Prognostic nutritional index as a risk factor for aseptic wound complications after total knee arthroplasty

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Abstract

Background:

Patients with malnutrition have a high risk of postoperative complications in total knee arthroplasty (TKA). Previously, serum albumin and total lymphocyte count were considered preoperative nutritional assessment measures. Prognostic nutritional index (PNI) is calculated by a combination of serum albumin and total lymphocyte count. This study aimed to identify the risk factors for postoperative complications after TKA, including preoperative nutritional assessment, and evaluated preoperative PNI as a predictor of postoperative complications.

Methods:

One-hundred and sixty patients (234 knees) who underwent primary TKA were enrolled consecutively from 2010 to 2018. The serum albumin (g/dL) and total lymphocyte count (/mm^3) were examined within 3 months before TKA; thereafter, the PNI was calculated. Postoperative aseptic wound problems, such as skin erosion and dehiscence within 2 weeks and periprosthetic joint infection after TKA were examined.

Results:

Periprosthetic joint infections occurred in 14 knees (6.0%). Postoperative aseptic wound problems within two weeks were significant risk factors of periprosthetic joint infection (odds ratio; 5.10, 95% confidence interval [CI]; 1.438–18.093, *p* = 0.012). No significant differences were noted in the patient demographics, such as age, sex, body mass index (BMI), and comorbidities between the positive and negative groups for periprosthetic joint infection, except for the rate of aseptic operative wound problems. Furthermore, postoperative aseptic wound problems were influenced by high BMI (odds ratio; 1.270, 95% CI; 1.111–1.453, p = 0.000) and low PNI (odds ratio; 0.858, 95% CI; 0.771–0.955, p = 0.015).

Conclusions:

Preoperative nutritional status, indicated by PNI and BMI, was associated with postoperative wound problems within two weeks. Periprosthetic joint infection after TKA was associated with early postoperative aseptic wound problems.

Introduction

Total knee arthroplasty (TKA) is commonly performed for patients with severe osteoarthritis and rheumatoid arthritis of the knee. A frequent cause of revision surgery after TKA is periprosthetic joint infection [1-5]. Preoperative risk factors of periprosthetic joint infection should be improved, for example, reduction of body weight [6], control of diabetes mellitus [7], improving malnutrition [8], supplementation of Vitamin D [9], smoking cessation [10]. Furthermore, although several preventive procedures during surgeries including prophylactic intravenous administration of antibiotics, preoperative skin disinfection, and intrawound lavage with a large amount of saline have been performed pre-, intra- and postoperatively, the risk of infection remains. The reported infection rates are approximately 2% to 5% after TKA [1,3-5,11].

However, it was reported that patients with malnutrition had a high risk of postoperative infection [8,12,13]. Therefore, it is important to evaluate nutrition for preoperative patients. Previously, prognostic nutritional index (PNI) was used to evaluate nutrition in patients who had heart failure [14] and underwent gastrointestinal surgery [15]. PNI can be easily calculated using serum albumin and total lymphocyte count; it is useful for the nutritional evaluation in patients before surgeries [13,15,16]. In fact, PNI was demonstrated as a predictor of the 5-year overall survival probability after colorectal cancer surgeries and postoperative delirium [16,17]. In the orthopedic field, it was reported that postoperative complications of spine surgeries were associated with the nutritional status of preoperative patients [18,19]. PNI and the modified Glasgow prognostic score were significant predictors of postoperative delirium or surgical site infections after spine surgeries [18,19]. Furthermore, the prevalence of malnutrition in patients undergoing total hip and knee arthroplasty has been reported to be as high as 40% [20]. However, there are no reports on how preoperative nutritional states, such as PNI are related to postoperative periprosthetic join infection after TKA. The purpose of this study is to identify the risk factors for postoperative complications after TKA, including preoperative nutritional assessment, and evaluated preoperative PNI as a predictor of postoperative complications, such as postoperative wound problems and periprosthetic joint infections.

