Age-Adjusted 5-factor Modified Frailty Index as a Valuable Tool for Patient Selection in Bilateral Simultaneous Total Knee Arthroplasty

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INTRODUCTION:
Bilateral simultaneous total knee arthroplasty (BSTKA) is a cost-effective intervention for patients with end-stage bilateral knee osteoarthritis, offering advantages such as shorter hospital stays and faster postoperative functional recovery compared to staged bilateral TKA. However, concerns remain regarding the safety profile of BSTKA, especially in high-risk patients, and the lack of validated risk stratification models specifically tailored for the selection of BSTKA candidates. The aim of this study was to determine (1) the complication rate after BSTKA and (2) the role of frailty in guiding patient selection using the age-adjusted 5-factor modified Frailty Index (aamFI-5).
METHODS:
We retrospectively reviewed the clinical and demographic data of 472 patients (944 knees) who underwent BSTKA between February 2012 and January 2021. After excluding 38 patients (76 knees) without at least one year of follow-up, 434 patients (868 knees) were eligible for analysis. We collected demographic factors including age, sex, body mass index (BMI), preoperative diagnosis, age-adjusted Charlson Comorbidity Index (ACCI), American Society of Anesthesiologists (ASA) score, and aamFI-5. Preoperative blood test results including hemoglobin, albumin, estimated glomerular filtration rate (eGFR), and D-dimer levels were also analyzed. Univariate and multivariate logistic regression analyses were used to evaluate the contribution of these factors to one-year postoperative complications after BSTKA.
RESULTS:
Complications occurred in 77 patients (18%) within one year after BSTKA. The most common complication was anemia requiring transfusion in 26 patients (5.9%), followed by delirium in 12 patients (2.8%), and delayed wound healing and heart failure in 11 patients each (2.5%). Univariate logistic regression analysis identified several risk factors for postoperative complications, including age ≥ 75 years ($p = 0.004$), ACCI ≥ 5 ($p = 0.003$), aamFI-5 ≥ 3 ($p < 0.001$), hemoglobin ≤ 11.0 ($p < 0.001$), albumin ≤ 3.5 ($p = 0.018$), eGFR < 45 ($p = 0.003$), and D-dimer ≥ 2.0 ($p = 0.001$). However, multivariate logistic regression analysis revealed that aamFI-5 ≥ 3 was the only independent risk factor for complications, with an odds ratio of 3.0 ($p = 0.002$). Patients with aamFI-5 ≥ 3 had a complication rate of 40% (23 of 58 patients) compared to 14% (54 of 376 patients) for those with aamFI-5 < 3 ($p < 0.001$).
DISCUSSION AND CONCLUSION:
This study highlights the practical utility of aamFI-5 in predicting postoperative complications after BSTKA, outperforming traditional scoring systems such as ACCI and ASA scores. The results suggest that frailty, as measured by the aamFI-5, is a significant predictor of adverse outcomes and should be incorporated into preoperative assessment to improve patient selection. Preoperative nutritional optimization, especially in patients with hypoalbuminemia, and careful assessment of anemia and renal function are recommended to reduce risk. Further research is warranted to validate these findings and refine risk stratification models to improve clinical outcomes in candidates for BSTKA.

LEGENDS

Table I. Patient demographic and surgical parameters (n = 434 patients [868 knees])

Table II. Postoperative complications (n = 434 patients [868 knees])

Table III. Logistic regression analysis of risk factors for complication after bilateral simultaneous total knee arthroplasty (R^2 = 0.09, p <0.001)

Table I. Patient demographic and surgical parameters (n = 434 patients [868 knees])

Parameter	
Age* *(years)*	76 (70–80)
Sex†	
Male	77 (18)
Female	357 (82)
Body mass index* *(kg/m²)*	26 (24–29)
Diagnosis†	
Osteoarthritis	416 (96)
Rheumatoid arthritis	18 (4.1)
American Society of Anesthesiologists score†	
1	67 (15)
2	341 (79)
3	26 (6)
Age-adjusted Charlson Comorbidity Index†	
0–2	52 (12)
3–4	267 (62)
≤ 5	115 (26)
Age-adjusted 5-item modified Frailty Index†	
0	46 (11)
1	141 (32)
2	189 (44)
3	52 (12)
4	6 (1.4)
Follow-up period* *(months)*	47 (24–71)
Operation time* *(min)*	109 (99–120)
Intra- and postoperative bleeding* *(ml)*	690 (430–910)

*Values are presented as the median (interquartile range); †Values are presented as numbers (%).

Table II. Postoperative complications (n = 434 patients [868 knees])

Complications	Number of patients (%)
Anemia requiring transfusion	26 (5.9)
Delirium	12 (2.8)
Delayed wound healing	11 (2.5)
Cardiovascular complication	11 (2.5)
Congestive heart failure	9 (2.1)
Arrhythmia	2 (0.5)
Symptomatic thrombosis	8 (1.8)
Pulmonary embolism	6 (1.4)
Deep vein thrombosis	2 (0.5)
Prosthesis infection	7 (1.6)
Gastrointestinal disorder	6 (1.4)
Gastrointestinal ulcer	3 (0.7)
Cholecystitis	3 (0.7)
Renal complication	4 (0.9)
Acute kidney failure	4 (0.9)
Respiratory complication	3 (0.7)
Pneumonia	3 (0.7)

Table III. Logistic regression analysis of risk factors for complication after bilateral simultaneous total knee arthroplasty (R^2 = 0.09, p <0.001)

Parameter	Univariate		Multivariate	
	Odds ratio (95% CI)	p-value	Risk ratio (95% CI)	p-value
Demographic factors				
Age ≥ 75 *(years)*	2.2 (1.3–3.8)	0.004	1.4 (0.8–2.6)	0.257
Sex (men)	1.3 (0.7–2.4)	0.442		
Body mass index ≤ 18.5 or > 25 *(kg/m²)*	0.9 (0.5–1.4)	0.575		
Diagnosis (Rheumatoid arthritis)	2.4 (0.9–6.7)	0.085		
ASA score ≥ 3	1.4 (0.6–3.7)	0.464		
ACCI ≥ 5	2.2 (1.3–3.7)	0.003	1.0 (0.5–2.1)	0.967
aamFI-5 ≥ 3	3.9 (2.2–7.1)	< 0.001	3.0 (1.5–5.9)	0.002
Preoperative laboratory tests				
WBC ≤ 3000 or ≥ 10,000 *(/mm³)*	0.7 (0.1–5.4)	0.697		
Hemoglobin ≤ 11.0 *(g/dL)*	3.4 (1.6–7.0)	< 0.001	1.9 (0.8–4.5)	0.121
Platelet ≤ 100,000 *(/μl)*				
CRP ≥ 1.0 *(mg/dl)*	2.3 (0.9–5.8)	0.083		
Total protein < 6.5 *(g/dL)*	1.2 (0.4–3.6)	0.786		
Albumin ≤ 3.5 *(g/dL)*	2.7 (1.2–6.0)	0.018	1.2 (0.4–3.2)	0.741
eGFR < 45 *(ml/d/1.73m²)*	2.8 (1.4–5.6)	0.003	1.8 (0.7–4.6)	0.203
D-dimer ≥ 2.0 *(μg/mL)*	2.9 (1.5–5.5)	0.001	2.1 (1.0–4.3)	0.053

ASA = American Society of Anesthesiologists; ACCI = age-adjusted Charlson Comobidity Index; aamFI-5 = age-adjusted 5-factor modified frailty index; WBC = White Blood Cells; CRP = C-reactive protein; eGFR = estimated glomerular filtration rate.