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Risk Factors of Postoperative Delirium in Elderly Patients With Intertrochanteric Fracture: An Age-Stratified Retrospective Analysis of 2307 Patients

Tao Wang, MD[1,*], Junfei Guo, MD[1,*], Zhiyong Hou, MD[1,2,3], and Yingze Zhang, MD[1,2,3]

Abstract

Background: Postoperative delirium (POD) is a serious and common complication of intertrochanteric fracture (IF). However, the risk factors for POD remain debated. The purpose of this study was to explore risk factors for POD after IF surgery in elderly patients by age-stratified analysis. **Methods:** A total of 2307 patients who underwent IF surgery in our hospital between Jan. 2017 and Nov. 2020 were included. 128 patients suffering from POD were regarded as the delirium group (DG) and the other patients as the normal group (NG). Univariate and multivariate analyses were conducted. **Results:** In our study, the occurrence of POD after IF surgery in elderly patients was 5.55% (128 of 2307). The results of univariate and multivariate analysis showed that advanced age and patients with a history of dementia were identified as the risk factors for POD. Age-stratified analysis showed different comorbidities influencing POD at different stages of age. Additionally, POD markedly increased along with age. Moreover, compared with younger than 70 years in male patients and younger than 80 years in female patients, patients over the age of 70 for males and over the age of 80 for females had a higher rate of POD. **Conclusions:** Advanced age and patients with a history of dementia were independent risks of delirium after IF surgery in both univariate and multivariate analyses. 70 years old in male patients and 80 years old in female patients may be the cut-off values for a significantly increased rate of POD. Preoperative measures should be taken to lower the incidence of POD. **Level of Evidence:** Prognostic Level III.

Keywords

postoperative delirium, elderly, intertrochanteric fracture, risk factors

Introduction

Postoperative delirium (POD), as a serious and common complication of hip fracture, is an acute brain dysfunction after surgery.[1-3] Delirium caused by mal-adaptation of the brain has not only higher mortality rates but also higher treatment costs. A recent study[4] reported that there was a 36% mortality rate at 6-month follow-up if patients suffered from POD, which costs upwards of 6.5 billion dollars in medicare hospital expenditures.[5] Thus, it is important to find the risk factors for POD. According to some literature,[6-9] age, cognitive impairment, type of admission (acute or

[1]Department of Orthopaedic Surgery, Third Hospital of Hebei Medical University, Shijiazhuang, China
[2]Orthopaedic Research Institute of Hebei Province, Shijiazhuang, China
[3]NHC Key Laboratory of Intelligent Orthopaedic Equipment ,The Third Hospital of Hebei Medical University, Shijiazhuang, China

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*Tao Wang and Junfei Guo contributed equally to this work

Corresponding Author:
Zhiyong Hou, Department of Orthopaedic Surgery, Third Hospital of Hebei Medical University. No. 139 Ziqiang Road, Shijiazhuang 050051, China.
Email: drzyhou@gmail.com

Table 1. Characteristics of the Study Participants in Two Groups With or Without Delirium.

