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Original Article

Proximal femoral nail anti-rotation versus hip arthroplasty for osteoporotic intertrochanteric fracture: surgical effects and indications

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Abstract: Objective: To compare the differences between proximal femoral nail anti-rotation (PFNA) and hip arthroplasty (HA) in treatment of osteoporotic intertrochanteric fracture and explore indications for selection between the two systems. Methods: One hundred patients with osteoporotic intertrochanteric fracture admitted to Ningbo NO.2 Hospital between January 2015 and December 2017 were enrolled for the study and randomized into the PFNA group and the HA group (n=50 in each group). Patients in the PFNA group were applied proximal femoral intramedullary nail fixation, whereas those in the HA group received HA. Duration of surgery, intraoperative blood loss, duration of hospital stay, effectiveness, and post-surgery complications were compared. Harris hip score was utilized at one year after the surgery to assess the recovery of the patients' hip joints. Results: PFNA group had shorter duration of surgery, and significantly less intraoperative blood loss than the HA group (both $P<0.05$). No significant difference existed in the duration of hospital stay ($P=0.357$). The effectiveness rate was 88% with PFNA and 94% with HA, without statistical significance ($P=0.485$). The incidences of post-surgery deep venous thrombosis, pulmonary infection, and joint dislocation in the PFNA group were significantly lower than those in the HA group (all $P<0.05$). No statistical difference was observed in prosthetic loosening between the two groups ($P=0.674$). The one year post-surgery Harris hip score showed significantly a higher score in the PFNA group than in the HA group ($P<0.05$). Conclusion: PFNA is a rational choice for patients with osteoporotic intertrochanteric fracture for its advantages as shorter duration of surgery, less intraoperative blood loss, lower incidence of post-surgery complications, and excellent function recovery of the hip joints.

Keywords: Osteoporosis, femoral intertrochanteric fracture, proximal femoral nail anti-rotation, hip arthroplasty

Introduction

Intertrochanteric femoral fracture is a common bone fracture usually caused by direct or indirect force, most of which is comminuted fracture. It severely lowers the quality of life in patients [1, 2]. Studies show that osteoporosis makes the elderly population at high risk for intertrochanteric femoral fracture [3]. Senile osteoporotic intertrochanteric femoral fracture is usually accompanied by underlying internal diseases of other body systems, which delays the union and increases the risk of complications. Conservative treatment may complicate the fracture with pneumonia and decubitus, etc., and the fatality rate may reach as high as approximately 20% [4]. Surgery is more inclined to apply to patients of this kind. It allows early ambulation of patients, lowers the death rate, and the incidence of coxa vara [5].

There are many surgical options currently. However, a consensus has not been reached regarding the selection of the operation. Thoughts vary among scholars [6, 7]. With rich blood supply in the broken ends of fractured femoral intertrochanter, proximal femoral nail anti-rotation (PFNA) internal fixation, a center locked intramedullary fixation system, could be used despite the existence of osteoporosis. Its advantages include simple use, less invasion and excellent biological performance. However, it may be complicated with hidden hemorrhage, femoral "cut-out", surgical area pain and coxa

Figure 1. Proximal femoral nail anti-rotation for the left intertrochanteric fracture.

vara deformity [8, 9]. Hip arthroplasty (HA) is another commonly used surgery option for osteoporotic femoral inter-trochanter, which offers the patients with pain free, stable and well-functioned hip joints, as well as the disadvantages such as larger wound, greater blood loss and infection [10, 11]. However, currently the therapeutic difference between PFNA and HA remains unknown. Therefore, this study aimed to compare the therapeutic effects of two surgical options and offer a scientific basis for the treatment of osteoporotic femoral intertrochanteric fracture.

Figure 2. Right-side hip anthriplasty.

Material and method

Subjects

All of the involved patients signed informed consent. This protocol was approved by the Ethic's Committee of the hospital. One hundred patients with osteoporotic intertrochanteric fracture admitted to the Orthopedics Department between January 2015 and December 2017 were enrolled and randomized into PFNA group and HA group (n=50 in each group). Inclusion criteria: patents with age >18 years, no history of bone fracture, clinically and imageologically diagnosed unstable osteoporotic femoral intertrochanteric fracture, fresh closed fracture, and decision to receive surgery. Exclusion criteria: patients with severe dysfunction of liver and kidney, open fracture, pathological fracture, complicated with coagulation disorders, manifested surgical contraindications, and those unable to cooperate.

