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Original Article

Differential impact of hemiplegia severity stratification on post-hemiarthroplasty dislocation in elderly intertrochanteric fracture patients

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Abstract: Objectives: To investigate the impact of hemiplegia due to cerebral infarction sequelae on postoperative dislocation after hemiarthroplasty (HHA) in elderly patients with intertrochanteric fractures, identify associated risk factors, and compare dislocation risks between moderate-to-severe and mild hemiplegia. Methods: We retrospectively analyzed 305 patients aged ≥70 years with intertrochanteric fractures who underwent HHA from January 2020 to May 2023. Inclusion criteria required confirmed cerebral infarction with hemiplegia, Evans-Jensen Type III/IV fracture, and ≥1-year follow-up. Postoperative dislocation was diagnosed radiographically, and preoperative motor dysfunction was assessed by the Fugl-Meyer Scale (mild ≥22, moderate-to-severe <22). Statistical analyses included chi-square and t-tests, Lasso regression, and logistic regression. A risk prediction model was developed and its discriminative capacity assessed by ROC analysis. Results: Dislocation occurred in 81 patients (26.6%). Significant factors included age ≥75 years, disease duration ≥6 months, fall-related injury, preoperative motor dysfunction, Evans-Jensen Type IV, diabetes mellitus, adverse lifestyle habits, inadequate nursing care, and posterolateral approach (all $P<0.05$). Multivariate analysis identified age (OR=3.164), preoperative motor dysfunction (OR=2.695), diabetes (OR=2.501), adverse lifestyle (OR=2.181), inadequate nursing care (OR=4.276), and posterolateral approach (OR=3.216) as independent predictors. In moderate-to-severe hemiplegia, age and diabetes were risk factors, whereas in mild hemiplegia, fall-related injury and diabetes predominated. The prediction model showed good performance (AUC=0.811; sensitivity 77.8%, specificity 71.9%). Conclusions: Hemiplegia from cerebral infarction sequelae significantly increases dislocation risk after HHA in elderly intertrochanteric fracture patients. Independent risk factors vary by hemiplegia severity, and the proposed risk model may aid preoperative risk stratification and clinical decision-making.

Keywords: Cerebral infarction sequelae, hemiplegia, intertrochanteric fracture, hemiarthroplasty, dislocation, risk prediction model

Introduction

Cerebral infarction is a common cerebrovascular disease, and its sequelae are particularly prevalent in older adults. Globally, approximately 15 million strokes occur each year, of which 60%-70% are cerebral infarctions [1]. With age-related physiological decline, elderly patients frequently manifest sequelae such as hemiplegia and cognitive impairment [2]. Hemiplegia - the predominant post-stroke sequela - compromises motor coordination, muscle strength, and activities of daily living; beyond diminishing quality of life, it may also increase the risk of perioperative complications in orthopedic settings [3]. Nevertheless, evidence directly examining how stroke sequelae, especially hemiplegia, affect orthopedic postoperative recovery in the elderly remains limited.

Intertrochanteric fracture (ITF) represents a frequent fracture pattern in older individuals and typically follows low-energy falls [4]. In people aged >65 years, the annual incidence is roughly 0.5%-1% and rises with advancing age. For this population, hemiarthroplasty (HHA) has been

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widely used because it enables rapid restoration of hip function and shortens time in bed compared with internal fixation in unstable fractures [5]. Relative to dynamic hip screws or intramedullary nails, internal fixation in osteoporotic bone entails risks of implant failure, cut-out, and non-union and often necessitates prolonged partial weight bearing, which increases immobility-related complications. By contrast, HHA generally permits immediate full weight bearing, facilitating early mobilization and reducing the risks of pneumonia, deep vein thrombosis (DVT), and pressure ulcers. Even so, dislocation remains a notable complication after HHA-reported in 1%-10% of cases - and can severely impair functional recovery and sometimes requires revision surgery [6]. In hemiplegic patients, postoperative activity limitation and reduced adherence to rehabilitation may further elevate the risks of dislocation and infection [7], while comorbidities such as diabetes mellitus and cognitive disorders can compound recovery challenges. Prior research has reported associations between hemiplegia and dislocation following hip arthroplasty [8, 9]; however, studies specifically targeting elderly patients with ITF are scarce.

Most available investigations focus on general elderly cohorts and lack systematic analyses of patients with stroke sequelae accompanied by hemiplegia, particularly with respect to differences in dislocation risk between moderate-to-severe and mild hemiplegia [10]. Moreover, the literature seldom constructs risk-prediction models, limiting precise identification of high-risk patients and timely intervention [11].

Accordingly, this study aims to evaluate whether hemiplegia due to cerebral infarction sequelae increases postoperative dislocation after HHA in elderly patients with ITF, to clarify associated risk factors, to compare dislocation risk between moderate-to-severe and mild hemiplegia, and to develop a multivariable risk-prediction model that can support clinical identification of high-risk patients and optimization of postoperative management. We anticipate that hemiplegia, diabetes history, advanced age, inadequate postoperative care, and the posterolateral surgical approach will emerge as independent risk factors, and that the proposed model will show strong discriminative capacity for clinical risk assessment. The innovative contributions include what we believe to be the first systematic analysis of hemiplegia's impact on postoperative dislocation in this setting, explicit differentiation of risk profiles by hemiplegia severity, and a practical prediction formula. This work addresses a gap at the intersection of cerebrovascular sequelae and orthopedic surgery and provides theoretical support for postoperative management in elderly patients.

Methods and materials

Sample size calculation

Based on a literature review and the report by Charissoux et al. indicating a 25% dislocation rate after total hip arthroplasty [12], the required sample size was estimated using $N=Z^2\times[P\times(1-P)]/E^2$, with E=0.05, Z=1.96, and P=0.25. The calculation yielded N≈289, which was considered adequate for the planned analyses.

General information

We performed a retrospective analysis of 305 consecutive patients who underwent hemiarthroplasty (HHA) at our institution between January 2020 and May 2023. The study protocol was reviewed and approved by the Xi'an International Medical Center Hospital affiliated with Northwest University Ethics Committee.

Inclusion and exclusion criteria

Inclusion criteria: patients aged ≥70 years with confirmed intertrochanteric fracture (ITF) treated with HHA [13]; a documented history of cerebral infarction with hemiplegia on the same side as the fracture; preoperative imaging with computed tomography (CT) or X-ray confirming Evans-Jensen type III or IV; a clearly recorded surgical approach (posterolateral or anterolateral); and completed postoperative follow-up for at least 1 year, including documentation of dislocation and other complications.

Exclusion criteria: concomitant major fractures (e.g., femoral neck or pelvic fractures) or multiple fractures; clear evidence of infection or abnormal preoperative infection markers (white blood cell count $>12\times10^9$/L or C-reactive protein >10 mg/L); pre- or postoperative malignant disease or concurrent chemotherapy/radiotherapy; and incomplete follow-up data or follow-up shorter than 1 year.

