ACTA
ORTHOPAEDICA
et
TRAUMATOLOGICA
TURCICA

Acta Orthop Traumatol Turc 2009;43(3):193-198
doi:10.3944/AOTT.2009.193

Major risk factors for the second contralateral hip fracture in the elderly

Yaşlılarda karşı taraf ikinci kalça kırığı için başlıca risk faktörleri

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Objectives: The purpose of this study was to determine which of the predisposing risk factors for the first hip fracture would continue to be effective for the development of the second hip fracture in the elderly.

Methods: Data of 125 patients (31 men, 94 women) aged 55 years or older were evaluated, who sustained first (group 1, n=97) and second contralateral (group 2, n=28) hip fracture. Patients who were treated with bisphosphonate, calcitonin, or estrogen were excluded.

Results: The incidence of the second hip fracture was higher (78.6%) beyond 12 months of the first fracture. The risk for sustaining a second hip fracture was 3.96-fold greater in patients over 85 years of age ($p<0.05$). Among comorbid medical conditions, eye diseases ($p=0.02$) and neurological diseases ($p=0.048$) were seen significantly more frequent in group 2. There was an obvious relationship between the second hip fracture and lower Singh index grades of ≤3 ($p<0.001$). Patients over 85 years of age and having a lower Singh index grade were found to have a 6.57-fold increased risk for developing a second hip fracture (95% CI: 2.13-20.3; $p=0.001$). In univariate analysis, neurological diseases represented a significantly increased risk. Eye diseases were highly associated with an increased risk for second hip fractures in univariate (OR: 3.3, 95% CI: 1.2-9.2, $p=0.020$) and multivariate (OR: 7.6, 95% CI: 1.9-30.7, $p=0.004$) analyses. The Singh index of grade ≤3 showed the highest associations with second hip fractures in both univariate (OR: 18.9, 95% CI: 5.8-65.9, $p<0.001$) and multivariate (OR: 30.00, 95% CI: 7.9-112.9, $p<0.001$) analyses.

Conclusion: We concluded that, of all the risk factors for the first hip fractures, only hypotrophic changes in the proximal femoral trabeculae, eye diseases, and neurological diseases acted as major risk factors for the second contralateral hip fractures in the elderly.

Key words: Age factors; hip fractures/etiology; recurrence; risk factors.

Amaç: Bu çalışmada, yaşlılarda ilk kalça kırığına zemin hazırlayan risk faktörlerinden hangilerinin ikinci kalça kırığı gelişimi için de risk faktörü olmayı sürdürdüğünün belirlenmesi amaçlandı.

Çalışma planı: Yaşları 55 veya daha yukarı olan, kalça kırıklı 125 hastanın (31 erkek, 94 kadın) verileri değerlendirildi. Doksan yedi hastada kalça kırığı ilk kez, 28 hastada karşı taraf kalçada ikinci kez kırık oluşmuştu. Bifosfonat, kalsitonin ve östrojen tedavisi gören hastalar çalışmaya alınmadı.

Sonuçlar: İkinci kalça kırığı çoğunlukla (%78.6) ilk kırıktan 12 ay sonraki dönemde meydana gelmişti. Seksen beş yaş üzeri hastalarda ikinci kırık riski 3.96 kat artmış bulundu ($p<0.05$). Eşlik eden hastalıklardan, göz hastalıkları ($p=0.02$) ve nörolojik hastalıklar ($p=0.048$) ikinci kırık grubunda anlamlı derecede sıktı. İkinci kırık oluşumu ile Singh indeksi derecelerindeki düşüklük (≤3) arasında anlamlı ilişki görüldü ($p<0.001$). Yaşı 85 üzerinde olan ve Singh indeksi derecesi ≤3 olan hastalarda ikinci kırık riski 6.57 kat artmış bulundu (%95 GA: 2.13-20.3; $p=0.001$). Tekdeğişkenli analizde, nörolojik hastalıkların riski anlamlı derecede artırdığı görüldü. Göz hastalıkları, hem tekdeğişkenli analizde (OO: 3.3, %95 GA: 1.2-9.2, $p=0.020$) hem de çokdeğişkenli analizde (OO: 7.6, %95 GA: 1.9-30.7, $p=0.004$) yüksek derecede riski temsil etmekteydi. Singh indeksi derecesinin ≤3 olması ise ikinci kırıkla en yüksek ilişki gösteren risk faktörü olarak bulundu (tekdeğişkenli analizde, OO: 18.9, %95 GA: 5.8-65.9, $p<0.001$; çokdeğişkenli analizde, OO: 30.00, %95 GA: 7.9-112.9, $p<0.001$).

