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ORIGINAL RESEARCH

Hemiarthroplasties via Posterior Trochanter Osteotomy for Treating Femoral Neck Fractures in Post-Cerebrovascular Disease

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Objective: The study investigated to examine the clinical outcomes of hemiarthroplasties using posterior femoral trochanter osteotomy for the treatment of femoral neck fractures in patients at the sequelae stage of cerebrovascular disease.

Methods: A retrospective analysis was conducted on the data of 53 patients who had been admitted to the Department of Orthopedics at Yan'an University Affiliated Hospital between May 2020 and May 2023. These patients had been diagnosed with femoral neck fractures and concurrent muscle weakness at the sequelae stage of cerebrovascular disease. The patients were divided into two groups: the osteotomy group (20 cases), which underwent hemiarthroplasties via an L osteotomy of the posterior femoral trochanter, and the conventional group (33 cases), which received hemiarthroplasties through the posterolateral approach of the greater trochanter. The two groups were compared on various parameters, including incision length, operation duration, intraoperative blood loss, post-operative drainage, blood transfusion rates, length of hospitalization, early mobilization post-surgery, hip joint function scores at follow-up visits (3 and 12 months), and the rate of postoperative dislocation of the femoral head.

Results: No significant differences were observed between the two groups regarding incision length (P=0.06), operation duration (P=0.284), intraoperative blood loss (P=0.925), Blood transfusion rate (P=0.489), postoperative drainage (P=0.831) and length of hospital stay (P=0.341). However, the early mobilization time following surgery was shorter in the osteotomy group compared to the conventional group (P<0.001). Additionally, the Harris hip joint function scores for the osteotomy group were significantly higher than those for the conventional group at both the 3- and 12-month postoperative assessments (P=0.003, P=0.004, respectively). The dislocation rate of the femoral head in the osteotomy group was lower than that in the conventional group with no statistical significance difference (P=0.521).

Conclusion: The use of hemiarthroplasties via posterior femoral trochanter osteotomy demonstrates favorable clinical outcomes in the treatment of femoral neck fractures.

Keywords: hemiarthroplasty, femoral neck fractures, surgical procedures, osteotomy, stroke

Introduction

With the onset of an aging society in China, femoral neck fractures are one of the most prevalent fractures among the older adult population.[1] These fractures can lead to significant long-term morbidity and may even pose life-threatening risks, particularly for these patients. Hemiarthroplasties has demonstrated considerable therapeutic efficacy in managing femoral neck fractures in older adults and is widely accepted in the medical community. However, opinions among scholars are divided regarding the optimal surgical approach to adopt.[2] Older adult patients with femoral neck fractures are at an increased risk for complications, including cardiovascular and respiratory diseases, which can exacerbate their

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condition. Following a fracture, these patients are particularly susceptible to hypostatic pneumonia, venous thrombosis, infections, and other complications.[1,3] If not addressed promptly and appropriately, these issues can endanger their lives.

Patients with cerebrovascular disease have a 2–4 times higher risk of hip fracture compared with normal adults.[4–6] Cerebrovascular disease is an important risk factor for hip fracture. Some elderly patients with cerebrovascular disease are accompanied by hemiplegia. Due to impaired balance and cognition, the risk of falling is increased.[7,8] This is because after the onset of cerebrovascular disease, impaired motor control and limb weakness not only reduce the generation of muscle strength but also disrupt the coordination of movements between limbs, thereby affecting balance. Compared with healthy individuals, the muscle strength of the affected lower limbs usually decreases by 34–62%.[9] Moreover, due to the pre-existing reduction in lower limb muscle strength in patients with cerebrovascular disease, the use of traditional surgical procedures after femoral neck fracture will damage the external rotator muscle group. During balance control, the weakness of the hip external rotator and abductor muscles will affect the stability of the weight-bearing lower limb, making it difficult to transfer body weight to the affected side.[10]

Additionally, dislocation of the femoral head following hemiarthroplasties has become a common complication among older adult patients with sequelae of cerebrovascular disease. Thus, selecting suitable surgical methods to minimize the incidence of complications and enhance the quality of life of patients has become a focal point of research. Patients with cerebral hemorrhage or cerebral infarction often have weaker muscle strength than normal. If the external rotator muscle group is sectioned during surgery, it may further reduce lower limb muscle strength, increasing the postoperative hip dislocation rate and significantly impairing function. To address this, the author's team developed a L-shaped osteotomy approach via the posterior femoral trochanter for hemiarthroplasty, which avoids sectioning the external rotator muscles and achieves bony union (Figure 1). This study retrospectively analyzed data from 53 patients with femoral neck fractures and reduced limb muscle strength due to cerebrovascular sequelae, treated in the Department of Orthopedics at Yan'an University Affiliated Hospital between May 2020 and May 2023. It compares the outcomes of the L-shaped osteotomy approach with those of the traditional posterolateral approach in patients with femoral neck fractures and cerebrovascular sequelae, aiming to determine whether the new approach can improve surgical outcomes, promote recovery, reduce complications, and enhance quality of life, thereby providing a reference for the surgical treatment of femoral neck fractures.

