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Original Article

Risk Factors and Clinical Outcomes of Delirium after Hip Fracture Surgery in Korean Older Adults: A Retrospective Study

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SUMMARY

Background: Delirium is the most common complication as well as the most significant cause of various clinical outcomes in older adults who undergo hip fracture surgery. However, there is scarce consensus on this. This study aimed to investigate the risk factors for delirium, its incidence and features, and clinical outcomes in Korean older adults who had undergone hip fracture surgery.
Methods: This retrospective study was conducted at Gyeonggi Provincial Medical Center Paju Hospital. Data (N = 231) were obtained between January 2016 and May 2019 using electronic medical records. Delirium was evaluated using a Korean version of the Nursing Delirium Screening Scale. The data were analyzed using descriptive statistics, independent t-test, chi-squared test, and logistic regression using SPSS 23.0 software.
Results: The incidence of delirium among older adults after hip fracture surgery was 45%. Multiple logistic regression identified higher age (odds ratio [OR] = 1.72, $p < 0.001$), low albumin level (OR = 2.65, $p = 0.005$), high creatinine level (OR = 2.97, $p = 0.003$), and dependent mobility status (OR = 3.84, $p < 0.001$) as risk factors for delirium. Compared to the non-delirium group, the delirium group was more likely to be admitted to a nursing home instead of returning home after discharge, owing to their inability to carry on independent living, and had significantly higher postoperative complications as well as fall, one-year readmission, and mortality rates.
Conclusion: Older adults are vulnerable to delirium after hip fracture surgery. Patients who experience delirium are at an elevated risk for complications and worsening of clinical outcomes. Therefore, multidisciplinary action and management efforts are needed.

1. Introduction

The increase in population aging is anticipated to result in a global rise in the number of hip fracture cases.[1,2] In South Korea, the incidence of hip fractures has nearly doubled over the past decade, with a sharp spike in one-year mortality rate to 20%.[3] Hip fracture is a major health problem and an important cause of functional decline among older adults,[4] thereby having a potentially grave impact on their lives.[5] The first-line treatment for hip fracture is surgical intervention to restore lost functions, but the postoperative complication rate is nearly 75%.[6] However, as the repercussions of absence of surgery outweigh those of postoperative complications, surgery is recommended at the earliest possible stage.[6]

Delirium is one of the most common postoperative complications of hip fracture surgery (HFS) among older adults.[7] While the incidence of postoperative delirium in other types of surgery ranges from 7% to 14%, it is very high in HFS, at 26–61%.[8] In a previous study, patients who developed delirium postoperatively had a 2.5 times higher mortality rate over a period of six months, 2.2 times greater reduction in activities of daily living,[9] and an average of four days or longer in-hospital stay.[10] Moreover, older adults who develop delirium after HFS are at an elevated risk of falls with no early ambulation, which, in turn, induces various complications such as bedsores, embolism, and pneumonia, thereby worsening prognosis and increasing mortality.[11] Thus, it is important to examine the incidence of falls or complications among patients with delirium to investigate the impact of these factors on mortality. Therefore, the research questions are as follows:

1. What are the risk factors for delirium in older adults who have undergone HFS?
2. Do clinical outcomes of HFS differ according to the onset of delirium?

2. Materials and methods

2.1. Study population and data collection

Of 319 older adults who had undergone HFS at the department of orthopedic surgery at the Gyeonggi Provincial Medical Center Paju Hospital between January 1, 2016 and May 30, 2019, 231 who met the inclusion criteria were enrolled in this study. The specific inclusion criteria were older adults who underwent HFS, had been followed up for one year after discharge, and had no missing data

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pertaining to underlying disease, blood test results, and surgery-related factors in the electronic medical records. Complete data were used to lower the risk of attrition bias. Patients with a history of hip surgery, those who had been diagnosed with dementia prior to injury, those with cerebrovascular or neurological disease, and those transferred to another hospital were excluded. Sample size was calculated with reference to a prior study[12] using G*Power 3.1.9.2 software. For a two-tailed logistic regression with an odds ratio (OR) of .17, incidence (Pr) of .45, significance (α) of .05, power (1-β) of 80%, and Nagelkerke R^2 of .2, the minimum sample size was 163, based on which our sample size was deemed appropriate.

