PRIMARY CEMENTED HEMIARTHROPLASTY VERSUS PROXIMAL FEMORAL NAIL ANTI-ROTATION FOR UNSTABLE INTERTROCHANTERIC FRACTURES IN ELDERLY OSTEOPOROTIC PATIENTS: WHICH ONE IS BETTER?

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ABSTRACT

Objective: *The purpose of this study was to compare the clinical effects between Primary cemented hemiarthroplasty (PCHA) and Proximal femoral nail anti-rotation (PFNA) for unstable intertrochanteric hip fractures in elderly osteoporotic patients.*

Methods: *There were 122 patients with intertrochanteric hip fractures from January 2017 to June 2019 who were included in this retrospective study. In total, 62 patients underwent Proximal femoral nail anti-rotation (PFNA group), while the other 60 patients underwent Primary cemented hemiarthroplasty (PCHA group). Outcome assessments included Perioperative information (such as the incision length, intraoperative bleeding, operation time, hospitalization time), complications, reoperations, and Harris hip score (HHS) were collected at follow-up 24 months.*

Results: *The incision length, operation time, intraoperative blood loss, and hospitalization time in the PFNA group were better than those in the PCHA group (P<0.05). During the 24months follow-up, the total incidence of postoperative complications in the PFNA group was 30.64%, higher than 20% in the PCHA group (P>0.05). The reoperation rate of PCHA group (1/60, 1.67%) was significantly lower than that of PFNA group (7/62,11.3%) (P<0.05). The HHS in the PCHA group at 6 weeks, 3 and 6 months after operation was higher than that in the PFNA group (P<0.05). There was no significant difference in hip function between the PFNA and PCHA groups, with a 12-month HHS (86.19±6.53 vs 85.27±5.47; P>0.05). At follow-up, PFNA group showed better Hip function (HHS) than PCHA group (86.23±10.42 vs 82.15±10.53, P<0.05).*

Conclusion: *Both procedures are effective methods for the treatment of unstable intertrochanteric fractures in the elderly. PCHA might be a good choice for the treatment of elderly osteoporotic patients with unstable intertrochanteric hip fractures in terms of lower reoperation and better function recovery in the early stage.*

Keywords: *Arthroplasty, proximal femoral nail anti-rotation, intertrochanteric fracture.*

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Introduction

Intertrochanteric fracture, one of the most common types of lower limb fractures in elderly patients. With the aging of society, the incidence of intertrochanteric fracture tends to increase. It is estimated that there will be over 4 million hip fractures worldwide by the year 2050, and 1.5 million cases will be in China[1]. Meanwhile, because of a high rate of morbidity, poor functional outcomes and quality of life, intertrochanteric fractures in elderly patients have become a major public health problem. However, the treatment of intertrochanteric fractures is challenging and controversial, especially in the elderly. Methods commonly used for clinical treatments include proximal femoral nail anti-rotation (PFNA), compression hip screw (CHS), gamma nail, dynamic hip screw (DHS), hemiarthroplasty (HA) and total hip arthroplasty (THA). Among them, PFNA and HA are the representatives of internal fixation and arthroplasty respectively, and both have their own unique advantages. Multiple mesh meta-analysis showed that PFNA is the optimal treatment method for intertrochanteric fracture

compared with other internal fixations[2-4]. Several advantages of PFNA had been proposed, such as shorter operative time, less intraoperative blood loss, and small operative wounds[5-7]. However, when elderly patients accompany with unstable fracture and serious osteoporosis, the higher failure rate of intramedullary fixation including screw cut-out, non-union, varus displacement, and shortening, and a series of postoperative complications caused by unable rapid mobilization should not be ignored[7, 8].

