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Research Article/Özgün Araştırma

The relationship between fracture type and time of trauma in elderly patients admitted to the emergency department with proximal femur fracture after a fall

Düşme sonrası proksimal femur kırığı ile acil servise başvuran yaşlı hastalarda kırık tipi ve travma oluş zamanı arasındaki ilişki

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Abstract

Aim: To investigate whether the time of day affects the type of fall-related hip fracture.

Materials and Methods: This retrospective study included patients diagnosed with hip fracture due to falls between 2012 and 2022. Fracture times were categorized as daytime (09:00–16:59) and nighttime (17:00–08:59). Patients were grouped accordingly, and demographic and radiological data were analyzed to assess differences in fracture types between groups.

Results: Among 935 patients, intracapsular fractures were more common during the day, while extracapsular fractures were more common at night ($p=0.003$). Intracapsular fractures peaked at 13:00; extracapsular at 11:00.

Conclusion: Hip fractures occurred most frequently during the day, especially at noon. Intracapsular fractures were significantly more common in daytime, extracapsular at night.

Keywords: Hip fracture; Time to fall; Daytime; Nighttime; Intracapsular; Extracapsular.

Öz

Amaç: Günün saatinin düşmeye bağlı kalça kırığı tipini etkileyip etkilemediğini araştırmak.

Gereç ve Yöntem: Bu retrospektif çalışmaya, 2012–2022 yılları arasında düşme nedeniyle kalça kırığı tanısı alan hastalar dahil edildi. Kırık oluş zamanı gündüz (09:00–16:59) ve gece (17:00–08:59) olarak ikiye ayrıldı. Hastalar bu zaman dilimlerine göre gruplandırıldı ve gruplar arası kırık tipi farklarını değerlendirmek amacıyla demografik ve radyolojik veriler analiz edildi.

Bulgular: Toplam 935 hasta çalışmaya dahil edildi. Gündüz saatlerinde daha sık intrakapsüler kırıklar, gece saatlerinde ise daha sık ekstrakapsüler kırıklar görüldü ($p=0.003$). İntrakapsüler kırıklar en sık 13:00 civarında, ekstrakapsüler kırıklar ise 11:00 civarında meydana geldi.

Sonuç: Kalça kırıkları en sık gündüz saatlerinde, özellikle öğle saatlerinde meydana geldi. İntrakapsüler kırıklar gündüz, ekstrakapsüler kırıklar ise gece saatlerinde anlamlı olarak daha sık görüldü.

Anahtar Kelimeler: Kalça kırığı; Düşme zamanı, Gündüz; Gece, İntrakapsüler; Ekstrakapsüler.

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Bu makale araştırma ve yayım etiğine uygun hazırlanmıştır.



intihal incelemesinden geçirilmiştir.



Introduction

Falls are a significant problem that can have negative consequences in every age group and cause more serious problems, especially in the geriatric age group.¹⁻³ Falls can cause a significant loss of functionality in elderly individuals and negatively affect more than one aspect of life.¹

Fractures that occur due to falls are important causes of morbidity and mortality in elderly individuals.^{4,5} The most common orthopedic trauma in these patients is hip fractures, which seriously affect morbidity and mortality.⁶ Studies have shown that the mortality rate in patients who have suffered a hip fracture is high, ranging between 33% and 45% within the first two years.⁷ It is estimated that these fractures, which cause high costs and difficult psychological rehabilitation, affect 18% of women and 6% of men throughout life.⁸

Due to the increase in life expectancy at the global level, projections expect serious increases in the incidence of hip fractures.^{9,10} Many studies are being conducted on these fractures, which are expected to be seen more frequently in the health sector in the coming years.^{4,11,12} These studies aim to reduce the incidence of fractures by determining risk factors. Studies have shown many internal and external factors.¹³ While external factors are balance and slipping and tripping hazards, internal factors are related to the individual's health status and physical structure. While the correction of internal factors requires long-term follow-up, reductions in fracture occurrence can be seen by considering strategies related to external factors.^{14,15} There are very few studies on the timing of falls that cause hip fractures, especially in elderly patients.^{9,16,17} Patients have daily routines that are distributed in time at home. These routines can cause differences in the risk of falling during the day.¹⁶ In studies conducted, the majority of hip fractures occur during the day.¹⁷

Having an idea about when and where hip fractures will occur can seriously affect fall prevention strategies. This study aims to determine the distribution of fall-related hip

fractures in elderly individuals based on different time periods throughout the day. Additionally, the relationship between the type of fracture and the time of the fall has been evaluated, and potential strategies to prevent falls in elderly individuals have been discussed in line with this relationship. Hip fractures are associated with high morbidity and mortality rates, particularly in the elderly population. Therefore, identifying the timing of fracture occurrence is of great importance for developing preventive measures. Our study is expected to contribute to the literature by providing insights into environmental modifications, individual precautions, and health policy developments aimed at reducing fall risk in elderly individuals.

