

Original Article

Characteristics of patients with hip fractures and comorbid fall-related injuries in the emergency department

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Aim: Hip fracture is one of the most common fall-related injuries in the elderly population. Although falls may cause multiple types of injuries, no study has investigated the details of fall-related injuries accompanied by hip fractures. This study aimed to characterize the features of such injuries.

Methods: This is a cross-sectional study using data from four tertiary emergency departments in Japan. We identified patients diagnosed with hip fracture including femoral neck fracture, trochanter fracture, or subtrochanteric fracture from May 12, 2014 to July 12, 2021. Among patients with hip fracture, we included those with fall-related hip fracture. We excluded patients ages <40 years old and whose fall was high energy onset, defined as fall from more than three steps or 1 m.

Results: Among 326 emergency departments patients diagnosed with fall-related hip fracture, 288 patients were eligible for the analysis. Seventeen patients (6%) had injuries in addition to hip fractures. The most frequent injury was upper limb injury (e.g., distal radial fracture; n = 5, 30%), followed by head injury (e.g., subdural hematoma; n = 4, 24%), chest injury (e.g., pneumothorax; n = 2, 12%), and trunk injury (vertebral compression fracture; n = 2, 12%). There were no significantly different clinical characteristics between patients with hip injuries and those without.

Conclusion: A total of 6% of patients diagnosed with hip fracture had other fall-related injuries. The most frequent were upper limb injury and head injury. Our findings underscore the importance of whole-body assessment in patients with fall-related hip fracture in the emergency department.

Key words: Elderly population, emergency department, fall, hip fracture, injury

INTRODUCTION

HIP FRACTURE IS one of the most common fall-related injuries with the estimated annual incidence of 1.31 million, and the prevalence of consequent disability was 4.48 million in the world.¹ Hip fracture is common in the elderly population, which is expected to increase to 1.4 billion in 2030 and to 2.1 billion by 2050.² As a result, the

annual incidence of hip fracture is estimated to increase to 4.5 million by 2050.³ Therefore, fall-related hip fractures is an important issue worldwide.

Hip fracture is not only frequent in the elderly, but also in female, osteoporosis, sarcopenia, cognitive decline, and institutionalized patients.^{4,5} These conditions are also risk factors for other injuries and fractures,⁶ suggesting that patients who visit the emergency department (ED) for fall-related hip fractures may also have other fall-related injuries.⁷ It was reported that the comorbid head injury with hip fracture was associated with a significantly higher mortality rate than hip fracture alone.⁸ Therefore, it is important to know other injuries accompanying a hip fracture.

To find such comorbid injuries, whole-body survey is important. It is often difficult to obtain medical histories because elderly patients with impaired cognitive status

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cannot complain of their symptoms and injury mechanisms clearly.⁹ Furthermore, apparent hip fracture sign may lead to a wrong medical prejudice with insufficient physical examination.¹⁰ However, whole-body survey is not always conducted in trauma including hip fracture. Even in trauma centers, it was conducted only in 65% of patients.¹¹

To our knowledge, no previous studies have investigated the frequency of fall-related injuries accompanied with hip fractures in the ED. It is important to know the epidemiological data because neglecting comorbid fall-related injuries with hip fracture results in delayed treatment and worse outcomes. We aimed to provide epidemiological data of fall-related injuries accompanied with hip fractures in the ED.

METHODS

Study design

THIS IS A cross-sectional study using data at the ED of Hitachi General Hospital (Ibaraki, Japan) between May 12, 2014 and October 11, 2020, Saiseikai Utsunomiya Hospital (Tochigi, Japan) between April 1, 2020 and May 18, 2021, Japanese Red Cross Society Kyoto Daiichi Hospital (Kyoto, Japan) between April 1, 2014 and June 11, 2021, and Kakogawa Central City Hospital (Kakogawa, Japan) between April 1, 2020 and July 12, 2021. Because we extracted data from the NEXT Stage ER system (an emergency department information system by TXP Medical Tokyo, Japan), there was variation in the period of data collection because of the dates of the system's implementation. The institutional review board of each participating hospital approved this study, and the requirement for informed consent was waived because the data was anonymized.

Data collection

We extracted the following clinical data: age, sex, route of presentation to the hospital (walk-in, ambulance, or physician staffed ambulance), chief complaint, medical history, physical examination, and physician's diagnosis, which was made on admission or discharge using the Next Stage ER system.¹² The Next Stage ER system can extract clinical data from electronic medical records and translate to existing categories through natural language processing algorithms. The details of the system have been previously described.¹³ This system can accurately extract clinical data and has been validated for use in clinical research.¹³⁻¹⁵ Anonymized patient information was extracted from the electronic medical records of each hospital. Among collected data, the following data were used for this research: age, sex, route of

presentation to the hospital (walk-in or ambulance), comorbidities, medications, type of hip fracture, and accompanied injuries based on the International Classification of Disease, Tenth Revision (ICD-10) codes. Comorbid injuries were counted in duplicate when the patients have multiple injuries. Therefore, the total number of comorbid injuries was presented regardless the number of patients.