Dislocation definition

Post-HHA dislocation was defined radiographically on CT or X-ray as an abnormal relationship between the femoral head prosthesis and the acetabulum, manifested by complete or partial displacement of the prosthesis from the acetabular cavity together with osseous or soft-tissue displacement. Typical findings included: misalignment between the centers of the femoral head prosthesis and acetabulum on coronal, sagittal, or axial views exceeding the normal joint space (>2 mm); separation of the prosthesis edge from the acetabular bony margins or impaction in an abnormal position; possible periarticular soft-tissue swelling, effusion, or bone fragments; and, on three-dimensional reconstructions, a markedly reduced or absent contact area between the prosthesis and acetabulum. This definition was applied to confirm dislocation and to exclude other complications such as prosthesis loosening [14].

Motor dysfunction definition

Motor dysfunction was attributed to hemiplegia secondary to cerebral infarction sequelae, characterized by reduced muscle strength in the upper or lower limbs (or both) and impaired coordination that limits activities of daily living. Severity was quantified using the Fugl-Meyer Assessment (FMA) motor domain (0-100 points; upper extremity 66, lower extremity 34). Each item is scored 0 (cannot perform), 1 (performs partially), or 2 (performs fully), evaluating reflexes, synergistic and isolated movements, coordination, and speed. Higher scores indicate better motor function. For analysis, patients were categorized as: mild motor dysfunction (FMA≥22), reflecting slight limitations with basic daily activities largely preserved; and moderate-to-severe motor dysfunction (FMA< 22), indicating obvious weakness, abnormal gait, or inability to complete basic independent activities (e.g., walking or grasping). This categorization followed the FMA-based grading for hemiplegia severity [15].

Clinical data collection

Data were abstracted from electronic medical records, outpatient and clinic follow-ups, and operative notes. Variables included: Baseline: age (≥75 vs <75 years), sex, and body mass index (BMI≥25 vs <25). Cerebrovascular and comorbidity profile: history and duration of cerebral infarction (≥6 months vs <6 months); preoperative motor dysfunction (present vs absent, with FMA stratification as above); diabetes mellitus; smoking; and alcohol consumption. Fracture and injury details: Evans-Jensen classification (type III or IV), injury mechanism (fall vs external force impact), and laterality (left vs right). Operative variables: surgical approach (posterolateral vs anterolateral), operative time, intraoperative blood loss, femoral head diameter, femoral head offset, and external rotator muscle repair. Postoperative variables: lifestyle behaviors (adverse vs normal). "Adverse" denoted premature high-intensity activity, violation of position restrictions, irregular rehabilitation, or continued smoking/drinking; "normal" indicated adherence to activity guidance, correct positioning, regular rehabilitation, and absence of adverse habits. Nursing care quality (inadequate vs appropriate) was defined as follows: "inadequate" encompassed failure to implement standardized positioning, insufficient activity guidance, or non-standard wound care; "appropriate" required standardized positioning and activity guidance, wound care, and on going individualized rehabilitation. Additional endpoints included length of stay, hospitalization costs, ≥1-year follow-up for dislocation and other complications, and imaging confirmation (preoperative CT or X-ray for classification; postoperative CT or X-ray for dislocation features such as abnormal prosthesis–acetabulum alignment, displacement from the acetabular cavity, >2 mm gap, or reduced contact on three-dimensional reconstruction) (**Figure 1**).

Outcome measures

The primary objective was to evaluate the effect of hemiplegia on postoperative dislocation by stratifying patients according to FMA motor scores and comparing dislocation incidence and risk factors between strata using χ^2 tests and logistic regression. Secondary objectives included: statistical characterization of clinical, surgical, and postoperative features in dislocation versus non-dislocation groups; comparison of dislocation risks between moderate-to-severe and mild motor dysfunction; construction of a multivariable risk-prediction model with assessment of clinical discrimination; and validation of the sensitivity and specificity of the prediction formula.

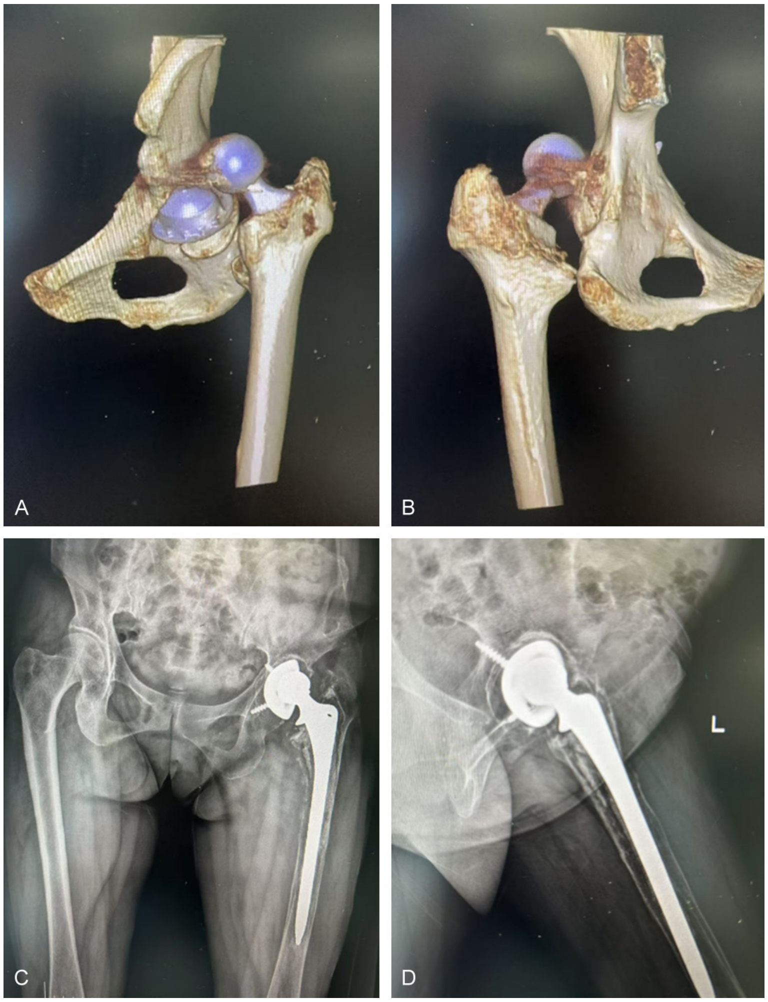

Figure 1. Postoperative dislocation in an elderly patient with intertrochanteric femoral fracture and cerebral infarction sequelae after hemiarthroplasty. A, B. 3D CT reconstruction images show abnormal alignment between the femoral head and acetabular prosthesis. The prosthetic femoral head is clearly displaced from its normal anatomical position, indicating postoperative dislocation. C, D. Postoperative X-ray images also demonstrate dislocation of the left hip prosthesis. The femoral head component is not properly seated within the acetabular cup.

