



Femoral Intertrochanteric Fractures of the Patients in the Emergency Department due to Minor Falls: Special Consideration in the Middle-old to Oldest-old Patients

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Background: The older population (≥ 65 years) has rapidly increased in size in recent years. Among them, the middle-to-oldest-old (≥ 75 years) tend to have a poor health status. Therefore, subdivision and evaluation of older patients with traumatic injury are required. We focused on the risk of femoral intertrochanteric fractures occurring in older adults due to minor falls and compared young-old and middle-to-oldest-old populations. **Methods:** The medical records of patients who visited the emergency center due to hip injuries between March 2017 and March 2019 were retrospectively analyzed. Patients were divided into older adult (≥ 65 years) and non-older (age 18–64 years) groups; the older adult group was subdivided into young-old (65–74 years), middle-old (75–84 years), and oldest-old (≥ 85 years) groups. This study investigated the occurrence rate of femoral intertrochanteric fractures and related factors. **Results:** The older adult group had a higher incidence of femoral intertrochanteric fractures than that in the non-older adult group (95.3% vs. 4.7%, $p < 0.001$). However, there was no significant difference between young-old and non-older groups (58.8% vs. 41.2%, $p = 0.145$). Middle-old to oldest-old age and osteoporosis were associated with an increased incidence of femoral intertrochanteric fractures ($p < 0.001$, $p = 0.004$). **Conclusion:** A higher incidence of femoral intertrochanteric fractures from minor falls was found among middle-old to oldest-old patients compared to that in young-old patients. Therefore, physicians should perform more thorough physical examinations and radiograph reading in middle-old to oldest-old patients even if the patients do not complain of pain.

Key Words: Older adults, Accidental falls, Intertrochanteric fractures, Emergency

INTRODUCTION

The proportion of the older population aged ≥ 65 years in Korea was about 14.1% in 2015 and is expected to increase to greater than 20% by 2025, becoming a so-called 'super-aged society'.¹⁾ This is the fastest annual aging rate in the world.²⁾ With a rapid increase in the older population, the lack of medical research focusing on the older population is a major concern.¹⁾ The increase in the older adult population leads to their increased participation in social and leisure activities, thus increasing the frequency of trauma in this popula-

tion. Furthermore, aging is significantly associated with decreased physiological ability, which is a cause of trauma, requiring special medical needs and treatment compared to other age groups.³⁾

Injuries from falls are the most common and major cause of trauma in older adults.^{4,5)} This age group has a higher frequency and risk of falls than those of younger age groups. Falls among older adults also cause severe spontaneous damages and complications.^{6,7)} Generally, as the number of older individuals hospitalized has increased recently, minor falls have also increased.⁸⁾ The injuries and damage sustained from minor falls are more severe in older adults than

those in non-older age groups.⁹⁻¹¹⁾

Many people visit emergency centers due to hip injuries caused by minor falls. Hip fractures are more likely to occur in older than in younger patients.¹²⁾ Femur intertrochanteric fractures, usually caused by minor falls in older adults with osteoporosis, are the most common type of fracture around the hip.¹³⁾ The frequency of femur intertrochanteric fractures is climbing due to the increased average life expectancy of older adults.¹³⁾ Furthermore, diagnosis of these fractures may not be possible by simple plain radiography,^{14,15)} thus, careful interpretation of radiographs and physical examination may be needed.¹⁴⁾

In younger patients, fractures are rare and more likely to be diagnosed because of severe resting pain. However, older patients usually experience more fractures than expected and less often complain of pain than younger individuals.¹⁶⁾ Hence, increased time and effort are needed for the diagnosis of older patients with hip injuries caused by minor falls.¹⁷⁾

As the overall health status of older adults has gradually increased, their health conditions vary depending on their age. Therefore, the older adult population may have to be subdivided. Although the criteria differ, several studies have proposed divisions of this group into early and late (75 years) old age or young-old, middle-old, and oldest-old age for 65–74, 75–84, and at least 85 years, respectively.¹⁸⁻²⁰⁾ In Korea, the proportion of older individuals aged > 85 years is increasing rapidly, from approximately 60,000 in 1980 to an estimated 530,000 by 2015 and 1.15 million by 2026, the highest increase rate among all age groups.^{1,2)}

Among older adults, the young-old have remained healthier than their counterparts in the past due to their better economic and nutritional status and frequent medical checkups. Therefore, the degree of damage and aftereffects that they acquire may differ for various traumas. Additionally, we have observed a rapid increase in the frequency of older patients visiting the emergency centers and who are diagnosed with intertrochanteric fractures due to minor fall injury. However, to our knowledge, no studies have yet been conducted to determine the incidence of femur intertrochanteric fractures among the rapidly increasing hip injuries of older adults.²¹⁾

Therefore, we investigated the differences in the incidence of femoral intertrochanteric fracture with age. Additionally, we aimed to determine the ages of patients who should be actively diagnosed with intertrochanteric fractures through examinations such as computed tomography (CT) scans.