	Delirium(n = 128)	No delirium(n = 2179)	p
Age(years)	82.5(87.0∼77)	79.0(84.0∼72)	<.001
Male(years)	81.0(86.0∼77) (n = 47)	77.0(83.0∼70) (n = 733)	.001
Female(years)	83.0(88.0∼77) (n = 81)	79.0(84.0∼73) (n = 1446)	<.001
From injury to the surgery(days)	6.0(8.0∼4.0)	5.0(7.0∼4.0)	.094
From injury to the hospital (hours)	11.0(21.0∼6.0)	9.0(20.0∼5.0)	.232
Blood transfusion volume(u)	4.0(6.0∼2.0)	2.0(6.0∼.0)	<.001
Hospital stay(days)	14.0(18.0∼10.0)	13.0(17.0∼10.0)	.233
Operation time (mins)	90.0(120.0∼75.0)	90.0(120.0∼75.0)	.440
Blood loss(mls)	200.0(300.0∼100.0)	200.0(300.0∼100.0)	.267
Body mass index(kg/m^2)	22.59(24.03∼20.03)	22.86(25.39∼21.40)	.005
Hemoglobin(g/L)	104.75(118.15∼89.6)	110.5(122.7∼98.7)	.001
Gender			
Male	47(36.7%)	733(33.6%)	.474
Female	81(63.3%)	1446(66.4%)	
AO A1.1-2.1	71(55.5%)	1190(54.6%)	.850
AO A2.2-3.1	57(44.5%)	989(45.4%)	
ASA classification			<.001
I,II	30(23.4%)	1111(51.0%)	
III,IV	98(76.6%)	1068(49.0%)	
Transfusion			<.001
Yes	113(88.3%)	1595(73.2%)	
No	15(11.7%)	584(26.8%)	
General anesthesia			.093
Yes	57(44.5%)	809(37.1%)	
No	71(55.5%)	1370(62.9%)	
Operation time			.324
≤60mins	26(20.3%)	369(16.9%)	
>60mins	102(79.7%)	1810(83.1%)	
Vein thrombosis(Admission)			.615
Yes	70(54.7%)	1241(57.0%)	
No	58(45.3%)	938(43.0%)	
Electrolyte disturbance			.157
Yes	9(7.0%)	95(4.4%)	
No	119(93.0%)	2084(95.6%)	
Anemia			.463
Yes	7(5.5%)	90(4.1%)	
No	121(94.5%)	2089(95.9%)	
Dementia			<.001
Yes	78(60.9%)	47(2.2%)	
No	50(39.1%)	2132(97.8%)	
Pneumonia			<.001
Yes	21(16.4%)	147(6.7%)	
No	107(83.6%)	2032(93.3%)	
Arteriosclerosis			<.001
Yes	45(35.2%)	326(15.0%)	
No	83(64.8%)	1853(85.0%)	
Cerebrovascular disease			.002
Yes	31(24.2%)	309(14.2%)	
No	97(75.8%)	1870(85.8%)	
Hypoproteinemia			.866
Yes	9(7.0%)	162(7.4%)	
No	119(93.0%)	2017(92.6%)	

(continued)

Table 1. (continued)

	Delirium(n = 128)	No delirium(n = 2179)	p
rArhythmia			.02
Yes	24(18.8%)	218(10.0%)	
No	104(81.2%)	1961(90.0%)	
Valvulopathy			.245
Yes	3(2.3%)	28(1.3%)	
No	125(97.7%)	2151(98.7%)	
Heart failure			.042
Yes	7(5.5%)	52(2.4%)	
No	121(94.5%)	2127(97.6%)	
Myocardial infarction			.059
Yes	4(3.1%)	23(1.1%)	
No	124(96.9%)	2156(98.9%)	
Diabetes			.956
Yes	26(20.3%)	447(20.5%)	
No	102(79.7%)	1732(79.5%)	
Cerebral hemorrhage			.186
Yes	3(2.3%)	24(1.1%)	
No	125(97.7%)	2155(98.9%)	
Cerebral infarction			<.001
Yes	47(36.7%)	384(17.6%)	
No	81(63.3%)	1795(82.4%)	
Coronary heart disease			.192
Yes	33(25.8%)	456(20.9%)	
No	95(74.2%)	1723(79.1%)	
Hypertension			.609
Yes	61(47.7%)	988(45.3%)	
No	67(52.3%)	1191(54.7%)	

BMI, body mass index; ASA, American Society of Anesthesiologists. Values are presented as the number (%) or the median (interquartile range). *P<.05, statistical significance.

elective), institutionalization, functional impairment, body mass index (BMI), level of albumin, American Society of Anesthesiologists (ASA) classification, general anesthesia, parkinsonism, polypharmacy, and vision impairment were associated with an increased risk of POD. Even though a growing number of scholars focus on it, the risk factors for POD remain debated. Hence, we performed this study to explore the risks of POD in elderly patients with intertrochanteric fracture (IF) based on age-stratified analysis.

Materials and Methods

Ethics Statement

The study was approved by the Institutional Review Board of the third hospital of Hebei Medical University before data collection and analysis.