Materials and Methods

The type of the study

This study was designed as a retrospective cross-sectional study

The samples of the research

Patients who applied to the emergency department of a university hospital due to a fall between January 2012 and December 2022 and were diagnosed with hip fractures were included in the study. When the hospital's digital database was searched between these years, 1135 patients who applied to the emergency department due to hip fractures were identified. Eligible patients included in the study were male and female patients aged ≥ 65 years with intracapsular femoral neck fracture or extracapsular hip fracture (intertrochanteric or subtrochanteric fractures). Additionally, patients with concomitant fractures in other regions along with hip fractures were also included in the study. The reason for including these patients is that falls often result in extensive trauma, leading to multiple fractures, and this inclusion ensures that the study reflects real-life data. Patients with the following criteria were excluded from the study: 1) Patients with incomplete data (patients whose trauma time was not known precisely) ($n=19$), 2) Patients who developed hip fractures other than fall-related causes such as osteoarthritis, infection, tumor metastasis, avascular necrosis of the femoral head ($n=43$), 3) Patients aged <65 years ($n=138$). Two

hundred patients who met the exclusion criteria were excluded from the study. The remaining 935 patients were included in the study. The patients were divided into two groups according to the time of the fall: daytime hours were determined as 09:00-16:59, and those with hip fractures between these hours were divided into Group 1, and nighttime hours were determined as 17:00-08:59, and those with hip fractures between these hours were divided into Group 2. Previous similar studies were considered in this separation of daytime and nighttime hours.^{18,19} In the Turkish healthcare system, regular daytime working hours are generally between 08:00 and 17:00, coinciding with the period when individuals engage in the most daily activities. Nighttime hours have been considered a separate category, as they represent the period when individuals are asleep and household mobility decreases. Similar studies have also categorized daytime and nighttime based on individuals' activity levels and the functioning of the healthcare system. These time intervals were determined to ensure that the results of our study align with the existing literature. The number of patients in Group 1 was 562, and the number in Group 2 was 373.

Data collection tools

In order to perform intergroup analysis, information on the time of the fall, fracture type, age, gender, fracture side, and presence of additional fractures was collected from the hospital digital data recording system. Data scanning was performed on the presence of hypertension, diabetes mellitus, coronary artery disease, cerebrovascular accident, cataract, Alzheimer's disease, chronic obstructive pulmonary disease, asthma, Parkinson's disease, vertigo, heart failure, and chronic renal failure as comorbidities to be examined. The times of the fall that led to the hip fracture of the patients were obtained by interviewing the patients themselves or their families during their admission to the emergency department.

Statistical analysis

SPSS version 25.0 (IBM Corp., Armonk, NY, USA) statistical package program was used

for statistical analyses. While evaluating the study data, descriptive statistical methods (mean, standard deviation, frequency, minimum-maximum, percentage) were used to summarize the data. Shapiro-Wilk Test was used for normality tests of continuous variables. In cases where normality was achieved, the significance of the differences between the means was investigated with a two-group independent sample t-test. In cases where normality was not achieved, the significance of the differences was investigated with Mann-Whitney Tests. Fisher's Exact Test was performed for the independence test between two-group categorical variables. When there were more than two groups of categorical variables, the Chi-Square Independence Test was applied. In order to find the relationships between two continuous variables, Spearman-Rho correlation coefficients were obtained in cases where normality was not achieved. The significance level was taken as 0.05 for all tests performed.

Ethics committee approval

This study was conducted with the necessary approval from the Adiyaman University Non-Interventional Clinical Research Ethics Committee (Ethics committee approval number: 2022/8-7 and date: 15.11.2022). This study was conducted in accordance with the principles of the Declaration of Helsinki. Informed consent form were obtained from all patients.

Results

A total of 935 patients, 517 (55.3%) female and 418 (44.7%) male, with an average age of 81.33 ± 8.08 (65-108 years), were included in the study. Intracapsular hip fracture was observed in 293 (31.3%) patients and extracapsular hip fracture was observed in 642 (68.7%). The relationship between the time of trauma and the variables is given in Table 1. According to the results, among the analyzed variables, only heart failure and the time of trauma were found to be significantly related ($p=0.05$). There was no relationship between the other variables and the time of trauma.

