Reconstruction Scheme of Cancellous Bone Screw Post Combined With Large- and Small-Thick Steel Wire Mesh in Hemihip Replacement Surgery for Unstable Intertrochanteric Fractures in the Elderly

Ann. Ital. Chir., 2025 96, 11: 1464–1470
https://doi.org/10.62713/aic.4254

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AIM: Evaluation of the clinical efficacy of pedicle screw fixation combined with hemiarthroplasty versus simple hemiarthroplasty in elderly patients with unstable intertrochanteric fractures of the femur.
METHODS: This retrospective analysis included 81 elderly patients with unstable intertrochanteric femoral fractures who underwent hemihip replacement surgery at the Yulin Hospital, the First Affiliated Hospital of Xi'an Jiaotong University, between May 2018 and May 2023. The patients' clinical data were collected and statistically analyzed. Study participants were divided into two groups: the experimental group (n = 40; those treated with the pile-building net fixation method combined with hemiarthroplasty) and the control group (n = 41; patients who received only hemiarthroplasty). The perioperative indicators, postoperative joint function scores, activities of daily living scores, and basic conditions of complications associated with surgical intervention were compared between the two groups.
RESULTS: Comparison of perioperative indicators between the experimental and control groups revealed that the experimental group experienced significantly longer operation time and greater intraoperative blood loss than the control group ($p < 0.05$). Similarly, the average fracture healing time was significantly shorter in the experimental group than in the control group ($p < 0.05$). Six months postoperatively, the degree of hip joint pain, limping, walking distance, total Harris hip score, and Barthel index score were all found to be significantly higher in the experimental group compared to the control group ($p < 0.05$). In the experimental group, one case developed a urinary tract infection and two cases had a pulmonary infection after the operation. In the control group, one case showed deep vein thrombosis, two patients had delayed fracture healing, three patients had pulmonary infection, and one case had prosthesis loosening. Moreover, there was no statistically significant difference in the complication rate between the two groups ($p > 0.05$).
CONCLUSIONS: Although the pile-building net fixation method in hemiarthroplasty for unstable intertrochanteric fractures in elderly patients can prolong the operation time and increase blood loss, it facilitates fracture healing and improves postoperative joint function recovery, indicating potential clinical benefit.

Keywords: cancellous bone screw post; steel wire mesh; unstable intertrochanteric femoral fracture; hemihip replacement surgery

Introduction

In recent years, proximal intramedullary nails, such as proximal femoral anti-rotation nails, have gradually become the preferred method for fixing unstable intertrochanteric femoral fractures. This approach provides enhanced axial stability and rotational resistance, making it well-suited for patients with osteoporosis. However, multiple meta-analyses have pointed out that even with the latest designs of proximal femoral anti-rotation intramedullary screws or gamma nails, the rate of complications, such as resection and screw loosening, remains comparable to those observed with traditional dynamic hip screw (DHS) systems [1–3]. Therefore, this study proposes a "cancellous bone screw column combined with steel wire mesh fixation scheme" approach. In this strategy, screws offer deep fixation of the fracture ends, while the surrounding steel wire mesh provides additional support, significantly enhancing the stability of the trochanteric region. This approach effectively distributes local stress, reduces the risk of resection, and improves initial weight-bearing stability in patients with osteoporosis. By combining the benefits of both internal and external fixation, this approach theoretically provides potential advantages over existing methods and requires further clinical validation. Additionally, in clinical practice, patients over 70 years old often present with severe osteoporosis and multiple comorbid conditions, leading to significantly higher surgical risks and reduced postoperative recovery compared to younger individuals. Therefore, this study uses 70 years as the age threshold and focuses on assessing reconstruction strategies for elderly patients with unstable fractures, and assessing the clinical efficacy and safety of different fixation methods in this population.

Submitted: 7 July 2025 Revised: 1 September 2025 Accepted: 9 September 2025 Published: 10 November 2025
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Table 1. Comparison of baseline characteristics between the two groups.

