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Communication

Therapeutic effects of femoral neck system internal fixation on femoral neck fracture

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Abstract: We aimed to compare the therapeutic effects of femoral neck system (FNS) internal fixation and other internal fixation methods on patients with femoral neck fracture. Thirty patients treated from January 2019 to January 2021 were assigned into control and observation groups. Intraoperative blood loss was less, fluoroscopy frequency was lower, postoperative off-bed ambulation time and length of hospital stay were shorter, and postoperative complication rate was lower in observation group than those in control group ($P<0.05$). At 1-3 d after operation, the observation group had significantly decreased pain score and levels of C-reactive protein and interleukin-6 compared with the control group ($P<0.05$). At 3 and 6 months after operation, the hip joint function score and quality-of-life score were significantly improved in both groups in comparison with those before operation ($P<0.05$). Both FNS and traditional cannulated screw internal fixations can effectively ameliorate the hip joint function, promote fracture healing and improve the quality of life of patients with femoral neck fracture. Compared with cannulated screw internal fixation, however, FNS internal fixation can alleviate operative trauma, postoperative pain sensation and inflammatory response and reduce intraoperative fluoroscopy frequency and postoperative complications, thereby enabling earlier discharge.

Keywords: neck fracture, femoral neck system, internal fixation, cannulated screw

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INTRODUCTION

Femoral neck fracture is a common type of lower limb fracture mostly caused by traffic accidents and high-altitude falling accidents. The injured patients often have limited hip joint motion and lower limb motor dysfunction, which can easily trigger infection at the fracture site, malunion of fracture and other serious consequences if not timely treated. In severe cases, limb amputation is even required, greatly jeopardising the physical and mental health of patients [1-3]. Thus, femoral neck fracture needs to be treated timely.

Surgery is the primary clinical method for treating femoral neck fracture, and internal fixation is the preferred clinical treatment for patients aged <65 years old [4]. During internal fixation, traction reduction or open reduction is mainly conducted at the fracture site under the fluoroscopy of C-arm X-ray machine, and the fracture site of femoral neck is fixed by internal fixation materials after satisfying reduction is achieved, so the fracture is healed effectively and the hip joint function is restored gradually [5-7]. Internal fixation with cannulated screws is the most common operative scheme for femoral neck fracture, in which 3 cannulated screws are inserted in an inverted triangular distribution to efficiently fix the fracture site. However, the patients are vulnerable to screw withdrawal and coxa vara after such traditional cannulated screw internal fixation, thus affecting their prognosis [8].

In contrast, femoral neck system (FNS) internal fixation has been increasingly applied in the treatment of femoral neck fracture in recent years. FNS internal fixation mainly has the following advantages. First, owing to the minimally invasive design, a 4-cm-long incision can be made at the lateral thigh, through which a series of manipulations such as fracture reduction and fixation of the femoral neck can be accomplished without completely cutting open the vastus lateralis and damaging the tendon of gluteus medius. Second, regarding physiological and mechanical properties, FNS internal fixation produces higher biomechanical strength than cannulated screw fixation. Third, the implanted FNS dynamic rod may compress the peripheral bone while the anti-rotation guide pin can enhance the rotation resistance of the fixture and guarantee the overall stability at the fracture site, thus avoiding femoral head cleavage due to Z-pinch effect [9, 10]. Nevertheless, the therapeutic effects of FNS internal fixation on femoral neck fracture still needs to be further verified.

Therefore, patients with femoral neck fracture treated with traditional cannulated screw internal fixation and those with femoral neck fracture subjected to FNS internal fixation were retrospectively researched in this study, in order to compare the treatment outcomes and to provide valuable clinical evidence.

MATERIALS AND METHODS

This study has been approved by the ethics committee of our hospital (approval no. NGPH201901003) and written informed consent has been obtained from all patients. A total of 30 patients with femoral neck fracture undergoing traditional cannulated screw internal fixation (control group) and other 30 patients receiving FNS internal fixation (observation group) in our hospital during January 2019 and January 2021 were selected as subjects. The clinical data of the two groups of patients were retrospectively analysed. There were 17 males and 13 females aged 20-63 years old (41.29±13.48 years old) in the control group, comprising 14 cases with left fracture and 16 cases with right fracture. As for the causes of fracture, there were 20 cases of traffic accidents, 7 cases of high-altitude falling and 3 cases of falls. The observation group consisted of 18 males and 12 females aged 20-64 years old (41.83±13.16 years old), 13 cases with left fracture and 17 cases with right fracture. The causes of fracture were traffic accidents (n=20), high-altitude falling (n=7) and falls (n=2). The differences in age, gender, fracture site and causes of fracture were not significant between the two groups of patients ($P>0.05$).