Patients

We included 2307 patients who underwent IF surgery from Jan. 2017 to Nov. 2020 in our hospital. There were 128 patients in the delirium group (DG) and 2179 patients were in the normal group (NG). The inclusion criteria for this study were as follows: (1) patients who underwent IF surgery; (2) no less than 60 years old; and (3) no comorbidity was caused at the time of IF. The exclusion criteria were as follows: (1) patients with a history of IF; (2) patients with a history of hip surgery; and (3) patients with a history of delirium. Possible factors were collected including age, blood transfusion volume, BMI, hemoglobin, ASA classification, transfusion, time from injury to surgery, time from injury to hospital, hospital stay, operation time, blood loss, sex, type of fracture, type of anesthesia, operation time, vein thrombosis and patients with a history of dementia, lung disease, arteriosclerosis, cerebrovascular disease, arrhythmia, heart failure, cerebral infarction, electrolyte disturbance, anemia, hypoproteinemia, valvulopathy, myocardial infarction, diabetes, cerebral hemorrhage, coronary heart disease, and hypertension.

The methods were carried out in accordance with the approved guidelines. Two authors identified and collected all the data of patients according to inclusion and exclusion criteria. In addition, two authors were responsible for data

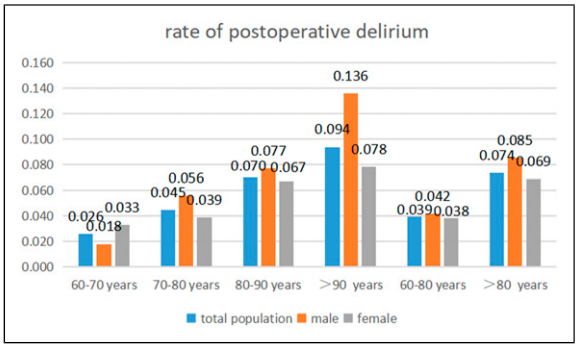

Figure 1. Rates of postoperative delirium based on subgroup of age.

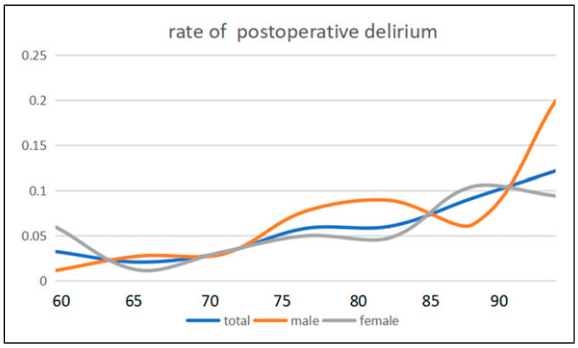

Figure 2. Tendency in the rates of postoperative delirium in male, female and total population.

analysis. Because our data did not satisfy the criteria for normality and homogeneity of variance, statistical analysis between groups was performed using the rank-sum test. For count data, the Chi-square test was used for data analysis. Statistical significance levels were considered to be $p < .05$. All statistical analyses were carried out using SPSS, version 21.0 (SPSS Inc, Chicago, IL). To identify the best predictors of POD, univariate and multivariate analyses were computed.

Results

As shown in Table 1**,** advanced age, more transfusion volume, low BMI, low hemoglobin, ASA classification, transfusion, and patients with a history of dementia, pneumonia, arteriosclerosis, cerebrovascular disease, arrhythmia, heart failure, and cerebral infarction were found to be associated with POD after IF surgery in univariate analysis. However, no significant difference was found in time from injury to surgery, time from injury to hospital, hospital stay, operation time, blood loss, sex, type of fracture, type of anesthesia, operation time, vein thrombosis and patients with a history of electrolyte disturbance, anemia, hypoproteinemia, valvulopathy, myocardial infarction, diabetes, cerebral hemorrhage, coronary heart disease, and hypertension.

We also conducted a univariate analysis based on subgroups of age. As seen in Figure 1, we observed that the rates of POD were 2.6%, 4.5%, 7.0%, and 9.4% of POD in patients 60 s, 70 s, 80 s, and older than 90 years, respectively. We can also see 1.8%, 5.6%, 7.7%, and 13.6% and 3.3%, 3.9%, 6.7%, and 7.8% of POD at four stages of age for male and female patients, respectively. Besides, our findings also showed 4.2%, 3.8%, and 3.9% of POD for male, female, and total patients ranging from 60 to 80 years old, respectively. Whereas, for those over the age of 80, 8.5%, 6.9%, and 7.4% of POD, -were observed in Figure 1, respectively. Figure 2 presented that an increasing incidence was along with age in male, female, and total population. Table 2 showed that time from injury to the hospital (>24 h) and patients with a history of dementia were related with POD for patients' 60 s. As for patients' 70 s, time from injury to surgery (>5 days), time from injury to the hospital (>24 h), ASA classification (III and IV), patients with a history of dementia, arteriosclerosis, and cerebral infarction were found to be associated with POD. Regarding patients' 80 s, blood transfusion volume(>8u), ASA classification (III and IV), transfusion, patients with a history of dementia, arteriosclerosis, and cerebral infarction had a close relationship with POD. However, only two factors (patients with a history of dementia and cerebral infarction) were found to be linked with POD in patients over the age of 90.

