Systematic Review

Risk factors associated with sacral stress fractures: a systematic review

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Objectives: The objective of this study was to examine and identify risk factors associated with the development of sacral stress fractures in order to improve diagnosis in clinical practice.
Methods: Electronic search strategies in PubMed, CINAHL, Scopus, and SPORTDiscus were combined with a hand search to identify articles for inclusion. Studies were considered if they described patient cases in which imaging confirmed diagnosis of a sacral stress fracture, and the diagnosis included whether the fracture was a sacral insufficiency or sacral fatigue stress fracture.
Results: In those that developed sacral insufficiency fractures, the risk factors that were most prevalent included osteoporosis, pelvic radiation therapy, rheumatoid arthritis, long-term corticosteroid therapy, and postmenopausal, each with a prevalence of 100%. Risk factors with 100% prevalence in those diagnosed with sacral fatigue fractures included recent increase in training intensity and deficient diet.
Discussion: A pattern of signs and symptoms are consistent among subjects with sacral stress fractures. Patients being unsuccessfully treated for low-back and buttock pain who fit the risk factor profiles for sacral stress fractures should be referred to a physician for further diagnostic workup.

Keywords: Sacral stress fracture, Insufficiency fracture, Fatigue fracture, Risk factors

Introduction

The etiology of sacral stress fractures involves pathological stress dissipation from vertical body forces of the spine into the sacrum and sacral ala.[1,2] Stress fractures can be divided into two main categories, insufficiency and fatigue, which are separated based on differing bone physiology and mechanism of injury.[1–4] Insufficiency fractures occur when normal stresses are applied to bone with decreased density, most often due to osteoporosis.[1,2] Fatigue fractures are caused when abnormal stresses are applied to normal bone, such as from the intense training of athletes for prolonged periods.[2] It is reported that the incidence of sacral fatigue fractures may be as high as 20% in runners; however, incidence is not reported for sacral insufficiency fractures because of the high number of undiagnosed cases.[1,2]

The diagnosis of sacral stress fractures requires a combination of clinical presentation findings, imaging results, and laboratory studies. Sacral stress fractures are commonly misdiagnosed because of a physical presentation similar to other pathologies, such as degenerative disk disease, sacroiliac joint dysfunction, herniated nucleus pulposus, vertebral compression fractures, facet arthropathy, trochanteric bursitis, hamstring and low-back muscle strains, and spondylolisthesis.[2,3] Current literature reports insidious low-back, buttock, or vague pelvic pain as the chief complaint in patients with sacral stress fractures.[1,2] Tenderness to palpation over the sacrum has been reported as a trademark physical examination finding of sacral insufficiency fractures. 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.[1,2]

Diagnosis of this pathology is also difficult because plain radiographs, which are used as an initial screening tool, fail to adequately display the fracture.[1,2] Bone scans, computed tomography (CT) scans, and magnetic resonance imaging (MRI) are also useful tools for diagnosis of sacral stress fractures; however, MRI is considered the imaging technique of choice for confirming the diagnosis.[1,2] Laboratory studies aid in this diagnosis and are able to evaluate the potential presence of osteoporosis, a proposed underlying condition associated with insufficiency fractures. Elevated serum alkaline phosphatase is a marker for increased bone formation, and dual energy X-ray absorptiometry (DEXA) has been reported as the gold standard for measuring bone mineral density (BMD).[1,2]

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There are a number of studies that have proposed risk factors associated with both forms of sacral stress fractures; yet to our knowledge, there have been no systematic reviews performed on this topic. Reported risk factors for sacral insufficiency fractures include osteoporosis, osteopenia, rheumatoid arthritis, corticosteroid use, radiation therapy, renal osteodystrophy, osteomalacia, Paget's disease, hyperparathyroidism, joint arthroplasty, and lumbosacral fusion.[1,2] Multiple studies have suggested osteoporosis as the leading risk factor for the development of insufficiency fractures.[1,2] Fatigue fractures typically occur in long distance runners and military recruits who participate in repetitive weight-bearing activity.[1,2] The female athlete triad involving amenorrhea, disordered eating, and osteopenia may play a role in the development of these fractures in women.[1,2] Insufficiency fractures are most commonly reported in patients with a mean age of 71, whereas fatigue fractures occur in a much younger population with a mean age in the twenties and thirties.[1,2]

The objective of this study is to examine and identify risk factors associated with the development of sacral stress fractures to improve diagnosis in clinical practice. This study provides a systematically derived review of the literature regarding prevalence of risk factors associated with sacral stress fractures. We hypothesize that clinicians will be able to utilize our findings to assist in the differential diagnosis and clinical decision making associated with sacral stress fractures.

