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의학석사 학위논문

Characteristics and Risk factors of
Fall in Elderly Hip Fracture Patients
고령 고관절 골절 환자의 낙상 특성 및
요인

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Characteristics and Risk factors of Fall in Elderly Hip Fracture Patients

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이 논문을 의학석사 학위논문으로 제출함

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ABSTRACT

Introduction: Falls and fall-related injuries are in big concerns as major health issues in elderly as it can cause considerable mortality and deteriorating QOL. To prevent hip fracture after fall, not only the risk factors for hip fracture, but also understanding the fall mechanism need to be investigated in hip fracture patients. This study tried to find out the fall mechanism and the association of risk factors in elderly hip fracture patients in Korea

Methods: Fall-related hip fracture patients who underwent hip surgery in our institute and transferred to our department from January 2014 to February 2017 were retrospectively recruited. Demographic data, fracture type and operation type, fall characteristics and functional evaluations were recorded for analysis.

Results: Most of patients fell to the side and backward on buttock. Age and gender differences were not significant in the direction of falls. The main mechanisms of fall were slip, followed by sudden weakness, more prominent in female. Patients aged 85 or above experienced more slipped down events than below 85. Most of falls happened during walking whereas falling backward on buttock was often seen while

standing, especially in male. Seventy one percent of patients fell at home. Roughly half of patients were previously healthy. Most common comorbidity was hypertension, followed by osteoporosis and diabetes mellitus. Prevalent risk factors were gait difficulty followed by balance deficit, multiple medications, impaired functional status, cognitive impairment, postural hypotension. By cross analysis, male and age below 85 with better DEXA score showed more fall down event by blockage of something while walking compared with other activities, and both male and female with postural hypotension fell with sudden weakness, in statistical significance.

Conclusions: Most hip fractures occurred after slip down, to the side, and fall backward on buttock by sudden weakness. By cross analysis, there were two statistically significant association in fall mechanism; male and age below 85 though had better bone mineral density showed more fall down event by blockage of something while walking compared with other activities, and both male and female with postural hypotension are easily fell down with sudden weakness. These findings could provide some clues to make the prevention strategy based on the fall mechanisms.

Key words: Fall, hip fracture, elderly, fall mechanism, fall characteristics

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INTRODUCTION

Fall is an unexpected, unintentional event in which the participant comes to rest on the ground, floor, or lower level(1). It is estimated that about 1/3 of people over age 65 experience fall every year and half in age over 80 in USA (2, 3) . In Korea, the incidence of fall is estimated to be 13.0~ 26% annually (4, 5).

Falls and fall-related injuries are in big concerns as major health issues in elderly as it can cause considerable mortality and deteriorating QOL(6). As elder people are more likely to have several underlying comorbidities, just one event of fall and related injury such as hip fracture can worsen the existing comorbidities, leading to detrimental course and even life-threatening consequence(7).

Among fall related fractures, hip fracture is the most catastrophic for patients and burdensome to their family members socioeconomically. It is estimated that the incidence of hip fracture will rise from 1.66 million worldwide in 1990 to 6.26 million by 2050(8). In Korea, Lim et al reported the incidence and cost of hip fracture from 2001 to 2004 analyzed from the Health Insurance

Review Agency(9). In age over 50, the incidence of hip fractures in women increased from 250.9/100,000 persons in 2001 to 262.8/100 000 in 2004(4.7% increase), while hip fracture incidence in men decreased from 162.8/100 000 in 2001 to 137.5/100 000 in 2004(15.5% decrease). Still, the direct medical care costs for hip fracture kept increasing from \$62,707,697 in 2001 to \$65,200,035 in 2004, and the proportion of hip fracture cost in the national medical costs increased by 4.5% over 4 years (from 0.200% in 2001 to 0.209% in 2004). The care and rehabilitation of patients with hip fractures pose critical challenges in terms of functional outcomes and medical costs in a super-aged society.

Not all fall results in fractures. In one survey from United States, approximately 20% of falls required medical attention and approximately 10% caused fractures(10). In other study reported that fewer than 5% of elder fall resulted in hip fractures(11). Still, over 90% of hip fractures are caused by falls(12) and once fractures occur, about 20% of patients die in the first year and only 25% is known to return to the premorbid status(13, 14).

Previous studies suggested that among the elder people who fell down, there were differences in injury severities that could be

explained by fall direction, fall mechanism, protective response, bone strength and absorption of the impact (15, 16). There have been many studies investigating risk factors associated with hip fractures such as in osteoporosis patients as it is one of major risk factors, but there are few studies considering the fall mechanism solely itself.

Fall mechanism is one of fall characteristics that explain how the patient was actually fall to the ground. In one study described this term as fall mode, consists of slipping, tripping, postural change, leg weakness, etc(17). In other study in Korea, evaluated fall mechanism (fall mode) by including slipping, tripping, sudden weakness, losing steps, sorted by prevalence(4).

Therefore, to prevent hip fractures after fall, not only the risk factors for hip fracture, but also the fall mechanism need to more understood and be investigated in hip fracture patients. For this rationale, the purpose of the study was to find out the fall mechanism and the association of risk factors in elderly hip fracture patients.

METHODS

Participants

Patients who underwent hip surgery at the department of orthopedic surgery Seoul National University Bundang Hospital and transferred to the department of rehabilitation medicine from January 2014 to February 2017 were retrospectively recruited. Patients above age 65 and who underwent hip surgery due to hip fracture (intertrochanteric, femur neck, subtrochanteric fracture) after fall were included. Surgical treatment options were bipolar hemiarthroplasty, total hip replacement arthroplasty and open reduction and internal fixation. Patients who underwent hip surgery not due to hip fracture such as septic hip, hip osteoarthritis, or avascular necrosis were excluded. After patients were transferred to the department of rehabilitation medicine, they participated in the clinical pathway for rehabilitation program for hip fracture launched first in Korea, which includes early individualized rehabilitation, education for activities of daily living (ADLs), review of general medical conditions, appropriate management, establishment of further plans, and arrangement for discharge

settings. The design and protocol of this study were approved by the Institutional Review Board of the Seoul National University Bundang Hospital (B-1101-119-110).

