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Research Article

Comparative Analysis of Spontaneous and Traumatic Osteoporotic Vertebral Compression Fractures

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Summary

Objective: Osteoporosis results in increased bone fragility, which predisposes patients to fractures with relatively little trauma. Osteoporotic fractures most often occur in the spine. Although most vertebral compression fractures (VCFs) occur as a result of trauma, they can also occur spontaneously. In this study, we aimed to analyze the clinical characteristics of spontaneous and traumatic osteoporotic VCFs.
Methods: In this retrospective study, 199 patients treated for osteoporotic VCFs at our institution between January 2011 and December 2013 were analyzed. We investigated the differences in clinical characteristics between spontaneous and traumatic osteoporotic VCFs.
Results: Spontaneous fractures accounted for 37.2% of the total osteoporotic VCFs. The traumatic fracture group exhibited significantly higher mean bone mineral density (BMD) T-scores than the spontaneous fracture group (p=0.000). A surgical history of percutaneous vertebroplasty/kyphoplasty (VP/KP) (p=0.000) and a medical history of rheumatoid disease (p=0.004) were significantly more frequent in the spontaneous group than in the traumatic group. The 2 groups did not differ in terms of distribution of age, sex, smoking status, weight, single versus multiple-level fracture, surgical history of spinal fusion or fixation, or medical history of hypertension, diabetes, heart disease, and cerebrovascular accidents.
Conclusion: It is difficult to draw definitive conclusions about the differences in clinical characteristics between spontaneous and traumatic osteoporotic VCFs with this limited retrospective study. However, our results showed that low BMD T-scores, a surgical history of percutaneous VP/KP, and a medical history of rheumatoid disease might be responsible for spontaneous osteoporotic VCFs.

Key words: Vertebral compression fractures, Osteoporosis, Bone mineral density, Rheumatoid disease

Spontan ve Travmatik Osteoporotik Vertebral Kompresyon Kırıklarının Karşılaştırmalı Analizi

Özet

Giriş ve amaç: Osteoporoz hastalarda artan kemik fragilitesi sonucunda oransal olarak hafif travmalarla oluşan kırıklara yol açar. Osteoporotik kırıklar genellikle omurgada görülür. Vertebral kompresyon kırıklarının (VKK) çoğunluğu travma sonucu oluşsa da spontan olarak da görülebilir. Bu çalışmada spontan ve travmatik osteoporotik VKK klinik özelliklerinin analizi hedeflendi.
Yöntem: Bu geriye dönük çalışmada kurumumuzda Ocak 2011 ve Aralık 2013 arasında tedavi edilen 199 osteoporotik VKK araştırıldı.Spontan ve travmatik osteoprotik VKK klinik özellikleri arasındaki farklılıklar incelendi.

Sonuçlar: Tüm osteoporotik VKK içinde spontan kırıklar %37,2'sini oluşturdu. Travmatik kırık grubu spontan kırık grubuna göre önemli ölçüde yüksek ortalama kemik mineral yoğunluğu (BMD) T-skorları sergiledi (p=0.000). Spontan grupta perkütan vertebroplasti/kifoplasti (VP/KP) cerrahi öyküsü (p=0.000) ve tıbbi romatoid hastalık öyküsü (p=0.004) travmatik gruba göre önemli ölçüde sık olarak saptandı. Her iki grup da yaş, cins, sigara içimi, kilo, tek ya da çok seviye kırık, spinal füzyon ya da fiksasyon cerrahi öyküsü ya da hipertansiyon, diabet, kalp hastalığı ve inme tıbbi öyküleri açısından farklılık arzetmedi.
Yargı: Bu sınırlı sayıda olgu ile yapılan geriye dönük çalışmada kesin yargıya varılması olası değilse de düşük BMD T-skoru, perkütan VP/KP öyküsü ve tıbbi romatoid hastalığı öyküsü olması spontan tipte bir osteoporotik VKK sorumlu tutulabilir.

