

*Original Article***Risk factors for patients who develop pneumonia either before or after hip fracture surgery****Hiromichi Metani, MD, PhD,¹ Akio Tsubahara, MD, PhD,¹ Takashi Hiraoka, MD, PhD,¹ Sosuke Seki, MD, PhD,¹ Toru Hasegawa, MD, PhD²**¹Rehabilitation Medicine, Kawasaki Medical School, Kurashiki, Okayama, Japan²Orthopedic Surgery, Kawasaki Medical School, Kurashiki, Okayama, Japan**ABSTRACT**

Metani H, Tsubahara A, Hiraoka T, Seki S, Hasegawa T. Risk factors for patients who develop pneumonia either before or after hip fracture surgery. *Jpn J Compr Rehabil Sci* 2015; 6: 43–49.

Objective: The objectives of this study were to examine the risk factors for patients who develop pneumonia either before or after hip fracture surgery and to investigate the utility of dysphagia rehabilitation and oral care.

Methods: The medical histories of 145 patients who were hospitalized for a new hip fracture and underwent surgical treatment were retrospectively investigated, and the rate of and risk factors for pneumonia were evaluated.

Results: The rate of pneumonia with hip fracture was 14.5%. Psychiatric disorders, history of stroke, time between admission and surgery, blood hemoglobin concentration, serum total protein level, and serum albumin level were risk factors associated with pneumonia. In particular, the serum albumin level and psychiatric disorders were independent risk factors.

Conclusion: The majority of pneumonias that develop either after admission or after hip fracture surgery are considered to be aspiration pneumonias, and their frequency was greater than expected. Since patients with malnutrition or psychiatric disorders are more susceptible to pneumonia, ascertaining the patient's activities of daily living prior to injury and conducting thorough oral care are considered essential for preventing aspiration pneumonia.

Key words: aspiration pneumonia, dysphagia, femoral neck fracture, intertrochanteric fracture, malnutrition

Introduction

Swallowing function is known to decline with age. In addition to the systemic decrease in motor function with ageing, some of the causes of this decline include decreased frequency of swallowing induced by decreased activity or exercise, decreased suprahyoid muscle strength and the descended position of the hyoid bone, decreased salivary secretion due to medication, and decreased cognitive function [1–3]. The characteristics of swallowing function in older people include laryngeal penetration caused by a delayed swallowing reflex, increased residue in the pharynx after swallowing due to decreased pharyngeal contraction or dysfunctional upper esophageal sphincter mechanism, and a decreased airway defense reflex [4, 5].

When swallowing function decreases, there is an increased risk of developing aspiration pneumonia, which often leads to death if it becomes severe [3]. In particular, in patients with neurological abnormalities such as stroke, traumatic brain injury, and neurodegenerative diseases, marked dysphagia occurs when tumors develop concomitantly in the oral cavity, pharynx, or larynx, or when sedatives are administered; thus, the prevention of aspiration pneumonia is essential [6–8]. Although aspiration pneumonia is known to develop in 7–28% of stroke patients, this frequency has been decreasing since the introduction of oral care and indirect swallowing therapy as a part of rehabilitation from the acute stages [7, 8].

Among elderly inpatients undergoing treatment, many are hospitalized due to hip fracture, and postoperative rehabilitation is consequently conducted with the goal of regaining ambulatory function. During the course of rehabilitation, some of these patients develop pneumonia; however, there are few reports on swallowing dysfunction or pneumonia after hip fracture, both domestically and internationally [9–11]. Therefore, in the present study, the medical histories of patients who were hospitalized due to new hip fracture and who subsequently underwent surgery and rehabilitation

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were retrospectively investigated. Furthermore, the risk factors for pneumonia, with a particular focus on aspiration pneumonia, were evaluated. We also assessed approaches to rehabilitation with the objectives of decreasing complications in patients with hip fracture and enhancing their quality of life.

Methods

1. Subjects

A retrospective study of medical histories was conducted in all patients who were hospitalized due to new hip fracture and who underwent surgical treatment between January 2008 and June 2010. This study surveyed the medical history of inpatients during the period in which they were eligible for the Diagnosis Procedure Combination (DPC) per diem payment system, in which the government insurance plan covers most of the cost, but the patient is responsible for a co-payment. Inclusion criteria for this study were as follows: 1) the patient was ≥ 65 years old; 2) the fracture was caused by falling from a bed or other type of fall; 3) the fracture was not a pathological fracture due to a tumor; 4) the patient subsequently underwent hip surgery; and 5) the patient underwent rehabilitation either preoperatively or postoperatively.

