Volume: 29, Issue: 4, October 2018 pp: 237-241 ORIGINAL ARTICLE

SACRAL STRESS FRACTURES: AN IMAGING BASED CROSS-SECTIONAL STUDY*

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***Informed consent was obtained from patients with respect to the retrospective analysis, and the study was approved by the institutional review board.**
Fields of Study: Spine Surgery; Radiology.
Conflict of Interest:The authors of this manuscript have no competing interests that influence the results and discussion of this paper.

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Received: 9th June, 2018.
Accepted: 14th August, 2018.

ABSTRACT

Background Data: Having been regarded as a rare cause of low back pain, sacral stress fractures are overestimated because of the lack of specific symptoms. Furthermore, the level of awareness of this pathological condition is quite low amongst the physicians.

Purpose: To present the incidence rate of sacral stress fractures by reviewing imaging modalities, and to compare the results of patient populations-at-risk in accordance with the current literature.

Materials-Methods: This retrospective study was held at a private tertiary care center between April 2013 and December 2017. With the exception of high energy trauma patients, all individuals who had lumbar magnetic resonance imaging (MRI) scans and those who further evaluated with a pelvic MRI scan consisted the study group. The patients' demographics and the radiological features were evaluated and reviewed by using electronic patient records and hospital-based picture archiving and communication system. The frequencies were calculated and compared with the data obtained from the literature.

Results: A total of 1321 individuals (female: 659, male: 662) had a lumbar MRI scan during the study period and 485 of them (female: 238, male: 247) were further analysed with a pelvic MRI scan for differential diagnosis. Fourteen of these patients were diagnosed as sacral stress fracture. The calculated frequencies within a 57 months period for females, males and the whole study population were 1.67 %, 0.45 % and 1.06 %, respectively.

Conclusion: This study has reviewed the MRI studies and found out the incidence rates for sacral stress fractures. These results suggest that physicians should be aware of sacral stress fractures in the setting of clinical suspicion, especially in the certain patient populations.

Key Words: fatigue fracture; insufficiency fracture; sacrum; stress fracture

Level of evidence: Retrospective clinical study, Level III

INTRODUCTION

Commonly misdiagnosed and having been regarded as a rare cause of low back pain, sacral stress fractures are overestimated because of the lack of specific symptoms [7,21]. Moreover, the level of awareness of this pathological condition is quite low amongst the physicians [12,15,21].

The term "stress fracture" is defined as a partial or complete fracture resulting from the inherent inability of bone to lean stress applied in a rhythmic, repeated, sub-threshold manner without intensity. These fractures are further classified by Pentecost et al. as "fatigue" and "insufficiency" based on bone physiology and mechanism of injury [8,11,16,17,28,29]. A fatigue fracture may occur if abnormal stresses are applied to a bone with normal elastic resistance, i.e. the intense training of athletes for prolonged periods [17,28,29]. On the other hand, fractures occurring in the setting of the physiological stresses in bones with deficient elastic resistance, i.e. osteoporosis, named as "insufficiency" [11,17,28,29]. Nowadays, some authors prefer to use the term "fragility fracture" instead of stress, fatigue or insufficiency fractures to describe osteoporosis-associated fractures due to a minor trauma [24].

The reported incidence rate of fatigue fractures may be as high as 20% in runners, and <1% for insufficiency fractures in general population [3]. Because of the high number of undiagnosed cases, the true incidence is unknown for sacral insufficiency fractures, and it has been reported to be between 1% and 5% in at-risk patient populations [14,25-27]. Even though, the prevalence of such situation increases in accordance with the longer life expectancy in the last two decades [1,24], there is a limited evidence in the literature for identifying the frequency rates for stress fractures of the sacrum. So, the purpose of this single-center study is to present the incidence rate of sacral stress fractures by reviewing imaging modalities, and to compare the results of patient populations-at-risk in accordance with the current literature.

