ORIGINAL RESEARCH

Effect of Preoperative Nutritional Status on Postoperative Functional Recovery of Hip Joint in Elderly Patients with Intertrochanteric Fractures

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ABSTRACT

Objective • The state of nutrition of senior patients with intertrochanteric fracture of femur before operation affects the patients' tolerance to the operation,the body recovery, healing of the wound and clinical prognosis. For these patients, the poor state of nutrition may lengthen the time of being in hospital, leading to poor hip recovery and clinical outcome. But currently, the relationship between functional recovery of hip joint after operation of intertrochanteric fracture in elderly patients and camp condition has not been reported. To investigate the effect of preoperative nutritional status on postoperative recovery of hip joint function in elderly patients with intertrochanteric fractures.

Methods • Retrospective analysis was performed on the data of 96 elderly patients with intertrochanteric fracture of the femur treated with closed reduction PFNAfrom January 2021 to January 2022 in Dongying People's Hospital Trauma Orthopedics Department. There were 36 male patients and 60 female patients aged from 65 to 92.The patients were divided into the normal nutrition group (GNRI ≥ 92, n = 46) and the malnutrition group (GNRI < 92, n = 50). The general clinical data, time from injury to operation, intraoperative and postoperative allogeneic blood transfusion rate, postoperative complication rate, postoperative mortality 1 year, and Harris hip function score at 3, 6, 9 months and the last follow-up were compared between the two groups.

Results • All patients were followed up for 9 to 15 months(mean,13.9 months) after surgery. The preoperative hemoglobin levels in the normal and malnutrition groups were 8.6-13.2 and 7.4-11.2 g/dL, respectively ($P < .05$). The time from injury to surgery in the normal nutrition group was significantly shorter than that in the malnutrition group ($P < .01$). The preoperative hemoglobin level in the normal nutrition group was significantly higher than that in the malnutrition group. The time from injury to operation in normal nutrition group and malnutrition group are respectively (1.1-5.2), (4.3-6.6)d; the intraoperative and postoperative allogeneic blood transfusion rates are respectively 47.8%(22/46), 92%(46/50);the incidence of postoperative complications are respectively 6.52%(3/46), 32%(16/50); the mortality rates within 1 year after operation are respectively 2.17%(1/46), 12%(6/50). In contrast, the postoperative allogeneic blood transfusion, postoperative complication, and postoperative complication rates in the normal nutrition group were significantly lower than those in the malnutrition group ($P < .05$). 3 months after surgery, the Harris hip function scores of patients in normal nutrition group and malnutrition group are respectively (75.26±4.02), (64.28±3.82); 6 months after surgery, the Harris hip function scores of them are respectively (80.42±3.86), (70.14±5.06). During the last follow-up, scores are (82.23±2.98), (72.12±4.62). At the 3, 6, and last follow-up after surgery, the Harris hip function score in the normal nutrition group was significantly higher than in the malnutrition group ($P < .05$).

Conclusion • Preoperative malnutrition in elderly patients with intertrochanteric fracture has adverse effects on postoperative hip function recovery, and 1-year postoperative survival rate. GNRI can be used for simple screening. Early assessment of patients' nutritional status. (*Altern Ther Health Med.* [E-pub ahead of print.])

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INTRODUCTION

Intertrochanteric fracture of the femur (IFF), also known as intertrochanteric fracture of the femur, is a clinically common extracapsular fracture of the hip joint, accounting for up to 36% of all hip fractures and about 3.51% of total body fractures.[1] It has a high disability rate and mortality rate. Falls and osteoporosis are the most common causes of intertrochanteric fractures in the elderly, with a male/female ratio is about 1:2. Elderly patients with intertrochanteric fractures of the femur have many underlying diseases, and the mortality rate can be as high as 20%~40% one year after surgery.[2] Therefore, we routinely followed up for more than one year in this study, averaging 13.9 months.

