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ORIGINAL ARTICLE

Percutaneous joystick reduction with reductor-T tape pin and fixation with a reconstruction nail for the treatment of ipsilateral femoral neck and shaft fractures

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ABSTRACT

Objectives: This study aims to investigate the efficacy and safety of a reconstruction nail combined with a percutaneous reductor-T tape pin for treating ipsilateral femoral neck and shaft fractures.

Patients and methods: Between January 2013 and December 2021, a total of 25 adult patients (19 males, 6 females, mean age: 32.8±10.9 years; range, 19 to 57 years) who sustained concurrent ipsilateral femoral neck and shaft fractures were included. The patients underwent internal fixation using a reconstruction nail with the assistance of a reductor-T tape pin, employing percutaneous techniques. The operation time, reduction time, fluoroscopy time, blood loss, preoperative and postoperative Visual Analog Scale (VAS) scores, fracture union time, Harris scores of the healthy and affected sides after fracture union, complications and lower limb functional outcomes two years post-surgery were recorded.

Results: All patients underwent successful surgery with the assistance of the reductor-T tape pin using percutaneous techniques without the need for open reduction. The mean operation time from skin incision to wound closure was 80.0±15.0 (range, 55 to 105) min. The mean fracture reduction time was 22.0±4.0 (range, 15 to 28) min. The mean fluoroscopy time was 16.0±3.8 (range, 9 to 25) sec. The mean blood loss was 335.0±142.0 (range, 150 to 550) mL. The postoperative VAS score of the affected limb was significantly lower than the preoperative score (p<0.01). The mean healing time of femoral neck fractures was 4.0±0.3 (range: 3.2 to 4.8) months. The mean healing time of femoral shaft fractures was 4.8±0.9 (range, 4.1 to 7.5) months. All patients were followed for over two years. No cases of delayed healing of femoral neck fractures or femoral head necrosis were observed. However, delayed union of femoral shaft fractures occurred in three patients. There was no statistically significant difference in Harris scores between the affected and healthy sides at the time of fracture healing (p>0.05).

Conclusion: The use of a reconstruction nail assisted by the percutaneous reductor-T tape pin demonstrated successful reduction of ipsilateral femoral neck and shaft fractures, with favorable postoperative functional outcomes. The reductor-T tape pin facilitates the reduction of femoral neck fractures and provides a safe environment for the reduction and fixation of femoral shaft fractures.

Keywords: Intramedullary nail, ipsilateral femoral neck and shaft fractures, percutaneous technique, reconstruction nail; reductor-T tape pin.

Ipsilateral femoral neck and shaft fractures are uncommon injuries, with additional femoral neck fractures occurring in only 1 to 9% of all femoral shaft fractures.[1-3] These injuries typically result from high-energy trauma and are more prevalent in adult men, often accompanied by multisystem injuries. Treating these fractures presents substantial challenges, as both fractures must be managed simultaneously during surgery. The optimal treatment approach remains uncertain, with existing methods varying widely. Addressing both fractures in a single surgical procedure requires a careful balance to ensure stability while minimizing complications, making clinical decision-making particularly complex.[4,5]

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Nearly 60 different treatment methods have been proposed for managing these concurrent fractures;[6-10] however, no consensus has been reached on the optimal approach. Recent biomechanical and clinical studies have demonstrated that using reconstruction nails for these fractures enhances bone healing and reduces blood loss.[11-14] However, during the application of reconstruction screws for femoral shaft fracture reduction, the substantial traction exerted by the surrounding muscles often leads to substantial fracture displacement. Furthermore, an unsecured femoral neck fracture may experience increased displacement. Consequently, it is often difficult to guide the wire from the proximal medullary canal through the fracture gap into the distal medullary cavity.

To address this challenge, the introduction of the reductor-T tape pin, an extramedullary reduction device, has greatly simplified the procedure. This innovative tool facilitates the precise and relatively straightforward placement of guide wires, enhancing the accuracy and efficiency of surgical interventions. While various techniques exist, the combination of reconstruction nails with the reductor-T tape pin offers a simpler, more effective approach for achieving accurate reduction, reducing surgical procedure times and minimizing complications.

In the present study, we aimed to evaluate the effectiveness and safety of using a reconstruction nail in combination with percutaneous reductor-T tape pin assistance for the reduction of ipsilateral femoral neck and shaft fractures. This technique provides an important tool for clinicians, improving both surgical precision and patient outcomes.

PATIENTS AND METHODS

This single-center, cohort study was conducted at Hebei Medical University Third Hospital, Department of the Fourth Orthopedics between January 2013 and December 2021. A total of 25 adult patients (19 males, 6 females, mean age: 32.8±10.9 years; range, 19 to 57 years) who sustained concurrent ipsilateral femoral neck and shaft fractures were included. The patients underwent internal fixation using a reconstruction nail with the assistance of a reductor-T tape pin, employing percutaneous techniques. Inclusion criteria were as follows: aged 18 years or older; treated using a one-stage internal fixation technique; femoral neck fractures classified as type 1, type 2 or type 3 according to the Garden classification; follow-up period of at least 24 months; femoral shaft fractures classified as 32-A, 32-B or 32-C according to the AO/OTA fracture classification; and availability of complete clinical data. Exclusion criteria were as follows: pathological fractures due to organic lesions (e.g. tumor, tuberculosis or infection); local infection around the fracture site; open fractures; and intertrochanteric fractures or multiple fractures of the femoral shaft. A 35-year-old male who

