

Original Article

Effects of intramedullary nailing fixation on quality of life and joint function in patients with femoral neck fractures

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Abstract: Objective: This study intended to investigate the changes in quality of life and joint function after intramedullary nailing fixation in patients with femoral neck fractures. Methods: A total of 38 patients with femoral neck fractures received surgical treatment from February 2016 to November 2018 were enrolled as study subjects, and were divided into the intramedullary nailing group (IIN group, n=13) and the plate fixation group (PO group, n=25). The efficacy, general surgical indices, postoperative complications, hip function scores and imaging results were compared between the two groups. Results: The response rate of the IIN group was 100.00%, significantly higher than 72.00% of the PO group ($P<0.05$). The length of hospital stay, blood loss, and the length of the healing period in the IIN group were lower than those in the PO group ($P<0.05$). The incidence of infection, deformity, loosening of internal fixation, and failed internal fixation in the PO group were significantly higher those than in the INN group ($P<0.05$). At 3, 6, and 12 months after surgery, the INN group had higher Harris scores and SF-36 scores than the PO group ($P<0.05$). The response rates of Harris scores of patients in the IIN group were significantly higher than those in the PO group at 12 months postoperatively ($P<0.05$). Conclusion: Intramedullary nailing fixation in patients with femoral neck fractures has the advantages of a shorter time in bed and better functional recovery, lower incidence of complications and higher long-term joint function with better quality of life.

Keywords: Femoral neck fracture, intramedullary nail fixation, quality of life, joint function

Introduction

Femoral neck fracture often occurs in the elderly population [1], and with the increasing aging of the population and the increase in average life expectancy in China, the patients with femoral neck fracture are on the rise [2]. Epidemiological investigations have shown that femoral neck fracture accounts for more than 53% of proximal femoral fractures, and over half of the patients are elderly patients. Due to poor physical conditions and high incidence of underlying diseases, patients with femoral neck fracture suffer from high incidence of fracture nonunion and femoral head necrosis, seriously affecting the patient's prognosis. Therefore, it is clinically recommended to carry out surgical treatment for these patients [3, 4].

Repositioning is the key to the surgical treatment of femoral neck fracture and is closely related to the recovery of postoperative limb function [5]. Femoral neck fracture is traditionally fixed by internal fixation with plate screws, and is characterized by wide applicability and adequate intraoperative visualization. However, it also has disadvantages such as having complex procedures and more damage to the patient and leads to slower postoperative recovery [6]. Intramedullary nailing is a measure developed after World War II and is now recognized as one of the basic treatment options for femoral fractures. With the development of television fluoroscopy, the closed intramedullary nailing technique has been promoted in clinical application [7]. A retrospective study conducted on 90 patients with femoral fractures indicated that the intramedul-

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lary nailing technique significantly shortened the patients' postoperative time in bed, reduced medical costs, and was more effective in improving patients' postoperative life functions [8]. Another study investigated the long-term effects of intramedullary nailing on femoral fractures, and found that patients had faster postoperative fracture healing, better hip function at the 2-year follow-up, and no complications such as shortening and rotational displacement [9].

Although there are clinical studies on femoral neck fracture, there are few studies comparing plate internal fixation with intramedullary nailing fixation, which is the subject of this study, aiming to provide clinical reference for improving the prognosis of these patients.

Materials and methods

General data

Thirty-eight patients with femoral neck fracture who received surgical treatment in our hospital from February 2016 to November 2018 were included as study subjects, and were divided into the intramedullary nailing group (IIN group, n=13) and the plate fixation group (PO group, n=25); including 22 males and 16 females, aged 16-68 years, with a mean age of (49.98±2.32) years.

Inclusion criteria: (1) all enrolled subjects were diagnosed with unilateral femoral neck fracture by imaging, and presented with clear indications for surgery; (2) with clear consciousness; (3) with complete case data and follow-up data; (4) with a clear history of trauma. The study has been approved by the Ethics Committee of the First Affiliated Hospital of Xinjiang Medical University (approval number ChiCTR2000016594). All patients or their guardians signed the informed consent.

