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Incidence and Risk Factors of Pulmonary Complications Following Femur Fracture Surgery in Patients Aged 80 Years and Older

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Purpose: Femur fractures and subsequent surgical procedures are expected to increase with the growth of the older population. Despite the elevated risk of postoperative pulmonary complications in older patients, research focusing on those of very advanced age is limited. We aimed to investigate the incidence and risk factors of pulmonary complications following femur fracture surgery in patients ≥80 years.

Patients and Methods: This retrospective cohort study included patients aged ≥80 years admitted to the Orthopedic Surgery Department for femur fracture surgery between 2020 and 2022. We assessed the incidence and risk factors of postoperative pulmonary complications, defined as pneumonia, atelectasis, pulmonary edema, pleural effusion, and venous thromboembolism (VTE). We also examined risk factors for respiratory failure and 90-day mortality, using logistic regression models.

Results: The study included 479 patients with a mean age of 86.0 years, and 78.5% were women. Postoperative pulmonary complications occurred in 11.7% of patients, with pleural effusion being the most common (4.4%), followed by pneumonia and atelectasis. The incidence of VTE was 1.5%. Patients who developed pulmonary complications had significantly longer hospital stays (14 days vs 10 days; $p<0.001$), a greater proportion of patients needing oxygen supplementation (71.4% vs 31.4%; $p<0.001$), and higher all-cause 90-day mortality (14.3% vs 5.9%; $p=0.042$). Age, chronic lung disease, and Parkinson's disease were significant risk factors for pulmonary complications. Coronary artery disease, stroke, and prolonged surgery were significantly associated with respiratory failure, whereas internal fixation, coronary artery disease and older age were associated with 90-day mortality. Distal femur fractures were significant risk factors for VTE, while VTE prophylaxis methods were not associated with VTE risk.

Conclusion: At least one postoperative pulmonary complication occurred in 11.7% of the participants. Several comorbidities were associated with pulmonary complications, respiratory failure, and 90-day mortality, highlighting the importance of identifying these comorbidities prior to surgery.

Plain Language Summary: As global average life expectancy rises, the number of older adults needing femur fracture surgery is also increasing. Advanced age increases the risk of complications after surgery, and many older patients have pre-existing health conditions, making them more likely to experience complications and, in some cases, death.

Our study focused on patients aged 80 years or older who underwent femur fracture surgery. We examined the incidence rate of pulmonary complications including venous thromboembolism (blood clots), as well as risk of death within 90 days.

Out of the 479 patients studied, 11.7% experienced at least one pulmonary complication after surgery, with pleural effusion being the most common. The overall 90-day death rate was 6.9%, and the rate of venous thromboembolism was 1.5%. Patients who developed pulmonary complications had worse clinical outcomes, including longer hospital stays, extended need for oxygen, and higher death rate within 90 days.

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We found several health conditions were associated with higher risk of pulmonary complications, such as advanced age, chronic lung diseases, and Parkinson's disease. Similarly, advanced age and coronary artery disease were identified as risk factors for death within 90 days.

Our study findings suggest that pulmonary complications are associated with worse outcomes and various pre-existing health conditions are risk factors for them. As more patients with advanced age are expected to undergo femur fracture surgery, it will be important to carefully assess risk factors to help prevent complications.

Keywords: femoral fracture, geriatric patient, postoperative pulmonary complications, mortality

Introduction

The global population is aging rapidly. By 2050, the number of individuals aged 60 years or older is projected to double, reaching 2.1 billion.[1] Similarly, the population aged 80 years or older is expected to triple, reaching 426 million.[1] This growth of the older adult population presents significant challenges, particularly in terms of fragility fractures. Older individuals are susceptible to fractures because age is a major risk factor irrespective of bone mineral density.[2] Furthermore, pre-existing medical conditions prevalent in the older adult population contribute to an increased risk of fractures.[3]

Among fractures, femur fractures have devastating consequences, with a high 1-year mortality in both men and women.[4,5] With the growing older population, the incidence of femur fractures and subsequent surgical procedures for treatment are expected to increase. However, older patients often present with various comorbidities that can affect prognosis, and old age itself is an important postoperative risk factor.[6–8] Franzo et al examined 6,629 patients aged 65 years or older undergoing hip fracture surgery and found a progressive increase in in-hospital mortality rates with aging: 1.5% for ages 65–69, 2.9% for the 70s, 6.3% for the 80s, and 8.8% for the 90s.[9] Therefore, the burden of femur fracture surgery is notably higher for individuals aged 80 years and above. In addition, femur fractures often result in post-operative pulmonary complications.[10] These complications can be severe and life-threatening, especially for older patients.[11] In a study conducted by Lefaivre et al involving 90,510 patients admitted to trauma centers, individuals aged 60 years and older had a 2.2 times higher risk of pulmonary complications than younger patients.[12] To reduce postoperative mortality and morbidity and optimize postoperative care for older patients undergoing femur fracture surgery, it is crucial to identify risk factors for pulmonary complications.

