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

Figure 2. Right-side hip arthroplasty.

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.

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: patients 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
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 1. Comparisons of general information

<table>
<thead>
<tr>
<th>Group</th>
<th>PFNA</th>
<th>HA</th>
<th>χ²</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case</td>
<td>50</td>
<td>50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male/Female (n)</td>
<td>31/19</td>
<td>34/16</td>
<td>0.396</td>
<td>0.529</td>
</tr>
<tr>
<td>Age (year)</td>
<td>66.5±2.9</td>
<td>67.0±2.6</td>
<td>0.222</td>
<td>0.835</td>
</tr>
<tr>
<td>Fracture laterality (left/right, n)</td>
<td>27/23</td>
<td>30/20</td>
<td>0.367</td>
<td>0.545</td>
</tr>
<tr>
<td>Cause of fracture (n)</td>
<td></td>
<td></td>
<td>2.008</td>
<td>0.366</td>
</tr>
<tr>
<td>Traffic accident</td>
<td>23</td>
<td>25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fall down injury</td>
<td>8</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fall off injury</td>
<td>19</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AO types (n)</td>
<td></td>
<td>1.772</td>
<td>0.412</td>
<td></td>
</tr>
<tr>
<td>A1</td>
<td>7</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A2</td>
<td>23</td>
<td>26</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A3</td>
<td>20</td>
<td>14</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: PFNA denotes proximal femoral nail anti-rotation; HA, hip arthroplasty.
Surgical effects and indications of proximal femoral nail anti-rotation

<table>
<thead>
<tr>
<th>Group</th>
<th>Case</th>
<th>Duration of surgery</th>
<th>Intraoperative blood loss</th>
<th>Duration of hospital stay</th>
</tr>
</thead>
<tbody>
<tr>
<td>PFNA</td>
<td>50</td>
<td>54.2±4.3</td>
<td>167.5±20.6</td>
<td>8.6±2.1</td>
</tr>
<tr>
<td>HA</td>
<td>50</td>
<td>75.6±4.9</td>
<td>278.4±21.3</td>
<td>10.7±2.8</td>
</tr>
<tr>
<td>t</td>
<td></td>
<td>5.686</td>
<td>6.482</td>
<td>1.039</td>
</tr>
<tr>
<td>P</td>
<td></td>
<td>0.005</td>
<td>0.003</td>
<td>0.357</td>
</tr>
</tbody>
</table>

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.
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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].

Table 4. Comparison on post-surgery complications

<table>
<thead>
<tr>
<th>Group</th>
<th>Case</th>
<th>DVT</th>
<th>Pulmonary infection</th>
<th>Joint dislocation</th>
<th>Prosthetic loosening</th>
</tr>
</thead>
<tbody>
<tr>
<td>PFNA</td>
<td>50</td>
<td>1 (2%)</td>
<td>2 (4%)</td>
<td>0 (0%)</td>
<td>2 (4%)</td>
</tr>
<tr>
<td>HA</td>
<td>50</td>
<td>8 (16%)</td>
<td>10 (20%)</td>
<td>6 (12%)</td>
<td>4 (8%)</td>
</tr>
<tr>
<td>$\chi^2$</td>
<td>4.396</td>
<td>4.640</td>
<td>8.701</td>
<td>0.177</td>
<td></td>
</tr>
<tr>
<td>$P$</td>
<td>0.036</td>
<td>0.031</td>
<td>0.003</td>
<td>0.674</td>
<td></td>
</tr>
</tbody>
</table>

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

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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