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Factors Associated with Fracture Rate in Community-Living Patients with Spinal Cord Injury

Toplum İçinde Yaşayan Spinal Kord Yaralı Hastalarda Kırık Oluşumunu Etkileyen Faktörler

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Abstract

Objective: The purposes of this study are (i) to determine the prevalence of long bone fractures in a sample of persons with SCI living in the community and (ii) to determine the relationship between functionality, community integration, and fracture occurrence.
Material and Methods: Two hundred fifty persons chosen randomly from the Northwest Regional Spinal Cord Injury System (NWRSCIS) database were screened by mailing the study questionnaire and consent forms. Demographic parameters and social integration levels were obtained from the NWRSCIS database, whereas walking index for spinal cord injury scores and activity levels were obtained from the study questionnaire. Patients were divided into two groups based on whether or not they had had any fractures since their acute SCI. The differences between groups were statistically analyzed.
Results: Seventy patients returned the questionnaire and the consent forms. Ten (14%) patients reported that they had experienced fractures after spinal cord injury. Those who had a longer duration of injury and who were older were more likely to have had a fracture since the acute SCI.
Conclusion: Fractures in community-living patients with SCI are common, and smoking, age, and time since injury are important factors that are related to fracture occurrence after SCI.
Key Words: Spinal cord injury, long bone fractures, osteoporosis

Özet

Amaç: Bu çalışmanın amaçları (i), toplum içinde yaşayan spinal kord yaralı bireylerde uzun kemik kırıklarının prevalansını ortaya koymak ve (ii) kırık oluşumu ile fonksiyonellik ve toplumsal entegrasyon arasındaki ilişkiyi tanımlamaktır.
Gereç ve Yöntemler: Kuzeybatı Bölgesel Spinal Kord Yaralanması Sistemi (KBBSKYS) veri tabanından rastgele seçilen 250 hastaya çalışma anketi ve onam formları gönderildi. Hastaların demografik parametreleri ve toplumsal entegrasyon seviyeleri KBBSKYS veri tabanından elde edilirken, yürüme indeksi skorları ile aktivite seviyeleri gönderilen anketlerden elde edildi. Ankete cevap veren hastalar kırığı olup olmamasına göre gruplara ayrıldı. Gruplar arası farklılıklar istatistiksel olarak analiz edildi.
Bulgular: Hastalardan 70 tanesi anket ve onam formlarını onaylayarak geri gönderdi. On hasta (%14) spinal kord yaralanması sonrasında kırık oluştuğunu bildirdi. Spinal kord yaralanması sonrasında geçen sürenin uzun olması ve ileri yaş, kırık oluşumu ile ilintili faktörler olarak belirlendi.
Sonuç: Toplum içinde yaşayan spinal kord yaralanmalı hastalarda kırıklar sıktır ve sigara kullanımı, yaş ile yaralanma sonrası geçen sürenin uzunluğu kırık oluşumunu etkileyen önemli faktörlerdir.
Anahtar Kelimeler: Spinal kord yaralanması, uzun kemik kırıkları, osteoporoz

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Introduction

Osteoporosis is a complication seen in approximately 75% of patients with SCI, and it increases the fracture rate 5- and 23-fold in the tibia and femur, respectively, when compared to able-bodied people (1,2). Cortical bone mineral loss is about 20%-25% over the first 2 years following SCI, whereas trabecular bone loss is about 55% (3). Efforts for the prevention of osteoporosis below the level of injury, such as exercise (4,5) and electrical stimulation (6,7), are not efficacious in this group of patients. The incidence of long bone fractures in SCI has been reported to be between 1%-7% (8-11) in short-term studies but 33% in long-term follow-up studies (12). Fractures in patients with SCI mostly result from minor traumas occurring during daily activities (9,10,13).

Immobilization and decreased weight load on the bones associated with the degree of paralysis are the main factors of osteopenia and osteoporosis in patients with spinal cord injury (SCI). Bone resorption markers begin to increase soon after the injury, and bone loss below the level of injury occurs early, especially in the first 6 months after SCI, and can predispose to long bone fractures. This study is a pilot study that will examine the factors that may impact this outcome of altered bone metabolism.