It is well known that the risk of venous thromboembolism (VTE) is significant in patients undergoing femur fracture surgeries,[13] which highlights the need for effective preventive measures. However, older patients are at an increased risk for both bleeding and VTE and there are currently no specific guidelines for VTE prophylaxis tailored to this demographic. Moreover, although Asian populations generally have a lower risk of VTE compared to Western populations,[14–16] the optimal prevention strategies for older Asian patients undergoing femur fracture surgery are still not well-defined.

In this study, we aimed to investigate the incidence and risk factors of postoperative pulmonary complications following femur fracture surgery in patients aged 80 years and above. Furthermore, we examined the risk factors for respiratory failure, 90-day mortality, and VTE.

Materials and Methods

Study Participants

We conducted a retrospective study of older adults aged 80 years and above who underwent femur fracture surgery at Ilsan Paik hospital in South Korea from January 2020 to December 2022. Both proximal and distal femur fractures were included in this study. The exclusion criteria included the presence of preoperative pneumonia, pulmonary edema, pleural effusion, or VTE identified from chest radiography or computed tomography scans.

Data Collection

The demographic data of the patients were obtained from electronic medical records. They included age, sex, body mass index (BMI), smoking status, pre-hospitalization residence, and comorbidities such as chronic lung diseases, dementia,

and Parkinson's disease. Additionally, we collected data on hospital admission and discharge dates, fracture location (proximal or distal), time to surgery, type of surgery and anesthesia, and VTE prophylaxis methods. Laboratory data on the admission date were also obtained.

The development of pulmonary complications was identified based on electronic medical records and a picture archiving and communication system. Lower-leg Doppler ultrasonography was routinely performed before hospital discharge. The severity and outcomes of pulmonary complications were documented, including the need for oxygen supplementation, duration and type of supplementation, and death. The mortality data were obtained from electronic medical records and supplemented with information from the Korean National Health Insurance regarding the eligibility status (whether it is terminated or not) for patients who were lost to follow-up. The study protocol for accessing and analyzing the electronic medical record data was fully approved by the Institutional Review Board of Ilsan Paik Hospital (No.: 2023–08-006). The Institutional Review Board of Ilsan Paik Hospital waived the need for informed consent due to the retrospective nature of this study and the minimal risk involved. This study was conducted in compliance with the Declaration of Helsinki, and patient confidentiality was maintained throughout the entire study.

Study Outcomes

The primary outcomes of our study were the incidence and risk factors of postoperative pulmonary complications. The pulmonary complications were pneumonia, atelectasis, pulmonary edema, pleural effusion, or VTE. The secondary outcomes were the risk factors for respiratory failure and 90-day mortality. Respiratory failure was defined as an oxygen demand necessitating a high-flow nasal cannula or mechanical ventilation. Additional outcomes included the characteristics of the patients who developed VTE and their risk factors.

Statistical Analysis

Descriptive statistics were used for the demographic data. Numerical variables were expressed as means ± standard deviation or median (interquartile range [IQR]). Categorical variables were presented as numbers (%). The chi-squared or Fisher's exact test was used for categorical variables, whereas Student's *t*-test or Mann–Whitney test was used for numerical variables. Binary logistic regression analysis was used to determine the risk factors for pulmonary complications, respiratory failure, 90-day mortality, and VTE. Variables with p-value of <0.10 during the simple logistic regression were entered into the multivariate analysis. All p-values were two-tailed, and p-values below 0.05 denoted statistical significance. All analyses were performed using Statistical Package for the Social Sciences software (version 23.0; IBM Corporation, Armonk, NY, USA).

Results

Baseline Characteristics of Study Participants

Between January 2020 and December 2022, 531 patients aged ≥80 years who underwent femur fracture surgery were identified (Figure 1). Of them, 52 presented with acute pulmonary disease preoperatively: 22 had pneumonia, 19 had pulmonary edema, 4 had pulmonary embolism, and 7 had a combination of two or more conditions. After excluding these cases, 479 patients were included in this study.