Measures

Demographic data

Demographic data such as age and gender were obtained. For subgroup analysis, age groups were divided by age below 85 and 85 or above. Also, patient's height, bodyweight were measured to the nearest 0.1 cm and 0.1 kg, each. Body mass index was calculated by weight divided by the square of the height (kg/m^2). T-score for bone mineral density was measured by Dual-Energy X-ray Absorptiometry (DEXA, Lunar Corporation, Madison, WI, USA).

Fracture type and operation type

Fracture characteristics such as laterality (Left or right), type of fractures (intertrochanteric, femur neck, subtrochanteric fracture), type of operations (bipolar hemiarthroplasty, total hip replacement arthroplasty (THRA), open reduction & internal fixation, closed reduction & internal fixation) and history of previous hip surgery

were also recorded.

Fall characteristics

Information about factors associated with fall such as direction of falls (forward, oblique forward, to the side, backwards on back, oblique backwards, backward on buttock, etc.), mechanism of the fall (slip down, sudden weakness, blockage of something, etc.), activities at the time (sitting, lying down, standing, changing position, walking, riding a wheel chair, etc.), location (home, long-term facility, walk road, mountain, etc.) and premorbid status (healthy, assisted with cane, bedridden, etc.) were obtained.

Comorbidity & risk factor in fall mechanism

Comorbidity information included whether patient had osteoporosis, diabetes mellitus(DM), hypertension(HTN), arthritis, brain lesion. Risk factors such as postural hypotension, gait deficit, balance deficit, visual deficit, drop attack(vertebrobasilar insufficiency), impaired functional status, asymmetric weakness, cognitive impairment, incontinence, multiple medications were also acquired and analyzed.

Functional outcome assessment

Post-surgery functional evaluation such as Modified Barthel Index(MBI), Mini-Mental Status Examination (MMSE) and Berg Balance Scale (BBS) were done. The MBI is the individual's performance evaluation on 10 ADLs(18). The each item scores in the MBI are based on the level of physical assistance required to perform each task, and scores are summed to score ranging from 0 to 100. The MMSE is screening test that is a brief, objective measure of cognitive function(19). The MMSE consists of seven categories of questions, each representing a different cognitive domain or function and has a maximum score of 30 points. The BBS is a tool to measure performance-oriented balance state in elderly individual(20). It consists of 14 items that scores on a scale of 0 to 4, summed to the maximum score of 56.

Statistical Analysis

Data were analyzed by gender and by age group respectively. To compare the mean data of continuous variables of each group, T-test and ANOVA were performed. Also, cross analysis such as

Pearson' s Chi-square analysis and Fisher' s exact test were done across each categorical variable to try to find association between the various fall characteristics and multinomial logistic regression was performed for overall analysis. All analysis was done by SPSS (Microsoft) version 19.

RESULTS

Demographics and fall-related fractures (Table 1)

After screening, we gathered total 112 patients' (Male 34, Female 78) data. The demographic and fracture information are shown in Table 1. There was no significant difference between male and female group in age, BMI, while male group are significantly taller (Male: 167.04 ± 7.04 cm/ Female: 154.38 ± 5.81 cm, p-value <0.05) and heavier (Male: 58.07 ± 12.40 kg/ Female: 51.20 ± 8.96 kg, p-value <0.05) while having better DEXA score (Male: -2.51 ± 1.14 / Female: -3.54 ± 1.1 cm, p-value <0.05).

Femur neck fracture was most frequent in both male and female. Still, in the age group 85 and above, intertrochanteric fracture is most prevalent in male and increased in female compared with

below 85 (Fig. 1). Also in both male and female, femur neck fracture was most frequent when falling to the side (Male: 9/17, Female: 28/44), while intertrochanteric fracture seems to be related with falling on backward (Fig. 2). In female, sudden weakness significantly resulted in femur fracture (19/49, Fischer exact test, p value: 0.046), while male showed no difference in frequency of femur neck (4/8) and intertrochanteric fracture (4/8) (Fig. 3).

Table 1. Demographic data and fracture information

		M	F	Total
Age		80.82 ± 8.27	82.12 ± 6.27	81.72 ± 6.96
Age Group	Below 85	22	48	70
	85 & Above	12	30	42
Bwt(kg)**		58.07 ± 12.40	51.20 ± 8.96	53.29 ± 10.61
Height (cm)**		167.04 ± 7.03	154.38 ± 5.81	158.22 ± 8.50
BMI(kg/cm²)		20.77 ± 3.88	21.47 ± 3.50	21.26 ± 3.63
DEXA**		-2.51 ± 1.14	-3.54 ± 1.1	-3.23 ± 1.21
Laterality	Left	18	42	60
	Right	16	36	52
Fracture type	Intertrochanteric	15	27	42
	Femur neck	16	50	66
	Subtrochanteric	1	1	2
	others	2	0	2
Operation	Bipolar hemiarthroplasty	16	46	62
	THRA	2	3	5
	OR & IF, CR & IF	11	24	35
	Others	4	5	9
Previous hip surgery	No	32	67	99
	Yes	2	11	13

** p-value < 0.05, Bwt: Body weight, THRA: Total Hip Replacement Arthroplasty, OR: Open reduction, CR: Close reduction, IF: Internal fixation