Due to the aging population and the increasing number of osteoporosis, the probability of intertrochanteric femur fracture in the elderly is on the rise. Elderly people are often complicated with osteoporosis and one or more underlying diseases, so elderly hip fracture has the characteristics of high incidence, high disability rate, high mortality and complications, which brings a serious burden to the family and society.Conservative treatment of hip fracture in the elderly requires long-term bed rest, which is easy to cause lung infection, pressure sore and other complications, and the mortality of patients increases significantly. In recent years, surgical treatment has become the primary treatment for elderly hip fractures, which can not only exercise the limb function in the early stage, quickly restore hip function and reduce pain, but also facilitate nursing and significantly reduce long-term bed complications. However, elderly patients with hip fracture are often faced with a series of problems, including poor physical conditions, combined with underlying diseases, long waiting time for bed and preoperative examination during perioperative period, and delayed consultation, which increases the preoperative bed waiting time, greatly increases the risk of later surgery, and even loses the optimal window period for surgery.

Elderly patients have insufficient caloric and protein intake, and most suffer from hypoproteinemia and anemia upon admission. The preoperative nutritional status of patients directly affects their tolerance to surgery, wound healing, and postoperative recovery. Older patients who are malnourished have severe dysfunction before fracture and for 6 months after a hip fracture and are more dependent on daily living, and they continued to lose their ability to do daily living during follow-up. Compared with well-nourished patients, fewer of them could return to pre-fracture activity levels. They are more likely to have delayed surgery, stay in hospital longer than 1 month, have delayed wound healing, and have higher in-hospital and 1-year postoperative mortality.

It has been reported that the functional recovery of the hip joint in elderly patients with intertrochanteric fractures after surgery is related to the fracture status (fracture classification, intraoperative reduction), the patient's own situation (age, whether there are medical diseases and osteoporosis), and whether there are complications during the perioperative period. With the increasing of age, the body's resistance and immunity decline, which is not conducive to the recovery of hip function. The lower the bone density, the worse the recovery of hip function. The occurrence of adverse conditions such as perioperative incision infection can also affect the functional recovery of hip joint. The unsatisfactory reduction during the operation of fracture may delay the healing of the fracture and thus affect the recovery of hip function.

However, there is no literature report on the correlation between functional recovery of the hip joint and nutritional status in elderly patients with intertrochanteric fractures after surgery. This study retrospectively analyzed the data of 96 elderly patients (aged ≥65 years) with intertrochanteric fracture who received closed reduction proximal femoral antirotation intramedullary nail (PFNA) from January 2021 to January 2022, aiming to investigate the influence of preoperative nutritional status of elderly patients with intertrochanteric fracture on postoperative recovery of hip function.

PATIENTS AND METHODS

General information

A total of 96 patients were included in this study, including 36 males and 60 females: 38 on the left and 58 on the right, aged 65-92 years old. The causes of injury were as follows: traffic injury in 4 cases, fall injury in 6 cases, and fall injury in 86 cases. Evans–Jensen classification grades: 56 cases grade II,24 cases grade III,16 cases grade IV. ASA grades: 37 cases grade II, 59 cases grade III. The time from injury to operation was < 7 d. According to GNRI, the patients were divided into the normal nutrition group (n = 46, GNRI ≥ 92) and the malnutrition group (n = 50, GNRI < 92). This study was approved by the Ethics Committee of Dongying People's Hospital, and all patients signed informed consent.

Inclusion criteria and exclusion criteria

Inclusion criteria: (1) Patients ≥65 years with unilateral intertrochanteric fracture of femur and no deformity of hip joint before injury with normal range of motion; (2) Patients with a clear history of trauma and imaging diagnosis, meeting the surgical criteria; (3) Receiving PFNA internal fixation; (4) Patients with the clinical classification in line with the Evans–Jensen classification grades II, III, and IV; (5) Complete follow-up data and follow-up time >12 months. (Explanation: Patients meeting the inclusion criteria support the reliability of this study.)

Exclusion criteria: (1) patients with poor compliance; (2) Pathological fracture, old, open injury, multiple fracture and nerve, vascular injury; (3) Patients with mental diseases; (4) The ASA grades IV~V, that is, the general condition is poor, complicated with serious medical disease; (5) Incomplete preoperative and postoperative follow-up data. (Explanation: The reason for excluding such patients is that they would affect the reliability of this study.)