Materials and methods

This research has been approved by the Institutional Review Board of the authors' affiliated institutions. From 2010 to 2018, consecutive patients with osteoarthritis of the knee who underwent primary TKA were included in this study. Although posterior-stabilized type implants were used in all TKAs, patellar replacement was not performed in most cases. Patients with rheumatoid arthritis, or previous histories of joint infection, and patients of revision surgery were excluded in this study. The study population included 190 patients (234 knees) with more than 1 year follow up (Table 1). There were 48 men (60 knees) and 142 women (174 knees), with an average age of 74.1 ± 7.6 years. The background data of each patient, such as age at surgery, sex, body mass index (BMI), operative time, intraoperative blood loss, and comorbidities were collected. If a patient had at least one disease preoperatively, for example, diabetes mellitus, chronic kidney disease, coronary artery disease, liver cirrhosis, and chronic obstructive pulmonary disease, their comorbidities were considered positive.

In blood laboratory data, serum albumin (g/dL) and total lymphocyte count ($/mm^3$) were examined; thereafter, the value of the PNI was calculated as 10 × serum albumin (g/dL) + 0.005 × total lymphocyte count ($/mm^3$) [15]. Blood sampling data were evaluated within 3 months before surgery (mean 6.3 weeks preoperatively, range; 3 – 11 weeks).

When operative wound healing took more than 2 weeks without infection, we defined it as the occurrences of postoperative aseptic wound problems including skin erosion and dehiscence. An operative site complication was identified as periprosthetic joint infection according to the International Consensus Meeting on Periprosthetic Joint Infections [21].

Procedure of prevention of infection

All patients underwent a standard protocol to prevent infection. Preoperative intravenous administration of antibiotics (cefazolin, 2 g) was started prior to skin incision. Preoperative skin preparation was performed with 10% povidone iodine, and a skin drape with povidone iodine was put on before skin incision. Then, intravenous administration of antibiotics was done once every 6 h (cefazolin, 1 g) on the day of surgery. From the day after surgery, cefazolin (1 g) was administered intravenously every 12 h and was continued for 2 days. There were no patients allergic to cefazolin in this study. A suction drain was used for 1 or 2 days after surgery.

Statistical analysis

Patients were divided into two groups according to whether they had periprosthetic joint infection or not, and statistical comparison was performed between groups, regarding age, sex, BMI, serum albumin, total lymphocyte count, PNI, operative duration, intraoperative blood loss, and postoperative aseptic wound problems within 2 weeks after TKA. Then, to calculated odds ratio for periprosthetic joint infection, multivariate regression analysis was performed.

Furthermore, patients were divided into two groups according to whether they had aseptic operative wound problems or not, and statistical comparison was also performed between groups, regarding age, sex, BMI, serum albumin, total lymphocyte count, PNI, operative duration, and intraoperative blood loss. Then, to calculate the odds ratio for the presence of postoperative aseptic wound problems, multivariate regression analysis was performed.

Comparisons of patient’s background and surgical data were performed using a t-test. The number of comorbidities and postoperative complications were compared using the chi-square test. If the number of subjects in either cell was less than 5, Fisher's exact test was employed. SPSS version 23 (IBM Corporation, Armonk, New York, USA) was used for statistical analysis. A p-value of 0.05 was considered statistically significant.

Results

Patients were followed for a mean of 4.9 years (range, 1.5 to 10 years) after TKA. Periprosthetic joint infections were occurred in 14 knees (6.0%) after mean 4.9 months (range, 1 to 24 months) postoperatively.

No significant differences in the patient demographics were observed between the group with periprosthetic joint infection and the group without periprosthetic joint infection, except for the rate of postoperative aseptic wound problems within 2 weeks (Table 2). In multivariate regression analysis, a significant risk factor of periprosthetic joint infection was identified as positive postoperative wound problems within two weeks (odds ratio; 5.10, 95% confidence interval [CI]; 1.438–18.093, p=0.012).