2. Study method

The contents of the survey included the following: patient demographics, present illness, past medical history, physical findings, treatment regimen, clinical course, medical history overview, therapist records, hip and thoracic X-ray findings, results of blood tests performed as screening tests at admission (specifically, blood hemoglobin concentration, serum protein level, and serum albumin level), and leukocyte count and CRP levels during a fever. From the above information, patients were classified into those who developed pneumonia during the DPC-eligible period (pneumonia group) and those who did not (non-pneumonia group) in order to determine the rate of concomitant pneumonia. Diagnostic criteria for pneumonia were: 1) presence of a fever of $\geq 37.5^\circ\text{C}$ or respiratory symptoms such as cough, wheezing, or cyanosis; 2) diagnosed as pneumonia by a radiologist based on thoracic X-ray findings; and 3) increased leukocyte and elevated CRP levels on blood tests. In the pneumonia group, the time frame of pneumonia onset (either preoperatively or postoperatively), meal content at admission, height, and weight were also investigated.

3. Analysis method

The relationships between the rate of pneumonia and sex, fractured lower limb (fracture side), type of fracture (femoral neck fracture, intertrochanteric fracture), operative procedure, coexisting diabetes/psychiatric disorders (such as schizophrenia, depression, delirium state, and mental confusion)/dementia, and

history of stroke were analyzed by the χ^2 test.

Age, time between admission and surgery, blood hemoglobin concentration, serum total protein level, and serum albumin level at admission were compared between the pneumonia and non-pneumonia groups using a non-paired *t*-test. In addition, the pneumonia group was divided into those who developed pneumonia preoperatively (preoperative pneumonia group) or those who developed pneumonia postoperatively (postoperative pneumonia group), and the relationships between the rate of pneumonia and sex, fractured lower limb (fracture side), type of fracture (femoral neck fracture, intertrochanteric fracture), operative procedure, coexisting diabetes/psychiatric disorders (such as schizophrenia, depression, delirium state, and mental confusion)/dementia, and history of stroke were analyzed by a χ^2 test. Additionally, age, time between admission and surgery, blood hemoglobin concentration, serum total protein level, serum albumin level, and body mass index (BMI) at admission were compared between the two groups using a non-paired *t*-test. Furthermore, stepwise binomial logistic regression analysis was carried out to determine the independent risk factors for pneumonia. The dependent variable was the presence or absence of pneumonia, and the independent variables were sex, age, fracture side, type of fracture, operative procedure, time between admission and surgery, blood hemoglobin concentration, serum total protein level, serum albumin level at admission, coexisting diseases, and history of stroke. Adjusted odds ratios were calculated for the selected risk factors. IBM SPSS Statistics 17 (SPSS Inc., Chicago, IL, USA) was used for statistical analysis, and data were expressed as mean \pm standard deviation (SD). $P < 0.05$ was considered significant.

This study was approved by the Kawasaki Medical School Ethics Review Committee (Application number: 707-1).

Results

1. Patient demographics and rate of concomitant pneumonia

A total of 145 hip fracture patients (35 men, 110 women; mean age \pm SD, 82.9 ± 7.2 years, age range, 67–96 years) met the inclusion criteria. No differences were found between the sexes in age (men, 82.3 ± 6.7 years; women, 83.1 ± 7.3 years).

The fracture was on the right side in 74 patients and on the left side in 71 patients. The types of fractures were femoral neck fractures ($n=67$) and intertrochanteric fractures ($n=78$). The operative procedures were hip hemiarthroplasty ($n=57$) and multiple pinning ($n=10$) for femoral neck fractures, and gamma nail fixation ($n=76$) and compression hip screw (CHS) fixation ($n=2$) for intertrochanteric fractures. The mean time between admission and surgery was 5.4 ± 5.2 days

(range, 0–35 days).