Table 1 shows the baseline patient characteristics. The mean age of the participants was 86.0 years, and 78.5% were women. Patients in their 90s constituted 20.0% of all study participants. The most prevalent comorbidity was hypertension (76.0%), followed by diabetes (35.3%) and dementia (30.1%). Approximately 11.5% reported a prior diagnosis of chronic lung diseases, such as asthma, chronic obstructive pulmonary disease, bronchiectasis, and interstitial lung disease. Proximal femur fractures accounted for 92.5%; of these, 64.3% were treated with internal fixation using proximal femoral nails, while 35.2% underwent hip arthroplasty. Distal femur fractures (7.5%) were treated with internal fixation using plate and screw. General anesthesia was performed in 92.3%. The median duration to surgery was 2.0 (IQR, 1.0–3.0) days.

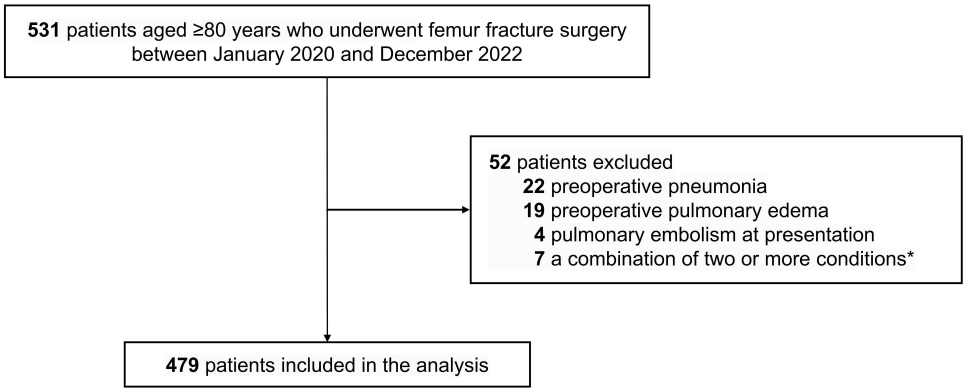

Figure 1 Study patient selection.
*Pneumonia and pulmonary edema (n=5), pulmonary edema and pulmonary embolism (n=1), pneumonia and pulmonary embolism (n=1).

Supplementary Table 1 shows the baseline characteristics of the 52 excluded patients. The excluded group had a significantly higher prevalence of chronic lung disease, more frequent hip arthroplasty and non-general anesthesia, higher C-reactive protein concentrations, and a longer duration to surgery.

Table 1 Baseline Characteristics of Study Patients

Characteristics	N=479
Age, years	86.0±4.2
Age groups	
80–89 years	383 (80.0)
≥90 years	96 (20.0)
Female sex	376 (78.5)
BMI, kg/m^2	22.0±3.7
Current smoking	16 (3.3)
Residence	
Home	424 (88.5)
Long-term care facility	55 (11.5)
Comorbidities	
Hypertension	364 (76.0)
Diabetes	169 (35.3)
Dementia	144 (30.1)
Coronary artery disease	75 (15.7)
Stroke	74 (15.4)
Chronic lung disease[a]	55 (11.5)
Arrhythmia	41 (8.6)
Congestive heart failure	30 (6.3)
Chronic kidney disease	28 (5.8)
Parkinson disease	19 (4.0)
Active cancer	15 (3.1)
Fracture location	
Proximal femur	443 (92.5)
Distal femur	36 (7.5)
Type of surgery[b]	
Internal fixation	323 (67.4)
Arthroplasty	156 (32.6)

(*Continued*)

Table 1 (Continued).

Characteristics	N=479
Anesthesia	
General	442 (92.3)
Non-general	37 (7.7)
VTE Prophylaxis	
IPC device alone	343 (71.6)
IPC device + pharmacologic agent	127 (26.5)
None	9 (1.9)
Time to surgery, days	2.0 [1.0;3.0]
Initial laboratory results	
Hemoglobin, g/dL	11.3±4.8
CRP, mg/dL	2.0±3.5
D-dimer, μg/mL	6.4±5.0
NT-proBNP, pg/mL	4449.5±7883.0
CK-MB, ng/mL	3.6±8.7
Troponin-I, ng/L	115.6±422.9

Notes: Data are presented as number (%), mean ± SD, or median [IQR]. [a]Chronic lung diseases included asthma (n=22), chronic obstructive pulmonary disease (n=13), interstitial lung disease (n=5), tuberculosis destroyed lung (n=5), nontuberculous mycobacterial lung disease (n=3), bronchiectasis (n=2), emphysema (n=1), two or more conditions (n=4). [b]Proximal femur fractures were treated with internal fixation using proximal femoral nails (n=287) or hip arthroplasty (bipolar hemiarthroplasty or total hip arthroplasty) (n=156). Distal femur fractures were treated by internal fixation with plate and screw (n=36).