Exclusion criteria: patients with (1) open fractures; (2) abnormal pre-injury limb function; (3) pathological fractures or severe osteoporosis; (4) old fractures; (5) concomitant vascular and nerve injuries; (6) concomitant coagulation disorders or cardiovascular and cerebrovascular disorders affecting the operation; and (7) poor compliance with postoperative rehabilitation plans or follow-up were excluded.

Elimination criteria: (1) those who were lost in the study; (2) those who voluntarily requested to withdraw from the study; and (3) death.

Intervention methods

Preoperative coagulation analysis, blood preparation, prophylactic antibiotics, liver, kidney and cardiopulmonary function were examined.

PO group: An incision was made to expose the fracture end, blood clots were removed at the fracture end, and anatomical reduction was performed under direct vision. Subsequently, a plate of an appropriate length was chosen and the periosteum was removed for reduction. Bone grafting was performed depending on the patient's condition during the operation, followed by drainage and wound closure.

IIN group: Traction bed assisted closed reduction was performed. After correct resetting under C-arm fluoroscopy, the guide pin was implanted. The medullary cavity was expanded, and then the IIN was set in a prograde manner, and the distal and proximal interlocking screws were locked. Incisional reset could be used for some patients with difficult reset, followed by postoperative drainage and closure of the wound.

Patients were given antibiotics to prevent infection after surgery, the drainage tube was removed within 48 h, and quadriceps contraction resection was performed 2 d after surgery under the guidance of physicians. Patients received functional exercises of the knee joint after 7 days.

Observation indicators

Efficacy evaluation: The fracture healing of the two groups was evaluated with reference to Karlstrom and Olerud's criteria for evaluating the efficacy of femur fractures [10], i.e., the degree of fracture healing was categorized into three types: excellent, good, and poor, where excellent was defined as patients with no pain in the thigh, normal walking ability, and no angulation, rotation, shortening or deformity of the fracture; good was defined as patients with intermittent or mild pain, no limitation in walking, angulation (<10°), rotation (<10°) or shortening of the lower limb (<1 cm), and poor was defined as significant thigh pain, limited walking distance, angulation (10-20°), rotation (10-20°) or shortening of the lower limb (1-3 cm).

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Table 1. Comparison of clinical indicators ($\chi \pm s$)/ [n (%)]

| Clinical information | | INN group (n=13) | PO group (n=25) | t/ χ^2 | P |
|----------------------|---------------------|------------------|------------------|-------------|-------|
| Gender | Male | 8 | 14 | 0.108 | 0.743 |
| | Female | 5 | 11 | | |
| Mean age (years) | | 49.61 \pm 2.32 | 50.32 \pm 2.21 | 0.924 | 0.361 |
| Cause of injury | Heavy object strike | 4 | 8 | 0.334 | 0.656 |
| | Traffic accidents | 4 | 9 | | |
| | Fall injuries | 5 | 8 | | |
| Fracture site | Left side | 6 | 12 | 0.012 | 0.914 |
| | Right side | 7 | 13 | | |
| Garden typing | I | 3 | 6 | 0.765 | 0.211 |
| | II | 3 | 8 | | |
| | III | 4 | 6 | | |
| | IV | 3 | 5 | | |

Table 2. Comparison of efficacy [n (%)]

| Group | Number of cases | Excellent | Good | Poor | Response rate |
|-----------|-----------------|------------|-----------|-----------|---------------|
| INN group | 13 | 10 (76.92) | 3 (23.08) | 0 (0.00) | 13 (100.00) |
| PO group | 25 | 10 (40.00) | 8 (32.00) | 7 (28.00) | 18 (72.00) |
| χ^2 | - | - | - | - | 4.462 |
| P | - | - | - | - | 0.035 |

The response rate = (excellent + good)/total number of cases \times 100%.