Statistical analysis

Analyses were conducted using R version 4.3.3. Categorical variables were analyzed by frequency methods with test selection based on expected counts: Pearson χ^2 when assumptions were met; continuity-corrected χ^2 when expected frequencies were <5 but ≥1; and Fisher's exact test when expected frequencies were <1 or when sample size was small, comparing variables such as age, sex, disease duration, injury mechanism, motor dysfunction, Evans-Jensen classification, diabetes, postoperative lifestyle, nursing care, and surgical approach. Continuous variables underwent normality assessment using the Kolmogorov-Smirnov (K-S) test. Normally distributed data were compared using independent-samples t-tests (means ± standard deviations) for measures such as operative time, blood loss, length of stay, hospitalization costs, femoral head diameter, and femoral head offset; non-normal data were compared using the Mann-Whitney U test (medians and interquartile ranges). Correlation analysis used correlation matrices reporting linear correlation coefficients (R) and *P* values. Feature selection employed the least absolute shrinkage and selection operator (LASSO) with cross-validation (lambda.min = 0.000529; lambda.1se = 0.050508). Univariate and multivariable logistic regressions were used to identify independent risk factors, reporting odds ratios (ORs) and 95% confidence intervals, with multicollinearity assessed by variance inflation factors (VIFs) (<1.1). Discrimination of the prediction model was evaluated using receiver operating characteristic (ROC) curves with area under the curve (AUC), alongside sensitivity, specificity, Youden index, accuracy, precision, and F1 score. Subgroup analyses were performed separately for moderate-to-severe (FMA<22) and mild (FMA≥22) preoperative motor dysfunction, including baseline comparisons and logistic regression with forest plots of ORs and confidence intervals. Statistical significance was defined as $P<0.05$.

Results

Baseline characteristics comparison between patients with and without dislocation at one year postoperatively

As summarized in **Tables 1**, **2**, we compared baseline characteristics between patients who

Table 1. Baseline characteristics comparison between dislocation and non-dislocation groups

Variable	Dislocation Group (n=81)	Non-Dislocation Group (n=224)	X^2	*P*-value
Age			17.675	<0.001
≥75 years	61 (75.31%)	108 (48.21%)		
<75 years	20 (24.69%)	116 (51.79%)		
Gender			0.865	0.352
Male	53 (65.43%)	159 (70.98%)		
Female	28 (34.57%)	65 (29.02%)		
Disease Duration			4.227	0.04
≥6 months	44 (54.32%)	92 (41.07%)		
<6 months	37 (45.68%)	132 (58.93%)		
BMI			3.778	0.052
≥25 kg/m^2	24 (29.63%)	43 (19.20%)		
<25 kg/m^2	57 (70.37%)	181 (80.80%)		
Injury Mechanism			3.892	0.049
Fall injury	54 (66.67%)	121 (54.02%)		
External force impact	27 (33.33%)	103 (45.98%)		
Lesion Location			0.386	0.534
Left side	47 (58.02%)	121 (54.02%)		
Right side	34 (41.98%)	103 (45.98%)		
Preoperative motor dysfunction			15.234	<0.001
Present	53 (65.43%)	90 (40.18%)		
Absent	28 (34.57%)	134 (59.82%)		
Evans-Jensen Fracture Classification			13.809	<0.001
Type III	53 (65.43%)	190 (84.82%)		
Type IV	28 (34.57%)	34 (15.18%)		
Smoking History			0.27	0.604
Yes	55 (67.90%)	159 (70.98%)		
No	26 (32.10%)	65 (29.02%)		
Alcohol Consumption History			1.054	0.305
Yes	28 (34.57%)	92 (41.07%)		
No	53 (65.43%)	132 (58.93%)		
Diabetes History			10.872	<0.001
Yes	28 (34.57%)	38 (16.96%)		
No	53 (65.43%)	186 (83.04%)		

Note: BMI, Body Mass Index.

experienced dislocation and those who did not at 1 year after surgery. Multiple variables differed significantly. The dislocation group comprised a higher proportion of elderly patients (P<0.001), showed longer disease duration (P=0.040), and had more fall-related injuries (P=0.049). Preoperative motor dysfunction was more frequent (P<0.001), Evans-Jensen classification was more severe (P<0.001), and diabetes history was more prevalent (P<0.001). Regarding postoperative factors, adverse lifestyle habits (P=0.004) and inadequate postoperative care (P<0.001) were enriched in the dislocation cohort. The posterolateral surgical approach also occurred more often among those with dislocation (P=0.004). No significant between-group differences were detected for sex, body mass index, injury side, smoking or alcohol history, operative time, intraoperative blood loss, length of stay, hospitalization costs, external rotator muscle suturing, femoral head diameter, or femoral head offset (all P>0.05).

Table 2. Surgical and postoperative characteristics comparison between dislocation and non-dislocation groups

Variable	Dislocation Group (n=81)	Non-Dislocation Group (n=224)	t/χ²	*P*-value
Operative Time (min)	73.74±11.28	72.44±11.13	0.9	0.369
Intraoperative Blood Loss (mL)	321.11±30.80	325.54±30.18	1.127	0.261
Length of Stay (days)	19.77±3.05	19.28±3.73	1.048	0.295
Hospitalization Costs (Yuan)	34533.01±3640.11	33806.99±3763.63	1.501	0.134
Poor Postoperative Lifestyle Habits			8.241	0.004
Yes	34 (41.98%)	56 (25.00%)		
No	47 (58.02%)	168 (75.00%)		
Inadequate Postoperative Care			11.501	<0.001
Yes	18 (22.22%)	18 (8.04%)		
No	63 (77.78%)	206 (91.96%)		
External Rotator Muscle Suturing			1.224	0.269
Yes	62 (76.54%)	157 (70.09%)		
No	19 (23.46%)	67 (29.91%)		
Femoral Head Diameter (mm)	44.31±3.12	44.11±3.27	0.47	0.639
Femoral Head Offset (mm)	42.99±2.57	43.13±3.35	0.357	0.721
Surgical Approach			8.335	0.004
Posterolateral	70 (86.42%)	157 (70.09%)		
Anterolateral	11 (13.58%)	67 (29.91%)		

Note: BMI, Body Mass Index; CNY, Chinese Yuan.

Correlation analysis and LASSO feature screening

The correlation matrix (**Figure 2A**) depicts linear relationships among variables, with correlation coefficients (R) in the upper triangle and corresponding *P* values in the lower triangle. Significant associations included injury mechanism with adverse postoperative lifestyle habits (P=0.002), age with injury mechanism (P=0.035), age with preoperative motor dysfunction (P=0.043), and diabetes history with adverse postoperative lifestyle habits (P=0.047) (*P<0.05; **P<0.01). Other pairs - such as surgical approach with inadequate postoperative care (P=0.051) and diabetes history with surgical approach (P=0.061) - did not reach significance. The coefficient path plot (**Figure 2B**) shows how estimates varied across λ values, with several variables maintaining strong effects near lambda.min (0.000529). The model selection curve (**Figure 2C**) identified optimal λ values by cross-validation (lambda.min = 0.000529; lambda.1se = 0.050508). All 9 candidate variables entered the model, indicating their collective contribution to predicting dislocation.