Abbreviations: SD, standard deviation; BMI, body mass index; VTE, venous thromboembolism; IPC, intermittent pneumatic compression; IQR, interquartile range; CRP, C-reactive protein; NT-proBNP, N terminal-pro B type natriuretic peptide; CK-MB, creatine kinase-myocardial band.

Postoperative Pulmonary Complications and Associated Outcomes

The incidence and types of pulmonary complications are shown in Figure 2A. Fifty-six patients (11.7%) experienced at least one postoperative pulmonary complication, and the most common complication was pleural effusion, accounting for 4.4%. The second most common complications were pneumonia (3.5%) and atelectasis (3.5%). The incidence of VTE was 1.5%, and that of isolated pulmonary embolism without deep vein thrombosis (DVT) was 0.6%.

Figure 2B shows the incidence of respiratory-related outcomes and the all-cause 90-day and in-hospital mortality rates. A postoperative oxygen requirement longer than 2 days was observed in 36.1% of the study participants. The 90-day mortality rate was 6.9%, while the respiratory failure rate was 1.5%. The in-hospital mortality rate was 0.4% for all the participants.

Table 2 shows the clinical outcomes of patients who developed pulmonary complications. Those with pulmonary complications experienced a significantly longer hospitalization duration (14 days vs 10 days; p<0.001) and a higher proportion of patients requiring oxygen for more than 2 days (71.4% vs 31.4%; p<0.001). In addition, all-cause 90-day mortality was significantly higher in this group (14.3% vs 5.9%; p=0.042).

Risk Factors for Pulmonary Complications

In the unadjusted analysis, older age, male sex, and chronic lung disease were significantly associated with the development of pulmonary complications (Table 3). Additionally, a history of stroke or Parkinson's disease tended to be associated with pulmonary complications. In the adjusted analysis, older age (odds ratio [OR], 1.095; 95% confidence interval [CI], 1.026–1.170; p=0.006), chronic lung disease (OR, 3.759; 95% CI, 1.853–7.624; p<0.001), and Parkinson's disease (OR, 3.723; 95% CI, 1.226–11.306; p=0.020) remained as significant risk factors for the development of postoperative pulmonary complications.