Comparison of surgical indicators and complication rates: The incidence of surgical indicators (including operation time, length of hospitalization, blood loss, duration of fracture healing) and various complications (including post-operative infection, healing deformity, bone nonunion or delayed healing, loosening of internal fixation, and failure of internal fixation) were recorded in the two groups.

The short-term and long-term hip function and quality of life: The review was carried out at 1, 3, 6 and 12 months after surgery. The review included X-ray of the fracture site and functional assessment of the hip joint by Harris Scale [11], which includes 10 items covering 4 domains. The domains were pain, function, absence of deformity, and range of motion. The maximum score possible was 100. Results were interpreted with the following [1]: <70 = poor result; 70-80 = fair, 80-90 = good, and 90-100 = excellent. Quality of life was assessed using SF-36 scale [12], which includes 8 dimensions, comprising somatic physiological function, somatic physiological function, body pain, social function, and mental health, etc.,

ranging 0-100 scores, with higher scores representing better quality of life.

Statistical analysis

SPSS 22.0 was used for data analysis. The collected data were tested using a normal distribution.

Count data conforming to normal distribution were expressed using [n (%)], and the chi-square test was used for the between-group comparison. Measurement data (mean \pm standard deviation) were compared by t-test. $P < 0.05$ indicated significant difference and GraphPad Prism 8 was used for image plotting in this study [13].

Results

Comparison of clinical data

This study enrolled 38 patients, including 22 males and 16 females, aged 16-68 years and (49.98 \pm 2.32) years in average. The INN group had 13 patients (M/F: 8/5), and the PO group had 25 patients (M/F: 14/11). The gender, mean age, cause of injury, fracture site, and Garden typing were compared, and these baseline data did not differ significantly between the two groups ($P > 0.05$), suggesting that the two groups were comparable (**Table 1**).

Comparison of fracture healing

The fracture healing in the INN group was excellent in 10 cases and good in 3 cases, with the response rate of treatment of 100.00%, while the fracture healing in the PO group was excellent in 10 cases, good in 8 cases, and poor in 7 cases, with the response rate of treat-

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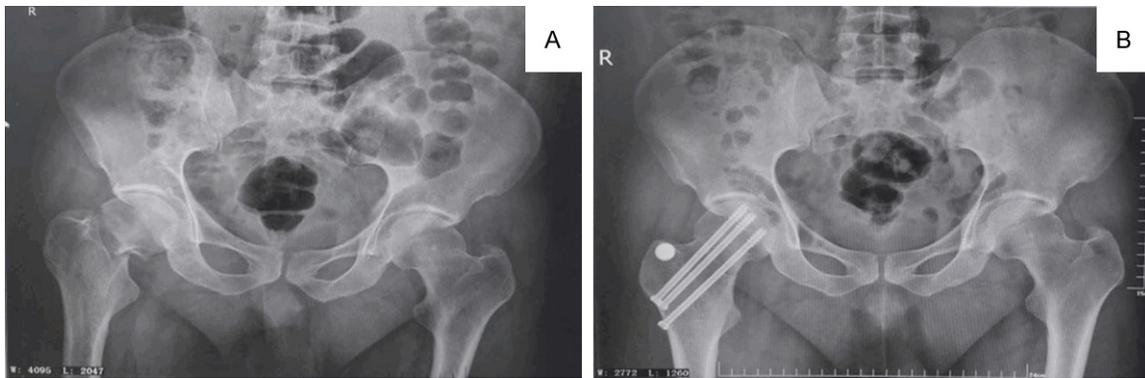


Figure 1. Comparison of X-ray of hip joint before and after treatment in IIN group. X-ray examination showed that the fracture of the femoral neck was obvious before treatment (A). After intramedullary nailing intervention, the femoral neck of patients in the IIN group was well fixed (B).