Anahtar Kelimeler: Vertebral kompresyon kırığı; osteoporoz; kemikmineral yoğunluğu; romatoid artrit

INTRODUCTION

Osteoporosis is a systemic skeletal disease characterized by compromised bone strength. This results in increased fragility of the bone, which predisposes patients to fractures with relatively little trauma[9,31]. The axial skeleton is composed of roughly 70% by volume and 35% by weight of cancellous bone. Cancellous bones have a honeycomb-like structure of vertical and horizontal trabeculae, which contain a large amount of bone marrow[12]. These bones are a site of high bone turnover, which causes an imbalance between bone resorption and formation[31]. Due to this imbalance, osteoporosis often occurs in cancellous bones, and osteoporotic fractures most often occur in the hip, spine, or distal radius[29].

Vertebral compression fractures (VCFs) are well-identified complications of osteoporosis. The prevalence of VCFs varies, but generally increases with age, reaching about 40% in 80-year-old women[28]. Osteoporotic VCFs at any site are associated with an approximately two-fold higher risk of physical and functional limitation, thereby affecting activities of daily living[6,14]. Osteoporotic VCFs can also lead to significant morbidities and mortalities associated with pulmonary disease and cancer[17]. Although most VCFs occur as a result of trauma, they can also occur spontaneously in the course of daily living[24]. Therefore, it is very important to investigate the risk factors for spontaneous VCFs. Although these risk factors have been explored in previous studies, to date, there are no papers on comparative studies between spontaneous and traumatic osteoporotic VCFs. The authors' goal was to analyze the clinical characteristics of spontaneous and traumatic osteoporotic VCFs.

MATERIAL AND METHODS

Patients who had undergone vertebroplasty/kyphoplasty (VP/KP) for new osteoporotic VCFs between January 2011 and December 2013 were identified from the medical records of our institution. All patients complained of new onset of back pain that developed within 3 months. Radiographs showed VCFs in the area of the reported back pain.

Diagnosis of acute osteoporotic VCFs

Radiographic VCFs were defined as a 20% or 4-mm decrease in height of any vertebral body. All patients were diagnosed with acute VCFs by using computed tomography, which showed the acute fracture line; magnetic resonance imaging, which showed high signal intensity in a subsequent short-TI inversion-recovery image; and/or bone scan, which showed high uptake at the affected vertebra. Patients with pathologic fractures caused by tumors or infections were excluded from this study. According

to the World Health Organization (WHO)[22], osteoporosis is diagnosed by using dual energy X-ray absorptiometry. Patients whose lowest bone mineral density (BMD) T-scores were below -2.5 standard deviation (SD) were defined as osteoporotic patients.

Patients' characteristics

This study was performed using retrospective medical chart reviews. In order to identify the differences in clinical characteristics between spontaneous and traumatic osteoporotic VCFs, the patients were divided into 2 groups. The patients of the traumatic group had a history of trauma, such as slips, falls, heavy lifting, or traffic accidents at the time of pain onset. The patients of the spontaneous group either did not have or did not remember particular events that could have caused back pain. To determine the risk factors for spontaneous VCFs, we investigated several patient characteristics that could be possible risk factors, including age, sex, body weight, and medical conditions such as diabetes, hypertension, rheumatoid disease, heart disease, and cerebrovascular accidents (CVAs). We also investigated social and surgical factors such as smoking status, percutaneous VP/KP, and spinal fusion or fixation. In patients with a surgical history of VP/KP, we evaluated whether the VCFs were adjacent-segment fractures. We then evaluated mean BMD T-scores and the incidence of single- versus multiple-level fractures.

Statistical analysis

Statistical analyses were performed using SPSS software (version 19). Patient and clinical characteristics were summarized and described using descriptive statistics. Comparisons of continuous variables between groups were conducted using independent t-tests. A chi-squared test was used to analyze categorical variables. A p value of less than 0.05 was considered statistically significant.