Data were collected using the hospital's electronic medical records by two registered nurses with more than 10 years of clinical experience at an orthopedic surgical ward. Interrater agreement for the 231 participants' data was analyzed with Cohen's kappa and percentage, and the results (96%, kappa of .91) indicated almost perfect agreement.

2.2. Measurement tools

Delirium was measured using the Korean Nursing Delirium Screening Scale (Nu-DESC),[13] an authorized adaptation of Gaudreau et al.'s.[14] Nu-DESC. The Nu-DESC consists of five areas: disorientation, inappropriate behavior, inappropriate communication, illusions or hallucinations, and psychomotor retardation. Each item is given a score of 0 (no symptoms) or 1 (symptoms present), for a total score ranging from 0 to 5. A score of 2 or higher is diagnosed as delirium. This instrument is appropriate for use in a clinical setting, as nurses are able to quickly and easily screen for delirium simply through observation and even screen for hypoactive delirium. The sensitivity and specificity were .85 and .86, respectively, for the original instrument and .81 and .97, respectively, for the Korean version.

2.3. Statistical analysis

SPSS version 23.0 (IBM Corp., Armonk, NY, USA) was utilized for data analysis. Participants' demographic and clinical characteristics and clinical outcome parameters were analyzed using frequency with percentage or mean with standard deviation. Variations according to delirium status were tested for normality using the Shapiro-Wilk test, with continuous variables analyzed using independent t-tests and categorical variables using chi-squared tests. The risk factors for delirium were analyzed with logistic regression, and the fit of the model was tested using the Hosmer-Lemeshow goodness-of-fit test.

2.4. Ethical statement

Ethical considerations (plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) were completely observed by the authors. This study was approved by the institutional review board (IRB approval number: PJMC-2019-101).

3. Results

3.1. Demographic and clinical characteristics of the sample

As shown in Table 1, the delirium and non-delirium groups differed significantly according to age, ambulation and functional state, diabetes mellitus, creatinine level, albumin level, SPaO2 level, and whether blood transfusion was performed. The mean age of the delirium group (83.5 years) was 4.5 years higher than that of the non-delirium group ($p < 0.001$), with significant differences according to preoperative ambulation and functional state ($p < 0.001$) and having diabetes as a pre-existing condition ($p = 0.002$). Regarding hematologic findings, there were statistically significant differences when creatinine ($p = 0.006$), albumin ($p < 0.001$), and SPaO2 ($p < 0.001$) levels were abnormal and when blood transfusion was performed ($p < 0.001$) (Table 1).

3.2. Incidence and features of delirium

Of 231 participants, 104 were diagnosed with delirium, with an incidence of 45%. The most common feature of delirium was disorientation (n = 89, 85.6%), followed by inappropriate behavior (51.9%), inappropriate communication (36.5%), illusions/hallucinations (7.7%), and psychomotor retardation (1.9%). The most common time of delirium onset was nurses' night shift hours (22:00–06:00; 71.1%), and restraints were applied for patient safety in 68 cases (65.4%). Delirium most commonly occurred within 24 hours after HFS (46.2%), followed by postoperative day 1 (33.7%) and day of admission (11.5%) (Table 2).

3.3. Delirium risk factors

The results showed that delirium occurrence significantly differed according to age, albumin level, creatinine level, and ambulation and functional state. The odds for delirium were 1.72 times higher with higher age (OR = 1.72, $p < 0.001$), 2.65 times higher with an albumin level below the normal range ($\geq$ 3.5 g/dL) (OR = 2.65, $p = 0.005$), 2.97 times higher with a creatinine level above the normal range ($\leq$ 1.17 mg/dl) compared to those with normal levels (OR = 2.97, $p = 0.003$), and 3.84 times higher with a preoperative dependent mobility status (OR = 3.84, $p < 0.001$). The Hosmer-Lemeshow test confirmed a good model fit ($\times^2 = 6.75$, $p = 0.563$). The proportion of variance explained was determined using the Nagelkerke R^2 (45%), and the classification accuracy of the presence of delirium was 88.9% (Table 3).