The pneumonia group comprised 21 patients, and the non-pneumonia group comprised 124 patients, showing that pneumonia was present in 14.5% of all hip fracture cases (14.3% in men and 14.5% in women). One patient in the pneumonia group died (4.8% of the pneumonia group, 0.7% of all patients), while no deaths were reported in the non-pneumonia group. The pneumonia group included 10 patients in the preoperative and 11 in the postoperative pneumonia group. Of the 21 patients in the pneumonia group, 17 were provided with normal meals from admission. Three patients were given energy-controlled meals due to diabetes, and one patient was fasting. None of the patients were provided with dysphagia diet.

2. Relationships between the rate of pneumonia and various factors

Of the various factors (sex, fracture side, type of fracture, operative procedure, coexisting diabetes/psychiatric disorders/dementia, and history of stroke), coexisting psychiatric disorders and history of stroke demonstrated significant associations with the rate of pneumonia (Table 1).

Comparisons between the pneumonia and the non-pneumonia groups in age, time between admission and

surgery, blood hemoglobin concentration, serum total protein level, and serum albumin level are shown in Table 2. The pneumonia group tended to be older, but this difference was not significant. The time between admission and surgery was significantly longer in the pneumonia than in the non-pneumonia group. Blood hemoglobin concentration, serum total protein level, and serum albumin level were all significantly lower in the pneumonia group.

BMI was unable to be calculated in 3 of the 21 patients in the pneumonia group because their heights were not measured preoperatively. Consequently, these 3 patients were excluded from the comparison of preoperative vs. postoperative pneumonia groups. The mean age of the resulting pneumonia group was 82.9 ± 7.12 years, with a mean BMI of 19.89 ± 3.12 kg/m². Sex, fracture side, type of fracture, operative procedure, coexisting diabetes/psychiatric disorders/dementia, and history of stroke were compared between the two groups, but no significant differences were found (Table 3). In addition, no significant differences were observed between the preoperative and postoperative pneumonia groups in age, time between admission and surgery, blood hemoglobin concentration, serum total protein level, serum albumin level, or BMI at admission (Table 4).

Table 1. Association between presence or absence of pneumonia and various factors.

Factor		Pneumonia group	Non-pneumonia group	T-value	P-value
Sex	Male	5	30	0.001	0.97
	Female	16	94		
Fracture side	Right	11	63	0.018	0.894
	Left	10	61		
Type of fracture	Femoral neck fracture	9	58	0.111	0.739
	Intertrochanteric fracture	12	66		
Operative procedure	Hip hemiarthroplasty	9	48	3.809	0.283
	Multiple pinning fixation	0	10		
	Gamma nail fixation	11	65		
	CHS fixation	1	1		
Diabetes	Coexisting	4	40	1.483	0.223
	Not coexisting	17	84		
Psychiatric disorders	Coexisting	7	14	7.045	0.008**
	Not coexisting	14	110		
Dementia	Coexisting	5	22	0.436	0.509*
	Not coexisting	16	102		
Stroke	With prior history	7	19	3.959	0.047
	No history	14	105		

Note CHS, compression hip screw.

* $P < 0.05$, ** $P < 0.01$.

Table 2. Association between presence or absence of pneumonia and age, days until surgery, and blood test data at admission.

Factor	Pneumonia group (N=21)	Non-pneumonia group (N=124)	P-value
Age (y)	84.8±7.4	82.6±7.1	0.208
Days between admission and surgery	7.48±5.73	4.99±5.00	0.041*
Blood Hb concentration	10.5±2.2	11.4±1.9	0.049*
Serum total protein level	6.4±0.6	6.88±0.75	0.006**
Serum albumin level	3.33±0.44	3.80±0.45	<0.001**

* $P < 0.05$, ** $P < 0.01$.**Table 3.** Association between time of pneumonia onset and various factors.

Factor	Preoperative pneumonia (N=9)	Postoperative pneumonia (N=9)	T-value	P-value
Sex	Male	2	0.277	0.599
	Female	7		
Fracture side	Right	6	0.900	0.343
	Left	3		
Type of fracture	Femoral neck fracture	4	0.000	1.000
	Intertrochanteric fracture	5		
Operative procedure	Hip hemiarthroplasty	4	1.111	0.574
	Gamma nail fixation	5		
	CHS fixation	0		
Diabetes	Coexisting	1	0.400	0.527
	Not coexisting	8		
Psychiatric disorders	Coexisting	2	2.777	0.599
	Not coexisting	7		
Dementia	Coexisting	3	0.277	0.599
	Not coexisting	6		
Stroke	With prior history	7	1.000	0.317
	No history	2		

Note CHS, compression hip screw.

