CLINICAL EFFICACY AND SAFETY OF PFNA AND DHS IN THE TREATMENT OF UNSTABLE INTERTROCHANTERIC FRACTURES IN ELDERLY PATIENTS

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ABSTRACT

Objective: *This study was designed to explore the clinical efficacy and safety of proximal femoral nail antirotation (PFNA) and dynamic hip screw (DHS) in the treatment of unstable intertrochanteric fractures in elderly patients.*

Methods: *A total of 130 elderly patients with unstable intertrochanteric fractures admitted to our hospital from January 2016 to September 2019 were enrolled, and assigned to an observation group (n=80) and a control group (n=50) according to different treatment methods. Patients in the observation group were treated with PFNA, while those in the control group were treated with DHS. The operation situation, pressure injury, visual analog scale (VAS) score, injury area, neurological function, and limb function of the two groups were evaluated, and the complication rate, recovery, and treatment satisfaction of them were investigated.*

Results: *Compared with the control group, the observation group experienced shorter operation time and fracture healing time and less intraoperative blood loss, and suffered a shorter incision. In addition, compared with the control group, there were less patients with pressure injury in the observation group, and the observation group showed smaller injury area, got lower VAS score, higher American spinal injury association (ASIA) motor score, and Fugl-Meyer Assessment (FMA) score, and showed higher Barthel index, lower complication rate, better recovery, and higher treatment satisfaction.*

Conclusion: *PFNA is more effective and safer in the treatment of elderly patients with unstable intertrochanteric fractures.*

Keywords: *PFNA, DHS, unstable intertrochanteric fracture, ASIA score.*

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Introduction

Intertrochanteric fracture is one of the basic clinical problems in the orthopedics department. Patients are easily saddled with serious social and economic pressure once suffering from it. Hip fractures in more than 90 % of elderly patients belong to intertrochanteric fractures, and the complication rate and mortality of intertrochanteric fractures in the patients are 20-30% and about 17%, respectively[1, 2]. Femoral intertrochanteric fractures in the elderly are generally caused by osteoporosis and mild or severe injuries. In most cases, internal fixation operation can be adopted to treatment them and provide satisfactory clinical results[3-6]. However, the treatment of unstable intertrochanteric fractures in elderly patients is a challenge, because it is difficult to obtain anatomical reduction in the treatment of this disease, and the morbidity and mortality of the disease are both high. Moreover, due to technical limitations, internal fixation operation often fails in the treatment of unstable intertrochanteric fractures[7]. Therefore, it is necessary to find other safer and more effective means to treat this disease.

Dynamic hip screw (DHS) is widely used for the treatment of intertrochanteric fractures, because it can provide both dynamic pressure and static pressure to stabilize the fractures[8, 9] and has good effect on two-part stable intertrochanteric fractures. However, in the treatment of intertrochanteric fractures, especially unstable intertrochanteric fractures, DHS is prone to bring various complications including delayed fracture union, looseness of steel plate, and incision infection(10-12), and these complications are often induced by screw displacement caused by infinite dynamic pressure(13). Proximal femoral nail antirotation (PFNA) is another method that stabilizes the femoral head using a single helical blade instead of a screw system for fixation.

Helical blades can promote the compaction of cancellous bones, so they can better stabilize unstable intertrochanteric fractures(14, 15). The comparison between PFNA and DHS is common in many clinical studies on unstable intertrochanteric fractures, but the clinical efficacy and safety of the two are not comprehensively studied. This study mainly detected different indexes to compare the clinical efficacy and safety between the two in treating unstable intertrochanteric fractures.

Methods

General materials

A total of 130 elderly patients with unstable intertrochanteric fractures admitted to our hospital from January 2016 to September 2019 were enrolled, and assigned to an observation group (n=80) and a control group (n=50) according to different treatment methods. Patients in the observation group were treated with PFNA, while those in the control group were treated with DHS. All patients and their family members signed relevant consent forms after understanding this study, and the study was approved by the Ethics Committee of our hospital.