Methods

Study design

A systematic review was completed in agreement with the 27-item PRIMSA Statement for Reporting Systematic Reviews.[5] The study was exempt from review of the Human Subject Review Board (HSRB) at Walsh University.

Search strategy

The following databases were utilized for our search: PubMed, CINAHL, Scopus, and SPORTDiscus. The following terms were included in our search strategy: sacrum OR sacral AND stress fracture OR insufficiency OR fatigue fracture OR overuse AND risk factors OR risk factor OR risk OR etiology OR presentation OR incidence OR prevalence. Search filters used included English language and human subjects. No limitation was put on the date of publication. The search was completed on 29 November 2012.

Eligibility criteria

Eligible studies included were case studies or case series. We considered studies that described patient cases in which imaging confirmed diagnosis of a sacral stress fracture, and diagnosis included whether the fracture was a sacral insufficiency or sacral fatigue stress fracture.

Study selection

The study selection process began with two reviewers (KY and CL) who independently screened all article titles for inclusion in our study. A third reviewer (KA) resolved any discrepancies between the two reviewers. Two additional reviewers (JB and EM) completed the same process for abstracts, with a third reviewer (CL) who resolved discrepancies. Full text review was completed by two reviewers (KY and KA), and disagreements were reviewed by a third party (JB). Additionally, an extensive hand search was completed, including review of references within previous literature reviews on sacral stress fractures.

Data collection

The case studies from the included articles were divided into two categories by diagnosis: sacral insufficiency fractures and sacral fatigue fractures. The data extracted were patient description, physical examination findings, imaging, follow-up, and risk factors reported.

Quality assessment

Five of the six authors of this study reviewed the studies for quality assessment. The studies were reviewed using a single three-point quality score, measuring the effectiveness of the description of each study. The quality measures were extracted from a qualitative preexisting scale[4] that evaluated cohort-based studies which assessed the internal and external validity of dedicated risk factors. Because we targeted case reports or case series, we were required to modify our scale to capture the items that were most specific to those designs.

Each quality measure investigates: (1) comprehensiveness of patient description, (2) etiology and consequences, and (3) risk factor inclusion and description. Each aspect was scored as either present or absent within each study. The qualitative threshold for comprehensiveness of patient description involved the inclusion of multiple demographic and dedicated risk factors that carefully define a proper description of the patient included within the publication. Explanation of etiology and consequences demanded a longitudinal description of the patient's bout with the stress fracture including the prognosis of the individual. Proper risk factor inclusion and description required operational definitions for each risk factor (when appropriate e.g. age is self-explanatory) including at what phase of the bout with the stress fracture the information was collected.

Results

Search results

A comprehensive search of PubMed, CINAHL, Scopus, and SPORTDiscus elicited a total of 521 articles. After removal of duplicates, 444 studies remained. We excluded 363 studies based upon

review of titles and abstracts, with 81 studies remaining for full text review. Relevant titles including sacral fracture, stress fracture, fatigue fracture, or insufficiency fracture were included in the abstract review. Articles were excluded if the abstract did not include a description of one or more patients with a sacral stress fracture. Based on our eligibility criteria, we eliminated 35 studies after full text review, leaving 46 studies. Articles were excluded if they were not classified as a case report or case series that reported individual patient characteristics or if a diagnosis of sacral stress fracture was not confirmed with imaging. A hand search revealed three studies that were considered eligible based on our inclusion criteria. A total of 49 studies were selected for inclusion in this systematic review. After further analysis of the full text studies, the authors excluded 17 articles that did not report the type of sacral fracture. Ultimately, 32 articles[6–37] were included in the systematic review (Fig. 1). In total, 101 cases from the included studies described patients with sacral insufficiency fractures and 12 cases described patients with sacral fatigue fractures, for a total of 113 patients.

Study characteristics

We examined each case report and extracted information regarding patient description, physical examination findings, which diagnostic imaging tool was utilized, follow-up time, and reported risk factors. Within patient description, we extracted gender, age, and occupation if applicable. For physical examination, we focused on the subjective complaint of the patient, onset of symptoms, objective assessment findings, and special tests. In each study, we reported positive and negative results of diagnostic imaging for sacral stress fracture, including plain radiograph, bone scan, CT scan, and MRI. Follow-up data that were collected include report of time for relief of symptoms and/or return to activity, as well as any report of repeat imaging demonstrating healing of the sacral stress fracture. All reported risk factors (whether detrimental or protective) associated with the patients' development of a sacral stress fracture are listed in the last column of Supplementary Materials 1 http://dx.doi.org/10.1179/2042618613Y.0000000055.S1 and 2 http://dx.doi.org/10.1179/2042618613Y.0000000055.S2, which can be accessed online.