Çıkarımlar: Bulgularımız, yaşlılarda birinci kalça kırığına ait risk faktörleri içinden sadece üçünün (femur proksimalinde trabeküler yapıdaki hipotrofik değişimler, göz hastalıkları ve nörolojik hastalıklar) ikinci kalça kırığı için de başlıca risk faktörleri olduğunu göstermektedir.

Anahtar sözcükler: Yaş faktörü; kalça kırığı/etyoloji; nüks; risk faktörü.

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Submitted / *Başvuru tarihi:* 29.11.2008 **Accepted / *Kabul tarihi:*** 29.01.2009

Hip fractures are considered to be a major public health problem in many regions of the world and the incidence of these fractures are presumed to increase in the future. The rates of a second hip fracture have been reported to be 2.9% per year[1] or 5% to 10% in general.[2,3] The rise in the occurrence of second hip fractures has been associated with the increasing rates of the first hip fracture. Complication rates following the first hip fracture have been significantly lower than those occurring after a second hip fracture.[3] Information on the risk factors leading to the first hip fracture is considered to be important to prevent further fractures in elderly patients.

The purpose of this study was to evaluate which of the predisposing risk factors for the first hip fracture would continue to be effective for the development of the second hip fracture in the elderly.

Patients and methods

Study population

We studied a total of 125 patients (31 men, 94 women) aged 55 years or older, who were consecutively treated for hip fractures at our hospital between January 2000 and September 2008. Inclusion criteria for sample collection were assigned as follows: first hip fracture presenting as an intertrochanteric or femoral neck fracture, the second hip fracture contralateral to the first hip fracture, of which roentgenograms of the first hip fracture were available.

We excluded patients whose fractures occurred due to pathological causes or high-energy trauma (e.g., traffic accidents or falls from a greater height than standing height), patients who sustained simultaneous bilateral hip fractures, hip fractures associated with a primary or secondary tumor lesion, and patients with renal osteodystrophy or metabolic bone disease. In addition, patients who developed a second hip fracture on the same side as the first hip fracture, and those who were previously treated with bisphosphonate, calcitonin, or estrogen were excluded.

Of 125 patients evaluated, 97 patients had the first hip fracture (group 1) and 28 patients had a second contralateral hip fracture (group 2). In group 2, data on each patient were recorded from the first hip fracture event to the second hip fracture event. Therefore, data collection for each patient was adequate. We compared the data of both groups.

Baseline data collection

Overall information and a complete health history were obtained from the medical history. Data were recorded from the time of the first hip fracture episode in both groups.

Demographic factors included age (55-74, 75-84, >85 years), gender, and duration between the first and second hip fractures (<12 months or >12 months). The Singh index (SI), cognitive function, injury mechanism, fracture category, pre-injury ambulatory function, and comorbidities including knee osteoarthritis were defined as medical predictors.

The pre-injury ambulatory function was assessed using the following grading system: walking without an assistive device, walking inside but not outside, locomotion using a wheelchair, and bed confinement. Data on comorbid medical conditions were based on the presence of the following conditions: hypertension, neurological diseases (cerebrovascular accident, dementia, Parkinson's disease), heart diseases (myocardial infarction, angina pectoris, arrhythmia), respiratory diseases (chronic obstructive pulmonary disease, asthma), diabetes mellitus, rheumatoid arthritis, knee osteoarthritis, and eye diseases (cataracts, glaucoma, diabetic retinopathy, and hypertensive retinopathy). Data on cognitive impairment of each patient was evaluated for orientation at the time of admission for the first hip fracture. The patient was considered to be mentally clear if disorientation was not noted. In the absence of orientation, the patient was considered to be confused, and a psychiatric consultation was requested. Many factors of a subsequent hip fracture (eye diseases or impaired depth perception, dizziness, neurological diseases, poor or fair self-perceived health, cognitive impairment, and other comorbid medical diseases) were not recorded as potential risk factors for the second hip fracture provided that those factors had been corrected and well-controlled before a second fracture event. The fracture causes were categorized as fall from a standing height or less and fracture from ambulation during nursing care.