Data and Methods

Inclusion Criteria and Exclusion Criteria

Inclusion Criteria: 1) Patients who meet the diagnostic criteria for femoral neck fractures. 2) Patients with a history of cerebral hemorrhage or cerebral infarction, with muscle strength of the affected limbs assessed at ≤ 4 prior to surgery. 3)

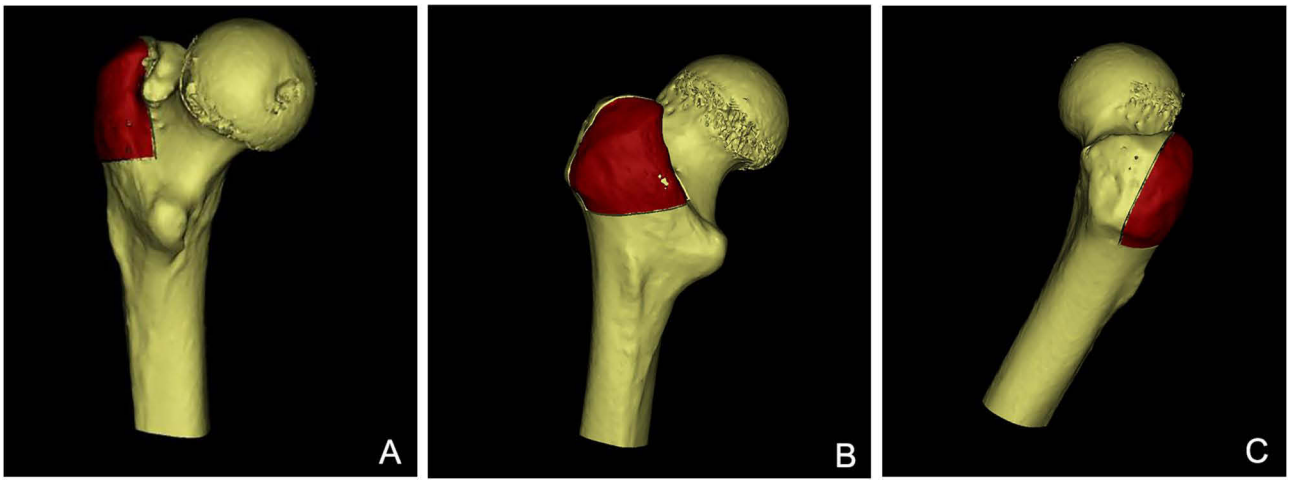

Figure 1 Schematic representations of the "L" osteotomy approach for hemiarthroplasties (**A**–**C**).

Patients aged 65 years or older, classified as Garden types III and IV. 4) Patients who fulfill the indications for surgery and are scheduled to receive hemiarthroplasties.

Exclusion Criteria: 1) Individuals with surgical contraindications. 2) Individuals with coagulation dysfunction. 3) Individuals with mental illness. 4) Individuals with pathological fractures. 5) Individuals with incomplete clinical data that prevent timely follow-up visits. 6) Individuals with fractures located in other anatomical regions.

General Data

A total of 53 participants were included in the study, comprising of 20 cases (10 males and 10 females) in the osteotomy group, with a mean age of 74.3 ± 6.5 years and a body mass index (BMI) of 22.5 ± 2.5 kg/m^2. Within this group, 4 participants had a history of cerebral hemorrhage, and 16 had experienced cerebral infarction. The conventional group consisted of 33 cases (11 males and 22 females), with a mean age of 74.7 ± 9.4 years and a BMI of 22.7 ± 2.1 kg/m^2; among these, 7 participants had cerebral hemorrhage, and 26 had cerebral infarction. No statistically significant differences were found between the two groups regarding gender (χ^2 = 1.446, P = 0.229), age (t = −0.179, P = 0.858), BMI (t = −0.385, P = 0.702), Garden type (χ^2 = 0.212, P = 0.645), prosthesis type (χ^2 = 0.001, P = 0.981), and the presence of complicating cerebrovascular disease (χ^2 = 0.001, P = 1) ($P > 0.05$), indicating that the groups were comparable. Refer to Table 1 for further details.

Methods

Preoperative Treatment and Evaluation

Prior to the operation, a comprehensive physical examination along with auxiliary tests were conducted on the patients. The physical examination included assessments such as the hip flexion and contracture test, single-leg independent test, and lower limb shortening test. Auxiliary examinations included blood analysis, urinalysis, routine stool examination, liver function tests, renal function tests, blood glucose assessment, electrolyte levels, electrocardiogram, X-rays, and CT scans. Cardiopulmonary function, as well as the condition of other organs and internal diseases, were assessed. Potential complications that could impact surgical outcomes were proactively addressed. In particular, patients with a history of stroke underwent thrombus risk assessment and preventive anticoagulation measures. Routine treatment with low molecular weight heparin calcium was administered for anticoagulation until one day prior to the operation. Additionally, intravenous antibiotics were given 30 minutes before the surgery and continued for 3 to 5 days post-operatively to prevent infection. Blood pressure was maintained below 150/90 mmHg, cardiac function was above Grade II, fasting blood glucose ≤ 8.0 mmol/L, and oxygen partial pressure ≥ 60 mmHg were kept in a resting state.