Group	n	Age (years)	Body mass index (kg/m^2)	Gender (%)		Time from fracture to surgery (days)	Improved Evans classification (%)		
				Male	Female		III type	IV type	V type
Experimental group	40	76.3 ± 3.8	21.86 ± 1.80	14 (35.00)	26 (65.00)	2.9 ± 0.7	14 (35.00)	8 (20.00)	18 (45.00)
Control group	41	77.0 ± 3.5	21.60 ± 1.93	19 (46.34)	22 (53.66)	3.1 ± 0.8	11 (26.83)	14 (34.15)	16 (39.02)
t		–0.863	0.627	1.079		–1.196	2.102		
p-value		0.391	0.533	0.299		0.235	0.350		

Materials and Methods

Recruitment of Study Participants

This retrospective analysis included elderly patients with unstable intertrochanteric femoral fractures who underwent hemihip replacement surgery at Yulin Hospital, the First Affiliated Hospital of Xi'an Jiaotong University, between May 2018 and May 2023. Clinical data of the study cohort were collected and statistically analyzed. Of the total 81 patients, 40 were treated with pile and net fixation method combined with hemihip replacement surgery and were included as the experimental group, while 41 patients who received hemiarthroplasty alone were assigned to the control group.

This study was approved by the Medical Ethics Committee of Yulin Hospital, the First Affiliated Hospital of Xi'an Jiaotong University (Ethics Approval Number: 2024076).

The inclusion criteria for patient selection were as follows: (1) age ≥70 years; (2) unilateral unstable intertrochanteric femoral fractures confirmed by X-ray and CT examinations; (3) time interval from fracture to surgery of less than 2 weeks; (4) conscious individuals able to communicate verbally; and (5) availability of complete baseline clinical data and a minimum follow-up of 12 months.

The exclusion criteria included (1) fractures caused by malignant tumors, (2) fractures resulting from severe bone tuberculosis, (3) diagnosis of autoimmune diseases or Human Immunodeficiency Virus (HIV) infection, and (4) a history of cerebrovascular disease, myocardial infarction, or major surgery within 3 months before hip joint surgery.

Baseline characteristics of patients in the experimental and control groups were statistically analyzed, demonstrating good comparability and balance ($p > 0.05$, Table 1).

Surgical Procedures

Patients in the experimental group were treated with the piling and mesh fixation method combined with hemiarthroplasty. All surgical procedures were conducted under lumbar anesthesia with the patients in the lateral position, employing the Hardinge approach via an 8–10 cm incision. Initially, the skin and subcutaneous tissue were incised, followed by exposure of the gluteus medius by splitting the tensor fascia muscle. The hip was externally rotated, and a longitudinal incision was made along the anterior 1/4 to 1/5 of the gluteus medius to protect the muscle. Then, an L-shaped incision is made in the anterior joint capsule, exposing the intertubercle fracture. The patient was adjusted to the neutral position and gently pulled to reduce the fracture. A bone-prying tool was used to help in fracture reduction. Moreover, the hip joint underwent a moderate external rotation to restore the original anatomy of the proximal femur. After femoral head removal, the resulting U-shaped bone fragment was excised and preserved.

Owing to the gluteus medius traction, the large trochanteric fragment moved backward and upward, while the lesser trochanter shifted medially and upward because of the attachment of the associated tendon. The affected limb was placed in flexion, adduction, and external rotation, and the U-shaped bone mass near the femur was repositioned under the visual field using a bone crowbar. The anteversion angle was then established, and the depth of the prosthesis was marked. In all cases, 160 biological femoral stalks (No. A40002) with double mobility heads, manufactured by the Beijing Chunli Company, were implanted.

The surface of the femoral handle was fully coated with plasma, while the middle and distal portions of the prosthesis were designed with convex ridges to enhance rotational stability. The highly smooth eccentric design at the distal end of the prosthesis helps reduce irritation to the lateral cortical bone, minimizing the risk of thigh pain. During the process of marrow dilation, appropriate trial prosthesis and femoral head models were selected. After hip reduction, the prosthesis size, positioning, and limb length differences were evaluated using fluoroscopy.

Initially, a steel wire was inserted via a wire guide at the lesser trochanter (small protrusion) but left untightened. After removal of the trial model, the 160-type biological femoral prosthesis was implanted. Since the large protrusion (greater trochanter) shifts upward and backward due to the gluteus medius traction, one to two 7.5 mm cancellous bone screws were used to fix the fragment after repositioning. The position of the minor trochanter was adjusted, and the steel wire was then tightened. On the lateral femur, the steel wire looped three times around the cross, leaving the tail uncut. A shallow groove was created on the outer side of the U-shaped femoral rectangular bone block using a swing saw to facilitate the placement of a second steel wire and prevent displacement. The second wire was rotated three times anteriorly, and the strands of both steel wires were cross-tightened to form a "woven steel wire mesh", preventing proximal and distal migration of the fixation.