Logistic regression: independent risk factors for postoperative dislocation

Variable coding and variance inflation factors (VIFs) appear in **Table 3**; all VIFs were <1.1, suggesting negligible multicollinearity. In univariate analyses (**Figure 3**), age ≥75 years (OR=3.276), preoperative motor dysfunction (OR=2.818), diabetes history (OR=2.586), adverse postoperative lifestyle habits (OR=2.170), inadequate postoperative care (OR=3.270), and the posterolateral approach (OR=2.716) were each associated with increased risk (all P<0.05), relative to the reference categories (<75 years; no preoperative motor dysfunction; no diabetes; no adverse lifestyle; appropriate postoperative care; anterolateral approach). Disease duration ≥6 months approached significance (OR=1.706, P=0.041), whereas fall injury did not (OR=1.702, P=0.050). Evans-Jensen type III was protective versus type IV (OR=0.339, P<0.001).

Multivariable modeling (**Figure 2**) confirmed independent associations for age (OR=3.164), preoperative motor dysfunction (OR=2.695), diabetes (OR=2.501), adverse lifestyle (OR=2.181), inadequate postoperative care (OR=

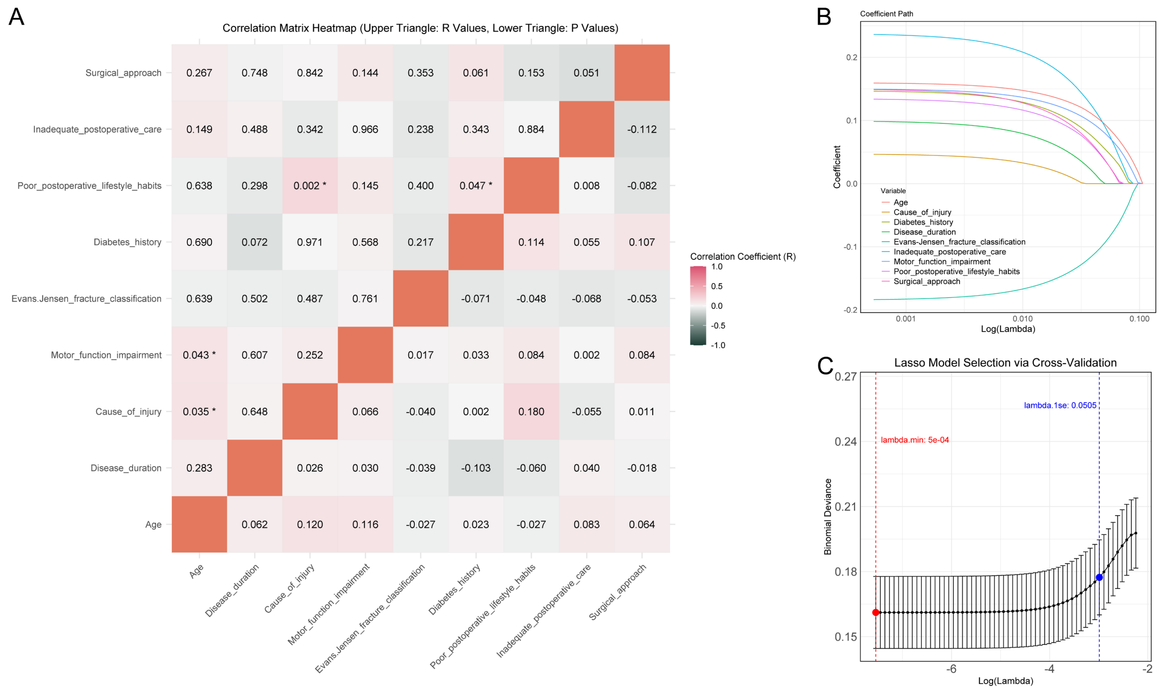

Figure 2. Correlation and lasso regression analysis. A. Correlation matrix (Upper triangle shows R values, lower triangle shows *P* values). B. Coefficient path. C. Lasso model selection via cross-validation. Note: Motor Dysfunction is a preoperative test.

Table 3. Variable assignment for logistic regression analysis of independent risk factors for postoperative dislocation

Variable	Variable Type	Assignment	VIF
Age	(X_1)	≥75 years = 1, <75 years = 0	1.022
Disease Duration	(X_2)	≥6 months = 1, <6 months = 0	1.032
Cause of Injury	(X_3)	Fall injury = 1, External force impact = 0	1.032
Preoperative motor function impairment	(X_4)	Yes = 1, No = 0	1.038
Evans-Jensen Fracture Classification	(X_5)	Type III = 1, Type IV = 0	1.019
Diabetes History	(X_6)	Yes = 1, No = 0	1.056
Poor Postoperative Lifestyle Habits	(X_7)	Yes = 1, No = 0	1.046
Inadequate Postoperative Care	(X_8)	Yes = 1, No = 0	1.087
Surgical Approach	(X_9)	Posterolateral = 1, Anterolateral = 0	1.085
Dislocation	(Y)	Yes = 1, No = 0	1.022

4.276), and the posterolateral approach (OR=3.216) (all P<0.05). Disease duration remained significant (OR=1.881, P=0.039), while injury mechanism was not independently associated (OR=1.518, P=0.191). Evans-Jensen type III persisted as a protective factor compared with type IV (OR=0.359, P=0.004).

Clinical value of the risk formula for predicting dislocation

Using variables retained after screening, we constructed the following risk score (**Figure 4**):

Risk Score = -3.655 + 1.152 × Age + 0.632 × Disease duration + 0.417 × Cause of injury + 0.991 × Preoperative motor function impairment - 1.025 × Evans-Jensen fracture classification + 0.917 × Diabetes history + 0.780 × Poor postoperative lifestyle habits + 1.453 × Inadequate postoperative care + 1.168 × Surgical approach.

