad. The more vascular trabecular bone of the sacrum may facilitate healing of stress fractures more rapidly rather than in long bones.

Preventive issues

A recent analysis focussed on the history of stress fractures in runners with/without a concomitant history of ball sports during adolescence [10]. In both men and women, playing ball sports in youth correlated with reduced stress fracture incidence later in life by almost half. Runners who participate during childhood and adolescence in ball sports may develop bone with greater and more symmetrically distributed bone mass, and with enhanced protection from future stress fractures. Besides the evaluated ball sports soccer and basketball, it is conceivable that to broad variation of different sports, may be including balance board training as well, will lead to different loads to the bony trabeculae will best strengthen the skeleton among runners.

Take home message

Sacral stress fractures in running, diagnosed with MRT, can be treated with rapid rehabilitation involving low impact physical activity, such as Walking and Nordic pole walking, for gradual increase of load. Variation of physical activity with moderate intensity starting 2 weeks after initial rest with daily cycling and cross-training, followed by walking and strength training starting another 2 weeks later facilitate a rapid return to sport within 7 weeks to running. Preventive activities, such as various sports during adolescence, might decrease the risk for future stress fractures and should therefore be recommended in the future.

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