Table 3. Comparison of surgical indicators ($\bar{x}\pm s$)

| Group | Number of cases | Operation time (min) | Length of hospitalization (d) | Surgical blood loss (mL) | Duration of healing time (d) |
|-----------|-----------------|----------------------|-------------------------------|--------------------------|------------------------------|
| IIN group | 13 | 149.28±21.22 | 16.32±2.11 | 421.28±30.98 | 83.21±0.43 |
| PO group | 25 | 123.98±20.21 | 18.98±2.32 | 459.71±32.11 | 93.71±0.71 |
| χ^2 | - | 4.123 | 4.096 | 4.117 | 34.78 |
| <i>P</i> | - | <0.001 | <0.001 | <0.001 | <0.001 |

ment of 72.00%. The response rate of treatment in the IIN group was higher than that in the PO group ($P<0.05$) (Table 2; Figure 1).

Comparison of surgical indicators

Patients in the IIN group had a shorter recovery process, lower blood loss, shorter length of hospitalization, and longer operation time than PO group ($P<0.05$), suggesting that patients in the PO group had significantly shorter operation time and longer recovery process (Table 3; Figure 2).

Comparison of incidence of complications

The IIN group had 1 case of bone discontinuity and 1 case of loosening of internal fixation, with a complication rate of 15.38%, while the PO group had 3 cases of infection, 3 cases of healing deformity, 4 cases of bone discontinuity, 5 cases of loosening of internal fixation, and 1 case of failure of internal fixation, with a complication rate of 64.00%, which exhibited statistically significant difference between the two groups ($P<0.05$) (Table 4).

Analysis of hip function and quality of life

The hip function and quality of life of the two groups were dynamically evaluated, and the

observation points were selected as 1 month, 3 months, 6 months and 12 months after surgery, and the difference between the two groups was compared. The results showed that the Harris scores and SF-36 scores in the IIN group were significantly higher than those in the PO group from 3 to 12 months after surgery, and the difference between groups was statistically significant ($P<0.05$) (Figure 3). The comparison of the response rate of Harris scores between the two groups after 12 months of intervention showed that there was no significant difference between the two groups in the response rate of Harris scores before intervention ($P>0.05$), but the comparison after 12 months of intervention showed that the response rate was significantly improved in the IIN group than in the PO group ($P<0.05$) (Figure 4).

Discussion

Clinical treatment of femoral neck fracture can be divided into three categories: non-surgical treatment, internal fixation and artificial hip replacement [14], in which non-surgical treatment is mainly applicable for patients with incomplete fractures or mild symptoms, namely, young patients. However, elderly patients

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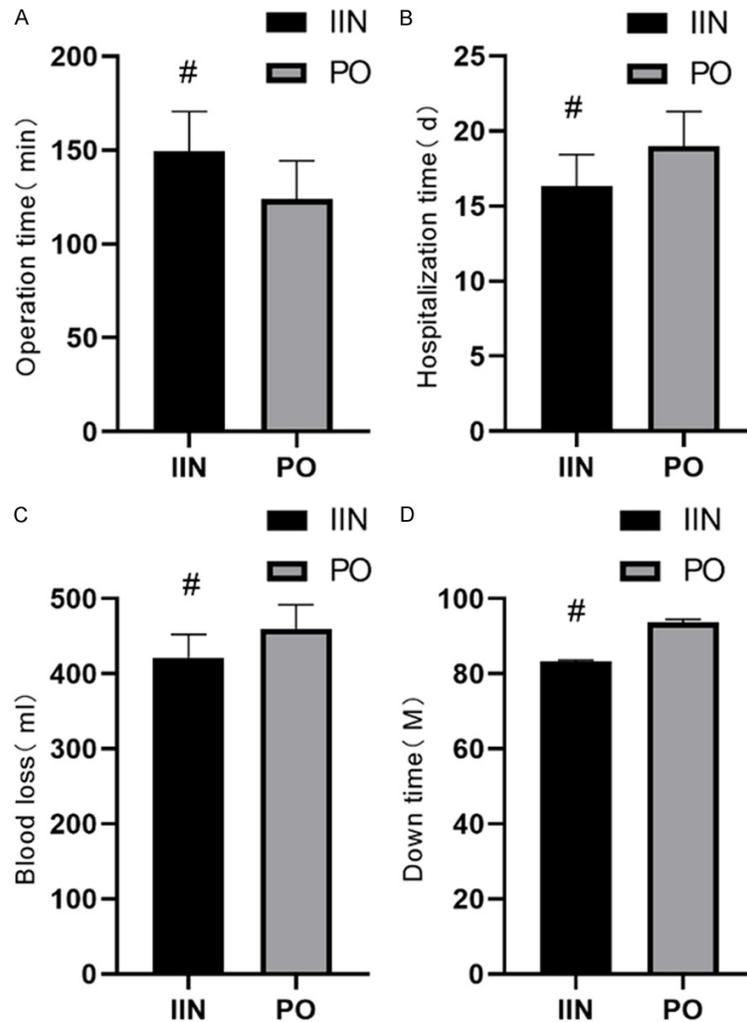