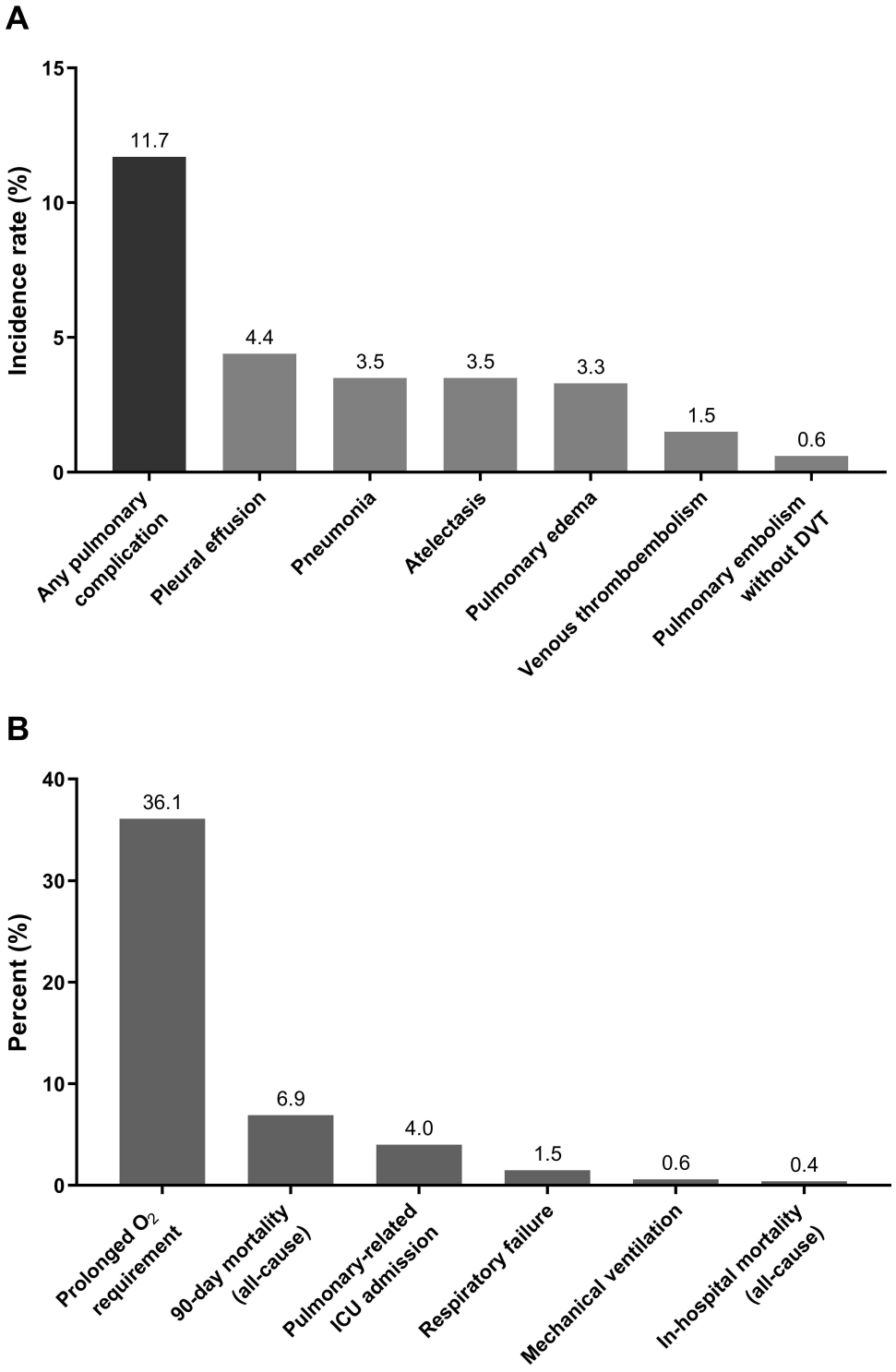

Figure 2 Incidence of (**A**) postoperative pulmonary complications and (**B**) respiratory-related outcomes, all-cause 90-day mortality and in-hospital mortality.
Abbreviations: DVT, deep vein thrombosis; O_2, oxygen; ICU, intensive care unit.

Risk Factors for Respiratory Failure and 90-Day Mortality

Tables 4 and 5 show the risk factors of respiratory failure and 90-day mortality, respectively. Coronary artery disease was significantly associated with both respiratory failure and 90-day all-cause mortality in the adjusted analyses. Additionally,

Table 2 Clinical Outcomes of Patients with Postoperative Pulmonary Complications Compared to Those Without

	Pulmonary Complication (N=56)	No Pulmonary Complication (N=423)	p
Duration of hospitalization (days)	14 [11.0;20.0]	10 [9.0;13.0]	<0.001
Prolonged oxygen supplementation	40 (71.4)	133 (31.4)	<0.001
Duration of oxygen supplementation (days)	8.5 [5.0;13.5]	4.0 [3.0;7.0]	<0.001
Postoperative ICU admission	19 (33.9)	46 (10.9)	<0.001
90-day all-cause mortality	8 (14.3)	25 (5.9)	0.042

Notes: Data are presented as number (%), or median [IQR].
Abbreviations: ICU, intensive care unit; IQR, interquartile range.

Table 3 Risk Factors for Pulmonary Complications

Variables	Unadjusted			Adjusted		
	Odds Ratio	95% CI	p	Odds Ratio	95% CI	p
Age	1.073	1.008–1.143	0.027	1.095	1.026–1.170	0.006
Male sex	2.072	1.134–3.786	0.018	1.648	0.876–3.100	0.122
Body mass index	0.974	0.901–1.052	0.498			
Current smoking	2.635	0.820–8.470	0.104			
Hypertension	0.764	0.410–1.423	0.396			
Diabetes	1.022	0.571–1.828	0.943			
Chronic kidney disease	1.279	0.427–3.831	0.660			
Chronic lung disease	3.503	1.783–6.881	<0.001	3.759	1.853–7.624	<0.001
Arrhythmia	1.330	0.533–3.321	0.541			
Coronary artery disease	0.886	0.401–1.956	0.764			
Congestive heart failure	0.830	0.243–2.831	0.766			
Dementia	1.016	0.554–1.863	0.959			
Stroke	1.794	0.912–3.531	0.091	1.934	0.951–3.933	0.069
Parkinson	2.864	0.991–8.282	0.052	3.723	1.226–11.306	0.020
Proximal femur fracture[a]	0.636	0.252–1.604	0.338			
Internal fixation[b]	1.123	0.613–2.056	0.707			
General anesthesia[c]	0.534	0.223–1.281	0.160			
Time to surgery	1.080	0.976–1.195	0.138			

Notes: [a]Proximal femur fracture versus distal femur fracture. [b]Internal fixation versus hip arthroplasty. [c]General anesthesia versus non-general anesthesia.
Abbreviation: CI, confidence interval.

stroke and a longer duration to surgery were significantly associated with respiratory failure whereas internal fixation and older age were identified as significant risk factors for 90-day mortality.