Table 2. Comparison of perioperative indicators between the two groups.

Group	n	Operation time (min)	Average surgical blood loss (mL)	Incision length (cm)	Blood transfusion rate (%)	Postoperative time to get out of bed (days)	Fracture healing time (weeks)
Experimental group	40	65.9 ± 9.2	202.3 ± 32.1	12.81 ± 1.83	14 (35.00)	5.5 ± 1.2	7.7 ± 1.2
Control group	41	60.7 ± 8.8	182.4 ± 27.6	12.45 ± 1.90	10 (24.39)	5.2 ± 1.3	8.3 ± 1.4
t		2.600	2.994	0.868	1.093	1.079	–2.069
p-value		0.011	0.004	0.388	0.296	0.284	0.042

By looping two additional steel wires around the tail of the cancellous bone screw and tightening them, the fixation method resembles the post-and-net technique used in fishing. Therefore, this method is called the "pile-building net fixation method". During the procedure, the excised femoral head was cut with a rotary saw to obtain an appropriate amount of cancellous bone, which was subsequently implanted into the proximal femur and prosthesis cavity to increase bone mass. Bidirectional femoral heads with appropriate diameters and neck lengths were installed, the hip was reduced, and joint range of motion and stability were evaluated. After confirming the correct position and proper alignment of the prosthesis through fluoroscopy, the joint capsule was sutured. The incision was sutured in layers while being soaked in tranexamic acid injection (Zhejiang Chengyi Pharmaceutical Co., Ltd., National Drug Approval No. H33021422, 5 mL:0.25 g), and a drainage tube was placed to reduce postoperative inflammation. Postoperatively, patients received intravenous infusion of tranexamic acid (No. 020014, Zhejiang Chengyi Pharmaceutical Co., Ltd.) to prevent possible bleeding complications.

However, in the control group, hemiarthroplasty was conducted using the same surgical strategy, but without pile or net fixation.

Hip Joint Function Evaluation

Hip joint function was evaluated using the Harris hip score [4], which assesses ten parameters: pain intensity, ability to climb stairs, ability to transfer and sit, ability to independently put on shoes and socks, lameness, need for walking aids, walking distance, joint mobility, and joint deformity. The total score of the scale is 100 points, with a higher score indicating better recovery of the joint function.

The Barthel index [5] was used to evaluate patient's activities of daily living at different time points after surgery. This scale covers 10 areas, including control over urination and defecation, toilet use, ability to eat by themselves, personal self-care (such as washing the face and combing hair), ability to go up and down stairs, and ability to take a bath independently. The total score is 100 points, with a higher score indicating greater patient's independence in performing daily living activities.

Statistical Analysis

Data were analyzed using SPSS 21.0 software (IBM Corp). Perioperative indicators, Harris hip joint scores, and other continuous parameters were assessed for normality using the Shapiro-Wilk test and were presented as means ± standard deviations ($\bar{x} \pm s$). A *t*-test was used for comparisons between two groups, and a paired *t*-test was used for within-group pre- and post-treatment comparisons. Categorical data, such as the modified Evans classification and surgical complication rates, were reported as frequencies and percentages (%) and analyzed using the χ^2 test. A *p*-value of <0.05 was considered statistically significant.

Results

Comparison of Perioperative Indicators Between the Two Groups

Both groups of patients successfully underwent surgery, and all fractures healed during the 6-month follow-up. As detailed in Table 2, the Shapiro-Wilk test was used to test the normality of the measurements in the experimental and control groups. The results showed that the *p*-values for all continuous variables were greater than 0.05, indicating that the data conformed to a normal distribution. The W values for all tests were close to 1, further indicating that the data were approximately normal. The experimental group needed a longer operation time and showed greater intraoperative blood loss compared to the control group, while the average fracture healing time was shorter in the experimental group. These differences were found to be statistically significant ($p < 0.05$). However, there were no significant differences between the two groups regarding incision length, blood transfusion rate, or postoperative ambulation time ($p > 0.05$, Table 2).

Comparison of Postoperative Hip Joint Function Scores Between the Two Groups

The Shapiro-Wilk test was used to test the normality of the measurements in the experimental and control groups. The results showed that the *p*-values for all continuous variables were greater than 0.05, indicating that the data conformed to a normal distribution. The W values for each test were close to 1, further suggesting that the data were approximately normal.

Two weeks after the procedure, there were no significant differences between the two groups in pain intensity, abil-

Table 3. Postoperative hip joint function score comparison between the two groups at 2-week and 6-month time points.

