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ORIGINAL STUDY

Proximal femoral nail anti-rotation (PFNA) and hemi-arthroplasty in the treatment of elderly intertrochanteric fractures

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To determine reasonable treatment of intertrochanteric fractures with proximal femoral nail anti-rotation (PFNA) or hemi-arthroplasty (HA) in elderly patients.

Between January 2009 and June 2013, a total of 367 patients were admitted to the Orthopedics Department of The Second Affiliated Hospital of Soochow University. Patient data were retrospectively analyzed and included 160 males and 207 females. The ages of the patients were between 60 and 97 years and the average age was 72 +/- 3.9 years. According to the Evans-Jensen classification scheme, the fracture types were type IA (n = 18), type IB (n =3 1), type II (n=154), and type III (n = 164). A comparison between the two surgical methods (PFNA and HA) included the duration of surgery, intra-operative blood loss, post-operative weight-bearing time, implant complications, and the Harris hip score.

The data were analyzed after 14-50 months (average 24 months) of follow-up. The gender and age of the patients did not differ significantly between the two methods of treatment; however, the duration of surgery between the PFNA hemi-arthroplasty groups did differ (hemi-arthroplasty required less time), the intra-operative blood loss in the PFNA group was significantly less than the hemi-arthroplasty group, and the post-operative weight-bearing time was significantly shorter in the hemi-arthroplasty group than the PFNA group.

A retrospective study was conducted in 367 patients during the 42-month study period (January 2009–June 2013) to observe the efficacy of PFNA and hemi-arthroplasty. Complete data were available for analysis. There are significant advantages and disadvantages with respect to the two surgical treatment modalities. For elderly patients with unstable fractures, severe osteoporosis, and pre-operative mobility, hemi-arthroplasty is preferred because hemi-arthroplasty has fewer disadvantages compared to PFNA, which is not suitable for full weight bearing and bone union. PFNA for the treatment of intertrochanteric fractures has been increasingly accepted and widely used; however the use of arthroplasty remains controversial *(3)*. Conservative treatment for intertrochanteric fractures in elderly patients has become a main trend and often takes longer, gives rise to more complications, and has mortality rates higher than surgical treatment.

Keywords : intertrochanteric fractures ; arthroplasty ; replacement ; hip ; elderly ; PFNA.

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INTRODUCTION

Intertrochanteric fractures often occur in the elderly, who also have severe osteoporosis. Even minor trauma is likely to cause serious, unstable fractures. In the current study we have investigated treatment of intertrochanteric fractures with proximal femoral nail anti-rotation (PFNA) or hemi-arthroplasty (HA) in elderly patients.

PATIENS AND METHODS

Three hundred sixty-seven patients (PNFA group, n =1 95; HA group, n =1 72) were diagnosed with intertrochanteric fractures between January 2009 and June 2013 in the Department of Orthopedics of The Second Affiliated Hospital of Soochow University. The patients were available for long-term follow-up with final physical and radiologic examinations, which were included in this study. Of the 367 patients, 160 were males and 207 were females, with an age range between 60 and 97 years and an average age of 72.4 ± 3.9 years. Eighteen, 31, 154, and 164 cases were classified as type IA, type IB, type II, and type III, respectively, according to the Evans-Jensen classification *(2)*. There were 112 and 140 patients with systemic medical conditions in the PFNA and HA groups, respectively (Table 1).

All surgical procedures were performed by the same group of surgeons. Continuous epidural or general anesthesia was used.