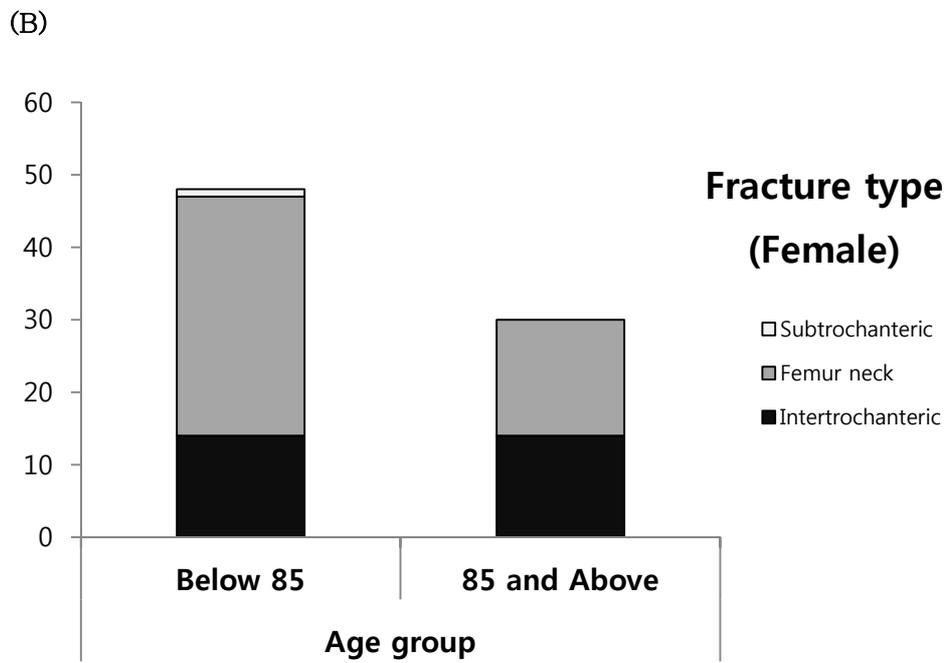
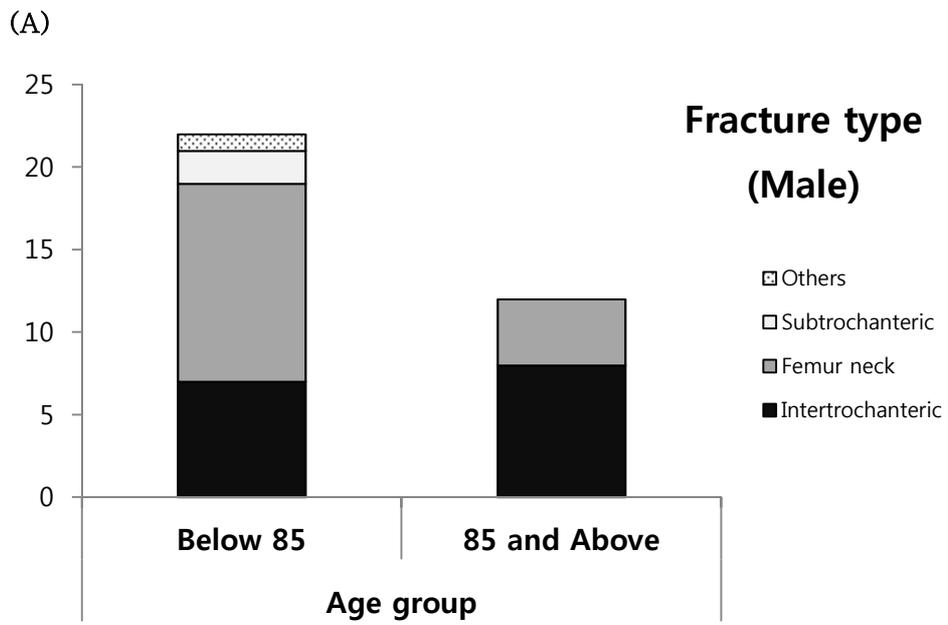


