A Retrospective Study of 98 Elderly Patients with High-Risk Lateral Femoral Wall Intertrochanteric Hip Fractures to Compare Outcomes Following Surgery with Proximal Femoral Nail Antirotation (PFNA) Versus Dynamic Hip Screw (DHS)

Zhi Tian*
Jia Chen*
Yazhou Zhang
Lifang Shi
Wenyi Li

* Zhi Tian and Jia Chen wish it to be known that, in their opinion, the first 2 authors should be regarded as joint First Authors

Department of Osteopathy, Hebei Provincial People's Hospital, Shijiazhuang, Hebei, PR China

Corresponding Author:
Wenyi Li, e-mail: lwy2@medmail.com.cn

Background: The aim of this study was to evaluate the efficacy of dynamic hip screw (DHS) and femoral nail antirotation (PFNA) in the treatment of lateral-wall high-risk type of intertrochanteric fractures.

Material/Methods: A total of 98 patients with high-risk intertrochanteric fractures of the lateral wall who underwent surgery from January 2019 to December 2020 were selected as the study subjects. Of these, 52 were treated surgically with PFNA (mean age 73.45±5.95 years) and 46 with DHS (71.37±6.22 years). We followed up these patients and compared the occurrence of the 2 surgical methods in terms of perioperative period, complication rate, and functional recovery.

Results: In terms of lateral wall fracture, there were 2 cases of PFNA and 10 cases of DHS, and the difference between groups was statistically significant (P<0.05). Operative time (mean 54.94±7.29 vs 61.17±6.45) and intraoperative blood loss (72.80±9.18 vs 96.12±8.22) was significantly lower in the PFNA group compared to the DHS group (all P<0.05). Efficacy in the PFNA group was significantly better than in the DHS group. The HHS at follow-up was significantly higher in the PFNA group (mean 80.73±9.20 vs 64.19±8.12) than in the DHS group (P<0.001). The VAS score at follow-up was significantly lower in the PFNA group (1.78±0.34 vs 2.65±0.23) than in the DHS group (P<0.001).

Conclusions: PFNA is more effective than DHS in the treatment of high-risk lateral wall fractures in the elderly, with the advantages of lower incidence of complications and better recovery of hip joint function. PFNA warrants clinical application.

Keywords: Femoral Fractures • Fracture Fixation, Intramedullary • Hip Fractures

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Background

Femoral intertrochanteric fracture (FIF) is a fracture mostly associated with osteoporosis that occurs between the base of the femoral neck and the lesser trochanter and, as a common type of hip fracture in clinical practice, accounts for about 36% of hip fractures [1,2]. In recent years, with population aging, the incidence of FIF has also been increasing year by year and has become a serious traumatic disease threatening the health of the elderly [3], which greatly affects the short-term and long-term quality of life of patients [4,5].

For the treatment of FIF, it has been shown that conservative treatment can easily lead to complications such as coxa vara, osteoporosis, and pulmonary infection [3,6-8]. At present, internal fixation is widely accepted for use in surgical treatment. Internal fixation surgery should be used when the patient’s physical condition allows, as it can ensure that the FIF is reduced in a timely and stable manner, allowing the patient to regain mobility as soon as possible, reducing serious complications caused by long-term bed rest, and ultimately reducing mortality and improving the prognosis [9,10]. At present, there are many surgical methods for the clinical treatment of FIF, including dynamic hip screw (DHS), femoral antirotation intramedullary nail (PFNA), and artificial joint replacement [6,11]. However, for the treatment of high-risk intertrochanteric fractures of the lateral wall, the optimal treatment remains controversial. As early as 2004, Gotfried proposed the concept of the lateral wall of the proximal femur in the clinical application of DHS and defined unstable fractures along the intertrochanteric region as high-risk intertrochanteric fractures of the lateral wall. In this fracture reduction treatment, the structure of the lateral greater trochanter is weak, and there is a rupture, while the medial wall is not supported. Therefore, inappropriate internal fixation can cause damage to the lateral wall, leading to treatment failure.

We hypothesized that PFNA would have better clinical outcomes than DHS for treating patients with high-risk intertrochanteric fractures of the lateral wall. Therefore, 96 patients with high-risk intertrochanteric fractures of the lateral wall treated with PFNA or DHS were retrospectively analyzed in this study. We compared the perioperative period, incidence of complications, and functional recovery to evaluate the therapeutic effect of PFNA and DHS in patients with high-risk intertrochanteric fractures of the lateral wall, and then provide a reference for clinical treatment.