Hemiarthroplasty can avoid the above-mentioned adverse results. In recent years, application of femoral head replacement in the treatment of femoral intertrochanteric fracture has been of considerable interest to the Orthopaedic community[9]. And there had been studies highlighting primary operative treatment with a hemiarthroplasty as soon as possible after the injury had proven satisfactory outcomes in several studies[9-11]. Unfortunately, researchers also found that HA brings much more surgical injury than PFNA to patients due to the longer operation time and much more blood loss, and recommended that HA should be undertaken with caution in carefully selected[12-14]. Jincheng Huang et al indicated that HA should not be selected as the primary option for intertrochanteric fractures in elderly patients[15]. Until now, although most previous studies had clarified the treatment results of HA and PFNA in femoral intertrochanteric fractures, there was no stratification for cemented and uncemented types of implants, stable and unstable intertrochanteric fractures. And their results are inconsistent.

The objective of this article was to investigate the outcomes of PFNA and PCHA, including incision length, operation time, intraoperative blood loss, hospitalization time, complications, reoperations and Harris hip score, thereby proving which one is the better choice for elderly patients with unstable intertrochanteric fractures.

Methods

General information

Inclusion criteria:

- Patients over 75 years;
- Patients with type III-V intertrochanteric fracture according to the Evans-Jensen classification;
- Patients with severe osteoporosis (Dual-energy x-ray absorptiometry scans, T<-2.5 SD);
- The patient's hip function was normal before injury.

Exclusion criteria:

- Stable intertrochanteric fracture;
- Open fracture or multiple fractures;
- Multiple organ dysfunctions;
- Patients with osteoarthritis or previous hip disorder;
- Other diseases affecting lower limb function;
- Duration of follow-up less than 24 months.

There involved 122 elderly patients with unstable femoral intertrochanteric fractures admitted to the 967th Hospital of the Joint Logistics Support Force of the PLA from January 2017 to June 2019, of whom 62 patients underwent PFNA, while the other 60 patients underwent PCHA. This study was approved by our hospital Ethics Committee.

Perioperative management

Before surgery, the patients received active preoperative preparations, including having their medical conditions (such as hypertension and diabetes) under control. And prophylactic antibiotics were started 30min before surgery.

About surgery, the two groups underwent surgery under spinal anesthesia or general anesthesia. For both surgical treatments, all operations were performed by the same group of surgeons, which were expert technicians and well experienced. All the patients undergoing PFNA performed after closed reduction on a hip traction table with a small incision in the lateral femur, PFNA was performed by the standard surgical method, which was then internally fixed with proximal femoral nail and then inserted the femoral neck screw until its tip as close as 5 mm to the subchondral bone (Dabo Company (Xiamen, China)) under C-arm X-ray. PCHA was carried out with a cemented prosthesis (Zimmer, USA) through the standard posterolateral hip approach, with the patient in a lateral position. The displaced greater trochanter fracture fragments were reduced and fixed by Titanium cable binding system. No complications related to anesthesia or orthopedic procedure occurred during the surgery.

After surgery, the patient received antibiotics (cefuroxime 750 mg three times daily) to prevent infection not more than 72 hours, and were also given anti-osteoporosis drugs (vitamin D3 and calcitriol) and anticoagulation treatment that rivaroxaban was used one month after operation. The patients with PCHA were immediately allowed full weight-bearing according to the physical status and pain threshold of them. At the same time, we taught the patients that excessive hip flexion and adduction

were not allowed to avoid incision cracking and dislocation. The patients with PFNA were taught to ambulate with partial weight-bearing with the aid of crutches or walkers until 6 weeks after surgery. All patients were followed up at 6 weeks, 3 months, 6 months, and 12 months, and 24 months for clinical and radiological evaluation after operation.

Outcome measurements

• Perioperative information: time from injury to surgery, incision length, intraoperative blood loss, operation time, and hospitalization time.

• Complication and reoperation rate: complications of surgical treatment of intertrochanteric fractures can be divided into two categories. Surgical complications such as the occurrence of superficial wound infection, deep wound infection, lag screw cut-out, non-union of fracture, joint dislocation, loosening of prosthesis, and periprosthetic fractures were recorded. Complications related medical conditions such as cardiovascular complications, respiratory complications, urinary tract infection, deep vein thrombosis, and bed sores were recorded. Reoperation rate was defined as the percentage of postoperative complications that was resolved by surgical treatment.

• Functional outcome: the Harris hip scoring system was used for assessing the postoperative clinical results, which were recorded at 6 weeks, 3 months, 6 months, and 12 months, and 24 months.