Operation Method

All surgeries for the both two groups were collaboratively performed by a team of highly experienced attending orthopedic surgeons and their team members, all qualified in hemiarthroplasties procedures. A combined spinal-epidural anesthesia approach was used, along with a posterolateral surgical technique, with the patient positioned in the contralateral decubitus position. Bone cement and biological prostheses used in the procedure were from Shanghai Smith & Nephew. (The uncemented femoral stem was made of Ti6Al4V titanium alloy, which meet ISO 5832-3 standards. The cemented femoral stem and monoblock head were made of cast cobalt-chromium-molybdenum alloy, which meet ISO 32-4 standards. The femoral head was made of forged cobalt-chromium-molybdenum alloy, which meet ISO 5834-12 standards). In the osteotomy group, 6 participants received bone cement prostheses, while 14 participants were fitted with biological prostheses. In the conventional group, 10 participants received bone cement prostheses, and 23 participants were fitted with biological prostheses. In the conventional group, the surgical procedure involved incising the skin, subcutaneous tissue, and deep fascia sequentially. The gluteus maximus was split, and the gluteus medius was protected by pulling it forward. The external rotator muscle group was transected, and care was taken to protect the sciatic nerve. The joint capsule was incised to expose the affected hip joint and femoral neck fracture. Femoral osteotomy was performed approximately 1.5 cm above the trochanter, with the femoral bone marrow cavity being reamed at a forward inclination of 15° to accommodate an appropriately-sized femoral stem prosthesis.

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Table 1 Comparison of Preoperative General Data between Two Groups of Patients with Femoral Neck Fractures

Group	Number of Subjects	Gender (Number)		Age (Years, x±s)	BMI [kg/m^2, x±s]	Lateral (Number)		Injury to Operation Time (d, x±s)	Cerebrovascular Disease		Garden Type		Prosthesis Type	
		Male	Female			Left	Right		Cerebral Hemorrhage	Cerebral Infarction	III	IV	Bone Cement	Biological
Osteotomy group	20	10	10	74.3±6.5	22.5±2.5	7	13	6.4±4.1	4	16	14	6	6	14
Conventional group	33	11	22	74.7±9.4	22.7±2.1	11	22	5.4±1.7	7	26	25	8	10	23
t/χ^2		1.446		−0.179	−0.385	0.015		1.242	<0.001		0.212		0.001	
P value		0.229		0.858	0.702	0.901		0.220	1		0.645		0.981	

Note: In the osteotomy group, hemiarthroplasties was performed using the posterior "L" osteotomy approach of the greater trochanter, whereas in the conventional group, it was performed using the conventional posterior lateral extortion group amputation approach.

A ceramic artificial femoral head was then installed, followed by traction to restore hip joint function. The hip joint was passively moved to ensure appropriate tightness without a tendency for dislocation. After thorough wound irrigation and hemostasis, the external rotator muscle group was sutured, and the surgical incision was closed layer by layer. In the osteotomy group, a similar shallow exposure was achieved, with the external rotator muscle group left intact. An L-shaped osteotomy was performed in the posterior 1/3 of the greater trochanter. The gluteus medius was minimally split, and the osteotomy block was retracted posteriorly along with the external rotator muscle. The remaining surgical procedures mirrored those of the conventional group. Upon completion of the prosthesis installation, the osteotomy block was stabilized using a pin tension band and/or a reconstruction locking titanium plate. Refer to Figure 2 for additional details.