Figure 1. Fracture type distribution by age group in (A) Male, (B) Female

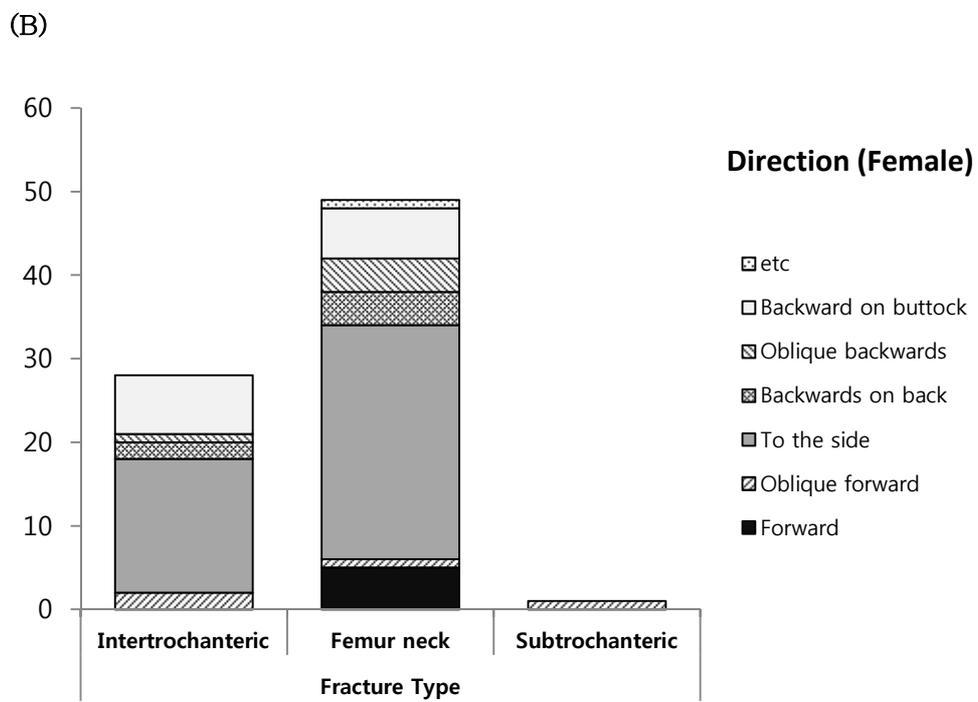
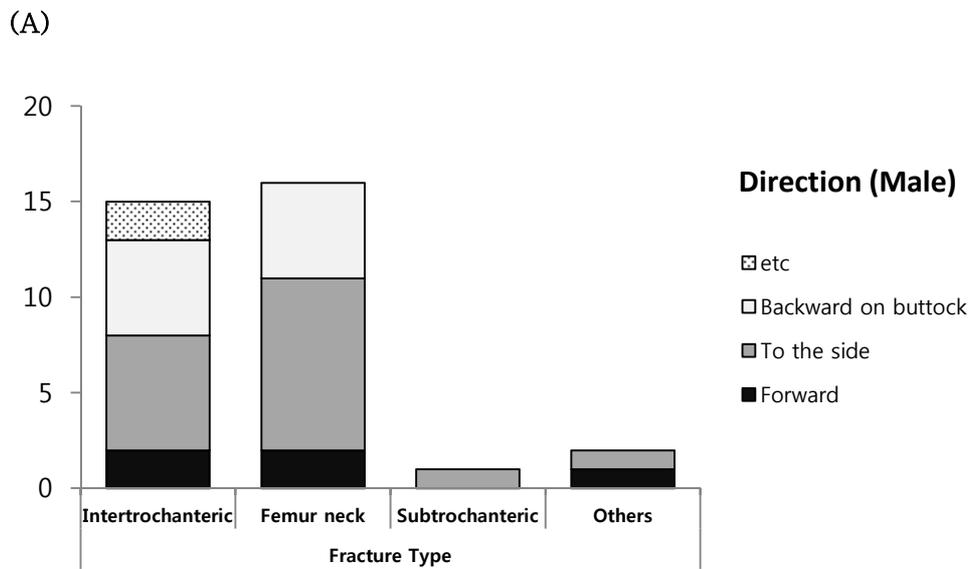


Figure 2. Cross analysis of fall direction and fracture type in (A) Male, (B) Female

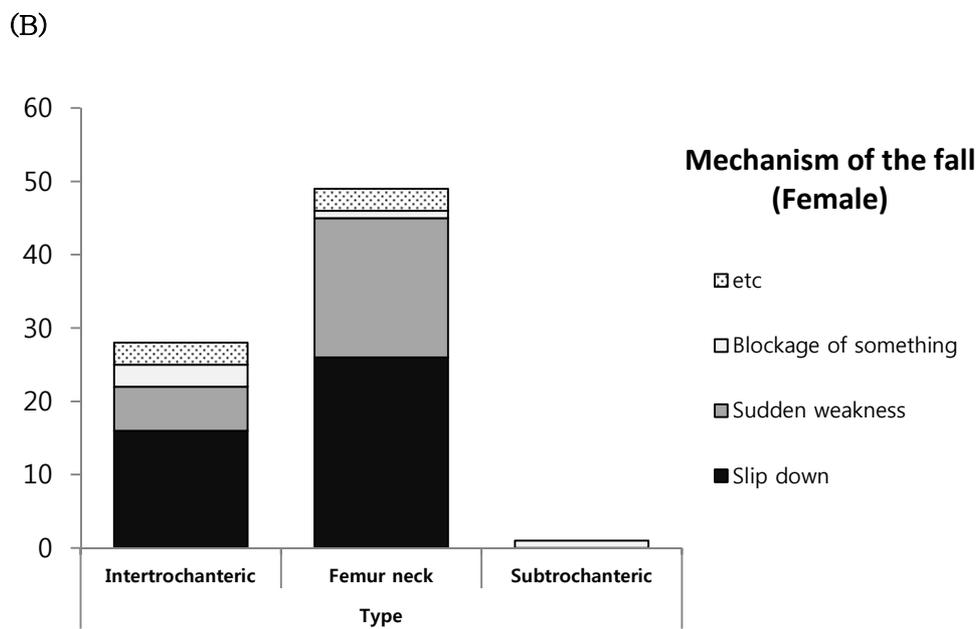
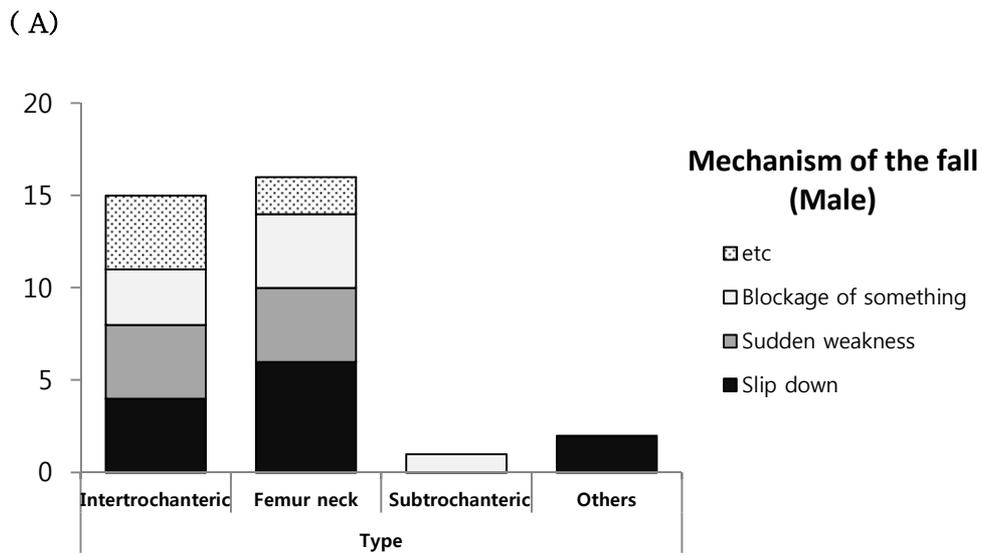