MATERIALS AND METHODS

Patients

The present study retrospectively reviewed the medical records of

patients > 18 years of age who visited the emergency center due to hip injuries between March 2017 and March 2019. This emergency center is a local emergency center located in Seoul that sees approximately 30,000 patients annually. During the study period, 893 patients with hip injuries visited our emergency center, approximately 851 of whom were > 18 years of age.

Among these, 598 patients were included in the study. The reasons for exclusion included a mechanism of injury that was not a fall or was unclear, the patient was transferred to another hospital, missing or incorrect medical records, or lack of examination due to patient refusal or death upon visit. The study was approved by the Institutional Review Board of Kyung Hee University Hospital (No. KHUH 2019-07-050). Written informed consents were obtained.

Study Protocols

The target patients were divided into those aged > 65 years (older patients) and those aged 18–64 years (non-older patients). The older patients were then classified as young-old (aged 65–74 years), middle-old (75–84 years), or oldest-old (> 85 years). Falls were defined as ‘unexpected falls to the floor or other low position, without loss of consciousness.’²²⁾ Minor falls were defined as ‘falling from a sitting or standing position to the ground, from a height of less than 1 meter, and below three steps’ and other cases were excluded.²³⁾ The medical records of patients were reviewed to determine the age, sex, time of accident, drinking alcohol at the time of accident, hip radiograph findings, underlying diseases, and prognosis. The time of accident was defined as the time of the accident described by the patient or caregiver. Drinking alcohol was determined based on the patient’s smell and caretaker and paramedic statements. All hip radiograph examinations were read by imaging specialists and were assessed for the possible presence of femur intertrochanteric fractures. The type of intertrochanteric fracture was classified using Tronzo classification.²⁴⁾ Underlying diseases included stroke, osteoporosis, Parkinson disease, dementia, and cancer, which are known to affect low-energy fall injury and eventually cause femur intertrochanteric fracture.²⁵⁾ The prognosis was for patients hospitalized with femoral intertrochanteric fractures and, as of the time of discharge, discharged without complications was classified as a favorable prognosis, while cases of transfer or death due to complications were classified as unfavorable prognosis.

Statistical Analysis

The analysis of collected data was performed using PASW Statistics version 18.0 for Windows (SPSS Inc., Chicago, IL, USA). Data on categorical and continuous variables were presented as percentages and mean \pm standard deviation, respectively. In univariate analysis, categorical variables were analyzed using chi-squared or Fisher exact

tests; normally-distributed continuous variables were analyzed using independent t-tests (Student t-tests) and normal distributions were analyzed using Shapiro–Wilk tests. Binary logistic regression analysis was performed on variables with significant results in univariate analysis. Findings were considered statistically significant if $p < 0.05$.

RESULTS

A total of 893 patients visited the emergency medical center during the study, including patients with pelvic damage. Among these, 598 patients were included in the study, except for 42 patients who were < 18 years of age, 134 patients who were not aware of the causes of their minor falls, 83 patients who were from other hospitals, 34 patients who had missing or incorrect information in their medical records, and 2 patients who did not undergo any examination. Among the patients included in the study, 162 were aged 18–64 years, 117 were in the young-old group (65–74 years), 217 were in the middle-old group (75–84 years), and 102 were in the oldest-old group (> 85 years) (Fig. 1).