The inclusion criteria were set as follows: 1) patients definitely diagnosed with femoral neck fracture via imaging examination; 2) those with operative indications of internal fixation and treated with internal fixation; 3) those aged ≥18 and <65 years old; and 4) those whose clinical data such as preoperative diagnostic report, operation record, postoperative observational report, and postoperative follow-up record were completely preserved without deletion.

The exclusion criteria were: 1) patients with cognitive impairment or mental disorder before operation; 2) those complicated with severe infection or coagulation disorder; 3) those with multiple fractures or fractures injuring the nervous system; or 4) those complicated with diabetes mellitus, hypertension or other chronic underlying diseases.

Traditional cannulated screw internal fixation was performed in the control group, during which ultrasound-guided lumbar plexus-sciatic nerve block anesthesia was adopted and the patients were placed in the supine position, with flexion and lateral rotation of healthy hip joint. Firstly, the traction reduction of the fracture site on the affected limb was implemented under the fluoroscopy of C-arm X-ray machine, and open reduction was conducted by making an incision at the anterior femoral neck if the traction reduction failed. Secondly, after the fracture reduction was confirmed satisfactory by the fluoroscopy of C-arm X-ray machine, a longitudinal incision was made at the lateral thigh and the vastus lateralis was lifted upfront to expose the fracture site. Thirdly, 3 half-thread cannulated screws (7.3 mm) were screwed in an inverted triangular distribution to fix the femoral neck fracture site. Finally, the nuts were screwed in, a drainage tube was indwelled, and the incision was closed.

FNS internal fixation was implemented in the observation group, during which the patients were anesthetised by ultrasound-guided lumbar plexus-sciatic nerve block, and lay in the supine position with flexion and lateral rotation of healthy hip joint. Then a 4-cm-long incision was made parallel to the femoral diaphyseal axis at 2 cm from the greater trochanter. Next, the skin, subcutaneous tissue and fascia lata were cut open layer by layer, and the vastus lateralis was separated from the femur. A 2.5-mm anti-rotation thread guide pin was placed at the anterior and superior portion of the femoral neck to temporarily fix the fracture site. Later, a central guide pin was inserted closely along the femoral neck by means of a 130° guide device, and the angle of the central guide pin was corrected under the fluoroscopy of C-arm X-ray machine so as to ensure that the central guide pin was located at the centre of the femoral neck and 5 mm away from the subchondral bone. After that, a hole was drilled along the central guide pin using a hollow drill to establish a bolt bone tunnel, and FNS fixing bolts, steel plates and handle guide sleeves were inserted. An anti-rotation screw was inserted into the femoral neck along the anti-rotation guide pin, which was then withdrawn along with the central guide pin. Subsequently, locking screws were screwed in along the FNS handle guide sleeves to fix the steel plates, and the black nuts on the FNS handle were tightened for compressive fixation. Finally, a drainage tube was indwelled and the incision was closed.

The operation time, intraoperative blood loss, intraoperative fluoroscopy frequency, postoperative off-bed ambulation time, length of hospital stay, fracture healing time, postoperative complication rate, postoperative pain score, postoperative inflammatory factors in the serum, rate of hip joint function recovery, hip joint function score and quality-of-life score were compared between the two groups of patients.

In terms of the postoperative pain score, Visual Analogue Scale was applied to evaluate the pain sensation at the incision 1, 2 and 3 d after operation. The score was 0-10 in total; a higher score indicated a stronger pain sensation at the incision. As for the serum inflammatory factors after

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operation, the levels of serum C-reactive protein and interleukin-6 were determineded by means of immunity transmission turbidity and enzyme-linked immunosorbent assay respectively 1, 2 and 3 d after operation.

The hip joint function of patients was assessed through Harris score before operation. The total score was 0-100; a higher score indicated a better hip joint [11]. Furthermore, the hip joint function recovery was evaluated according to the assessment results of Harris score 3 and 6 months after operation: (excellent cases + good cases)/total cases ×100% = 95-100, 80-94, 60-79 and 0-59 stood for excellent, good, fair and poor function respectively.

The quality of life was rated before operation and 3 and 6 months after operation using World Health Organisation Quality of Life – Brief Version, which included 4 dimensions (physiology, psychology, environment and social relation), with 0-100 points for each dimension. A higher score indicated a better quality of life [12].

Statistical Analysis

SPSS 22.0 software was employed. The numerical data (n (%)) were examined by χ^2 test, and the measurement data ($\bar{x} \pm s$) were analysed by *t*-test. P<0.05 suggested that a difference was statistically significant.