3. Independent risk factors for pneumonia

Of the independent variables, the following factors were determined to be associated with pneumonia prior to regression analysis: time between admission and surgery ($P=0.041$); blood hemoglobin concentration ($P=0.048$); serum total protein level ($P=0.006$); serum albumin level ($P=0.000$); coexisting psychiatric disorders ($P=0.008$); coexisting dementia ($P=0.041$); and history of stroke ($P=0.047$). Serum albumin level and coexisting psychiatric disorders were determined to be independent risk factors on regression analysis (Table 5).

Discussion

According to the “Practice Guideline for Treatment of Femoral Neck and Trochanteric Fractures” in Japan, the most common postoperative complication of hip fracture is pneumonia, affecting about 3.2% of the cases. Moreover, pneumonia is the most common complication that results in death in these patients during hospitalization, accounting for 30–44% of cases [12]. Previous studies that investigated hip fracture resulting from a fall reported that pneumonia occurred before and after surgery in 7–9% of cases [9–11]. Although the rate of pneumonia in the present

Table 4. Association between time of pneumonia onset and age, days until surgery, and blood test data at admission.

Factor	Preoperative pneumonia group (N=9)	Postoperative pneumonia group (N=9)	P-value
Age (y)	85.0±8.69	85.8±6.24	0.830
Days between admission and surgery	9.11±5.23	6.33±6.58	0.336
Blood Hb concentration	10.3±2.28	10.9±2.35	0.563
Serum total protein level	6.48±0.57	6.44±0.69	0.884
Serum albumin level	3.54±0.39	3.13±0.48	0.064
BMI (kg/m ²)	19.5±3.14	20.3±3.24	0.610

Table 5. Independent factors associated with pneumonia.

Factor	Partial regression coefficient B	Odds ratio Exp (B)	95% confidence interval	
			Lowerlimit	Upperlimit
Serum albumin level	-1.922	0.146	0.053	0.405
Coexisting psychiatric disorders	1.439	4.215	1.34	13.255
Constant	4.792	120.5		

study was less than 14.5%, these other reports demonstrated high 30-day-or-less mortality rates; specifically, the mortality rates of pneumonia patients were 43% according to Roche et al. [9] and 37.1% according to Khan et al. [11]. Only one patient died in the present study. This indicates that the other reports only investigated patients who were diagnosed with severe pneumonia, and that mild pneumonia may have been overlooked. Typically, antibiotics are used immediately after hip surgery, and this may have been why patients with mild pneumonia recovered without the illness being noticed. The higher rate of pneumonia in the present study does not indicate that poor medical management was provided at our institution; rather, we postulate that this was due to our verifying the diagnosis of pneumonia under a strict set of guidelines.

According to a recent report from the Japanese Health, Labour and Welfare Statistics Association, the number of ≥70-year-old persons receiving medical care for pneumonia was 150 per 100,000 elderly people, and this number increased in individuals in their 80s and 90s [13]. Teramoto et al. reported that 80.1% of patients ≥70 years old who were hospitalized with pneumonia had aspiration pneumonia [14]. Based on these reports, we can deduce that it is necessary to actively suspect aspiration pneumonia when elderly inpatients who had not been diagnosed with community-acquired pneumonia develop pneumonia. Aspiration

pneumonia is known to occur in 7–28% of stroke patients [7, 8]. Since patients who developed aspiration pneumonia concurrently with stroke in these reports were younger at the time of onset than the hip fracture patients in the present study, a direct comparison may be problematic. However, since the rate of pneumonia with hip fracture was much greater than expected, and since the study population comprised older individuals, it is highly likely that the majority of these patients had aspiration pneumonia. Therefore, the prevention and early diagnosis of pneumonia are critical challenges.