The ROC analysis (**Figure 4A**) yielded an AUC of 0.811 (95% CI, 0.761-0.862), with specificity 71.88%, sensitivity 77.78%, Youden index 49.65%, optimal cut-off -1.086, accura-

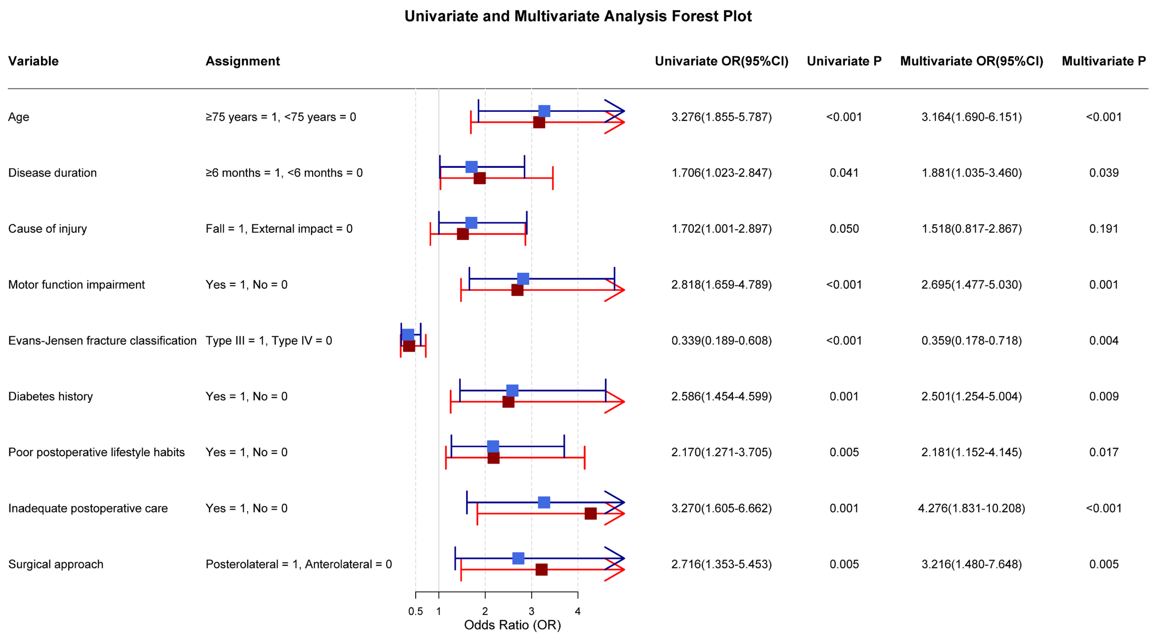

Figure 3. Univariate and multivariate analysis forest plot. Note: OR, Odds Ratio; CI, Confidence Interval; Red segments represent multivariate analysis, blue segments represent univariate analysis, Motor Dysfunction is a preoperative test.

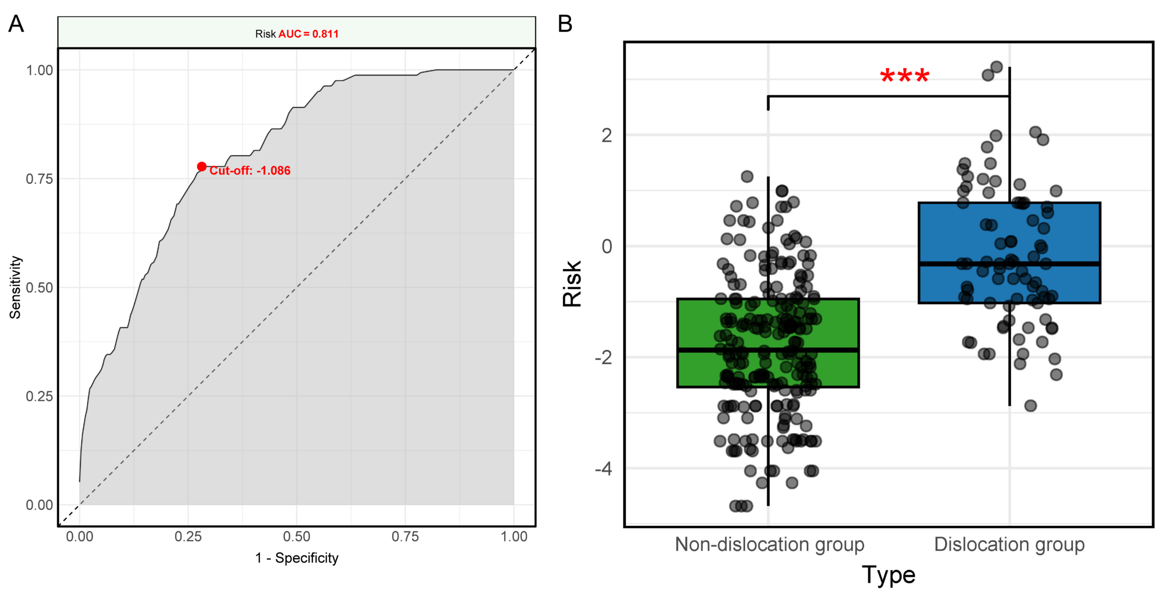

Figure 4. Risk score analysis. A. ROC curve. B. Risk score comparison between dislocation and non-dislocation groups. Note: AUC, Area Under the Curve; CI, Confidence Interval; ROC, Receiver operating characteristic curve.

cy 73.44%, precision 77.78%, and F1 score 60.87%, indicating good discriminative capacity. Risk scores were significantly higher in the dislocation group than in the non-dislocation group (**Figure 4B**, P<0.001), supporting the score's ability to distinguish risk.

Baseline characteristics: moderate-to-severe versus mild preoperative motor dysfunction

For patients with moderate-to-severe dysfunction (FMA<22; **Tables 4**, **5**), dislocation was associated with age ≥75 years (P=0.032) and

Table 4. Baseline characteristics comparison for moderate-to-severe preoperative motor dysfunction patients

Variable	Dislocation Group (n=27)	Non-Dislocation Group (n=48)	χ^2	*P*-value
Age			4.577	0.032
≥75 years	27 (90.00%)	31 (68.89%)		
<75 years	3 (10.00%)	14 (31.11%)		
Gender			2.557	0.11
Male	19 (63.33%)	36 (80.00%)		
Female	11 (36.67%)	9 (20.00%)		
Disease Duration			1.505	0.22
≥6 months	17 (56.67%)	19 (42.22%)		
<6 months	13 (43.33%)	26 (57.78%)		
BMI			0.248	0.618
≥25 kg/m^2	6 (20.00%)	7 (15.56%)		
<25 kg/m^2	24 (80.00%)	38 (84.44%)		
Injury Mechanism			0.459	0.498
Fall injury	17 (56.67%)	29 (64.44%)		
External force impact	13 (43.33%)	16 (35.56%)		
Lesion Location			0.081	0.776
Left side	17 (56.67%)	24 (53.33%)		
Right side	13 (43.33%)	21 (46.67%)		
Evans-Jensen Fracture Classification			2.238	0.135
Type III	21 (70.00%)	38 (84.44%)		
Type IV	9 (30.00%)	7 (15.56%)		
Smoking History			0	1
Yes	22 (73.33%)	33 (73.33%)		
No	8 (26.67%)	12 (26.67%)		
Alcohol Consumption History			0.25	0.617
Yes	9 (30.00%)	16 (35.56%)		
No	21 (70.00%)	29 (64.44%)		
Diabetes History			4.23	0.04
Yes	9 (30.00%)	5 (11.11%)		
No	21 (70.00%)	40 (88.89%)		

Note: BMI, Body Mass Index.

diabetes history (P=0.040). The posterolateral approach appeared more common in those with dislocation (P=0.046). No significant differences were observed for sex, disease duration, body mass index, injury mechanism, side, Evans-Jensen classification, smoking, alcohol consumption, operative time, intraoperative blood loss, length of stay, hospitalization costs, adverse postoperative lifestyle, postoperative care adequacy, external rotator suturing, femoral head diameter, or offset (all P>0.05).

