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ORIGINAL ARTICLE

The role of preoperative nutritional status in predicting surgical outcomes after total knee arthroplasty: A CONUT-based analysis

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Malnutrition is a common and modifiable risk factor which adversely impacts surgical outcomes, particularly in older adults undergoing orthopedic surgery.[1] In this population, impaired immune function, delayed wound healing and increased susceptibility to infection have been consistently associated with poor nutritional status.[2] Several studies have shown that malnutrition significantly increases the risk of surgical site infection (SSI), periprosthetic joint infection (PJI), prolonged hospitalization, intensive care unit (ICU) admission, re-operation and even mortality in patients undergoing total joint arthroplasty.[3,4] Recent meta-analyses have demonstrated that malnourished

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ABSTRACT

Objectives: This study aims to investigate the association between the preoperative Controlling Nutritional Status (CONUT) score and two important postoperative outcomes, surgical site infection (SSI) and prolonged hospital stay, in patients aged 60 years and older undergoing total knee arthroplasty (TKA).

Patients and methods: Between February 2019 and December 2023, a total of 268 patients (54 males, 214 females; mean age: 68.2±5.9 years; range, 60 to 87 years) aged ≥60 years who underwent elective primary TKA were retrospectively analyzed. The Nutritional status was assessed using the CONUT score, and patients were categorized as at nutritional risk (CONUT ≥2) or normal (CONUT 0-1). Primary outcomes were postoperative infection and length of hospitalization. Multivariate logistic regression was used to adjust for confounding variables including age, body mass index (BMI), American Society of Anesthesiologists (ASA) score, Visual Analog Scale (VAS), hemoglobin, C-reactive protein (CRP), and surgery duration.

Results: Of the patients, 27.2% (n=73) were at nutritional risk. These patients had significantly higher rates of postoperative infection (11% *vs.* 3.1%, p=0.010) and longer hospital stays (5.5±1.7 *vs.* 1.5±0.5 days, p<0.001). A higher CONUT score was independently associated with increased risk of infection (adjusted odds ratio [OR]=4.12; 95% confidence interval [CI]: 1.33-12.7; p=0.014) and prolonged hospitalization (adjusted OR=4.03; 95% CI: 3.75-4.30; p<0.001).

Conclusion: The CONUT score is a valuable tool for preoperative risk assessment in TKA. High CONUT scores are associated with an increased risk of postoperative infection and prolonged hospitalization. Routine nutritional assessment using the CONUT score prior to surgery in older adults may help improve surgical outcomes, reduce complications and lower healthcare costs.

Keywords: Geriatrics, knee arthroplasty, malnutrition, nutritional status, periprosthetic joint infections, postoperative complications, wound infection.

patients have a 2.6-fold increased risk of SSI and a 3.4-fold increased risk of PJI compared to well-nourished individuals.[4] In addition, the prevalence of malnutrition in patients scheduled for joint arthroplasty has been reported to be between 8.5 and 50%, indicating a significant proportion of patients whose surgical outcomes could be improved by targeted nutritional interventions.[2]

Various methods are available to assess nutritional status in surgical patients, including anthropometric measurements, body mass index (BMI), laboratory biomarkers and screening questionnaires.[3] In recent years, immunonutrition scoring systems have established themselves as practical and objective instruments for this purpose.[2] Among them, the Controlling Nutritional Status (CONUT) score is characterized by its simplicity, low cost and applicability based on blood parameters (serum albumin concentration, total lymphocyte counts and total cholesterol level).[5] These parameters reflect the patient's protein reserves, immunocompetence and calorific status, respectively, thereby providing a multidimensional insight into nutritional status.[6]

New evidence suggests that a higher preoperative CONUT score is associated with a higher rate of postoperative complications, longer hospital stays,[6] and higher rates of treatment failure in patients with PJI.[2] Despite these findings, the role of CONUT in predicting surgical outcomes after total knee arthroplasty (TKA), an elective surgical procedure, has not yet been sufficiently investigated. Given the high prevalence of malnutrition and the increased risk of postoperative complications in older populations, routine preoperative nutritional screening using the CONUT score could provide valuable prognostic insights and enable risk stratification.

In the present study, we aimed to investigate the association between the preoperative CONUT score and two important postoperative outcomes, SSI and prolonged hospital stay, in patients aged 60 years and older undergoing TKA.