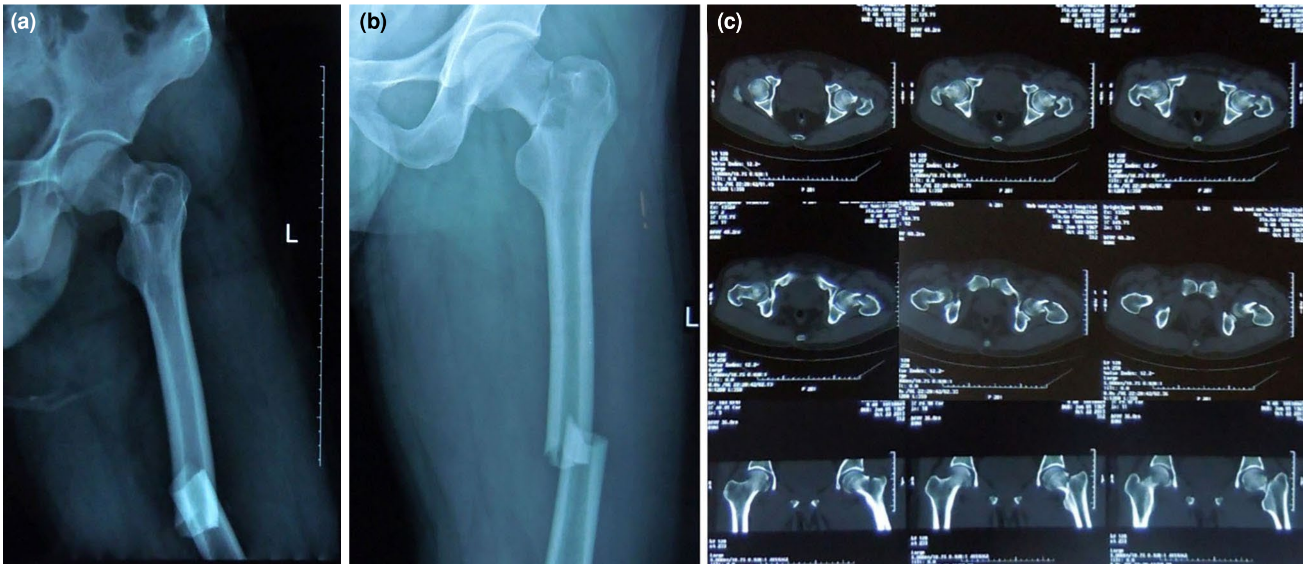

FIGURE 1. The patient is a 35-year-old male who suffered from left femoral neck and shaft fracture in a traffic accident. **(a)** Anterior and posterior images of X-ray image of fracture. **(b)** Lateral image of X-ray image of fracture. **(c)** Computed tomography image of femoral neck fracture.

suffered from left femoral neck and shaft fracture are shown in Figure 1. Written informed consent was obtained from each patient. The study protocol was approved by the Hebei Medical University Third Hospital Ethics Committee (Date: 02.11.2018, No: 2018-024-1). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Surgical technique

For patients undergoing reconstruction nail internal fixation, the reductor-T tape pin, composed of a screw head, connecting rod and T tape handle, was introduced during the procedure. The screw head's diameter gradually increased from 4.5 mm to 6 mm over a 3 cm length. After securing the screw head onto the unilateral cortical bone of the femoral shaft, the surgeon manipulated the connecting rod and T-tape handle to control the fracture site using the joystick technique (traction and internal rotation).

During surgery, fractures were initially reduced by applying traction on a fracture table. The relative displacement of fracture fragments was meticulously tracked using C-arm fluoroscopy in both anterior-posterior and lateral projections, ensuring precise monitoring throughout the procedure. If femoral neck fractures exhibited minor displacement, the hip fractures were stabilized with Kirschner wires (K-wires). The first K-wire was positioned adjacent to the anterolateral cortex, while the second was inserted from the midpoint of the intertrochanteric crest to the center of the femoral head. This alignment ensured that the two K-wires remained parallel to the femoral neck, facilitating