Risk factors

In those who developed sacral insufficiency fractures, the risk factors that were most prevalent included osteoporosis, pelvic radiation therapy, rheumatoid arthritis, long-term corticosteroid therapy, and postmenopausal, each of which exhibited a prevalence of 100% (Table 1). Of the total cases of sacral insufficiency fractures reviewed (101), 75 involved elderly females. Thirty-six of the studies reported the patient had osteoporosis, 18 had undergone pelvic radiation therapy, 12 had rheumatoid arthritis, 12 had a history of long-term corticosteroid use, and seven reported the patient as postmenopausal.

Risk factors with 100% prevalence in those diagnosed with sacral fatigue fractures included recent increase in training intensity and deficient diet, each reported as present in seven case studies (Table 2). A deficient diet was reported when a dietary analysis was completed and showed inadequate caloric intake, malnutrition, and/or low vitamin/mineral intake. The calculated mean ages for cases with confirmed diagnosis of sacral insufficiency and sacral fatigue fracture were 70.5 and 25.1 years, respectively.

Most prevalent complaint of symptoms

The most common chief complaint of patients with sacral stress fractures found in this review was low-back and buttock pain, with a significant number also reporting hip and groin pain. Many patients expressed discomfort with palpation over the sacrum and sacroiliac joint region. Another common physical exam finding was that the pain worsened with weight-bearing activities. Motor function and sensation were usually unimpaired when tested.

Use of diagnostic imaging and sensitivity values

The most common diagnostic imaging technique used to diagnose sacral insufficiency fractures was a plain radiograph, followed by bone scan, CT scan, and lastly MRI. When a bone scan or MRI was completed, it was positive 100% of the time. CT scans confirmed an insufficiency fracture in 97.7% of the cases. Fatigue fractures reflected similar findings that can be seen in Table 3. Overall, MRI was found to be the most accurate in diagnosing sacral insufficiency and fatigue fractures.

Follow-up periods

Many of the studies we found reported follow-up times in which healing of sacral fractures was monitored and recorded. Follow-up times reported within the case studies varied widely for patients with both sacral insufficiency and fatigue fractures. Reported follow-up times for those with sacral insufficiency fractures ranged from 2 weeks to 1 year for pain-free recovery, 1 to 22 months for complete healing, and 1 to 8 months for return to activity. The reported follow-up times for patients with sacral fatigue fractures ranged from 2 months to 1 year for pain-free recovery and return to activity. We have included follow-up times specific to recovery in Supplementary Materials 1and 2, which can be accessed online.

Quality scoring

Table 4 provides the qualitative scoring of the three quality items for each study. The most commonly missing item was the comprehensive description of the etiology and consequence of the individuals,