In order to examine the distribution of the fracture type in patients with the time of the

fall, the relationship between the intracapsular and extracapsular hip fracture types and the time of the trauma is given in Figure 1. According to the data obtained, it is seen that intracapsular hip fractures are seen in small numbers starting at night and start to increase towards morning, are seen at the highest rate at noon, and finally decrease in the evening and are seen very rarely again towards midnight. It

is seen that extracapsular hip fractures do not follow a regular course like intracapsular hip fractures. It is understood that they decrease at night and in the morning, like intracapsular hip fractures, but increase during the day. It is seen that intracapsular fractures occur most around 13:00, and extracapsular fractures occur most around 11:00.

Table 1. Characteristic of patients falls in daytime and nighttime.

Variables		Time of Fall		p
		Group 1 (N: 562)	Group 2 (N: 373)	
Age (years)		81,17±7,97	81,58±8,25	0,347 ¹
Gender	Female	311 (%55,3)	206 (%55,2)	0,513 ²
	Male	251 (%44,7)	167 (%44,8)	
Side	Right	288 (%51,4)	193 (%52)	0,893 ²
	Left	272 (%48,6)	178 (%48)	
Additional Fracture	Distal Radius fracture	10 (%1,8)	2 (%0,5)	0,157 ³
	Proximal humerus fracture	7 (%1,2)	3 (%0,8)	
	Clavicle fracture	3 (%0,5)	0	
Hypertension		394 (%70,1)	270 (%72,4)	0,463 ²
Diabetes Mellitus		198 (%35,2)	149 (%39,9)	0,147 ²
Coronary Artery Disease		210 (%37,4)	133 (%35,7)	0,628 ²
Cerebrovascular Disease		86 (%15,3)	69 (%18,5)	0,209 ²
Alzheimer's Disease		57 (%10,1)	32 (%8,6)	0,495 ²
Chronic Obstructive Pulmonary Disease		76 (%13,5)	51 (%13,7)	0,999 ²
Asthma		24 (%4,3)	13 (%3,5)	0,610 ²
Parkinson's Disease		6 (%2)	17 (%2,6)	0,519 ²
Vertigo		12 (%2,1)	11 (%2,9)	0,519 ²
Heart Failure		42 (%7,5)	16 (%4,3)	0,05²
Chronic Kidney Failure		18 (%3,2)	12 (%3,2)	0,999 ²

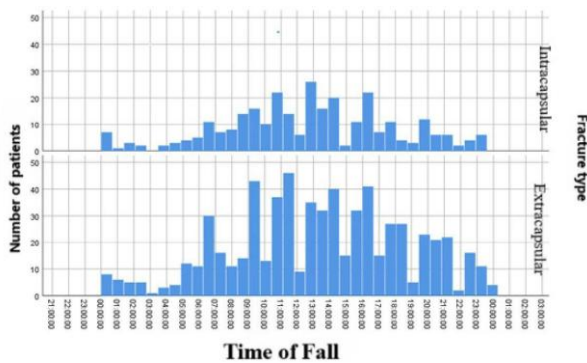


Figure 1. Hourly distribution of the occurrence of intracapsular and extracapsular hip fractures

The distribution between the fracture types and the time of the fall is given in Table 2. Extracapsular fractures were the most common

type of fracture both during the day and at night among all fractures. However, when evaluated proportionally, intracapsular fractures were more frequently observed during daytime hours (34.9% during the day vs. 26% at night), while extracapsular fractures occurred at a higher rate during nighttime hours (74% at night vs. 65.1% during the day). This difference was found to be statistically significant ($p=0.003$). These findings indicate that intracapsular fractures predominantly occur during daytime hours, whereas extracapsular fractures show a significant increase during nighttime hours.

Table 2. The distribution of fracture types during daytime and nighttime.

Variables		Time of Fall		p
		Group 1 (N: 562)	Group 2 (N: 373)	
Fracture type	Intracapsular fracture	196 (%34,9)	97 (%26)	0,003¹
	Extracapsular fracture	366 (%65,1)	276 (%74)	

¹ Fisher's Exact Test

Discussion

Some significant results were obtained in this study. As a result of the analyses, it was seen that the frequency of both intracapsular and extracapsular hip fractures decreased at night, increased in the morning hours, and reached the highest level at noon. Another significant result was that while intracapsular hip fractures were more common during the day, extracapsular hip fractures occurred at a higher rate at night. In addition, it was observed that the frequency of hip fractures due to falls increased during the day in patients with heart failure. This difference was not detected in other comorbid diseases.