Patient selection criteria and definition

We identified patients diagnosed with hip fracture who had comorbid fractures including femoral neck fracture, trochanter fracture, and subtrochanteric fracture. These diagnoses were based on ICD-10 codes S72.0X (femoral neck fractures), S72.1X (trochanter fracture), and S72.2X (subtrochanteric fracture). We further identified fall-related hip fracture from their medical records. To exclude atypical fall-related hip fractures (i.e., endogenous or secondary to high energy trauma), the exclusion criteria were patients ages <40 years old and whose fall was high energy onset defined as more than a fall from more than three steps or 1 meter, based on the definition of fragility fracture.^{16,17} Comorbid injuries were also diagnosed using ICD-10 codes.

Statistical analysis

Continuous data was expressed as medians (interquartile range) and were compared using the Mann-Whitney *U* test. Categorical data was expressed as frequency (%) and were compared using a χ^2 test or Fisher's exact test. We used R statistical software (version 4.1.0; R Foundation for Statistical Computing, Vienna, Austria) for all analyses.

RESULTS

A TOTAL OF 106,477 patients visited the EDs of the participating hospitals during the study period (Fig. 1). Among these patients, 456 patients were diagnosed with hip fracture, and 326 patients were diagnosed with fall-related hip fracture. We excluded 38 patients who were younger than 40 years old (four patients) or had high energy onset (34 patients), and the remaining 288 patients were eligible for the analysis (Fig. 1).

The median age of the patients was 84 (interquartile range, 77-89) years, 197 (68%) patients were women, and 264 (92%) were transported by ambulance (Table 1). The most frequent comorbidities were hypertension (43%), diabetes (20%), dementia (13%), and osteoporosis (3%). The medications most frequently used were anticoagulants (26%), benzodiazepine (13%), and corticosteroids (5%). Forty-four patients were on more than four drugs. There

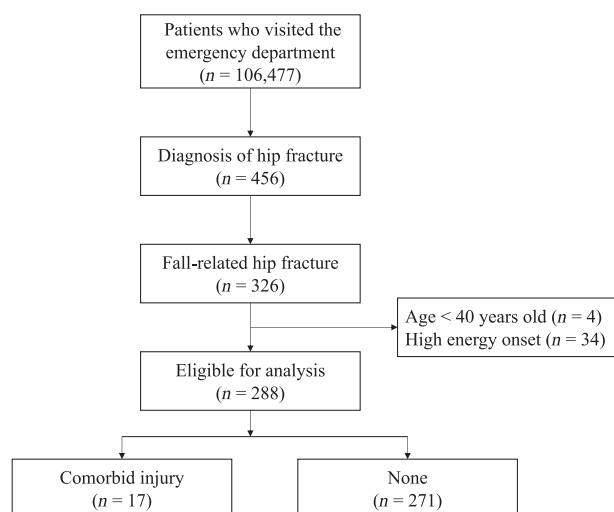


Fig. 1. Patient selection procedure.

Table 1. Clinical characteristics of hip fracture and comorbid fall-related injuries

	Patients with hip fracture (n = 288)	Presence of comorbid fall-related injuries		
		Yes (n = 17)	No (n = 271)	P value
Age, y (median [IQR])	84 (77–89)	87 (81–90)	84 (76–89)	0.12
Women	197 (68)	14 (82)	184 (68)	0.21
Transported by ambulance	264 (92)	17 (100)	264 (97)	0.20
Comorbidities				
Hypertension	125 (43)	9 (53)	116 (43)	0.41
Diabetes	60 (20)	4 (24%)	56 (21)	0.78
Dementia	37 (13)	2 (12)	35 (13%)	0.89
Osteoporosis	8 (3)	0 (0)	8 (3)	0.47
Medications				
Anticoagulants	75 (26)	5 (30)	70 (26)	0.74
Benzodiazepine	38 (13)	4 (24)	34 (13)	0.19
Corticosteroids	14 (5)	0 (0%)	14 (5)	0.34
On more than 4 medications per day	127 (44)	6 (35)	121 (43)	0.45
Type of hip fracture				
Femoral neck fracture	277 (96)	16 (94)	263 (97)	0.42
Trochanteric fracture	91 (32)	5 (29)	86 (32)	0.84

Data were presented as n (%) unless indicated otherwise. IQR, interquartile range.