Surgical method

All patients were operated by senior physicians and anesthetized by general anesthesia or intraspinal anesthesia. The patient lay supine on the traction bed, with flexion and extension of the healthy lower extremity, traction of the affected limb, and assisted adduction and internal rotation. After satisfactory fracture reduction was achieved under a C-arm perspective, a longitudinal incision of about 5 cm was made above the femoral greater trochanter. A guide needle was inserted along the direction of the medullary cavity after the opening at the apex of the femoral greater trochanter. The main nail was inserted after the extension of the medullary cavity. A guide pin is driven through the sight into the neck of the femur, located in the lower 1/3 of the femur and in the middle of the femur under positive and lateral perspective. Drive a spiral blade of appropriate length, ensure that the minimum distance between the tip of the

Table 1. General data of patients in the two groups

Group	n	Gender		Age	Fracture classification			Injured side		Cause of injury			ASA grade	
		Male	Female		II	III	IV	Left	Right	Traffic injury	High fall injury	Fall injury	II	III
normal nutrition group	46	18	28	70.2±16.6	26	13	7	18	28	3	4	39	19	27
malnutrition group	50	18	32	78.8±17.3	30	11	9	20	30	1	2	47	18	32
Testing statistic		0.262		-0.624	0.826			0.205		0.884			1.624	
P value		.806		.032	.756			.687		.924			.768	

Table 2. Comparison of clinical characteristics between the two groups ($\bar{x} \pm s$)

Group	n	Hemoglobin (g/Dl, $\bar{x} \pm s$)	The time from injury to operation	The rates of allogeneic blood transfusion	The incidence of postoperative complications	The mortality rates within 1 year
Normal nutrition group	46	8.6-13.2	1.1-5.2	47.8%(22/46)	6.52%(3/46)	2.17%(1/46)
Malnutrition group	50	7.4-11.2	4.3-6.6	92%(46/50)	32%(16/50)	12%(6/50)
Testing statistic		9.267	6.205	8.347	18.32	10.64
P value		.013	.005	.007	.004	.015

spiral blade and the arc surface of the femoral head is about 5 mm, and visually detect TAD less than 25 mm. Lock the spiral blade, screw in the distal locking screw, and install the tail cap. After the reduction was satisfied by C-type fluoroscopy, one drainage tube was indwelled at the knife edge to seal the wound. Intraoperative and postoperative blood transfusion was performed according to the bleeding and anemia of the patient. Antibiotics were administered to prevent infection, once 30 minutes before surgery and again 24 hours after surgery. Fluids were provided for hydration, thrombosis prevention measures were taken, analgesia was administered for pain relief, and other symptomatic support treatments were given. After the operation, the team of TCM rehabilitation physicians customized rehabilitation training plans for patients, including early joint activities, early outpatient review, planned and gradual weight bearing, and recovery of pre-injury status as soon as possible.

Observation index

After admission, general vital signs of patients were monitored, medical history was inquired to understand the general condition of patients, physical examination was conducted in detail, preoperative examination (routine, biochemical and coagulation, etc.) of patients was further improved, X-ray films and three-dimensional reconstructed CT were used to determine the fracture type and degree of soft tissue injury, and patients with other medical diseases were consulted and treated to achieve the degree of surgical tolerance.

Age at admission, sex, injury side, Evans-Jensen fracture type, hemoglobin level, time from injury to surgery, intraoperative and postoperative allogeneic blood transfusion rate, postoperative complication rate, and mortality within 1 year were collected. GNRI(geriatric nutrition risk index), is a very simple, objective assessment based on weight, height and serum albumin levels. Its advantages are good operability, no need for special equipment, no need to move patients, more in line with clinical practice.

GNRI=1.489 × serum albumin (g/L) + 41.7 × (body weight/ideal body weight). Male ideal weight: height (cm) - 100 - [(height (cm) - 150) / 4], female ideal weight: height (cm) - 100 - [(height (cm) - 150) / 2.5]). The same group of professional physicians evaluated the Harris hip function score at 3 and 6 months after surgery and at the last follow-up visit. If the patient died, the Harris hip function score at the last outpatient review was used (Table 1,2).