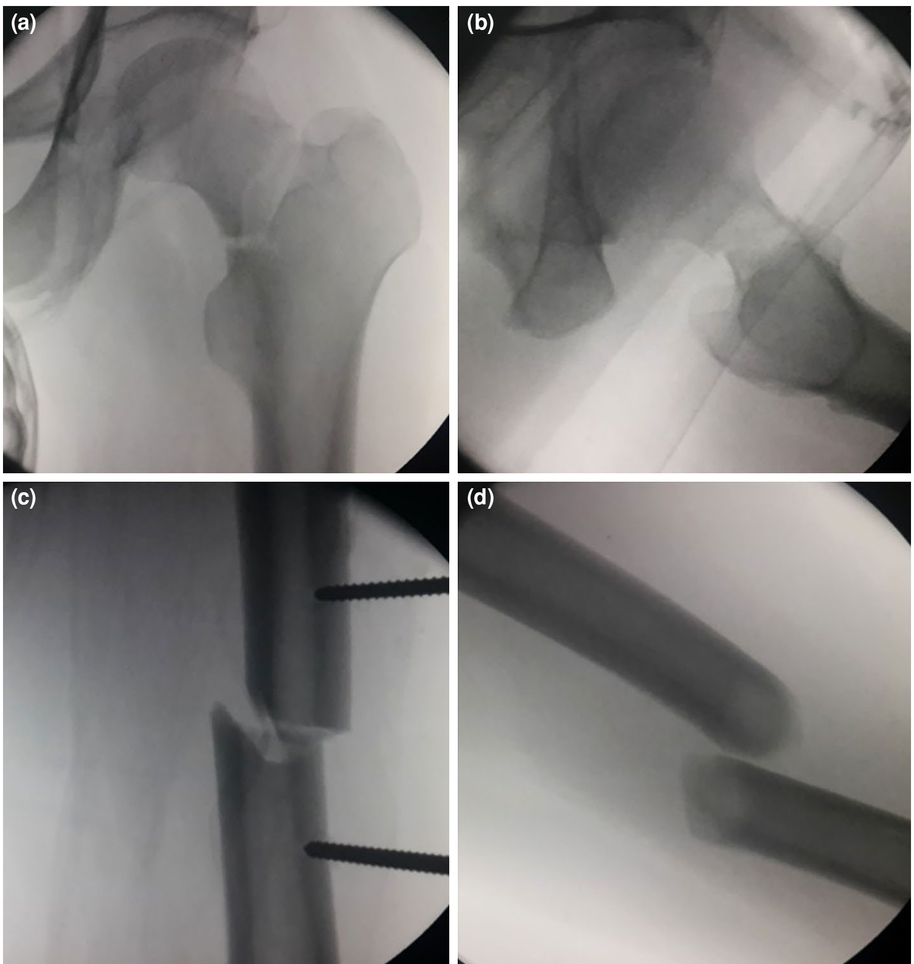

FIGURE 2. The fractures were firstly reduced by traction with a fracture table. **(a)** anterior and posterior images of the femoral neck fracture. **(b)** Lateral image of the femoral neck fracture. **(c)** Anterior and posterior images of the femoral shaft fracture. **(d)** Lateral image of the femoral shaft fracture.

accurate reduction and alignment. Careful placement of the K-wires was essential to prevent interference with the reconstruction nail's canal or the proximal locking screws.

If substantial displacement was present, the reductor-T tape pin was required to correct the hip fractures. A 0.5-cm stab incision was made laterally in the thigh at the distal fracture fragment below the hip fracture. The unilateral cortex of the femoral shaft was drilled through a sleeve using a drill. The reductor-T tape pin was then screwed into the unilateral cortical bone of the femoral shaft to facilitate proximal fracture reduction via the joystick technique (Figure 2). Subsequently, K-wires were used to secure the hip fractures, as described earlier, without the need for open reduction.

A skin incision was made to expose the tip of the greater trochanter, which served as the entry point for the reconstruction nail. A guide pin was inserted and advanced along a sleeve to the starting point. The guide pin was carefully positioned approximately 3 to 5 cm from either side of the fracture level. The residual displacement of the femoral shaft fracture was aligned using the reductor-T tape pin with a double joystick technique (Figure 3). Simultaneously, the guidewire was meticulously advanced from the proximal to the distal femoral medullary canal.

Following the reaming process, the reconstruction nail was inserted along the guide wire into the medullary cavity of the femoral shaft. To stabilize the proximal fractures, cancellous screws were partially threaded into the femoral neck and head using an insertion jig, ensuring precise placement. The fracture gaps[15] were, then, reduced using a forward-striking technique, following the application of loose traction. This method effectively compressed the fragments, facilitating alignment. Finally, interlocking bolts were securely fastened into the distal locking holes. Figure 4 shows postoperative X-ray images of patients who underwent fixation with reconstruction nails assisted by the reductor-T tape pin (Figure 4).

