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Malnutrition and Its Association with the Mortality of Patients with Femoral Intertrochanteric Fractures: A Retrospective Analysis of Japanese Patients

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Abstract

Background: The incidence of femoral intertrochanteric fractures in older adults is higher than that of femoral neck fractures; however, both conditions are often analyzed together as proximal femoral fractures. Considering the difference in treatment, postoperative complication, and mortality risk, these two fractures should be analyzed separately. This study aimed to analyze 1-year mortality and its risk factors in patients with surgically treated femoral intertrochanteric fractures. **Methods:** Consecutive patients with intertrochanteric fractures who underwent surgical interventions at our institution between January 2017 and December 2021 were retrospectively reviewed. A total of 238 patients were eligible for inclusion in this study. Patients' demographic and clinical information were retrospectively collected. Patients were divided into the 1-year mortality (n = 16) and survival (n = 222) groups. The incidence of 1-year mortality and its independent risk factors were investigated using univariate and multivariate logistic regression analyses. **Results:** The mean age of patients was 85.6 ± 8.5 years. The 1-year mortality rate was 6.7% (16/238). Preoperative albumin level, the Geriatric Nutritional Risk Index (GNRI), and malnutrition status (GNRI < 92) were significantly different between the two groups (p = 0.02, p = 0.02, and p = 0.0011, respectively). Multivariate analysis showed that malnutrition status (GNRI < 92; odds ratio, 2.1; 95% confidence interval, 0.0037 - 0.62; p = 0.035) was an independent risk factor for 1-year mortality. **Conclusion:** Malnutrition status assessed using GNRI (GNRI < 92) was an independent risk factor for 1-year mortality. Our findings suggest that GNRI may be an effective screening tool for predicting postoperative 1-year mortality of patients with surgically treated femoral intertrochanteric fractures.

Keywords

Intertrochanteric Fracture, Mortality, Geriatric Nutritional Risk Index, Malnutrition, Risk Factor

1. Introduction

The incidence of proximal femoral fractures is increasing globally due to the deterioration of bone quality in older adults [1] [2]. The annual number of patients with new proximal femoral fractures is estimated to increase to approximately 6 million by 2050 with an aging society if the incidence rate does not continue to improve [1]. Proximal femoral fractures are common in elderly patients with poor bone quality, and are associated with fatal consequences such as gait disturbances and impaired activities of daily living, and a high mortality rate is the most concerning. The 1-year mortality rate of proximal femoral fractures is between 20% and 30%, although it varies according to reports [3] [4] [5] [6].

Proximal femoral fractures are categorized into two groups based on their anatomy: femoral neck and intertrochanteric fractures [5]. Each fracture type has a characteristic array of complications and differs in incidence, treatment options, amount of blood loss, intraoperative blood loss, and mortality risk [3] [5] [7] [8]. According to the survey of hip fractures in Japan, the overall incidence of intertrochanteric fractures is higher than that of femoral neck fractures, especially in patients aged ≥ 75 years [8] [9]. Therefore, these two fractures should be analyzed separately. However, most studies have collectively analyzed both fractures as proximal femoral fractures, whereas few only focused on femoral intertrochanteric fractures.

In the present study, we analyzed femoral neck fractures and intertrochanteric fractures as separate entities and focused on patients with femoral intertrochanteric fractures, who are less likely to recover activities of daily living postoperatively [10]. The present study included patients with femoral intertrochanteric fractures surgically treated with the same technique and implants. Furthermore, we analyzed 1-year mortality and its risk factors in these patients.

2. Methods

2.1. Patient Population

We retrospectively reviewed consecutive patients with intertrochanteric fractures who underwent surgical interventions at our institution between January 2017 and December 2021. Patients who received conservative treatment, had subtrochanteric fractures, had pathological fractures, and were not followed-up for 1 year postoperatively were excluded from this study. A total of 238 patients were eligible for inclusion in this study.

The medical records of the enrolled patients were reviewed to gather pertinent

demographic and clinical information, including the age at surgery, sex, body mass index (BMI), and preoperative waiting period. In addition, preoperative laboratory data, such as albumin and hemoglobin levels, were collected. The general data were compared between dead and alive participants and between malnutrition and normal groups.