Fracture reduction and implantation of the PFNA was performed on a fracture table under image intensifier control. To facilitate nail insertion, the affected limb was placed in 10°–15° of adduction. A 5 cm skin incision was made approximately 5 cm cranial to the tip of the greater trochanter. After splitting the fascia and gluteus medius muscle in line with the fibers, a 3.2 mm guide wire was inserted from the tip of the greater trochanter. The wire was introduced 15 cm further into the femur to locate the AP and ML planes. Protecting the soft tissues, the proximal femur was manually opened with a 17.0 mm reamer. An appropriate length nail was mounted on the insertion handle and manually introduced into the femur. The 130° aiming arm was attached to the insertion handle and the guide wire for the PFNA blade was inserted through a 2 cm lateral incision, thus ensuring the central position in the femoral head in AP and lateral views. The PFNA blade length was measured and attached to the inserter. The outer cortex was opened with an 11.0 mm drill and the femoral neck and head were reamed with an 11.0 mm cannulated reamer with a fixed fixation sleeve. The PFNA blade was inserted by light blow with the hammer. When the position of the PFNA blade in the femoral head was satisfactory, the inserter was rotated clockwise to lock the PFNA blade, thus securing and preventing rotation of the PFNA blade and femoral head. Distal locking was performed using a freehand technique.

The modified Gibson approach was used for the HA group. After performing a meticulous capsulotomy, the femoral neck was removed with preservation of the lesser and greater trochanters. The medullary canal of the femur was then reamed. A bipolar cup and a decent size femoral head were used. The length of the stem depended on whether or not the calcar was intact or unstable. Under normal circumstances, a 140–170 mm stem was used (Evans–Jensen type I), but if the calcar was unstable, an Evans–Jensen type II–III was used (180–240 mm). In this group, we chose bipolar hemi-arthroplasty; 59 cases were ordinary in length and 113 cases were long stems. Proximal fixation of the implant was reinforced with the additional

Table I. — General information

Group	Cases	Gender (cases)		Age(yrs,x±s)	Evans-Jensen Classification (cases)				Complications(cases)
		Male	Female		IA	IB	II	III	
PFNA	195	84	111	71.3±4.2	10	18	84	83	112
HA	172	76	96	73.6±5.8	8	13	70	81	140
p	--	0.998		0.913	0.783				0.785

fixation of trochanteric fragments around the proximal stem. Wires or non-absorbable sutures were used for fixation, depending on the size of the fragment.

The patients were routinely given antibiotics intra-operatively, and deep venous thrombosis (DVT) prophylaxis post-operatively. The patients in the PFNA group sat up in bed with assistance and did isometric quadriceps exercises 24 h post-operatively. Partial weight-bearing with crutch walking was started 2 weeks following surgery, with a goal of full weight-bearing after complete fracture healing. Elderly patients with severe osteoporosis were not allowed to bear weight too early. For the HA group, partial weight-bearing with crutches and full weight-bearing were started 3 days and within 3 months post-operatively, respectively.

A: Post-operative weight bearing: Post-operative ambulation with crutches part of the load time.

B: Fracture healing: All patients had X-rays 48 h post-operatively. X-ray examinations were obtained every month until the fracture healed. The delayed union and malunion of fractures are defined below, as follows: after 6 months, the fracture line exists without any new bone formation. Coxa-vara was defined, as below: the femoral neck-shaft angle pre-operatively compared to the post-operative change < 10 degrees *(6)*.

C: Clinical evaluation: The Harris hip score *(4)* was used for evaluation, including pain, function, lower limb deformities, and hip activity. The maximal score was 100; a score ≥ 90 was regarded as excellent, a score of 80–90 was good, a score of 70–80 was normal, and a score < 70 was poor.

D: Post-operative complications.

SPSS 13.0 statistical software was used to analyze the data. The measurement was expressed as $X \pm s$. A X^2 test was used to compare the two groups. Measured data were compared with single factor analysis of variance. A $P < 0.05$ was considered a statistically significant difference.

RESULTS

The data were analyzed after 14-50 months (average 24 months) of follow-up. None of patients lost for follow-up.

Operative time: The operative time in the PFNA and HA groups was 60 ± 9.7 min and 43.2 ± 5.4 min, respectively (p = 0.031; Table II).

Blood loss: The blood loss in the PFNA and HA groups was 80.7 ± 26.2 ml and 425.8 ± 32.3 ml (p = 0.002; Table I).