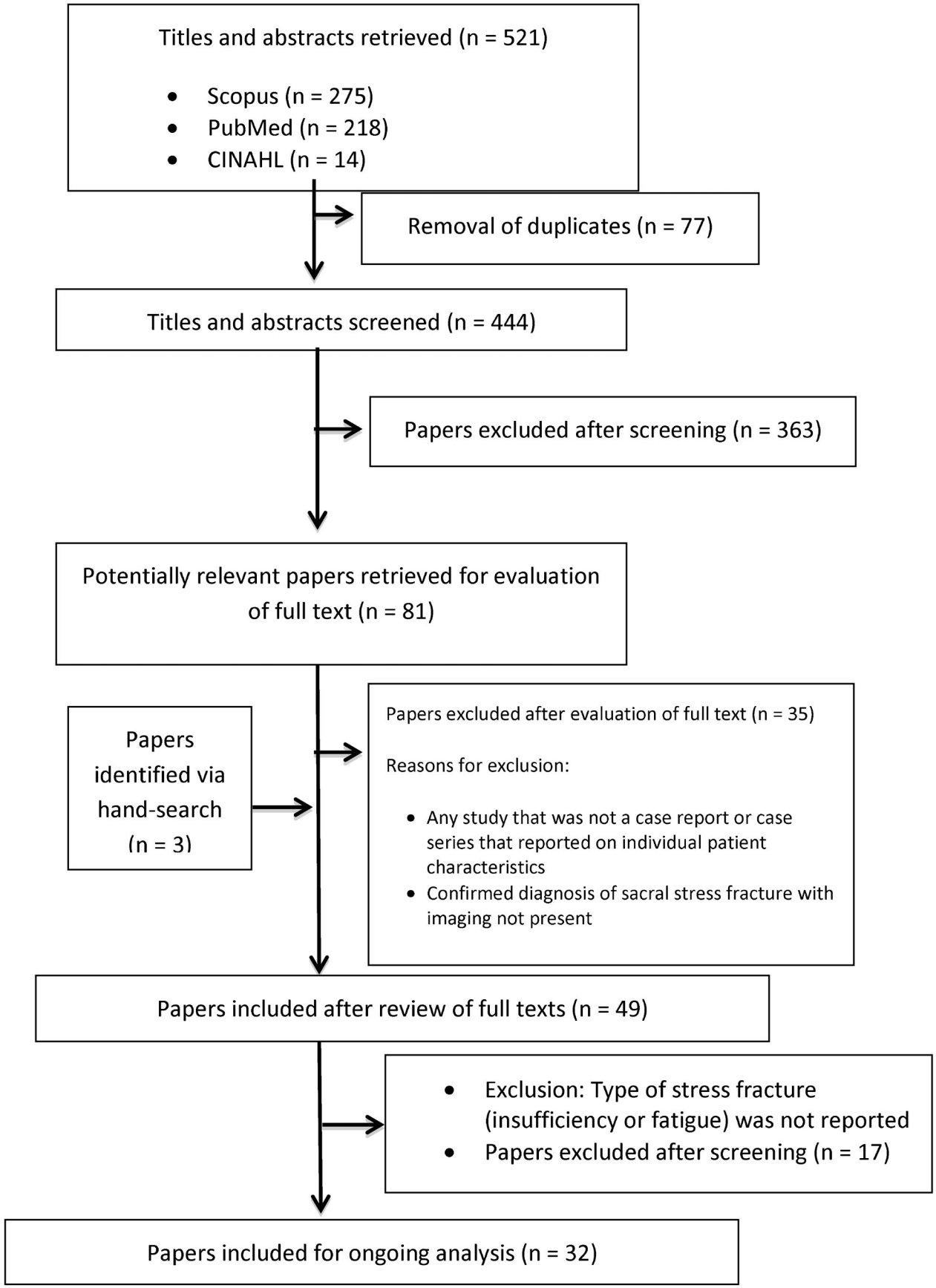

Figure 1 Flow diagram of retrieved, screened, and included studies.

representing 12 of the 16 total deficits. Failure to adequately report the comprehensive inclusion/assessment of risk factors represented the other four missing items. Half (16) of all the reviewed studies have all three items represented in detail within the manuscripts. Fifteen studies exhibited at least two of

the three items, whereas only one study represented one of the three items.

Discussion

Summary of evidence

The primary purpose of this study was to identify and analyze the risk factors associated with patients diagnosed with sacral stress fractures. Sacral stress fractures are best divided into two main categories: sacral insufficiency and sacral fatigue fractures. Our findings demonstrated that a different set of risk factors is related to each specific type of stress fracture. In those diagnosed with sacral insufficiency fracture, the risk factors that are most commonly present included being an elderly osteoporotic female, having rheumatoid arthritis with long-term corticosteroid therapy as treatment, and pelvic radiation therapy for treatment of cancer in the pelvic region. The most prevalent risk factors found for patients who developed sacral fatigue fractures included a recent increase in training intensity and a deficient diet.

Our comprehensive search of the literature confirmed many of the purported risk factors described in previous literature reviews regarding sacral insufficiency and fatigue fractures. In the literature, it is proposed that the risk factor most indicative of sacral insufficiency fracture was being an elderly female with postmenopausal osteoporosis, findings that we confirm.[1,2,6] We found that the prevalence of these risk factors was elderly female (74.3% of 101 cases), osteoporosis (100% of 36 cases), and postmenopausal (100% of 7 cases). In descending order of frequency reported, the authors also found that insufficiency fractures were reported in cases involving pelvic radiation therapy (100% of 18 cases), corticosteroid therapy (96% of 25 cases), rheumatoid arthritis (100% of 12 cases), and osteopenia (100% of 4 cases). In the present review, the average age of those who developed sacral insufficiency fractures was 70.5 years. This is essentially the same as reported in the literature (71 years of age).[1,2]

The results of our study suggest a couple of differences from what is currently reported in the literature regarding sacral insufficiency fractures. We were unable to account for any cases that reported renal osteodystrophy, osteomalacia, Paget's disease, hyperparathyroidism, or joint arthroplasty as a cause of insufficiency fracture. All of these factors have been identified as risk factors in previous narratives.[1,2] We also found that there were only five confirmed cases of insufficiency fractures in which the patient also had a history of lumbosacral fusion. Our failure to find renal osteodystrophy, osteomalacia, Paget's disease, hyperparathyroidism, or joint arthroplasty as a risk factor

