Inpatient knee pain after hip fracture surgery affects gait speed in older adults - a retrospective chart-referenced study

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Title Page

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Inpatient knee pain after hip fracture surgery affects gait speed in older adults - a retrospective chart-referenced study

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Abstract [245 words]

Aim: Post-hip fracture knee pain (PHFKP) develops in 28–37.4% of patients with hip fracture and contributes to prolonged hospitalization. Although reduced balance and gait speed contribute to falls, the effects of PHFKP remain unclear. This study aimed to clarify whether PHFKP is a factor in balance and gait speed.

Methods: We retrospectively reviewed the medical records of patients after hip fracture. Development of PHFKP, basic information, and physical function were examined. Berg balance scale (BBS) and maximum walking speed (MWS) were collected at discharge. These parameters were compared with the presence or absence of PHFKP. In addition, multiple analyses were conducted with BBS and MWS as dependent variables and PHFKP as one of the independent variables.

Results: Of the 146 patients enrolled, 43 (29.5%) developed PHFKP, and 37.2% of patients with PHFKP showed residual symptoms at discharge. Intensity of PHFKP was mostly mild to moderate. The PHFKP group showed extended length of stay (+13.3 days) and a tendency toward more discharges to facilities compared to the control group. Knee extension range of motion limitation, knee extensor strength, and BBS did not differ between groups, while MWS was significantly lower in the PHFKP group (0.85±0.32m/s vs. 1.07±0.39m/s). Multiple analyses showed that development of

PHFKP was not associated with BBS, but was associated with declined MWS (standardized beta = -0.202, *P* = 0.005).

Conclusions: PHFKP was identified as an independent factor in gait speed decline. PHFKP patients should be monitored for reduced gait speed during rehabilitation.

Key words

aged, hip fracture, knee joint, pain, walking speed

Text [2,683 words in total for abstract and text]

Introduction

Hip fractures occur more frequently in old and very old individuals, with 75% of these injuries occurring among individuals ≥75 years old.[1] The absolute number of hip fractures is thus strongly influenced by observed demographic changes. With a significant increase in the number of older adults worldwide predicted by 2050,[2] the problems caused by hip fracture are likely to become increasingly important. This problem is of particular prominence in Asia,[3] and 45% of hip fractures are expected to occur in Asia by 2050, increasing from 1.12 million in 2018 to 2.56 million (2.28 times).[4] Hip fracture patients require post-injury rehabilitation, which is enormously expensive and represents a serious problem in terms of healthcare costs.[5]

Older adults are more likely to fall during hospitalization,[6] and patients with a first hip fracture have a higher risk of a second fracture than those with no hip fracture.[7] In addition, many older adults fail to recover after hip fracture surgery and falls are a frequent cause of death.[8] Furthermore, second fracture is more likely to occur within a short period of time after the first fracture.[9] Because of this, predicting and preventing falls during hospitalization after hip fracture is important.

Recent studies have shown that post-hip fracture knee pain (PHFKP) is common in rehabilitation after hip fracture, with an incidence of 28–37.4%.[10,11,12] Knee osteoarthritis (OA)[11] and intertrochanteric femoral fracture[10,12] have been reported as risk factors for PHFKP. In addition, postoperative varus deformity in the neck-shaft angle of the affected lower extremity has been associated with the development of PHFKP, and intertrochanteric femoral fracture has been shown to have greater varus deformity.[10] Thus, although the clinical features of PHFKP have been clarified, physical function characteristics that may contribute to falls remain unclear.

Physical function factors known to influence falls include balance function[13] and gait speed.[14] In older adults after hip fracture, age, sex, and cognitive decline have been reported as factors associated with balance function,[15] and sex, type of fracture, knee extensor strength, and cognitive decline have been reported as factors associated with gait speed.[16] The clinical question of this study is whether PHFKP development during hospitalization could be a factor influencing balance function and gait speed.

Clarification of the relationship between PHFKP and physical function is important in determining the weighting of interventions in the postoperative rehabilitation of hip fracture patients with PHFKP. The aims of this study were to: 1) investigate whether PHFKP is a factor in balance function and gait speed; and 2) identify precautions for the rehabilitation of PHFKP patients.

Material and Methods

Research design

This study comprised a retrospective review of medical records of patients during rehabilitation after hip fracture surgery. All study protocols were approved by the ethics committee at Hidaka Hospital (approval number: 301), and the need to obtain informed consent was waived due to the retrospective nature of the study.