PATIENTS AND METHODS

This single-center, retrospective, observational study was conducted at Ankara Bilkent City Hospital, Department of Orthopedics and Traumatology between February 2019 and December 2023. Patients who underwent elective primary orthopedic surgery were reviewed. Patients were retrieved from the hospital's electronic medical record system. Inclusion criteria were age ≥60 years, complete availability of preoperative laboratory and clinical data, and a minimum follow-up of two years. Patients were excluded, if they had prior history of surgery on the ipsilateral knee (arthroscopy, osteotomy, trauma etc.), and if any of the relevant laboratory parameters or postoperative clinical outcome data were missing. During the study period, 494 patients were operated at our institution, of which 110 were <60 years of age. Seventy-four patients had a history of surgery on the ipsilateral knee and 42 patients had incomplete laboratory or clinical data (Figure 1). Finally, a total of 268 patients (54 males, 214 females; mean age: 68.2±5.9 years; range, 60 to 87 years) who met the inclusion criteria were recruited. Written informed consent was obtained from each patient. The study protocol was approved by the Ankara Bilkent City Hospital Ethics Committee

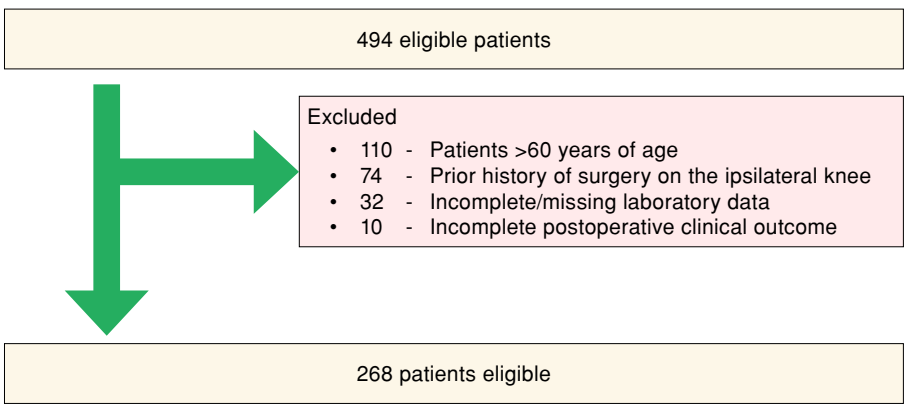


FIGURE 1. Study flowchart.

(Date: 21.05.2025, No: T1-25-1288). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Data collection and clinical assessment tools

Demographic characteristics including age, sex, BMI, surgical variables including duration of surgery, length of hospitalization, ICU admission, reoperation, and postoperative complications were recorded.

Several standardized instruments were used for clinical assessment and for ruling out confounding variables. The Charlson Comorbidity Index (CCI) was used to quantify comorbidity burden and predict 10-year survival based on chronic disease profiles.[7] The American Society of Anesthesiologists (ASA) Physical Status Classification was used to assess preoperative anesthesia risk.[8]

The Knee Society Score (KSS) and the KSS Functional Score were used to assess joint-specific outcomes and physical activity, respectively.[9] The Forgotten Joint Score (FJS), a patient-reported outcome measure, was used to assess joint perception during daily activities.[10] The Visual Analog Scale (VAS) was used to measure pain intensity on a scale from 0 (no pain) to 10 (worst pain imaginable).[11] All functional scores were recorded during the patients' final follow-up visit by a specialized orthopedic surgeon.

Laboratory data and nutritional status

Preoperative laboratory parameters included hemoglobin (g/dL), lymphocyte count (/µL), albumin (g/L), total cholesterol (mg/dL) and C-reactive protein (CRP, mg/L). At our institution, among other parameters, total cholesterol levels for older adults are required during their preoperative cardiology consultation in the vast majority of patients >60 years of age. If not present during the preoperative blood work-up, cholesterol levels were assessed using the national database (e-Pulse) and were included for analysis in the study, if they were obtained within three months from the time of surgery. All other parameters were obtained during the preoperative blood work-up.

Nutritional status was assessed using the Controlling Nutritional Status score, which integrates albumin, total cholesterol and lymphocyte count to categorize patients as normally nourished (score 0-1) or at risk of malnutrition (score 2-4: mild malnutrition risk, score 5-8: moderate malnutrition risk, score 9-12: severe malnutrition risk). Albumin contributes 0-6 points: ≥35 g/L= 0, 30-34.9= 2, 25-29.9= 4, <25= 6. Lymphocytes contribute 0-3 points: ≥1600= 0, 1200-1599= 1, 800-1199= 2, <800= 3. Cholesterol contributes 0-3 points: ≥180= 0, 140-179= 1, 100-139= 2, <100= 3. The total score ranges from 0 to 12, with higher scores indicating worse nutritional status.[5]

Outcome measures

Primary outcome variables were as follows:

1. Postoperative infection, defined as any clinically or microbiologically confirmed SSI (requiring local debridement in the operating room), periprosthetic join infection (requiring implant removal) or systemic infection (requiring in-hospital treatment) during hospitalization or follow-up.
2. Length of hospitalization, measured in days from the day of surgery to discharge.