Harris hip score project	2 weeks after the operation		*t*	*p*-value	6 months after the operation		*t*	*p*-value
	Experimental group (n = 40)	Control group (n = 41)			Experimental group (n = 40)	Control group (n = 41)		
Pain intensity	30.51 ± 5.50	31.09 ± 4.98	–0.494	0.622	42.30 ± 6.19	39.52 ± 5.74	2.083	0.041
Go upstairs	0.50 ± 0.13	0.53 ± 0.16	–0.920	0.360	1.78 ± 0.20	1.73 ± 0.34	0.802	0.425
Transfer	0.52 ± 0.14	0.52 ± 0.17	0.000	1.000	1.03 ± 0.26	0.98 ± 0.30	0.797	0.428
Wearing shoes and socks	0.49 ± 0.16	0.50 ± 0.18	–0.263	0.794	1.89 ± 0.54	1.80 ± 0.66	0.667	0.506
Limping	3.10 ± 0.83	3.23 ± 0.85	–0.692	0.491	8.19 ± 1.56	7.43 ± 1.61	2.144	0.035
Sit	1.98 ± 0.66	1.85 ± 0.82	0.781	0.437	5.51 ± 1.40	5.12 ± 1.29	1.296	0.199
Walking aids	0.90 ± 0.23	0.93 ± 0.31	–0.492	0.624	1.74 ± 0.43	1.58 ± 0.51	1.517	0.133
Walking distance	4.90 ± 1.07	4.76 ± 1.04	0.593	0.555	8.96 ± 2.21	7.57 ± 2.09	2.890	0.005
Joint movement	3.28 ± 0.98	3.41 ± 1.10	–0.558	0.578	4.16 ± 1.10	3.98 ± 1.13	0.722	0.473
Limb deformity	3.18 ± 0.67	3.39 ± 0.73	–1.340	0.184	4.30 ± 0.98	4.03 ± 1.06	1.183	0.240
Total score	49.36 ± 5.50	50.41 ± 5.80	–0.831	0.409	80.86 ± 6.17	73.74 ± 7.11	4.783	<0.001

ity to climb stairs, transfer ability, sitting, independence in putting on shoes and socks, limping, need for walking aids, walking distance, joint mobility, joint deformity, and overall Harris hip score ($p > 0.05$). Additionally, patients in the experimental group showed substantially better outcomes than the control group in pain intensity, limping, walking distance, and total Harris hip score at 6 months ($p < 0.05$, Table 3).

Comparison of Postoperative Recovery of Daily Living Activities Between the Two Groups

The Shapiro-Wilk test was used to test the normality of the measurements in the experimental and control groups. The results showed that the *p*-values for all continuous variables were greater than 0.05, indicating that the data conformed to a normal distribution. The W values for each test were close to 1, further suggesting that the data were approximately normal. Two weeks after the operation, there was no significant difference in the Barthel index scores between the experimental and control groups ($p > 0.05$). However, at 6 months postoperatively, patients in both groups demonstrated considerable improvement in activities of daily living compared to the 2-week evaluation, with Barthel index scores significantly increased ($p < 0.05$). Furthermore, the experimental group showed greater improvement in activities of daily living, with substantially higher Barthel index scores than the control group ($p < 0.05$, Table 4).

Comparison of Surgical Complication Rates Between the Two Groups

In the experimental group, one patient developed a urinary tract infection, and two patients developed pulmonary infections after the operation. In the control group, one patient experienced deep vein thrombosis, two patients experienced delayed fracture healing, three patients experienced pulmonary infection, and one patient experienced prosthesis loosening. There was no statistically significant difference in the overall complication rate between the two groups ($p > 0.05$, Table 5).

Discussion

In elderly patients, reduced physical function combined with multiple chronic diseases, osteoporosis, and other complications substantially increases the difficulty and complexity of managing intertrochanteric femoral fractures [6]. Treatment options for intertrochanteric femoral fractures are usually divided into nonsurgical and surgical approaches. Research has shown that 34% of individuals receiving nonsurgical therapy may die from complications within three months [7]. In view of the high risk associated with nonsurgical treatment, domestic orthopedic trauma experts recommend prioritizing surgical intervention for elderly patients with hip fractures, unless specific contraindications to surgery exist [8].