Patients

Data from 471 postoperative hip fracture patients admitted to the convalescent ward of Hidaka Hospital between March 2012 and August 2020 were included according to the following inclusion criteria: age >65 years; and history of hip fracture for which surgery had been performed. Exclusion criteria were: cognitive impairment (revised Hasegawa Dementia Scale score <21);[17] any knee pain at rest or during gait within 3 months before hip fracture;[11] no gait exercises; ipsilateral knee replacement or fractures around the knee; history of stroke; sudden transfer due to onset of another disease or recurrent fractures; or missing data.

All participants in the present study underwent a conventional rehabilitation program prescribed by a physician and conducted by physical therapists and occupational therapists, as required. A rehabilitation program was started within 1–3 days postoperatively. Therapies were customized and involved muscle strength, balance, gait, and activities of daily living. Rehabilitation was performed 7 days/week, for 1–2 h/day.

Data collection

Basic information, parameters at discharge, physical function at discharge, and information on the development of PHFKP were collected from medical records. Basic information included age, sex, body mass index (BMI), type of fracture (femoral neck fracture or intertrochanteric femoral fracture), American Society of Anesthesiologists physical status (ASA-PS), and use of analgesics. The ASA-PS is an index for classifying the general state of a patient based on their comorbidities.[18] The admission parameter was the Functional Independence Measure motor score (FIM-motor). Discharge parameters were: discharge destination (home or facility), length of hospital stay (days from surgery to discharge), FIM-motor, gait ability (Functional Ambulation Categories: FAC), and gait independence (FAC 0–3, not independent; 4–5, independent). Physical function on admission was measured using knee extension range of motion (KE-ROM) limitation and manual muscle testing of knee extension (MMT). Physical function at discharge was measured using KE-ROM limitation, MMT, Berg balance scale (BBS), and maximum walking speed (MWS). MWS was measured on a 10-m gait path. PHFKP defined pain as present if the pain, including the word “knee (affected side),” was noted in the medical records along with a record of the numerical rating scale (NRS). We referred to three locations in the medical record: 1) results of physical therapy assessment, as regular assessments for all patients that always collect pain information, performed by the physical therapist on admission to the ward and at discharge; 2) daily chart entries by the physical therapist; and 3) pain location and pain intensity recorded daily by nurses. PHFKP was surveyed in the two phases. The early period was 1 week from the time of physical therapy assessment immediately after admission, and the late period was 1 week before the physical therapy assessment at discharge. Pain intensity was assessed by NRS and the maximum recorded score was considered representative. The NRS is a 10-point pain rating scale, categorized as: 1–3, mild; 4–7, moderate; and 8–10, severe pain.[19]

To prevent information bias, sheets recording the primary outcome, PHFKP, and sheets recording other basic information and radiographic analysis were kept separately and collected on separate days.

Statistical analysis

For continuous variables, the mean, standard deviation, median and interquartile range (25–75%) are presented. Categorical variables are presented in terms of the number of patients. Basic information, FIM-motor as the admission parameter, discharge parameters, and physical function were compared between groups with and without PHFKP. Student's t-test was used to compare continuous variables with a normal distribution, and the Mann-Whitney test was used for variables with a non-parametric distribution. The chi-square test was used to compare categorical variables. As age differed significantly in the above comparisons between the two groups, *P*-values adjusted for age were calculated for all parameters except age. Adjustment of continuous variables was done by analysis of covariance (ANCOVA) for normally distributed variables and by non-parametric ANCOVA for non-parametric distributed variables.[20] For categorical variables, age was stratified into age groups of 65–74 years, 74–84 years, and 85 years and older, and adjusted *P* values were calculated using the Cochran-Mantel-Haenszel Tests.[21]

Multiple analysis with a forward stepwise selection method was conducted to clarify the effect of PHFKP on balance function and gait speed, using BBS and MWS as

154 dependent variables. Patients were divided into two groups using a BBS cut-off value for falls (50 points),[22] as the BBS was not normally distributed. Logistic regression analysis was then performed. As MWS showed a normal distribution, multiple linear regression analysis was performed with the MWS value as the dependent variable. For both BBS and MWS, PHFKP, age, sex, BMI, type of fracture, ASA-PS, use of analgesics, ROM on admission, and MMT on admission were entered as independent variables. Variance inflation factor (VIF) was calculated for the independent variables entered to check for multicollinearity.