The purposes of this study are (i) to determine the prevalence of long bone fractures in a sample of persons with SCI living in the community and (ii) to determine the relationship between functionality, community integration, and fracture occurrence.

Material and Methods

Exclusion criteria for this study were (1) SCI<18 and >55 years of age; (2) metabolic diseases, such as thyroid and parathyroid gland disorders and metabolic bone diseases (Paget's disease, algodystrophy); (3) chronic inflammatory diseases and malignancies; (4) treatment with drugs affecting bone metabolism, such as chronic corticosteroids (excluding any given at the time of the acute injury), oral contraceptive drugs, hormone replacement therapy, thiazide diuretics, antiepileptics, lithium, and androgens; and (5) chronic renal and liver diseases. The Northwest Regional Spinal Cord Injury System (NWRSCIS) database was prescreened for those exclusion criteria, and among 850 people who met the criteria, 250 persons chosen randomly were screened by mailing the study questionnaire and consent forms. The study design was approved by the IRB at University of Washington Medical Center.

Demographic data (gender, age, race, education level, date of injury, date of first admission to acute rehabilitation, hours of physical, occupational, recreational and vocational rehabilitation during their different admissions, American Spinal Injury Association [ASIA] motor, and sensory levels), ASIA Impairment Scale (14), Functional Independence Measure (FIM) (15), Craig Handicap Assessment Reporting Technique (CHART) (16), and Craig Hospital Inventory of Environmental Factors (CHIEF) (17) scores were obtained from the NWRSCIS database, whereas walking index for spinal cord injury (WISCI) (18) scores and activity levels were obtained from the study questionnaire.

Walking index for spinal cord injury is an index used to assess walking in patients with SCI. It has 19 levels of walking in a hierarchical order with the use of devices and assistance. Activity levels were assessed with the Godin Leisure Time Activity Questionnaire (GLTEQ) in our study (19). This is a 3-item self-reported questionnaire that shows strenuous, moderate, and mild activities weekly.

Statistical Analysis

Patients were divided into two groups based on whether or not they had had any fractures since their acute SCI. The differences between groups were statistically analyzed by using standard software (SPSS v10.0). Chi-square test was used for demographic characteristics, and Mann-Whitney U-test was used to compare study parameters between fracture and non-fracture groups.

Results

Seventy patients returned the questionnaire and the consent forms, and the return rate was 28%. Fifteen patients were female (21.4%), and 55 were male (78.6%). Mean age for the study group was 39.23±10.27 (between 21-55 years). Neurological level was cervical in 27, thoracic in 32, and lumbar in 11 patients. Other demographic parameters of the study group are presented in Table 1.

Ten (14%) patients reported that they had experienced fractures after spinal cord injury. Smoking was significantly common in patients who had fractures (Table 2). Age and time since injury were the two factors significantly associated with fractures (Table 3). Those who had a longer duration of injury and who were older were more likely to have had a fracture since the acute SCI. There was no difference between groups according to functional parameters used in this study. Specific parameters of patients who had fractures are presented in Table 4.

Table 1. Descriptive statistics of the study group

	Minimum	Maximum	Mean	Standard Deviation
Age	21.00	55.00	39.23	10.27
BMI	16.70	47.40	25.17	6.57
Time since SCI	1.00	15.00	6.84	4.32
Exercise score	.00	128.00	28.45	29.24
Leisure time activity	1.00	4.00	2.20	0.76
WISCI	1.00	21.00	7.47	8.38
Age at injury	16.00	53.00	32.28	9.87
Motor FIM	6.00	54.00	26.51	13.36
CHART-T	220.00	600.00	470.54	121.9
CHIEF-T	.00	3.00	.87	0.81

BMI: body mass index; WISCI: walking index for spinal cord injury; FIM: functional independence measure; CHART-T: Craig Handicap Assessment Reporting Technique-Total; CHIEF-T: Craig Hospital Inventory of Environmental Factors-Total

Table 2. Chi-square test results of the demographic characteristics of study groups