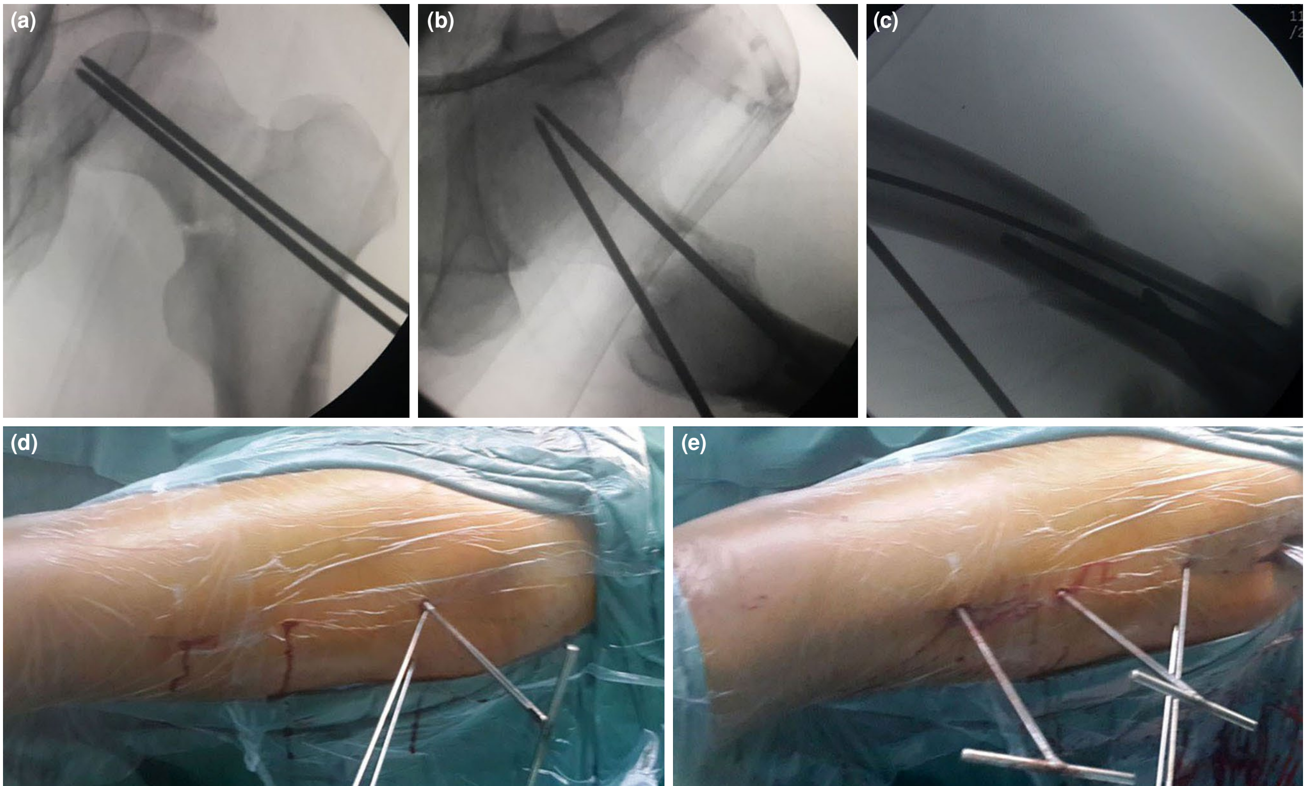

FIGURE 3 The residual displacement of femoral neck and shaft fracture was aligned by the reductor-T tape pin with double joystick technique. (Traction and internal rotation for reduction of femoral neck fractures with reductor-T tape pin) **(a)** anterior and posterior image of temporary fixation of femoral fractures with Kirschner wires; **(b)** Lateral image of temporary fixation of femoral fractures with Kirschner wires; **(c)** The guide pin through the fracture end with the assistance of reductor-T tape pin; **(d)** Intraoperative proximal appearance image; **(e)** Intraoperative distal appearance image.

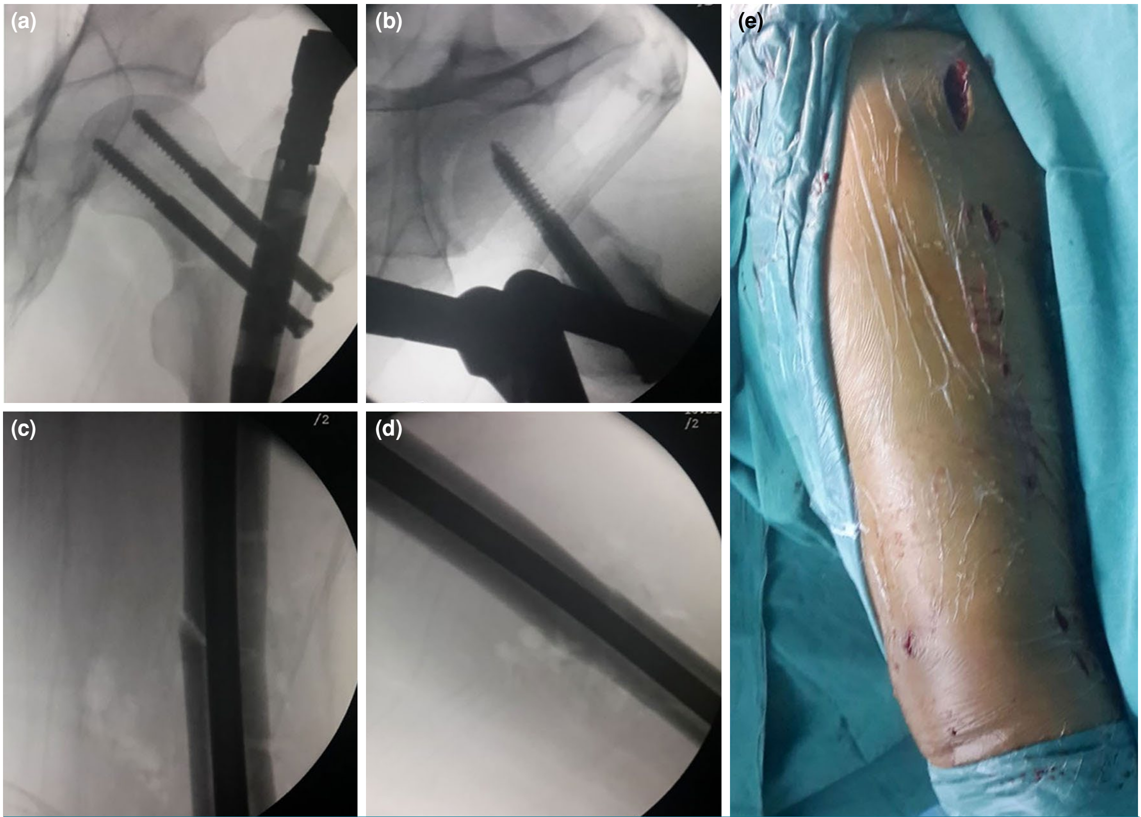

FIGURE 4. The immediate intraoperative X-ray images (anterior and posterior images and lateral images of the femoral neck and shaft) of patients fixed with reconstruction nails assisted by reductor-T tape pin. **(a)** anterior and posterior image of femoral neck fracture fixed with reconstruction nails. **(b)** Lateral image of femoral neck fracture fixed with reconstruction nails. **(c)** Anterior and posterior image of femoral shaft fracture fixed with reconstruction nails. **(d)** Lateral image of femoral shaft fracture fixed with reconstruction nails. **(e)** Intraoperative incision image.