Table 1 Prevalence of risk factors for developing sacral insufficiency fractures

Risk factor	Sacral insufficiency fracture
Osteoporosis	100% (36/36)
Pelvic radiation therapy	100% (18/18)
Rheumatoid arthritis	100% (12/12)
Long-term corticosteroid therapy	100% (12/12)
Postmenopausal	100% (7/7)
Thoracolumbosacral/lumbosacral fusion	100% (5/5)
Osteopenia	100% (4/4)
Hx or present spondylosis/spondylolisthesis	100% (4/4)
Hypothyroidism	100% (4/4)
High body mass index (BMI) indicating obesity/obese	100% (4/4)
Polymyalgia rheumatica	100% (3/3)
Liver transplantation	100% (3/3)
Lung transplantation	100% (3/3)
Sacral Tarlov cyst	100% (2/2)
Heart and lung transplantation	100% (1/1)
Scoliosis	100% (1/1)
Increased lumbar lordosis	100% (1/1)
High BMI indicating overweight/overweight	100% (1/1)
Eating disorder	100% (1/1)
Corticosteroid therapy	92.3% (12/13)
High alkaline phosphatase level	90% (9/10)
Low bone mineral density (BMD)	83.3% (5/6)
Smoker	75% (3/4)
Elderly female	74.3% (75/101)
Vitamin D deficiency	57.1% (4/7)
Low serum calcium level	12.5% (1/8)
Low serum phosphorus level	0% (0/7)
Malabsorption	0% (0/3)
Recent increase in activity	0% (0/1)
Osseous metastases	0% (0/1)
Hx of stress fractures	0% (0/1)

Not all studies evaluated each risk factor; thus, the total values in parentheses represent the numerator (risk factor present) over the denominator (risk factor evaluated) within the total number of studies included in the investigation.

Table 2 Prevalence of risk factors for developing sacral fatigue fractures

Risk factor	Sacral fatigue fracture
Deficient diet	100% (7/7)
Recent increase in training intensity	100% (7/7)
Hx of amenorrhea/oligomenorrhea	100% (2/2)
Low body mass index (BMI) indicating underweight/underweight	100% (1/1)
High BMI indicating overweight/overweight	100% (1/1)
High BMI indicating obesity/obese	100% (1/1)
Large weight gain during pregnancy	100% (1/1)
Eating disorder	100% (1/1)
Female child	100% (1/1)
Long distance runner	80% (4/5)
Hx of stress fractures	75% (3/4)
Postpartum	66.7% (2/3)
Recent increase in activity	50% (1/2)
Low bone mineral density (BMD)	42.9% (3/7)
Amenorrhea	33.3% (2/6)
Elderly female	0% (0/12)
Smoker	0% (0/1)
Prolonged immobilization	0% (0/1)
Corticosteroid therapy	0% (0/1)
Vitamin D deficiency	0% (0/1)
Low serum calcium level	0% (0/1)
Low serum phosphorus level	0% (0/1)
High alkaline phosphatase level	0% (0/1)
Hypothyroidism	0% (0/1)

Not all studies evaluated each risk factor; thus, the total values in parentheses represent the numerator (risk factor present) over the denominator (risk factor evaluated) within the total number of studies included in the investigation.

may be associated with publication bias or the possibility that the risk associated with these factors is overstated. Perhaps, these risk factors were under-reported within the literature. Our design is unable to sort out this quandary.

The most common risk factors proposed in the literature for the development of sacral fatigue fracture were long distance running and engaging in repetitive weight-bearing activities for prolonged periods of time, such as the activities performed by military recruits.[2] The findings of our study support a recent increase in training intensity as a prevalent risk factor associated with fatigue fracture. This risk factor was reported as being present in 7 of the 12 case study subjects, with a prevalence of 100% in 7 cases. It has been suggested that sacral fatigue fractures typically occur in long distance runners with the average age reported in the twenties and thirties. Our results indicated a mean age of 25.1 years and were consistent with this literature.[1,2]

The results of our extensive search differ from those found within the current literature regarding sacral fatigue fractures in a few ways. As noted, previous studies have emphasized long distance running as the most common risk factor for the development of this pathology.[1,2] Our search revealed that a deficient diet and a recent increase in training intensity are more common risk factors for developing these fractures than long distance running. We found only a total of five cases within the literature that reported on long distance running as a risk factor. Four of the five cases (80% prevalence) confirmed the diagnosis of a sacral fatigue fracture. There have been confirmed diagnoses of sacral stress fractures in military recruits, but we were unable to obtain any cases that reported specifically that the fracture was of the fatigue fracture origin. It has been reported that the female athlete triad (amenorrhea, disordered eating, and osteopenia) plays a role in the development of sacral fatigue fractures in women.[1,2] Our search resulted in 1 confirmed case of the presence of an eating disorder out of 12 total reported cases, 2 cases of confirmed amenorrhea out of 6 total reported cases, and no patients had a confirmed