In our study, age(>80), blood transfusion volume(5–8u), patients with a history of dementia, pneumonia, arteriosclerosis, **arrhythmia**, myocardial infarction, and cerebral infarction were important risks of POD in multivariate analysis, shown in Table 3. In addition, we also performed a multivariate analysis based on the subgroup of age. Table 4 indicated that transfusion and patients with a history of dementia, arteriosclerosis, and coronary heart disease were risk factors in patients' 60 s. But as for patients' 70 s, blood transfusion volume(0–4u), and patients with a history of dementia and arteriosclerosis were found to be independent factors. While blood transfusion volume(1–8u) and patients with a history of dementia, arteriosclerosis, and cerebral infarction were proved to be predictive factors in the patients' 80 s. Regarding patients over the age of 90, patients with a history of dementia and cerebral infarction were identified as prognostic factors for POD.

Discussion

As we know, POD is not only a common complication after hip surgery but also a major reason for mortality after surgery. Some studies[9-12] reported that the rate of POD among the elderly ranged from 2% to 7% in Asian

Table 2. Characteristics of the Study Participants in Two Groups Stratified by Age.

	60–70 years	70–80 years	80–90 years	>90 years	*P*
Age	n=348	n=874	n=925	n=160	.001
Delirium	9(2.6%)	39(4.5%)	65(7.0%)	15(9.4%)	
No delirium	339(97.4%)	835(95.5%)	860(93.0%)	145(90.6%)	
Sex					
Male					.011
Delirium	3(1.8%)	16(5.6%)	22(7.7%)	6(13.6%)	
No delirium	161(98.2%)	272(94.4%)	262(92.3%)	38(86.4%)	
Female					.054
Delirium	6(3.3%)	23(3.9%)	43(6.7%)	9(7.8%)	
No delirium	178(96.7%)	563(96.1%)	598(93.3%)	107(92.2%)	
P	.401	.272	.569	.255	
From injury to the surgery(days)					
Delirium					
≤2	1(11.1%)	1(2.6%)	10(15.4%)	2(13.3%)	
2–5	3(33.3%)	9(23.1%)	22(33.8%)	5(33.3%)	
>5	5(55.6%)	29(74.4%)	33(50.8%)	8(53.4%)	
No delirium					
≤2	36(10.6%)	103(12.3%)	93(10.8%)	14(9.7%)	
2–5	122(36.0%)	347(41.6%)	335(39.0%)	50(34.5%)	
>5	181(53.4%)	385(46.1%)	432(50.2%)	81(55.9%)	
P	.987	.002	.462	.903	
From injury to the hospital (hours)					
Delirium					
≤12	4(44.4%)	17(43.6%)	38(58.5%)	11(73.3%)	
12–24	2(22.2%)	18(46.2%)	19(29.2%)	4(26.7%)	
>24	3(33.3%)	4(10.2%)	8(12.3%)	0(.0%)	
No delirium					
≤12	213(62.8%)	539(64.6%)	509(59.2%)	73(50.3%)	
12–24	106(31.3%)	255(30.5%)	281(32.7%)	55(37.9%)	
>24	20(5.9%)	41(4.9%)	70(8.1%)	17(11.8%)	
P	.005	.023	.479(44.4%)	.166	
Blood transfusion volume(u)					
Delirium					
0	2(22.2%)	5(12.8%)	7(10.8%)	1(6.7%)	
1–≤4	4(44.4%)	20(51.3%)	24(36.9%)	9(60.0%)	
<4–≤8	2(22.2%)	10(25.6%)	22(33.8%)	5(33.3%)	
>8	1(11.1%)	4(10.3%)	12(18.5%)	0(.0%)	
No delirium					
0	169(49.9%)	240(28.7%)	159(18.5%)	16(11.0%)	
1–≤4	126(37.2%)	419(50.2%)	424(49.3%)	68(46.9%)	
<4–≤8	32(9.4%)	138(16.5%)	205(23.8%)	46(31.7%)	
>8	12(3.5%)	38(4.6%)	72(8.4%)	15(10.4%)	
p	.231	.052	.004	.514	
Operation time (mins)					
Delirium					
≤60	0(.0%)	7(17.9%)	14(21.5%)	4(26.7%)	
>60	9(100.0%)	32(82.1%)	51(78.5%)	11(73.3%)	
No delirium					
≤60	59(17.4%)	126(15.1%)	152(17.7%)	32(22.1%)	
>60	280(82.6%)	709(84.9%)	708(82.3%)	113(77.9%)	
P	.367	.627	.434	.920	

