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# Risk factors for contralateral hip refractures in patients aged over 80 years with intertrochanteric femoral fractures

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**Purpose:** The purpose of this study was to identify which of the risk factors would contribute to the contralateral fracture in very elderly patients after intramedullary nail fixation.

**Methods:** Clinical data of 227 intertrochanteric fracture patients aged 80 years or older were retrospectively reviewed. Intramedullary nails (IMNs) were used on all of the patients. Potential risk factors for contralateral hip refractures were determined using univariate and logistic regression analyses.

**Results:** Contralateral hip refractures occurred in 11 patients (4.84%). Univariate analysis revealed that age, gender, body mass index, fracture classification, hematocrit, D-dimer, and CRP level were not associated with contralateral fractures ( $P > 0.05$ ). However, neurological diseases, cardiovascular disease, and visual impairments were significantly associated with contralateral fractures ( $P < 0.05$ ). Multivariate analysis further revealed that neurological diseases (OR 4.25,  $P = 0.044$ ) and visual impairments (OR 5.42,  $P = 0.015$ ) were independent risk factors associated with contralateral refractures.

**Conclusion:** To prevent contralateral refractures, more attention should be paid to elderly intertrochanteric fracture patients with underlying neurological disease and visual impairments.

## KEYWORDS

contralateral hip refracture, intertrochanteric fracture, intramedullary nails, elderly patients, refractures

## Introduction

Hip fractures remain a worldwide epidemic and costly injury in the elderly, and the number of patients will increase significantly in the future (1, 2). Some investigational data have shown that between 1.2% and 9% of patients who have a hip fracture will suffer a contralateral refracture within 1 year (3, 4) and up to 20% in the course of their lives (5–7). Second contralateral fractures are related to significantly higher complication rates, socioeconomic cost, and mortality than the first fractures (8–11).

Associations between several risk factors and contralateral fractures have been reported, including gender, osteoporosis, body mass index (BMI), dementia, diabetes, and heart disease (12, 13). In general, patients aged over 80 years are

more susceptible to medical comorbidities and possibly at high risk of contralateral fracture (14, 15). Another characteristic of elderly patients is that advanced age is more strongly associated with the risk of intertrochanteric fractures than femoral neck fractures, and intramedullary nails (IMNs) are recommended for fixation (16–18). Some studies, for example, on femoral neck fractures, have revealed that specific fixation methods are associated with a different risk of second hip fracture (19–22). One possible explanation is that surgical fixation may alter an individual's gait and subsequently increase the fall risk by changing muscle moment and bone structure at the fracture site (23). Similarly, for intertrochanteric fractures, intramedullary nailing has been shown to alter the strength of hip muscles and the walking gait (24, 25). However, no research has been able to determine the IMN relative risk for contralateral refractures, especially in patients of advanced age. We hypothesized that the incidence and risk factors of these patients might differ from those of the general population. The aim is to explore potential contralateral fracture risk factors for intertrochanteric fracture patients who aged over 80 years and were treated with intramedullary nails.

## Materials and methods

Medical records of 227 eligible patients who had been treated for intertrochanteric fracture in our institution from January 2019 to January 2021 were retrospectively reviewed. In the study, intertrochanteric fractures were classified using AO/OTA criteria (26, 27). The inclusion criteria are as follows: (1)  $\geq 80$  years old; (2) intertrochanteric fractures; and (3) stabilized with proximal femur nail antirotation (PFNA). Patients with the following conditions were excluded: (1) hip fractures caused by high-energy trauma; (2) open fractures; (3) pathological fractures caused by bone tumors; and (4) incomplete clinical information. The involvers were monitored until a contralateral hip fracture occurred until February 2022. The study was reviewed and approved by the Ethics Committee of our institution.

Various parameters were analyzed to identify potential risk factors for contralateral refractures. The following clinical information is carefully extracted from their clinical data: age, gender, body height/weight, BMI, living circumstances, fracture site, and classification. Comorbidities are categorized as follows: hypertension, cardiovascular disease, diabetes mellitus, respiratory disease, neurological diseases, and visual impairments. The category of cardiovascular disease included coronary atherosclerotic heart disease, cardiomyopathy, heart failure, and arrhythmia. Respiratory diseases included bronchiectasis, pulmonary tuberculosis, chronic obstructive pulmonary disease (COPD), chronic bronchitis, and bronchial asthma. The category of neurological diseases

included dementia, Parkinson's disease, intracerebral hemorrhage, and stroke. Cataract, diabetic retinopathy, retinal neurodegeneration, and glaucoma are all examples of visual impairments. Surgical information included time from fracture to surgery, operation time, and intraoperative blood loss (ml). Peripheral blood samples were collected for laboratory tests including hematocrit (HCT), hemoglobin levels, D-dimer, and C-reactive protein (CRP).

## Statistical analysis

Continuous data were presented as mean  $\pm$  standard; categorical data were expressed as frequencies. Statistical analyses were performed using Student's *t*-test or  $\chi^2$  test relatively. Multivariate analysis was performed using logistic regression analysis to determine the risk factors, and results were presented as the odds ratios (OR) by 95% confidence interval (CI).  $P < 0.05$  was considered statistically significant.