Table 3 Imaging accuracy in diagnosing sacral insufficiency and sacral fatigue fractures

	Sacral insufficiency fracture			Sacral fatigue fracture		
Imaging technique	Positive	Negative	Percentage correct	Positive	Negative	Percentage correct
Plain radiograph	27	59	31.4	1	11	9.1
Bone scan	74	0	100	8	1	88.9
CT scan	42	1	97.7	8	2	80.0
MRI	15	0	100	11	0	100

Table 4 Quality assessment of studies

Study name	Comprehensive description of study participant(s)	Comprehensive description of etiology and consequences	Comprehensive inclusion/assessment of risk factors
Khan *et al.*[6] Sacral insufficiency fractures following multilevel instrumented spinal fusion: case report	*	*	*
Mathews *et al.*[7] Early fracture of the sacrum or pelvis: an unusual complication after multilevel instrumented lumbosacral fusion	*	*	*
Lee *et al.*[8] Looking beyond low bone mineral density (BMD): multiple insufficiency fractures in a woman with postmenopausal osteoporosis on alendronate therapy	*	*	*
Parikh and Edlund.[9] Sacral insufficiency fractures – rare complication of pelvic radiation for rectal carcinoma: report of a case	*	*	*
Stroebel *et al.*[10] Sacral insufficiency fractures: an often unsuspected cause of low-back pain	*		*
Schulman *et al.*[11] Insufficiency fractures of the sacrum: a cause of low-back pain after lung transplantation	*	*	*
Jacquot *et al.*[12] Neurological complications in insufficiency fractures of the sacrum. Three case reports	*	*	*
West *et al.*[13] Sacral insufficiency fractures in rheumatoid arthritis	*		*
Cooper *et al.*[14] Insufficiency fractures of the sacrum	*	*	
Ungaro *et al.*[15] Groin pain in sacral insufficiency fracture. Avoiding delayed diagnosis	*		*
Galbraith *et al.*[16] Sacral insufficiency fractures: an easily overlooked cause of back pain in the ED	*	*	*
Cheng *et al.*[17] Sacral insufficiency fracture: a masquerader of diskogenic low-back pain	*	*	*
Muthukumar *et al.*[18] Cauda equina syndrome presentation of sacral insufficiency fractures	*		*
Schizas and Theumann[19] An unusual natural history of a L5-S1 spondylolisthesis presenting with a sacral insufficiency fracture	*		*
Peris *et al.*[20] Sacral stress fracture after liver transplantation	*	*	*
Wild *et al.*[21] Sacral insufficiency fracture, an unsuspected cause of low-back pain in elderly women	*	*	
Lin *et al.*[22] Sacral insufficiency fractures: a report of two cases and a review of the literature	*		*
Dasgupta *et al.*[23] Sacral insufficiency fractures: an unsuspected cause of low-back pain	*		*
Peh *et al.*[24] Sacral insufficiency fractures. Spectrum of radiological features	*	*	
Oliver and Beggs.[25] Defects in the pelvic ring as a cause of sacral insufficiency fractures	*		*
Fourney *et al.*[26] Early sacral stress fracture after reduction of spondylolisthesis and lumbosacral fixation: case report	*	*	*
Peh and Evans.[27] Tarlov Cysts – another cause of sacral insufficiency fracture	*	*	*
Blake and Connors.[28] Sacral insufficiency fracture	*		*
Grasland *et al.*[29] Sacral insufficiency fractures: an easily overlooked cause of back pain in elderly women.	*	*	*
Scheib.[30] Sacral insufficiency fracture	*		

Table 4 Continued

Study name	Comprehensive description of study participant(s)	Comprehensive description of etiology and consequences	Comprehensive inclusion/assessment of risk factors
Henry *et al.*[31] Pelvic insufficiency fractures after irradiation: diagnosis, management, and rehabilitation	*		*
Breuil *et al.*[32] Insufficiency fracture of the sacrum revealing a pregnancy associated osteoporosis. First case report	*		*
Haun *et al.*[33] Sacral fatigue fracture in a female runner: a case report	*	*	*
Johnson *et al.*[34] Stress fractures of the sacrum. An atypical cause of low-back pain in the female athlete	*	*	*
Rajah *et al.*[35] Fatigue fracture of the sacrum in a child	*	*	*
Narvaez and Narvaez.[36] Post-partal sacral fatigue fracture	*	*	*
Patterson *et al.*[37] Fatigue fracture of the sacrum in an adolescent	*		*

*indicates whether the quality measure item is present within that study.

diagnosis of osteopenia out of the 12 total patients in our study with sacral fatigue fractures. According to our results, a deficient diet (confirmed in 100% of 7 cases) alone should be considered a more sensitive risk factor for determining predisposition for fatigue fracture.