A total of 150 patients had femur intertrochanteric fractures; the

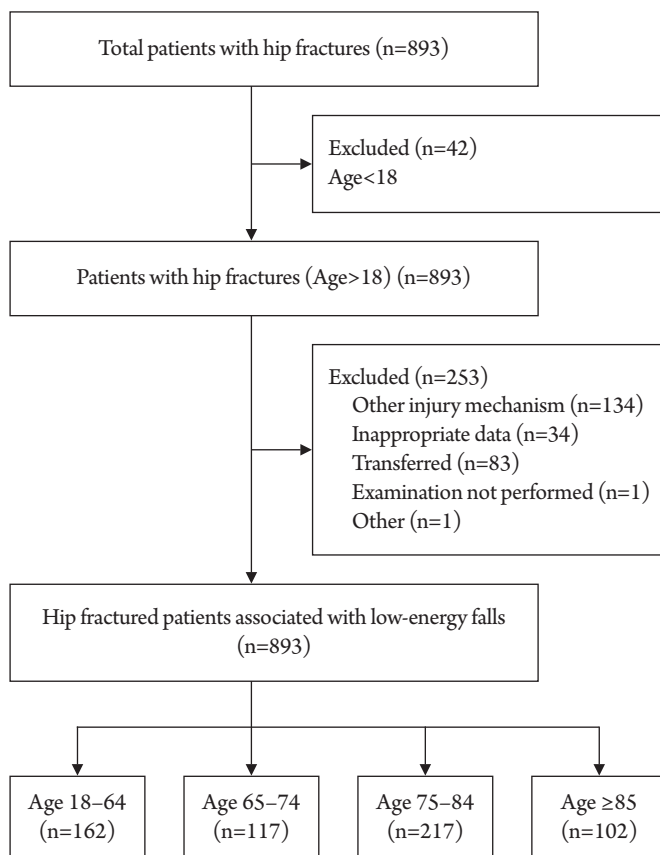


Fig. 1. Diagram of patients categories.

proportion was significantly higher in older patients than in non-older patients (4.7% vs. 95.3%, $p < 0.001$). Additionally, the incidence of femur intertrochanteric fractures in the middle-old to oldest-old patients was significantly higher than in the non-older adults (92% vs. 8%, $p < 0.001$; 88.3% vs. 11.7%, $p < 0.001$), but no significant difference was observed between the young-old patients and the non-older adult patients (58.8% vs. 41.2%, $p = 0.145$). There was no significant difference in the frequency of femoral neck fracture and femoral subtrochanteric fracture (Table 1).

Of the 117 young-old patients, 48 (14%) were men and 69 (59%) were women; of the 217 middle-old patients, 57 (26.3%) were men and 160 (73.7%) were women; of the 102 oldest-old patients, 21 (20.6%) were men and 81 (79.4%) were women. The differences in sex ratios between the three patient groups were statistically significant ($p = 0.002$). The frequency of drinking alcohol was higher in the middle-old patients than in the young-old and oldest-old patients but it was not statistically significant ($p = 0.392$). Among the underlying diseases surveyed, the frequencies of stroke (21.4% vs. 23.5% vs. 21.6%, $p = 0.877$) was higher in the middle-old patients, while those of dementia (0.9% vs. 5.1% vs. 14.4%, $p < 0.001$) and osteoporosis (29.9% vs. 43.8% vs. 70.6%, $p < 0.001$) were higher in the oldest-old patients and the frequencies of Parkinson disease (6.8% vs. 4.6% vs. 4.9%, $p = 0.673$) and cancer (7.7% vs. 3.7% vs. 2.9%, $p = 0.164$) were higher in the young-old than the middle-old to oldest-old patients but only the frequencies of dementia and osteoporosis were statistically significant. The time of accident was trended higher for each group between 12:00 and 17:59 but was not statistically significant ($p = 0.114$). The frequencies of intertrochanteric fractures were significantly higher in middle-old and oldest-old patients than that in young-old patients (8.5% vs. 36.9% vs. 52.0%, $p < 0.001$) and, while Tronzo type 3 was tend to be higher in middle and oldest-old patient groups, the difference was not statistically significant ($p = 0.907$). The frequency of unfavorable outcomes was trended higher in the middle and oldest-old patients but was also not statistically significant (0% vs. 1.4% vs. 2.9%, $p = 0.238$) (Table 2).

Investigation of the relationship between femoral intertrochanteric fractures in older patients revealed that age > 75 years, sex, and osteoporosis were statistically significant ($p < 0.001$, $p = 0.020$, $p < 0.001$), while other underlying conditions such as time of accident, drinking alcohol at the time of accident, stroke, dementia, Parkinson disease, and cancer were not. No significant associations were observed between femoral neck and femoral subtrochanteric fractures (Table 3).