3.4. Comparison of clinical outcomes according to delirium status

The fall incidence after HFS was significantly higher in the delirium group (25%) than the non-delirium group (2.4%) ($p < 0.001$). Postoperative complication rates were also higher in the delirium group, with the highest rate for bedsores (55.8%), followed by pneumonia (24.0%) and urinary tract infection ($p < 0.001$). Regarding destination after discharge, in the delirium group, 76.4% went to a nursing home while 24.6% returned home, with the percentages significantly different in the non-delirium group (36.5% and 63.5%, respectively) ($p = 0.036$). The one-year readmission rate was higher in the delirium group (37.5%) than in the non-delirium group (24.4%) ($p = 0.012$), and the one-year mortality rate also significantly differed, with 52.9% in the delirium group and 14.1% in the non-delirium group ($p < 0.001$) (Table 4).

4. Discussion

At 45%, the incidence of postoperative delirium after HFS in older adults was high, consistent with previous studies.[15] The most common feature of delirium was disorientation, similar to a previous report.[16] However, as delirium cases that manifest as a reduction in mental activities can go undetected and thus may be neglected in

Table 1
Demographic and clinical characteristics of the participants (n = 231).

Variable	Delirium group (n = 104) n (%) or M ± SD	Non-delirium group (n = 127) n (%) or M ± SD	X^2 or t	p-value
Age (years)	83.5 ± 6.9	79.0 ± 8.5	17.19	< 0.001
Sex			0.074	0.885
Men	32 (30.8)	37 (29.1)		
Women	72 (69.2)	90 (70.9)		
Visual disturbance			7.59	0.781
Yes	31 (29.8)	21 (16.5)		
No	73 (70.2)	106 (83.5)		
Hearing defect			12.31	0.345
Yes	10 (9.6)	6 (4.7)		
No	94 (90.4)	121 (95.3)		
Ambulation and functional state			19.27	< 0.001
Able to walk alone	54 (51.9)	78 (61.4)		
Requiring minimal assistance (use of aids)	23 (22.1)	21 (16.5)		
Requiring substantial assistance (help from people)	21 (20.2)	22 (17.3)		
Invalidity	6 (5.8)	6 (4.7)		
Comorbidity				
HTN	37 (35.6)	35 (27.5)	3.55	0.474
DM	36 (34.6)	16 (12.6)	9.71	0.002
Both HTN and DM	20 (19.2)	18 (14.2)	0.78	0.184
None	11 (10.6)	58 (45.7)	1.14	0.305
Hemoglobin (g/dL)			14.85	0.512
Normal (13–17)	15 (14.4)	47 (37)		
Abnormal	89 (85.6)	80 (63)		
Na+ (mmol/L)			10.35	0.652
Normal (136–146)	56 (53.8)	93 (73.2)		
Abnormal	48 (46.2)	34 (26.8)		
K+ (mmol/L)			7.19	0.538
Normal (3.5–5.1)	68 (65.4)	90 (70.9)		
Abnormal	36 (34.6)	37 (29.1)		
BUN (mg/dL)			2.14	0.891
Normal (7.9–20)	50 (48.1)	86 (67.7)		
Abnormal	54 (51.9)	41 (32.3)		
Creatinine (mg/dL)			0.36	0.006
Normal (0.67–1.17)	35 (33.7)	92 (72.4)		
Abnormal	69 (66.3)	35 (27.6)		
Albumin (g/dL)			6.29	< .001
Normal (≥ 3.5)	61 (59.2)	116 (91.3)		
Abnormal	43 (40.8)	11 (8.7)		
AST (IU/L)			1.72	0.422
Normal (0–35)	88 (84.6)	102 (80.3)		
Abnormal	16 (15.4)	25 (19.7)		
ALT (IU/L)			0.67	0.591
Normal (0–45)	75 (72.1)	97 (76.4)		
Abnormal	29 (27.9)	30 (23.6)		
SPaO2 (%)			21.12	< 0.001
Normal (≥ 90)	56 (53.8)	104 (81.9)		
Abnormal	48 (46.2)	23 (18.1)		
Glucose (mg/dL)	149.3 ± 46.3	141.8 ± 32.1	1.98	0.124
Blood transfusion			18.84	< 0.001
Yes	86 (82.7)	71 (55.9)		
No	18 (17.3)	56 (44.1)		
Type of surgery			13.22	0.662
ORIF	53 (51.0)	94 (74.0)		
Bipolar	50 (48.1)	32 (25.2)		
THR	1 (1.0)	1 (.8)		
Operation time (min)	157.92 ± 34.27	142.06 ± 32.51	2.75	0.613
Type of anesthesia			0.42	0.548
Spinal	98 (94.2)	122 (96.1)		
General	6 (5.8)	5 (3.9)		
Hospital stay (days)	29.77 ± 13.81	27.49 ± 10.22	0.64	0.213