The inclusion criteria of the study:

- Patients diagnosed with osteoporosis according to X-ray absorptiometry (DXA);
- Patients confirmed with intertrochanteric fracture according to X-ray examination;
- Patients whose fractures were old fractures, patients with a course of disease longer than three weeks;
- Patients without contraindication to related operation;
- Patients without mental disorder;
- And those who can fully express their feelings.

The exclusion criteria of the study:

- Patients without complete bone mass;
- Patients with contraindication to related operation;
- And those with mental disorder or disorder of expression.

Methods

After admission, skin traction or skeletal traction was carried out to the affected limb of each patient in the two groups to avoid aggravating soft tissue damage during operation. Before operation, it is necessary to carry out routine physical examination on each patient and CT scanning on the skull of the patient, including cardiac ultrasound examination, electrocardiogram, screening for infectious diseases, and color Doppler ultrasonography of lower extremity arteries. In addition, the medical staff were required to understand the general situation of each patient and evaluate the tolerance of the patient to operation. Moreover, before operation, the symptoms including medical complication, hypoproteinemia, and refractory heart failure of the patients were treated, and the patients' blood pressure and blood glucose were controlled within a suitable range. At 1 h before operation, antibiotics were adopted for the patients to prevent intraoperative infection. Patients in both groups were anesthetized by lumbar plexus-sciatic nerve block.

Patients in the control group were treated with DHS as follows: Each patient was asked to lie on a traction bed in the supine position, with lateral hip raised by about 10 cm. After anesthesia, an incision with a length of about 8 cm was made through the greater trochanter top of the affected side of the patient to fully expose the stump of the fracture site. Subsequently, a kirschner wire was inserted into the top of the femoral head along the femoral neck. After the insertion site was confirmed correctly under a C-arm X-ray perspective machine, a second kirschner wire was inserted into the cartilage of femur from the femoral trochanter through the femoral neck, and the length of the bone screw was measured, followed by reaming. Afterwards, a suitable steel plate and bone screws with a corresponding size were introduced into the hole using a guide pin, and corresponding compression screws and hip screws were tightened. In addition, the plate was fixed with cortical bone screws. When the fracture is aligned well under the C-arm X-ray perspective machine, measures were taken to flush the incision, stop bleeding, place a drainage tube, and suture the incision layer by layer, and the operation ended.

Patients in the observation group were treated with PFNA as follows: each patient was asked to lie on a traction bed in the supine position, with lateral hip raised slightly and a catheter indwelt. After anesthesia, a C-arm X-ray perspective machine was adopted for closed reduction to each patient. When closed reduction was satisfactory, a longitudinal incision with a length of about 5 cm was made through the greater trochanter top of the affected side of the patient, and then separated towards the apex of greater trochanter under the premise of tissue protection. The junction point of 1/3 greater trochanter and 2/3 greater trochanter was opened, and a wire was inserted with the open as the entry point. A mouth gag was used to drill through the medullary cavity, and the medullary cavity was reamed after a guide pin was inserted. The main nail of PFNA was inserted into the medullary cavity along the guide pin and its depth and anteversion angle was finely tuned under the C-arm X-ray perspective machine. Afterwards, the size of helical blades was measured, and then a suitable helical blade used to drill into the hole with corresponding depth in the femoral neck. A distal nail was placed after the helical blade was fixed, and then a tail cap was installed after confirming that the PFNA site was appropriate under the C-arm X-ray perspective machine. Finally, measures were taken to flush the incision, stop bleeding, place a drainage tube, and suture the incision layer by layer, and the operation ended.

Detection indexes

Operation details

The operation details including operation time, intraoperative blood loss, incision length, and fracture healing time of the two groups were evaluated and compared.

Pressure injury

The pressure injury of the two groups after operation was recorded and evaluated. Pressure injury of the patients was staged according to skin color, integrity, exudation, and tactility. Stage I pressure injury was characterized by complete skin and erythema that did not turn white under shiatsu; stage II pressure injury was characterized by partial skin defect, exposed dermis layer, and complete or damaged serous blisters; stage III pressure injury was characterized by full-thickness skin defects, exposed adipose tissue, granulation tissue, local eschar or carrion; stage IV pressure injury was characterized by full-thickness ulcerous skin defects, exposed muscles, fascia, tendon, cartilage and ligament, and local eschar or carrion.