Table 3. Comparison of hip Harris scores between the two groups ($\bar{x} \pm s$)

Group	n	3 months after surgery	6 months after surgery	Last follow-up
Normal nutrition group	46	75.26±4.02	80.42±3.86	82.23±2.98
Malnutrition group	50	64.28±3.82	70.14±5.06	72.12±4.62
Testing statistic		2.738	3.287	3.642
P value		.008	.016	.022

Statistical analysis

IBM Statistic Package for Social Science (SPSS) 23.0 statistical software (IBM, Armonk, NY, USA) was used for data analysis. The comparison of measurement data between the normal nutrition group and the malnutrition group was conducted using Wilcoxon signed rank test.Counting data between the two groups were compared using the χ^2 test and *t* test. The difference was statistically significant when $P < .05$.

RESULTS

There were no significant differences in age,gender, injury side, Evans-Jensen classification, injury cause, and ASA classification between the normal and malnutrition groups , using the Levene's test to determine that the data is normally distributed and the variance is homogeneous. ($P > .05$, Table 1).

All patients were followed up for 9 to 15 months(mean,13.9 months) after surgery. The preoperative hemoglobin levels of the normal nutrition group and malnutrition group were 8.6-13.2 g/dL and 7.4-11.2 g/dL, respectively. The two groups' time from injury to operation were 1.1-5.2 and 4.3-6.6 d, respectively. The rates of allogeneic blood transfusion in the two groups were 47.8% (22/46) and 92% (46/50). The incidence of postoperative complications in the two groups was 6.52% (3/46) and 32% (16/50). The mortality rates within 1 year after surgery were 2.17% (1/46) and 12% (6/50), and there were statistically significant differences between the two groups, using the χ^2 test. ($P < .05$, Table 2).

The Harris hip function scores in the normal nutrition group were 75.26±4.02, 80.42±3.86, and 82.23±2.98 at 3 months, 6 months after surgery and the last follow-up, respectively. The Harris hip function scores in the malnutrition group were 64.28±3.82, 70.14±5.06, 72.12±4.62 at 3 months, 6 months and the last follow-up. The above items were statistically significant between the two groups, using the Levene's test. ($P < .05$, Table 3).

DISCUSSIONS

The treatment of femoral intertrochanteric fracture

With the continuous progress of medical technology and the progress of aging in China, the proportion of the elderly in the overall population has increased rapidly. According to the International Osteoporosis Foundation (IOF), the number of patients with hip fractures will reach more than 4 million by 2050.

Non-surgical treatment may lead to malunion or nonunion of bones in elderly patients with intertrochanteric fracture, and constipation, pressure ulcer and other complications are easy to occur in bed for a long time, and the disability rate and mortality of elderly patients will increase. Surgical treatment is mainly to restore the normal anatomical structure of the fracture site and give fixation, which can improve the healing effect of the fracture, so as to improve the postoperative joint function of the patient. PFNA(proximal femoral nail antirotation) is a commonly used scheme for the treatment of femoral intertrochanteric fracture. The proximal spiral blade of the PFNA increases grip and reduces the likelihood of the femoral neck being cut. In addition, when the spiral blade entered the femoral neck, the cancellous bone was gradually compressed to make the cancellous bone in the femoral neck more firm after fixation, thus improving the overall stability after internal fixation Qualitative.

Impact of Malnutrition on Postoperative Complications

The elderly often have multiple medical diseases such as respiratory, cardiovascular, cerebrovascular, and endocrine systems, cardiovascular, cerebrovascular, and endocrine systems, which pose a greater risk for elderly patients with hip fractures during the perioperative period. Studies[3] showed that 6% of elderly patients with hip fractures died in the hospital, and the mortality rates were 14% and 26% at 3 months and 1 year after surgery, respectively. Elderly patients with hip fractures have insufficient caloric and protein intake and often suffer from hypoproteinemia, anemia, and other conditions after admission. The pain and harm caused by postoperative complications will also lead to reduced quality of life and increase the burden on families and society.[4]