Secondary outcome variables included admission to the ICU during the same hospitalization and the need for reoperation at any point during follow up.

Statistical analysis

Statistical analysis was performed using the IBM SPSS version 25.0 software (IBM Corp., Armonk, NY, USA). Normality of continuous variables was tested using the Shapiro-Wilk test. Continuous data were expressed in mean ± standard deviation (SD) or median (min-max), while categorical data were expressed in number and frequency. Normally distributed data were compared using the independent t-test, while non-normally distributed variables were analyzed using the Mann-Whitney U test. Categorical variables were compared using the chi-square test and Fisher exact test. Effect sizes (Cohen's d for continuous variables, Phi/Cramer's V for categorical variables) were calculated to assess the magnitude of observed differences. Univariate and multivariate logistic regression analyses were performed to determine the independent association between CONUT score and adverse postoperative outcomes. Variables with a p value <0.20 in the univariate analysis and clinically relevant factors based on previous literature were included in the multivariate models. The final models were adjusted for age, BMI, VAS, ASA score, hemoglobin, CRP and duration of surgery. The results were given in odds ratios (ORs) with 95% confidence intervals (CIs). A p value of <0.05 was considered statistically significant.

RESULTS

Among a total of 268 patients included in the study, the mean follow-up was 38.4±13.1 (range, 24 to 61)

months. Based on the CONUT score, 73 (27.2%) patients were categorized as at risk of malnutrition (CONUT ≥2), while 195 (72.8%) patients had a normal nutritional status (CONUT 0-1).

The at-risk patients had significantly lower mean preoperative albumin levels (35.8±6.1 *vs.* 44.7±2.4 g/L, p<0.001), lymphocyte counts (1532±548 *vs.* 2163±604/μL, p<0.001) and total cholesterol levels (189.4±35.8 *vs.* 207.1±31.1 mg/dL, p<0.001) compared to the patients with normal nutritional status (Table I). These results are consistent with the components used in the calculation of the CONUT score.

No statistically significant differences were found between the groups in terms of age (p=0.927), sex (p=0.808), BMI (p=0.237), follow-up time (p=0.106), CCI) (p=0.084), functional scores including KSS (p=0.629), KSS Functional Score (p=0.688), FJS (p=0.609), pain scores (VAS, p=0.143), ASA classification (p=0.189), hemoglobin (p=0.293), CRP (p=0.472), operative time (p=0.652), ICU admission (p=0.488) or the need for reoperation (p=0.213) (Table I).

Regarding surgical outcomes, patients in the CONUT risk group had a significantly longer mean hospital stay (5.5±1.7 *vs.* 1.5±0.5 days, p<0.001), and postoperative infections occurred more frequently during overall follow-up in these patients (11% *vs.* 3.1%, p=0.010). While overall infection rates were significantly different between the groups, when studied alone (as SSI, PJI and systemic infection), no significant difference was observed (p=0.506) (Table I).

In the univariate logistic regression analysis, a higher CONUT score was associated with an increased risk of postoperative infection (OR=3.87; 95% CI: 1.29-11.59; p=0.015). This association remained statistically significant