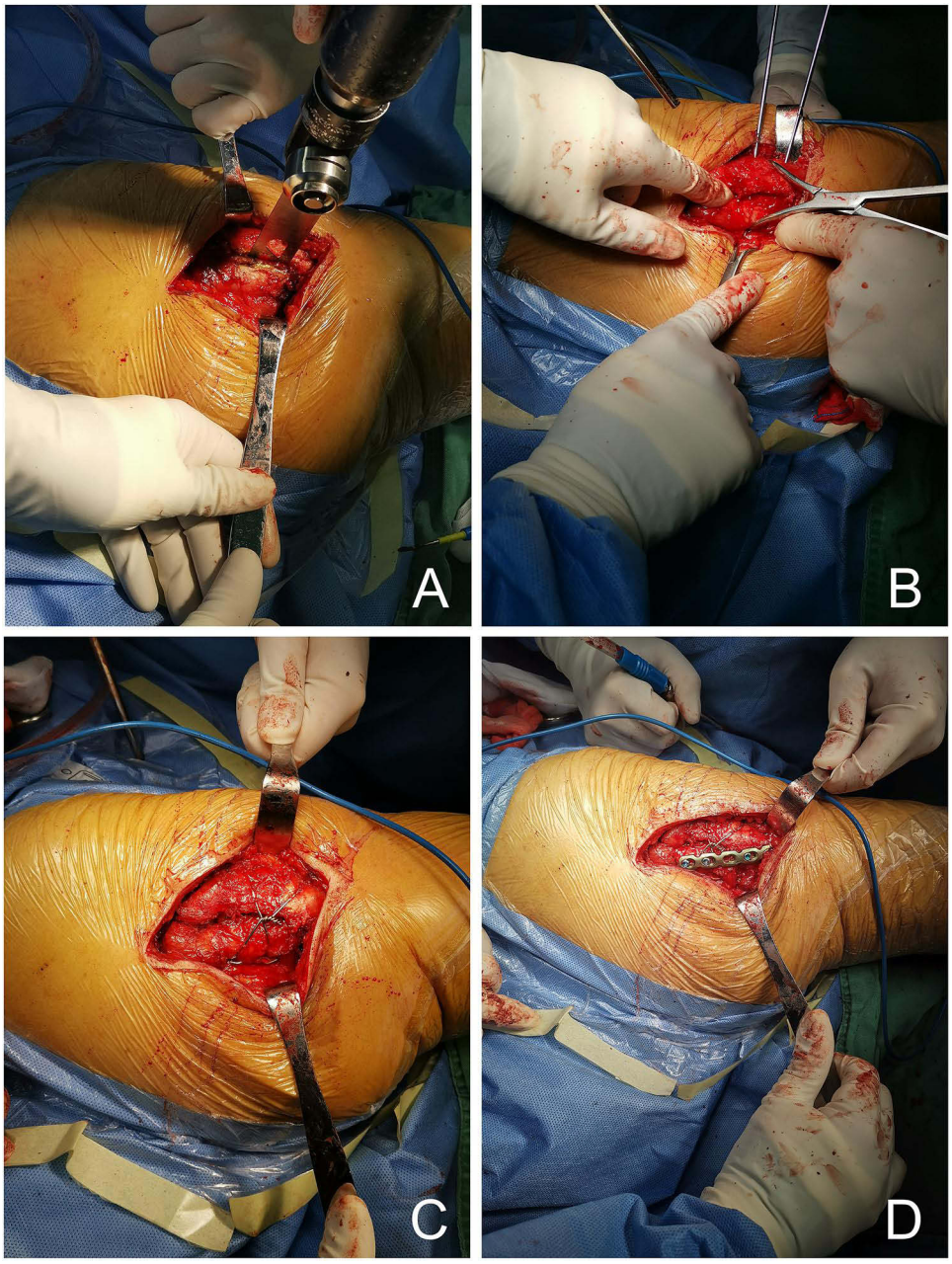

Figure 2 Intraoperative views of the L-shaped osteotomy in the posterior one-third of the right femoral trochanter. (**A**) L-shaped osteotomy; (**B** and **C**) fixation of the osteotomy block with a pin tension band; (**D**) final fixation of the osteotomy block with a locking titanium plate.

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Postoperative Treatment

Following the administration of anesthesia, patients had their affected limbs stabilized in an abduction-neutral position using a lower limb brace. They were instructed to perform isometric muscle contraction exercises, ankle flexion and extension, and isometric contractions of the lower limb muscles. The objective of these exercises was to progressively strengthen hip muscles and facilitate early mobilization. In both groups, on the first postoperative day, patients began alternating use of inflatable compression devices to mechanically prevent lower limb thrombosis. Subcutaneous injections of low molecular weight heparin sodium (2500 U) were administered 6 hours postoperatively and continued until discharge. After 2–3 days, patients were encouraged to engage in partial weight-bearing activities with the aid of a walker. Upon discharge, they were prescribed rivaroxaban 10 mg orally, which continued for 35 days post-operation.

Observation Measures

The postoperative parameters recorded for both groups included incision length, operation time, intraoperative blood loss, postoperative drainage, blood transfusion rate, duration of hospital stay, early mobilization time, and the incidence of femoral head dislocation. Following surgery, the recovery of joint function was assessed using the Harris Hip Score, which assesses joint pain (44 points), range of motion (5 points), joint function (47 points), and deformity (4 points), with a total possible score of 100 points.[11] The outcomes were categorized as excellent (≥ 90 points), good (≥ 80 points), average (≥ 70 points), or poor (< 70 points), with higher scores reflecting better joint recovery. The flowchart of the study was shown in the Figure 3.

Statistical Treatment

The data were analyzed using SPSS 20.0 statistical software (IBM, Armonk, NY, USA). For measurement data, the Kolmogorov-Smirnov test was first used to assess normality. Data that met the normal distribution criteria were described using the mean ± standard deviation ($\bar{x} \pm s$). For comparisons between two groups, the independent-samples *T*-test was used for statistical inference. For count data, comparisons between two groups were made using the chi-square test (χ^2 test) or Fisher's exact test. $P < 0.05$ was considered to indicate a statistically significant difference.

Results

There was no significant difference in the preoperative general data between the two groups of patients (all $P > 0.05$, Table 1), indicating comparability. No significant differences were observed between the two groups in terms of incision length (10.5±1.4 cm vs 10.5±2.1 cm, P=0.06), operation time (80.2±37.2 min vs 74.9±19.1 min, P=0.284), intraoperative blood loss (175±128.2 mL vs 177.9±94 mL, P=0.925), Blood transfusion rate (P=0.489), postoperative drainage (128.8 ±170.2 mL vs 136.7±99.8 mL, P=0.831), and hospital stay (14.9±4.6 d vs 17.4±5.1 d, P=0.341). No vascular or nerve injury occurred during the operation. All incisions healed by primary intention. Postoperative follow-up radiographs showed satisfactory positioning of the prosthesis. However, the early off-bed time in the osteotomy group was significantly shorter compared to the conventional group (4.3±1.7 d vs 11.9±5.1 d, $P=3.12\times10^{-8}$). The Harris hip joint function scores at both 3 and 12 months postoperatively were significantly higher in the osteotomy group than in the conventional group (81.1±5.7 vs 76.6±4.9, 74.8±4.8 vs 69.8±6.8, P=0.003, P=0.004, respectively). Although the dislocation rate of the femoral head was lower in the osteotomy group, the difference was not statistically significant (P=0.521). Refer to Tables 2, 3 and Figure 4 for further details.