A binary logistic regression of the factors that showed statistically significant differences in the single-variable analysis of the relationship between femoral intertrochanteric fractures in the older

Table 1. Comparisons of incidence frequencies of femoral intertrochanteric fractures according to age group

	Intertrochanteric fracture (n = 150)	Non-intertrochanteric fracture				p-value [†]
		Total (n = 448)	FNF (n = 130)	STF (n = 15)	Others* (n = 303)	
Comparison 1						< 0.001
Non-older adults (A)	7 (4.7)	155 (34.6)	13 (10.0)	5 (33.3)	137 (45.1)	
Older adults (B)	143 (95.3)	293 (65.4)	117 (90.0)	10 (66.7)	166 (54.9)	
Comparison 2						0.145
Non-older adults (A)	7 (41.2)	155 (59.2)	13 (26.5)	5 (55.6)	137 (67.8)	
Young-old (B1)	10 (58.8)	107 (40.8)	36 (73.5)	4 (44.4)	65 (32.2)	
Comparison 3						< 0.001
Non-older adults (A)	7 (8.0)	155 (53.1)	13 (19.4)	5 (45.5)	137 (63.1)	
Middle-old (B2)	80 (92.0)	137 (46.9)	54 (80.6)	6 (54.5)	80 (36.9)	
Comparison 4						< 0.001
Non-older adults (A)	7 (11.7)	155 (76.0)	13 (32.5)	5 (100)	137 (86.2)	
Oldest-old (B3)	53 (88.3)	49 (24.0)	27 (67.5)	0 (0.0)	22 (13.8)	
Comparison 5						< 0.001
Young-old (B1)	10 (11.1)	107 (43.9)	36 (40.0)	4 (40.0)	65 (44.8)	
Middle-old (B2)	80 (88.9)	137 (56.1)	54 (60.0)	6 (60.0)	80 (55.2)	
Comparison 6						< 0.001
Young-old (B1)	10 (15.9)	107 (68.6)	36 (57.1)	4 (100)	65 (74.7)	
Oldest-old (B3)	53 (84.1)	49 (31.4)	27 (42.9)	0 (0.0)	22 (25.3)	
Comparison 7						0.008
Middle-old (B2)	80 (60.2)	137 (73.7)	54 (66.7)	6 (100)	80 (78.4)	
Oldest-old (B3)	53 (39.8)	49 (48.0)	27 (33.3)	0 (0.0)	22 (21.6)	

Values are presented as number (%).

Patients were divided into two main group: 18–64 years (group A; non-older adults, n=7) and ≥65 years (group B; older adults, n=143). Group B was again subdivided into three subgroups: 65–74 years (group B1; young-old, n=10), 75–84 years (group B2; middle-old, n=80), and ≥85 years (group B3; oldest-old, n=53).

FNF, femoral neck fracture; STF, subtrochanteric fracture.

*Others included femoral greater trochanteric fractures, femoral shaft fractures, and distal femoral fractures.

[†]By chi-square and Fisher exact tests, respectively.

patient group showed that age > 75 years and osteoporosis were statistically significant ($p < 0.001$; $p = 0.004$). The odds ratio of femur intertrochanteric fractures among older patients was 6.620 times (95% confidence interval [CI], 3.309–13.245) higher for those aged > 75 years and 1.906 times (95% CI, 1.231–2.949) higher in those with osteoporosis (Table 4).

DISCUSSION

The prevalence and mortality rates of trauma are higher among older adults than those among younger adults^{26,27} due to the decreased ability of older adults to cope with aging processes such as reduced visual acuity, hearing loss, physical disability, drug use, baseline disease, and cognitive impairment.^{28,29} These characteristics differ in their clinical patterns from trauma between older and younger adults. Therefore, the actual severity of the trauma tends to be underestimated at an earlier stage.³⁰ Moreover, older patients more often require long-term and complicated in-patient treat-

ment processes, which has led to increased interest and study of older adults in trauma fields.³¹

In the United States, about 340,000 femoral fractures are reported annually.³² Femoral fractures, the most common major fracture among older adults, are also the most common causes of hospitalization in older trauma patients.⁴ The mechanism of fracture is falling from a standing height. In particular, the reason for the high frequency in older adults is related to reduced femoral bone strength with increasing age.⁴

With the increase in the average life expectancy, the older population has increased and their quality of life has improved due to social and economic development in this population. The older adult population consists of different age groups, from relatively healthy 65-year-olds to older adults > 85 years of age who have difficulty moving; therefore, it is difficult to classify them as a single group.³³ Therefore, viewing all older persons aged > 65 years using the same standards may be inappropriate and establishing a finer-scale classification is necessary. Young-old persons are rela-

Table 2. Comparisons of characteristics between the young-old, middle-old, and oldest-old age groups