MATERIALS AND METHODS

This retrospective study was held at a private tertiary care center, and approved by the institutional review board (ATADEK 2017-13/6). Between April 2013 and December 2017, with the exception of high energy trauma patients, all individuals who had lumbar magnetic resonance imaging (MRI) scans and those who further evaluated with a pelvic MRI scan consisted the study group. A flow chart of the study design is given in Figure-1.

The patients' demographics and the radiological features were evaluated and reviewed by using electronic patient records and hospital based picture archiving and communication system (PACS). The frequencies were calculated, and compared with the data obtained from the literature.

Statistical Analysis

Data were expressed as mean values and standard deviations (SD) for continuous variables and as percentages for categorical variables. The difference between the two rates with its 95% confidence interval and associated p-value was calculated [19]. Type-I error rate was taken as α=0.05 for statistical significance. Statistical analyses were performed using MedCalc for Windows, version 18.9 (MedCalc Software, Ostend, Belgium).

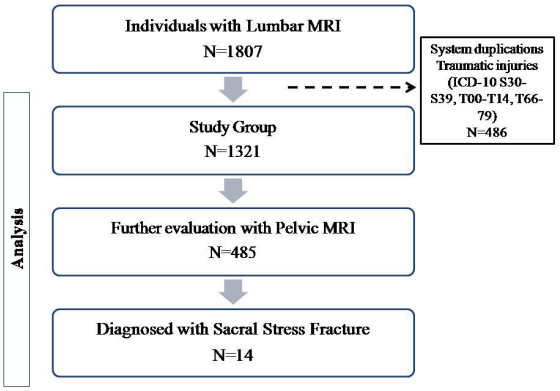

Figure-1. Flowchart of the study.

RESULTS

A total of 1321 individuals (female: 659, male: 662) had a lumbar MRI scan during the study period and 485 of them (female: 238, male: 247) were further analyzed with a pelvic MRI scan for differential diagnosis. Fourteen of these patients were diagnosed as sacral stress fracture, six of them were unilateral and the rest were bilateral. The characteristics of the study population and patient number in the distribution of age groups containing 11 females and 3 males are summarized on Table-1and Figure-2, respectively.

When the fractures further classified according to the recent literature by Bakker et al. [1], the numbers of fractures for Type A, Type B, and Type C were 1, 9 and 4, respectively (Figure-3).

The calculated frequencies within a 57 months period for females, males and the whole study population were 1.67 %, 0.45 % and 1.06 %, respectively. When the incidence rates were compared between the study group and the eligible appropriate literature, no statistically significant difference was found with respect to the whole study population as well as to the patient populations-at-risk in a total person-years analysis (Table-2A-B).

Table-1. Characteristics of the study population.

	Lumbar MRI (+) patients	Further evaluated with Pelvic MRI	Diagnosed with Sacral Stress Fracture
Characteristic	n (%)	n (%)	n (%)
Gender			
Female	659 (49.9)	238 (49.1)	11 (78.6)
Male	662 (50.1)	247 (50.9)	3 (21.4)
Total	1321 (100)	485 (100)	14 (100)
Age years (mean, min-max)	42.8 (1-94)	40.98 (9-82)	54.4 (35-81) F: 53.6 (35-81), M: 61.7 (45-75)

F: female, M: male, min: minimum, max: maximum, MRI: magnetic resonance imaging

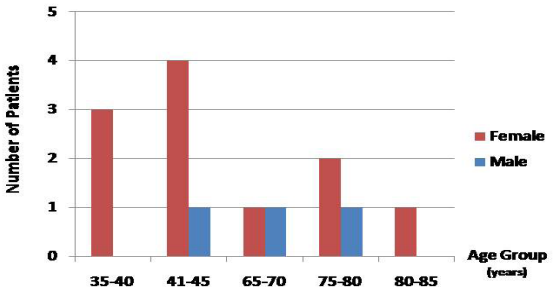

Figure-2. The patient number in the distribution of age groups containing 11 females and 3 males.