Discussion

A femoral neck fracture refers to the fracture occurring at the junction between the femoral head and the femoral neck end. It is among the most frequent fractures observed in older adult patients. In recent years, with the increase in life expectancy and the intensification of population aging, the incidence of femoral neck fractures has become a rising trend and a significant health concern for the older adult population.[1] Based on current data, femoral neck fractures account for approximately 3.58% of all systemic fractures. According to research, the all-cause mortality rate within one year of sustaining a femoral neck fracture is about 9.83%, with older adult patients being particularly vulnerable to a higher mortality rate.[12] The anatomical characteristics of the femoral neck, including its limited blood supply, contribute to the increased risk of complications like nonunion and avascular necrosis of the femoral head, even following internal fixation

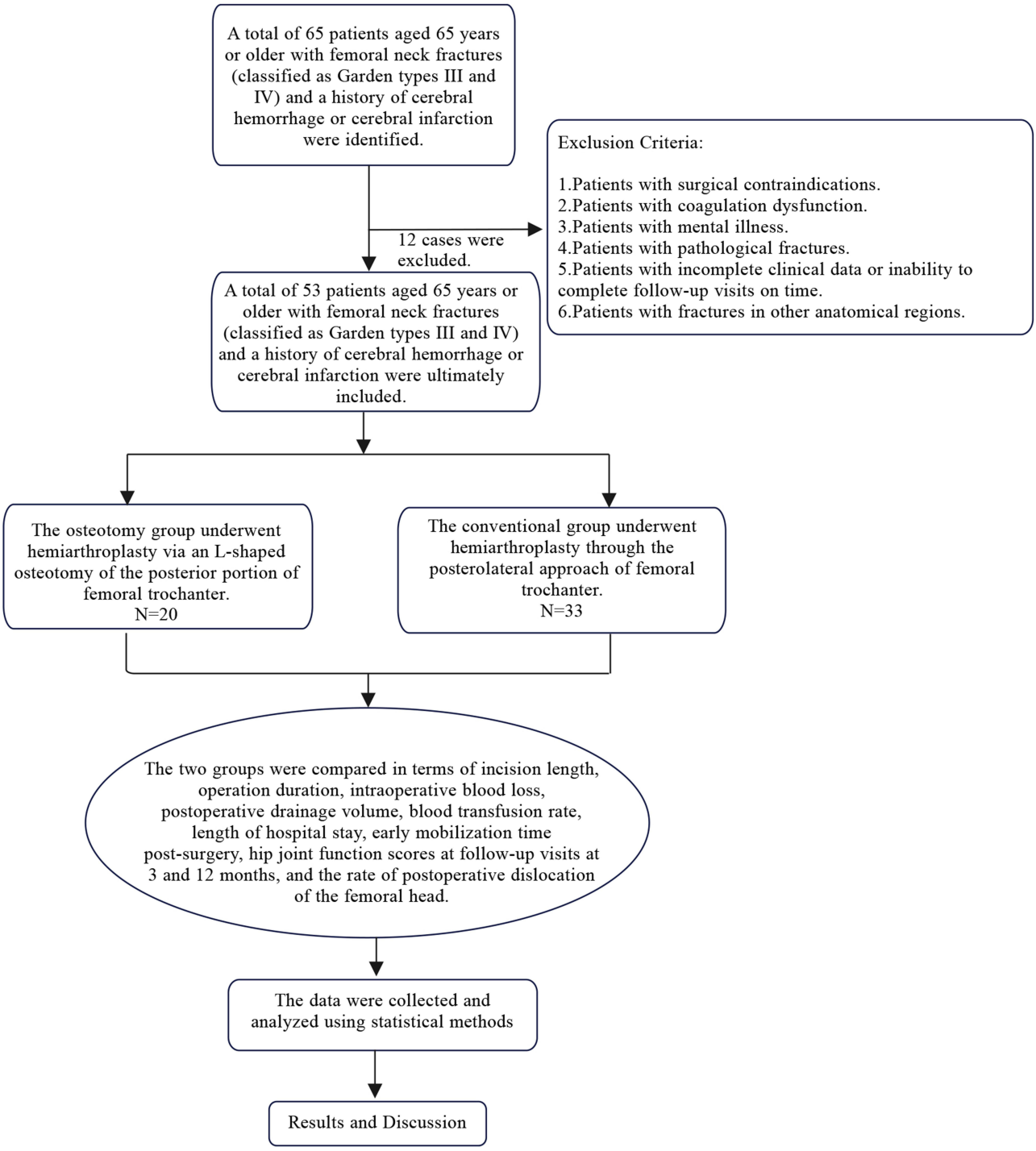

Figure 3 The flowchart of the study.

procedures.[13] Related literature indicates that the incidence of nonunion following either conservative or surgical treatment ranges from 10%-34%, while the likelihood of ischemic necrosis of the femoral head may reach as high as 30%-50%.