A further interesting finding is that sacral fatigue fractures result from abnormal stresses and high-load activity applied to normal bone;[1] however, a significant number of patients diagnosed with sacral fatigue fractures from the cases we examined have low BMD (42.9%). Therefore, a few cases with the confirmed diagnosis of a sacral fatigue fracture may, in fact, have been correctly classified as insufficiency fractures.

Imaging should be considered during the differential diagnosis process of a sacral stress fracture (Table 3). The most common imaging technique utilized for diagnostic purposes was a plain radiograph. However, this technique provided the most false negative results of any imaging tool. Bone scan, CT scan, and MRI techniques correctly confirmed the presence of sacral stress fractures in a greater percentage of cases. In our review, a plain radiograph was not always able to capture sacral stress fractures. It is therefore recommended that, if a sacral fatigue or insufficiency fracture is suspected, a plain radiograph should not be used to confirm the diagnosis. Instead, an MRI, bone scan, or CT scan (in descending order) should be utilized to identify the fracture.

Limitations

There were a few limitations to this study. One limitation is that we only included cases reports and case series in our review, which are considered low-level evidence. In addition, the quality measure used to assess each article is based on subjective opinion and is not currently supported by the literature. The review team was not blinded to the authors of each of the manuscripts included. Another limitation of this study is that we were able to uncover three articles from the hand search, which were not found in the original search strategy. Additionally, a total of five articles requested from the hand search were never obtained. A final limitation of this systematic review is that not all of the cases utilized to write this paper reported on each risk factor presented, making it difficult to generalize findings with prevalence numbers that may be somewhat biased.

Conclusion

This comprehensive review of current literature provides clinicians with pertinent risks factors associated with sacral stress fractures. Patients who report insidious onset of low-back and buttock pain should have a sacral stress fracture ruled out if they exhibit the prevalent risk factors. Our results support the inclusion of sacral insufficiency fractures as a differential diagnosis in patients who are elderly women with osteoporosis and report an insidious onset of low-back and buttock pain. Clinicians need to be aware of the possibility of a sacral fatigue fracture in patients who run long distances, especially with a recent increase in training intensity, as well as those who report an inadequate diet. Patients who fit the risk factor profiles and are being treated for low-back and buttock pain with no improvement of symptoms should be referred to a physician for further diagnostic workup.