For radiographic studies, the fractures were classified as intertrochanteric and femoral neck fractures. Hypotrophic changes in proximal femoral trabeculae were observed on the anteroposterior radiographs of the contralateral unfractured hip according to the Singh criteria.[4] Trabecular changes were graded separately by one orthopedist and one radiologist.

Table 1. Demographic and clinical features of the two fracture groups

	Group 1 (n=97) (First hip fracture)		Group 2 (n=28) (Second hip fracture)			
	n	%	n	%	Odds ratio (95% CI)	*p*
Age groups (years)						
55-74	49	50.5	9	32.1	1.0	**0.020**
75-84	37	38.1	11	39.3	1.62 (0.61-4.31)	
>85	11	11.3	8	28.6	3.96 (1.25-12.57)	
Gender						0.44
Male	22	22.7	9	32.1		
Female	75	77.3	19	67.9		
Fracture category						0.723
Intertrochanteric	44	45.4	11	39.3		
Femoral neck	53	54.6	17	60.7		
Fracture cause						0.312
Fall from a standing position	94	96.9	26	92.9		
Ambulation during nursing care	3	3.1	2	7.1		
Singh index grading						
Grade 1-3	19	19.6	23	82.1		**<0.001**
Grade 4-6	78	80.4	5	17.9		**<0.001**
Pre-injury ambulation function						
Walking without assistive device	56	57.7	13	46.4		0.399
Walking inside but not outside	41	42.3	15	53.6		
Cognitive function						0.377
Orientation	92	94.9	25	89.3		
Disorientation	5	5.2	3	10.7		
Time to second hip fracture						
≤ 12 months			6	21.4		
> 12 months			22	78.6		

Statistical analysis

For statistical differences between the two groups, quantitative data were analyzed using the Student's t-test (normality) or Mann-Whitney U-test (non-normality), and qualitative data were analyzed using the chi-square test. The results were expressed as odds ratios by 95% confidence interval (CI). A *P* value of less than 0.05 was considered statistically significant. Statistical analysis was performed using the SPSS version 11.5 software program. The effects of each predisposing risk factor for the second hip fracture were investigated with univariate and multivariate analyses.

Inter-observer reliability for the Singh grading system was found to be 0.70 (p<0.001, 95% CI: 0.479-0.921), which meant a good strength of agreement.[5]

Results

Demographic and clinical features of the two fracture groups are summarized in Table 1. In the patients over 85 years of age, the risk of experiencing a second hip fracture was 3.96-fold greater than that of the patients in the same age group in group 1 (p<0.05; Table 1).

There were no significant differences between the two groups with respect to the cause and type of fracture, and pre-injury ambulation function (Table 1). The incidence of the second hip fracture was higher (78.6%) 12 months after the first fracture (Table 1).

Among comorbid medical conditions, eye diseases (p=0.020) and neurological diseases (p=0.048) were seen significantly more frequent in group 2 (Table 2). There were no cases of rheumatoid arthritis in group 2 in spite of 2.1% in group 1.

Table 2. Comparison of comorbid medical conditions between the two fracture groups

	Group 1 (n=97) (First hip fracture)		Group 2 (n=28) (Second hip fracture)		
	n	%	n	%	*p*
Hypertension	54	55.7	15	53.6	0.99
Neurological diseases	24	24.7	13	46.4	**0.048**
Heart diseases	26	26.8	12	42.9	0.16
Respiratory diseases	11	11.3	3	10.7	0.99
Diabetes mellitus	28	28.9	7	25.0	0.87
Knee osteoarthritis	22	22.7	9	32.1	0.76
Eye diseases	16	16.5	11	39.3	**0.020**

There was an obvious relationship between the second hip fracture and a lower Singh index (grade 3 or lower) ($p<0.001$; Table 1). Among the age groups, patients over 85 years of age and having a lower Singh index were found to have a 6.57-fold increased risk for developing a hip fracture (95% CI: 2.13-20.3; $p=0.001$; Table 3).

