Original article

Sacral insufficiency fracture with compression fracture of the thoracolumbar spine: Analysis of coincidence rate and risk factors

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Abstract

Objectives: The purpose of present study was to investigate the coincidence rate and risk factors of sacral insufficiency fracture accompanied by compression fracture of thoracolumbar spine.

Material and methods: The candidates for this study were 945 patients who measured their bone mineral density (BMD) and showed spinal compression fracture on MRI or CT between January 2008 and December 2012. Sacral insufficiency fracture was diagnosed by MRI and the whole body bone scan. We assessed the risk factors of sacral insufficiency fracture which include sex, age, body mass index (BMI), underlying diseases (hypertension, diabetes mellitus, rheumatoid arthritis, and thyroid disease), the number of spinal compression fractures and the presence of osteoporosis.

Results: Among 945 patients with spinal compression fracture [76 (8%) males and 869 (92%) females], 36 (3.8%) had sacral insufficiency fractures (3 [8.3%] males and 33 [91.7%] females). Age and the presence of osteoporosis among risk factors were significant (p < 0.05). Logistic regression analysis indicated that age(odds ratio: 3.7, p = 0.019) and the presence of osteoporosis(odds ratio: 5.4, p < 0.0001) were associated with the coincidence rate of sacral insufficiency fracture.

Conclusions: The coincidence rate of sacral insufficiency fracture is about 3.8%. The clinicians should evaluate sacral insufficiency fractures more actively in patient with compression fracture of thoracolumbar spine accompanied by risk factors (age, the presence of osteoporosis).

Keywords: Thoracolumbar compression fracture; Sacral insufficiency fracture; Osteoporosis

1. Introduction

Sacral insufficiency fracture is one of the causes of low back pain that occurs in the absence of a distinct injury in elderly patients with osteoporosis [1,2]. It is often clinically or radiologically overlooked and not fully diagnosed and treated in elderly patients complaining of pain in the back, hip and inguinal region due to the accompanying lumbar degenerative changes [1,3,4]. We reviewed the charts of the patients who were hospitalized in our center for thoracolumbar compression fracture to investigate the coincidence rate of sacral insufficiency fracture accompanied in those patients, and compared the data with the patients who did not accompany sacral insufficiency fracture to determine the factors that may be helpful in making its diagnosis.

2. Materials and methods

2.1. Materials

Among the patients who received bone mineral densitometry (BMD) in our center between January 2008 and
December 2012, 945 patients who had a thoracolumbar compression fracture on computed tomography or magnetic resonance image were included in the study. Subjects who had a history of a high-energy trauma such as fall or accident, an infection such as osteomyelitis, and a pathologic fracture from primary or metastatic bone tumor were excluded from the study. Among the subjects, 76 were male and 869 were female subjects. The age was 67.8 years old on average (range, 47–98).

2.2. Methods

Sacral insufficiency fracture was diagnosed when a fracture was present on one or more diagnostic tests among CT, MRI and whole body bone scan: a fracture line should have been visible in case of CT or a signal change due to fracture-mediated bone marrow edema in case of MRI. Technetium 99m medronate methylene diphosphonate (MDP) was used for bone scan, and sacral insufficiency fracture could be diagnosed when the characteristic sign of increased bone resorption (Honda sign) was observed in bilateral sacral alae and sacral vertebral body [5,6] (Fig. 1). Sex, age, body mass index (BMI), comorbidity (diabetes mellitus, hypertension, rheumatic arthritis), thyroid disease [hyperthyroidism, hypothyroidism, hyperparathyroidism and hypoparathyroidism], number of compression fracture, and presence or absence of osteoporosis were selected as patient factors, and the relationships between each factor and sacral insufficiency fracture were examined. Final approval of exemption from review by the Institutional Review Board was obtained for this study because this study was retrospective in nature. Odds ratio and 95% confidence interval were computed by logistic regression analysis to determine statistical significance between each clinical factor and sacral insufficiency fracture. Consistent with Hicks et al.[7] and Jellema et el [8], the level of significance for the univariate screening regressions was set at \( P = 0.2 \), assessed by likelihood ratio tests; more stringent significance levels can lead to the exclusion of potentially useful predictor variables. Predictor variables found to be significant according to this criterion were entered into a multiple logistic regression model. The level of significance for the multivariate logistic regression model was set at \( p < 0.05 \). All statistical analyses were performed by IBM SPSS Statistics, version 19.0.