RESULTS

Patient characteristics

A total of 199 patients with acute osteoporotic VCFs were included in this study. The clinical characteristics of both groups are summarized in Table 1. The spontaneous VCF group consisted of 74 patients (9 men, 65 women) with a mean age of 72±8.66 years at the time of diagnosis. The traumatic VCF group was composed of 125 patients (28 men, 97 women) with a mean age of 70.7±9.17 years at the time diagnosis. The mean age of the spontaneous group was slightly higher than that of the traumatic group, but the difference was not statistically significant (p=0.325). The sex distribution was slightly higher in the traumatic group, but this difference also had no statistical significance (p=0.073). The spontaneous group accounted for 37.2% of the total osteoporotic VCFs. The mean body weight was 54.3±8.61kg in the spontaneous group and 55.9±9.77kg in the traumatic group. Contrary to our expectations, patients in the traumatic group had a slightly higher body weight, but the difference was not statistically significant (p=0.101). Multiple acute VCFs were diagnosed in 16 cases (21.6%) in the spontaneous group and in 20 cases (16%) in the traumatic group at the time of diagnosis; however, this difference was also not statistically significant (p=0.319). There was no significant intergroup difference in the rate of hypertension (52.7% vs. 48.8%, p=0.595), diabetes (23.0% vs. 15.2%, p=0.169), heart disease (7.4% vs. 8.8%, p=0.381), CVA (6.8% vs. 8.0%, p=0.748), surgical history of fusion (4.1% vs. 4.8%, p=0.807), and smoking status (10.8% vs. 11.2%, p=0.933) (Table 1).

The factors associated with spontaneous VCFs

When compared retrospectively, the 2 groups showed notable differences (Table 2). In the spontaneous group, 35 of 74 patients (47.2%) had a surgical history of

VP/KP. However, 12 of 125 patients (9.6%) in the traumatic group had a surgical history of VP/KP, which is significantly lower than that in the spontaneous group (p=0.000, Figure 1). Among the patients with a surgical history of VP/KP, 21 of 35 patients (60.0%) in the spontaneous group and 3 of 12 patients (25.0%) in the traumatic group exhibited adjacent new VCFs. Comprehensive analysis showed that VP/KP-related adjacent new VCFs were present in 21 of 74 patients (28.4%) in the spontaneous group and in 3 of 125 patients (2.4%) in the traumatic group (p=0.000, Figure 2). A difference also existed between the BMD T-scores of the 2 groups. Figure 3 shows that the spontaneous group exhibited a significantly lower mean BMD T-score than the traumatic group (-3.142 vs. -2.626, p=0.000). Patients in the spontaneous group were also significantly more likely to have a medical history of rheumatoid disease than those of the traumatic group (Figure 4). Eight of 74 patients (10.8%) had rheumatoid disease in the spontaneous group, while only 2 of 125 patients (1.6%) had rheumatoid disease in traumatic group (p=0.004).

Table 1 Characteristics of the VCF patients.

Characteristics	Spontaneous group (n = 74)	Traumatic group (n = 125)	p-value
Sex			0.073
Male	9 (12.2%)	28 (22.4%)	
Female	65 (87.8%)	97 (77.6%)	
Age (years)	72 ± 8.66	70.7 ± 9.17	0.325
Body weight (kg)	54.3 ± 8.61	55.9 ± 9.77	0.101
Hypertension	39 (52.7%)	61 (48.8%)	0.595
Diabetes	17 (23.0%)	19 (15.2%)	0.169
Heart disease	4 (5.4%)	11 (8.8%)	0.381
CVA	5 (6.8%)	10 (8.0%)	0.748
No. of fractures			0.319
Single	58 (78.4%)	105 (84.0%)	
Multiple	16 (21.6%)	20 (16.0%)	
History of fusion	3 (4.1%)	6 (4.8%)	0.807
Smoking	8 (10.8%)	14 (11.2%)	0.933

VCFs = vertebral compression fractures; CVA = cerebrovascular accident.

Table 2 Factors associated with spontaneous and traumatic VCFs.