Statistical analysis

The independent t-test was used for the comparison of continuous variables, and the Chi-square (Fisher's exact) test was used to analyze categorical variables between the two groups. Data are expressed as mean ± standard deviation, depending on the situation. All statistics Using SPSS 23.0 statistical software (IBM Corp, Armonk, NY, USA), p-value <0.05 was considered to indicate a statistically significant difference.

Results

Patient clinical characteristics

A total of 122 patients with unstable intertrochanteric fractures were included in this study, including 54 males and 68 females. The mean age of the patients in the PFNA group and the PCHA group was 82.18±5.97 years and 83.15±4.88 years, respectively, the age distribution of the two groups has no statistical sense (P=0.326). No significant differences were found regarding sex (P=0.301), body mass index (BMI) (P=0.649), or side (left/right) (P=0.229) between Groups PFNA and PCHA.

The American Society of Anesthesiologists (ASA) score was used to evaluate the preoperative health status of the patients. There was also no statistically significant difference in ASA score between the 2 groups (P>0.05) (Table 1).

Comparison of perioperative information

Details of perioperative information are shown in Table 1. The method of anesthesia did not differ between the 2 groups (P>0.05). Time from injury to surgery was similar between the two groups, with no statistically significant difference (2.74±1.41days vs 3.05±1.53days, P>0.05).

The mean Incision length was 6.97±1.27 cm in PFNA group and 11.53±1.56 cm in PCHA group (P<0.05). Intraoperative blood loss was 65.98±13.81 mL in PFNA group and 176.38±58.23 mL in PCHA group (P<0.05). Operation time was 64.74±16.49 min in PFNA group and 70.62±11.44 min in PCHA group (P<0.05). Moreover, the mean hospitalization time was 11.47±3.72 days in PFNA group and 13.7±3.79 days in PCHA group (P<0.05). The incision length, intraoperative blood loss, operation time and hospitalization time of PFNA group were shorter than those of PCHA group, and the differences were statistically significant (P<0.05).

Variables	PDF	PC	P-value
Age (years)	82.18±5.97	83.15±4.88	0.326
Gender			0.742
Female	39	33	
Male	27	27	
BMI (kg/m2)	22.23±2.05	21.93±2.05	0.432
Side (left/right)	25/37	26/34	0.736
ASA score	1.97±0.63	2.05±0.75	0.512
Method of anesthesia (spinal/general)	49/13	51/9	0.391
Time from injury to surgery (days)	2.74±1.41	3.05±1.53	0.251
Incision length (cm)	6.97±1.27	11.53±1.56	<0.001
Intraoperative blood loss (ml)	65.98±13.81	176.38±58.23	<0.001
Operation time (min)	64.74±16.49	70.62±11.44	0.024
Hospitalization time (days)	10.92±3.71	13.13±3.86	0.002

Table 1: Details of general information and perioperative information.

Comparison of complications and reoperations

The incidence of postoperative complications in PCHA group was lower than that in PFNA group, although not statistically significant (20% vs 30.46%, P>0.05) (Table 2). In the PFNA group, the

surgical complications occurred in seven patients, which include four patients with lag screw cut-out, and three patients with non-union of fracture. No superficial and deep wound infection was detected in group PFNA (P=0.493). In the PCHA group, the surgical complications were observed in four patients, which include three patients with superficial infection, and one patient with periprosthetic fractures. Superficial wound infection is defined as infection of the wound, in which there is no evidence that the infection extends to the site of the implant.

The patient with superficial infection were treated successfully with antibiotics and recovered. All patients had no deep wound infection, aseptic loosening, peri-prosthetic infections, ectopic ossification or injuries to nerves and vessels. The medical complications included cardiovascular complications in two patients, respiratory complications in four, urinary tract infection in three, deep vein thrombosis in one and bedsores in two in the PFNA group and complications include cardiovascular complications in four patients, respiratory complications in two, urinary tract infection in one and deep vein thrombosis in one in the PCHA group (P>0.05, Table 2). The rate of reoperation was higher in the PFNA group (7/62, 11.3%) than in the PCHA (1/60, 1.67%) (P = 0.04). In the PFNA group, four patients underwent conversion cemented hemiarthroplasty due to cut-out of lag screw, three patients due to non-union. In the PCHA group, one patient underwent stem revision due to periprosthetic fractures (Table 2).