Pain and injury area

The pain of each patient at 30 min and 72 h after operation was analyzed using the visual analog scale (VAS)[16], and the VAS scores (0-10 points) between the two groups were compared. A higher VAS score indicated more serious pain. In addition, the injury areas of patients at 30 min and 72 h after operation were recorded, and compared.

Neurological function

The neurological function recovery of the two groups at admission, 14 d after operation, and 30 d after operation was evaluated according to the criteria developed American spinal injury association (ASIA)[17], and the ASIA score between the two groups was compared. A lower ASIA score indicated better recovery.

Limb function

The limb function recovery of the two groups at admission, 14 d after operation, and 30 d after operation was evaluated using the Fugl-Meyer assessment (FMA) score and Barthel index[18, 19]. A higher FMA score indicated better recovery.

Complication rate

The complications of the two groups were analyzed, and the complication rates of them were calculated. Complications included delayed fracture union, looseness of steel plate, and incision infection.

Recovery

The recovery of the two groups was compared, and the recovery of them was evaluated using the Harris hip score[20]. A higher Harris hip score indicated better recovery. A score between 90 and 100 points implied excellent recovery; a score between 80 and 90 points implied good recovery; a score between 70 and 79 points implied fair recovery; a score less than 70 points implied poor recovery.

Treatment satisfaction

The treatment satisfaction of the two groups were explored and compared. A questionnaire survey was carried out to each patient, and the test content and scoring standards were selected by the hospital. The questionnaire had a full score of 100 points, with a score between 85 and 100 points for satisfaction, a score equal to 65 points or more for basic satisfaction, and a score less than 65 points for dissatisfaction.

Statistical analysis

The data were analyzed comprehensively and statistically using SPSS19.0 (Asia Analytics Formerly SPSS, China). The enumeration data were analyzed using the X^2 test, and measurement data were expressed by the (x±s), and analyzed by the t test. P<0.05 indicates a significant difference.

Results

General materials

There was no significant difference between the two groups in sex, age, body mass index (BMI), education level, place of residence, injury cause, and Evans-Jensen type (all P>0.05)[21]. Table 1.

Item	The observation group (n = 80)	The control group (n = 50)	t/X^2	P-value
Sex			0.05	0.824
Male	40 (50.00)	26 (52.00)		
Female	40 (50.00)	24 (48.00)		
Age (Y)	69.65±8.55	68.31±8.93	0.85	0.394
BMI (kg/m²)	23.11±5.92	22.98±6.15	0.12	0.905
Education level (years)	8.89±3.54	9.20±3.21	0.50	0.616
The place of residence			0.55	0.457
Rural area	24 (30.00)	12 (24.00)		
Urban area	56 (70.00)	38 (76.00)		
Injury cause			2.46	0.293
Injury from fall	54 (67.50)	32 (64.00)		
Vehicle accident injury	20 (25.00)	10 (20.00)		
Others	6 (7.50)	8 (16.00)		
Evans-Jensen type			1.05	0.591
Type III A	40 (50.00)	24 (48.00)		
Type III B	32 (40.00)	18 (36.00)		
Type IV	8 (10.00)	8 (16.00)		

Table 1: General data of the two groups.

Operation situation

Comparison of operation time, intraoperative blood loss, incision length, and fracture healing time between the two groups showed that these indexes of the observation group were all better than those of the control group (all P<0.05), which implying that the operation situation of operation time was better than that of the control group. Figure 1.