## Results

The general clinical features of the two groups are presented in **Table 1**. A total of 234 patients were enrolled in the study; 7 patients were excluded due to a lack of data on whether a contralateral hip fracture occurred. A total of 227 individuals were finally included, including 75 males and 152 females. Contralateral hip refractures occurred in 11 patients (4.84%) within 1 year after the surgery, including 1 male patient and 10 female patients. Each of the 11 patients had a history of falling and sustaining an injury.

The baseline data from the two groups were compared. No significant differences were found in age, gender, BMI, fracture site, AO/OTA classification, time from fracture to surgery, operation time, and intraoperative blood loss between the contralateral fracture and nonfractured patients ( $P > 0.05$ ).

There was no significant statistical difference between the 11 patients and the 216 controls when preoperative and postoperative laboratory tests of hematocrit, D-dimer level, and C-reactive protein level were examined ( $P > 0.05$ ; **Table 2**). In addition, no statistical difference was founded in hemoglobin levels between the contralateral fracture and nonfractured patients ( $P > 0.05$ ).

For comorbid medical diseases, contralateral fracture patients had higher rates of hypertension, cardiovascular disease, neurological diseases, respiratory disease, and visual impairments than the control group (**Table 3**). However, only visual impairments and neurological and cardiovascular diseases were seen as significantly different between the two groups ( $P < 0.05$ ).

Univariate analysis revealed that demographic characteristics, fracture features, and laboratory tests were not

TABLE 1 Comparison of baseline data between the two groups.

Characteristics	Non-refracted (n = 216)	Refracted (n = 11)	t/ $\chi^2$ value	P-value
Age, years (SD)	83.63 ± 3.25	83.27 ± 2.83	0.440	0.725
Gender (male/female)	74/142	1/10		0.106
Body height (cm)	163.3 (7.49)	162.4 (8.64)	0.422	0.674
Body weight (kg)	63.74	66.27	0.668	0.505
Body mass index (kg/m <sup>2</sup> )	23.80 ± 3.76	25.07 ± 3.82	1.085	0.279
Living circumstances				
Assisted living	216 (100%)	11 (100%)		>0.999
Other	0	0		
Fracture site				0.117
Right	101 (46.76%)	2 (18.18%)		
Left	115 (53.24%)	9 (81.82%)		
AO/OTA classification				0.665
A1.1–A1.3	54 (25.00%)	2 (18.18%)		
A2.1–A2.3	140 (64.81%)	7 (63.64%)		
A3.1–A3.3	22 (10.19%)	2 (18.18%)		
Time from fracture to surgery (days)	4.54 ± 3.04	5.27 ± 2.97	0.783	0.434
Operation time (min)	90.69 ± 28.27	87.27 ± 36.63	0.386	0.700
Intraoperative blood loss (ml)	283.02 ± 155.06	277.2 ± 108.08	0.121	0.904

TABLE 2 Comparison of laboratory tests between the two groups.

Characteristics	Nonrefracted (n = 216)	Refracted (n = 11)	t value	P-value
Hematocrit				
Preoperation	0.34 ± 0.05	0.33 ± 0.04	0.832	0.406
Postoperation	0.34 ± 0.07	0.31 ± 0.04	1.494	0.137
Hemoglobin levels	118.32 ± 17.48	110.36 ± 14.59	1.483	0.139
D-dimer				
Preoperation	1207.77 ± 1350.00	1227.27 ± 925.30	0.0473	0.962
Postoperation	677.26 ± 567.22	581.82 ± 315.65	0.553	0.581
C-reactive protein				
Preoperation	39.15 ± 36.70	43.36 ± 49.10	0.365	0.716
Postoperation	54.59 ± 38.57	65.82 ± 42.73	0.937	0.350

associated with contralateral fractures. However, neurological diseases, cardiovascular disease, and visual impairments were significantly associated with contralateral fractures. Multivariate analysis further revealed that visual impairments (OR 5.42, *P* = 0.015) and neurological diseases (OR 4.25, *P* = 0.044) were independent risk factors for contralateral hip refractures (Table 4).

## Discussion

Contralateral hip refractures are associated with major clinical and social cost implications (4, 11, 28, 29). How to

TABLE 3 Comparison of comorbidity between the two groups.

	Nonrefracted (n = 216)	Refracted (n = 11)	P-value
Hypertension	117 (54.17%)	8 (72.73%)	0.353
Cardiovascular disease	49 (22.69%)	6 (54.55%)	0.026
Diabetes mellitus	58 (26.85%)	2 (18.18%)	0.732
Respiratory diseases	26 (12.04%)	3 (27.27%)	0.153
Neurological diseases	36 (16.67%)	5 (45.45%)	0.030
Visual impairments	32 (14.81%)	5 (45.45%)	0.019

TABLE 4 Univariate and multivariate analyses of factors.