Among patients with mild dysfunction (FMA≥22; **Tables 6**, **7**), fall injury (P=0.030) and diabetes history (P=0.041) were associated with dislocation. Other variables - including age, sex, disease duration, body mass index, side, Evans-Jensen classification, smoking, alcohol, operative time, blood loss, length of stay, hospitalization costs, adverse lifestyle, postoperative care adequacy, external rotator suturing, femoral head diameter, femoral head offset, and surgical approach - did not differ significantly (all P>0.05).

Logistic regression in the two dysfunction strata

For moderate-to-severe dysfunction (FMA<22; **Figure 5**), univariate analyses showed that age ≥75 years (OR=2.331), Evans-Jensen type III

Table 5. Surgical and postoperative characteristics comparison for moderate-to-severe preoperative motor dysfunction patients

Variable	Dislocation Group (n=27)	Non-Dislocation Group (n=45)	t/χ^2	*P*-value
Operative Time (min)	77.50±10.15	73.87±10.87	-1.455	0.15
Intraoperative Blood Loss (mL)	317.13±32.55	328.96±27.58	1.691	0.095
Length of Stay (days)	19.47±3.08	19.24±4.37	-0.241	0.81
Hospitalization Costs (Yuan)	34981.70±4103.57	34071.87±4315.01	-0.912	0.365
Poor Postoperative Lifestyle Habits			1.863	0.172
Yes	11 (36.67%)	10 (22.22%)		
No	19 (63.33%)	35 (77.78%)		
Inadequate Postoperative Care			0.426	0.514
Yes	5 (16.67%)	4 (8.89%)		
No	25 (83.33%)	41 (91.11%)		
External Rotator Muscle Suturing			0	1
Yes	22 (73.33%)	33 (73.33%)		
No	8 (26.67%)	12 (26.67%)		
Femoral Head Diameter (mm)	43.80±3.43	43.96±3.38	0.194	0.847
Femoral Head Offset (mm)	42.87±2.74	43.38±3.37	0.692	0.491
Surgical Approach			3.97	0.046
Posterolateral	28 (93.33%)	34 (75.56%)		
Anterolateral	2 (6.67%)	11 (24.44%)		

Note: BMI, Body Mass Index; CNY, Chinese Yuan.

(protective, OR=0.356), diabetes (OR=3.034), and the posterolateral approach (OR=3.013) were associated with dislocation (all P<0.05). In multivariable models, age (OR=2.267) and diabetes (OR=2.836) remained independent risk factors (P<0.05), while the posterolateral approach trended toward significance (OR= 2.553, P=0.066).

For mild dysfunction (FMA≥22; **Figure 6**), univariate analyses identified fall injury (OR= 3.443) and diabetes (OR=3.077) as significant risk factors (P<0.05). Multivariable models confirmed both as independent risks (fall injury OR=5.332; diabetes OR=4.965; both P<0.05).

Discussion

This retrospective study of 305 elderly patients with intertrochanteric fractures provides, to our knowledge, the first systematic assessment of how hemiplegia secondary to cerebral infarction sequelae relates to instability after hemiarthroplasty. The dislocation rate of 26.6% observed in our cohort stands in marked contrast to prior reports in broader populations - 6.1% in the single-center series by Bue et al. [16] and, in a Swedish national cohort, 7.2% with the posterior approach versus 2.7% with the direct lateral approach [17]. Considered together, these data suggest that stroke-related hemiplegia confers a clinically meaningful vulnerability to postoperative dislocation that is not captured by estimates derived from unselected elderly groups. In practical terms, the magnitude of difference implies that conventional perioperative pathways designed for general hip-fracture populations may be insufficient for patients with hemiplegia.

Risk factor profiling in our analysis aligns with both biomechanical reasoning and the extant literature. Preoperative motor dysfunction was independently associated with dislocation (OR =2.695), a finding consistent with the expected effects of muscle imbalance, reduced selective motor control, and impaired postural reflexes in hemiplegic gait. The synthesis by Wang et al. [18] identified the posterolateral approach as the only factor with strong evidence for dislocation risk, with anatomic correlates of instability - such as a small acetabular coverage angle and a high femoral head exposure index - also being implicated [19]. Our findings therefore extend prior knowledge by situating these surgical and anatomic risk determinants within a

Table 6. Baseline characteristics comparison for mild preoperative motor dysfunction patients

Variable	Dislocation Group (n=23)	Non-Dislocation Group (n=45)	X^2	*P*-value
Age			0.915	0.339
≥75 years	12 (52.17%)	18 (40.00%)		
<75 years	11 (47.83%)	27 (60.00%)		
Gender			0.018	0.895
Male	16 (69.57%)	32 (71.11%)		
Female	7 (30.43%)	13 (28.89%)		
Disease Duration			2.169	0.141
≥6 months	13 (56.52%)	17 (37.78%)		
<6 months	10 (43.48%)	28 (62.22%)		
BMI			1.774	0.183
≥25 kg/m^2	8 (34.78%)	9 (20.00%)		
<25 kg/m^2	15 (65.22%)	36 (80.00%)		
Injury Mechanism			4.686	0.03
Fall injury	18 (78.26%)	23 (51.11%)		
External force impact	5 (21.74%)	22 (48.89%)		
Lesion Location			1.636	0.201
Left side	15 (65.22%)	22 (48.89%)		
Right side	8 (34.78%)	23 (51.11%)		
Evans-Jensen Fracture Classification			2.694	0.101
Type III	16 (69.57%)	40 (88.89%)		
Type IV	7 (30.43%)	5 (11.11%)		
Smoking History			1.966	0.161
Yes	13 (56.52%)	33 (73.33%)		
No	10 (43.48%)	12 (26.67%)		
Alcohol Consumption History			2.268	0.132
Yes	5 (21.74%)	18 (40.00%)		
No	18 (78.26%)	27 (60.00%)		
Diabetes History			4.167	0.041
Yes	10 (43.48%)	9 (20.00%)		
No	13 (56.52%)	36 (80.00%)		

Note: BMI, Body Mass Index.

high-risk neurological phenotype and by quantifying their joint contribution alongside care-process variables. The multivariable risk model we constructed showed robust discrimination (AUC=0.811; 95% CI, 0.761-0.862) with balanced sensitivity and specificity, supporting its feasibility for clinical screening and shared decision-making.