Untimely management of these complications can significantly affect the quality of life of patients, thus positioning femoral neck fractures as an indication for artificial hip replacement, particularly in older adult patients.[14,15] According to Mingli et al, artificial joint replacement may be considered for older femoral neck fractures or sequelae of cerebrovascular accidents in patients with Garden III and IV fresh fractures on the hemiplegic side, provided the patients are in

Table 2 Comparison of Observational Measures between Two Groups of Patients with Femoral Neck Fractures

Group	n	Incision Length	Operation Time	Intraoperative Blood Loss	Postoperative Drainage	Hospital Stay	Early Off-Bed Time After Operation
Osteotomy group	20	10.5±1.4	80.2±37.2	175±128.2	128.8±170.2	14.9±4.6	4.3±1.7
Conventional group	33	10.5±2.1	74.9±19.1	177.9±94	136.7±99.8	17.4±5.1	11.9±5.1
t/χ^2		0.029	0.699	−0.094	−0.214	1.799	−6.430
P value		0.060	0.284	0.925	0.831	0.341	3.12×10^{-8}

Note: In the osteotomy group, hemiarthroplasties was performed using the posterior "L" osteotomy approach of the greater trochanter, whereas in the conventional group, it was performed using the conventional posterior lateral extortion group amputation approach.

Table 3 Comparison of Harris Score and the Incidence of Femoral Head Dislocation between Two Groups of Patients with Femoral Neck Fractures

Group	n	Harris Score (Points)		Femoral Head Dislocation		Blood Transfusion	
		3 Months After Operation	12 Months After Operation	Yes	No	Yes	No
Osteotomy group	20	81.1±5.7	74.8±4.8	0	20	6	14
Conventional group	33	76.6±4.9	69.8±6.8	2	31	13	20
t/χ^2		3.067	2.997	–	–	0.478	
P value		0.003	0.004	0.521*		0.489	

Notes: In the osteotomy group, hemiarthroplasties was performed using the posterior "L" osteotomy approach of the greater trochanter, whereas in the conventional group, it was performed using the conventional posterior lateral extortion group amputation approach. *The Fisher's exact probability method was used, and there was no result in the chi-squared calculation.

generally good condition and can tolerate major surgery.[16] For patients with poor muscle strength in the affected limbs (Garden IV or below), hemiarthroplasties is recommended. Conversely, for those with greater muscle strength (Garden IV or above), cemented total hip replacement has been indicated to yield better outcomes. Despite the widespread clinical

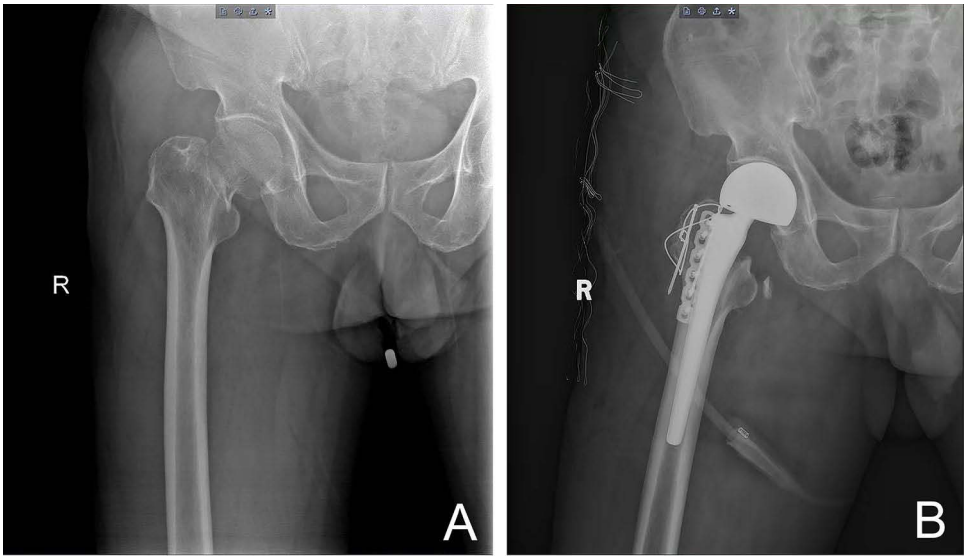

Figure 4 Pre- and postoperative imaging of a 73-year-old female patient with a 12-year history of cerebral infarction, presenting with a right femoral neck fracture (Garden type III) and lower limb muscle strength Grade III. (**A**) Preoperative X-ray reveals the right femoral neck fracture. (**B**) Postoperative X-ray shows successful fixation with 2 pins, a steel wire tension band, a titanium plate, and 4 screws, as well as acceptable positioning of the femoral stem prosthesis, double-acting head, and locking titanium plate.

use of hip replacement surgery, postoperative complications, particularly hip joint dislocation remain common, with an initial dislocation rate of 2%-3%.[17]

The conventional post lateral approach, which involves the removal of the external rotator muscle group, often results in hip muscle relaxation and reduced muscle strength, thereby compromising joint stability and predisposing patients to dislocation. For older adult patients with cerebrovascular diseases, up to 80% of stroke survivors experience varying degrees of lower limb dysfunction, leading to reduced muscle strength, diminished motor function, and decreased quality of life. Impaired intracranial hemodynamics is recognized as a key contributor to motor dysfunction in these patients.[18] According to research, reduced blood perfusion in the motor areas of the cerebral cortex is one of the mechanisms underlying lower limb dysfunction following a stroke.[19] Given the plasticity of the cerebral cortex in patients with stroke, strategies aimed at enhancing cerebral hemodynamics to enhance lower limb muscle strength are essential. Along with preserving muscle and blood perfusion in the lower limbs, hemiarthroplasties through osteotomy is indicated to enhance motor function and overall quality of life in older adult patients, as it minimizes damage to lower limb muscle strength.