Postoperative management and follow-up

Figure 5 shows immediate postoperative X-ray images. The patients were encouraged to initiate isometric quadriceps exercises on the first postoperative day. From the second postoperative day, they were guided to commence crutch-assisted walking, strictly avoiding weight-bearing to protect the healing site. At the eight-week postoperative mark, patients progressed to limited weight-bearing exercises, cautiously introducing 5 kg of load to the affected limb as a measured step towards recovery. Weight-bearing was gradually increased based on the progress of bone healing, with full weight-bearing permitted only after fracture union was confirmed by serial radiographs.

During the first postoperative year, both radiological and clinical assessments were meticulously scheduled monthly until fracture consolidation was confirmed. Figure 6 shows an X-ray image of a patient after fracture healing. Once healing was established, evaluations were conducted every three months to monitor long-term integration and functionality. Between the 13th and 24th month following surgery, patients with fully healed fractures were reassessed semi-annually, while those with incomplete healing continued to undergo monthly evaluations. The final assessment was conducted at the two-year mark post-surgery, concluding the structured follow-up regimen.

Clinical indexes

Clinical indicators were collected from patient records and follow-up assessments. These included onset age, sex, causes and types of ipsilateral femoral neck and shaft fractures, operation time, reduction time, fluoroscopy time, blood loss, preoperative and postoperative Visual Analog Scale (VAS) scores, fracture union time, Harris scores of the healthy and affected sides after fracture union, complications and lower limb functional outcomes recorded two years post-surgery.

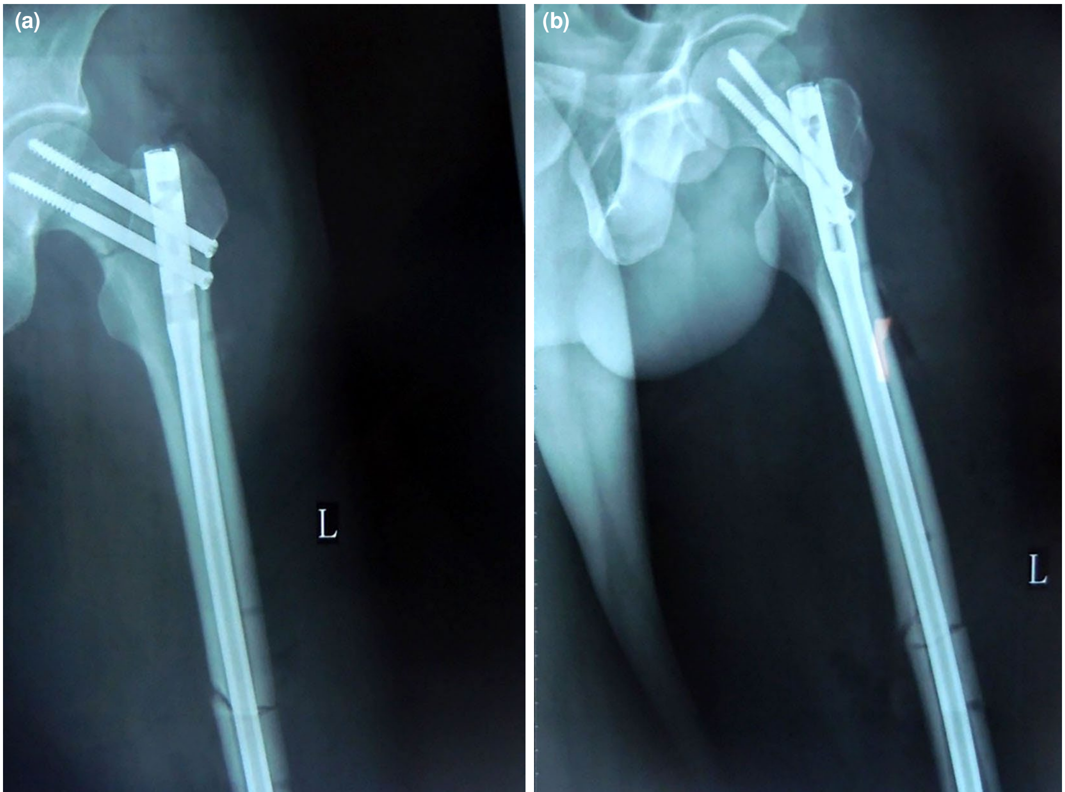

FIGURE 5. The immediate postoperative X-ray images (anterior and posterior images and lateral images of the femoral neck and shaft) of patients fixed with reconstruction nails assisted by reductor-T tape pin. **(a)** Anterior and posterior image of fractures fixed with reconstruction nails. **(b)** Lateral image of fractures fixed with reconstruction nails.