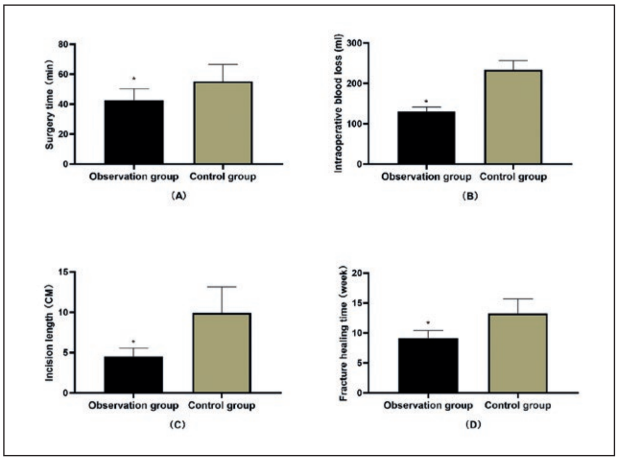

Figure 1: Comparison of operation situation between the two groups. A, Operation time: The observation group experienced shorter operation time than the control group (P<0.05). B, Intraoperative blood loss: The intraoperative blood loss of the observation group was less than that of the control group (P<0.05). C, Incision length: The incision length of the observation group was shorter than that of the control group (P<0.05). D, Fracture healing time: The observation group experienced shorter fracture healing time than the control group (P<0.05).
*Note: *indicates P<0.05 vs. the control group.*

Pressure injury

In terms of pressure injury level, in the observation group, there were 5 patients with pressure injury in total, including 3 patients with stage I pressure injury, 1 patient with stage II pressure injury, 1 patient with stage III pressure injury, and no patient with stage IV pressure injury, while in the control group, there were 15 patients with pressure injury in total, including 6 patients with stage I pressure injury, 5 patients with stage II pressure injury, 2 patients with stage III pressure injury, and 2 patients with stage IV pressure injury.

Therefore, the total number of patients with pressure injury in the observation group was significantly less than that in the control group (P<0.05). Table 2.

Item	The observation group(n=80)	The control group (n = 50)	X^2	P-value
Stage I	3 (3.75)	6 (12.00)	-	-
Stage II	1 (1.25)	5 (10.00)	-	-
Stage III	1 (1.25)	2 (4.00)	-	-
Stage IV	0 (0.00)	2 (4.00)	-	-
Total	5 (6.25)	15 (30.00)	13.33	<0.001

Table 2: Pressure injury of the two groups.

Pain and injury area

Comparison of VAS score and injury area between the two groups at 30 min after operation and 72 h after operation showed that at the two time points, the VAS score of the observation group was lower than that of the control group, and the injury area of the observation group was smaller than that of the control group (both P<0.05). Figure 2.

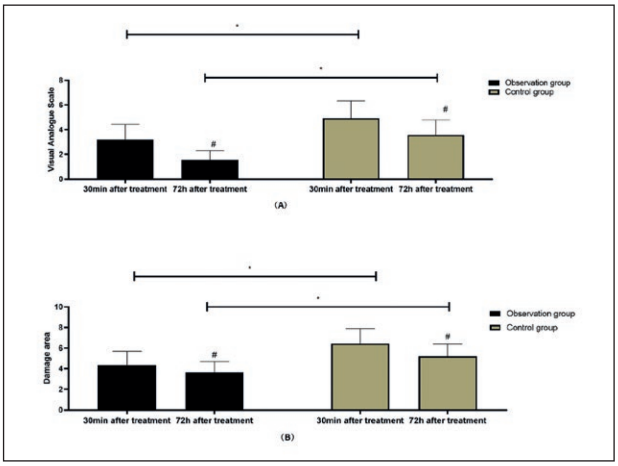

Figure 2: Comparison of VAS score and injury area. A, VAS score: At 30 min after operation and 72 h after operation, the VAS score of the observation group was lower than that of the control group (P<0.05). B, Injury area: At 30 min after operation and 72 h after operation, the injury area of the observation group was smaller than that of the control group (P<0.05).

*Notes: *indicates P<0.05 vs. the control group; #indicates P<0.05 vs. the situation at 30 min after operation.*

Neurological function

Comparison of ASIA score between the two groups at admission, 14 d after operation, and 30 d after operation showed that at 14 d after operation and 30 d after operation, the ASIA score of both groups increased, and the score of the observation group was higher than that of the control group (P<0.05). Figure 3.