Partial weight-bearing time: The partial weight-bearing time in the PFNA and HA groups was 14.4 ± 3.7 days and 4.3 ± 1.4 days, respectively (p = 0.017; Table II).

The Harris hip score: The Harris hip score in the PFNA and HA group was a mean of 81.1 ± 3.4 points and 92.7 ± 4.1 points, respectively (p = 0.042; Table II).

There were no deaths reported during the hospital admission period. After 1 year post-operatively, there were five deaths reported due to other illnesses (three patients in the HA group and two patients in the PFNA group). The overall incidence of complications was 9.5%, of which 25 patients were from the PFNA group (12.8%) and ten patients were from the HA group (5.8%; Table 3). The majority of complications in the PFNA group were removal of the proximal screw (n = 11), coxa-vara (n = 9),

Table II.— Intraoperative and postoperative comparasion

Group	Cases	Hospital stay (days)	Operation time (minutes)	Blood loss (ml)	Postoperative partial weight bearing time (days)	6 months post-opteration the Harris hip score (points)
PFNA	195	15.5±4.1	60±9.7	80.7±26.2	14.4±3.7	81.1±3.4
HA	172	12.3±3.3	43.2±5.4	425.8±32.3	4.3±1.4	92.7±4.1
p	--	0.052	0.031	0.002	0.017	0.042

and delayed union or non-union of the fracture (n = 5). The majority of complications in the HA group were loosening of the prosthesis (n = 4), acetabular wear (n = 3), delayed and non-union (n = 2), and a peri-prosthetic fracture (n = 1).

The follow-up ended with fracture healing or non-union in the PFNA and HA groups 6 and 24 months post-operatively, respectively.

DISCUSSION

Proximal femoral fracture fixation, despite being the most commonly performed operation, remains controversial and is prone to complications. Cephalomedullary devices are being used more frequently for the treatment of proximal femoral fractures. Mechanically, a cephalomedullary nail inserted using a minimally invasive technique appears to be better in elderly patients. Anatomic reduction of the intertrochanteric fractures is difficult to achieve and maintain, often leading to malunion or reduction failure *(10)*. Closed reduction of the fracture preserves the hematoma, an essential element in fracture healing. PFNA allows the surgeon to minimize soft tissue dissection, thereby reducing surgical trauma, blood loss, and lowering the incidence of infections and wound complications. PFNA was designed to counteract the rotation potential of the head–neck fragment. The main features of PFNA are the introduction of an anti-rotation 6.5 mm neck screw, fluting of the nail tip to decrease stress, and more proximal positioning of the distal locking screws to avoid abrupt changes in the stiffness of the construct. PFNA has been widely used for the treatment of unstable intertrochanteric fractures with short operating times and minimal blood loss *(12)*.

PFNA surgical procedures were shown to have longer operative times than HA ($P < 0.05$), but the blood loss was significantly less ($P < 0.05$). The nail could be inserted without comminuting the reamer at the distal femur. For unstable intertrochanteric fractures, PFNA requires a tiny incision to perform an open reduction, thereby retaining the blood and reducing the incidence of post-operative non-union. Thus, as reported in the literature *(7)*, PFNA is suitable for all types of intertrochanteric fractures, especially unstable fractures. In addition, PFNA is also suitable for elderly patients in poor physical condition because the surgery is simple, less time-consuming, and bleeding is minimized.

We used PFNA for 195 patients in this study; 11 (5.6%) of whom had the screw cut out, nine were coxa-vara (4.6%), five had (2.6%) non-union or delayed union, and the remaining patients achieved good results. The reason for the screw cut-out cases may have been that the entrance points of the femoral neck screw were so close to the cortex at the top of the femoral neck *(5)*. In addition, the tip-apex distance was too much to meet "the ideal 25 mm" or less criterion *(13)*. Of the nine coxa-vara cases, eight were comminuted fractures (Evans–Jensen classification type III) with severe osteoporosis. These patients had full weight-bearing too early, and three had total hip arthroplasty 8~14 months prior to this procedure.