Variables	PDF	PC	P-value
Surgical complications	7 (11.2%)	4 (6.67%)	0.373
Superficial wound infection	0	3	
Deep wound infection	0	0	
Lag screw cut-out	4	-	
Non-union of fracture	3	-	
Joint dislocation	-	0	
Loosening of prosthesis	-	0	
Periprosthetic fractures	-	1	
Medical complications	12 (19.35%)	8 (13.33%)	0.369
Cardiovascular complications	2	4	
Respiratory complications	4	2	
Urinary tract infection	3	1	
Deep vein thrombosis	1	1	
Bed sores	2	0	
Overall complications	19 (30.64%)	12 (20%)	0.171
Reoperations	7 (11.3%)	1 (1.67%)	0.04

Table 2: Comparison of complications and reoperations between PFNA and PCHA group.

Comparison of functional outcome

After follow-up, the mean Harris hip scores in the PFNA group were 53.79±5.51, 67.07±9.81, and 71.42±10.24 at 6 weeks after operation, 3 months after operation and 6 months after operation, while in the PCHA group were 59.63±7.46, 72.11±8.96, and 75.93±11.94. The differences were statistically significant (P<0.001, P=0.004, and P=0.022, respectively). The PFNA group showed a better mean Harris Hip Score at 12 months although not statistically significant when compared to the PCHA group (78.84±11.32 vs 76.67±13.29, P>0.05), whereas when the Harris Hip Score was compared at 24 months a significant difference was noted favouring the PFNA group (86.23±10.42 vs 82.15±10.53, P<0.05) (Table 3).

HHS	PDF	PC	P-value
6 weeks score	53.79±5.51	59.63±7.46	<0.001
3 months score	67.07±9.81	72.11±8.96	0.004
6 months score	71.42±10.24	75.93±11.94	0.022
12 months score	78.84±11.32	76.67±13.29	0.334
24 months score	86.23±10.42	82.15±10.53	0.034

Table 3: Comparison of Harris hip scores between PFNA and PCHA group.

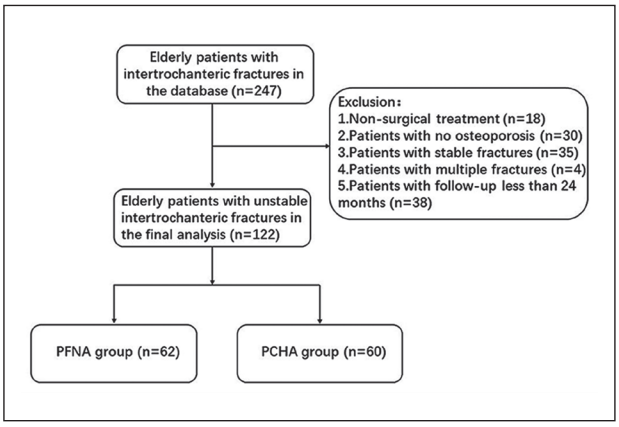

Figure 1: Flow chart of patients in this study.

Discussion

With an increasing aging population, the intertrochanteric fracture in elderly is a relatively common and severe injury, it has become a major public health issue. Treatment of unstable intertrochanteric fracture is challenging for elderly patients with severe osteoporosis and different degrees of internal diseases. Therefore, how to minimize the disability of the injury, optimize rapid return to full function, and prevent complications

have been a focus for us. For several decades, as an internal fixation method, PFNA has been used most widely as the primary treatment method for intertrochanteric fractures[2]. Although the advantages of PFNA have been generally recognized by orthopedists, some studies reported that there is still a long period of non-weight-bearing and higher failure rates in cases of unstable intertrochanteric fractures in elderly osteoporotic patients, such as loss of fixation, nonunion and cut out of the lag screw[16-18]. That's why primary cemented hemiarthroplasty has become popular. When the two methods are compared, PCHA avoids the complications of lag screw cut-out and non-union[19]. It also may shorten the weight-bearing time and improve hip function. Recent evidence supports that PCHA can provide results that are similar to, or even better than the results obtained with PFNA[9, 10, 14].