Factors	Spontaneous group (n = 74)	Traumatic group (n = 125)	p- value
Prior vertebroplasty	35 (47.2%)	12 (9.6%)	0.000
Adjacent new VCF	21 (28.4%)	3 (2.4%)	0.000
BMD (mean T-score)	-3.142	-2.626	0.000
Rheumatoid disease	8 (10.8%)	2 (1.6%)	0.004

VCFs = vertebral compression fractures; BMD = bone mineral density.

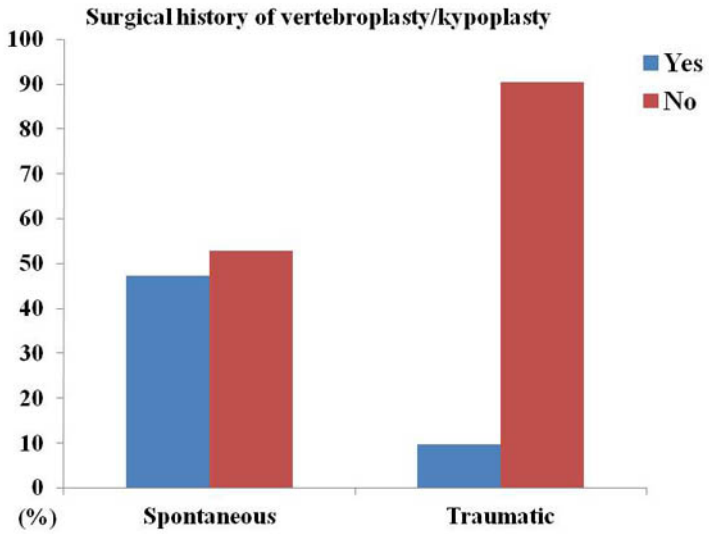

Figure 1: *The portion of patients in the spontaneous and traumatic groups with surgical histories of vertebroplasty/kyphoplasty.*

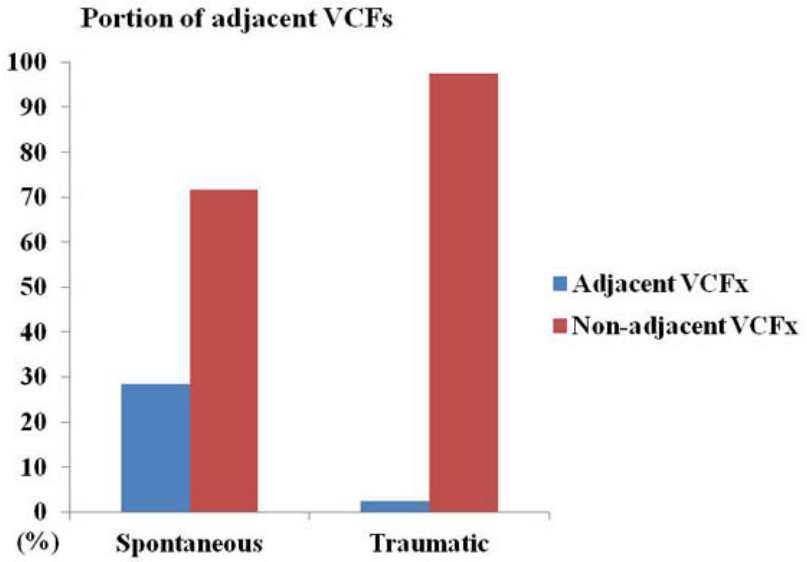

Figure 2: *The proportion of vertebroplasty/kyphoplasty-related adjacent vertebral compression fractures (VCFs) among patients in spontaneous and traumatic groups.*