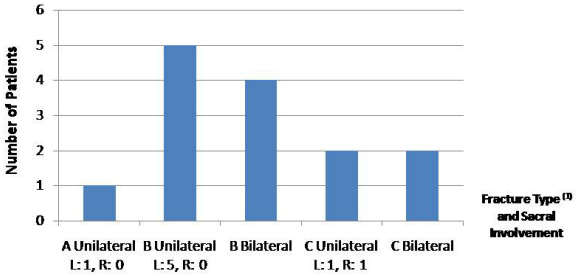

Figure-3. Classification of the sacral stress fractures in accordance with the recent literature by Bakker et al. [1]

Table-2. The comparison between the incidence rates for; **(A)** whole study population, and **(B)** patient populations-at-risk, in a total person-years analysis.

	Incidence Rate	95% CI	p	Incidence Rate Difference, 95% CI	Incidence Rate Ratio, 95% CI
A.					
Present Study	0.002231	0.00122-0.003743	0.06	-0.001995, -0.004093-0.000102	0.5279, 0.2467-1.0989
Weber et al. [26] (1993)	0.004227	0.002582-0.006528			
B.					
Present Study	0.005435	0.001481-0.013915	0.27	-0.004417, -0.012273-0.003438	0.5516, 0.1371-1.6467
Weber et al. [26] (1993)	0.009852	0.006018-0.015216			

CI: Confidence interval

DISCUSSION

This single center study aimed to analyze the incidence rate of sacral stress fractures by reviewing imaging modalities, and to compare the results of patient populations-at-risk in accordance with the literature. The calculated incidence rate was 1.06% for whole study population within a 57 months period. Moreover, no statistically significant difference was found with respect to the whole study population as well as to the patient populations-at-risk in a total person-years analysis (Table-2A-B).

Sacral stress fractures are mainly divided into two categories as "insufficiency" and "fatigue" [17,28]. Both types have different set of risk factors and disease mechanisms. First described by Lourie as spontaneous osteoporotic fracture of the sacrum in 1982 [13], insufficiency fractures occur after normal stress in bone with decreased mineralization and elastic resistance, as caused by postmenopausal osteoporosis [29].

The risk factors for sacral insufficiency fractures are; older age, female gender, osteoporosis, osteopenia, rheumatoid arthritis, corticosteroid use, pelvic radiation therapy, hyperparathyroidism, renal osteodystrophy, osteomalacia, Paget's disease, previous thoracolumbar / lumbosacral fusion surgery, joint arthroplasty, immunosupression, obesity, smoking history, vitamin D insufficiency, and anticoagulant therapy with heparin [12,28,29]. On the other hand, first discovered in 1989 by Volpin et al. [23], sacral fatigue fractures occur when abnormal stresses are applied to normal bone, and are typically seen in long-distance runners and those that engage in regular repetitive weight-bearing exercises for prolonged periods, such as military recruits [29]. The possible risk factors for sacral fatigue fractures are long distance running, a recent increase in training intensity, deficient diet, and to be a military personnel [11,28,29]. Moreover, the female athlete triad (amenorrhea, eating disorder, and osteopenia) is another important factor for the development of sacral fatigue fractures [11,28,29]. Both stress and fatigue type of sacral stress fractures have been reported during the last trimester of pregnancy and the early postpartum period [4,18,20].

Risk factors for the fractures during pregnancy or in the first weeks after delivery include vaginal delivery of a high-birth-weight infant, increased lumbar lordosis, excessive weight gain, rapid vaginal delivery, ligamentous laxity, and transient osteoporosis associated with pregnancy and lactation [12,29]. The authors of the present study have evaluated such type of fractures with imaging studies and the evaluated clinical parameters in the study were only age and gender. There was a female predominance as in line with the literature [11,28,29].

The mean age was 54.4 years that was different from the previous studies [11,28,29]. Here, 21.4 % of the patients were between 35-40 years, 35.7 % of them were between 41-45 years, and the rest (42.9 %) were between 65-85 years. Although the majority of the patients were between 65-85 years, as because of lack of detailed clinical information and bone-mineral density test, the authors were unable to further classify the sacral stress fractures, but they have claimed that all these fractures in the present study could have been classified as insufficiency fractures.