Dong-peng Tu et al performed meta-analysis using two RCTs and seven RCTs including a total of 1300 patients aged 70 years or over with unstable intertrochanteric fractures to prove that PCHA can reduce postoperative complications, allows early weight-bearing, and achieves a stable fixation[13]. However, Wen-Le Tan et al found that PFNA and HA had similar functional outcome, but HA had more postoperative complications in elderly patients aged 85 years or more with intertrochanteric fractures[12]. In addition, Junming Chen et al pointed out that there were no significant differences between the two interventions for mechanical complications, general complications, and functional outcomes[9]. So far as we know, the amount of current literature is limited and the results are inconsistent. Therefore, it is very necessary to clarify which surgery is more conducive to the recovery of elderly patients and provide a theoretical basis for the selection of clinical treatment methods, this study compared and analyzed the advantages and disadvantages of the two surgical methods.

There were strict inclusion and exclusion criteria for this study, and the general clinical data of patients in this study revealed no difference to ensure the comparability of the two groups (Table 1). In our study we noted statistically less blood loss in the PFNA group (P=0.024), which is probably caused by shorter incision length and operation times significantly. These findings are understandable because the surgical procedure of PFNA is simpler and less traumatic than PCHA. Besides, we observed a shorter hospital length of stay for the PFNA group. This finding differs from that of O¨ zkayın et al, who reported no difference between the two groups[20]. For some elderly patients, due to their weak physical level, they have a low tolerance for more traumatic surgery (PCHA). Thus, they had a longer postoperative recovery time in the hospital. From the perspective of perioperative information, PFNA has strong advantages, which are small incision, short operation time and less intraoperative bleeding. The results obtained were consistent with those of other studies[7, 11, 14]. However, several researchers have investigated that PFNA is usually accompanied by surgical complications and long-term bedridden complications in the unstable intertrochanteric femur fractures in osteoporotic geriatric patients[17, 21, 22].

In the current study, the overall incidence of postoperative complications in the two groups (30.64% in group PFNA and 20% in group PCHA, P=0.171) was comparable. Although not all complications may be observed, if major complications had occurred, the patient would have been brought to the hospital, so complications would have been detected and recorded in this follow-up examination. In terms of surgical complication, consistent with most studies, lag screw cut-out was the major complication seen in the PFNA group. Some researches had shown that cut-out of the lag screw through the femoral head represent a complication with an incidence between 2% and 8%6,23. As in Peifu Tang study[24], twelve patients of PFNA developed complications, lag screw cut-out/ migration occurred in four patients. We suggest that the poor bone condition of the elderly is a primary cause. For the joint replacement, it is generally known that joint dislocation is the most common surgical complication. However, there were no complications of joint dislocation in our PCHA group, which may be related to guiding patients to avoid excessive flexion of the joint after operation.

Meanwhile, the amount of daily activity of overaged was little, so periprosthetic fractures were relatively small, and aseptic loosening hadn't occurred in our sturdy. These observations were similar with Adem Cobden's research that reported dislocation of the prosthetic hip joint and periprosthetic fracture were not detected during the follow-up[25]. In comparison with the PFNA group, superficial wound infections were observed in three patients of PCHA group. The main reasons for the complication with PCHA are the larger surgical incision and trauma. Form medical complications, there was no difference in the incidence of medical complications between the two groups. We found

that patients who had received PFNA treatments had more long-term Bedridden complications including respiratory complications, urinary infection, and bedsore, which commonly due to a longer bed rest time. Only one deep venous thrombosis occurred in each group. This may be related to our DVT prevention measures including administration of anticoagulant drugs and active in-bed plantar flexion/dorsiflexion exercises during the perioperative period. Moreover, our results demonstrated that patients in the PCHA group had the highest incidence of cardiovascular complications, the main reason may be the decrease of cardiac function caused by larger surgical trauma and more blood loss.