Surgery procedures

PFNA: The patient was generally anesthetized in a supine position before the traction and

Table 1. Comparisons of general information

Group	PFNA	HA	t/χ^2	P
Case	50	50		
Male/Female (n)	31/19	34/16	0.396	0.529
Age (year)	66.5±2.9	67.0±2.6	0.222	0.835
Fracture laterality (left/right, n)	27/23	30/20	0.367	0.545
Cause of fracture (n)			2.008	0.366
Traffic accident	23	25		
Fall down injury	8	12		
Fall off injury	19	13		
AO types (n)			1.772	0.412
A1	7	10		
A2	23	26		
A3	20	14		

Note: PFNA denotes proximal femoral nail anti-rotation; HA, hip arthroplasty.

reduction of the broken ends of fractured bone. After routine disinfection and covering the surgical site with surgical drape, an approximate 5 cm incision was made in the patient's femoral major trochanter. The skin, subcutaneous tissue, and muscle were cut open layer-by-layer to allow a full exposure of the major trochanter. The guide pin was placed from the medial vertex to guide marrow reaming. Appropriate PFNA main nail was placed into medullary cavity and its location was confirmed by C-Arm X-ray. A proper length spiral blade was selected and placed into femoral neck through an interlocking nail under the guide of a locator. C-Arm X-ray was applied again for confirmation of a successful reduction, followed by locking the spiral blade, and the distal femoral interlocking nail. A drainage tube was placed after irrigation and hemostasis of the wound. Finally, the surgical incision was sutured layer-by-layer (**Figure 1**).

HA: The patient was placed in a healthy lateral position. After general anesthesia, the patients received routine disinfection and the surgical site was covered with a surgical drape. An incision was made at the posterolateral articulatio coxae. The skin, subcutaneous tissue and muscle were cut open layer-by-layer to allow a full exposure of the trochanter femoral fracture, femoral neck, and joint capsule. A longitudinal incision was made in the capsule, and femoral neck osteotomy site was selected at approximately 1.5 cm upper away from the base of femoral major trochanter to minor trochanter. The femoral head, soft tissue in the acetabulum, and the surrounding capsules were removed. The artificial joint was selected according to the diameter of the femoral head. Intra-medullarily reaming was manipulated and reduction of intertrochanteric fracture was completed. Proper prosthesis was selected for installation. Bone cement was used to fix the artificial femur kit. A drainage tube was placed after irrigation and hemostasis of the wound. Finally, the surgical incision was sutured layer-by-layer (**Figure 2**).

Assessment for therapeutic effects

Comparisons were made between groups regarding the duration of surgery, intraoperative blood loss and length of hospital stay. The therapeutic effects were also compared. Patients with hip joint movement disorder, existence of severe pain, and serious influence to daily life were considered ineffective. Those with restriction of hip joint movement, existence of mild pain, and slight influence to daily life were considered effective. Those reaching over 80% normal movement of hip joint, existence of slight pain and no influence to daily life were considered obviously effective. A full recovery was confirmed in those with normal hip joint movement and with no pain. Effectiveness rate = (number of full recovery + number of obvious effectiveness + number of effectiveness)/total number of patients *100%. The incidence of complications was compared between the two groups in deep venous thrombosis (DVT), implant loosening, joint dislocation, and pulmonary infection. A one-year follow-up was conducted comparing the recovering condition of hip joint function between the PFNA group and the HA group. The hip joint function was evaluated by Harris Hip Score, which includes 4 items under a 100 mark system: pain, living ability, joint deformity, and joint range of motion. Higher score indicates better recovery of the hip joint.

Statistical analysis

All data were analyzed with SPSS 20.0 software. Measurement data are presented as

Table 2. Comparisons of duration of surgery, intraoperative blood loss and duration of hospital stay

Group	Case	Duration of surgery	Intraoperative blood loss	Duration of hospital stay
PFNA	50	54.2±4.3	167.5±20.6	8.6±2.1
HA	50	75.6±4.9	278.4±21.3	10.7±2.8
t		5.686	6.482	1.039
P		0.005	0.003	0.357

Note: PFNA denotes proximal femoral nail anti-rotation; HA, hip arthroplasty.

mean ± standard deviation. Independent-sample *t* test was used for comparison between groups. Enumeration data are described as a percentage. Chi-square test was applied for comparison between groups. A *P* value <0.05 was considered statistically significant.

Results

General information

No significant differences were observed in comparisons of gender, age, fracture laterality, cause of fracture and types of fracture (P>0.05, **Table 1**).

Comparisons on duration of surgery, intraoperative blood loss and duration of hospital stay

Compared with HA group, patients in the PFNA group had statistically shorter duration of surgery, and less blood loss during surgery, while the duration of hospital stay had no significant difference (**Table 2**).

Comparison of effectiveness

The PFNA group had 9 cases cured, 15 cases obviously effective, 20 cases effective, and 6 cases ineffective. The effectiveness rate was 88%. The HA group had 26 cases cured, 17 cases obviously effective, 4 cases effective, and 3 cases ineffective. The effectiveness rate was 94%. No statistical difference was noted between the two groups (**Table 3**).

Comparison of post-surgery complications

The PFNA group had statistically lower incidences of post-surgery DVT, pulmonary infection, and joint dislocation than the HA group (all P<0.05). No significant difference was seen in the prosthetic loosening incidence rate (P>0.05, **Table 4**).

Comparison of Harris hip score

At one year after the surgery, patients in the PFNA group were assessed 84.7±4.8 Harris hip score, while those in the HA group scored 69.8±3.7. The scores of the two groups had statistical difference (t=4.258, P=0.013, **Figure 3**).