References

1 Lin JT, Lane JM. Sacral stress fractures. J Womens Health. 2003;12:879–87.

2 Zaman FM, Frey M, Slipman CW. Sacral stress fractures. Curr Sports Med Rep. 2006;5:37–43.
3 Micheli LJ, Curtis C. Stress fractures in the spine and sacrum. Clin Sports Med. 2006;25:75–88.
4 Hoy D, Bain C, Williams G, March L, Brooks P, Blyth F, *et al*. A systematic review of the global prevalence of low back pain. Arthritis Rheum. 2012;64:2028–37.
5 Liberati A, Altman DG, Tetzlaff J, Mulrow C, Gotzsche PC, Ioannidis JP, *et al*. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. PLoS medicine. 2009;6:e1000100.
6 Khan MH, Smith PN, Kang JD. Sacral insufficiency fractures following multilevel instrumented spinal fusion: case report. Spine. 2005;30:484–8.
7 Mathews V, McCance SE, O'Leary PF. Early fracture of the sacrum or pelvis: an unusual complication after multilevel instrumented lumbosacral fusion. Spine (Phila Pa 1976). 2001;26:571–5.
8 Lee P, van der Wall H, Seibel MJ. Looking beyond low bone mineral density: multiple insufficiency fractures in a woman with post-menopausal osteoporosis on alendronate therapy. J Endocrinol Invest. 2007;30:590–7.
9 Parikh VA, Edlund JW. Sacral insufficiency fractures–rare complication of pelvic radiation for rectal carcinoma: report of a case. Dis Colon Rectum. 1998;41:254–7.
10 Stroebel RJ, Ginsburg WW, McLeod RA. Sacral insufficiency fractures: an often unsuspected cause of low back pain. J Rheumatol. 1991;18:117–9.
11 Schulman LL, Addesso V, Staron RB, McGregor CC, Shane E. Insufficiency fractures of the sacrum: a cause of low back pain after lung transplantation. J Heart Lung Transplant. 1997;16:1081–5.
12 Jacquot JM, Finiels H, Fardjad S, Belhassen S, Leroux JL, Pelissier J. Neurological complications in insufficiency fractures of the sacrum. Three case-reports. Rev Rhum Engl Ed. 1999;66:109–14.
13 West SG, Troutner JL, Baker MR, Place HM. Sacral insufficiency fractures in rheumatoid arthritis. Spine (Phila Pa 1976). 1994;19:2117–21.
14 Cooper KL, Beabout JW, Swee RG. Insufficiency fractures of the sacrum. Radiology. 1985;156:15–20.
15 Ungaro E, Astore F, Bonora C, Ferrari MC. Groin pain in sacral insufficiency fracture. Avoiding delayed diagnosis. Int J Osteopath Med. 2011;14:106–9.
16 Galbraith JG, Butler JS, Blake SP, Kelleher G. Sacral insufficiency fractures: an easily overlooked cause of back pain in the ED. Am J Emerg Med. 2011;29:359.
17 Cheng DS, Herzog RJ, Lutz GE. Sacral insufficiency fracture: a masquerader of diskogenic low back pain. PM R. 2010;2:162–4.
18 Muthukumar T, Butt SH, Cassar-Pullicino VN, McCall IW. Cauda equina syndrome presentation of sacral insufficiency fractures. Skeletal Radiol. 2007;36:309–13.
19 Schizas C, Theumann N. An unusual natural history of a L5-S1 spondylolisthesis presenting with a sacral insufficiency fracture. Eur Spine J. 2006;15:506–9.
20 Peris P, Navasa M, Guañabens N, Monegal A, Moya F, Brancós MA, *et al*. Sacral stress fracture after liver transplantation. Br J Rheumatol. 1993;32:702–4.
21 Wild A, Jaeger M, Haak H, Mehdian SH. Sacral insufficiency fracture, an unsuspected cause of low-back pain in elderly women. Arch Orthop Trauma Surg. 2002;122:58–60.
22 Lin J, Lachmann E, Nagler W. Sacral insufficiency fractures: a report of two cases and a review of the literature. J Womens Health Gend Based Med. 2001;10:699–705.
23 Dasgupta B, Shah N, Brown H, Gordon TE, Tanqueray AB, Mellor JA. Sacral insufficiency fractures: an unsuspected cause of low back pain. Br J Rheumatol. 1998;37:789–93.
24 Peh WC,Khong PL, Ho WY, Yeung HW, Luk KD. Sacral insufficiency fractures. Spectrum of radiological features. Clin Imaging. 1995;19:92–101.
25 Oliver TB, Beggs I. Defects in the pelvic ring as a cause of sacral insufficiency fractures. Clin Radiol. 1999;54:852–4.
26 Fourney DR, Prabhu SS, Cohen ZR, Gokaslan ZL, Rhines LD. Early sacral stress fracture after reduction of spondylolisthesis and lumbosacral fixation: case report. Neurosurgery. 2002;51:1507–10.
27 Peh WC, Evans NS. Tarlov cysts – another cause of sacral insufficiency fracture. Clin Radiol. 1992;46:329–30.
28 Blake SP, Connors AM. Sacral insufficiency fracture. Br J Radiol. 2004;77:891–6.
29 Grasland A, Pouchot J, Mathieu A, Paycha F, Vinceneux P. Sacral insufficiency fractures: an easily overlooked cause of back pain in elderly women. Arch Intern Med. 1996;156:668–74.
30 Scheib JS. Sacral insufficiency fracture. Orthopedics. 1989:12:1271, 1274–6.
31 Henry AP, Lachmann E, Tunkel RS, Nagler W. Pelvic insufficiency fractures after irradiation: diagnosis, management, and rehabilitation. Arch Phys Med Rehabil. 1996;77:414–6.
32 Breuil V, Brocq O, Euller-Ziegler L, Grimaud A. Insufficiency fracture of the sacrum revealing a pregnancy associated osteoporosis. First case report. Ann Rheum Dis. 1997;56:278–9.
33 Haun DW, Kettner NW, Yochum TR, Green RL. Sacral fatigue fracture in a female runner: a case report. J Manipulative Physiol Ther. 2007;30:228–33.
34 Johnson AW, Weiss CB Jr, Stento K, Wheeler DL. Stress fractures of the sacrum. An atypical cause of low back pain in the female athlete. Am J Sports Med. 2001;29:498–508.
35 Rajah R, Davies AM, Carter SR. Fatigue fracture of the sacrum in a child. Pediatr Radiol. 1993;23:145–6.
36 Narvaez J, Narvaez JA. Post-partal sacral fatigue fracture. Rheumatology. 2003;42:384–5.
37 Patterson SP, Daffner RH, Sciulli RL, Schneck-Jacob SL. Fatigue fracture of the sacrum in an adolescent. Pediatr Radiol. 2004;34:633–5.
38 Tsiridis E, Upadhyay N, Giannoudis PV. Sacral insufficiency fractures: current concepts of management. Osteoporos Int. 2006;17:1716–25.