

A comparative study of proximal femoral locking compress plate, proximal femoral nail antirotation and dynamic hip screw in intertrochanteric fractures

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Abstract. – OBJECTIVE: We aimed to compare the clinical efficacy of three different internal fixation methods, i.e. proximal femoral locking compress plate (PF-LCP), proximal femoral nail antirotation (PFNA) and dynamic hip screw (DHS) system in intertrochanteric femur fracture.

PATIENTS AND METHODS: We selected a total of 150 patients with Intertrochanteric femur fracture who were admitted to this hospital between January 2015 and December 2016 for treatment, and those patients were divided into three groups according to the difference in treatment methods, i.e., Group A (n=50), Group B (n=50) and Group C (n=50). For patients in Group A, they received the PF-LCP treatment, patients in Group B received PFNA treatment while those in Group C received DHS treatment; ultimately, clinical efficacy was compared among three groups.

RESULTS: In Group B, the efficacy was superior to those in Group A and C in terms of comparison of surgical duration, bleeding amount, time point of callus formation, healing time of fracture and length of stay (LOS) in hospital ($p < 0.05$); after operation, the prevalence rate of complication in Group B was significantly lower than those in Group A and Group C ($p < 0.05$); in comparison of preoperative Harris score among three groups, the different had no statistical significance ($p > 0.05$). The Harris scores in Group B at the 1st, 3rd, and 6th month after operation were all significantly higher than those in Group A and C ($p < 0.05$).

CONCLUSIONS: Compared with PF-LCP and DHS, PFNA can better fix the intertrochanteric femur fracture with little effect on blood circulation at the fracture end and slight damage to sclerotin, thereby accelerating the recovery of hip joint function without any increase in prevalence of complications. Therefore, PFNA has a promising clinical efficacy and safety, which is worthy of being promoted in clinical practice.

Key Words

Intertrochanteric femur fracture, Proximal femoral locking compress plate (PF-LCP), Proximal femoral nail antirotation (PFNA), Dynamic hip screw (DHS) system.

Introduction

Intertrochanteric femur fracture refers to the fracture in region from femur neck fundus to the minor trochanter, which is frequently seen in aged population. However, the prognosis of patients with intertrochanteric femur fracture is much better than that of patients with femoral neck fractures due to the abundant blood circulation in trochanter that can facilitate the healing of fracture.

In patients with intertrochanteric femur fracture, the mortality rate in traction treatment group is as high as 34.6%, while that in internal fixation group is only 17.5%. With the improvement in surgical technique and continuous development in material of internal fixation, the prevalence of surgical complications is substantially reduced. In addition, surgical treatment of intertrochanteric femur fracture has become a preferred method¹. Currently, in clinical practice, proximal femoral locking compress plate (PF-LCP), proximal femoral nail antirotation (PFNA) and dynamic hip screw (DHS) system have their own advantages and disadvantages².

Thus, a comparative study on clinical efficacy of DHS, PF-LCP, and PFNA on intertrochanteric femur fracture was expected to provide reference for increasing the healing rate of clinical treatment, and detailed information of this study is reported as follows.

Patients and Methods

Patients

We selected a total of 150 intertrochanteric femur fracture patients who were admitted to this hospital for treatment between January 2015 and December 2016. Inclusion criteria:

diagnoses of all patients were all confirmed by imaging examination, which suggested the definite history of hip trauma, and all patients were informed of the content of this study and signed the written informed consent. This study was approved by the Ethics Committee of Renji Hospital Affiliated to Shanghai Jiaotong University School of Medicine. Exclusion criteria: patients with open fracture, old fracture, pathological fracture, diseases in hematological system or diseases in immune system. According to the difference in treatment methods, all patients were divided into Group A (n=50), Group B (n=50) and Group C (n=50). In Group A, there were 28 males and 22 females aged between 35 and 78 years old with the average age of (61.62±6.18) years old; in Group B, there were 27 males and 23 females aged between 31 and 79 years old with the average age of (61.81±6.57) years old; in Group C, there were 29 males and 21 females aged between 36 and 80 years old with the average age of (61.26±6.29) years old. No significant differences were identified in comparison of general materials of patients among three groups, and the differences had no statistical significance ($p>0.05$), suggesting that the general material of three groups was comparable.

Methods

In three groups, food and water were regularly withdrawn before surgery. At 30 min before surgery, intravenous injection of antibiotics (Qilu Antibiotics Pharmaceutical Co., Ltd. Jinan, China) was performed followed by routine sterilization and draping. Thereafter, patients received either continuous epidural anesthesia or general anesthesia, and reduction of fracture was performed under C-arm guidance.

PF-LCP was used for patients in Group A in following procedures: in supine position, a vertical incision was prepared from the lateral side of upper thigh to expose the major trochanter, femoral neck fundus and upper fracture of femoral shaft, where the soft tissues and hematoma were appropriately eliminated. Then traction reposition was performed, and PF-CRP was placed on the lateral side of upper femur, where Kirschner's wire was temporarily fixed. We underwent drill under the guidance of screw sleeve until the satisfactory results were attained, where the screw was placed. If necessary, minor trochanter or posterior fracture fragments were fixed using screw, or bone grafting was performed.