3. Results

3.1. Sex

Among 945 subjects who had a thoracolumbar compression fracture from October 2008 through 2012, the number of female subjects was approximately 11 times greater than that of male subjects (869 [92%] vs. 76 [8%]). Among the 945 subjects with compression fracture, 36 (3.8%) subjects had a sacral insufficiency fracture, 3 (3.9%) among 76 male subjects and 33 (3.8%) among 869 female subjects. In univariate logistic regression analysis, relative risk of sacral insufficiency fracture was 1.0 time higher in male subjects than in female subjects, and the difference was not statistically significant (\( p = 0.948 \)) (Table 1).

3.2. Age

The subjects with a thoracolumbar compression fracture were divided into 3 categorical variables according to their age: less than 60 in 255 subjects (27.0%), in their 60s in 321 subjects (34.0%), and 70 or older in 369 subjects (39.0%). The number of the subjects who had both thoracolumbar fracture and sacral insufficiency fracture was 4 (1.6%) among the subjects aged less than 60, 7 (2.2%) among the subjects in their 60s, and 25 (6.8%) among the subjects aged 70 or older. In univariate logistic regression analysis, relative risk of sacral insufficiency fracture was 1.4, 4.6 times higher, respectively, than that among the subjects aged less than 60, and the differences were statistically significant only in aged 70 or older (\( p = 0.596, p = 0.005 \)) (Table 1).
3.3. Body mass index (BMI)

BMIs among the subjects with a thoracolumbar compression fracture could be divided into 4 categorical variables: less than 18.5 in 66 subjects (7.0%), greater than or equal to 18.5 and less than 25.0 in 547 subjects (57.9%), greater than or equal to 25.0 and less than 30.0 in 286 subjects (30.2%), and greater than or equal to 30.0 in 46 subjects (4.9%). The number of the subjects who had both thoracolumbar fracture and sacral insufficiency fracture was 2 (3.0%) in BMI group less than 18.5, 22 (4.0%) in BMI group greater than or equal to 18.5 and less than 25.0, 11 (3.8%) in BMI group greater than or equal to 25.0 and less than 30.0 and 1 (2.2%) in BMI group greater than or equal to 30.0. In univariate logistic regression analysis, relative risks of sacral insufficiency fracture in each group was 13 (3.5%), 7 (2.2%), 5 (9.3%), 4 (7.4%), and 7 (5.1%), respectively. In univariate logistic regression analysis, relative risks of sacral insufficiency fracture in subjects with 2, 3, 4 or 5 fractures were 0.6, 2.8, 2.2, and 1.5 times higher, respectively, than the risk in subjects with 1 fracture. The differences were significant in subjects with 3, 4 fractures at 20% significance level (p = 0.312, p = 0.056, p = 0.174, and p = 0.404, respectively) (Table 1).

3.4. Comorbidity

Among the subjects with a thoracolumbar compression fracture, 212 (22.4%) of them had diabetes mellitus, 439 (46.5%) hypertension, 158 (16.6%) rheumatic arthritis, and 58 (6.1%) a thyroid disease. Among the subjects with a sacral insufficiency fracture, 12 (5.7%) of them had diabetes mellitus, 16 (3.6%) hypertension, 3 (1.9%) rheumatic arthritis, and 2 (3.4%) a thyroid disease. In univariate logistic regression analysis, relative risks of sacral insufficiency fracture were increased by 1.8, 0.9, 0.4, and 0.9 times, respectively, in subjects who had diabetes mellitus, hypertension, rheumatic arthritis, and a thyroid disease. The differences were significant at 20% significance level in diabetes mellitus and rheumatic arthritis groups (p = 0.114, p = 0.805, p = 0.181, and p = 0.882, respectively) (Table 1).