Figure 3. Cross analysis of fall mechanism and fracture type in (A) Male, (B) Female

Falls characteristics (Table 2a)

Fall characteristics are summarized in Table 2a. In terms of fall direction, most of patients fell to the side (61/112 (Male: 17/34, Female: 44/78)) and backward on buttock (23/112 (Male: 10/34, Female: 13/78)). Age and gender differences were not significant in the direction of the falls. About fall mechanisms, the main mechanisms of fall were slip down (54/112 (Male: 12/34, Female: 42/78)), followed by sudden weakness (33/112 (Male: 8/34, Female: 25/78)), more prominent in female. Regarding the activities at the time of the fall, most of falls happened during walking (54/112), especially in age group below 85 (Below 85: 38/70 (54.3%), 85 and above: 16/42 (38.1%)). Also, seventy one percent of patients fell at home (80/112 (Male: 19/34, Female: 61/78)).

Premorbid status, comorbidity & risk factors (Table 2b)

Roughly half of patients were previously healthy 57/112 (Male: 17/34, Female: 40/78). Most common comorbidity was hypertension (70/112 (Male: 19/34, Female: 51/78)), followed by osteoporosis and diabetes mellitus. Most prevalent risk factors were gait difficulty (55/112 (Male: 19/34, Female: 36/78)) followed

by balance deficit, multiple medications, impaired functional status,
cognitive impairment and postural hypotension.

Table 2a. Fall characteristics

	M	F	Total
Fall direction			
Forward	5	5	10
Oblique forward	0	4	4
To the side	17	44	61
Backwards on back	0	6	6
Oblique backwards	0	5	5
Backward on buttock	10	13	23
etc	2	1	3
Mechanism of the fall			
Slip down	12	42	54
Sudden weakness	8	25	33
Blockage of something	8	5	13
etc	6	6	12
Activities at the time			
Sitting	1	5	6
Lying down	0	0	0
Standing	12	20	32
Changing position	2	13	15
Walking	15	39	54
Riding a wheel chair	1	0	1
etc	3	1	4
Location of the fall			
Home	19	61	80
Long-term facility	5	4	9
Walk road	4	10	14
Mountain	1	1	2
etc	5	2	7

Table 2b. Premorbid status, comorbidity and risk factors of the fall

	M	F	Total
Premorbid status			
Healthy	17	40	57
Assisted with cane etc	11	31	42
Bedridden	1	3	4
etc	5	4	9
Comorbidity			
Osteoporosis	9	44	53
Diabetes mellitus	14	21	35
Hypertension	19	51	70
Arthritis	1	12	13
Brain lesion	10	14	24
etc	13	32	45
Risk factors of the fall			
Postural hypotension	6	5	11
Gait deficit	19	36	55
Balance deficit	10	29	39
Visual deficit	1	1	2
Drop attack (vertebrobasilar insufficiency)	0	2	2
Impaired functional status	10	21	31
Asymmetric weakness	3	4	7
Cognitive impairment	5	24	29
Incontinence	6	3	9
Multiple medications	13	19	32

Cross analysis of variables in fall mechanism

Demographic data vs Fall mechanism (Table 3)

Patients age group 85 or above experienced more slipped down events (26/42) than age group below 85 (28/70). In particular, male showed more tendency to fall by blockage of something than female and also age group below 85 showed higher incidence than age 85 and above. Also, slip down and sudden weakness group were significantly older than blockage group (Slip down: 83.37 ± 6.26 , Sudden weakness: 81.52 ± 6.31 , Blockage: 78.00 ± 8.71 , p-value < 0.05), while blockage group was significantly taller group (Slip down: 156.86 ± 7.56 , Sudden weakness: 157.12 ± 8.73 , Blockage: 164.46 ± 7.92 , p-value < 0.05) and heavier (Slip down: 52.27 ± 9.46 , Sudden weakness: 52.83 ± 13.24 , Blockage: 60.49 ± 9.72 , p-value < 0.05) than other groups (Table 3).

Table 3. Demographic data of each fall mechanism (Cross analysis)

Fall mechanism		Slip down	Sudden weakness	Blockage of something	etc
Age**		83.37 ± 6.26	81.52 ± 6.31	78.00 ± 8.71	78.92 ± 8.21
Age Group	Below 85	28	22	11	9
	85 & above	26	11	2	3
Gender	M	12	8	8	6
	F	42	25	5	6
Height(cm)**		156.86 ± 7.56	157.12 ± 8.73	164.46 ± 7.92	160.63 ± 10.29
Bwt (kg)**		52.27 ± 9.46	52.83 ± 13.24	60.49 ± 9.72	51.32 ± 5.59
BMI (kg/cm²)		21.26 ± 3.61	21.27 ± 4.16	22.37 ± 3.31	19.99 ± 2.39
DEXA**		-3.39 ± 1.08	-3.32 ± 1.14	-2.67 ± 1.39	-2.84 ± 1.57
Laterality	Left	27	21	9	4
	Right	27	12	4	8
Fracture type	Intertrochanteric	20	10	6	7
	Femur neck	32	23	5	5
	Others	2	0	0	0
	Subtrochanteric	0	0	2	0
Operation	Bipolar hemiarthroplasty	32	20	4	6
	THRA	3	1	1	0
	OR/CR & IF	17	8	7	3
	Others	1	4	1	3
Previous hip surgery	No	46	28	13	12
	Yes	8	5	0	0

** p-value < 0.05, THRA: Total Hip Replacement Arthroplasty, OR: Open reduction, CR: Close reduction, IF: Internal fixation

Fall direction vs Fall mechanism (Table 4)

By the cross analysis, there was close association between falling to the side and slipping down, while falling backward on buttock was closely associated with sudden weakness but not showed definite statistical significance.