PFNA treatment was carried out for patients in Group B: with patients in supine position, reduction of fracture was performed through traction, adduction and inner rotation. At the proximal end of apex in major trochanter, a straight incision was made with the muscle fiber being dissected bluntly, and the medullary space was exposed after the apical sclerotin was cut through using a rhombus-shaped awl, where guide pin was inserted into the medullary space. After medullary space was expanded, the main nail was placed under X-ray with anti-rotary nail and distal femur nail being placed inside femur neck³.

Patients in Group C underwent DHS: with patients in supine position and hip being slightly elevated, a lateral incision was made in hip joint to expose the proximal end of femur and major trochanter. After traction for fracture reposition, a Kirschner's wire was placed from the head to the neck of femur under the guidance of positioner. When satisfactory results were gained under the guidance of C-arm, a triad solid reamer was used for hole expansion and tapping. Thereafter, a threaded nail was screwed, and the compression screw was fixed and tightened after installation of plate of sleeve⁴.

In three groups, patients, after operation, were intubated with the drainage tube regularly followed by rinsing and suture of wounds. At 3 to 5 days after operation, intravenous titration of antibiotics was performed, and intravenous injection of low-molecular heparin was carried out for 7 d. At 3 to 7 d after operation, functional exercise of hip joint was initiated.

Observation Indexes

In this study, we observed the surgical duration, bleeding amount, time point of callus formation, healing time of fracture and prevalence of complications. Before and at the 1st, 3rd and 6th month after surgery, the function of hip joint of all patients in 3 groups was evaluated *via* Harris scoring⁵.

Statistical Analysis

In this study, data were processed using Statistical Product and Service Solutions 22.0 (SPSS 22.0 Inc., Armonk, NY, USA). Measurement data were presented by ($\bar{x}\pm s$), and *t*-test was performed for intergroup comparisons. Enumeration data were presented as %, and χ -test was carried out for intergroup comparisons. $p<0.05$ suggested that the difference had statistical significance.

Table I. Comparison of surgical indicators among groups.

Group	Surgical duration (min)	Bleeding amount (mL)	Time point of callus formation (d)	Healing time of fracture (d)	Length of stay in hospital (d)
Group A (n=50)	105.65±12.43	211.43±7.89	10.38±3.28	97.11±1.78	24.37±2.46
Group B (n=50)	70.27±6.73*	139.28±4.53*	4.47±1.24*	89.34±0.87*	17.61±1.68*
Group C (n=50)	103.46±12.59	213.57±8.58	10.53±3.58	96.79±1.52	24.04±2.81

Note: Compared with Group A and C, $p < 0.05$.

Table II. Comparison of surgical indicators among groups.

Group	Infection in urinary system	Pulmonary infection	Rupture or loosening of inner fixation	Non-healing fracture	Incidence rate
Group A (n=50)	3 (6%)	1 (2%)	2 (4%)	1 (2%)	7 (14%)
Group B (n=50)	1 (2%)	0 (0%)	1 (2%)	0 (0%)	2 (4%)*
Group C (n=50)	2 (4%)	1 (2%)	2 (4%)	1 (2%)	6 (12%)

Note: Compared with Group A and C, $p < 0.05$.

Results

Comparison of Surgical Indicators Among Groups

In Group B, the surgical duration was (70.27±6.73) min, bleeding amount was (139.28±4.53) mL, time point of callus formation was (139.28±4.53) d, healing time of fracture was (89.34±0.87) d, and length of stay in hospital was (17.61±1.68) d, which were significantly superior to those in Group A and Group C ($p < 0.05$; Table I).

Comparison of Prevalence Rate of Complications Among Three Groups

In Group B, the prevalence rate of complications after surgery was 4%, which was significantly lower than those in Group A (14%) and Group C (12%), and the difference had statistical significance ($p < 0.05$; Table II).

Comparison of Hip Joint Function Among Three Groups

Before surgery, no significant difference was identified in comparison of preoperative Harris scores of patients among three groups, and the difference had no statistical significance ($p > 0.05$). At the 1st, 3rd and 6th months after operation, the Harris scores in Group B were respectively (60.28±5.93), (74.85±6.44) and (83.78±9.32) months, which were significantly higher than those in Group A and C ($p < 0.05$; Table III).

Comparison of Pain Scores at the 1st and 7th Days After Treatment and Before Discharge Among Three Groups

At the 1st and 7th days after treatment and before discharge, the pain scores of patients in Group B were respectively (4.31±0.98), (2.85±0.73) and (1.04±0.11), which were superior to those in Group A and C, and the differences had statistical significance ($p < 0.05$).

Table III. Comparison of hip joint function among three groups.

Group	Before surgery	At the 1 st month after surgery	At 3 rd month after surgery	At 6 th month after surgery
Group A (n=50)	91.19±7.35	50.53±4.85	63.49±5.85	72.62±8.72
Group B (n=50)	91.66±7.47	60.28±5.93*	74.85±6.44*	83.78±9.32*
Group C (n=50)	191.43±7.72	51.64±4.68	64.37±5.83	73.31±8.71

Note: Compared with Group A and C, $p < 0.05$.