3.5. Number of compression fracture

Subjects were divided into 5 groups according to the number of fracture: 1 in 376 subjects (39.8%), 2 in 323 subjects (34.2%), 3 in 54 subjects (5.7%), 4 in 54 subjects (5.7%), and 5 or more in 138 subjects (14.6%). The number of the subjects who had both thoracolumbar fracture and sacral insufficiency fracture in each group was 13 (3.5%), 7 (2.2%), 5 (9.3%), 4 (7.4%), and 7 (5.1%), respectively. In univariate logistic regression analysis, relative risks of sacral insufficiency fracture in subjects with 2, 3, 4 or 5 fractures were 0.6, 2.8, 2.2, and 1.5 times higher, respectively, than the risk in subjects with 1 fracture. The differences were significant in subjects with 3, 4 fractures at 20% significance level (p = 0.312, p = 0.056, p = 0.174, and p = 0.404, respectively) (Table 1).

3.6. Osteoporosis

Mean T-score on BMD was −2.4 among the subjects with a thoracolumbar compression fracture, and osteoporosis was present in 361 subjects (38.2%) but not in 584 subjects (61.8%). Mean T-score on BMD among the subjects who had both compression fracture and sacral insufficiency fracture was −3.1; osteoporosis was present in 28 subjects (77.8%) and osteopenia in 8 subjects (22.2%). In univariate logistic regression analysis, relative risk of sacral insufficiency fracture was 6.1 times greater in the subjects with osteoporosis than the risk in the subjects without one. The difference was significant statistically (p < 0.0001) (Table 1).

Among 36 patients who were diagnosed sacral insufficiency fractures, 30 patients were diagnosed by MRI, 2 patients were diagnosed by CT. 4 patients who had subtle,
undisplaced fracture in CT or an ambiguous signal change in MRI were confirmed by bone scan.

Based on these results as seen above, multiple logistic regression analysis was performed for the variables (age, diabetes mellitus, rheumatic arthritis, number of compression fracture and osteoporosis) that were significant at 20% significance level in the univariate logistic regression analyses. Age and osteoporosis were selected as the final 2 variables (p < 0.05). When the other variable were controlled, relative risk of sacral insufficiency was 3.7 times higher in aged 70 or older subjects than in less than 60 (p = 0.019), 5.4 times higher in the presence of osteoporosis than in the absence of one (p < 0.05) (Table 2).

4. Discussion

Approximately 3.8% of the patients with a vertebral compression fracture also had a sacral insufficiency fracture, which was found to be affected by age and presence of osteoporosis.

Reports so far indicated that vertebral compression fracture and sacral insufficiency fracture were both closely associated with osteoporosis in elderly patients, especially in postmenopausal women [2,9–12]. In our study, thoracolumbar compression fracture was 11 times more common among female subjects than in male subjects (92% vs. 8%, respectively), but the compression fracture was similarly accompanied by sacral insufficiency fracture in both subjects (3.8% vs. 3.7%) and the difference was not statistically significant (p = 0.948), like previous reports [13,14].

As for the incidence of fracture by age, subjects in their 60s and 70s accounted for 69.6% of thoracolumbar compression fractures cases and 88.9% of them also had sacral insufficiency fracture. Among the 36 subjects who had both thoracolumbar fracture and sacral insufficiency fracture, the prevalence of sacral insufficiency fracture was increased with age (4 [1.6%] of them were in less than 60, 7 [2.2%] were in their 60s, and 25 [6.8%] were aged 70 or above). Therefore, old aged subjects with thoracolumbar fractures should be assessed carefully about the likelihood of sacral insufficiency fracture because the differences were statistically significant in aged 70 or above.

Among the hypothetical risk factors, including diabetes mellitus, hypertension, rheumatic arthritis and thyroid disease, diabetes mellitus and rheumatic arthritis were found as significant risk factors at 20% significance level in the univariate logistic regression analysis, but not in the multiple logistic regression analysis. Apart from osteoporosis, metabolic diseases such as rheumatic arthritis and hyperparathyroidism were also reported as potential causes of insufficiency fracture [1,2,11,15,16]. Small number of subjects might be a reason of the lack of statistical significance in our study.