Activity at the time of fall vs Fall mechanism (Table 4)

During walking, slip down was most dominant fall mechanism, whereas fall by sudden weakness was common while standing or sitting. In particular, male and age below 85 group showed more fall event by blockage of something during walking compared with other activities (Fig. 4), which were statistically significant (Fischer exact test, p-value : 0.030).

Table 4. Fall characteristics vs Fall mechanism (Cross analysis)

Fall mechanism		Slip down	Sudden weakness	Blockage of something	etc
Direction of the fall	Forward	5	2	2	1
	Oblique forward	3	0	1	0
	To the side	33	18	7	3
	Backwards on back	3	2	0	1
	Oblique backwards	2	2	0	1
	Backward on buttock	7	9	3	4
	etc	1	0	0	2
	Activity at the time of the fall	Sitting	2	3	0
Standing	12	12	3	5	
Changing position	9	5	0	1	
Walking**	29	12	10**	3	
Riding a wheel chair	1	0	0	0	
etc	1	1	0	2	
Location of the fall	Home	41	25	7	7
	Long-term facility	3	4	1	1
	Walk road	5	4	4	1
	Mountain	1	0	1	0
	etc	4	0	0	3
Premorbid status	Healthy	25	15	11	6
	Assisted with cane	21	16	1	4
	Bedridden	2	1	0	1
	etc	6	1	1	1

** Fischer' s exact test, p-value < 0.05

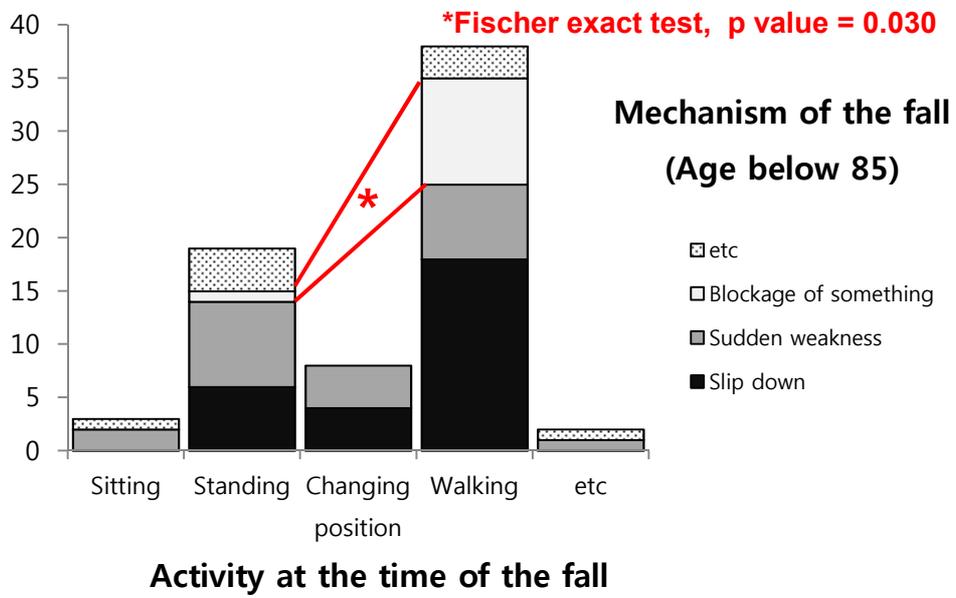


Figure 4. Cross analysis of activity at the time and fall mechanism in age below 85

Comorbidity & risk factor vs Fall mechanism (Table 5, 6)

Among various comorbidity and risk factor, only postural hypotension was significantly associated with fall with sudden weakness (Pearson chi square test, p-value: 0.24). Fall by gait deficit & balance deficit seems to be related with slip down, especially in male, but other than these, there were no definite statistically significant findings in other comorbidity and risk factor (Table 5).

On multinomial logistic regression model for fall mechanism, considering major comorbidities (osteoporosis, DM, HTN), risk factors (postural hypotension, gait deficit, balance deficit, impaired function, cognitive impairment, multiple medication) other relevant data (height, body weight, DEXA score) as dependent variables, only statistically significant variable was a postural hypotension as a relevant factor for sudden weakness (B: 3.379, p-value 0.006, referring slip down), as postural hypotension is more likely to cause sudden weakness fall by 3.379 folds compared with slip down events, while other variables showing no statistically relevant association in the regression model (Table 6)

Table 5. Comorbidity & risk factor vs Fall mechanism (Cross analysis)