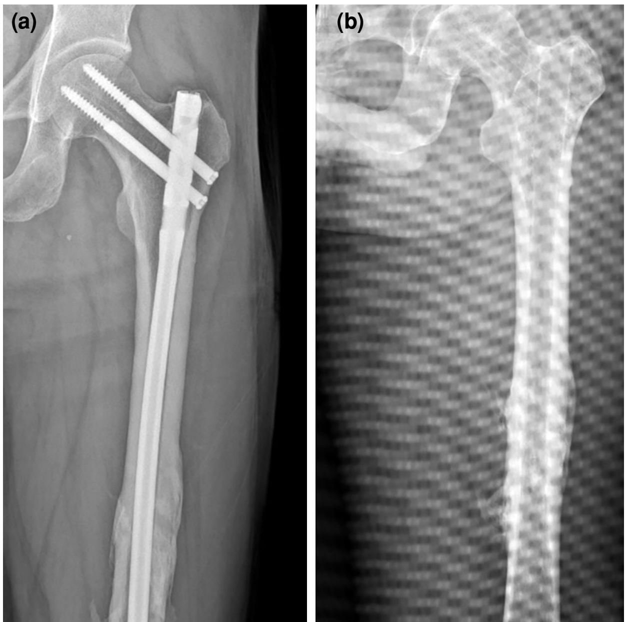

FIGURE 6. The X-ray image of fracture healing one year after surgery for ipsilateral femoral neck and shaft fracture. **(a)** Anterior and posterior images of fractures union. **(b)** Anterior and posterior images of fractures that removing internal fixation.

Union was defined as painless, full weight-bearing on the affected limb, with radiological evidence of consolidation in both anteroposterior and lateral views. Healing was assessed by the formation of bridging callus and bone trabeculae crossing the fracture line in at least three out of four cortices. Delayed union was defined as a fracture that had not united after six months. Functional outcomes were evaluated using the Friedman and Wyman functional criteria,[16] which are detailed in Table I.

Statistical analysis

Study power and sample size calculation were performed using the G*Power version 3.1.9.7 software (Heinrich-Heine-Universität Düsseldorf, Düsseldorf, Germany). For the paired t-test comparing pre- and postoperative VAS scores, with our sample size of 25 patients, effect size of 2.92 (calculated from our data), and alpha level of 0.05, the achieved power was 0.99. However, for detecting rare complications such as avascular necrosis (AVN, with an expected incidence of 10 to 15% in similar fractures), our study was underpowered

TABLE I Friedman and Wyman classification of functional outcome				
	Activities of daily living	Pain	Loss of hip or knee motion (%)	Patients (n=25)
Good	No limitation	None	<20	18
Fair	Mild limitation	Mild to moderate	20-50	7
Poor	Moderate limitation	Severe	>50	0

(power=0.32), indicating that larger sample sizes would be needed to make definitive conclusions about such outcomes.

Statistical analysis was performed using the IBM SPSS version 27.0 software (IBM Corp., Armonk, NY, USA). Continuous data were presented in mean ± standard deviation (SD) or median (min-max), while categorical data were presented in number and frequency. The operation time, reduction time, fluoroscopy time, blood loss, fracture union time and healing times for femoral neck and shaft fractures were analyzed. A *p* value of <0.05 was considered statistically significant.

RESULTS

All images are provided by the same patient. There were 25 patients with ipsilateral femoral neck and shaft fractures included in this study. Among them, nine patients had fractures on the left side, and 16 patients had fractures on the right side. According to the AO/OTA classification, four fracture patterns were type 32-A, 15 fracture patterns were type 32-B and 6 fracture patterns were type 32-C. The injury mechanisms included 12 cases resulting from high-altitude falls and 13 cases due to traffic accidents.

A total of 18 out of 25 patients had 32 associated injuries, including humerus fractures (n=1), radius and ulna fractures (n=2), ankle fractures (n=2), scalp lacerations (n=4), foot injuries (n=5), patella fractures (n=3), clavicle fractures (n=3), scapular fractures (n=2), rib fractures (n=5), tibia–fibula fractures (n=3) and pelvic bone fractures (n=2). The characteristics of patients with ipsilateral femoral neck and shaft fractures are shown in Table II.

All patients underwent successful surgery with the assistance of the reductor-T tape pin using percutaneous techniques without open reduction. The mean operation time from skin incision to wound closure was 80.0±15.0 (range, 55 to 105) min. The mean fracture reduction time was 22.0±4.0 (range, 15 to 28) min. The mean fluoroscopy time was 16.0±3.8 (range, 9 to 25) sec. The mean blood loss was 335.0±142.0 (range, 150 to 550) mL.

The VAS score of the affected limb in postoperative patients was significantly lower than the preoperative score (p<0.01) (Table III). The mean healing time of femoral neck fractures was 4.0±0.3 (range: 3.2 to 4.8) months. The mean healing time of femoral shaft fractures was 4.8±0.9 (range, 4.1 to 7.5) months (Table V).

All patients were followed for more than two years. No cases of delayed healing in femoral neck fractures or femoral head necrosis were observed. However, three patients experienced

TABLE II Characteristics of patients with ipsilateral femoral neck and shaft fractures (n=25)		
Parameters	n	Mean±SD
Age (year)		32.8±10.9
Sex		
Male	19	
Female	6	
Injured limb parts		
Right	16	
Left	9	
Injury mechanism		
Traffic accident	13	
Fall from height	12	
Associated injuries		
Humerus fracture	1	
Fracture of radius and ulna	2	
Ankle fracture	2	
Scalp laceration	4	
Foot injury	5	
Patella fracture	3	
Clavicle fracture	3	
Scapular fracture	2	
Rib fracture	5	
Tibia-fibula fracture	3	
Pelvic bone fracture	2	

SD: Standard deviation.