(continued)

Table 2. (continued)

	60–70 years	70–80 years	80–90 years	>90 years	*P*
Body mass index(kg/m^2)					
Delirium					
≤24	4(44.4%)	29(74.4%)	52(80.0%)	10(66.7%)	
24–28	5(55.6%)	9(23.0%)	9(13.8%)	5(33.3%)	
>28	0(.0%)	1(2.6%)	4(6.2%)	0(.0%)	
No delirium					
≤24	185(54.6%)	485(58.1%)	606(70.5%)	118(81.4%)	
24–28	117(34.5%)	261(31.3%)	209(24.3%)	24(16.6%)	
>28	37(10.9%)	89(10.7%)	45(5.2%)	3(2.0%)	
P	.324	.088	.159	.248	
AO A1.1-2.1					
Delirium	6(3.0%)	16(3.4%)	40(7.8%)	9(10.8%)	
No delirium	192(97.0%)	453(96.6%)	470(92.2%)	74(89.2%)	
AO A2.2-3.1					
Delirium	3(2.0%)	23(5.7%)	25(6.0%)	6(7.8%)	
No delirium	147(98.0%)	382(94.3%)	390(94.0%)	71(92.2%)	
P	.549	.105	.282	.508	
ASA classification					
I,II					
Delirium	0(.0%)	11(2.5%)	15(3.4%)	4(5.7%)	
No delirium	191(100.0%)	426(97.5%)	428(96.6%)	66(94.3%)	
III,IV					
Delirium	9(5.7%)	28(6.4%)	50(10.4%)	11(12.2%)	
No delirium	148(94.3%)	409(93.6%)	432(89.6%)	79(87.8%)	
P	.001	.005	.000	.161	
Transfusion					
Yes					
Delirium	9(3.5%)	32(5.2%)	57(8.2%)	15(10.6%)	
No delirium	251(96.5%)	579(94.8%)	640(91.8%)	127(89.4%)	
No					
Delirium	0(.0%)	7(2.7%)	8(3.5%)	0(.0%)	
No delirium	88(100.0%)	256(97.3%)	220(96.5%)	18(100.0%)	
P	.119	.091	.017	.133	
General anesthesia					
Yes					
Delirium	3(2.3%)	18(5.8%)	32(8.9%)	4(6.0%)	
No delirium	128(97.7%)	290(94.2%)	328(91.1%)	63(94.0%)	
No					
Delirium	6(2.8%)	21(3.7%)	33(5.8%)	11(11.8%)	
No delirium	211(97.2%)	545(96.3%)	532(94.2%)	82(88.2%)	
P	.787	.144	.077	.210	
Vein thrombosis(Admission)					
Yes					
Delirium	4(1.9%)	17(3.7%)	38(7.1%)	11(10.0%)	
No delirium	204(98.1%)	442(96.3%)	496(92.9%)	99(90.0%)	
No					
Delirium	5(3.6%)	22(5.3%)	27(6.9%)	4(8.0%)	
No delirium	135(96.4%)	393(94.7%)	364(93.1%)	46(92.0%)	
P	.342	.253	.901	.687	
Comorbidities					
Dementia					
Yes					
Delirium	7(58.3%)	25(56.8%)	38(66.7%)	8(88.9%)	