Fall mechanism		Slip down	Sudden weakness	Blockage of something	Etc
<Comorbidity>					
Osteoporosis	No	26	16	10	7
	Yes	28	17	3	5
Diabetes mellitus	No	39	19	9	10
	Yes	15	14	4	2
Hypertension	No	20	11	6	5
	Yes	34	22	7	7
Arthritis	No	47	28	12	12
	Yes	7	5	1	0
Brain lesion	No	42	27	10	9
	Yes	12	6	3	3
<Risk factor>					
Postural hypotension**	No	53	26**	12	10
	Yes	1	7	1	2
Gait deficit	No	28	13	8	8
	Yes	26	20	5	4
Balance deficit	No	34	19	12	8
	Yes	20	14	1	4
Visual deficit	No	54	32	12	12
	Yes	0	1	1	0
Drop attack	No	54	32	13	11
	Yes	0	1	0	1
Impaired functional status	No	40	19	13	9
	Yes	14	14	0	3
Asymmetric weakness	No	48	32	13	12
	Yes	6	1	0	0
Cognitive impairment	No	41	22	10	11
	Yes	13	11	3	1
Incontinence	No	50	29	13	11
	Yes	4	4	0	1
Multiple medications	No	37	25	10	8
	Yes	17	8	3	4

** Pearson chi square test, p-value < 0.05

Table 6. Multinomial regression analysis:
Sudden weakness (Reference: slip down)

	Beta	p-value
Height	0.014	0.691
Bwt	0.019	0.540
DEXA	-0.125	0.683
Osteoporosis	0.227	0.684
Diabetes mellitus	0.741	0.188
Hypertension	0.546	0.386
Postural hypotension	3.379	0.006
Gait deficit	0.210	0.696
Balance deficit	0.286	0.596
Impaired function	0.521	0.356
Cognitive impairment	0.259	0.648
Multiple medications	-1.261	0.054

** p-value < 0.05

Inpatient functional outcome of each fall mechanism (Table 7a, 7b, 7c)

MBI scores of each subgroup by age group and gender for fall mechanism was analyzed (Table 7a). MBI of slip down group was relatively lower in all subgroup (36.18) than other fall mechanism (Sudden weakness: 42.06, Blockage of something: 49.25), but showed wide range of scores resulting no definite significant statistical difference between each subgroup. MMSE for each mechanism (Slip down: 20.56, Sudden weakness: 19.37, Blockage of something: 24.44) and BBS (Slip down: 14.94, Sudden weakness: 11.00, Blockage of something: 14.10) also showed no definite significant statistical difference between each subgroup (Table 7b, 7c).

Table 7a. MBI subgroup analysis of fall mechanism

	Total (n=102)	Below 85		85 and Above	
		Male (n=20)	Female (n=45)	Male (n=10)	Female (n=27)
Slip down	36.18 ± 19.65	25.20 ± 18.85	38.35 ± 23.62	34.43 ± 21.24	37.59 ± 13.84
Sudden weakness	42.06 ± 20.46	34.60 ± 15.11	45.38 ± 21.41	45.38 ± 21.41	36.50 ± 21.86
Blockage of something	49.25 ± 17.35	46.14 ± 13.95	51.75 ± 25.25	-	61.00
p-value	0.229	0.326	0.643	0.456	0.100

Table 7b. MMSE subgroup analysis of fall mechanism

	Total (n=99)	Below 85		85 and Above	
		Male (n=16)	Female (n=47)	Male (n=10)	Female (n=26)
Slip down	20.56 ± 6.91	19.00 ± 9.59	20.36 ± 7.00	23.29 ± 4.07	20.12 ± 7.19
Sudden weakness	19.37 ± 8.68	23.67 ± 1.16	17.94 ± 9.28	29.50 ± 0.71	18.22 ± 8.54
Blockage of something	24.44 ± 8.62	28.40 ± 1.14	19.50 ± 11.73	-	-
p-value	0.365	0.140	0.596	0.173	0.115

Table 7c. BBS subgroup analysis of fall mechanism

	Total (n=99)	Below 85		85 and Above	
		Male (n=18)	Female (n=45)	Male (n=9)	Female (n=27)
Slip down	14.94 ± 12.56	14.80 ± 14.15	17.10 ± 14.16	23.29 ± 4.07	20.12 ± 7.19
Sudden weakness	11.00 ± 9.86	5.20 ± 4.38	14.87 ± 11.71	29.50 ± 0.71	18.22 ± 8.54
Blockage of something	14.10 ± 12.62	13.50 ± 12.76	15.00 ± 14.31	-	-
p-value	0.515	0.518	0.480	0.424	0.374

DISCUSSION

This was first study taken in Korea trying to reveal fall mechanism and the association of risk factors in elderly hip fracture patients. There were studies showing simple incidence and epidemiology in Korea, but had limitation to show the relationship between the variables(21, 22).

Fall mechanism was categorized by fall by slip down, sudden weakness and blockage of something (tripping) in this study(23). In other study, fall mechanism was described by term as a 'fall mode' where included slipping, tripping, postural change, leg weakness, dropping down, dizziness or others(17). This categorization could be more specific but has some variables overlapping with activities and risk factors that could be confounding factor to the analysis. So this study categorization of fall mechanism is simpler with less overlapping factors.

In one previous prospective cohort study, osteoporotic patients who suffered hip fractures showed more incidence of falling sideway or straight down and landing on or near the hip than those with no consequence of hip fractures(24). Also in other study

reported 76% of patients had fallen directly to the side(25). Our study results are in line with previous study that most of hip fracture patients had fallen to the side or backward. The previous study explains that falling to the side has more chance to have direct impact of the greater trochanter which results in more chance of actual hip fracture (25, 26).

In this study, there were two statistically significant associated variables by Chi-square analysis. First was that male and age below 85 showed more fall down event by blockage of something while walking compared with other activities though had better DEXA score. We can assume that old male but below age 85 tends to walk faster that has more chance to get tripped down with something, which can bring enough impact by high-speed inertia to result in fracture though had better bone mineral density. So we should not loss attention also to the more active male individuals that mistakenly considered safer in nature.