All patients provided informed consent, and the study protocol was approved by the medical research ethics committee of the authors' affiliated institution (R23-018).

2.2. Malnutrition Assessment Using the GNRI

According to previous studies, the Geriatric Nutritional Risk Index (GNRI) is calculated using the following formula:

GNRI = (1.489 × albumin concentrations [g/L]) + (41.7 × [body weight/ideal body weight, kg]) [11].

Body weight or ideal body weight was denoted as 1 in cases when the patient's body weight surpassed the ideal body weight to account for malnourished patients who were overweight or obese. A BMI of 22 kg/m^2 is considered the ideal body weight [12] [13]. In the present study, we defined malnutrition as a GNRI < 92, whereas those with a GNRI ≥ 92 were defined as normal, according to previously studies [12] [13].

2.3. Surgical Procedures

The patients were positioned in the supine position on the fracture table. Employing fluoroscopy for guidance, fracture reduction was accomplished through limb traction. The operative technique followed the manufacturer's instructions. In our hospital, the Multi Fixation Hip Screw Nail System (NexMed international, Japan), proximal femoral nail, is used to treat patients with trochanteric fractures. During rehabilitation, full weight-bearing was permitted, starting on the day following surgery.

2.4. Statistical Analyses

All statistical analyses were conducted using GraphPad Prism v.10 (GraphPad Software, San Diego, CA). Data are expressed as the mean ± standard deviation. The differences in the demographic, clinical, and laboratory characteristics were compared between the two groups. For univariate analysis, the Student's t-test was used to analyze quantitative variables, whereas the chi-square test was used to analyze qualitative variables. To examine the independent risk factors for 1-year mortality, factors with a p-value < 0.05 were introduced into the multivariate logistic regression analysis after univariate analyses. The statistical significance was set at $p < 0.05$. The outcomes are expressed as odds ratio (OR) and 95% confidence interval (CI). Survival status between the malnutrition and normal groups was analyzed using the Kaplan-Meier estimation method for mortality. The log-rank test was used to analyze significance.

3. Results

Comparison of patient characteristics and the results of univariate analysis between the 1-year mortality and survival groups are described in Table 1. The patients' mean age was 85.6 ± 8.5 years. There were 49 males (20.6%) and 189 females (79.4%). The 1-year mortality rate was 6.7% (16/238). The general data of patients who died within 1 year postoperatively were compared with those of survivors. The results showed that preoperative albumin level, GNRI, and malnutrition status (GNRI < 92) demonstrated significant differences between both groups ($p = 0.02$, $p = 0.02$, and $p = 0.0011$, respectively). The results of multivariate logistic regression analysis are shown in Table 2. This study revealed that only malnutrition status (GNRI < 92; OR, 2.1; 95% CI, 0.0037 - 0.62; $p = 0.035$) was an independent risk factor for 1-year mortality postoperatively.

In addition, when comparing the malnutrition and normal groups classified according to GNRI, patients in the malnutrition group were significantly older and had a lower BMI, albumin level, and hemoglobin level (Table 3). The 1-year mortality rate was also significantly higher in the malnutrition group (11.0%) than in the normal group (1.0%) ($p = 0.011$).

Table 1. Comparison of patient demographics and univariate analysis between the 1-year mortality and survival group.

Variables	Total n = 238	Death within 1 year n = 16	Survival n = 222	*p*-value
Age (years)	85.6 ± 8.5	84.1 ± 8.3	85.7 ± 8.5	0.48
Sex (male/female)	49/189	5/11	44/178	0.14
BMI (kg/m^2)	20.3 ± 3.7	19.0 ± 3.3	20.4 ± 3.7	0.14
Albumin (g/dL)	3.3 ± 0.5	3.1 ± 0.4	3.4 ± 0.5	0.02
Hemoglobin (g/dL)	10.9 ± 1.8	10.3 ± 2.0	10.9 ± 1.8	0.20
Preoperative waiting period (days)	5.7 ± 4.0	5.8 ± 3.0	5.7 ± 4.1	0.95
GNRI	86.9 ± 9.9	81.2 ± 7.8	87.3 ± 9.9	0.02
Malnutrition (GNRI < 92)/normal (GNRI ≥ 92)	136/102	15/1	121/101	0.0011

Values are expressed as the mean ± standard deviation. BMI: Body mass index, GNRI: Geriatric nutritional risk index.