Lumbers et al.[5] reported that 1/6 of elderly female patients with hip fractures were malnourished. Eneroth et al.[6] reported that one-third of elderly patients with hip fractures had malnutrition. O'Daly et al.[3] reported that among elderly patients with hip fractures, the in-hospital mortality of malnutrition patients reached 9.8%. Studies have confirmed that malnutrition has become an important factor affecting the mortality of elderly patients with hip fractures 12 months after surgery.[7] Studies[8] have shown that preoperative malnutrition is closely related to delayed surgery, prolonged hospital stay, increased complications, cognitive and functional disorders, and increased mortality. Bajada et al.[9] have shown that internal fixation failure in patients with hip fractures is associated with preoperative malnutrition. There are nutritional intake or absorption disorders due to movement difficulties, high body catabolism, and other reasons after surgery for hip fractures. Nutrition intervention can significantly reduce mortality by improving the clinical prognosis and quality of life of patients.[10]

Timely screening of malnourished individuals and selecting reasonable nutritional support pathways are important for elderly patients with malnutrition to safely survive the perioperative period, reduce complications, and improve postoperative function. The results of this study showed that the age of patients in the malnutrition group, the time from injury to surgery, the rate of intraoperative and postoperative allogeneic blood transfusion, the incidence of postoperative complications, and the one-year mortality rate were higher than those in the normal group. However, the sample size of this study is relatively small, and patients in the malnutrition group do not rule out interference factors such as natural death. Whether nutritional intervention during the patient's hospitalization period affects the occurrence of postoperative complications needs further investigation. The Harris function score and preoperative hemoglobin level of the hip joint were significantly lower than those of the normal group.

Koren Hakim et al.[11] conducted a nutritional assessment on elderly patients with hip fractures and found that 44.2% were at risk of malnutrition, while 11.6% were malnourished. Elderly patients often have multiple internal medical diseases such as respiratory, cardiovascular, cerebrovascular, and endocrine systems. As they age, the functions of various tissues and organs in the elderly gradually deteriorate, and the rate of anabolism decreases. Studies have shown that age is the main risk factor for preoperative malnutrition in elderly patients with hip fractures.[12] The basic physical condition of patients with preoperative malnutrition is poor. In order to improve the patient's tolerance to surgery and anesthesia and reduce the incidence of adverse conditions such as stress reactions, incision infections, etc., preoperative consultation with the nutrition department is often required to provide nutritional supplements to increase the patient's total energy, protein, and lipid intake. Therefore, the time from injury to surgery in the malnutrition group will be longer than in the normal group. The preoperative hemoglobin level of patients with malnutrition is lower than that of the normal group, and their hemoglobin regeneration ability and ability to correct anemia are poor. Moreover, the preoperative occult blood loss, its proportion to preoperative blood volume, and the incidence of high occult blood loss in patients with hip fractures gradually increase as their nutritional status decreases.[13] Therefore, the intraoperative and postoperative allogeneic blood transfusion rate of patients with malnutrition was higher than that of patients with normal nutrition.

Relevance of Albumin Levels

Albumin is an important marker of nutritional status because it can predict mortality and other outcomes in the elderly, including perioperative complications. Elderly people

with serum albumin concentrations<35 g/L have a significantly increased risk of death, and ≤ 30 g/L is associated with a high mortality rate.[14] Relevance of Albumin Levels

Albumin levels as a risk factor for wound healing in patients undergoing joint replacement have been reported in many studies in the past, and they are currently one of the effective indicators for clinicians to assess the nutritional status of patients before surgery.[15]

Preoperative hypoalbuminemia is closely related to increased postoperative complications and mortality in elderly patients with hip fractures.[16] Preoperative hypoalbuminemia is associated with the incidence of postoperative complications in elderly patients with hip fractures and is also a risk factor for postoperative complications in elderly patients with hip fractures.[17] Research by Nagai et al.[18] has shown that the relationship between poor nutritional status and sarcopenia can lead to decreased muscle strength in the lower limbs, leading to a decrease in functional activity independence, which is not conducive to early recovery of hip joint function.