There were significant differences in BMI and PNI between the group with operative wound problems within 2 weeks postoperatively and the group without operative wound problems (Table 2). Based on the above results, the significant risk factors of postoperative aseptic wound problems were identified as BMI (odds ratio; 1.270, 95% CI; 1.111–1.453, p=0.000), and PNI (odds ratio; 0.858, 95% CI; 0.771–0.955, p=0.015) in multivariate regression analysis.

Discussion

The most important finding of the present study was that postoperative wound problems were significantly associated with preoperative BMI and PNI, and early postoperative wound problems influenced periprosthetic joint infection after TKA.

There were several reports that BMI was associated with postoperative complications after TKA: for example, infection, sepsis, and renal insufficiency [8,22-24]. Based on our study, BMI should be considered as a predictor of postoperative wound problems.

To the best of our knowledge, this study is the first to investigate the relationship between preoperative nutritional status using PNI and postoperative wound problems affecting periprosthetic joint infection after TKA. Previously, the values of serum albumin, prealbumin, and transferrin were commonly measured for evaluation of preoperative malnutrition. Several reports showed that low albumin, prealbumin, and transferrin were associated with postoperative infection, wound complications, increased length of hospital stay, and death [8,25-29]. However, there were also several controversial reports that various serological markers related to malnutrition status were questionable for use in predicting postoperative complications [20,30-32]. Rai et al. showed that preoperative malnutrition, as assessed by low levels of serum albumin, serum transferrin, and total lymphocyte count, did not necessarily lead to delayed wound healing [20]. Morey et al. reported that the values of serum albumin level and total lymphocyte count were highly questionable as a surrogate of malnutrition for predicting wound complications after TKA [31]. We considered that all parameters for malnutrition should be subnormal if, theoretically a patient is malnourished. In the present study, when we considered isolateed serum albumin level or total lymphocyte count as malnutrition parameters respectively, then 32.4% of patients were interpreted as malnourished; when both serum albumin level and total lymphocyte count were defined as malnutrition dependently, just 2.0% of patients were termed as malnourished. Morey et al. also reported that when they considered serum albumin level or total lymphocyte count as malnutrition parameters respectively, then 21% of patients were interpreted as malnourished; in contrast, when both serum albumin level and total lymphocyte count were defined as malnutrition dependently, only 1.6% of patients were termed as malnourished [31]. Therefore, we assume that the prevalence rate of malnutrition in TKA patients can be changed considerably by using the different definitions of parameters. In this study, serum albumin and total lymphocyte count were not directly associated with operative wound problems and periprosthetic joint infection. However, PNI which was calculated by a combination of serum albumin and total lymphocyte count affected early postoperative wound problems. This result of PNI may be unique for the prediction of postoperative complications after TKA.

There are some limitations to this study. First, we evaluated only serum albumin and total lymphocyte count levels as serological markers. However, serum albumin and total lymphocyte count were commonly assessed in previous studies. Furthermore, a novel contribution of this study is the calculation of PNI, which was associated with early postoperative aseptic wound problems after TKA. Second, laboratory examinations immediately after surgery, including serum albumin and total lymphocyte count levels, were not evaluated. Postoperative complications might be associated with nutrition status after surgery. However, in this study, we tried to detect preoperative factors of periprosthetic joint infection and aseptic wound problems. Third, there was an unfair patient population with women dominating. Our results might not be applied to other studies with different populations relative to our study. However, more women patients undergo TKA than men in Japan. In addition, we avoided its confounding effect by using multivariate regression analysis.

Despite of presence of multiple causes for periprosthetic joint infection after TKA, aseptic operative wound problems in the early phase after TKA were associated with incidence of periprosthetic joint infection. Furthermore, preoperative BMI and PNI are significant risk factors for early postoperative wound problems, and preoperative nutritional assessment may be important for avoiding postoperative complications. Therefore, in patients with high BMI or low PNI, careful attention regarding operative wound condition after TKA is required.