Note. HTN: hypertension; DM: diabetes mellitus; ORIF: open reduction internal fixation; THR: total hip replacement; SA: spinal anesthesia; GA: general anesthesia.

clinical practice,[17] it is important for nurses to evaluate delirium status based on patient characteristics. Delirium generally occurred between 22:00 and 06:00 (71.1%), which can be understood in the same context as Foroughan et al.'s[18] findings that the incidence of

delirium is 3.18 times higher among older adults with sleep deprivation. Delirium is more likely to occur at night and the nursing staff can be sensitive, so more nursing staff should be assigned. Further, delirium most commonly occurred within 24 hours after HFS. This result is consistent with the findings of Most et al.,[19] where 89.4% of older adults who had undergone HFS developed delirium within 24 hours after surgery. There were significant differences in delirium status with higher age, lower albumin level, higher creatinine level, and a more dependent preoperative ambulatory and functional state.

Nutritional imbalance can be suspected upon low albumin concentration. As this is one of the risk factors for delirium,[20] adequate pre-operative nutrition should be a preventive measure.[21] Further, we confirmed that the risk of delirium increases with an increase in creatinine level. This is contradictory to the results of Kim et al., where delirium did not significantly vary according to water and electrolyte metabolism disturbance,[22] but is consistent with the finding that elevated blood creatinine concentration in seriously ill patients is associated with delirium.[23] As an equivalent comparison is difficult for older patients owing to severe hematological variations according to the type of surgery and underlying disease, further studies with more diverse samples are needed to investigate the relationship of water and electrolyte metabolic disorder with delirium. In the present study, the odds for delirium were more than threefold higher among patients who had a more dependent preoperative ambulatory or functional status. This is in line with previous findings.[16,24] Regarding clinical outcomes, delirium significantly differed according to falls, complications, destination after discharge, readmission rate, and mortality rate. Another fall during the postoperative recovery period can not only delay recovery but also lead to unanticipated adverse outcomes, which calls for continuous observation. In the present study, the most common complication after HFS was bedsores, followed by pneumonia and urinary tract infection, and these occurred more frequently in the delirium group. This was similar to the findings of a Finnish study involving older adults with hip fracture that analyzed clinical outcomes and delirium risk factors, wherein onset of delirium was found to be associated with lung, heart, and urinary tract infection.[24] In contrast, a US study reported that postoperative delirium after HFS was not associated with pneumonia, urinary tract infection, kidney disease, and heart disease,[16] contradicting our findings. These results may vary depending on the medical environment, patients' levels of awareness, and their active participation in treatment, and further studies are warranted. In addition, patients hospitalized for HFS are more vulnerable than others to bedsores despite various preventive activities such as bedsore evaluation and posture changes.[25] Therefore, more effective prevention and management measures are needed for bedsores. Most patients in the delirium group went to a nursing home instead of their homes upon discharge. This percentage was similar to the 91.8% reported in a previous study[24] and the percentage found in a study that reported a 1.65 times higher likelihood for the delirium group to be admitted to a nursing home compared to the non-delirium group.[16] As this aspect requires long-term follow-up and is thus associated with a serious socioeconomic burden,[26] there is a need for diverse nursing intervention programs to compute the appropriate length of hospital stay and facilitate quick recovery.

The delirium group showed a significantly higher one-year re-

Table 2
Characteristics and features of delirium in patients (n = 104).