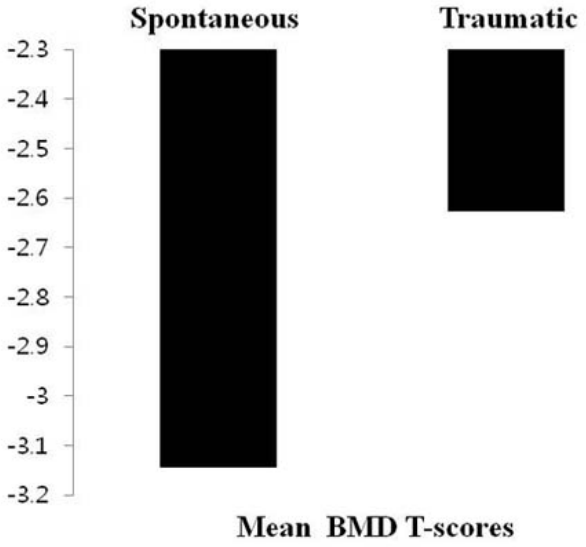

Figure 3: *Mean bone mineral density (BMD) T-scores for patients in spontaneous and traumatic groups.*

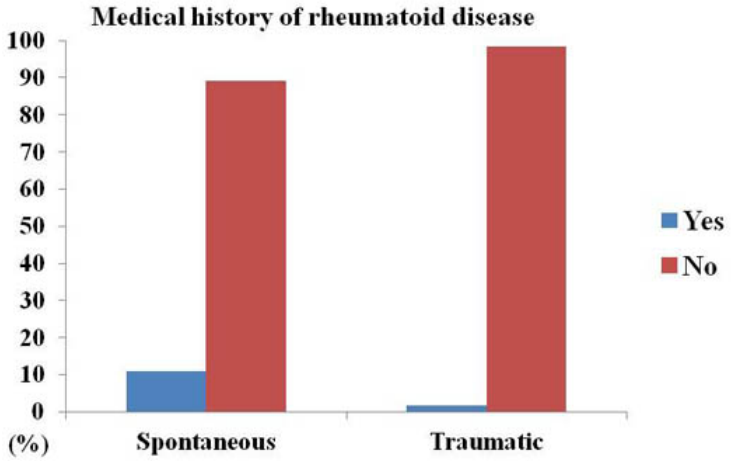

Figure 4: *The portion of medical histories of rheumatoid disease among patients in spontaneous and traumatic groups.*

DISCUSSION

VCFs can cause severe back pain, progression of kyphosis, and increase overall morbidity and mortality. Risk factors for osteoporotic VCFs have been proposed in previous studies, these include age, sex, race, BMD, steroid therapy, low body weight, cigarette smoking, endocrine disease, neuromuscular dysfunction, and rheumatoid disease[18,20,21]. These risk factors could lead to VCFs occurring under non-traumatic conditions. While it was not possible to evaluate all of these risk factors, we were able to evaluate several risk factors of spontaneous VCFs, including surgical history of VP/KP, T-score of BMD, and medical history of rheumatoid disease, by using a comparative method.

VP/KP for VCFs were introduced as an effective way to improve short-term outcomes for pain and restoration of patient's quality of life[5,23]. However, according to recent studies[26,33], the incidence of additional VCFs significantly increased after VP/KP, especially in the upper adjacent vertebral segment. Mudano et al.[26] reported that the VP/KP group had a significantly greater risk of secondary VCFs within 90 days than the other patients. They also reported that VP/KP-related new VCFs tend to occur earlier than those in the comparison group[26]. Another study reported a 63.8% incidence of new VCFs after VP[33]. Several theories were proposed to explain the adjacent VCFs. This excessive cement rigidity causes increased loading of the adjacent vertebra[3]. After VP, stiffness of the cancellous bone in the treated vertebra increases 12-fold[2]. Additionally, in order to obtain sufficient strength and stiffness, the vertebrae were filled with more cement, which led to a greater incidence of adjacent VCFs[3]. Second, the kyphotic deformity that results from VCF itself can contribute to adjacent vertebral facet joint degeneration[2,3,30,33]. This kyphotic deformity and adjacent vertebral degeneration can also influence the occurrence of a new-onset VCF. Third, cement leakage from the treated vertebra can lead to an adjacent VCF[25]. Overall, our results revealed that VP/KP increased the incidence of spontaneous adjacent VCFs. We believe that stiff vertebra caused by the previously mentioned mechanisms predispose adjacent vertebra to fracture, even in non-traumatic conditions. We also propose one possible mechanism that the VP/KP itself can be considered trauma, and cause the adjacent new VCFs[13]. For example, VCFs with

severe vertebral collapse may show fracture clefts within the vertebral bodies. Insertion of cannula into the fractured vertebra, combined with positional gravity, causes reduction of the collapsed vertebral body. This upward reduction may have a traumatic effect on the upper adjacent vertebra, leaving the adjacent vertebra in a fragile state. The fragile adjacent vertebra may develop a new VCF immediately, or in course of the activities of daily living after VP/KP. This theory is supported by studies that show that adjacent new VCFs tend to occur earlier than nonadjacent fractures[26,33].