(continued)

Table 2. (continued)

	60–70 years	70–80 years	80–90 years	>90 years	*P*
No delirium	5(41.7%)	19(43.2%)	19(33.3%)	1(11.1%)	
No					
Delirium	2(.6%)	14(1.7%)	27(3.1%)	7(4.6%)	
No delirium	334(99.4%)	816(98.3%)	841(96.9%)	144(95.4%)	
P	.000	.000	.000	.000	
Arteriosclerosis					
Yes					
Delirium	2(6.1%)	11(8.3%)	26(15.6%)	5(13.2%)	
No delirium	31(93.9%)	121(91.7%)	141(84.4%)	33(86.8%)	
No					
Delirium	7(2.2%)	28(3.8%)	39(5.1%)	10(8.2%)	
No delirium	308(97.8%)	714(96.2%)	719(94.9%)	112(91.8%)	
P	.186	.019	.000	.360	
Cerebrovascular disease					
Yes					
Delirium	2(7.1%)	8(7.3%)	17(10.5%)	4(9.8%)	
No delirium	26(92.9%)	101(92.7%)	145(89.5%)	37(90.2%)	
No					
Delirium	7(2.2%)	31(4.1%)	48(6.3%)	11(9.2%)	
No delirium	313(97.8%)	734(95.9%)	715(93.7%)	108(90.8%)	
P	.113	.120	.057	.923	
Diabetes					
Yes					
Delirium	5(5.0%)	10(4.5%)	8(6.0%)	3(20.0%)	
No delirium	95(95.0%)	214(95.5%)	126(94.0%)	12(80.0%)	
No					
Delirium	4(1.6%)	29(4.5%)	57(7.2%)	12(8.3%)	
No delirium	244(98.4%)	621(95.5%)	734(92.7%)	133(91.7%)	
P	.127	.999	.605	.138	
Cerebral infarction					
Yes					
Delirium	2(2.6%)	13(8.1%)	27(15.7%)	5(21.7%)	
No delirium	74(97.4%)	147(91.9%)	145(84.3%)	18(78.3%)	
No					
Delirium	7(2.6%)	26(3.6%)	38(5.0%)	10(7.3%)	
No delirium	265(97.4%)	688(96.4%)	715(95.0%)	127(92.7%)	
P	.951	.013	.000	.044	
Coronary heart disease					
Yes					
Delirium	3(5.9%)	10(5.6%)	15(9.4%)	5(14.3%)	
No delirium	48(94.1%)	169(94.4%)	145(90.6%)	30(85.7%)	
No					
Delirium	6(2.0%)	29(4.2%)	50(6.5%)	10(8.0%)	
No delirium	291(98.0%)	666(95.8%)	715(93.5%)	115(92.0%)	
P	.108	.414	.180	.323	
Hypertension					
Yes					
Delirium	4(2.5%)	23(5.3%)	27(6.6%)	7(13.7%)	
No delirium	155(97.5%)	409(94.7%)	380(93.4%)	44(86.3%)	
No					
Delirium	5(2.6%)	16(3.6%)	38(7.3%)	8(7.3%)	
No delirium	184(97.4%)	426(96.4%)	480(92.7%)	101(92.7%)	
P	.971	.222	.678	.245	

BMI, body mass index; ASA, American Society of Anesthesiologists.Values are presented as the number (%) or the median (interquartile range).
*P<.05, statistical significance.

Table 3. Multivariate Analysis of Association Between Risk Factors and the Postoperative Delirium in 2307 Patients.

					95% CI	
	B	S.E	P Value	Odds Ratio	Lower	Upper
Age (>80)	.723	.342	.035*	2.060	1.054	4.026
Blood transfusion volume (5–8u)	1.611	.377	<.001*	5.006	2.389	10.487
Dementia	4.421	.170	<.001*	83.16	59.65	116.07
Pneumonia	1.135	.206	<.001*	3.111	2.078	4.656
Arteriosclerosis	.736	.169	<.001*	2.088	1.500	2.906
Arrhythmia	.543	.201	.007*	1.721	1.160	2.555
Myocardial infarction	1.021	.392	.009*	2.776	1.288	5.986
Cerebral infarction	.718	.164	<.001*	2.050	1.486	2.828

*P<.05, statistical significance.