It is possible to come across many studies in which an etiological examination was made in hip fractures resulting from falls.^{10,20-23} Apart from etiological reasons related to the person, the number of studies conducted on whether the type of hip fracture that occurs will change according to place and time is few and insufficient.^{9,17} In one of the studies investigating how seasonal changes affect the type of hip fracture, the study conducted by Crawford et al. found that more hip fractures occurred in the winter months compared to the summer months.²⁴ In addition, an increase in the number of extracapsular fractures and a tendency for higher mortality in patients admitted during the winter months have been detected. It is also possible to reach other studies on this subject.^{25,26} However, the number of studies examining the relationship between the type of hip fracture and the time of the fall is limited.^{9,17,27} According to Kim et al., among these studies, it has been shown that the risk of falling at night increases due to factors such as visual impairment, and the incidence of hip fractures increases accordingly.²⁷ However, according to Chen et al., the opposite is the case.⁹ It has been shown that fracture events occur mainly during the day and reach their highest level between 8-10 in the morning. Our study also obtained results similar to the results of Chen et al. According to the results we obtained, it has been determined that intracapsular hip fractures are seen in small numbers during the night and start to increase towards the morning, are seen at the highest rate at noon, and finally decrease

in the evening and are seen very rarely again towards midnight. It has been shown that extracapsular hip fractures also decrease at night and in the morning but increase towards noon.

Elderly patients start their customary daily rituals by getting out of bed in the morning and going to the toilet. With these actions, they enter a more active period compared to the nighttime. Being more active during the daytime may lead to falling more during this active period. Another significant result determined in this study is that the types of hip fractures change according to the time of the fall. According to the results, intracapsular hip fractures are more common during the daytime, while extracapsular hip fractures due to falls are more common at night. It is possible to determine many etiological factors that contributed to the formation of these two fracture types in the literature.^{21,22} Many factors such as age, gender, body mass index, comorbidities, fall position, and fall energy have been investigated.^{10,17,20-22} As a result of our literature review, no study has correlated the fracture type with fall time. According to literature data, the extracapsular hip fracture type frequency increases as the average age of patients with hip fractures increases.²⁴ In our study, it was determined that the average age of patients who had hip fractures at night was higher. The statistically significant result obtained in our study on this issue may be explained by the fact that the average age of patients with hip fractures at night was higher. In addition, rotational movements during falls are associated with the formation of extracapsular hip fractures.²³ Patients' ability to balance may be weakened at night compared to daytime due to waking up from sleep. In this case, it may cause the fall to be more uncontrolled. We think that the increase in rotational movements during uncontrolled falls compared to daytime may cause an increase in the formation of extracapsular hip fractures.

This study highlights the importance of implementing fall prevention measures at different times of the day in the elderly population. Getting out of bed is particularly a high-risk movement, and to reduce this risk, bed rails can be installed along the edges of the

bed. Elderly individuals are at high risk of falling at any time of the day when going to the toilet. Therefore, the widespread use of protective equipment should be encouraged to enhance safety. Using non-slip flooring inside the home, increasing nighttime lighting, and installing grab bars in bathrooms and hallways can help reduce fall risk. Additionally, the use of assistive walking devices such as walkers, canes, and support equipment should be promoted. Handrails on stairs and well-organized movement areas are also crucial safety measures. Moreover, falls in some elderly individuals may be linked to health conditions such as orthostatic hypotension. In such cases, slow movements during initial mobilization, taking support while sitting and standing up, and performing circulation-balancing exercises are recommended. In elderly care facilities, ensuring sufficient staff during night shifts, adjusting bed heights appropriately, and using mobility-supporting equipment can further enhance safety.

Limitation of the study

There are several limitations in our study. First, our study was designed retrospectively. Second, although the study only included hip fractures that occurred due to “falls,” the homogeneity of the patients included in the study may have been disrupted due to the difference in the concept of “falls” commonly understood among patients. Third, no examination was made on where the fall occurred. With all these limitations, future multicenter studies using larger samples and including where the fall occurred will increase the contribution to the literature.

Conclusion

This study has shown that the time of fall and fracture types in hip fractures may vary. Our findings revealed that both types of hip fractures included in the study were most frequently seen during the daytime, with a peak during the afternoon. It was also determined that extracapsular hip fractures were significantly more common at night, and intracapsular fractures were significantly more common during the daytime. This information may help develop fall prevention strategies for elderly individuals.

Ethics Committee Approval

Approval was taken from the Ethical Board of the State University the study was conducted in (Ethics committee approval number: 2022/8-7 and date: 15.11.2022) and written permission was taken from University. The study was conducted in accordance with the Helsinki declaration principles.

Author Contributions

Idea, design, collection of resources, analysis and interpretation of results and literature, written and critical: BK, HKOK, OK, KT, MB

Conflict of Interest

There is no conflict of interest to declare

Financial Disclosure

There is no person/organization supporting this study financially.

Peer-review

Externally peer-reviewed.

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