A two-sided *P*-value less than 0.05 was considered statistically significant. All statistical analyses were performed using IBM SPSS version 26 statistical software (IBM Corp., Armonk, NY, USA) and R statistical software.

Results

Of the 471 patients who met the inclusion criteria, 325 met the exclusion criteria (Figure 1). Overall, 43 of the 146 patients (29.5%) developed PHFKP. PHFKP was present in the early period in 39 patients and in the late period in 20 patients, with 16 patients (37.2%) showing pain in both the early and late periods. Pain intensity in the early phase was mild in 18 patients, moderate in 18, and severe in 3. Pain intensity in the late phase was mild in 15 patients, moderate in 4, and severe in 1. Mean duration from date of surgery to initial assessment was 25.6 ± 14.7 days.

Table 1 shows basic information, FIM-motor as the admission parameter, discharge parameters, and physical function for all subjects. Table 2 shows basic information, FIM-motor as the admission parameter, discharge parameters, pain intensity, and physical function in the non-PHFKP and PHFKP groups. The PHFKP group was older (*P* = 0.019) and showed a higher frequency of intertrochanteric femoral fracture (*P* = 0.010, adjusted *P* = 0.014). The PHFKP group tended to be more frequently discharged to a facility (*P* = 0.028, adjusted *P* = 0.086). Mean length of stay was 13.3 days longer in the PHFK group (*P* < 0.001, adjusted *P* < 0.001). FIM, FAC, and frequency of gait independence did not differ significantly according to age-adjusted *P*-values. KE-ROM limitation, MMT, and BBS (*P* = 0.034, adjusted *P* = 0.254) showed no significant difference between groups, while MWS (*P* = 0.001, adjusted *P* = 0.006) was significantly lower in the PHFKP group.

Table 3 shows the results of logistic regression analysis with BBS as the dependent variable. BBS was good in 85 patients and poor in 61 patients. Age, type of fracture, and MMT were selected as factors, while PHFKP was not. Table 4 shows the results of multiple linear regression analysis with MWS as the dependent variable.

PHFKP (standardized beta (β) = -0.202, P = 0.005), age (β = -0.438, P < 0.001), sex (β = -0.156, P = 0.025), and BMI (β = 0.182, P = 0.009) were selected as significant factors. The model had an F-value of 18.49 and adjusted R^2 of 0.325 (P < 0.001). VIF of independent variables was small (1.022–1.061).

Discussion

The present study investigated whether PHFKP is a factor influencing balance function and gait speed. The results showed that patients with PHFKP had a significant decrease in MWS. Furthermore, multiple linear regression analysis showed that PHFKP was a factor independently associated with reduction of gait speed. In addition, more patients in the PHFKP group tended to be discharged to facilities. In the rehabilitation of patients with hip fractures, PHFKP represents a problem that should be kept in mind because of the risk of reducing gait speed.

The PHFKP group showed that MWS was significantly reduced and multiple linear regression analysis identified PHFKP as a factor associated with MWS. These results indicate PHFKP as a factor independently associated with reduced gait speed. In older adults, the cut-off value of MWS for falls is known to be 1.0 m/s.[23] The present results showed that mean values were less than the cut-off value in the PHFKP group.

Our results suggest that among hospitalized older adults hip fracture patients, many of whom have a MWS around 1.0 m/s, the risk of falling may be increased in patients who develop PHFKP.

Although FIM, FAC, and gait independence did not differ significantly, patients in the PHFKP group were more likely to undergo facility discharge, suggesting that PHFKP may have an impact on outcomes. However, the number of subjects in the PHFKP group was small, and further validation is needed for gait independence and discharge destination.

The PHFKP group showed a significant decrease in BBS scores, but the age-adjusted *P* value did not show a significant difference and BBS was not selected as an associated factor in logistic regression analysis. The reasons why PHFKP was a factor for MWS and not for BBS are considered below. Discrepancies have been reported between knee pain and knee OA severity.[24] Reduced gait speed has been reported to be caused by knee pain alone,[25] while balance function has been reported to be caused by knee OA severity,[26] not knee pain. Although not directly investigated, the exclusion of previous knee pain and the large number of patients with relatively mild pain intensity suggest that the number of patients with severe knee OA might have been small. PHFKP may therefore not have been selected as a factor in impaired balance function, although the association with reduced gait speed was strong.