Eight independent risk factors emerged from multivariate modeling and can be interpreted across three conceptual domains. First are patient baseline characteristics, notably age ≥75 years (OR=3.164) and preoperative motor dysfunction (OR=2.695). Beyond chronological age, the interplay of sarcopenia, osteoporotic bone quality, and diminished balance control plausibly amplifies instability when combined with hemiplegic deficits. Prior large-sample evidence underscores that the choice of reconstructive strategy itself shapes downstream risk (12-month dislocation 2.9% after total hip arthroplasty vs 1.9% after hemiarthroplasty) [20]; our data extend this perspective by showing that even within hemiarthroplasty, neurologic impairment materially shifts the risk profile. Second are disease- and injury-related features, including disease duration ≥6 months (OR=1.881) and the Evans-Jensen classification. Prolonged neurological deficits favor dis-

Table 7. Surgical and postoperative characteristics comparison for mild preoperative motor dysfunction patients

Variable	Dislocation Group (n=23)	Non-Dislocation Group (n=45)	t/χ²	*P*-value
Operative Time (min)	69.00±12.27	69.31±12.48	0.098	0.922
Intraoperative Blood Loss (mL)	316.57±22.57	316.53±30.92	-0.004	0.997
Length of Stay (days)	20.00 [18.50, 21.50]	20.00 [17.00, 22.00]	0.691	0.49
Hospitalization Costs (Yuan)	34273.17±3181.17	33874.20±2868.86	-0.523	0.603
Poor Postoperative Lifestyle Habits			0.957	0.328
Yes	11 (47.83%)	16 (35.56%)		
No	12 (52.17%)	29 (64.44%)		
Inadequate Postoperative Care			2.037	0.153
Yes	5 (21.74%)	3 (6.67%)		
No	18 (78.26%)	42 (93.33%)		
External Rotator Muscle Suturing			2.124	0.145
Yes	20 (86.96%)	32 (71.11%)		
No	3 (13.04%)	13 (28.89%)		
Femoral Head Diameter (mm)	46.00 [43.00, 46.00]	44.00 [41.00, 46.00]	1.782	0.075
Femoral Head Offset (mm)	42.91±2.47	42.84±2.91	-0.097	0.923
Surgical Approach			1.472	0.225
Posterolateral	19 (82.61%)	31 (68.89%)		
Anterolateral	4 (17.39%)	14 (31.11%)		

Note: BMI, Body Mass Index; CNY, Chinese Yuan.

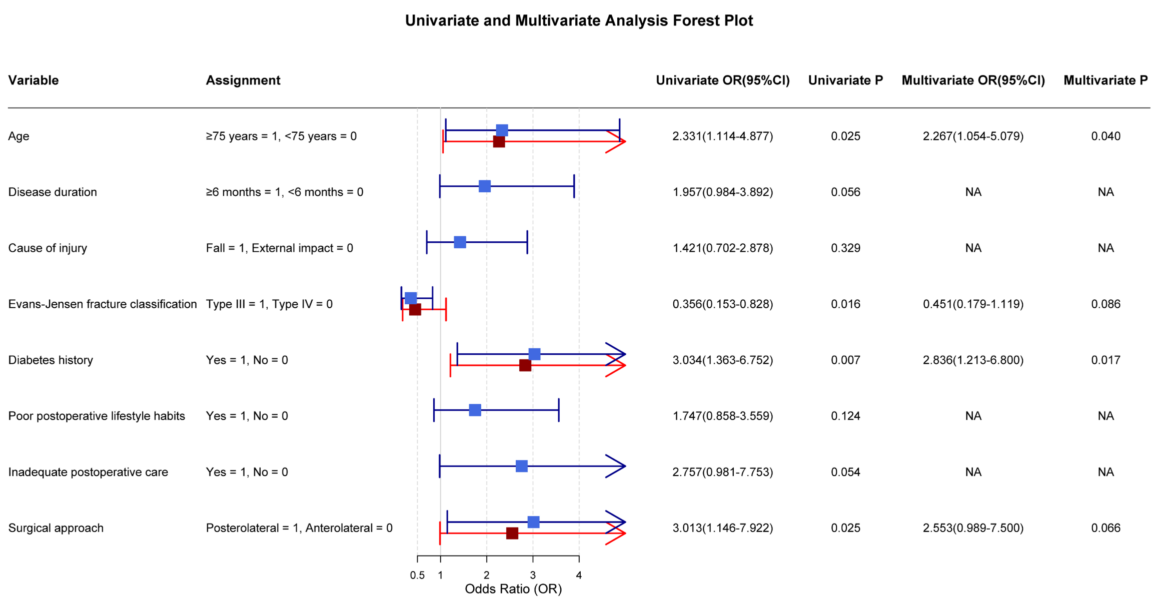

Figure 5. Univariate and multivariate analysis forest plot for severe motor impairment. Note: OR, Odds Ratio; CI, Confidence Interval; Motor Dysfunction is a preoperative test.

use atrophy, joint stiffness, and altered muscle tone, all of which degrade dynamic stability during early mobilization [21]. For elderly AO-OTA 31A2 fractures, functional outcomes may favor hemiarthroplasty over internal fixation, but the trade-off includes instability concerns that require explicit mitigation [22]. In this context, our finding that type III fractures were protective versus type IV (OR=0.359, P=0.004) is clinically coherent: type IV patterns entail sub-

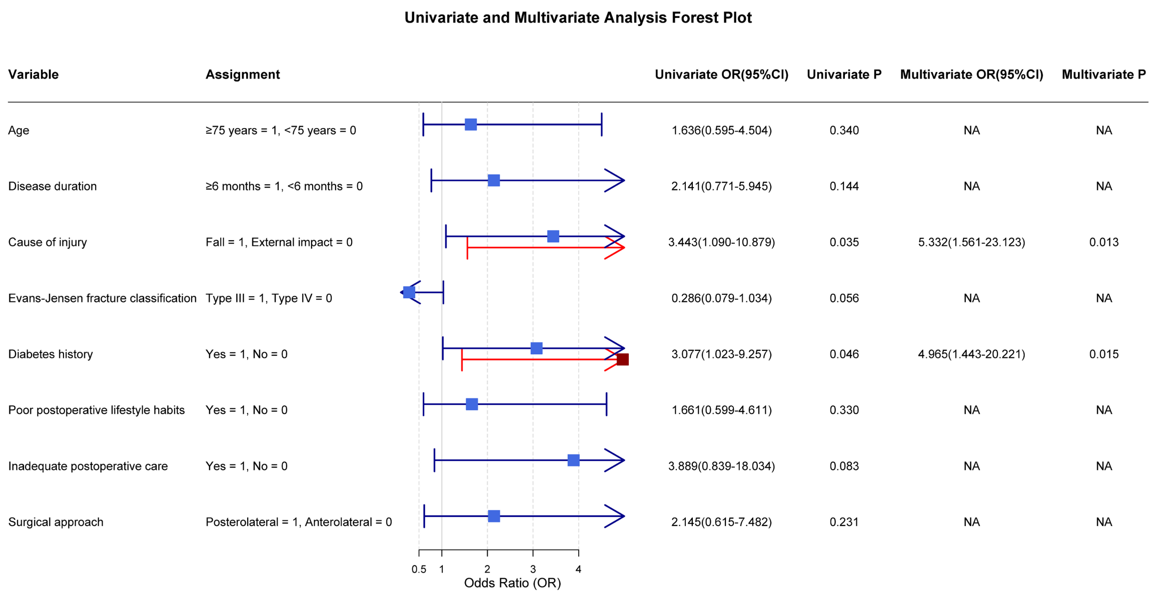

Figure 6. Univariate and multivariate analysis forest plot for mild motor impairment. Note: OR, Odds Ratio; CI, Confidence Interval; Motor Dysfunction is a preoperative test.