The results of our study showed that PCHA resulted in a lower rate of reoperation compared with PFNA. For elderly patients, reoperation should be avoided as much as possible, because it will cause secondary trauma to the body and mind. Xiangping Luo et al 14 compared 52 cemented hemiarthroplasty patients and 71 PFNA patients and the reoperation rate was 2.8% in the PFNA patients, while only one of the HA patients necessitated reoperation due to dislocation of prosthesis. Jin Woo Kim et al conducted a hospital based multicenter cohort on 564 patients with unstable intertrochanteric fractures and the rate of reoperation was higher in the IF group (24/396, 6.1%) than in the HA (4/168, 2.4%)11. In our study, seven PFNA patients (7/62, 11.29%) underwent conversion hip arthroplasty due to cut-out of lag screws and non-union of fracture. The conversion rate in our patients was similar with that of a previous study by Kayali et al, which reported the reoperation rate was 13.3% in the IF patients, while no HA patients underwent revision at a minimum 6-month follow-up[26].

The most important finding of this study is that HHS in PCHA group was higher than that in PFNA group at 6 weeks, 3 and 6 months after operation, the differences were statistically significant. This may be due to earlier full weight-bearing in the PCHA group. Furthermore, in older patients with poor bone quality and very thin diaphyseal cortices, cement improves stem fixation by providing immediate stability and additionally decreases the risk of long-term bedridden complications. Zhuangzhuang Jin et al also found that HHS at the 6 months follow-up were significantly higher in the HA group than in the PFNA group[10]. When 12 months after operation, there was no significant difference in the hip function between the two groups, indicating that artificial femoral head replacement is more conducive to the early recovery of affected limb function and the early improvement of patients' quality of life. In the study of Jincheng Huang et al, they pointed out that although HA and PFNA have similar functional outcome 12 months after operation by analyzing clinical data of 202 elderly intertrochanteric fractures patients aged 80 years or more[15]. A study done by Xiangping Luo et al also observed that there was no significant difference between the two groups regarding to the HHS at 12 months follow-up[14].

These are consistent with our research. Nadir O¨ zkayın et al revealed that the difference of Harris hip score between the patients treated with hemiarthroplasty and proximal femoral nailing was statistically significant in favour of the hemiarthroplasty group within the first 3 months. However, the functional results of patients in PFNA group reached to the same level with that of HA after 6 months period, and even reversed at one year post-operatively[20]. In our study, the mean HHS in the late post-operative period (24 months) in the PFNA group reliably suggested a better outcome of PCHA. The Harris Hip scores of PFNA patients started increasing once full weight was carried after fracture union, eventually surpassing the Harris Hip scores of PCHA patients.

An important limitation of our study is the retrospective design. Although the two groups were comparable according to the main variables (gender, age, BMI, fracture side, fracture type, ASA score and follow-up time), we acknowledge that the evidence for evaluating the outcome of treatment is not as strong as the evidence from randomized controlled trials. A further large-scale RCT is needed in the future to further confirm the current findings. Additionally, our study lacked preinjury functional data that could have been used to optimize cohort matching and minimize confounding. Patients with acute fractures were all enrolled consecutively, which made it difficult to obtain preinjury data. In spite of limitations, we believe that our study offers insight into clinical practice and scientific research, and provide valuable assumptions for prospective randomized trials.

In conclusion, both methods are effective methods for the treatment of unstable intertrochanteric fractures in the elderly. PCHA may be the better operative technique in term of lower reoperation, an immediate mobilization with full weight bearing and higher HHS during 6 weeks, 3 months, and 6 months after operation. However, PFNA has the advantages of short operation time, less intraoperative bleeding,

less trauma to patients and a significant superiority of the long-term (24m) functional outcome.

No significant differences were found statistically regarding complications between the two groups. Therefore, for each individual patient, the clinician should choose the most appropriate method.

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The ethic committee of No. 967 Hospital of the PLA Joint Logistics Support Force approved this study (PLA967-GC2017-020), and all persons gave their informed consent.

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