The external rotator muscle group of the hip joint comprises of the internal obturator muscle, external obturator muscle, superior gemellus, inferior gemellus, and quadratus femoris. The muscle stops at the greater trochanter of the femur and these muscles originate from the pelvis and insert at the greater trochanter of the femur, primarily located beneath the gluteus maximus. This muscle group plays a key role in stabilizing the hip joint, with its primary function being the control of external rotation and abduction of the hip joint.[20] Injury to the external rotator muscle group can lead to dysfunction in hip external rotation, resulting in an abnormal toe-out posture in the lower limb of the patient.

Older adult patients are particularly susceptible to femoral head dislocation following hemiarthroplasties, and this risk is compounded by the presence of stroke-related complications. Stroke often leads to diminished lower limb muscle strength and imbalance in local muscle and soft tissue. Additionally, cognitive dysfunction can impair the adherence of the patient to postoperative dislocation prevention measures, increasing the likelihood of falls and improper movements. During femoral head replacement, if the external rotator muscle group is severed, postoperative suturing may fail to restore adequate strength, particularly in patients with pre-existing muscle weakness. This leads to slower recovery of muscle strength and a heightened risk of femoral head dislocation. Furthermore, the success rate of external rotator muscle group repair is limited.

Studies have demonstrated a significant failure rate in such repairs, with Sthelin et al reporting that 75% of patients experienced fractures following repair.[21] Similarly, Loiba et al discovered that out of 37 participants who underwent external rotator muscle group repair during total hip replacement, only 2 cases were successful postoperatively.[22] In this study, the L-shaped osteotomy technique used in the osteotomy group does not involve cutting the external rotator muscle group during femoral surgery. This avoids complications like external rotator muscle shortening or tension following repair, thus reducing the risk of repair failure and postoperative dislocation. Additionally, the osteotomy group experienced reduced blood loss compared to the conventional group, which may be attributed to the preservation of the external rotator muscle group, resulting in less surgical trauma.

Anatomical reduction of the external rotator muscle attachment point was almost achieved, minimizing soft tissue injury and consequently reducing intraoperative bleeding and postoperative drainage. In the osteotomy group, bone healing was successfully achieved postoperatively, and the surgical technique, due to its fixation reliability, allowed for early mobilization. This early mobilization enabled patients to begin functional exercises sooner, promoting recovery of the affected limb. Retaining the external rotator muscle group during femoral head replacement through a posterolateral approach also supports better joint function recovery in older adult patients with femoral neck fractures. This is likely because the preservation of the external rotator muscle group enhances joint stability, reduces the risk of artificial joint dislocation, and removes the need for postoperative joint adduction and internal rotation restrictions. Consequently, early activity and functional exercises become more feasible, facilitating rapid recovery of joint function.

The innovation of this study lies in the surgical approach of posterior trochanteric osteotomy, which avoids cutting the external rotator muscle group. During the surgery, efforts are made to minimize the decline in lower limb muscle strength in patients with femoral neck fractures due to cerebrovascular disease sequelae. However, the osteotomy group will cause damage to the bone, while the traditional group will damage the external rotator muscle group. Of course, we have to

admit that different surgical methods can affect the inflammatory response in elderly patients. Therefore, it is necessary to select appropriate biomarkers to monitor the inflammatory response.[23]

However, our study still has some limitations. Firstly, as a single-center retrospective study, the number of cases included in our study was not large. The small sample size may affect the accuracy of the results. Secondly, the short study time frame made it difficult to comprehensively assess the long-term effects of the surgical procedure, which may lead to an overly optimistic evaluation of the surgical outcomes. In future studies, we are going to include a larger sample size to adequately conduct power analyses and conduct multicenter, prospective studies to compare the therapeutic effects of different approaches.

Conclusion

In conclusion, the treatment of femoral neck fractures in patients with stroke by using a posterior femoral trochanter osteotomy approach, while preserving the external rotator muscle group, demonstrates superior clinical outcomes. Compared to the conventional posterolateral approach, this method offers several advantages, including earlier post-operative mobilization, a lower rate of femoral head dislocation, and enhanced hip joint stability and function. These factors contribute to more rapid postoperative rehabilitation, presenting a novel and effective option for hemiarthroplasties.

Abbreviation

BMI, body mass index.

Data Sharing Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Ethics Approval and Consent to Participate

The study was conducted in accordance with the Declaration of Helsinki (as was revised in 2013). The study was approved by Ethics Committee of the Affiliated Hospital of Yan'an University (No. S-S20240043). Written informed consent was obtained from all participants.

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Disclosure

The authors declare that they have no competing interests.