Table 2. Comorbid fall-related injuries accompanied by hip fracture

	Details of comorbid injury	Overall (n = 17)
Head	Subdural hematoma, pneumocephalus, zygomatic bone fracture, head bruise	4 (24)
Chest	Clavicle fracture, pneumothorax	2 (12)
Trunk	Vertebral compression fracture	2 (12)
Pelvis	Pelvic fracture	1 (6)
Upper limb	Distal radial fracture (n = 3), humerus fracture (n = 2), bruise	6 (35)
Lower limb	Phalanx fracture	1 (6)
Others	Whole body bruise	3 (18)

Data were presented as n (%).

Comorbid injuries were observed at 19 sites in 17 patients.

were no significant differences in age, female, comorbidities, medications, and types of hip fractures between patients with and without comorbid fall-related injuries. The most frequent type of femoral fracture was femoral neck fracture (277/288, 96%), followed by trochanter fracture (91/288, 32%), including multiple fractures. There were no patients diagnosed with subtrochanteric fracture.

Hip fractures with comorbid fall-related injuries were observed in 17 patients (6%). The most frequent injury was upper limb injury (n = 6, 35%), followed by head injury (n = 4, 24%). Other injuries were whole body bruise (n = 3, 18%), chest (n = 2, 12%), trunk (n = 2, 12%), pelvis (n = 1, 6%), and lower limb injury (n = 1, 6%). Of upper limb injuries, three were distal radial fractures, two were humerus fractures and one was a bruise (Table 2). Head injuries included subdural hematoma, pneumocephalus, zygomatic bone fractures, and head bruises. Other injuries included clavicle fracture, pneumothorax, vertebral compression fracture, pelvic fracture, and phalanx fracture.

DISCUSSION

IN THIS STUDY using data from four EDs of tertiary care hospitals, 6% of patients with all-related hip fractures had comorbid injuries. Among these, upper limb and head injuries were the two major comorbid injuries. Because there were no specific clinical characteristics in patients with comorbid injury, it is important to look thoroughly for other injuries in patients with hip fracture.

The most frequent site of comorbid injury was the upper limb, which plays the important role of preventing critical injuries secondary to falls. It is reasonable to assume that

patients tend to have comorbid upper limb injuries with fall-related hip fractures because upper limb reacts first when a patient falls. Because the defense reaction is unintentional and the pain of hip fracture is tremendous, even patients may not be aware of upper limb injuries. Head injury was the next frequently observed comorbid injury. Misdiagnosis of serious head injuries could be critical to patients' prognoses. Indeed, in our study, comorbid subdural hematoma was observed with hip fracture.

This study suggests that careful, systematic examination of patients with fall-related hip fractures may be needed to properly assess comorbid injuries in the ED. The systematic examination is a head-to-bottom examination based on the anatomical physical examination as the tertiary survey, and it is important to examine all parts of the body, even those that may not be related to the injury. Because this study investigated the characteristics of comorbid injury and not overlooked injury, this study data did not include missed injuries. Therefore, this study may have underestimated the possible risk of missed injuries. According to a previous epidemiological study, up to 38% of injuries were missed among trauma patients in intensive care units.¹⁸ Therefore, our findings should facilitate whole body trauma survey in fall-related hip fracture. Previous evidence suggests that whole body examinations are highly effective in reducing missed injuries. For instance, a meta-analysis showed that the addition of tertiary surveys to secondary surveys significantly reduced missed injuries in trauma patients (odds ratio, 0.63, 95% confidence interval [CI], 0.44–0.90).¹⁹ In our study, some patients required early medical intervention, such as those with subdural hematoma and pneumothorax. Treatment delay may lead to severe complications. Therefore, the identification of comorbid injury in patients with hip fractures in the ED is essential.

In our study, comorbid injuries were more likely to be found in women (among patients with accompanied injury, women accounted for 82%), suggesting that female sex may be correlated with comorbid fall-related injuries in patients with hip fractures. This may be because frailty is common in the elderly female population, which may lead to more fall-related injuries.²⁰ Harmsen *et al.*²¹ also reported that older age and female sex are risk factors for fall-related injuries. Because this is a small exploratory study, larger studies are needed to further explore the identified candidate risk factors of comorbid fall-related injuries with hip fractures.

There are several limitations to this study. First, although this study used data from four tertiary care hospitals, the sample size was limited, especially patients who had comorbid injuries. Second, we only identified comorbid injuries among hip fractures because the data set of this study did not allow for sufficient discussion of diagnostic delays and

did not identify missed comorbid injuries, therefore, the true frequency of missed comorbid injuries is unknown.

CONCLUSION

SEVENTEEN PATIENTS (6%) with hip fracture had other fall-related injuries. The frequent sites of comorbid injuries were the upper limb and head. A thorough assessment of the whole body may be beneficial in preventing missed diagnoses of comorbid injuries in patients with hip fracture.