Table 4. Multivariate Analysis of Association Between Risk Factors and the Postoperative Delirium Stratified by Age.

					95% CI	
	B	S.E	P Value	Odds Ratio	Lower	Upper
60–69 years old						
Arteriosclerosis	1.643	.637	.010*	5.169	1.483	18.021
Coronary heart disease	1.735	.609	.004*	5.667	1.719	18.683
Dementia	5.730	.783	<.001*	307.97	66.37	1428.9
70–79 years old						
Blood transfusion volume (0u)	1.043	.319	.001*	2.839	1.518	5.307
Blood transfusion volume (1–4u)	1.188	.435	.006*	3.281	1.400	7.689
Dementia	4.481	.290	<.001*	88.30	50.05	155.78
Arteriosclerosis	1.148	.312	<.001*	3.151	1.710	5.808
80–89 years old						
Blood transfusion volume (1–4u)	.794	.354	.025*	2.212	1.105	4.428
Blood transfusion volume (5–8u)	2.634	.472	<.001*	5.925	3.517	11.144
Dementia	4.366	.271	<.001*	78.73	46.27	133.96
Arteriosclerosis	1.082	.253	<.001*	2.950	1.798	4.841
Cerebral infarction	.923	.241	<.001*	2.517	1.569	4.036
>90 years old						
Dementia	6.716	1.121	<.001*	825.51	91.73	7429.1
Cerebral infarction	2.164	.723	.003*	8.708	2.110	35.927

*P<.05, statistical significance.

countries and even 50% or higher following hip fracture repair and cardiac surgery.[13] Predisposing dementia, age, and infection during admission were independent potential risk factors of POD.[14] Choi[9] demonstrated that predisposing dementia, parkinsonism, and a higher ASA score were found to be associated with the risk of POD. In addition, Oh[8] performed a meta-analysis and found that cognitive impairment, BMI or albumin levels, and multiple comorbidities were closely related to POD after hip fracture surgery. Although a number of articles tried to find the risks of postoperative dementia, it remained controversial. As far as we know, few studies were analyzed by subgroups of age. Thus, we collected data of 2307 patients to explore the risk factors of POD after IF surgery by univariate and multivariate analyses based on subgroups of age.

In our study, the overall incidence of POD was 5.5%, which was lower than other researches[15,16] varying from 12% to 50% after surgery in elderly patients with an increasing incidence as patients grow older, which can be seen in Figure 2. No matter in univariate or multivariate analysis, age was regarded as an independent risk factor of POD after IF surgery, which was consistent with previous studies.[7,17] Additionally, we performed univariate analysis according to age-stratified and found that 2.6%, 4.5%, 7.0%, and 9.4% of POD in patients 60 s, 70 s, 80 s, and more than 90 years old,

respectively. It was evident that the risk of POD markedly increased along with age, which was in the same trend with male and female patients, as seen from Figure 2.

Poeran[18] performed an age-stratified study by two subgroups (<80 years old vs ≥80 years old) on this topic and no clear age-specific upper limit in delirium incidence emerged was found in his study. We divided all patients into four subgroups (60 s, 70 s, 80 s, and ≥90 years old) and we inferred the cut-off values of age for a significantly increased rate of POD. From Table 3, the data demonstrated that older than 80-year-old patients had about twice the rate of POD as those less than 80 years of age. Interestingly, we observed that the rates of POD in male patients 70 s and older than 70 years old were 3.1 and 3.9 times higher than the rate in their 60 s, respectively. It is worth noting that great attention must be paid to male patients with more than 90 years of age due to the highest rate of POD (13.6%). Nevertheless, regarding female patients, a remarkable rise can be seen in the comparison between over the 80-year-old group and under 80 year-old age group. Besides, we also found that the rate of POD in female patients older than 80 years was 2.02 times higher than the rate in patients younger than 80 years old. Therefore, we supposed that 70 years old for male patients and 80 years old for female patients may be the cut-off points for a significantly increased rate of POD. A possible reason was that in our study, compared with less than 70 years old in male patients and 80 years old in female patients, patients older than 70 years old in male patients and 80 years old in female patients suffered from more comorbidities such as impaired cognition linked with a higher risk of delirium may explain this observation.