Table 2. Multivariate analysis of 1-year mortality risk.

Variables	Odds ratio (95% CI)	*p*-value
Albumin (g/dL)	0.60 (0.28 - 14.0)	0.54
GNRI	0.49 (087 - 1.08)	0.63
Nutrition status Malnutrition (GNRI < 92)/normal (GNRI ≥ 92)	2.1 (0.0037 - 0.62)	0.035

GNRI: Geriatric nutritional risk index. CI: Confidence interval.

Table 3. Comparison of univariate analysis between malnutrition and normal groups.

Variables	Malnutrition (GNRI < 92) n = 136	Normal n = 102	*p*-value
Age (years)	86.9 ± 7.1	83.8 ± 9.8	0.0022
Sex (male/female)	22/114	27/75	0.03
BMI (kg/m^2)	18.8 ± 3.4	22.4 ± 3.0	<0.0001
Albumin (g/dL)	3.0 ± 0.4	3.7 ± 0.3	<0.0001
Hemoglobin (g/dL)	10.1 ± 1.5	11.9 ± 1.5	<0.0001
Preoperative waiting period (days)	5.6 ± 3.6	5.9 ± 4.5	0.7189
GNRI	80.1 ± 7.2	95.8 ± 4.1	<0.0001
1-year mortality rate	11.0% (15/136)	1.0% (1/102)	0.0011

Values are expressed as the mean ± standard deviation. BMI: Body mass index, GNRI: Geriatric nutritional risk index.

Figure 1 shows the Kaplan–Meier analysis of the cumulative survival rate in both groups. There was a correlation between nutrition status assessed using GNRI and cumulative survival rate.

4. Discussion

The most important finding of this study is that malnutrition assessed by GNRI is a risk factor for 1-year mortality in patients with femoral intertrochanteric fractures undergoing surgery. Malnutrition has been previously reported as a risk factor for postoperative complications, including mortality [14] [15] [16] [17]. In the present study, we included an evaluation using the GNRI as a screening tool for malnourishment, in addition to albumin level, which is already a reliable indicator [18]. Bouillanne *et al.* [11] introduced the GNRI as a direct screening method that calculates a score by considering the patient's ideal weight and serum albumin levels. This method minimizes the effects of hydration and is associated with sarcopenia and frailty in older adults [19].

Previous studies have confirmed the usefulness of the GNRI in evaluating the nutritional status and predicting perioperative complications, such as sepsis, postoperative pneumonia, surgical site infections, revision surgery, the prevalence of preoperative deep vein thrombosis, and mortality [12] [13] [19]-[25]. In the present study, the preoperative albumin level was not significantly associated with 1-year mortality, whereas the malnutrition status determined using GNRI was identified as an independent risk factor. These findings imply that the GNRI screening tool can detect cases of malnutrition that might be missed when evaluating based on serum albumin levels alone. Thus, the group identified as malnourished through GNRI assessment may benefit from early nutritional interventions as a controllable risk factor.

Previous observational retrospective studies that analyzed the mortality of patients with surgically treated proximal femoral fractures using GNRI reported