Factors Associated with VTE

Lower leg Doppler ultrasonography was performed for 91.9% of the patients. Seven patients (1.5%) developed VTE after surgery. The clinical characteristics of the patients with and without VTE are shown in Supplementary Table 2. Age, sex, BMI, and current smoking status were not significantly different for the two groups. Distal femur fracture was significantly more common in the VTE group.

Regarding the method of VTE prophylaxis, using an intermittent pneumatic compression (IPC) device alone was the most common method for both patients with (85.7%) and without (71.4%) VTE. No significant differences were observed in the prophylactic method. Overall, 1.9% of the patients did not receive any prophylaxis, but no VTE was found. Patients with VTE showed a higher rate of oxygen supplementation, longer duration of oxygen supplementation, and higher 90-day mortality rate than those without VTE, although the difference was not statistically significant.

Table 4 Risk Factors for Respiratory Failure

Variables	Unadjusted			Adjusted		
	Odds Ratio	95% CI	p	Odds Ratio	95% CI	p
Age	1.117	0.954–1.308	0.168			
Male sex	2.790	0.614–12.669	0.184			
Body mass index	0.983	0.800–1.208	0.869			
Hypertension	1.911	0.228–16.037	0.551			
Diabetes	0.731	0.140–3.806	0.709			
Chronic kidney disease	2.747	0.319–23.637	0.357			
Chronic lung disease	1.290	0.152–10.920	0.815			
Coronary artery disease	7.531	1.650–34.365	0.009	10.656	2.127–53.372	0.004
Dementia	3.162	0.699–14.312	0.135			
Stroke	7.657	1.678–34.951	0.009	10.971	2.157–55.787	0.004
Proximal femur fracture[a]	0.481	0.056–4.104	0.503			
Internal fixation[b]	1.211	0.232–6.311	0.820			
Time to surgery	1.154	0.983–1.356	0.081	1.223	1.007–1.485	0.042

Notes: [a]Proximal femur fracture versus distal femur fracture. [b]Internal fixation versus hip arthroplasty.
Abbreviation: CI, confidence interval.

Table 5 Risk Factors for 90-Day Mortality

Variables	Unadjusted			Adjusted		
	Odds Ratio	95% CI	p	Odds Ratio	95% CI	p
Age	1.135	1.051–1.226	0.001	1.124	1.034–1.222	0.006
Male sex	1.650	0.759–3.588	0.206			
Body mass index	0.942	0.851–1.043	0.248			
Hypertension	1.833	0.691–4.864	0.223			
Diabetes	1.052	0.504–2.195	0.893			
Chronic kidney disease	3.284	1.161–9.292	0.025	2.454	0.772–7.800	0.128
Chronic lung disease	1.414	0.522–3.829	0.495			
Arrhythmia	1.074	0.313–3.682	0.910			
Coronary artery disease	3.474	1.628–7.411	0.001	2.989	1.327–6.734	0.008
Congestive heart failure	1.552	0.445–5.411	0.490			
Dementia	2.048	1.002–4.187	0.049	1.898	0.895–4.024	0.095
Stroke	1.842	0.797–4.259	0.153			
Active cancer	2.149	0.464–9.950	0.328			
Proximal femur fracture[a]	0.799	0.232–2.757	0.723			
Internal fixation[b]	3.748	1.294–10.858	0.015	3.113	1.054–9.196	0.040
General anesthesia[c]	0.825	0.239–2.844	0.761			
Time to surgery	1.099	0.981–1.232	0.103			

Notes: [a]Proximal femur fracture versus distal femur fracture. [b]Internal fixation versus hip arthroplasty. [c]General anesthesia versus non-general anesthesia.
Abbreviation: CI, confidence interval.

Distal femur fracture was the only significant risk factor for VTE (Table 6). There was no significant association between VTE prevention and pharmacotherapy, relative to mechanical prophylaxis alone or no prophylaxis.