Figure 2. Comparison of surgical indicators. Patients in the IIN group had a shorter length of hospitalization (B), less blood loss (C), shorter fracture healing time (D) and longer operation time (A) than the PO group ($P < 0.05$). # represents that the difference between groups of the same index is statistically significant, $P < 0.05$.

with femoral neck necrosis are prone to a lack of blood supply to the fracture site and long-term bed rest. Data show that the response rate of conservative treatment can only reach 20%, so surgical intervention is often recommended [15]. Artificial hip arthroplasty is a class IV surgery, which has a significant impact on the joint function of patients, and is generally not recommended for elderly patients to avoid the incidence of postoperative complications that impair the patient's ability to live a normal life, as a result, internal fixation has become the most commonly used surgical procedure for patients with femoral neck fracture [16].

Although the efficacy of internal fixation on femoral neck fracture has been confirmed by clinical studies, the choice of internal fixation material and modes remains controversial [17, 18]. In this study, it was found that in terms of intervention efficacy, the response rate of patients in the IIN group receiving intramedullary nailing was 100.00%, which was significantly better than that of the PO group with plate fixation, while intraoperative bleeding, hospital stay, and fracture healing time were significantly shorter in the IIN group. A controlled study of 135 patients with humeral stem fractures indicated that the intraoperative bleeding in the IIN group was 125 mL, which was less than 212 mL in the plate group, and the response rate in the IIN group reached 89.5%, which was higher than 88.1% in the plate group, and these results are similar to the results of this study [19]. Another retrospective study conducted on 433 patients with long bone fractures showed that patients with intramedullary nailing could bear weight early after surgery, have better functional recovery, and their fracture

healing time is significantly shorter than those in the plate group (3.23 months vs. 9.92 months), which was considered a significant advantage of intramedullary nailing [20]. We speculate that the plate fixation has been applied in clinical practice for more than 100 years, and its advantages are easy to grasp and do not require special instruments, which helps it be easily promoted. However, it causes obvious injury to patients, and the intraoperative dissection of the periosteum can affect the blood supply to the bone cortex and prolong the postoperative recovery time [21]. The intramedullary nailing technique is a new internal fixation technique introduced in 1939, and its

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Table 4. The incidence of postoperative complications [n (%)]

| Group | Number of cases | Infection | Healing deformity | Bone discontinuity or delayed healing | Loosening of internal fixation | Failure of internal fixation |
|-----------|-----------------|-----------|-------------------|---------------------------------------|--------------------------------|------------------------------|
| IIN group | 13 | 0 (0.00) | 0 (0.00) | 1 (7.69) | 1 (7.69) | 0 (0.00) |
| PO group | 25 | 3 (15.00) | 3 (15.00) | 4 (16.00) | 5 (25.00) | 1 (4.00) |
| χ^2 | - | 1.694 | 1.694 | 2.325 | 0.608 | 0.534 |
| <i>P</i> | - | 0.193 | 0.193 | 0.127 | 0.435 | 0.465 |