	OR	95% CI	P-value
Cardiovascular disease	2.53	0.63–9.98	0.177
Neurological diseases	4.25	1.02–18.17	0.044
Visual impairments	5.42	1.35–22.16	0.015

develop effective preventive strategies for hip fracture patients is still under controversy (13). Recently, reports have raised the question of whether specific surgical fixation of the initial hip fracture is associated with a different risk of subsequent contralateral fracture. Souder et al. (22) found an increased risk of hip refractures in patients who underwent closed reduction and percutaneous puncture compared to those who underwent arthroplasty. Changes in individual's gait and subsequent fall risk due to different fixation methods may be

one of the important reasons (23, 24). To our knowledge, no research has determined the IMN relative risk of contralateral hip refractures, especially in patients of advanced age.

Our results showed that 11 in 227 patients (4.84%) suffered a contralateral hip refracture during the data collection period. The incidence correlated with the risk of 3%–10% for second hip refractures (3, 20, 30, 31). In general, elderly patients are prone to contralateral fractures due to osteoporosis and susceptible to medical comorbidities (15). However, only a few studies have reported the age-specific incidence and risk factors for contralateral fractures. Yamanashi et al. (32) reported that the incidence was 3.8% within the first year in patients aged  $\geq 65$  years. Similarly, Lönnroos et al. (33) noted an incidence of 5.08% for patients aged  $\geq 60$  years within the first year, and the rate increased further to 8.11% at 2 years following the initial fracture. For very elderly patients, Vochteloo et al. (34) found that the incidence of patients aged over 85 years was not different from other age categories. Lawrence et al. (35) also found female patients over the age of 84 years have a similar risk to the general population. Similarly, our results showed that the incidence of patients aged over 80 years was not significantly increased compared to previous hip refracture data. One theoretical explanation is that the increasing age of patients is not exclusively related to bone strength loss. Indeed, Gnudi et al. (36) suggested that bone loss will gradually slow down after the age of 65 years. Moreover, we noted that none of the enrolled patients lived alone and had a reduced range of physical activity, which may have reduced the risk of falls, which are a major cause of hip fractures.

To further identify risk factors, we evaluated the difference between the patients who suffered a contralateral hip fracture and those in the control group. Univariate analysis revealed that gender distribution, BMI, fracture classification, operation time, and intraoperative blood loss were not associated with contralateral fractures. Although some authors have emphasized the relationship between gender and second hip fractures (7, 31), our study did not support this suggestion. Similar to our results, no significant gender difference was also seen in previous studies (15, 33, 34, 37, 38).

At present, few publications have emphasized the value of laboratory-based indicators for contralateral fracture risk. Preoperative CRP was found to be a primary risk factor for postoperative death in elderly patients with hip fractures in a recent study (39). Chen et al. (37) reported that the serum CRP/Alb ratio is a risk factor in elderly hip fracture patients treated by total hip arthroplasty. In our study, there was no difference between the patient's preoperative and postoperative laboratory tests of hematocrit, D-dimer level, and CRP level between the two groups. Traumatic stress and perioperative drugs all affect the level of expression of these inflammatory and nutritional indicators in the perioperative period (40); therefore, their significance in contralateral fracture needs to be further evaluated.

An increased risk of contralateral hip refractures has been found to be associated with several comorbid diseases (12, 13, 38, 41–43), including hypertension, diabetes mellitus, cardiovascular disease, neurological diseases, respiratory diseases, and visual impairments. In our study, neurological diseases and visual impairments were found to be significantly associated with contralateral hip refractures. Although contralateral fracture patients had higher rates of hypertension, cardiovascular disease, and respiratory diseases than the control group, differences were only seen in neurological diseases, cardiovascular disease, and visual impairments using univariate analysis. Multivariate analysis revealed that neurological diseases and visual impairments were independent risk factors for contralateral hip refractures. Risk factors determined in our study can aid in identifying high-risk populations among very elderly intertrochanteric fracture patients. However, our research also has some limitations. Some clinical information was collected retrospectively, and a relatively small population was the study's main limitation. This may have led to a bias in the analysis of the incidence of contralateral fractures. In addition, some potentially meaningful items, such as the clinical data on vitamin D levels and the use of bone health medications (vitamin D, bisphosphonates, trospium) were not available for all patients, so this was not analyzed in the study.

In summary, neurological diseases and underlying visual impairments are risk factors for contralateral hip refractures in intertrochanteric fracture patients aged over 80 years and who were treated with intramedullary nails. More attention should be given to the patients with these underlying comorbidities.

## Data availability statement

The original contributions presented in the study are included in the article/Supplementary Material, further inquiries can be directed to the corresponding author/s.

## Ethics statement

The studies involving human participants were reviewed and approved by Ethics Committee of Tianjin Hospital. The patients/participants provided their written informed consent to participate in this study.

## Author contributions

SY and SW designed the study. CL, YZ, and JZ collected clinical data and performed statistical analysis. ZZ and SW

wrote the manuscript. SY and YZ revised the manuscript. All authors contributed to the article and approved the submitted version.

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