In univariate analysis, patients with neurological diseases had a significantly increased risk; however, in multivariate logistic regression analysis, neurological diseases were not associated with a significant effect (Table 4). Eye diseases were highly associated with an increased risk for second hip fractures (3.3-fold and 7.6-fold in univariate and multivariate analyses, respectively; Table 4).

A Singh index of grade 3 or lower showed the highest correlations with the occurrence of a second hip fracture in both univariate and multivariate analyses (Table 4). Patients whose Singh index was grade 3 or lower at the time of the first hip fracture had 18.9-fold and 30-fold increased risk for the second hip fracture in univariate and multivariate analyses, respectively. (Table 4).

Discussion

Hip fractures tend to occur more frequently in the elderly population.[6,7] During the first year after the first hip fracture, 10-20% of elderly patients are at high risk for death.[8] Risk factors for first hip fracture have been well documented[9,10] and include previous fracture at any site, advanced age, low body weight, and low bone mineral density. Many patients who suffer a hip fracture remain untreated and have a high risk for a second hip fracture.

Yamanashi et al.[1] reported that the annual incidence of second hip fractures was 29 out of 1,000 patients. Few studies have addressed the epidemiology of second hip fractures. Several risk factors including neurological diseases, falls, poor perceived health, low weight gain, absence of walking for exercise, dizziness, and osteomalacia have been reported to be associated with an increased risk for a second hip fracture.[2,8] The benefit of predictors such as bone mineral density and ultrasound have not been clarified.[2] Therefore, we investigated which of the predisposing risk factors involved in the first hip fracture were still effective in the occurrence of second hip fractures in the elderly.

In our study, we excluded patients who were previously treated with bisphosphonate, calcitonin, and estrogen. Oral risedronate therapy reduces the incidence of nonvertebral fractures.[11] A previous study emphasized the importance of hormone replacement therapy with estrogen in the management of patients

Table 3. Relationship between age groups and the Singh index grading

	Singh index grade 1-3 (n=42)		Singh index grade 4-6 (n=83)			
	n	%	n	%	Odds ratio (95% CI)	*p*
Age (years)						
55-74	12	28.6	46	55.4	1	0.001
75-84	18	42.9	30	36.1	2.3 (0.97-5.45)	
>85	12	28.6	7	8.4	6.57 (2.13-20.3)	

Table 4. Univariate and multivariate analyses of factors associated with a second hip fracture

	Crude odds ratio	95% CI	*p*	Adjusted odds ratio	95% CI	*p*
Singh index grade 1-3	18.9	5.8-65.9	**<0.001**	30.00	7.9-112.9	**<0.001**
Eye diseases	3.3	1.2-9.2	**0.020**	7.6	1.9-30.7	**0.004**
Neurological diseases	2.6	1.1-6.9	**0.048**			0.421