A decreased BMD level is one of the most important risk factors for osteoporotic VCFs. When bone samples were investigated in a laboratory setting, BMD accounted for 60% to 80% of bone strength[8,11,34]. A relatively small decrease of about 10-15% in BMD values approximately doubles the risk for fracture[10,27]. BMD data are reported typically as T-scores and represent the degree of SD from the normal young adult mean BMD values[19]. According to the WHO definition[19], people with a BMD of less than 2.5 SDs from the mean are considered to have osteoporosis. Well-controlled prospective studies indicate that the risk of VCFs increases about 2-fold for each SD reduction in BMD[27]. In addition, a metanalysis of the relationship between BMD and fracture risk explained that the predictive power of BMD for osteoporotic fracture at any site is similar to the predictive power of blood pressure for stroke, and superior to the predictive power of serum cholesterol level for cardiovascular disease[27]. However, there were no comparative data on the effect of BMD in spontaneous versus traumatic VCFs. Our results show that the patients classified into the spontaneous VCF group tended to show a greater decrease in BMD than those in the traumatic group. In other words, the more the BMD T-scores decreased, the greater the predisposition to VCFs, even in non-traumatic conditions.

Rheumatoid disease is an inflammatory disease involving not only the distal and symmetrical synovial joints, but the bone as well[32,38]. Bone complications can be categorized into 3 different types: periarticular osteopenia, bone erosion, and systemic osteoporosis[4,16,32,38]. Although fractures near inflamed joints have been reported in conjunction with osteolytic lesions[7], most fractures occur in bones, such as femurs, vertebrae, and distal radii, which are not eroded[1]. Osteoporotic VCFs in rheumatoid disease patients are a well-known consequence. Therefore, most papers focus on the relationship between rheumatoid disease and osteoporosis when explaining fractures associated with rheumatoid disease. Steroids are one of the most commonly used drugs in the treatment of rheumatoid disease patients. A metanalysis concluded that steroid treatment in rheumatoid disease patients led to an increased risk of osteoporosis and fractures[36]. However, the risk of osteoporosis and related fractures in patients with rheumatoid disease remained elevated after excluding patients who had taken steroid therapy[35]. The cause of osteoporosis and fracture risk in rheumatoid disease patients appears to be multifactorial, with rheumatoid disease duration and severity, steroid use, age, disability, prior history of fracture, and other factors needing consideration[16,35,37]. However, several studies concluded that aging and disability were identified as independent risk factors of osteoporosis and related VCFs in rheumatoid disease patients[15,16]. In our study, the numbers available were too small to fully evaluate the effect of rheumatoid disease on spontaneous VCFs. Moreover, because we could not determine whether the rheumatoid disease patients in the study had received steroid treatment, the effect of rheumatoid disease on VCFs between 2 groups is unclear. However, the spontaneous VCFs group had more patients diagnosed with rheumatoid disease than the traumatic group.

It is difficult to draw conclusions about the comparison of clinical characteristics between spontaneous and traumatic osteoporotic VCFs with this limited retrospective study. Moreover, appropriate laboratory studies of osteoporosis such as parathormone or calcium/24 h urine to look for clinical utility was not performed. However, our results showed that low BMD T-scores, a surgical history of percutaneous VP/KP, and a medical history of rheumatoid disease may be contributing factors for spontaneous osteoporotic VCFs. Further studies are required to elucidate risk factors of spontaneous osteoporotic VCFs.

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