The incidence of PHFKP in our study (29.5%) was similar to that reported in previous studies.[10,11,12] PHFKP patients were found to have more frequent intertrochanteric femoral fractures and a longer hospital stay by 13.3 days. These results were also significantly different after adjusting for age, and seem to be generalizable. As for hospital stay, a previous study confirmed that hip fracture patients with PHFKP stayed 5.1 days[12] longer in acute wards and 12.7 days[10] longer in convalescent wards, supporting the present results. KE-ROM limitation was significantly greater in the PHFKP group in the two-group comparison, but not after adjusting for age, suggesting that the effect of age was greater among subjects in this study. In the present analysis, we adjusted only for age. We therefore need to analyze factors associated with PHFKP in multiple analyses that also adjust for other variables to determine whether KE-ROM limitation is independently associated with the development of PHFKP.

Our results reveal for the first time that PHFKP caused decreases in gait speed, in addition to prolonging hospitalization.[11,12] Moreover, PHFKP may have an impact on discharge destination. Because of the potential for such problems, investigation of prevention and treatment methods for PHFKP is important. The findings from this study suggest a high risk of reduced gait speed in patients with PHFKP, which should be considered in rehabilitation.

The present study showed three main limitations. First, selection bias may have been present, as a large proportion of patients (325 of 471 patients) were excluded from analysis. Second, we used MMT to measure muscle strength. The MMT is subjective, and has low inter-rater reliability in differentiating between "normal" (score 5) and "good" (score 4).[27] For this reason, hand-held dynamometers are increasingly being used for quantitative muscle strength measurements.[28] Third, because this study investigated knee pain in a retrospective study, some patients with PHFKP may not have been included in the medical record.

In conclusion, MWS was lower in patients with PHFKP. In multiple analyses, PHFKP was not identified as a factor associated with BBS, but was a factor for MWS. The results revealed that PHFKP is independently associated with reduced gait speed. In the rehabilitation of patients who develop PHFKP after hip fracture, attention should be paid to findings of reduced gait speed.

Disclosure statement

The authors declare no conflict of interest.

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Figure legend

Figure 1

Flow diagram of participant data.

Table 1. Basic information, admission parameter, discharge parameters, and physical function for all participants

Variable	All participants (n = 146)
Basic information	
Age, years	80.5±7.9 (81, 75–86)
Sex, male/female	24/122
Body mass index, kg/m^2	20.5±3.2 (20.5, 18.1–22.6)
Type of fracture, femoral neck/intertrochanteric	83/63
ASA-PS, 1/2/3/4	36/65/43/2
Analgesic, taken/not taken	93/53
Admission parameter	
Functional Independent Measure motor score	50.3±16.2 (53, 38–63)
Discharge parameters	
Destination, home/facility	132/14
Length of hospital stay, days	70.3±18.5 (71, 57–82)
Functional Independent Measure motor score	76.7±11.4 (79, 72–85)
Functional ambulation categories, 2/3/4	1/14/131
Physical function at admission	
Manual muscle testing, 2/3/4/5	23/28/62/33
Knee extension range of motion, degrees	3.8±5.6 (0, 0–5)
Physical function at discharge	
Manual muscle testing, 3/4/5	7/42/97
Knee extension range of motion, degrees	3.3±5.3 (0, 0–5)
Berg balance scale	49.8±6.4 (52, 46–55)
Maximum walking speed, m/s	1.01±0.35 (0.99, 0.78–1.2)

Values are shown as mean±SD (median, interquartile range).

Table 2. Comparison of basic information, discharge parameters and physical function between groups