Material and Methods

Patients

In this retrospective cohort study, we systematically reviewed medical records of all patients with high-risk intertrochanteric fractures of the lateral wall who underwent surgery from January 2019 to December 2020. According to inclusion and exclusion criteria, 98 patients were finally included after screening. All procedures were performed by 2 senior chief physicians with comparable technical experience. According to surgical method, the patients were divided into 2 groups: the PFNA group and the DHS group. Of these, 52 (mean age 73.45±5.95 years) were in the PFNA group and 46 (71.37±6.22 years) were in the DHS group. The sex ratio was 22/30 male/females in the PFNA group and 22/24 in the DHS group. The study was approved by the Institutional Review Board of Hebei Provincial People’s Hospital and conducted in accordance with the Declaration of Helsinki and the regulations of the Health Insurance Portability and Accountability Act (HIPAA). The requirement of informed consent was waived by the Ethics Committee of Hebei Provincial People’s Hospital due to the retrospective nature of the study and anonymity of data.

Inclusion and Exclusion Criteria

Inclusion criteria were: (1) Patients hospitalized in Hebei Provincial People’s Hospital due to intertrochanteric fracture from January 2019 to December 2020, (2) Patients with lateral-wall high-risk type of intertrochanteric fracture confirmed by X-ray and CT, (3) Complete medical records, (4) Patients undergoing PFNA or DHS surgery, and (5) Patients signed the informed consent. Exclusion criteria (to eliminate the impact of other diseases on clinical outcomes) were: (1) Patients with blood diseases, coagulation disorders, or immune system diseases, (2) Pathological fractures and old femoral fractures, (3) Lost to follow-up or follow-up less than 6 months, (4) Patients with consciousness, communication, or mental disorders, and (5) Patients with a history of lower-limb surgery.

Surgical Process

In the PFNA group, epidural anesthesia or general anesthesia was used. The patient was supine on the traction bed, the traction bed was adjusted, the internal rotation was retracted to reduce the fracture, and fluoroscopy confirmed that the fracture reduction fracture was satisfactory. The operation area was disinfected. At 3-4 cm from the apex of the greater trochanter of the femur, a 4-cm longitudinal incision was made, the skin, subcutaneous tissue, and deep fascia were incised, and the lateral femoral muscle group was bluntly separated to fully expose the greater trochanter and cortex of the femur. A guide wire and reamer were placed in the direction of the medullary canal from the anterior third of the apex of the greater trochanter. We inserted the PFNA staple extension into the medullary cavity. Install the aiming device, we drilled the guide wire in its direction, and placed the helical blade in the direction of the guide wire, which passes through the middle and lower part of the femoral neck near the superior femoral.
moment. We loosened the traction appropriately, placed the distal locking pin, and installed the tail cap. C-arm fluoroscopy confirmed fracture reduction and good internal fixation position. After repeated flushing, we placed drainage and sutured the incision.

DHS group: The anesthesia and reduction process were the same as in the PFNA group. After acceptable reduction, the skin, subcutaneous tissue, and deep fascia were incised, the lateral femoral muscle group was bluntly separated, and the greater femur and cortex were entirely exposed through a 10-cm incision on the lateral side of the greater trochanter. After reaming and measuring the depth in the direction of the guide wire, the suitable DHS screw was driven in, and a sleeve plate was attached and screwed to the lateral cortex of the femoral shaft. C-arm fluoroscopy confirmed fracture reduction and good internal fixation position. After repeated flushing, we placed drainage and sutured the incision.

**Postoperative Management**

Patients in both groups received an intravenous infusion of standard antibiotics within 24 hours of surgery to avoid infection. Under the supervision of a doctor, patients were asked to conduct quadriceps stretching contraction exercises as well as flexion and extension activities involving the hip on the second postoperative day. Low-molecular-weight heparin was used to prevent lower-limb thrombosis from the first day of hospitalization until 2 weeks after surgery.

One week after surgery, the patient was required to stand on the ground with crutches (walking aids), bear weight on the unaffected lower limb, and do not bear weight on the surgical limb; partial weight-bearing training was started 4 weeks after surgery, and weight-bearing was gradually increased according to the callus formation shown by X-ray examination, followed by full weight-bearing after complete fracture healing (generally 12-16 weeks after surgery). Balance training and functional motor training were carried out 12 weeks after surgery.