RESULTS AND DISCUSSION

There were no significant differences in the operation time and fracture healing time between the observation group and control group (P>0.05). The intraoperative blood loss and fluoroscopy frequency were significantly smaller (P<0.05), and the postoperative off-bed ambulation time and length of hospital stay were significantly shorter (P<0.05) in the observation group than those in the control group (Table 1). The postoperative complication rate was significantly lower in observation group than that in control group (P<0.05) (Table 2).

Table 1. Operation time, intraoperative blood loss, intraoperative fluoroscopy frequency, postoperative off-bed ambulation time, length of hospital stay and fracture healing time ($\bar{x} \pm s$)

Group	Operation time (min.)	Intraoperative blood loss (mL)	Intraoperative fluoroscopy frequency (times)	Postoperative off-bed ambulation time (d)	Length of hospital stay (d)	Fracture healing time (w)
Control (n=30)	43.36±9.25	74.12±13.47	16.29±3.94	9.68±1.73	14.31±2.85	17.30±2.96
Observation (n=30)	42.81±9.68	58.46±12.83*	10.08±3.21*	7.53±1.45*	11.09±2.30*	17.09±2.87

*P<0.05 *vs* control group

Table 2. Postoperative complication rate (n (%))

Group	n	Screw withdrawal	Coxa vara	Total incidence rate
Control	30	2 (6.67%)	2 (6.67%)	4 (13.33%)
Observation	30	0 (0%)	0 (0%)	0 (0%)*

*P<0.05 *vs* control group

At 1-3 d after operation, the observation group exhibited significant decrease both in pain score and levels of C-reactive protein and interleukin-6 compared with the control group (P<0.05) (Table 3).

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Table 3. Postoperative pain score and serum inflammatory factors ($\bar{x} \pm s$)

Group	Pain score (point)			C-reactive protein (mg/L)			Interleukin-6 (ng/L)		
	1 d after operation	2 d after operation	3 d after operation	1 d after operation	2 d after operation	3 d after operation	1 d after operation	2 d after operation	3 d after operation
Control (n=30)	4.52±1.07	3.74±0.81	2.95±0.78	8.97±1.65	7.93±1.50	6.80±1.54	26.54±3.09	23.49±3.15	21.07±2.98
Observation (n=30)	3.46±0.91*	2.79±0.74*	2.10±0.67*	7.32±1.20*	6.41±1.24*	5.27±1.19*	23.56±2.41*	20.34±2.50*	18.10±2.43*

*P<0.05 *vs* control group

The excellent and good rate of hip joint function recovery was not significantly different between observation group and control group 6 months after operation (P>0.05) (Table 4). At 3 and 6 months after operation, the hip joint function score and quality-of-life score significantly improved in both groups in comparison with those before operation (P<0.05), although there were no significant differences between the two groups (P>0.05) (Table 5).

Table 4. Excellent and good rate of hip joint function recovery (n (%))

Group	n	Excellent	Good	Fair	Poor	Excellent and good rate
Control	30	13 (43.33%)	15 (50.00%)	2 (6.67%)	0 (0%)	28 (93.33%)
Observation	30	16 (53.33%)	13 (43.33%)	1 (3.33%)	0 (0%)	29 (96.67%)

Table 5. Hip joint function score and quality-of-life score ($\bar{x} \pm s$, point)

Group	Time	Hip joint function score	Quality-of-life score			
			Physiology	Psychology	Environment	Social relation
Control (n=30)	Before operation	69.43±7.57	70.96±3.17	70.45±3.02	70.57±3.29	70.71±3.16
	3 months after operation	80.18±8.29#	84.05±4.59#	83.39±4.28#	83.14±4.63#	83.82±4.71#
	6 months after operation	85.06±8.61#	85.27±4.35#	84.62±4.72#	84.53±4.37#	84.97±4.65#
Observation (n=30)	Before operation	69.78±7.43	70.89±3.28	70.34±3.20	70.46±3.24	70.59±3.10
	3 months after operation	80.69±8.03#	84.63±4.47#	83.70±4.31#	83.42±4.58#	84.17±4.23#
	6 months after operation	85.54±8.47#	85.74±4.89#	84.97±4.56#	84.81±4.67#	85.34±4.78#

#P<0.05 vs before operation within the group

CONCLUSIONS

Both FNS internal fixation and traditional cannulated screw internal fixation can effectively ameliorate the hip joint function, promote fracture healing and improve the quality of life of patients with femoral neck fracture. However, FNS internal fixation can alleviate operative trauma, postoperative pain sensation and inflammatory response, and reduce intraoperative fluoroscopy frequency and postoperative complications of patients, thereby enabling earlier discharge of patients. Nevertheless, this study has limitations: first, this is a retrospective study and second, the sample size is small. In the future, prospective studies with larger sample sizes are required to confirm our conclusions.

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