	Young-old (65–74 y)	Middle-old (75–84 y)	Oldest-old (≥ 85 y)	p-value*
Number of patients	117	217	102	
Sex				0.002
Male	48 (41.0)	57 (26.3)	21 (20.6)	
Female	69 (59.0)	160 (73.7)	81 (79.4)	
Drunken state	2 (1.7)	4 (1.9)	0 (0.0)	0.392
Underlying disease				
Cerebrovascular accident	25 (21.4)	51 (23.5)	22 (21.6)	0.877
Dementia	1 (0.9)	11 (5.1)	15 (14.4)	<0.001
Osteoporosis	35 (29.9)	95 (43.8)	72 (70.6)	<0.001
Parkinson's disease	8 (6.8)	10 (4.6)	5 (4.9)	0.673
Malignancy	9 (7.7)	8 (3.7)	3 (2.9)	0.164
Accident time				0.114
0:00–5:59	6 (5.1)	25 (11.5)	15 (14.7)	
6:00–11:59	29 (24.8)	69 (31.8)	31 (30.4)	
12:00–17:59	51 (43.6)	78 (35.9)	32 (31.4)	
18:00–23:59	31 (26.5)	45 (20.7)	24 (23.5)	
Intertrochanteric fracture	10 (8.5)	80 (36.9)	53 (52.0)	<0.001
Subtype (Tronzo classification)				0.907
Type 1	2 (20.0)	7 (8.8)	8 (15.1)	
Type 2	1 (10.0)	12 (15.0)	9 (17.0)	
Type 3	3 (30.0)	36 (45.0)	20 (37.7)	
Type 4	4 (40.0)	23 (28.7)	15 (28.3)	
Type 5	0 (0)	2 (2.5)	1 (1.9)	
Unfavorable outcome†	0 (0)	3 (1.4)	3 (2.9)	0.238

Values are presented as number (%).

*By chi-square and Fisher exact tests, respectively.

†Unfavorable outcome indicates cases of transfer or death due to complications.

tively healthy and active. They often enjoy continuous self-development and active leisure as they did when they were younger. In contrast, older adults > 75 years of age are more likely to experience fatal diseases and often have a combination of geriatric diseases such as heart disease, hypertension, diabetes, cancer, and osteoporosis. These geriatric diseases are chronic degenerative diseases that require long-term treatment and increased medical resource utilization and medical costs.^{34,35} The middle-old to oldest-old individuals experience fewer activities of daily living compared to those in young-old individuals.³⁶ Moreover, chronic disease morbidity significantly increases, which results in a variety of dysfunction, loss of function, and pathological changes.³⁷ Several studies have reported a significant increase in complications and mortality from various trauma in middle-old patients aged 75 years.^{38–40} Additionally, the common risk factors for minor falls, such as weakness of balance or strength,⁴¹ increase in the middle-old and oldest-old individuals.³⁷ Hence, these populations are more vulnerable to minor falls compared to the other age groups. Hip injuries due to minor falls in older adults are the most common injuries.⁴²

In particular, femur intertrochanteric fractures have the highest mortality rate among all femoral fractures⁴³ and have emerged as an important study in the area of trauma for in older adults. However, few studies have subdivided older adults with minor fall injury according to age. Specifically, no study has assessed the incidence of femoral intertrochanteric fractures due to minor falls among middle and oldest-old patients.

Compared to young-old individuals, middle and oldest-old individuals are expected to have more severe hip impact and damage from fall injuries. In our study, the incidence of femur intertrochanteric fractures did not vary significantly between young-old and non-old individuals; however, the incidence of femur intertrochanteric fractures was approximately 13 times higher in the middle-old and oldest-old individuals than that in young-old individuals. This result is significant because it differs from those of previous studies that showed an increased frequency of femoral intertrochanteric fractures in individuals aged 65 years.^{12,25,44}

Additionally, as age and underlying disease increase, bone mineral density decreases significantly, making patients more vulnera-

Table 3. Clinical variables related to the development of femoral intertrochanteric fractures from minor falls in older patients