To the best of our knowledge, there are no reports concerning the risk factors for pneumonia that develops in association with hip fractures. In the present study, risk factors that are highly associated with aspiration pneumonia were retrospectively investigated. Coexisting psychiatric disorders, history of stroke, time between admission and surgery, blood hemoglobin concentration, serum total protein level, and serum albumin level were factors that were highly associated with pneumonia. In particular, serum albumin level and coexisting psychiatric disorders were independent risk factors. Regardless of when pneumonia developed, no differences were evident in BMI and serum albumin levels at admission. According to the 2010 National Health and Nutrition Survey conducted by the Ministry of Health, Labour and Welfare, the BMI of elderly people with ages

similar to the mean age of the pneumonia group in the present study was 22.49 ± 3.01 kg/m² in men and 22.63 ± 3.82 kg/m² in women [15]. Compared to these numbers, the BMI of the pneumonia group in the present study tended to be lower from the time of admission, with a mean of 19.89 ± 3.12 kg/m². This signified that patients hospitalized due to malnutrition, including those with a history of stroke, are more susceptible to pneumonia due to weakened resistance to infection. In addition, Ohno et al. reported that hip fracture patients with low rapid turnover protein (RTP) have decreased repetitive saliva swallowing test (RSST) scores [16], indicating a high probability that hip fracture patients who are malnourished also have decreased swallowing function. It is often difficult to perform oral care in patients with coexisting psychiatric disorders, and this may have been the cause of pneumonia (especially aspiration pneumonia) in the present study.

In the present investigation, sufficient information regarding the presence or absence of dysphagia, frequency of oral care, and premorbid living circumstances, primarily concerning meals, could not be obtained. Such information is typically given little attention when patients are hospitalized due to illnesses that are seemingly unrelated to dysphagia, and consequently, normal meals are usually provided unsuspectingly. With the exception of one patient who was instructed to fast, patients who developed pneumonia in the present study were not provided with a dysphagia diet. While we cannot assume that this had caused pneumonia, it is important to assess the following: the presence or absence of dysphagia, which is profoundly associated with aspiration pneumonia; frequency of oral care; and premorbid living circumstances, especially the meals taken when patients with a hip fracture, which is common in older people, are admitted to the hospital. Moreover, this study was limited to examining the presence or absence of psychiatric disorders based on the symptoms listed in the medical records. In older people, psychiatric and dementia symptoms are frequently affected by hospital-associated deconditioning (such as restraint, malnutrition, and drug administration), and swallowing function exacerbates transiently as a result. Since this was a retrospective study, an in-depth analysis of the causes of psychiatric disorders could not be performed, but a prospective study examining the details of psychiatric disorders would be helpful for preventing aspiration pneumonia, though elucidating the causes of psychiatric disorders observed in the present study would also have been helpful in preventing aspiration pneumonia.

Regarding patients who waited a long time between admission and surgery, since this was a retrospective study, the cause of this was unknown; however, it is presumed that the time needed to confirm that patients with concurrent conditions such as malnutrition or

decreased cardiac function could undergo general anesthesia was one of the factors that led to a prolonged waiting period. Since these patients did indeed undergo surgery eventually, an unnecessarily long waiting period until surgery is considered unfavorable.

Several variables identified in the present study, namely blood hemoglobin concentration, serum total protein level, and serum albumin level, were measured at the time of admission. Therefore, malnutrition indicates the patient's condition prior to the fracture injury and is not a result of pneumonia-induced energy consumption. If serum albumin levels are low at admission, the chances of preventing at least aspiration pneumonia may increase by taking specific intervention measures such as thorough oral care and selection of diet, nutritional support, indirect swallowing therapy, and early rehabilitation to improve physical activity [7, 8]. In the present study, it was not possible to determine the cutoff serum albumin level for susceptibility to pneumonia. Determining the cutoff value in future studies is important from the perspective of pneumonia prevention. Moreover, since this was a retrospective study, it is unclear to what extent concomitant pneumonia was expected. In the future, it will be necessary to verify whether the rate of pneumonia decreases with comprehensive prevention of aspiration pneumonia.

Although the onset of pneumonia is not necessarily linked directly to death, it is predicted that decreased physical activity, such as motor dysfunction, will arise. It has been reported that there are marked decreases in the Barthel Index (odds ratio: 3.8) and the Modified Rankin scale score (odds ratio: 3.4) in aspiration pneumonia that accompanies stroke [17]. Since there are no reports regarding the association between aspiration pneumonia and physical activity following hip fractures, future studies on this topic are needed.

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