Since the 1980s, the use of arthroplasty in the treatment of intertrochanteric fractures has been attempted and investigated; however, HA remains controversial. Several important indicators for evaluating the treatment of intertrochanteric fractures include determining if this method causes less trauma, a shorter hospital stay, fewer complications, lower mortality, early ambulation, and the advantages of functional recovery *(8)*. The indications for HA include intertrochanteric fractures with late complications of non-union, traumatic arthritis, or patients with fresh fractures combined with severe osteoporosis. For patients > 80 years of age with severe osteoporosis who are ambulatory pre-operatively, and capable of undergoing surgery, arthroplasty is an option by which to achieve early ambulation and enhancing the quality of life *(1)*. Regarding the choice of arthroplasty, in addition to the hip degeneration for which patients choose total hip replacement *(11)*, it is appropriate to choose bipolar femoral head replacement for intertrochanteric fractures, which makes the surgical procedure simple, the duration of surgery short, and the surgical trauma minimal. The use of a cementless prosthesis makes the availability of immediate post-operative stability and early ambulation possible. Biomechanical analysis has shown that the long-handled implant

has better stability and is more suitable for the treatment of elderly comminuted intertrochanteric fractures *(9)*. If the calcar is fragmented, it is necessary to use a long-stem prosthetic to increase the gripping force of the femoral prosthesis. In contrast, we used an ordinary length stem to reduce the economic burden. Surgeons should note that the greater trochanter must be reduced and fixed firmly in a simple and effective way to enhance stability of the prosthesis and restore the tension of the gluteus medius muscle. In the current study, 21 cases of greater trochanteric fractures were reduced by wires or non-absorbable sutures. Compared with the PFNA group, the age was higher in patients in the HA group, which led to more complications. The pre-operative assessment and reduction in surgical trauma should be improved. The post-operative functional exercise guidance should be started early. In addition, it is crucial to pay more attention to the prevention of DVT.

These groups of 172 cases were elderly osteoporotic patients. Of these patients, four (2.3%) had loosening of the prosthesis, three (2.9%) had acetabular wear, two (1.2%) had greater trochanter fracture non-union, and one had a peri-prosthetic fracture (0.6%) caused by post-operative trauma. Follow-up was scheduled for all patients, two of whom were lost to follow-up after the diagnosis of prosthesis loosened. The other two patients tolerated the pain after a long walk, and were unwilling to undergo revision surgery. Three patients with acetabular wear had minor pain without rest. As shown on X-ray, two cases of greater trochanter fracture non-union had no negative symptoms with normal weight-bearing. The patient with a peri-prosthetic fracture was 89 years of age and had other medical complications, thus making her a candidate for conservative treatment. Others obtained good results. We found that compared with the PFNA group, the HA group had a shorter operative time ($P < 0.05$), earlier post-operative weight-bearing ($P < 0.05$), better post-operative hip functional recovery ($P < 0.05$), and a lower rate of complications (5.8%). The immediate stability of bone cement enables early ambulation in patients, which makes functional recovery significantly better than the PFNA group. At the same time, PFNA greatly improves the quality of life for patients and enhances their cardio-pulmonary function more rapidly.

This study was a retrospective analysis with a small sample size Why choose this method of study, we found that a retrospective analysis of two surgical methods have a positive meaning for the treatment of intertrochanteric fractures in elder people. In agreement with the existing literature, we found that PFNA is suitable for unstable fractures or severe osteoporosis fractures in patients who could not tolerate arthroplasty surgery; however, disadvantages, such as increased rate of bone and full weight bearing, remain. For the elderly with unstable fractures, bipolar HA is more advantageous for patients with severe osteoporosis who are able to walk and tolerate surgery. In summary, when deciding on the treatment method for an intertrochanteric fracture, several factors must be considered, including but not limited to the type of fracture, patient age, health status, and whether or not the patient has been diagnosed with osteoporosis. As long as there is no absolute contraindication for surgery, it is appropriate to perform surgery and to restore function as early as possible.

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