trochanteric extension and comminution compromising medial cortical support and the calcar, requiring broader dissection and weaken ing the soft-tissue envelope that contributes to stability. Third are care and technique variables, among which the posterolateral approach (OR=3.216), inadequate postoperative care (OR=4.276), and adverse postoperative lifestyle habits (OR=2.181) were prominent. Techniques that preserve key posterior soft tissues have reported lower dislocation than traditional posterior approaches [23], and anterior exposure has been associated with reduced instability relative to the posterolateral route [24]. Together with our findings, these data argue for deliberate approach selection and meticulous soft-tissue management when neurological deficits are present.

A unique feature of our results is the consistency of diabetes as an independent predictor across all analytic strata: overall (OR=2.501), moderate-to-severe motor dysfunction (OR= 2.836), and mild dysfunction (OR=4.965) were also important factors. This gradient implies that diabetes exerts a cross-cutting influence that may be especially pronounced when patients retain partial autonomy and, therefore, are more exposed to risky maneuvers in early rehabilitation. Prior work links cognitive impairment to higher dislocation risk after hemiarthroplasty [25], and diabetes is epidemiologically associated with cognitive decline - offering one plausible behavioral pathway. Mechanistically, several diabetes-related processes may converge: microvascular dysfunction and endothelial injury with impaired wound and capsular healing [26]; peripheral neuropathy that compounds the central motor and sensory deficits of hemiplegia [27]; innate and adaptive immune dysfunction that elevates postoperative infection risk and periprosthetic inflammation [28]; and hyperglycemia-mediated alterations in collagen crosslinking and bone remodeling that degrade the soft-tissue and osseous substrates of stability [29]. In aggregate, these mechanisms help explain both the consistency and the magnitude of effect observed in our models.

The neurological dimension warrants particular attention. Hemiplegia after cerebral infarction is not purely a motor syndrome; attentional deficits, executive dysfunction, and slowed processing are common and may undermine adherence to hip precautions and graded activity plans. Patients with moderate-to-severe dysfunction often rely heavily on nursing assistance; for them, the quality and consistency of postoperative care become dominant determinants of safety. By contrast, those with mild dysfunction may underestimate their limitations, leading to unsupervised movements that violate precautions and precipitate dislocation. Evidence that anterior approaches can reduce complication rates in intertrochanteric fracture hemiarthroplasty supports the view that approach choice can partially offset neurologic risk when combined with structured care pathways [30]. From a systems perspective, these observations argue for embedding neurocognitive and behavioral assessments into perioperative planning, not merely cataloging motor scores.

Translationally, our findings support a risk-stratified perioperative model. Patients who are elderly, hemiplegic, and diabetic should be managed as extremely high-risk. Preoperative work-up can include Fugl-Meyer grading, glycemic indices (e.g., HbA1c), cardiopulmonary evaluation, and appraisal of social supports, followed by a tailored plan that coordinates surgical approach with postoperative supervision intensity. Multidisciplinary hip-fracture programs have demonstrated benefits in geriatric care [31], and dislocation after hemiarthroplasty is associated with increased mortality - rising from 29.5% to 44.7% at one year in some series [32]. Consistent inpatient glycemic control (e.g., fasting 6.1-7.0 mmol/L; 2-hour postprandial <10.0 mmol/L) with endocrinology input, nutrition optimization, and explicit caregiver education may reduce complications. For recurrent instability, constrained revision constructs have shown favorable results [33], though the prognosis in this subgroup remains guarded, with multi-center data reporting one-year mortality as high as 46.0% [34]. Where implant selection is discretionary, Bayesian network meta-analysis suggests that bipolar hemiarthroplasty carries the lowest dislocation risk relative to total hip arthroplasty and unipolar hemiarthroplasty [35]; such evidence may inform device choice when balancing stability against other priorities.

Several limitations temper interpretation. As a single-center, retrospective analysis, our study is susceptible to selection and information biases, and findings require validation across diverse institutions and practice styles. Diabetes was treated as a binary exposure; future work should incorporate disease duration, complication burden, and granular glycemic control measures to refine risk estimates. Although the Fugl-Meyer scale offers stroke-specific motor assessment, rater subjectivity and context-dependent performance may introduce misclassification. Prospective, multicenter studies with predefined protocols, larger cohorts, and longer follow-up are needed to test whether intensive glycemic management, standardized nursing bundles, and individualized rehabilitation can causally reduce dislocation among hemiplegic patients. Parallel mechanistic studies - ranging from imaging of soft-tissue healing to molecular analyses of glycation and collagen integrity - could illuminate the biological underpinnings of instability at the interface of diabetes and hemiplegia. Finally, economic evaluations should explore whether targeted prevention in very-high-risk patients improves quality-adjusted outcomes and offsets the costs associated with dislocation treatment and its sequelae.

In summary, the present findings reframe postoperative dislocation after hemiarthroplasty as not merely a surgical or implant problem but as a multifactorial syndrome in which neurological status, metabolic disease, fracture biology, surgical approach, and care processes interact. The combination of advanced age, motor dysfunction, and diabetes is particularly deleterious, yet our data also suggest practical levers - approach selection, rigorous postoperative care, and improved glycemic and rehabilitation management - through which risk may be mitigated. The proposed prediction model offers a quantitative framework to identify candidates for these intensified strategies and to guide patient-centered conversations about anticipated risk and monitoring intensity.

Conclusion

In elderly patients with intertrochanteric fractures undergoing hemiarthroplasty, hemiplegia due to cerebral infarction sequelae is associated with a substantially elevated risk of postoperative dislocation (26.6%). Independent risk factors comprised age ≥75 years, preoperative motor dysfunction, diabetes history, inadequate postoperative care, adverse lifestyle habits, and the posterolateral approach, whereas Evans-Jensen type III was protective compared with type IV. These observations support proactive, risk-stratified perioperative management and underscore the value of integrating surgical decision-making with optimized nursing protocols, glycemic control, and rehabilitation planning.

Disclosure of conflict of interest

None.

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