	Intertrochanteric fracture (n = 143)	Non-intertrochanteric fracture				p-value [†]
		Total (n = 293)	FNF (n = 117)	STF (n = 10)	Others* (n = 166)	
Age						< 0.001
Young-old (65–74 y)	10 (7.0)	107 (36.5)	36 (30.8)	4 (40.0)	65 (38.9)	
Middle-old (75–84 y)	80 (55.9)	137 (46.8)	54 (46.2)	6 (60.0)	80 (47.9)	
Oldest-old (≥ 85 y)	53 (37.1)	49 (16.7)	27 (23.1)	0 (0)	22 (13.2)	
Sex						0.020
Male	31 (21.7)	95 (32.4)	32 (27.4)	3 (30.0)	58 (34.7)	
Female	112 (78.3)	198 (67.6)	85 (72.6)	7 (70.0)	108 (65.3)	
Drunken state	0 (0)	6 (2.0)	2 (1.7)	0 (0)	4 (2.4)	0.086
Accident time						0.751
0:00–5:59	17 (11.9)	29 (9.9)	10 (8.5)	2 (20.0)	16 (9.6)	
6:00–11:59	42 (29.4)	88 (30.0)	40 (34.2)	1 (10.0)	49 (29.3)	
12:00–17:59	55 (38.5)	105 (35.8)	45 (38.5)	4 (40.0)	56 (33.5)	
18:00–23:59	29 (20.3)	71 (24.2)	22 (18.8)	3 (30.0)	45 (27.5)	
Underlying disease						
Cerebrovascular accident	31 (21.7)	67 (22.9)	31 (26.5)	3 (30.0)	33 (19.8)	0.780
Dementia	8 (5.6)	19 (6.5)	10 (8.5)	0 (0)	9 (5.4)	0.717
Osteoporosis	87 (60.8)	115 (39.2)	63 (53.8)	5 (50.0)	63 (37.7)	< 0.001
Parkinson disease	7 (4.9)	16 (5.5)	6 (5.1)	0 (0)	10 (6.0)	0.804
Malignancy	6 (4.2)	14 (4.8)	2 (1.7)	2 (20.0)	10 (6.0)	0.785

Values are presented as number (%).

FNF, femoral neck fracture; STF, subtrochanteric fracture.

*Others included femoral greater trochanteric fractures, femoral shaft fractures, and distal femoral fractures.

[†]By chi-square and Fisher exact tests, respectively.

Table 4. Risk factors related to the development of femoral intertrochanteric fractures from minor falls in older patients by multivariate logistic regression analysis

	OR	95% CI		p-value*
		Low	High	
Gender	1.233	0.743	2.047	0.417
Middle and oldest-old	6.620	3.309	13.245	< 0.001
Middle-old (75–84 y)	6.248	3.089	12.637	< 0.001
Oldest-old (≥ 85 y)	11.573	5.436	24.639	< 0.001
Osteoporosis	1.906	1.231	2.949	0.004

OR, odds ratio; CI, confidence interval.

*p<0.05 in multivariate analysis were entered into the binary logistic regression analysis.

ble to fractures.⁴⁵⁾ In particular, studies have shown that a decrease in bone density exponentially increases the incidence of intertrochanteric fractures.⁴⁶⁾ Our study also showed that osteoporosis increases the incidence of femoral intertrochanteric fractures by approximately 1.9-fold, a finding consistent with those of previous studies.

According to the World Health Organization, the number of patients with hip fractures is expected to significantly increase from 1.7 million in 1990 to 6.3 million in 2050;⁴⁷⁾ furthermore, the frequency of femoral intertrochanteric fractures in Korea is also in-

creasing.⁴⁸⁾ Although the number of patients visiting the emergency center due to hip injuries is increasing, it is difficult to diagnose all intertrochanteric fractures using a plain radiograph alone because emergency centers are pressed for time in the field. Additionally, the accident mechanism is an important factor in predicting the severity of trauma in patients; hip injuries caused by minor falls are more frequent and may seem relatively more minor than other severe traumas. Therefore, intertrochanteric fractures are often ruled out if a fracture line is not visible on simple radiographs. Additionally, while hip CT is often considered in cases in which

diagnosis is difficult using radiography, patients may not want to be examined because of the relatively high cost of CT scans.

In our study, the incidence of femoral intertrochanteric fractures caused by minor fall injuries in the middle-old and oldest-old patients was higher than that in young-old patients. Therefore, the imaging results of middle-old and oldest-old patients should be carefully read even if the patients do not complain of pain. If necessary, hip CT should also be performed. Moreover, increased attention should be paid to middle-old and oldest-old patients with stroke or dementia than to young-old patients.

The limitation of this study was that it was conducted in a single emergency center located in a metropolitan urban area where people with relatively good nutrition or high socioeconomic status were more likely to reside; thus, there may be bias in the patient distribution or propensity. Additional multicenter studies including local emergency centers will provide more accurate results on the incidence of femoral intertrochanteric fractures according to age groups of older patients.

CONFLICT OF INTEREST DISCLOSURES

The researchers claim no conflicts of interest.

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