**Outcomes**

(1) Demographic characteristics and clinical parameters, such as sex, age, body mass index (BMI), alcohol consumption status, smoking status, cause of injury, and fracture type, were recorded for all patients. (2) Intraoperative conditions and postoperative recovery were recorded in all patients in both groups, including: operation time, number of intraoperative fluoroscopies, intraoperative blood loss, and time to start ambulation. Radiographic evaluation was performed to estimate fracture union, hip varus deformity, and internal fixation failure. Anterior and lateral X-rays were taken monthly for 6 months after surgery. After that, X-rays were taken every 3 months for 6 months. Internal fixation failure, delayed fracture union, nonunion, and lateral wall fractures were recorded. (3) We evaluated the functional recovery of patients. Hip joint function recovery was evaluated according to Harris Hip Score (HHS) [12] from 4 aspects: function, pain, deformity, and activity. The total score is 100 points, and the score and corresponding evaluation are as follows: excellent: ≥90 points; good: 80-89 points; fair: 70-79 points; poor: <70 points. The HHS and excellent and good rate were recorded. The visual analog scale (VAS) was used to evaluate the degree of hip pain in the 2 groups during follow-up [12].

**Statistical Analysis**

Data analysis was performed using SPSS Statistics, Version 21 (SPSS, Inc., Chicago, IL, USA). Results are expressed as mean±standard deviation (m±SD). Categorical variable data were analyzed by chi-square test. The independent samples t test and Mann-Whitney U test were performed for normally distributed data. P<0.05 was recognized as statistical significance.

**Result**

**Demographic data**

Demographic data, including sex, age, side of injury, cause of injury, smoking status, alcohol consumption status, fracture type, and follow-up time, showed no statistical difference (all P>0.05) (Table 1).

**Incidence of Complications**

There was no significant difference in incision infection, bedsores, delayed fracture healing, deep venous thrombosis, pulmonary infection, urinary tract infection, internal fixation failure, and nonunion between the PFNA and DHS groups (all P>0.05). In terms of lateral wall fractures, PFNA occurred in 2 patients and DHS occurred in 10 patients, with a statistically significant difference (P<0.05) (Table 2).

**Perioperative Conditions**

The PFNA group had a significantly shorter operative time (54.94±7.29 min vs 61.17±6.45 min) and less intraoperative blood loss (72.80±9.18 ml vs 96.12±8.22 ml) compared to the DHS group (all P<0.05). No significant difference was found between groups in the number of intraoperative fluoroscopies (38.40±10.17 vs 37.18±8.26) (P=0.516) (Table 3).

**Clinical Outcomes**

Fracture healing time was not significantly different between the PFNA and DHS groups (14.78±4.76 weeks vs 15.53±3.16 weeks).
weeks) \( (P=0.367) \). The PFNA group had a considerably shorter time to ambulation than the DHS group (8.51±3.23 days vs 13.87±2.74 days) \( (P<0.001) \) (Table 4).

There was no significant difference in preoperative HHS between the PFNA and DHS groups (45.50±6.49 vs 44.73±7.89) \( (P=0.598) \). However, HHS at follow-up was significantly higher in the PFNA group (80.73±9.20 vs 64.19±8.12; \( P<0.001 \)). There was a significant increase in HHS before follow-up in both groups \( (P<0.05) \) (Table 5). There was no significant difference in preoperative VAS scores between the PFNA and DHS groups (6.54±2.76 vs 6.43±2.44) \( (P=0.836) \). However, the VAS score at follow-up was significantly lower in the PFNA group (1.78±0.34 vs 2.65±0.23) \( (P<0.001) \). The VAS scores at follow-up were significantly lower in both groups \( (P<0.05) \) (Table 6).

In the PFNA group, the treatment outcome was excellent in 18 cases and good in 26 cases, and the excellent and good rate of the treatment outcome was 84.62%. In the DHS group, the treatment outcome was excellent in 10 cases and good in 15 cases, with an excellent and good rate of 54.35%. The treatment effect in the FNA group was significantly better than that of the DHS group \( (P=0.001) \) (Table 7).