	Fx group (n=10)	Non-Fx group (n=60)	p
Etiology			
MVA	4 (40%)	28 (46.7%)	0.50
Gunshot wound	-	5 (8.3%)	
Fall	3 (30%)	10 (16.7%)	
Crush (by tree, etc)	1 (10%)	3 (5.0%)	
Surgery	-	1 (1.7%)	
Sports	2 (20%)	8 (13.3)	
Other	-	4 (6.7)	
Missing		1 (1.7%)	
Race			
Caucasian	9 (90%)	48 (80%)	0.70
Black	-	2 (3.3%)	
Hispanic	-	1 (1.7%)	
Asian American	-	5 (8.3%)	
Native	-	1 (1.7%)	
Unknown	-	1 (1.7%)	
Other	1 (10%)	1 (1.7%)	
Missing	-	1 (1.7%)	
Smoking			
No	5 (50.0%)	50 (83.3%)	0.04
<1/2 packet	1(10.0%)	6 (10.0%)	
≥1/2 packet	3 (30.0%)	3 (5.0%)	
Missing	1 (10.0%)	1 (1.7%)	
DVT	2 (20%)	17 (28.3%)	0.85
HO	2 (20%)	4 (6.7%)	0.37
Pressure sore	7 (70%)	28 (48.3%)	0.43

MVA: motor vehicle accident; DVT: deep vein thrombosis; HO: heterotopic ossification

Table 3. Mann-Whitney U-test results between groups

	Fracture group Mean (SD)	Non-fracture group Mean (SD)	p
Age	45.70 (7.33)	38.15(10.34)	0.03
BMI	26.54 (7.38)	24.93 (6.46)	0.48
Time since injury	10.70 (3.97)	6.19 (4.05)	0.003
Exercise score	21.80 (29.8)	29.69 (29.25)	0.35
Leisure time activity	2.30 (0.67)	2.19 (0.78)	0.67
Age at injury	34.90 (8.66)	31.83 (10.06)	0.30
Motor FIM	20.00 (7.86)	27.61 (13.82)	0.11
CHART-P	65.14 (43.49)	81.38 (32.21)	0.22
CHART-M	81.50 (19.55)	81.42 (22.34)	0.86
CHART-O	62.29 (21.93)	63.57 (37.41)	0.74
CHART-T	471.33 (98.88)	470.49 (123.94)	0.80
CHIEF-T	1.10 (0.49)	0.85 (0.82)	0.22
WISCI	6.00 (8.29)	7.72 (8.44)	0.44

BMI: body mass index; FIM: functional independence measure; CHART-P: Craig Handicap Assessment Reporting Technique-Physical Independence; CHART-M: Craig Handicap Assessment Reporting Technique-Mobility; CHART-O: Craig Handicap Assessment Reporting Technique-Occupation; CHART-T: Craig Handicap Assessment Reporting Technique-Total; CHIEF-T: Craig Hospital Inventory of Environmental Factors-Total; WISCI: Walking Index for Spinal Cord Injury

Discussion

The results of this study revealed that fractures are common in SCI persons and that fracture risk is increasing with smoking, a longer duration of injury, and increasing age in community-living persons with SCI. There was no difference between groups in terms of social integration, exercise level, and other demographic parameters.

The fractures after SCI are mostly due to minor traumas (9,10,13). Moreover, in some cases, there is no trauma reported. The distribution and the reason of fractures in our study group were relevant with the literature. Almost all of the fractures in this pilot study occurred below the level of injury, and the reason of the fractures was mostly minor activities, such as range-of-motion exercises and transfers.

Early mobilization, standing, exercise, and functional electrical stimulation are the main recommended interventions for preventing osteoporosis in patients with SCI after the injury (20). However, the level of scientific evidence for those interventions is inconclusive and poor (20). On the other hand, the potential detrimental effects (falls and heterotopic ossification related to microtrauma) of these interventions are challenging. The results of our study showed that there was no difference between fracture and non-fracture groups in terms of exercise level, leisure time activity, WISCI, and social integration. Thus, the level of activity and standing seems to have no effect on fracture incidence in this pilot study.