Low clinical suspicion and not to be even aware of such clinical problem, the diagnosis of sacral stress fractures are often delayed or mistaken. Because of the high number of undiagnosed cases, the true incidence is unknown. Weber et al. reported that sacral insufficiency fractures were present in 1.8 % (20/1030) of female patients over age 55 [0.9 % of all 2366 patients (20/2366)] admitted by physicians working in a rheumatology division during a period of 2 years [26]. West et al. reported a rate of 1 % (4/386) of such fractures in a specific group of rheumatoid arthritis patients over 6 years [27]. Here, the calculated incidence rates for sacral stress fractures within a 57 months period for females, males and the whole study population were 1.67 %, 0.45 % and 1.06 %, respectively. When the incidence rates were compared with the study by Weber et al., no statistically significant difference was found with respect to the whole study population as well as to the patient populations-at-risk (female patients over age 55years) in a total person-years analysis. The authors of the current study were not able to compare their results with the study by West et al. [27], because only patients with rheumatoid arthritis were evaluated in aforementioned study [27]. Moreover, data about the "population under risk" is limited in previously published series [1,9,10,22,28], so that's why the present authors have compared their results with only one study in the literature. Of note, as was mentioned before, the authors were unable to further classify the sacral stress fractures, but they have claimed that all these fractures in the present study could have been classified as insufficiency fractures and have made the statistical analysis accordingly.

The diagnosis of sacral stress fractures requires a combination of clinical findings, imaging studies, and laboratory examinations. They are commonly misdiagnosed because of the similar physical presentation findings as other pathological conditions, i.e. low back muscle strain, facet arthropathy, trochanteric bursitis, lumbar disc herniation, degenerative disc disease, vertebral compression fracture, spondylolisthesis, and sacroiliac joint dysfunction [16,28,29]. The most common chief complaints are insidious low-back, buttock or vague pelvic pain [11,28,29].

Furthermore, patients with sacral insufficiency fractures report minimal or no trauma, whereas patients with sacral fatigue fractures report excessive repetitive activity and recent increases in training [11,28,29]. Physical examination shows point tenderness with palpation, and the single leg hop test often reproduces pain [5]. Imaging studies could be performed during the period of differential diagnosis. American College of Radiology appropriateness criteria recommend plain radiographs as the initial imaging study in the suspected cases of sacral stres fractures. However, they can only detect complete fractures [2,12]. Of note, there is a high incidence of concomitant pelvic insufficiency fractures, and radiologists should be aware of this association [14]. When radiography is negative, the next imaging study should be pelvis MRI without intravenous contrast or bone scan, with reported high sensitivities [6,9,21]. In accordance with the systematic review by Yoder et al., an MRI, bone scan, or computed tomography (CT) scan (in descending order) should be utilized to identify the sacral stress fractures [28]. Laboratory studies aid in this diagnosis and are able to evaluate the potential presence of osteoporosis, one of the proposed underlying condition associated with insufficiency fractures [28]. In the present study, the authors have reviewed the MRI scans of the patients focusing on lumbar area as well as the pelvis. None of these patients had bone scan and CT scan. Unlike the recent study by Kim et al. [9], none of the lumbar MRI scans have been able to detect sacral stres fractures in the present study.

This study has several limitations. First, this is a single-center study in a private tertiary care settlement which might affect the study population. Second, because of the lack of detailed clinical information, the authors were unable to further classify the sacral stress fractures. Third, no information was presented about the treatment protocols. This might be because of the lack of detailed clinical data and/or the missing patients after having diagnosed by the MRI scans because of the private setting.

Conclusion

This study has retrospectively reviewed the MRI studies and found out the incidence rates for sacral stress fractures. These rates were 1.67%, 0.45% and 1.06%, for females, males and the whole study population, respectively, during a 57 months study period. Although the rate in the general population is still unknown, the results of this study suggest that physicians should be aware of sacral stress fractures in the setting of clinical suspicion especially in the certain patient populations; and they should evaluate such patients accordingly.

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