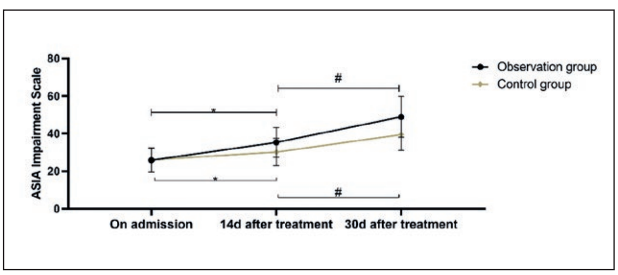

Figure 3: Comparison of ASIA score between the two groups: At 14 d after operation and 30 d after operation, the ASIA score of both groups increased, and the score of the observation group was higher than that of the control group (P<0.05).

*Notes: *indicates P<0.05 vs. the situation at admission; #indicates P<0.05 vs. the situation at 14 d after operation.*

Limb function

Comparison of FMA score and Barthel index between the two groups at admission, 14 d after operation, and 30 d after operation showed that at 14 d after operation and 30 d after operation, the FMA score and Barthel index of both groups increased, and the FMA score and Barthel index of the observation group were both higher than those of the control group (both P<0.05). Figure 4.

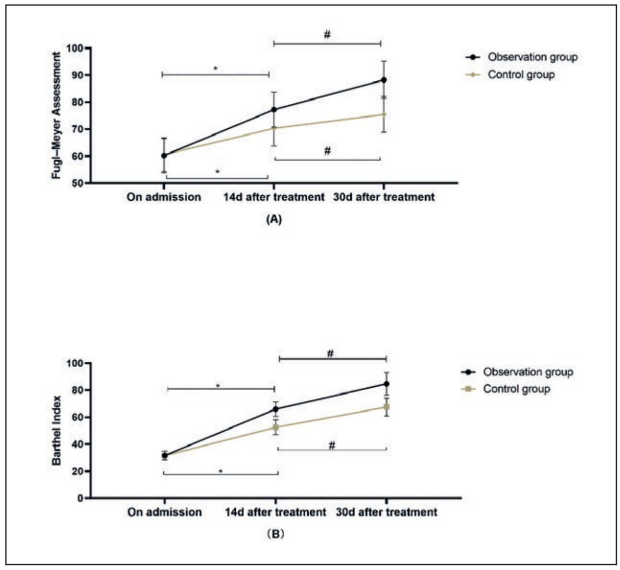

Figure 4: Comparison of FMA score and Barthel index between the two groups. A, FMA score: At 14 d after operation and 30 d after operation, the FMA score of both groups increased, and the FMA score of the observation group was higher than that of the control group (P<0.05). B, Barthel index: At 14 d after operation and 30 d after operation, the Barthel index of both groups increased, and the Barthel index of the observation group was higher than that of the control group (P<0.05).

*Notes: *indicates P<0.05 vs. the situation at admission; #indicates P<0.05 vs. the situation at 14 d after operation.*

Complication rate

Investigation of the complication rate in the two groups revealed that the complication rate in the observation group was significantly lower than that in the control group (P<0.05). Table 3.

Item	The observation group (n = 80)	The control group (n = 50)	X^2	P-value
Delayed fracture union	3 (3.75)	6 (12.00)	-	-
Looseness of steel plate	1 (1.25)	2 (4.00)	-	-
Incision infection	0 (0.00)	4 (8.00)	-	-
Complication rate (%)	4 (5.00)	12 (24.00)	10.29	0.001

Table 3: Comparison of complication rate between the two groups.

Recovery situation

Investigation of the recovery of the two groups revealed that the excellent and good rate in the observation group was higher than that in the control group (P<0.05), suggesting that the recovery of the observation group was better than that of the control group. Table 4.

Item	The observation group (n = 80)	The control group (n = 50)	X^2	P-value
Excellent	48 (60.00)	20 (40.00)	-	-
Good	20 (25.00)	12 (24.00)	-	-
Fair	12 (15.00)	10 (20.00)	-	-
Poor	0 (0.00)	8 (16.00)	-	-
Excellent and good rate (%)	68 (85.00)	32 (64.00)	7.64	0.006

Table 4: Recovery of the two groups.