Clinically, surgical fixation for intertrochanteric femoral fractures includes external medullary fixation methods, such as dynamic femoral condyle screws, dynamic hip screws, and minimally invasive locking bone plates, as well as intramedullary fixation methods, such as Gamma nails and proximal femoral nails (PFNs), in addition to artificial hip replacement. At present, intramedullary fixation methods such as PFN remain the mainstream clinical treatment strategy [9]. However, in elderly patients, especially those with severe osteoporosis, coronal fractures of the large tubercle or problems in the lateral or medial wall, intramedullary fixation may require prolonged bed rest, reducing its clinical advantages [10]. Additionally, intramedullary fixation such as PFN may present the risk of screw cutting or internal fixation failure during early mobilization.

Furthermore, for such elderly patients with unstable intertrochanteric femoral fractures, hemiarthroplasty can be a more effective option, enabling early mobilization, re-

Table 4. Comparison of postoperative recovery of daily living activities between the experimental and control groups.

Group	n	2 weeks after the operation	6 months after the operation	*t*	*p*-value
Experimental group	40	55.10 ± 7.38	84.10 ± 5.18	–21.091	0.001
Control group	41	57.03 ± 7.91	80.66 ± 6.24	–15.380	0.001
t		–1.135	2.696		
p-value		0.260	0.009		

Table 5. Comparison of surgical complication rates between the two groups.

Group	n	Deep vein thrombosis	Delayed fracture healing	Urinary tract infection	Pulmonary infection	Loosening of the prosthesis	Complication rate (%)
Experimental group	40	0	0	1	2	0	3 (7.50)
Control group	41	1	2	0	3	1	7 (17.07)
χ^2							1.715
p-value							0.190

ducing the risk of complications associated with prolonged immobility, and promoting functional recovery. However, hemihip replacement alone may be associated with complications such as unstable fixation or unhealed fractures [11]. In recent years, with advances in orthopedic fixation techniques, the pile-building net fixation method combined with hemiarthroplasty has been increasingly applied in clinical practice, demonstrating promising outcomes [12]. However, current research-based evidence remains limited, and its effectiveness and safety need further validation through systematic clinical studies before broader clinical adoption.

In this study, the average time from fracture to surgical treatment for both groups of patients exceeded 48 hours, with some cases failing to complete the surgery within the time frame recommended by the guidelines. In this regard, the research team accounted for actual clinical indicators during case selection, such as the preoperative assessment of comorbidities, the discontinuation period for anticoagulant drugs, and the optimization of preoperative internal medicine conditions. These partial surgical delays were the result of multidisciplinary consultations that carefully weighed complication risks and surgical benefits. Additionally, this study aims to reflect the current real-world diagnosis and treatment practices for elderly patients with hip fractures, retaining preoperative delays for optimization and evaluation.

This study first analyzed perioperative indicators for the two groups of patients. The results revealed that the experimental group showed a longer operation time and greater intraoperative blood loss than that of the control group. These findings indicate that the pile and net fixation method, when combined with hemihip replacement surgery, is more complex and invasive than hemihip replacement surgery alone. This increased complexity is mainly related to the additional placement and fixation of cancellous bone screw posts and steel wire mesh. Specifically, the pile-building net fixation method requires additional steps, including placing cancellous bone screw posts at the proximal end of the femur and installing and fixing the steel wire net, which adds procedural complexity and prolongs operation time to ensure accuracy and safety [13].

Furthermore, fracture reduction, precise placement of the prosthesis, and adjustment of the steel wires demand highly precise operations, all of which contribute to longer duration. The pile and net fixation method also involves more manipulations in the fracture area, such as drilling and screw insertion, which can lead to greater vascular damage and increased blood loss. Moreover, frequent handling of muscles and soft tissues during the operation may further increase tissue damage and corresponding bleeding [14]. However, there was no statistically significant difference in blood transfusion rate between the two groups, suggesting that the increased blood loss in the experimental group remained within the clinically acceptable range and did not affect perioperative safety.

The average fracture healing time in the experimental group was shorter than in the control group, indicating that the pile-building net fixation method facilitates earlier fracture healing. This outcome is related to the enhanced local stability and appropriate mechanical environment provided by the procedure. The additional stability provided by the pile and net fixation helps maintain good alignment of the fracture ends, creating a favorable setting for fracture healing. Properly placed prostheses and fixation devices reduce mechanical stress at the affected site, thereby promoting bone healing [15].