Table 1. General information of the patients in the 2 groups.

| General characteristics         | PFNA (n=52) | DHS (n=46) | Statistical value | \( p \) |
|--------------------------------|-------------|------------|-------------------|--------|
| Age (years)                    | 73.45±5.95  | 71.37±6.22 | 1.691             | 0.094  |
| Sex                            |             |            |                   |        |
| Male                           | 22          | 22         | 2.831             | 0.093  |
| Female                         | 30          | 24         |                   |        |
| Fractured side                 |             |            |                   |        |
| Left                           | 20          | 16         | 0.142             | 0.706  |
| Right                          | 32          | 30         |                   |        |
| BMI (kg/m²)                    | 25.45±3.47  | 24.82±3.71 | 0.868             | 0.387  |
| Cause of injury                |             |            |                   |        |
| Fall                           | 36          | 27         | 1.18              | 0.277  |
| Collision                      | 16          | 19         |                   |        |
| Smoking status                 |             |            |                   |        |
| Yes                            | 7           | 6          | 0.004             | 0.952  |
| No                             | 45          | 40         |                   |        |
| Alcohol consumption            |             |            |                   |        |
| Yes                            | 8           | 6          | 0.109             | 0.741  |
| No                             | 44          | 40         |                   |        |
| AO classification of fracture  |             |            |                   |        |
| A1                             | 22          | 16         | 0.656             | 0.721  |
| A2                             | 20          | 19         |                   |        |
| A3                             | 10          | 11         |                   |        |
| Follow-up period (months)      | 14.26±2.43  | 13.62±2.63 | 1.252             | 0.214  |

Table 2. Incidence of complications of the patients in the 2 groups.

|                | PFNA (n=52) | DHS (n=46) | Statistical value | \( p \) |
|----------------|-------------|------------|-------------------|--------|
| Incision infection | 0          | 0          | –                 | –      |
| Bedsore         | 1           | 2          | 0.012             | 0.914  |
| Delayed fracture healing | 1     | 3          | 0.406             | 0.524  |
| Deep vein thrombosis | 2        | 1          | 0.012             | 0.914  |
| Lung infection  | 2           | 2          | 0.149             | 0.699  |
| Urinary infection | 0          | 0          | –                 | –      |
| Lateral wall fracture | 2       | 10         | 7.272             | 0.007  |
| Instrumentation failure | 2    | 4          | 0.333             | 0.564  |
| Nonunion        | 1           | 2          | 0.012             | 0.914  |
**Table 3.** Perioperative conditions of the patients in the 2 groups.

| Groups     | n  | Operation time (min) | Intraoperative blood loss (mL) | Intraoperative fluoroscopy times (n) |
|------------|----|----------------------|-------------------------------|--------------------------------------|
| PFNA group | 52 | 54.94±7.29           | 72.80±9.18                    | 38.4±10.17                          |
| DHS group  | 46 | 61.17±6.45           | 96.12±8.22                    | 37.18±8.26                          |
| t          |    | 4.455                | 13.177                        | 0.647                                |
| P          |    | 0.000                | 0.000                         | 0.516                                |

**Table 4.** Comparison of postoperative recovery between the 2 groups (x±s).

| Groups     | n  | Time to ambulation (d) | Fracture healing time (w) |
|------------|----|------------------------|---------------------------|
| PFNA group | 52 | 8.51±3.23              | 14.78±4.76                |
| DHS group  | 46 | 13.87±2.74             | 15.53±3.16                |
| t          |    | 8.797                  | 0.906                     |
| P          |    | 0.000                  | 0.367                     |

**Table 5.** Comparison of preoperative and postoperative HHS between the 2 groups (x±sd).

| Groups     | n  | Before operation | Follow-up |
|------------|----|------------------|-----------|
| PFNA group | 52 | 45.50±6.49       | 80.73±9.20 |
| DHS group  | 46 | 44.73±7.89       | 64.19±8.12 |
| t          |    | 0.53             | 9.381      |
| P          |    | 0.598            | 0.000      |

**Table 6.** VAS score of hip joint pain before and after operation in both groups (x±sd).

| Groups     | n  | Before operation | Follow-up |
|------------|----|------------------|-----------|
| PFNA group | 52 | 6.54±2.76        | 1.78±0.34 |
| DHS group  | 46 | 6.43±2.44        | 2.65±0.23 |
| t          |    | 0.208            | 14.639    |
| P          |    | 0.836            | 0         |

**Table 7.** The excellent and good rate of the 2 groups.

| Groups     | n  | Excellent | Good | Fair | Poor | Excellent and good |
|------------|----|-----------|------|------|------|--------------------|
| PFNA group | 52 | 18        | 26   | 5    | 3    | 44                 |
| DHS group  | 46 | 10        | 15   | 12   | 9    | 25                 |
| χ²         |    |           |      |      |      | 10.732             |
| P          |    |           |      |      |      | 0.001              |
Discussion