References

1. Liu P, Zhang Y, Sun B, et al. Risk factors for femoral neck fracture in elderly population. *Zhong Nan Da Xue Xue Bao Yi Xue Ban*. 2021;46(3):272–277. doi:10.11817/j.issn.1672-7347.2021.190378
2. Guyen O. Hemireplacement or total Hip replacement in recent femoral neck fractures? *Orthop Traumatol Surg Res*. 2019;105(1S):S95–S101. doi:10.1016/j.otsr.2018.04.034
3. Wang J, Zhao C, Yang B. Risk factors for early complications following replacement in elderly patients with a femoral neck fracture. *J Back Musculoskelet Rehabil*. 2023;36(2):309–315. doi:10.3233/BMR-220044
4. Carda S, Cisari C, Invernizzi M, et al. Osteoporosis after stroke: a review of causes and potential treatments. *Cerebrovasc Dis*. 2009;28:191–200. doi:10.1159/000226578
5. Kanis J, Oden A, Johnell O. Acute and long-term increased risk of fracture after stroke hospitalization. *Stroke*. 2001;32:702–706. doi:10.1161/01.str.32.3.702
6. Dennis MS, Lo KM, McDowall M, et al. Fractures after stroke: frequency, type, and association. *Stroke*. 2002;33:728–734. doi:10.1161/hs0302.103621

7. Sennerby U, Melhus H, Gedeborg R, et al. Cardiovascular diseases and risk of Hip fracture. *JAMA*. 2009;302:1666–1673. doi:10.1001/jama.2009.1463
8. Marsden J, Gibson LM, Lightbody CE, et al. Can early onset bone loss be effectively managed in post-stroke patients? An integrative review of the evidence. *Age Ageing*. 2008;37:142–150. doi:10.1093/ageing/afm198
9. Abd Elsabour AK, Zakaria HM, Fahmy EM, et al. Effect of plyometric exercises of lower limb on strength, postural control, and risk of falling in stroke patients. *Medicina*. 2025;61(2):223. PMID: 40005340; PMCID: PMC11857203. doi:10.3390/medicina61020223
10. Vishakha D, Suruliraj K. Lower limb motor function and Hip muscle weakness in stroke survivors and their relationship with pelvic tilt, weight-bearing asymmetry, and gait speed: a cross-sectional study. *Curr J Neurol*. 2020;19:1–7.
11. Hersnaes PN, Gromov K, Otte KS, et al. Harris Hip Score and SF-36 following metal-on-metal total hip replacement and hip resurfacing - a randomized controlled trial with 5-years follow up including 75 patients. *BMC Musculoskelet Disord*. 2021;22(1):781. doi:10.1186/s12891-021-04671-1
12. Li XP, Zhang P, Zhu SW, et al. All-cause mortality risk in aged femoral intertrochanteric fracture patients. *J Orthop Surg Res*. 2021;16(1):727. doi:10.1186/s13018-021-02874-9
13. Gu H, Wang Q, Yang M, et al. Complete fracture of posterior cortex increases the risk of avascular necrosis after osteosynthesis for non-displaced femoral neck fractures in elderly patients. *Chin Med J*. 2023;136(20):2514–2515. doi:10.1097/CM9.0000000000002842
14. White JJ, Khan WS, Smitham PJ. Perioperative implications of surgery in elderly patients with Hip fractures: an evidence-based review. *J Perioper Pract*. 2011;21(6):192–197. doi:10.1177/175045891102100601
15. Phruetthiphat OA, Lawanprasert A, Khuangsirikul S, et al. Effectiveness of periarticular injection after bipolar hemireplacement for displaced femoral neck fracture in elderly patients: a double blinded randomized, controlled study. *J Replacement*. 2021;36(6):2006–2011. doi:10.1016/j.arth.2021.01.017
16. Feng ML, Shen HL, Yong YM, Hu WJ, Cao L, Wang W. Total Hip arthroplasty for femoral neck fractures on the hemiplegic side in elderly patients with cerebrovascular accidents. *Chin J Orthop*. 2004;24(4):10–13.
17. Gillinov SM, Joo PY, Zhu JR, et al. Incidence, timing, and predictors of hip dislocation after primary total hip replacement for osteoarthritis. *J Am Acad Orthop Surg*. 2022;30(21):1047–1053. doi:10.5435/JAAOS-D-22-00150
18. Nozoe M, Inoue T, Ishida M, et al. Malnutrition on admission is associated with trunk function recovery but not with lower limb muscle strength recovery in patients with acute stroke: an observational cohort study. *Nutrition*. 2023;109:111971. doi:10.1016/j.nut.2023.111971
19. Firwana YMS, Zolkefley MKI, Mohamed Hatta HZ, et al. Regional cerebral blood perfusion changes in chronic stroke survivors as potential brain correlates of the functional outcome following gamified home-based rehabilitation (IntelliRehab)-a pilot study. *J Neuroeng Rehabil*. 2022;19(1):94. doi:10.1186/s12984-022-01072-w
20. Wang Z, Zhu Y, Han D, et al. Effect of Hip external rotator muscle contraction on pelvic floor muscle function and the piriformis. *Int Urogynecol J*. 2022;33(10):2833–2839. doi:10.1007/s00192-021-05046-9
21. Stähelin T, Vienne P, Hersche O. Failure of reinserted short external rotator muscles after total Hip replacement. *J Replacement*. 2002;17(5):604–607. doi:10.1054/arth.2002.32187
22. Loiba V, Stucinskas J, Robertsson O, et al. The analysis of posterior soft tissue repair durability after total Hip replacement in primary osteoarthritis patients. *Hip Int*. 2015;25(5):420–423. doi:10.5301/hipint.5000232
23. Moldovan F, Ivanescu AD, Fodor P, Moldovan L, Bataga T. Correlation between inflammatory systemic biomarkers and surgical trauma in elderly patients with hip fractures. *J Clin Med*. 2023;12(15):5147. PMID: 37568549; PMCID: PMC10419519. doi:10.3390/jcm12155147