The number of compression fracture was 1 in 376 subjects (39.8%), 2 in 323 subjects (34.2%), 3 in 54 subjects (5.7%), 4 in 54 subjects (5.7%), and 5 or more in 138 subjects (14.6%). The number of the subjects who had both thoracolumbar fracture and sacral insufficiency fracture in each group was 13 (3.5%), 7 (2.2%), 5 (9.3%), 4 (7.4%), and 7 (5.1%), respectively. In the multiple logistic regression analysis, higher number of compression fracture did not indicate higher likelihood of insufficiency fracture, and statistically was not significant.

Osteoporosis is the most common cause of vertebral compression fracture, which is a clinically important issue, especially in elderly and postmenopausal patients, because it is associated with pain, kyphosis and height reduction. Osteoporosis has been also suggested as the cause of insufficiency fracture, which occurs when usual loads are applied to bones with abnormally low elastic resistance [1,12,17]. Apart from osteoporosis, rheumatoid arthritis, long-term steroid therapy, fibrous dysplasia, Paget’s disease, osteogenesis imperfecta, osteoporosis, osteomalacia, metabolic bone diseases such as hyperthyroidism, and radiotherapy are also indicated as the cause of insufficiency fracture [1,2,11,15,16], mostly in the sacrum, vertebrae, pubis, ilium, long bones of the lower limb, and calcaneus [1,2,12,15,18]. The relative risk of sacral insufficiency fracture was 6.1 times higher in the osteoporotic group compared with the non-osteoporotic group in our study as well (p < 0.05). Among the 36 subjects who had both sacral insufficiency fracture and compression fracture, osteoporosis was not present in 8 of them (22.2%), all of them being osteopenia patients.

Osteoporotic sacral insufficiency fracture was first described by Lourie in 1982 [19], but the accurate incidence has not been elucidated in the following numerous reports. According to Weber et al. [2], sacral insufficiency fracture was present in 20 patients (0.9%) out of 2366 who reported low back pain (medial age, 79 years; range, 58–94). All of the patients with sacral insufficiency fracture were female patients with osteopenia and aged 55 years or above, who accounted for 1.8% of all female patients. De Smet et al. [10] reported that all 8 patients with pubic insufficiency fracture were

<table>
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<th>Variable</th>
<th>Odds ratio</th>
<th>95% Confidence interval</th>
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DM: diabetes mellitus, RA: rheumatoid arthritis.  
* P < 0.05.
female patients with osteopenia, all of them accompanied by sacral insufficiency fracture. Aretxabala et al. [20] reported that pubic insufficiency fracture occurred in 78% of the patients with sacral insufficiency fracture, suggesting that sacral insufficiency fracture was commonly accompanied by fractures of other related areas in the vicinity.

In 2006, Gong et al. [13] reported that 17 cases (10.6%) out of 160 cases with thoracolumbar osteoporotic compression fracture were accompanied by sacral insufficiency fracture on radiographs and highlighted the importance of considering the possibility of sacral insufficiency fracture in patients with an osteoporotic thoracolumbar compression fracture on thoracolumbar MRI images. Similarly, Lee et al. [14] reported in 2008 that sacral insufficiency fracture was found in 18 cases (7.1%) out of 252 cases showing thoracolumbar osteoporotic compression fracture, the frequency higher than ours (3.8%).

Previous studies divided the patients with osteoporotic compression fracture into two groups, depending on the absence or presence of sacral insufficiency fracture, and conducted statistical analyses to determine their differences in frequency and clinical factors. Our study is different from the previous studies in that we attempted to find the factors associated with sacral insufficiency fracture by logistic regression analyses using coincidence rate as the dependent variable and clinical factors as independent variables. Limitation of this study is that there was no control group.

Coincidence rate of sacral insufficiency fracture was not uncommon (approximately 3.8%) among the patients with thoracolumbar compression patients, although it is often overlooked radiologically and clinically, and underdiagnosed, especially when accompanied by a thoracolumbar fracture.

In conclusion, age and presence of osteoporosis are useful diagnostic factors of sacral insufficiency fracture. Patients with a thoracolumbar compression fracture would need to be more closely monitored for the possibility of sacral insufficiency fracture if they had any of these factors.

Conflict of interest

None.

References