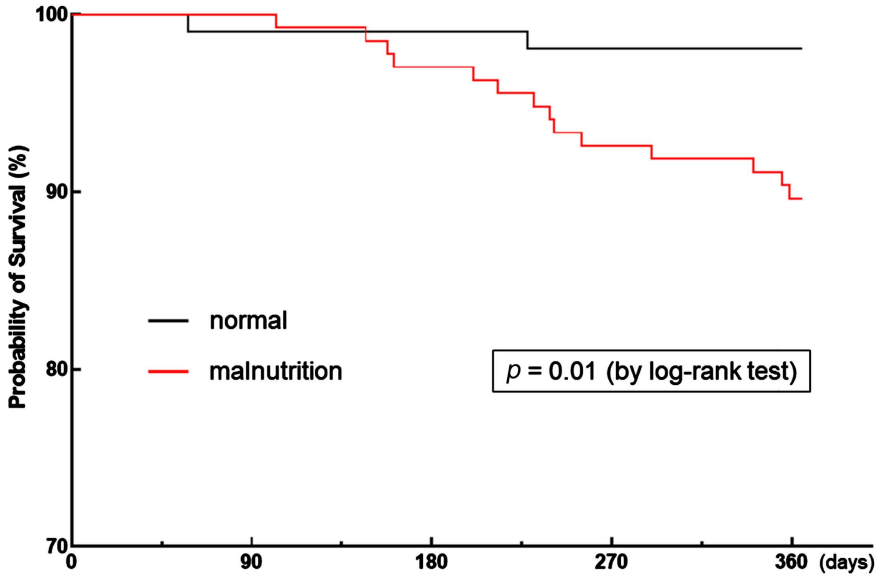

Figure 1. Cumulative 1-year survival rate according to nutrition status assessed using GNRI. The log-rank test shows a significant difference between the two groups.

that low GNRI was a risk factor for 30-day [20], 180-day [22] [25], and 1-year mortality [21] [23]. However, these studies were summarized for proximal femoral fractures and did not separately analyze femoral neck and intertrochanteric fractures. In addition, surgical implants and surgical methods are disparate. Patients with intertrochanteric fractures have been reported to be slightly older, sicker on admission, have longer hospital stays, and be less likely to recover activities of daily living at 2 months post-fracture compared with those with femoral neck fractures [10]. To rule out the difference between these two fractures as a relevant factor, the present study included only patients with femoral intertrochanteric fractures, considered more severe systemically than femoral neck fractures.

In addition, the present study aimed to analyze 1-year mortality and its risk factors in patients with surgically treated femoral intertrochanteric fractures. The multivariate analysis revealed that only malnutrition status assessed using GNRI was an independent risk factor for 1-year mortality postoperatively. Malnutrition status assessed using GNRI has been associated with hip fracture-related mortality in various studies [20] [21] [22] [23] [25]; however, to our knowledge, the present study is the first to examine the relationship between 1-year mortality and GNRI-defined nutritional status, focusing only on intertrochanteric fractures. Malnutrition in clinical practice remains a low concern and the rate of malnutrition remains underestimated. As a result, nutritional deficiencies prior to surgery for femoral intertrochanteric fractures are often untreated. This study shows that malnutrition is associated with 1-year mortality, indicating that early preoperative nutritional intervention may help improve postoperative outcomes for patients.

According to a systematic analysis, the average 1-year mortality rate of prox-

imal femoral fractures in North America, South America, Europe, and Asia was 21%, 26.8%, 23.3%, and 17.9%, respectively [6]. The overall average in 36 countries was 22.0%. It is unclear whether the 1-year mortality rate is lower in Asia than in other regions; however, some ethnic factors may be involved. In the present study, the 1-year mortality rate of femoral intertrochanteric fractures in Japan was low (6.7%).

Steinberg *et al.* [26] reported that delayed operation (>48 h) of patients with femoral neck fractures was associated with a 1.8-fold higher risk of 1-year mortality. Notably, no correlation between the number of waiting days and the 1-year mortality rate was observed in this study. Recently, several reports have promoted early surgery within 48 h [2] [27] [28]. The preoperative waiting period in the present study was slightly longer (5.6 days); however, it was low (6.7%) in relation to the 1-year survival rate. This may be because our hospital specializes in older adults and has thorough perioperative management; however, the actual situation is unknown.

One of the present study's advantages is that the comparative design focused on patients with femoral intertrochanteric fractures who underwent the same surgical treatment with same implants and were analyzed using multivariate logistic regression analysis. However, the present study had several limitations. First, this is a single-center retrospective comparative study, which may have influenced the generalizability of the results. However, the included patients had similar ages, BMIs, and sex ratios, and the surgical interventions were performed following an identical procedure. Second, the size of the sample population was relatively small, which may affect the reliability of the results. Therefore, larger-scale investigations are required.

5. Conclusion

This study evaluated the 1-year mortality and its established risk factors in patients with surgically treated femoral intertrochanteric fractures. The 1-year mortality rate in this study was 6.7%, which was considerably lower than that previously reported. Malnutrition status assessed using GNRI (GNRI < 92) was an independent risk factor for 1-year mortality. Our findings suggest that GNRI may be an effective screening tool for predicting postoperative 1-year mortality.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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