who had increased risk for a subsequent hip fracture.[12] Calcitonin can affect bone formation and reverses the loss of bone mass in the lumbar spine and the proximal femur.[13] These pharmacologic interventions provided evidence for a protective effect for a subsequent fracture.[14] Therefore, the medications, such as bisphosphonate, calcitonin, and estrogen, could change the biochemical and histomorphometric pattern of proximal femoral trabecular structure. In our study, the changes in the proximal femoral trabecular pattern observed in our patients were not confounded by these agents because we excluded patients who used these agents. The hypotrophic changes in the proximal femoral trabeculae as designated by a lower Singh index have never been reported as a predisposing risk factor for second hip fractures. Yamanashi et al.[1] reported no significant difference between the first and second hip fractures with regard to the Singh index, which was divided into six grades. According to Singh et al.[4] there is a break in the continuity of the principal tensile group of trabeculae which can be clearly seen in grade 3 or lower. Interestingly, we assessed the Singh index in two subgroups as grades 1-3 (lower) and grades 4-6. Our study showed a strong relationship between lower Singh index grades and the occurrence of a second hip fracture. In previous studies, lower Singh index grades were not clearly related to osteoporosis.[1,15] The Singh grading technique has been used to denote various stages which are characterized by an increasing loss of different groups of trabeculae with progress of the disease. According to Pauwels,[16] downward bone trabeculae and arches of tensile trabeculae are formed by compressive stress and tensile stress, respectively. Therefore, the decrease in bone trabeculae as a result of absence of proximal femoral compressive and tensile stress could be attributed to lack of mobility or weight-bearing activity. Dretakis et al.[2] also reported that patients who sustained a second hip fracture were older at the time of the latter hip fracture, had decreased mobility and greater instability, and tended to have a greater displacement of the second hip fracture. It has been demonstrated that age over 80 years and impaired mobility increase the risk for a second hip fracture.[14]

Our findings showed a strong correlation between lower Singh index grades and age over 85 years, at which time mobility and weight-bearing activity are substantially decreased. The number of these patients was significantly higher in group 2. This may reflect the relationship between lower Singh index grades and second hip fracture events.

Comorbid diseases were investigated in patients with a second contralateral hip fracture, and eye diseases were identified as an important risk factor in the univariate analysis. Blindness was reported to have a significant association with subsequent contralateral fractures in a previous case control study by Saxena and Shankar.[17] However, there are some differences in terms of data collection and inclusion criteria between our study and the research of Saxena and Shankar.[17] In our study, data collection covered the period from the first hip fracture episode to the occurrence of the second hip fracture. In addition, we excluded patients in whom any potential risk factor for a subsequent hip fracture had been corrected, such as eye diseases or impaired depth perception, dizziness, neurological diseases, poor or fair self-perceived health, cognitive impairment, and other comorbid medical diseases. There was no contamination of these corrected potential risk factors in data collection of the patients who had a second hip fracture. Therefore, the data collected and variables of the second hip fracture group reflected the effect of risk factors that predisposed to the first hip fracture and were still effective in the development of a second hip fracture. A previous study demonstrated that impaired depth perception increased the risk for a second hip fracture in elderly women.[8] The results of our study also showed that eye diseases represented a high risk for second hip fractures. Therefore, we can clearly infer that elderly male and female patients who have their first hip fracture and uncorrected eye diseases are still at high risk for second hip fractures. Eye diseases decrease ambulatory ability and may also facilitate falls. A significant expansion of aging population is expected in many countries in the coming years.[18] In parallel with this increase, the prevalence of eye

diseases will also show an incline.[19,20] On the other hand, impairment in visual perception can easily be detected and often corrected.

Stroke patients with incomplete recovery and Parkinson's disease patients have an increased tendency to fall because of impaired postural control.[1] Patients with dementia have more vulnerability to falls due to cognitive impairment.[1] In our study, neurological diseases were found to be a significant and effective risk factor in the univariate analysis. Patients who had their first hip fracture and untreated neurological diseases were at high risk for a second hip fracture.

It was reported that 50% and 75% of the second hip fractures occurred in a 24-month period and 48-month period after the first hip fracture, respectively.[2] We found that 21.4% of second hip fractures occurred within 12 months after the first hip fracture, and 78.6% occurred beyond 12 months. Our data indicated a lower tendency for the second hip fracture to occur within a 12-month period. Most patients can restore ambulatory ability and participate in rehabilitation programs during the first year after the first hip fracture as well as receiving more frequent follow-ups and appointments from physicians and physical therapists. Therefore, either within one year or over one year of the first hip fracture, maintenance of rehabilitation and mobility restoration is still the important part of preventing a second hip fracture.

In conclusion, the hypotrophic changes in proximal femoral trabeculae assessed by the Singh grading system and eye diseases were demonstrated as the predisposing risk factors for both the first hip fractures and the second hip fractures. Neurological diseases represent an important risk factor, as well. We recommended that these major risk factors be identified and corrected properly in patients who sustain their first hip fracture.

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