Variable	n (%)
Delirium	
Yes	104 (45)
No	127 (55)
Delirium feature	
Disorientation	89 (85.6)
Inappropriate behavior	54 (51.9)
Inappropriate communication	38 (36.5)
Illusions/Hallucinations	8 (7.7)
Psychomotor retardation	2 (1.9)
Time of occurrence (hour)	
6:00–15:00 (Day time)	19 (18.3)
15:00–22:00 (Evening time)	11 (10.6)
22:00–06:00 (Night time)	74 (71.1)
Use of physical restraint	
Yes	68 (65.4)
No	36 (34.6)
Occurrence of delirium	
Admission day	12 (11.5)
Operation day	48 (46.2)
Postoperative day 1	35 (33.7)
Postoperative day 4	7 (6.7)
Postoperative day 7 or later	2 (1.9)

Table 4
Comparison of clinical outcomes according to presence or absence of delirium.

Outcome variable	Delirium (n = 104) n (%)	Non-delirium (n = 127) n (%)	X^2	p-value
Fall	26 (25)	3 (2.4)	26.69	< .001
Postoperative complication			31.68	< .001
Bedsores	58 (55.8)	13 (10.2)		
Pneumonia	25 (24.0)	9 (7.1)		
Urinary tract infection	16 (15.4)	4 (3.1)		
Discharge route			8.51	0.036
Older adult care facilities	78 (76.4)	49 (36.5)		
Home	26 (24.6)	78 (63.5)		
Readmission			10.93	0.012
Within a year	39 (37.5)	31 (24.4)		
No readmission	65 (62.5)	96 (75.6)		
Death			40.82	< .001
Within a year	55 (52.9)	18 (14.1)		
No death	49 (47.1)	109 (85.8)		

Table 3
Factors influencing delirium in older adults who have undergone hip surgery (n = 231).

Variable	B	SE	Wald	OR	95% CI	p-value
Age (years)	1.92	0.48	11.76	1.72	1.24–2.27	< 0.001
Albumin (g/dL)	1.18	0.54	9.23	2.65	1.4–9.62	0.005
Creatinine (mg/dL)	0.84	0.37	5.81	2.97	1.18–4.60	0.003
Ambulation and functional state	0.52	0.08	8.97	3.84	2.16–12.84	< 0.001

Nagelkerke R^2 = 0.45, Hosmer-Lemeshow X^2 = 6.75, p = 0.563.
Correct classification (%) = 88.9%.
Note. SE: standard error; OR: odds ratio; CI: confidence interval.
Binary variable (abnormal = 1, normal = 0), ternary variable (assistance, invalidity = 1, normal = 0).

admission rate compared to the non-delirium group. In a study that examined 30-day readmission rates among 8,439 older adults who had undergone HFS,[16] the readmission rate was 1.94 times higher in the delirium group, which is similar to our percentage. However, a study that followed up with patients for two years after HFS[27] found a significant difference in the number of emergency department visits but no difference in readmission rate, in contrast to our findings. As the readmission rate among older adults with delirium is not consistent across studies, further research is needed on this matter. One-year mortality rate after HFS was about 3.7 times higher in the delirium group. This is similar to the results of Liu et al.,[28] wherein patients with delirium after HFS were at a twofold higher risk of death, and also to the results of a study[29] that reported a 17% increase in the risk of death at six months after surgery. In addition, these studies reported that delirium has an adverse impact on patients' prognoses, thereby supporting our findings. Therefore, subsequent studies should perform multidisciplinary analyses to identify the prognostic predictors after HFS in older adults as well as examine preventive interventions attempting to lower the incidence of delirium.

This study has some limitations. As it was a single-center study and did not include all predictors of delirium, generalization of the findings requires caution. Further, as nurses screened for delirium using only the Nu-DESC, there may have been differences in evaluations according to the tool's observational nature; subsequent studies should compare the results with those obtained through other delirium screening tools such as the Memorial Delirium Assessment Scale and Delirium Rating Scale. The clinical outcomes of older patients who have undergone HFS are also related to their will to undergo rehabilitation; therefore, future studies should consider this. Cognitive disorder or dementia were included in the exclusion criteria, as they can be confused with the symptoms (features) of delirium. However, other studies have identified these as delirium risk factors; therefore, subsequent studies should examine a broader scope of risk factors.

We observed that delirium that occurs after HFS in older patients has a grave impact on their clinical outcomes. The findings of this study can be utilized to predict and plan interventions for delirium.

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Conflicts of interest

None.

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