Second was that the elders with postural hypotension tends to fall by sudden weakness. It is well known that postural hypotension has high association with falls(27). In this study, also gets in line with the previous study and more specific, in hip fracture patients. So it

is essential in elders to manage and prevent the postural hypotension to prevent the falls.

Regarding the type of fractures, in both male and female, femur neck fracture was most frequent when fall to the side, while intertrochanteric fracture seems to be related with falling on backward. In previous cadaveric study, showed that hip fracture initiates with a failure in the superior femoral neck where stresses are primarily compressive during a sideways fall impact(28), which explains our study result. Considering these findings, we can consider various fall prevention strategies such as a device that could change the direction or have more cushioning at lateral hip(29) could prevent and reduce to the detrimental result of hip fracture.

Functional assessment (MBI, MMSE, BBS) after hip fracture surgery showed no statistically significant difference in each fall mechanism; slip down, sudden weakness and blockage of something. As evaluation was taken within short period after surgery just before discharge, it could have been too short period to show the actual difference by group. Long term outcome could be evaluated and analyzed in the future study.

Limitation

First, it was a limited evaluation as there was no appropriate comparable control group that has less power of study explanation. Still we could find some significant relationship of the variables associated with fall mechanism that resulted in hip fracture by only the cross-sectional data with cross analysis. Also, the study had rather small pool of patients. If more patients were recruited, there could have been more statistically significant results. Finally, there could have been selection bias as only the patient who was transferred from OS was recruited. In elders with intertrochanteric fracture are known to recover slower and have more sequelae compared with femur neck patients (30), so most of the patients who were transferred to the rehabilitation department could more likely to be the one with intertrochanteric fracture and the data also proves.

Still, it was suggestive than conclusive that could still show some fall mechanism association between variables by only the cross sectional data. In further study, more recruited patient data with comparable group will reveal better new explainable information.

CONCLUSIONS

Most hip fractures occurred after slip down, to the side, and fall backward on buttock by sudden weakness. Various fall characteristics were differed and explained by gender, age group and also other risk factor. Regarding the factors affecting and explaining the fall mechanism, by cross analysis, there were two statistically significant association; male and age below 85 though had better bone mineral density showed more fall down event by blockage of something while walking compared with other activities, and both male and female with postural hypotension are easily fell down with sudden weakness. These findings could provide some clues to make the prevention strategy based on the fall mechanisms.

CONFLICT OF INTEREST

There is no potential conflict of interest relevant to this article.

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국문 초록

서론: 낙상 및 낙상 관련 손상은 높은 사망률과 더불어 삶의 질을 악화시킬 수 있으므로 고령화 사회에서의 큰 건강 관련 이슈이다. 낙상에 의한 고관절 골절을 예방하기 위해서는 고관절 골절 환자의 위험 인자뿐만 아니라 낙상 기전에 대한 이해가 필요하다. 본 연구는 고령자 고관절 골절 환자에서의 낙상 기전과 위험 인자의 연관성을 알아보고자 하였다.

방법: 2014 년 1 월부터 2017 년 2 월까지 본원에서 낙상에 의한 고관절 골절로 고관절 수술을 받고 재활의학과로 전과 온 환자를 대상으로, 인구 통계학적 데이터, 골절 유형 및 수술 유형, 낙상 특성 및 기능적 평가를 후향적으로 추출하여 분석하였다.

결과: 대부분의 환자는 옆으로 또는 뒤로 낙상 하였으며, 나이와 성별에 따른 낙상 방향 차이는 유의하지 않았다. 낙상의 주요 기전은 미끄러짐이었고 갑작스런 힘빠짐으로 인한 낙상은 여성에서 상대적으로 흔하였다. 85 세 이상의 환자군이 85 세 미만의 보다 더 많은 미끄러짐으로 인한 낙상을 경험했다. 대부분의 낙상은 걷는 동안 발생하였으며, 뒤로 넘어지는 경우는 서있는 동안 상대적으로 발생 비중이 높았다. 환자의 70 %가 집에서 낙상을 경험하였으며, 환자의 약 절반이 병전에 독립 생활이 가능하였다. 가장 흔한 동반 질환은 고혈압이었으며 그 다음으로 골다공증과 당뇨병이 흔하였다. 위험

인자로는 빈도가 높은 순으로 보행문제, 균형문제, 다약제 복용, 기능장애, 인지 장애, 기립성 저혈압이었다. 교차 분석을 통해 DEXA score가 높은 85 세 이하 남성군 경우, 다른 활동에 비해 걷는 동안 걸러 넘어짐에 의한 낙상이 통계학적으로 유의하게 두드러졌으며, 위험인자 중 기립성 저혈압이 있는 경우 남성과 여성 모두에서 통계학적으로 유의하게 갑작스런 힘빠짐으로 인한 낙상 발생이 흔하였다.

결론: 대부분의 낙상에 의한 고관절 골절은 옆으로 미끄러지거나, 뒤로 갑작스럽게 넘어지는 경우 발생하는 것을 확인하였다. 각 요인 별 교차 분석을 통해, 통계학적으로 유의한 두 가지 요인들이 있었다. 85 세 이하 남성 환자 군들은 골 밀도가 상대적으로 좋았지만 다른 활동에 비해 걷는 동안 걸러 넘어지는 경우가 흔하였고 기립성 저혈압이 있는 남성과 여성 모두 갑작스런 힘빠짐으로 인한 낙상 발생이 흔하였다. 이러한 결과를 통해 낙상 기전을 더욱 이해하여 낙상 방지 및 예방 전략을 세울 수 있을 것이다.

주요어 : 낙상, 고관절 골절, 노인, 낙상 기전, 낙상 요인

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