Variable	Non-PHFKP (*n* = 103)	PHFKP (*n* = 43)	Unadjusted *P* value	Adjusted *P* value
Basic information				
Age, years	79.1±8.3 (80, 72-86)	82.6±7.1 (83, 78-88)	0.019[a]	-
Sex, male/female	20/83	4/39	0.150[c]	0.187
Body mass index, kg/m^2	20.3±3.2 (20.4, 18-22.2)	20.9±3.3 (21, 18.1-23.5)	0.283[a]	0.192
Type of fracture, femoral neck/intertrochanteric	66/37	17/26	0.010[c]	0.014
ASA-PS, 1/2/3/4	27/45/30/1	9/20/13/1	0.845[c]	0.917
Analgesic, take/not taken	66/37	27/16	0.883[c]	0.877
Admission parameter				
Functional Independent Measure motor score	51.7±15.9 (54, 39-64)	46.9±16.7 (51, 29-62)	0.117[b]	0.078
Discharge parameters				
Destination, home/facility	97/6	35/8	0.028[c]	0.086
Length of hospital stay, days	66.4±18.4 (66, 53-78)	79.7±14.9 (79, 69-87)	<0.001[a]	<0.001
Functional Independent Measure motor score	77.5±12.2 (80, 73–87)	74.7±8.9 (76, 70–80)	0.141[b]	0.241
Functional ambulation categories, 2/3/4	0/7/96	1/7/35	0.058[c]	0.213
Pain intensity, numerical rating scale				
Early period	0	3.6±2.1 (3, 2-5)	-	-
Late period	0	1.3±1.8 (0, 0-2)	-	-
Physical function at admission				
Manual muscle testing, 2/3/4/5	19/17/42/25	4/11/20/8	0.311[c]	0.371
Knee extension range of motion, degrees	2.5±4.1 (0, 0-5)	6.9±7.6 (5, 0-10)	0.012[b]	0.244
Physical function at discharge				
Manual muscle testing, 3/4/5	5/26/72	2/16/25	0.342[c]	0.425
Knee extension range of motion, degrees	2.2±3.7 (0, 0-5)	5.9±7.3 (5, 0-10)	<0.002[b]	0.236
Berg balance scale	50.6±6.1 (52, 47–55)	47.9±6.7 (49, 44–54)	0.034[b]	0.254
Maximum walking speed, m/s	1.07±0.39 (1.04, 0.85-1.3)	0.85±0.32 (0.89, 0.59-1.11)	0.001[a]	0.006

Values are shown as mean±SD (median, interquartile range).

PHFKP, post-hip fracture knee pain. The threshold for significance is $P < 0.05$.

[a] Independent t-test. [b] Mann-Whitney U test. [c] Chi-squared test.

Adjusted *P*-value is the *P*-value adjusted for age.

Table 3. Logistic regression analysis for variables on the Berg balance scale (*n* = 146)

Independent variables	β	Odds ratio [95%CI]	*P* value
Age	0.141	1.151 [1.082–1.225]	<0.001
Type of fracture	1.252	3.496 [1.564–7.815]	0.002
Manual muscle testing	-0.501	0.606 [0.394–0.931]	0.022

The threshold for significance is $P < 0.05$. β, standardized beta.

Table 4. Multiple regression analysis for variables on the maximum walking speed (*n* = 146)

Variable	β	*P* value	VIF	R^2	Adjusted R^2	F
Maximum walking speed				0.344	0.325	18.49**
PHFKP	-0.202	0.005	1.061			
Age	-0.438	<0.001	1.054			
Sex	-0.156	0.025	1.022			
BMI	0.182	0.009	1.029			

PHFKP, post-hip fracture knee pain; VIF, variance inflation factor. β, standardized beta.

The threshold for significance is $P < 0.05$. ** Significant at $P < 0.001$ level.

Figure

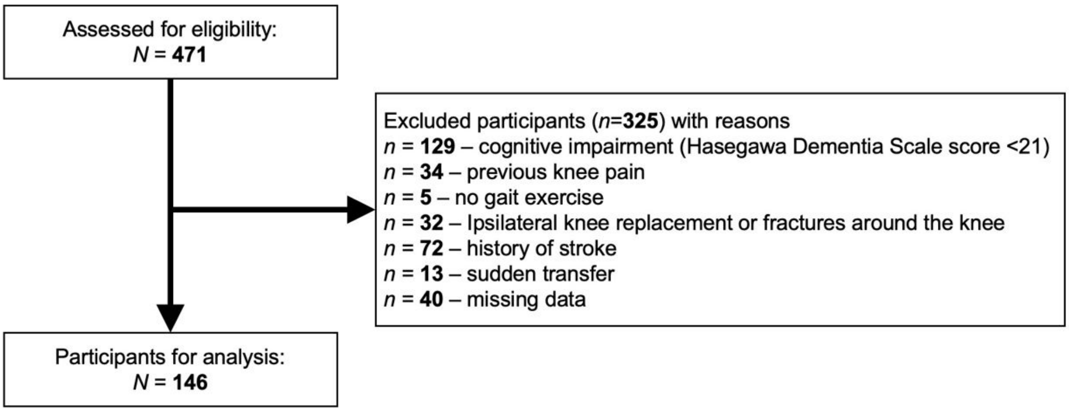

Figure 1

Flow diagram of participant data