TABLE III
Comparison of preoperative and postoperative VAS and Harris scores on the healthy and affected sides during fracture healing in patients

Time	VAS	Hip joint	Harris score
	Mean±SD		Mean±SD
Preoperative	6.16±1.21	Health side	90.32±2.14
Postoperative	2.64±1.22	Affected side	89.92±2.06
t	8.978	t	1.680
p	<0.01	*p*	0.106

VAS: Visual Analog Scale; SD: Standard deviation. Statistical analysis was performed using paired t-tests to compare preoperative and postoperative VAS scores, as well as Harris scores between affected and healthy sides. P values <0.05 were considered statistically significant.

TABLE IV
Detailed information of patients' surgeries

							Fracture union time (months)	
Patient no	Age/Sex	Injury mechanism	Operation time (min)	Reduction time (min)	Fluoroscopy time (sec)	Blood loss (mL)	Femoral neck	Femoral shift
1	48/M	Traffic accident	80	25	19	400	4.1	6.8
2	28/M	Traffic accident	80	28	21	500	4.1	4.1
3	43/M	Fall from height	90	26	19	450	3.7	4.7
4	21/M	Traffic accident	65	23	16	300	3.4	4.4
5	24/F	Traffic accident	60	29	13	500	3.9	4.2
6	29/M	Fall from height	60	18	12	150	4.2	4.2
7	52/F	Traffic accident	90	19	13	300	3.7	4.7
8	57/F	Traffic accident	75	22	16	500	4.2	4.5
9	53/M	Fall from height	100	26	20	500	4.0	4.3
10	35/M	Traffic accident	75	28	21	150	4.1	4.2
11	29/F	Fall from height	60	15	12	150	4.1	4.4
13	40/M	Traffic accident	90	18	12	500	4.2	7.2
13	19/M	Traffic accident	90	28	25	500	3.7	4.7
14	21/M	Fall from height	90	22	16	300	3.9	4.9
15	20/M	Fall from height	60	15	9	150	4.1	5.1
16	34/M	Fall from height	105	24	19	200	3.5	7.5
17	35/F	Fall from height	105	24	21	200	4.0	4.6
18	35/M	Traffic accident	90	18	12	180	3.8	5.2
19	22/F	Fall from height	75	22	14	450	4.1	5.3
20	34/M	Traffic accident	75	24	12	400	4.8	4.2
21	35/M	Traffic accident	95	23	16	400	4.5	4.5
22	37/M	Fall from height	60	20	15	300	3.5	4.5
23	27/M	Fall from height	95	26	17	200	4.1	4.1
24	25/M	Traffic accident	55	15	13	150	4.2	4.2
25	19/M	Fall from height	80	21	16	550	3.4	4.4

TABLE V
Operative data and outcomes

Parameters	Mean±SD	Median	Range
Operation time (min)	80.0±15.0	80	55-105
Reduction time (min)	22.0±4.0	22	15-28
Fluoroscopy time (sec)	16.0±3.8	16	9-25
Blood loss (mL)	335.0±142.0	300	150-550
Fracture union time (month)			
Femoral neck	4.0±0.3	4.1	3.2-4.8
Femoral shift	4.8±0.9	4.5	4.1-7.5

SD: Standard deviation. Continuous variables were analyzed using descriptive statistics. Healing times between femoral neck and shaft fractures were compared using Wilcoxon signed-rank test.

delayed healing of the femoral shaft fractures. Tables IV and V, respectively, display detailed data and surgical outcomes for all patients.

After continuous follow-up and rehabilitation, all fractures ultimately healed, and there was no statistically significant difference in Harris scores between the affected and healthy sides at the time of fracture healing ($p>0.05$) (Table III). Finally, according to the Friedman and Wyman criteria, 18 patients had a good outcome, seven patients had a fair outcome, and no patients had a poor outcome.

DISCUSSION

Ipsilateral femoral neck and shaft fractures represent a complex injury involving two distinct fracture types, necessitating a variety of reduction and fixation strategies. In the present study, we evaluated the effectiveness of reconstruction nails combined with the reductor-T tape pin for treating ipsilateral femoral neck and shaft fractures. The findings suggest that this method was successful in reducing both fractures, with all femoral neck fractures healing without complications. However, three patients experienced delayed healing of the femoral shaft fractures. These results indicate that this combined approach may offer a viable treatment option for such complex fractures, with promising outcomes in terms of fracture healing and functional recovery.

Currently, there is no consensus on the optimal treatment method for ipsilateral femoral neck and shaft fractures. Existing comparative studies show substantial differences in treatment methods and many lack randomization. Over the past few decades, different authors have compared the outcomes and complication rates of treating femoral neck fractures with single internal fixation versus double fixation. Some studies have shown no substantial difference between the two approaches.[17,18] However, other studies suggest that single internal fixation devices may reduce the incidence of femoral neck nonunion. Compared with double internal fixation devices, single internal fixation methods offer advantages such as reduced blood loss, less tissue damage, and lower costs.[19]

In theory, the use of reconstruction nails is the gold standard for the treatment of such fractures.[20,21] The reconstruction nail can promote closed reduction and stable fixation of both fractures and help control the angulation, shortening and rotation of the femoral shaft. In addition, this fixation method requires a smaller incision, results in less blood loss, lowers the infection risk and reduces operation time, making it suitable for biological fracture fixation.[19,22,23] However, studies have reported that reconstruction nails increase the incidence of complications such as femoral head necrosis and nonunion.[24] In this study, no cases of femoral head necrosis or nonunion were observed. Among the study participants, only three out of 25 patients experienced delayed healing of the femoral shaft. However, following the introduction of weight-bearing exercises, the fracture ends were subjected to beneficial compressive forces, ultimately leading to successful and robust healing.