Discussion

This study examined the incidence and risk factors of postoperative pulmonary complications in patients aged 80 years and above undergoing femur fracture surgery. We found that approximately 11.7% of patients experienced at least one pulmonary complication. Patients who developed pulmonary complications had worse clinical outcomes, including

Table 6 Risk Factors for Venous Thromboembolism

Variables	Unadjusted			Adjusted		
	Odds Ratio	95% CI	p value	Odds Ratio	95% CI	p value
Age	1.066	0.905–1.256	0.445			
Male sex	0.605	0.072–5.079	0.643			
Body mass index	1.071	0.893–1.285	0.461			
Hypertension	1.911	0.228–16.037	0.551			
Diabetes	2.481	0.549–11.217	0.238			
Chronic kidney disease	2.747	0.319–23.637	0.357			
Coronary artery disease	2.186	0.416–11.483	0.355			
Dementia	1.761	0.389–7.969	0.463			
Stroke	2.222	0.423–11.675	0.345			
Proximal femur fracture[a]	0.100	0.022–0.467	0.003	0.100	0.022–0.467	0.003
Internal fixation[b]	2.934	0.350–24.581	0.321			
Time to surgery	1.070	0.843–1.358	0.580			

Notes: [a]Proximal femur fracture versus distal femur fracture. [b]Internal fixation versus hip arthroplasty.
Abbreviation: CI, confidence interval.

longer hospital stays, extended need for oxygen supplementation, and higher all-cause 90-day mortality. Advanced age was a significant risk factor for the development of pulmonary complications and 90-day mortality. Several comorbidities were also associated with pulmonary complications, respiratory failure, and 90-day mortality, highlighting the need for the preoperative assessment of comorbidities in patients aged 80 years and older.

Research on postoperative pulmonary complications in individuals aged 80 years and above is lacking. Several previous studies on older patients have focused on those older than 60 years,[17–19] but few studies have targeted those older than 80 years, which is the focus of our study. Previous studies examining pneumonia after hip fracture surgery in older patients with differing age criteria have reported incidence ranging from 3.5 to 15%.[17,18,20,21] In our study, the incidence of pneumonia was 3.5%, which is slightly lower than the rates reported by previous studies, despite our focus on patients aged 80 years or older. However, the previous studies were retrospective and there exists a possibility of overestimation of pneumonia incidence, with conditions such as atelectasis being misclassified as pneumonia. The strength of our study is that we investigated not only the total incidence of pulmonary complications but also different types of pulmonary complications such as pulmonary edema, atelectasis, and pleural effusion.

In the present study, chronic lung disease was significantly associated with postoperative pulmonary complications. Consistent with our findings, chronic obstructive pulmonary disease, a prevalent chronic lung disease, has been recognized as a significant predictor of postoperative respiratory failure and mortality, irrespective of patient age.[22] Therefore, preoperative identification of such chronic lung diseases is crucial. However, this remains challenging because several patients may be unaware of their chronic respiratory conditions. Assessing pulmonary function in older patients with femur fractures can be difficult due to cognitive impairment, potentially impeding the accurate performance of pulmonary function tests. In addition, assuming an upright posture during the test is often infeasible because of the fracture. This may lead to an underestimation of pulmonary function. Therefore, a thorough investigation of respiratory symptoms and smoking history, along with chest X-ray examinations, are essential to detect undiagnosed chronic respiratory diseases.

The presence of Parkinson's disease showed a significant association with the risk of pulmonary complications. In addition to an elevated risk of falls and fractures, patients with Parkinson's disease are highly likely to develop conditions such as atelectasis, retained secretions, and pneumonia due to neuromuscular dysfunction.[23] Yuasa et al reported that postoperative pneumonia after hip fracture surgery occurred significantly more frequently in patients with Parkinson's disease than those without (8.6% vs 1.2%).[24] Similarly, a history of stroke was associated with respiratory failure and pulmonary complications. Previous research reported that patients with a history of stroke within 24 months before surgery had a 1.9-fold higher risk of postoperative pneumonia and 2.4-fold higher risk of 30-day in-hospital mortality.[25]

Stroke is linked to systemic atherosclerosis and often coexists with other comorbidities such as hypertension, dyslipidemia, and diabetes, which may contribute to poor outcomes. More importantly, complications such as impaired physical and/or cognitive function following stroke can impede appropriate postoperative lung care and increase the risk of postoperative pulmonary complications.

We also found that coronary artery disease was associated with respiratory failure and 90-day mortality. This implies an increased risk of mortality due to postoperative pulmonary complications in patients with underlying coronary artery disease. In stress-inducing conditions such as hypoxia following pulmonary complications, patients with coronary artery disease are more susceptible to cardiac ischemic damage than those without coronary artery disease. This predisposition may lead to compromised cardiac function, further preventing it from responding effectively to increased oxygen demand. Therefore, it is important to recognize these comorbidities as significant risk factors for pulmonary complications and outcomes, particularly considering their higher prevalence among older patients than among younger patients.