Discussion

The osteoporotic femur has the line of force different in its shaft from that in its superior portion, which may generate the opposite shear stress under lateral pressure and medial pressure, causing intertrochanteric fracture. It usually leads to different degrees of rotation displacement, separation displacement, and lateral displacement. The osteoporotic intertrochanteric fracture takes up approximately 50% of all intertrochanteric fractures, implying that it is of great necessity of effective fixation of osteoporotic intertrochanteric fracture. The fixation is closely correlated to the reduction of intertrochanteric fracture and post-surgery recovery of the hip joint function [12].

PFNA is composed of one nail, one distal interlocking nail, and femoral neck spiral blade. It limits the incision size with closed reduction, and minimizes periosteum injury. Therefore it is beneficial for the union of the fracture [13]. Studies prove that PFNA has higher biomechanical stability than other internal fixation systems [14]. With intramedullary center fixed load sharing the same force line with that of femoral shaft, the internal expansion load bearing effectively resists the shear force of the fractured bone end. The design of spiral blade's wide contact with bone makes it suitable for osteoporotic patients [15]. Nevertheless, studies show that HA should be the first option for intertrochanteric fracture [16, 17]. Clinical reports demonstrate that the synthetic bone graft could receive satisfactory outcome in treating elderly intertrochanteric fracture. It enables early load-bearing activity and reduces occurrence of complications and improves the quality of life [18]. Controversies remain currently on the choice of internal fixation systems for osteoporotic intertrochanteric fracture. This study compared the effects of PFNA and HA in the treatment of osteoporotic intertrochanteric fracture, and there was no significant differences. No statistical difference was also found

Table 3. Comparison of effectiveness

Group	Case	Ineffective	Effective	Obviously effective	Cured	Effectiveness rate
PFNA	50	6	20	15	9	88%
HA	50	3	4	17	26	94%
χ^2						0.488
P						0.485

Note: PFNA denotes proximal femoral nail anti-rotation; HA, hip arthroplasty.

Table 4. Comparison on post-surgery complications

Group	Case	DVT	Pulmonary infection	Joint dislocation	Prosthetic loosening
PFNA	50	1 (2%)	2 (4%)	0 (0%)	2 (4%)
HA	50	8 (16%)	10 (20%)	6 (12%)	4 (8%)
χ^2		4.396	4.640	8.701	0.177
P		0.036	0.031	0.003	0.674

Note: PFNA denotes proximal femoral nail anti-rotation; HA, hip arthroplasty; DVT, deep venous thrombosis.

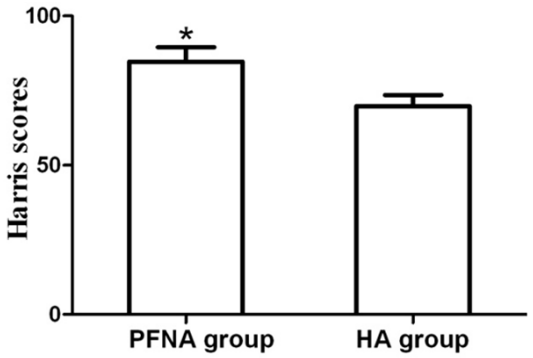

Figure 3. Comparison of Harris hip scores. *P<0.05, compared with HA group; PFNA denotes proximal femoral nail anti-rotation; HA, hip arthroplasty.

in the duration of hospital stay between the two groups. However, PFNA had less intraoperative blood loss and shorter duration of surgery than HA, which may be due to the technique and proficiency of the operator. For complications, there was no statistical difference in the incidence of prosthetic loosening between the two groups. However, the incidence of DVT, pulmonary infection, and joint dislocation in the PFNA group were significantly superior to those in the HA group, which benefit from the minimized invasion and easy use of PFNA that achieved better functional recovery of hip joint. In addition, HA needs complete reconstructing of the mechanical and anatomical stability, but its design limits the full recovery of hip joint stability. This outcome is consistent with the result reported by Tang et al. [19]. Our results reveal that PFNA resulted in a higher Harris hip score at one year post-surgery than HA. This may be due to PFNA's realization of both biomechanical and anatomical stability of femur defect that provides better joint stability, which is similar to the result of study conducted by Esen et al. [20].

According to this study, surgical indications for the fixation system selection should be evaluated by referring to the patient's general condition, cognitive status, post-surgery pain, fracture displacement, the type of fracture, and severity of osteoporosis. An appropriate individualized surgical protocol is based on correct evaluation [21]. The PFNA internal fixation system should be the choice of treatment for osteoporotic intertrochanteric fracture. For those of severe unstable osteoporotic intertrochanteric fracture, HA could be adopted in case of incapability of reduction for comminuted fracture, high failure rate of internal fixation, and the possibility of occurring internal fixation related complications and malunion.

In conclusion, PFNA is beneficial for patients with osteoporotic intertrochanteric fracture patients for its advantages (including shorter surgery duration, less intraoperative blood loss, low incidence of post-surgery complications, and excellent recovery of hip joint). However, the limitations of this study include small sample size, single center study, and relatively short follow-up time. Multi-center clinical trials with long term follow-up and larger sample size are needed for further evidence.

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Disclosure of conflict of interest

None.

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