In terms of hip joint function, at 2 weeks after the operation, there was no significant difference in the degree of pain, stair climbing ability, transfer ability, or other functional measures between the experimental and control groups. This finding indicates that in the short term, both surgical approaches have comparable impacts on early functional recovery. However, 6 months after the operation, the experimental group showed better outcomes in degree of pain, walking distance, and total Harris hip score, indicating that the pile-building net fixation method supports superior long-term recovery of joint function. This improvement is due to the greater biomechanical stability provided

by the pile-building net fixation method. Among them, the minimal clinically important differences (MCID) for the Harris hip score were 8 to 10 points, and the experimental group scored 7.12 points higher than the control group, approaching this threshold and retaining clinical relevance [16]. Good fracture fixation also enables patients to start rehabilitation training earlier, which is crucial for the recovery of femoral head and hip joint functions. Additionally, prosthesis loosening is a common cause of postoperative pain and functional limitations. In the long term, by increasing the contact area and fixation strength between the prosthesis and bone, the pile-building net fixation method can reduce the risk of prosthesis loosening [17]. Furthermore, good fixation helps alleviate chronic inflammation and irritative pain, thereby enhancing patient comfort and walking ability [18].

However, at 6 months, the experimental group demonstrated a higher score than the control group, underscoring the potential advantage of the pill-building net fixation method in improving the patient's activities of daily living. In terms of complications, there was no statistically significant difference in incidence between the two groups, indicating that although the pile-building net fixation method is more complex, its safety is comparable to that of standard hemihip replacement.

The results of this study further reveal that the Barthel index in the experimental group (84.10 $\pm$ 5.18 points) was 3.44 points higher than in the control group (80.66 $\pm$ 6.24 points), demonstrating a substantial improvement in daily living abilities. Patients in this group progressed from partial dependence, requiring assistance in daily activities such as dressing or toileting, to being largely independent in performing daily tasks, thereby alleviating caregiving burden on the affected families. Ban *et al*. [19] applied the pile-and-net fixation method combined with biological hemihip replacement in 39 elderly patients with unstable intertrochanteric femoral fractures. They reported complete fracture healed with no screw loosening or wire breakage, and the rate of excellent or good hip joint function at 6 months reached 92.3%, which is consistent with the results of this study.

In terms of complications, there was no statistically significant difference in the overall incidence between the two groups (7.50% vs. 17.07%, $p = 0.190$). However, implant-related complications were observed in the control group, with prosthesis loosening and delayed fracture healing accounting for 7.3%. Along with the observed differences in Harris hip scores, these results indicate that the additional fixation in the experimental group offers biomechanical benefits that facilitate more reliable joint function reconstruction without increasing the risk of infection or thrombosis, which is crucial for elderly patients to reduce the likelihood of secondary surgery.

This study was a single-center retrospective analysis. Despite applying unified inclusion and exclusion criteria, standardized concurrent evaluations, management by the same surgical and perioperative team, and assessments at fixed time points to increase comparability, clinical limitations remain. Non-random allocation, limited sample size, and a number of events may introduce residual confounding. Moreover, propensity score matching or comprehensive multivariate adjustment was not fully performed, and the relatively short follow-up time restricted the evaluation of long-term outcomes. Future research should adopt a multicenter prospective design, with an expanded sample size, improved statistical correction, and extended follow-up to further validate the robustness of these observations.

Conclusions

Although employing the pile-building net fixation method in hemihip replacement surgery for unstable intertrochanteric fractures in elderly individuals can prolong the operation time and increase blood loss, it supports fracture healing and improves postoperative joint function, making it a promising approach for clinical application.

Availability of Data and Materials

The data analyzed are available from the corresponding author upon reasonable request.

Author Contributions

LG was responsible for writing the manuscript. WG and JL were in charge of collecting and organizing project data. XZ was responsible for data analysis. LL was the person in charge of this research. LG and LL designed this study. All authors revised the manuscript critically for important intellectual content. All authors gave final approval of the version to be published. All authors have participated sufficiently in the work to take public responsibility for appropriate portions of the content and agreed to be accountable for all aspects of the work in ensuring that questions related to its accuracy or integrity.

Ethics Approval and Consent to Participate

This study was approved by the Medical Ethics Committee of Yulin Hospital, the First Affiliated Hospital of Xi'an Jiaotong University (Ethics Approval Number: 2024076). We have obtained the informed consent of the patients and are in compliance with the Declaration of Helsinki.

Acknowledgment

Not applicable.

Funding

This research received no external funding.

Conflict of Interest

The authors declare no conflict of interest.

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