In our study, internal fixation was identified as a significant risk factor for 90-day all-cause mortality compared to hip arthroplasty. A previous systematic review and meta-analysis reported that hip arthroplasty for unstable intertrochanteric fractures is associated with earlier mobilization than internal fixation;[26] however, it did not find a significant difference in mortality between the two surgical methods. Another systematic review and meta-analysis found that hip arthroplasty was associated with a lower reoperation rate and a reduced risk of complications compared to internal fixation,[27] though no mortality benefit was observed. It is unclear why internal fixation was associated with a higher risk of mortality in our study. The benefits of hip arthroplasty, such as earlier mobilization and a lower risk of reoperation, may have contributed to the observed lower mortality risk. However, further prospective studies are needed to validate this association.

Previous studies have reported the incidence of VTE ranging from 7.4% to 27.7% in patients undergoing hip fracture surgery.[28] While old age has been significantly associated with the risk of VTE,[29–32] our study focusing on older patients aged 80 and above, found a low incidence of DVT and pulmonary embolism. Racial differences may have contributed to the lower incidence of VTE in our study than that reported by other studies. Previous studies have shown that Asians tend to have a relatively lower incidence of VTE than Western populations.[14,15] In a retrospective study conducted in New Zealand by Liao et al, European patients showed a relative risk of 4.02 for VTE and 4.75 for DVT, compared to Asian patients after age standardization.[16] Our finding of a low incidence of VTE suggests that femur fracture surgery may not necessarily warrant immediate consideration of pulmonary embolism as the primary cause of hypoxemia after surgery in older Korean patients, although femur fractures carry a high risk of VTE.

In our study, 98.1% of patients received VTE prophylaxis; the most commonly used method was an IPC device alone employed in 71.6%. Interestingly, there was no significant difference in the incidence of VTE based on the VTE prophylaxis method. The ninth edition of the American College of Chest Physicians guidelines, published in 2012, recommends dual prophylaxis with an antithrombotic agent and an IPC device in patients undergoing major orthopedic surgery, based on data primarily from Caucasian populations.[33] The guidelines also suggest that using an IPC device alone is preferable for pharmacological prophylaxis in patients with a high bleeding risk. However, they did not specify whether prophylactic methods should vary with age. According to the results of our study, VTE prophylaxis using an IPC device alone seems to be sufficient to prevent VTE after femur fracture surgery in patients aged 80 years or older. Given the increased risk of bleeding associated with advanced age, using an IPC device alone could be an appropriate prophylactic method for this demographic.[34]

Our study has some limitations that should be addressed. First, the retrospective nature of the data collected from the electronic medical records may have introduced inaccuracies in identification of pulmonary complications, leading us to inadvertently overlook some cases. Additionally, because the data were obtained from a single center in South Korea, the generalizability of our findings to patients in different clinical settings may be limited. As discussed previously, racial disparities may influence the incidence of VTE. Therefore, further investigation involving a wider range of ethnic groups is warranted. Second, our analysis focused on the development of pulmonary complications during hospital stay; thus, complications post-discharge or following transfer to other medical facilities remain uncertain. Third, while routine lower leg Doppler ultrasound was conducted in 91% of the study cohort, the remaining 9% of patients may have had undetected asymptomatic VTE. However, routine Doppler ultrasound screening before hospital discharge is not recommended

according to the American College of Chest Physicians guidelines.[33] Even with the possibility of undetected asymptomatic DVT, we believe that it has minimal impact on clinical outcomes.

Conclusion

In conclusion, our findings indicate that 11.7% of patients aged 80 years or older experienced at least one pulmonary complication after femur fracture surgery, with a relatively low incidence of VTE of 1.5% of patients. Various comorbidities were significantly associated with the development of pulmonary complications, respiratory failure, or 90-day mortality. Considering the anticipated increase in the number of older patients undergoing femur fracture surgery, assessing risk factors, including careful identification of comorbidities is important prior surgery to prevent pulmonary complications and reduce mortality.

Abbreviations

BMI, body mass index; CI, confidence interval; CK-MB, creatine kinase-myocardial band; CRP, C-reactive protein; DVT, deep vein thrombosis; ICU, intensive care unit; IPC, intermittent pneumatic compression; IQR, interquartile range; NT-proBNP, N terminal-pro B type natriuretic peptide; OR, odds ratio; SD, standard deviation; VTE, venous thromboembolism.

Data Sharing Statement

The dataset analyzed during the current study is available from the corresponding author upon reasonable request.

Ethics Approval and Informed Consent

This study was approved by the Institutional Review Board of Ilsan Paik Hospital (No.: 2023-08-006). The need for informed consent was waived due to the retrospective nature of this study and the minimal risk involved. We conducted this study in compliance with the Declaration of Helsinki, and patient confidentiality was maintained throughout the entire study.

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Disclosure

The authors have no competing interests.

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