Declarations

Funding This study was not externally funded.

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval This research has been approved by the Institutional Review Board of the authors' affiliated institutions.

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Table 1

Demographic characteristics of the patients.

	190 patients (234 knees)
Age (yr)	74.1 ± 7.6
Sex (men/women)	48 (60 knees)/142 (174 knees)
Body height (cm)	155.6 ± 10.4
Body weight (kg)	58.1 ± 11.7
BMI (kg/m^2)	24.0 ± 4.0
Preoperative serum albumin (g/dL)	4.2 ± 0.3
Preoperative total lymphocyte count (/mm^3)	1813.7 ± 555.5
Preoperative PNI	50.7 ± 4.7
Operative duration (min)	155.4 ± 35.3
Intraoperative blood loss (g)	127.7 ± 120.6
Comorbidities	
Diabetes mellitus	45 (19.2%)
Chronic kidney disease	26 (11.1%)
coronary artery disease	9 (3.4%)
liver cirrhosis	6 (2.6%)
chronic obstructive pulmonary disease	6 (2.6%)
Postoperative aseptic wound problems within 2 weeks	20 (8.5%)
Periprosthetic joint infection	14 (6.0%)

Values are presented as numbers, mean and standard deviation, or percentage.

BMI, body mass index

PNI, prognostic nutritional index

Table 2

Comparison between patients with and without periprosthetic joint infection

	Patients without periprosthetic joint infection (n=220)	Patients with periprosthetic joint infection (n=14)	
Age (yr)	74.1 ± 7.1	77.2 ± 5.9	p=0.115
Sex (men/women)	54/166	6/8	p=0.227
Body height (cm)	152.0 ± 8.5	152.7 ± 7.6	p=0.788
Body weight (kg)	60.6 ± 11.5	64.4 ± 7.0	p=0.226
BMI (kg/m^2)	26.1 ± 3.8	27.6 ± 3.0	p=0.145
Serum albumin (g/dL)	4.2 ± 0.3	4.1 ± 0.4	p=0.593
Total lymphocyte count ($/mm^3$)	1825.2 ± 566.8	1633.4 ± 378.3	p=0.214
PNI	50.8 ± 4.8	49.1 ± 3.9	p=0.220
Operative duration (min)	155.0 ± 35.0	161.5 ± 40.1	p=0.505
Intraoperative blood loss (g)	125.9 ± 119.7	156.3 ± 135.3	p=0.365
Comorbidities	78 (35.5%)	6 (42.8%)	p=0.785
Postoperative aseptic wound problems within 2 weeks	16 (7.3%)	4 (28.6%)	p=0.022

Values are presented as number of sex, mean (standard deviation), and the rate (%) of comorbidities and complications.

BMI, body mass index

PNI, prognostic nutritional index

Table 3

Comparison between patients with and without postoperative aseptic wound problems within 2 weeks

	Patients without aseptic operative wound problems (n=214)	Patients with aseptic operative wound problems (n=20)	
Age (yr)	74.3 ± 6.9	74.2 ± 8.5	p=0.950
Sex (men/women)	56/158	4/16	p=0.736
BMI (kg/m^2)	25.8 ± 3.5	29.3 ± 4.8	p<0.001
Serum albumin (g/dL)	4.1 ± 0.3	4.1 ± 0.4	p=0.327
Total lymphocyte count (/mm^3)	1834.8 ± 554.4	1616.0 ± 541.7	p=0.096
PNI	51.0 ± 4.6	48.2 ± 5.7	p=0.015
Operative duration (min)	154.1 ± 35.0	166.4 ± 36.8	p=0.142
Intraoperative blood loss (g)	125.2 ± 117.0	152.3 ± 149.0	p=0.345
Comorbidities (%)	73 (34.1%)	11 (55.0%)	p=0.105

Values are presented as number of sex, mean (standard deviation), and the rate (%) of comorbidities.

BMI, body mass index

PNI, prognostic nutritional index