Table IV Comparison of pain scores at the 1st and 7th days after treatment and before discharge among three groups ($\bar{x}\pm s$).

Group	No.	At the 1 st day after treatment	At 7 th day after treatment	Before discharge
Group A	50	5.26±1.27	4.27±0.57	2.48±0.63
Group B	50	4.31±0.98*	2.85±0.73*	1.04±0.11*
Group C	50	5.72±1.42	4.05±0.82	2.76±0.73

Note: Compared with Group A and C, $p < 0.05$.

Discussion

Intertrochanteric femur fracture refers to the fracture in region from femur neck fundus to the minor trochanter, which is frequently seen in aged population, and its prevalence rate is similar to that of femoral neck fracture⁶. Fracture is associated with the osteoporosis, and the prevalence rate in female is higher than that in male. However, the prognosis of patients with intertrochanteric femur fracture is much better than that of patients with femoral neck fractures due to the abundant blood circulation in trochanter that can facilitate the healing of fracture. Closed reduction and internal fixation, with the feature of rigid internal fixation, promising stability, strong retentivity and shear force, is beneficial to the functional exercise in an early stage^{7,8}, and is quite suitable for treatment of unstable fracture of aged patients with advantages like minor trauma, little bleeding amount, operability and good tolerance. With a decrease in blood supply in closed region, the interference on fracture end is reduced, which is conducive to the recovery of fracture. Due to the seasonal change in winter, bone mineral density (BMD) in aged population is gradually decreased with the bone trabecula being more and more fragile⁹. Besides, elderly patients also suffer from the decreased functions and are frequently complicated with hypertension and diabetes mellitus, resulting in an overwhelming difficulty in treatment. Most of the scholars believed that surgical treatment should be carried out as early as possible, and rehabilitation exercise should be adopted for recovery of limb functions and reduce the postoperative complications¹⁰. In clinical practice, internal fixation is frequently employed in treatment of intertrochanteric femoral fracture, and there remain controversies in optimal choice for internal fixation despite of the application of materials for DHS, PF-LCP, and PFNA^{11, 12}.

In recent years, internal fixation has been developed with the progression in biological fixation theory. Angles form among the lock screws

on anatomic locking plate, and the force is evenly distributed on all locking screws, which, together with the plate, forms a stable internal fixation frame with the effect of internal fixation stent, and a promising angular stability and pulling-out resistance; the integrity consisting of screws and plate generates a strong holding-force on osteoporosis-fracture and complicated fracture¹³. Locking proximal femoral plate has following characteristics: a) in locking plate system, force can be delivered from the bones to plate in connection with the screws through thread, and, thus, it is unnecessary to obtain the structural stability by posing the pressure of plate on bone surface, thereby guaranteeing the blood supply of bones beneath the plate; b) screw head that is locked on bone plate, with the plate, forms a firm integrity, and this can avoid the loosening of screws or damages of screws to femoral head¹⁴; c) it has an enough strength of internal fixation, and 3 screws in screw holes in triangular distribution in proximal end form a triangular fixation frame inside the femoral neck, in which slight damages to blood supply inside the femoral head and spongy bones in neck due to the small diameter of screws, with a larger holding force of lag screws, are conducive to the reposition of minor trochanter and recovery of integrity of internal cortex. Thus, it can strongly fix the proximal end of fracture in addition to the potent antagonist effect on rotation of femoral neck and resistance to bending.

In this study, in patients of Group B, the efficacy was superior to those in Group A and C in terms of comparison of surgical duration, bleeding amount, time point of callus formation, healing time of fracture and length of stay (LOS) in hospital ($p < 0.05$); after operation, the prevalence rate of complication in Group B was significantly lower than those in Group A and Group C ($p < 0.05$); in comparison of preoperative Harris score among three groups, the different had no statistical significance ($p > 0.05$). The Harris scores in Group B at the 1st, 3rd, and 6th month

after operation were all significantly higher than those in Group A and C ($p < 0.05$). The results of this study suggested that PFNA treatment is conducive to the rehabilitation of patients with a shorter surgical duration, lower intraoperative bleeding amount, more stable internal fixation, less trauma to patients and faster recovery of hip joint functions after surgery¹⁵. However, this study is limited in following shortages: small sample size, patients from the same hospital, susceptibility of patients to the individual factors and poor representativeness. Thus, sample size should be further expanded, and further comprehensive trial is required for in-depth research.

Conclusions

Compared with PF-LCP and DHS, PFDA can better fix the intertrochanteric femur fracture with little effect on blood circulation at the fracture end and slight damage to sclerotin, thereby accelerating the recovery of hip joint function without any increase in prevalence of complications. Therefore, PFDA has a promising clinical efficacy and safety, which is worthy of being promoted in clinical practice.

Conflict of Interest:

The authors declared no conflict of interest.

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