Previous literature has demonstrated that cognitive impairment or dementia is one of the most important risk factors for delirium,[7] which was consistent with our results. In this study, we demonstrated that patients with a history of dementia were an important risk factor for POD, whether male or female, in univariate or multivariate analysis, or at any stage of age. In addition, our multivariate analysis showed that patients with dementia were about 83 times more likely to suffer from POD than those without dementia. Moreover, multivariate analysis based on subgroups of age presented that dementia were 88.30 and 78.73 times more likely to suffer from POD than those without dementia in patients 70 s and 80 s groups, respectively. Whereas, there were 307.97 and 825.5 times in patients' 60 s and older than 90 age groups, respectively. It was implied that compared with the patients 70 s and 80 s group, patients with a history of dementia had a higher occurrence of POD in patients 60 s and older than 90 age groups. Thus, regarding patients' 60 s and older than 90 age groups, more attention must be paid to patients with a history of dementia. The reasons for this observation may be related to differences in the number of relative factors influencing POD in the four stages of age in this study.

Actually, patients with comorbidities such as pneumonia, arrhythmia, arteriosclerosis, cerebrovascular disease, myocardial infarction, cerebral infarction, or hypertension, which were related to POD in the univariate or multivariate analysis in this study, was the same with dementia, indicating a dysfunctional state of the cardiocerebral vascular system that was unable to adapt to injury, surgery, or some sudden situation. This may be a possible reason that patients with a history of these comorbidities have a significantly higher rate of POD.

We also assessed preoperative physical condition by ASA classification simultaneously, which has been demonstrated that ASA classification (III and IV) was a risk factor for POD.[19,20] We found the same result in univariate analysis in the present study, especially for the patients in the less than 90 years age group. Nevertheless, ASA classification (III and IV) was not found to be a risk of POD in multivariate analysis. Another important risk factor found in our study was BMI. Low BMI, representing poor nutritional status, may be reflective of inflammatory states which might play a large role in delirium pathogenesis.[21,22] Our study revealed that the patients with POD had a lower BMI than those without delirium in the total population. However, the subgroup of BMI was not an independent risk factor affecting POD at any stage of age.

As for transfusion rate and blood transfusion volume, we found that transfusion rate was associated with POD in the 80 s group in univariate analysis. Whereas for patients 70 s and 80 s, blood transfusion volume was associated with that in univariate and multivariate analysis.

Although this study provides several novel findings, it has some limitations. This was a retrospective and single-center study. A multi-center, randomized controlled study was needed. Second, other factors that might influence POD, such as smoking history, were not fully included due to a lack of medical history data and retrospective studies' limitations. Finally, due to the large sample size included, although 10 doctors conducted the operations, they were all surgeons who worked in orthopedic surgery for more than 10-year with good surgical skill and experience.

In conclusion, advanced age, patients with a history of dementia were identified as vital predictors for POD after IF surgery by age-stratified analysis. Furthermore, male patients older than 70 years and female patients older than 80 years were susceptible to POD based on subgroups of age. Other comorbidities like arrhythmia, arteriosclerosis, cerebrovascular disease, myocardial infarction, cerebral infarction, heart failure, and hypertension could also be used as important supplementary information to predict POD. This article aimed to share some experience with the surgeons and to suggest that preoperative measures should be taken to lower the incidence of POD after IF surgery.

Abbreviations

Nomenclature

ASA	American Society of Anesthesiologists
BMI	body mass index
DG	delirium group
IF	Intertrochanteric Fracture
NG	normal group
POD	postoperative delirium

Author Contributions

TW and JFG were responsible for study concept and writing the article. YZZ was responsible for revising the article. ZYH was responsible for reviewing and writing the article.

Declaration of Conflicting Interests

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Ethics Approval and Consent to Participate

This study was approved by the institutional review board (IRB) of the Third Hospital of Hebei Medical University (No. T2018-026-1). An informed consent from the patients was not considered necessary by the Ethics Committee as it is a retrospective study. The present study has been conducted ethically in accordance with the World Medical Association Declaration of Helsinki.

Availability of Data and Materials

All data generated or analyzed during this study are include in this article. Further inquiries can be directed to the corresponding author.

ORCID iD

Zhiyong Hou https://orcid.org/0000-0001-5838-4025

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