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DISCLOSURE

APPROVAL OF THE research protocol: This study was approved by the institutional review board of each participating hospital.

Informed Consent: The requirement of written informed consent was waived.

Registry and the Registration no. of the study/trial: Not applicable.

Animal studies: Not applicable.

Conflict of Interest: Tadahiro Goto is the Chief Scientific Officer and Tomohiro Sonoo is the Chief Executive Officer of TXP Medical Liu Keibun received payments from TXP Medical and Senko Medical Instrument Mfg.

REFERENCES

- 1 Johnell O, Kanis JA. An estimate of the worldwide prevalence, mortality and disability associated with hip fracture. *Osteoporos. Int.* 2004; 15: 897–902.
- 2 Duault LA, Brown L, Fried L. The elderly: an invisible population in humanitarian aid. *Lancet Public Health* 2018; 3: e14.
- 3 Gullberg B, Johnell O, Kanis JA. World-wide projections for hip fracture. *Osteoporos. Int.* 1997; 7: 407–13.
- 4 Avola M, Mangano GRA, Testa G *et al.* Rehabilitation strategies for patients with femoral neck fractures in sarcopenia: a narrative review. *J. Clin. Med.* 2020; 9: 1–16.
- 5 Filipov O. Epidemiology and social burden of the femoral neck fractures. *J. IMAB.* 2014; 20: 516–8.

- 6 Yeung SSY, Reijnierse EM, Pham VK *et al.* Sarcopenia and its association with falls and fractures in older adults: A systematic review and meta-analysis. *J. Cachexia. Sarcopenia Muscle* 2019; 10: 485–500.
- 7 Verma SK, Willetts JL, Corns HL, Marucci-Wellman HR, Lombardi DA, Courtney TK. Falls and fall-related injuries among community-dwelling adults in the United States. *PLoS One* 2016; 11: 1–14.
- 8 Albrecht JS, Al Kibria G, Gruber-Baldini A, Magaziner J. Risk of mortality in individuals with hip fracture and traumatic brain injury. *J. Am. Geriatr. Soc.* 2019; 67: 124–7.
- 9 Riad K, Webber C, Batista R *et al.* The impact of dementia and language on hospitalizations: a retrospective cohort of long-term care residents. *BMC Geriatr.* 2020; 20: 397.
- 10 Mamede S, Schmidt HG, Rikers R. Diagnostic errors and reflective practice in medicine. *J. Eval. Clin. Pract.* 2007; 13: 138–45.
- 11 Mitchell BP, Stumpff K, Berry S, Howard J, Bennett A, Winfield RD. The impact of the tertiary survey in an established trauma program. *Am. Surg.* 2021; 87: 437–42.
- 12 Goto T, Hara K, Hashimoto K *et al.* Validation of chief complaints, medical history, medications, and physician diagnoses structured with an integrated emergency department information system in Japan: the Next Stage ER system. *Acute Med. Surg.* 2020; 7: 1–8.
- 13 Osawa I, Sonoo T, Soeno S, Hara K, Nakamura K, Goto T. Clinical performance of early warning scoring systems for identifying sepsis among anti-hypertensive agent users. *Am. J. Emerg. Med.* 2021; 48: 120–7.
- 14 Soeno S, Hara K, Fujimori R *et al.* Initial assessment in emergency departments by chief complaint and respiratory rate. *J. Gen. Fam. Med.* 2021; 22: 202–8.
- 15 Shibata J, Osawa I, Ito H *et al.* Risk factors of sepsis among patients with qSOFA < 2 in the emergency department. *Am. J. Emerg. Med.* 2021; 50: 699–706.
- 16 Kanis JA, Oden A, Johnell O, Jonsson B, de Laet C, Dawson A. The burden of osteoporotic fractures: a method for setting intervention thresholds. *Osteoporos. Int.* 2001; 12: 417–27.
- 17 Zerbini CA, Szejnfeld VL, Abergaria BH, McCloskey EV, Johansson H, Kanis JA. Incidence of hip fracture in Brazil and the development of a FRAX model. *Arch. Osteoporos.* 2015; 10: 224.
- 18 Thomson CB, Greaves I. Missed injury and the tertiary trauma survey. *Injury* 2008; 39: 107–14.
- 19 Hajibandeh S, Idehen N. Meta-analysis of the effect of tertiary survey on missed injury rate in trauma patients. *Injury* 2015; 46: 2474–82.
- 20 Hubbard RE, Rockwood K. Frailty in older women. *Maturitas* 2011; 69: 203–7.
- 21 Harmsen AM, Egea-Gómez RM, Garssen FP, Van Dulken E, Toor A, Bloemers FW. Fall-related injuries in Amsterdam: Frail older women at risk. *J. Women Aging* 2016; 28: 489–97.