Smoking is associated with low bone mineral density and increased fracture risk in the nondisabled population (21). Though its effect on bone loss is apparent, we could not find any article in the literature emphasizing its contributing effects on bone loss or fracture occurrence in patients with SCI (22). Our results showed that smoking may have an important effect, at least on fracture occurrence, in community-living adults with SCI. However, because of the small sample size of this study, this contributing effect needs to be confirmed with larger studies.

As it is well known, osteoporosis after SCI is a multifactorial and inevitable issue. Most of the drugs used for the complications and problems after SCI have a negative effect on bone metabolism. The necessity to use these drugs for months and years may further increase bone loss. Among these drugs, antidepressants are commonly used for depression and for neuropathic pain in the acute and subacute stages; antiepileptics are used for neuropathic pain; and heparin and low-molecular-weight heparin are used for the prophylaxis of deep vein thrombosis. However, in most of these instances, there is no alternative to shift these medications except, if possible, being careful while choosing the least detrimental ones on bone metabolism.

Table 4. Properties of patients who had fractures

Patient	AAI	BMI	DOI	Etiology	Neurologic Level (ASIA)	GLTEQ Score	Exercise frequency	FIM	WISCI Score	Location of Fx	Reason
46/F	31	19,20	12/27/1990	MVA	T12 (C)	15	2	80	19	Toe (1995)	Kick
										Femur	ROM
										Arm	Fall
45/M	30	20,30	11/04/1990	Crush (by tree, etc)	T6 (A)	102	1	77	1	Ankle	Accident
										Finger	Work
										Toe	Kick
47/M	32	29,40	04/02/1991	Fall	C6 (A)	3	3	59	1	Hand (2002)	Fall
47/M	34	22,70	01/28/1992	MVA	C5 (A)	0	2	34	1	Shoulder	Seizure
52/M	39	19,70	08/16/1992	Other	C5 (A)	21	2	77	21	Arm	MWA
39/M	29	21,70	07/19/1995	MVA	C1 (B)	0	3	16	1	Humerus (2003)	ROM
										Calcaneus (2004)	Kick
30/F	21	40,40	01/17/1996	MVA	T4 (B)	9	2	99	1	Toe	Fall
50/M	41	28,60	03/30/1996	Fall	T8 (A)	28	2	48	1	Knee (1998)	NA
44/M	39	36,90	09/24/2000	Other	L1 (A)	19	3	85	13	Calcaneus (2003)	Strenuous Activity
57/M	53	26,50	10/08/2001	Fall	C3 (A)	21	3	13	1	Wrist (2003)	Transfer

AAI: age at injury; BMI: body mass index; DOI: date of injury; GLTEQ: Godin leisure time exercise questionnaire; WISCI: walking index for spinal cord injury; MVA: motor vehicle accident; NA: not available

Bisphosphonates are a group of drugs used in the treatment of osteoporosis in able-bodied people. These drugs help to recover bone loss by inhibiting osteoclastic activity. There are promising reports in the literature about the use of bisphosphonates in patients with SCI for fracture prevention. However, in a recent review (23), it was pointed out that the data in the literature are insufficient to recommend routine use of bisphosphonates in SCI patients. It is obvious that further studies need to evaluate whether bisphosphonates prevent bone loss during acute periods and whether the effect of bisphosphonates on bone mineral density in SCI is associated with fracture risk reduction.

The limitation of our study was the small sample size, related to low response rate. This might have shaded the possible effects of other parameters on fracture occurrence in patients with SCI.

Conclusion

Fractures after SCI are common, and smoking, age, and time since injury are important factors that are related to fracture occurrence after SCI. When bone metabolism after SCI is analyzed and the insufficient results of different interventions, such as exercise and functional electrical stimulation, and the reported insufficient efficacy of the treatment of osteoporosis are taken into account, the necessity of prophylaxis for osteoporosis seems reasonable.

Ethics Committee Approval: Study was approved by IRB at University of Washington Medical Center.

Informed Consent: Consent forms were mailed to each patient and the results of questionaires of the patients who signed the consent forms were used for the study.

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