Treatment satisfaction

Investigation of treatment satisfaction of the two groups revealed that the treatment satisfaction of the observation group was significantly higher than that in the control group (P<0.05). Table 5.

Item	The observation group (n = 80)	The control group (n = 50)	X^2	P-value
Satisfaction	50 (62.50)	25 (50.00)	-	-
Moderate satisfaction	24 (30.00)	14 (28.00)	-	-
Dissatisfaction	6 (7.50)	11 (22.00)	-	-
Satisfaction degree (%)	74 (92.50)	39 (78.00)	5.69	0.017

Table 5: Satisfaction of the two groups.

Discussion

The treatment of unstable intertrochanteric fractures in elderly patients is an enormous challenge. Elderly patients usually have poor bone mass and weak muscles, so common treatments such as internal fixation usually make it difficult for elderly patients to endure early weight bearing and cause relatively slow function recovery. In addition, internal fixation is extremely prone to failure, and usually brings about various complications[22-24]. Therefore, this study focused on two methods (DHS and PFNA) different from internal fixation. We first detected the recovery of patients, and found that the recovery of patients in the observation group treated with PFNA was better, and the observation group showed a higher excellent and good rate, lower complication rate, and higher satisfaction. We analyzed the reason for the situation where PFNA can more effectively promote the recovery of patients based on the clinical effects. According to the results of neurological function and limb function, the neurological function and limb function recovery of the observation group was better. Elderly patients will encounter many problems in peripheral femoral nerve and nervous system of fascia and lateral skin after suffering from femoral fracture[25]. In some operations, the damage of the femoral nerve is often caused by the action of screws on the ischiadic nerve. Some related studies on orthopaedics have found that DHS has a crucial impact on the injury of nervous system[26, 27].

In the operation with DHS, bone screws are adopted for fixation. According to the previous data, screws cause certain damage to the nervous system, so patients in the control group treated with DHS showed poor recovery of neurological function. In some parts including pyriform sinus, nails may cause damage to the tendons of peripheral nerves, impairing the limb function. In the operation with PFNA, the entrance points of nails are different, so the damage to nerves is lighter[28]. Therefore, the above reasons can explore why patients treated with PFNA can get better recovery in neurological function and limb function. PFNA can contribute to faster recovery of the neurological function and limb function and thus promote a better overall recovery of the patients, so patients are more satisfied. One clinical study on PFNA in the treatment of unstable intertrochanteric fractures has showed that compared with DHS, PFNA can contribute to better recovery, and take effect on the recovery of functions more effectively[29], which is similar to the results of our study.

From the perspective of safety, patients treated with PFNA had less pressure injuries, lower VAS scores, and smaller injury areas, and showed a lower complication rate in this study. Additionally, in this study, compared with the control group, the observation group suffered smaller incision, more intraoperative blood loss, and larger injury area, and got a higher VAS score. The disadvantage of the DHS operation for the control group is that it requires a large area of incision exposure and reaming operation, which is easy to bring a large area of skin trauma and soft tissue injury, excessive blood loss and severe pain to patients[30]. In addition, medical equipment is the main cause of pressure injury in patients[31]. From the introduction of the previous studies, experiment process during operation and results, we found that screws used in DHS are easy to cause large-scale damage. Compared with DHS, PFNA helps to reduce the incision size, causes shorter exposure time, and requires no reaming, so it avoids a large amount of blood loss. The materials used for PFNA operation are friendlier to patients, especially to patients with osteoporosis, and the use of helical blades avoids further bone damage. From the material point of view, PFNA can effectively prevent a large number of complications(32). Therefore, based on these data and the results of this study, it is safer to use PFNA than DHS.

However, there are still some shortcomings in this study. We have not detected the inflammatory reaction of patients, so we are unable to fully investigate the damage caused by treatment methods. In the future, we will detect the inflammatory reaction and the molecular mechanism behind it, and we will also investigate the cooperation degree of patients during the operation based on the satisfaction questionnaire used in this study to better improve the clinical treatment methods.

To sum up, compared with DHS, PFNA is more effective and safer in the treatment of elderly patients with unstable intertrochanteric fractures.

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