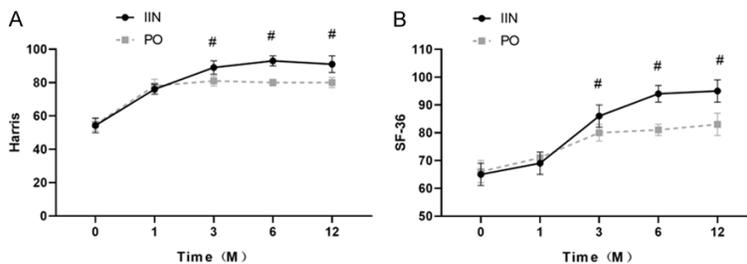


Figure 3. Analysis of hip function and quality of life. The Harris (A) and SF-36 (B) scores of the IIN group were significantly higher than those of the PO group at three time points from 3 months to 12 months after intervention. # represents that the difference between groups of the same index is statistically significant, $P < 0.05$.

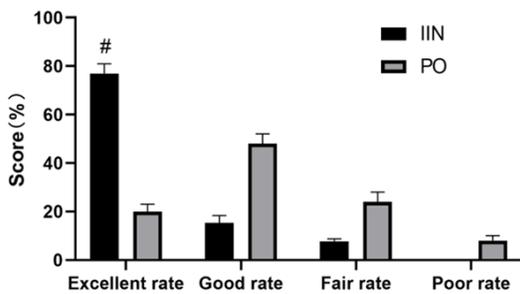


Figure 4. Comparison of response rate. After 12 months of intervention, the excellent rate of patients in the IIN group was 76.92% and the good rate was 15.38%, and the excellent rate of patients in the PO group was 20.00% and the good rate was 48.00%. The response rate of patients in the IIN group was significantly higher than that in the PO group. # represents that the difference between groups of the same index is statistically significant, $P < 0.05$.

mechanical characteristics are stress-sharing, which is in accordance with the biomechanics of the femur, so it does not change the biomechanics of the affected limb [22]. The results of this study showed that the intramedullary nailing had better efficacy on femoral neck fractures, and also has the advantages of less intraoperative injury and faster postoperative recovery, which may be related to the better stability of the intramedullary nail.

The results showed that the overall complication rate of patients in the IIN group was 15.38%, which was significantly lower than that of patients in the PO group (64.00%), and the Harris score and SF-36 score of patients in the IIN group from 3 months to 12 months after surgery were significantly higher than those in the PO group. Scholars have conducted a study on the effects of intramedullary nails and

plates on the postoperative function of patients with femoral shaft fractures and found that patients in the IIN group had higher postoperative knee function scores and shorter fracture healing time and weight-bearing walking time after 6-18 months of follow-up [23]. Another comparative study of proximal humerus fractures showed that patients with intramedullary nailing fixation had significantly shorter operation time, less blood loss and better postoperative functional recovery than the plate group [24]. We believe that, compared with plate fixation, intramedullary nailing does not cause injury to joints and soft tissues [25], and the incision site and nailing site of intramedullary nailing are farther away from the fracture site, which does not disrupt the blood supply to the fracture site, thus significantly reducing the incidence of infection and fracture non-union [26, 27], which, in a comprehensive view, results in less trauma to the patient, and faster recovery of bone-callus.

In conclusion, intramedullary nailing for patients with femoral neck fracture has the advantages of shorter time in bed, better functional recovery, lower postoperative complication rate, and higher long-term joint function and quality of life, which are worthy of clinical

promotion. The shortcomings of this study are that the included sample size is small, and the effect of fracture staging on patient outcomes is not excluded, which should be further investigated.

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Disclosure of conflict of interest

None.

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