Poor nutritional status can delay fracture healing, thereby affecting the recovery of hip joint function.[19]Whether a patient can tolerate surgery for hip fractures, postoperative recovery, wound recovery, and surgical prognosis are all affected by whether the patient's preoperative nutrition is good.[20] Poor nutritional status can delay fracture healing, thereby affecting the recovery of hip joint function.[21] The results of this study showed that the Harris function scores in the malnutrition group were lower than those in the normal group. Studies such as Drey[22] have found that patients with malnutrition have decreased muscle strength and function compared to the normal group, and low albumin can lead to insufficient muscle synthesis and decreased skeletal muscle quality, which affects the recovery of patient limb function, leading to poor postoperative rehabilitation, and affecting the quality of life and survival prognosis of patients, consistent with the results of this study. Research by Goisser et al.[23] showed that fewer elderly patients with malnourished hip fractures ould recover topre-fracture activity levels. Malnutrition can not only lead to delayed fracture healing but also affect the recovery of limb function, seriously affecting the quality of life of patients, thereby affecting their survival and prognosis.[24]

Relevance of Hemoglobin Levels

Hemoglobin levels are significantly associated with increased postoperative mortality and are an independent predictor of poor prognosis.[25] The results of Ho et al.[26] showed that the 1-year survival rate of patients with hip fractures with preoperative hemoglobin < 110 g/L was lower than that of patients with hemoglobin ≥ 110 g/L. O'Daly et al.[27] reported that among 322 elderly patients with hip fractures, the 1-year mortality rate in patients with malnutrition was 23.9%, and malnutrition can independently predict the 1-year mortality rate. Lu et al.[7] studied malnutrition as a risk factor for 1-year mortality in elderly patients with hip fractures and can predict the 1-year mortality risk. The one-year mortality rate of elderly patients with hip fractures after surgery is 16.97%. Complications are an independent risk factor for death. The mortality rate is proportional to the incidence of pneumonia in patients.[28] Folbert et al.[29] reported that malnutrition is an independent risk factor for postoperative death in elderly patients with hip fractures.

Advantages of GNRI

Therefore, finding simple and effective clinical indicators to assess the nutritional status of elderly patients with hip fractures as early as possible and taking timely and reasonable nutritional support methods are of great significance to help elderly patients safely survive the perioperative period, reduce complications, reduce patient mortality, and improve quality of life. The geriatric nutrition risk index (GNRI) is an evaluation method based on weight, height, and serum albumin level.[30] It has good operability, does not require special equipment, and does not require moving patients. It can be automatically calculated in an electronic medical record system. KOTERA[31]found that GNRI is an effective indicator for predicting short-term prognosis in elderly patients with hip fractures after surgery. The results of this study show that an objective and simple preoperative assessment of the nutritional status of patients is not only conducive to determining the condition and nutritional status, but also targeted prediction and intervention of perioperative risks, thereby reducing postoperative complications and improving the functional recovery of the patient's hip joint after surgery. The results of this study have certain value in predicting the functional recovery of the hip joint in elderly patients with intertrochanteric fractures after surgery using preoperative GNRI scores. Therefore, when the preoperative GNRI < 92, they should select reasonable nutritional support as soon as possible, formulate standardized and individualized intervention measures to improve nutritional status, and supplement and correct hypoproteinemia before surgery. It is of great significance to help elderly patients safely through perioperative period, reduce complications, shorten hospital stay, reduce medical costs and restore hip function after operation.

This study is retrospective, with a small sample size and a short follow-up period. The results may be biased, so long-term, multicenter, and large sample-size prospective studies are required for analysis and verification.

In summary, malnutrition patients with hip fractures in the elderly have prolonged preoperative waiting times, increased intraoperative and postoperative allogeneic blood, increased complication rates, and decreased postoperative hip function. Preoperative nutritional status is an important influencing factor for the clinical prognosis of elderly patients with hip fractures, and GNRI can be used for simple screening. Early assessment of patients' nutritional status, early and effective nutrition supplementation, and strengthening perioperative nutrition management can improve the recovery of patients' postoperative functions.

CONFLICT OF INTEREST

The authors have no potential conflicts of interest to report relevant to this article.

AUTHOR CONTRIBUTIONS

HX, YL and DL designed the study and performed the experiments, HX, YL and JL collected the data, DL and JL analyzed the data, HX, YL and DL prepared the manuscript. All authors read and approved the final manuscript. DL and YL contributed equally to this work.

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