TABLE I
Baseline characteristics of the total cohort

				CONUT score ≥2							
	Total (n=268)			Yes (n=73)			No (n=195)				
Variables	n	%	Mean±SD	n	%	Mean±SD	n	%	Mean±SD	*p*	Effect size
Age (year)			68.2±5.9			68.1±5.5			68.2±6.0	0.927*	0.001
Sex										0.808†	0.015
Female	214	79.9		59	80.8		155	79.5			
BMI (kg/m²)			31.6±5.1			31.2±4.7			31.8±5.2	0.237*	0.005
Follow-up (month)			38.4±13.1			40.7±14.7			37.5±12.3	0.106*	0.007
Assessment scores											
CCI			1.18±0.9			1.3±0.9			1.1±0.5	0.084*	0.011
KSS			83.1±11.9			84.0±10.6			82.8±12.3	0.629*	0.002
KSS functional			81.6±17.5			83.9±13.2			80.7±18.8	0.688*	0.012
FJS			81.4±17.2			82.9±16.8			80.8±17.4	0.609*	0.001
VAS			1.57±1.5			1.3±1.4			1.6±1.57	0.143*	0.007
ASA			1.76±0.6			1.8±0.6			1.7±0.7	0.189*	0.006
CONUT score			1.02±1.36			2.9±1.0			0.3±0.4	**<0.001***	0.692
Laboratory parameters											
Hemoglobin (g/dL)			12.8±1.0			13.0±1.0			12.8±1.0	0.293*	0.004
Lymphocyte (μL)			1991.3±652.2			1532.0±548.0			2163.0±604.2	**<0.001***	0.212
Albumin (g/L)			42.3±5.5			35.8±6.1			44.7±2.4	**<0.001***	0.301
Total cholesterol (mg/dL)			202.3±33.3			189.4±35.8			207.1±31.1	**<0.001***	0.051
CRP (mg/L)			7.4±9.4			7.0±12.5			7.5±8.0	0.472*	0.001
Surgical duration (min)			84.4±17.3			83.3±17.2			84.8±17.3	0.652*	0.011
Length of hospital stay (day)			2.6±2.0			5.5±1.7			1.5±0.5	**<0.001***	0.652
ICU admission requirement (yes)	11	4.1		4	5.5		7	3.6		0.488†	0.042
Postoperative infection (yes)	14	5.2		8	11		6	3.0		**0.010†**	0.158
Surgical wound site infection	7	2.6		4	5.5		2	1.0			
Periprosthetic join infection	3	1.1		1	1.4		2	1.0		0.506†	0.312
Systemic infection	4	1.5		3	4.1		2	1.0			
Reoperation requirement (yes)	15	5.6		2	2.7		13	6.7		0.213†	0.076

CONUT: Controlling nutritional status; SD: Standard deviation; BMI: Body mass index; CCI: Charlson Comorbidity Index; KSS: Knee Society Score; FJS: Forgotten joint score; VAS: Visual Analog Scale; ASA: American Society of Anesthesiologists Physical Status Classification; CRP: C-reactive protein; ICU: Intensive care unit; * Mann-Whitney U test; † Chi-square test.

TABLE II
Association between CONUT score and postoperative infection

	Unadjusted			Adjusted		
	OR	95% CI	*p*	OR	95% CI	*p*
CONUT	3.87	1.29-11.59	**0.015**	4.12	1.33-12.7	**0.014**

CONUT: Controlling nutritional status; OR: Odds ratio; CI: Confidence interval; Adjusted for: age, BMI, VAS, ASA, hemoglobin, C-reactive protein, surgical duration.

TABLE III
Association between CONUT score and length of hospital stay

	Unadjusted			Adjusted		
	OR	95% CI	*p*	OR	95% CI	*p*
CONUT	4.03	3.76-4.31	**<0.001**	4.03	3.75-4.30	**<0.001**

CONUT: Controlling nutritional status; OR: Odds ratio; CI: Confidence interval; Adjusted for: age, BMI, VAS, ASA, hemoglobin, C-reactive protein, surgical duration.

after adjustment for age, BMI, VAS, ASA score, hemoglobin, CRP and duration of surgery (adjusted OR=4.12; 95% CI: 1.33-12.7; p=0.014) (Table II).

Similarly, a higher CONUT score was strongly associated with a longer hospital stay, both in unadjusted (OR=4.03; 95% CI: 3.76-4.31; p<0.001) and adjusted analyses (OR=4.03; 95% CI: 3.75-4.30; p<0.001), independent of other clinical and laboratory variables (Table III).

DISCUSSION

In the present study, we investigated the association between the preoperative CONUT score and SSI and prolonged hospital stay in patients aged 60 years and older undergoing TKA. The main finding of this study is that a preoperative CONUT score was significantly associated with postoperative presence of infection and prolonged hospital stay in patients undergoing TKA.[12] Risk of malnutrition, defined by a CONUT score ≥2, was found to be an independent risk factor, even after adjustment for confounding variables such as age, BMI, ASA score, hemoglobin, CRP and duration of surgery. These results emphasize that the CONUT score is a simple, objective and clinically useful tool for risk stratification in TKA surgery.