It is necessary to use the traction bed to traction the affected limb in the treatment of such fractures with reconstruction nails. However, Rhorer[25] found that it was impossible to counteract the powerful deforming and shortening force of the quadriceps with traction provided by a fracture table alone. Heavy traction may lead to complications such as the displacement of the femoral neck fracture, nerve injuries (including pudendal nerve trauma and peroneal nerve palsy), and skin injury (such as stretch injury of the foot, perineal ulcers, and compartment syndrome).[26,27]

In the present study, the reductor-T tape pin demonstrated several advantages over traditional joystick techniques such as Schanz screws or femoral distractors. Compared to Schanz screws, which typically require bicortical fixation, the reductor-T tape pin provides sufficient control with unicortical fixation, reducing the risk of creating stress risers. Our technique resulted in an average reduction time of 22 min, which compares favorably to traditional reduction techniques in similar fracture patterns. The T-shaped handle design allows for single-handed manipulation with improved rotational control compared to standard joystick pins, which often require two-handed operation. This ergonomic advantage contributed to our relatively short mean operation time of 80 min, compared to reported times of 95 to 120 min while using conventional femoral distractors.[28] Furthermore, the threaded design of the screw head provides secure temporary fixation while avoiding interference with the entry path of the reconstruction nail. Minimal soft tissue disruption is a comparative advantage of our technique over conventional external fixator-based reduction methods. The percutaneous approach with the reductor-T tape pin maintains the biological environment around the fracture site, potentially explaining our low rate of delayed union (12%) compared to reported rates of 15 to 20% with more invasive reduction techniques.[29] Additionally, the unique design enables better control of floating intermediate fragments during reaming, potentially reducing iatrogenic soft tissue and vascular injuries.

In our study, the use of the reductor-T tape pin exhibited some independent advantages over other double joystick technology. First, while fixing and moving the fracture ends with the reductor-T tape pin, the presence of threads at the end provides sufficient strength for single cortical fixation, ensuring that it does not interfere with the entry of the reconstruction nail into the bone marrow during use. Second, due to the T-shaped appearance of the reductor-T tape pin handle, it can be easily operated with one hand, making the surgical process simpler and further shortening the surgery time.

The reduction and fixation of femoral neck fractures are the key factors affecting the quality of reduction of such fractures. Affected by the mechanism of fracture injury, femoral neck fractures typically have small displacement, making it necessary to prioritize fixation of the femoral neck fracture to prevent increased displacement during reduction.[30] During the use of the reconstruction nail, as the nail is inserted into the medullary cavity, the traction applied to the femoral shaft fracture end can cause an increase in femoral neck fracture displacement. This may explain why the use of reconstruction nails can lead to nonunion of femoral neck fractures and even an increased probability of femoral head necrosis.[31,32]

In our study, after two years of follow-up, there was no nonunion of femoral neck fractures or femoral head necrosis. This suggests that the reductor-T tape pin can not only control the reduction of femoral shaft fractures, but also reduce the risk of increased displacement in femoral neck fractures. After evaluation using Friedman and Wyman functional results, no patient had a poor outcome. Finally, it must be mentioned that the efficacy of reconstructing nails in treating such fractures is closely related to the surgeons' experience and surgical techniques.

Avascular necrosis has been reported at high incidence with certain fixation methods for femoral neck and shaft fractures. However, in our study, no cases of AVN were observed, which may be due to the relatively small sample size. We plan to explore the incidence of AVN associated with our surgical technique further through larger clinical trials in the future.

Nonetheless, this study has several limitations. First, the absence of a control group treated with established methods, such as dual fixation with screws and intramedullary nails, limits our ability to directly compare the efficacy and safety of the new technique. While our findings provide preliminary evidence of feasibility, comparative data are necessary to determine its advantages over existing approaches. Second, the small sample size of 25 patients may limit the generalizability of the results. Although this pilot study aimed to explore the feasibility, larger trials with formal power analyses are needed to confirm our findings. Third, the non-randomized design introduces a potential for selection bias, which may affect the validity of our conclusions. Additionally, the heterogeneity of fracture patterns among patients, including Garden I-II femoral neck fractures and AO/OTA 32-A, B, and C femoral shaft fractures, may contribute to variability in outcomes. Finally, long-term recovery outcomes should be further evaluated in future studies to assess the durability of the results.

Despite these limitations, our study provides valuable insights into the potential of the novel technique as a viable alternative in specific clinical scenarios. Future research should incorporate controlled comparative designs, larger sample sizes and more homogeneous patient populations to further validate its clinical role and assess long-term outcomes.

In conclusion, the use of a reconstruction nail assisted by the percutaneous reductor-T tape pin demonstrated successful reduction of ipsilateral femoral neck and shaft fractures, with favorable postoperative functional outcomes. The reductor-T tape pin facilitates the reduction of femoral neck fractures and provides a safe environment for the reduction and fixation of femoral shaft fractures. However, further multi-center, large-scale, randomized-controlled trials are necessary to confirm the efficacy and safety of this technique.

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

Author Contributions: Contributed to conception, design, supervosoin, writing-original draft and writing-review: W.W.; Contributed to conception, design, writing-original draft and writing-editing: Z.G.; Contributed to date analysis and writing-original draft: L.Y.; Contributed to data collection: Y.Q., J.G., J.L., S.L., Z.L. All authors read and approved the final manuscript.

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