With population aging in recent years, the incidence of FIF has increased [13,14]. The notion of the lateral femoral wall was first developed by Israeli surgeon Gotfried, who introduced it into the surgical treatment of fractures in 2004, stating that it plays an important role in maintaining the integrity of internal fixation of fractures [15]. The extent of the lateral femoral wall remains controversial. According to some research, the lateral femoral wall is the location where the lateral femoral cortex joins the lateral femoral cortex along the tangent line of the femoral neck’s upper and lower edges [16]. According to some research, the lateral femoral ridge is the upper boundary of the lateral wall, while the junction point between the lateral femoral cortex and the tangent of the lower neck of the femur is the lower boundary [17].

It has been confirmed that the lateral wall of the femur plays an important mechanical stabilization role in the treatment of femoral fractures, and that the integrity of the lateral wall can provide rotational stability for the femur, support the bone of the head and neck, and effectively resist its varus, rotation, and diaphyseal displacement, which can avoid the cut-out of screws [16,18]. The helical blade must be implanted in the femoral head neck through the lateral wall for FIF, whether treated with extramedullary fixation or intramedullary nailing, and maintaining the integrity of the lateral wall is critical to the stability of FIF internal fixation [19,20]. However, Palm et al [21] found that 74% of lateral wall fractures were due to intraoperative manipulation, while patients with lateral wall fractures had a 22% re-operation revision rate. Therefore, how to select the appropriate fixation method and make the fracture well fixed while protecting the lateral wall is a very critical clinical problem. In addition, compared with intertrochanteric fractures in general, the lateral wall danger type of intertrochanteric fractures is more severe, and fracture reduction is more difficult due to severe comminuted fractures and involvement of the lesser trochanter.

From a stability point of view, it is very important to select the appropriate fixation treatment [14]. In clinical practice, there are still many disagreements about the best internal fixation procedure for hazardous lateral femoral wall fractures in the elderly [22]. For the treatment of hazardous lateral femoral wall fractures, both PFNA and DHS are common surgical options [20]. In this study, patients with serious lateral femoral wall fractures were compared to the efficacy of DHS internal fixation and minimally invasive PFNA internal fixation. The results of this study suggest that the PFNA internal fixation technique has significant advantages over the DHS technique. The PFNA group had a shorter operation duration, less intraoperative blood loss, quicker ambulation, better hip function, and a lower incidence of complications than the DHS group. The PFNA group had a significantly lower rate of lateral femoral wall fractures than the DHS group, which could be due to the DHS’s excessive dissection of the lateral wall’s soft tissue during fracture treatment, causing the lateral wall to lose its soft tissue protection and be more likely to fracture perioperatively. PFNA is a minimally invasive internal fixation approach characterized by short operation time and less intraoperative bleeding [23]. These were also the main reasons for the early ambulation and high hip function scores in the PFNA group. In addition, in stable intertrochanteric 31-A1 and 31-A2 fractures, the absence of distal blocking screws does not compromise bone healing and may prevent multiple clinical complications. Palm et al [21] evaluated and examined the clinical efficacy of PFNA and DHS in the treatment of patients with femoral fractures, and discovered that DHS was more likely to cause perioperative fracture of the lateral wall of the greater trochanter, and that the re-operation revision rate of patients in the PFNA group was much lower than that of patients in the DHS group. Other studies have found that PFNA reduces injury and complications in the treatment of risky lateral wall fractures in older people, which is effective in reducing fracture healing time and promoting hip joint function recovery [27-29]. These findings show the feasibility and efficacy of closed reduction and minimally invasive internal fixation with PFNA for the treatment of hazardous aneurysms. For the high-risk type of lateral wall of femoral fracture with high stability requirement, DHS fixation method is not effective.

Several limitations of this study should be considered. First, this was a retrospective cohort study, and the data were not comprehensive enough, which may cause bias. Second, each study group had a small number of patients, which resulted in inadequate statistical power. Future research that improves these factors may provide further information to validate the findings presented here.

Conclusions

In conclusion, PFNA is more effective than DHS in the treatment of hazardous lateral wall fractures in the elderly, with the benefits of a lower risk of complications, shorter operation duration, less intraoperative blood loss, and better hip joint function recovery.
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