In our cohort, the overall postoperative infection rate was 5.2% and increased to 11% in patients with a high CONUT score, compared with only 3.1% in well-nourished individuals during an overall mean follow-up of 38 months. Specific infection subtypes (SSI, PJI and systemic infection) were similar in rates within the subgroup at risk. These results are largely consistent with previous studies. A recent meta-analysis by Chen and Chen[4] found that the incidence of SSI in patients undergoing total joint arthroplasty ranged from 3 to 6%, with malnourished patients 3.4 times more likely to have an infection than their well-nourished counterparts.[4] In addition, studies in abdominal, thoracic and urological surgery have shown that malnutrition increases the incidence of postoperative infection and delays recovery, emphasizing the universal importance of malnutrition as a risk factor regardless of surgical specialty.[13-17]

The average length of hospitalization was 2.6 days in the entire study population, but was significantly longer in the malnourished patients (5.5±1.7 days *vs.* 1.5±0.5 days). The length of stay in orthopedic wards in our community is usually due to prolonged local wound discharges, which, among other things, are also related to poor nutritional support before and after surgery. Malnutrition is known to impair wound healing and inadequate tissue repair contributes indirectly to a longer hospitalization period.[18,19] These findings are consistent with those of Misevic et al.[17] who found a significant association between CONUT score and prolonged hospitalization time in patients undergoing gastrointestinal surgery. While TKA is often associated with short hospital stays due to improved perioperative care and early mobilization, malnutrition can negate these benefits and lead to delayed recovery and increased complication rates.

Of an interesting note is the fact that postoperative clinical functional scores, as well as the CCI, were not different between the groups. Clinical scores have not been previously included in studies dealing with malnutrition after knee (or other joint) arthroplasty. This emphasizes the point that malnutrition alone, or the risk of it, is not sufficient to impair clinical function and that other mechanisms are at play in dissatisfied TKA patients.[20-22] Further studies are required to elucidate the relationship between malnutrition and overall clinical function after arthroplasty surgery.

Our findings are consistent with the growing body of evidence that emphasizes the negative impact of poor nutritional status on surgical outcomes. Malnutrition has been strongly associated with an increased risk of complications in surgical patients.[3,6,23] Mechanistically, immunosuppression, reduced defense against infection, impaired wound healing and inadequate tissue repair contribute to this increased risk.[18,19] Hypoproteinemia and lymphocytopenia have been shown to significantly increase susceptibility to infection.[2,18,23] Phillips et al.[23] emphasized the clinical benefit of serum-based nutritional indices, such as the CONUT score, which integrates albumin, lymphocyte and cholesterol levels, in total joint arthroplasty. A systematic review confirmed that malnutrition was not only associated with a higher risk of PJIs, but also with a longer hospital stay, a higher readmission rate and a higher overall mortality.[3,4] In addition, studies from various surgical fields including gastrointestinal and cardiac surgery have confirmed that malnutrition is a universal risk factor for surgical complications.[24-26]

The CONUT score derived from routine laboratory parameters is a practical, inexpensive and effective method for identifying patients at high risk of postoperative complications. It reflects protein reserves, immunocompetence and calorie intake based on serum albumin, lymphocyte and total cholesterol levels, respectively.[2,5] Due to its ease of use and reproducibility, it is particularly useful in high-volume orthopedic facilities where malnutrition in older adults often goes unrecognized. In addition, the CONUT score has demonstrated its predictive validity for postoperative complications and prolonged hospitalization in other elective surgical procedures such as thoracic surgery, colorectal surgery and hepatobiliary surgery which further supports its broad applicability.[17,27-29]

Nonetheless, this study has several limitations. The retrospective design at a single center may limit generalizability and lead to selection bias. Long-term functional outcomes, patient-reported quality of life and reoperation reasons were not analyzed, which could have provided further insight into the clinical relevance of preoperative nutritional screening. Although the CONUT score covers critical nutritional components, it does not assess functional status (e.g., sarcopenia) or micronutrient deficiencies. In addition, our study population was limited to patients over 60 years of age undergoing TKA, which may limit its applicability to younger patients or other surgical groups. Biochemical parameters were collected at a single preoperative time point, and not all potential confounding variables, such as smoking status, diabetes control or physical activity were included in the analysis. Finally, almost all patients included in this study were the ones requiring a cardiology consultation or somehow required cholesterol tests. Keeping in mind that hypercholesterolemia is often related to metabolic conditions, it has the potential to affect how malnutrition affects the response of the body to surgical trauma, including postoperative outcomes and infections. This is a further limitation since it carries the risk of potential selection bias into the final results.

In conclusion, the CONUT score is a valuable tool for preoperative risk assessment in TKA surgery. High CONUT scores are associated with an increased risk of postoperative infection and prolonged hospitalization. Routine nutritional assessment using the CONUT score prior to surgery in older adults may help improve surgical outcomes, reduce complications and lower healthcare costs.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

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