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ORIGINAL RESEARCH

Impact of preoperative frailty on choice of anesthesia modality and outcomes in elderly total joint replacement patients

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Abstract

This study investigated the correlation between the degree of frailty and postoperative adverse outcomes after total joint arthroplasty (TJA) in patients undergoing TJA who received general anesthesia (GA) or intraspinal anesthesia (IA). The cohort comprised 660 elderly patients who underwent TJA and were assessed using the Fatigue, Resistance, Ambulation, Illness and Loss of Weight (FRAIL) scale. A total of 660 patients aged 65 years or older who underwent elective total joint arthroplasty were included in the analysis. Of them, 182 (27.58%) were identified as frail. GA was performed in 252 patients and IA in 408 patients. The type of anesthesia did not significantly affect outcomes across the Healthy, Pre-frailty and Frailty groups ($p > 0.05$). During the 1-year follow-up period, 78 deaths occurred: 3 in the Healthy group, 16 in the Pre-frailty group, and 59 in the Frailty group, revealing significant differences in mortality rates among these groups ($p < 0.05$). Multivariate logistic regression analysis indicated that frailty significantly increased the risk of 1-year postoperative mortality following total joint arthroplasty in this elderly cohort ($p < 0.05$). Specifically, the Frailty group exhibited a 2.674-fold higher risk of 1-year postoperative death compared to the Healthy group. Further analysis within the frail elderly population demonstrated that GA was a significant predictor of increased 1-year postoperative mortality risk ($p < 0.05$), with frail patients undergoing GA experiencing a 2.958-fold higher risk of death within one year post-operation compared to those receiving IA. In conclusion, the results support prioritizing IA in frail elderly patients to minimize the adverse effects of GA on long-term mortality risk.

Keywords

Total joint arthroplasty; Elderly; Anesthesia; Frailty; Risk of death

1. Introduction

Total joint arthroplasty (TJA), predominantly involving total hip replacement (THR) and total knee replacement (TKR), is a common orthopedic procedure in elderly patients despite being associated with significant bleeding, substantial surgical trauma, and prolonged recovery periods. Therefore, the selection of an appropriate anesthetic technique is important for ensuring perioperative safety. Presently, there are many controversies about the selection of the optimal anesthesia regimen for patients treated with TJA [1, 2]. General anesthesia (GA) offers comfort but is associated with an increased incidence of postoperative adverse events related to anesthetic drugs and mechanical ventilation. On the other hand, intraspinal anesthesia (IA) provides effective anesthesia and analgesia in elderly patients, including those with hip fractures. However, challenges such as hemodynamic instability post-IA and technical difficulties in performing spinal punctures due to degenerative spinal changes in the elderly should not be overlooked in clinical practice.

Elderly patients undergoing TJA often present with severe preoperative conditions and numerous medical complications. The preoperative consultation and evaluation are paramount in the preparatory phase before surgery. In recent years, the evaluation of preoperative frailty has gained significant attention. Frailty, a geriatric syndrome, reflects a decreased reserve capacity and resilience in aging individuals, increasing their vulnerability to adverse health outcomes. Even minor stressors can precipitate a marked decline in health status, making frailty an early indicator of deteriorating bodily function and health [3]. Studies have shown that preoperative frailty is associated with a reduced ability to live independently after total joint replacement, with a higher risk of in-hospital complication rates and reoperation rates [4]. Moreover, frail patients exhibit a markedly higher risk of mortality one year after surgery, with the risk exceeding fivefold for THR [4]

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and eightfold for TKR [5]. Consequently, early assessment of frailty is becoming increasingly acknowledged as essential for deciding on the appropriateness of joint replacement surgery and the choice of anesthesia regimen [6]. However, the impact of different anesthetic techniques on postoperative outcomes in elderly, frail patients undergoing total joint replacement remains unknown.

In this study, we examined the relationship between the choice of anesthetic regimen (GA *vs.* IA) for TJA patients and the association between the level of preoperative frailty and adverse outcomes following THR or TKR.

2. Materials and methods

2.1 Study population

Data from elderly patients who underwent elective TJA at the Affiliated Hospital 2 of Nantong University between October 2019 and October 2022 were included in this study. The inclusion criteria were as follows: (1) elderly patients undergoing elective unilateral total hip or total knee arthroplasty (including primary and revision surgeries); (2) age ≥65 years; (3) a preoperative American Society of Anesthesiology (ASA) of grade I to IV; (4) underwent GA or IA during surgery; and (5) provision of informed consent from the patients and their families who were able to cooperate with preoperative questionnaires and postoperative follow-ups.

The exclusion criteria for the study were as follows: (1) presence of combined spinal, craniocerebral, and rib fractures, along with multiple internal organ injuries; (2) participation in another clinical trial within the past 3 months; (3) severe hearing, reading, or verbal communication disorders that hindered normal communication; (4) dementia or severe cognitive dysfunction that made it impossible for the participant to cooperate with survey completion; (5) a history of severe psychiatric disorders that led to refusal or inability to cooperate with the study requirements; and (6) refusal to participate by the patient or their family members.

2.2 Frailty evaluation

Upon hospital admission, the degree of frailty was evaluated by an anesthesiologist not involved in the subsequent follow-up study, utilizing the Fatigue, Resistance, Ambulation, Illness, and Loss of Weight (FRAIL) screening scale, a validated tool endorsed by clinical practice guidelines to assess a patient's frailty level through a simple questionnaire [7]. The FRAIL scale consists of 5 questions with a total score of 5, in which a higher score indicates a more severe level of frailty. A score of 0 was categorized as healthy, 1–2 as pre-frail, and a score of 3 or above was classified as frail.

2.3 Data collection

General information, including age, gender, body mass index (BMI), ASA classification, complications, hemoglobin, albumin, operative time, bleeding and total rehydration, was routinely collected during the perioperative period.

2.4 Assessment of outcome indicators

The primary outcome was the incidence of mortality one year after surgery. Secondary outcomes included (1) duration of hospital stay and associated hospitalization costs; (2) incidence of complications during hospitalization, including postoperative delirium, postoperative pulmonary infection, deep vein thrombosis, and surgical site infection; and (3) mortality rates at 30 and 90 days postoperatively.

2.5 Statistical analysis

Data were assessed using IBM SPSS Statistics for Macintosh (version 23.0, Chicago, IL, USA). Continuous variables with a normal distribution are presented as mean ± standard deviation and analyzed using the independent samples *t*-test. Categorical data were analyzed using the χ^2 test or Fisher's exact probability method. To identify factors affecting postoperative outcomes, one-way analysis was conducted to screen for relevant variables, followed by multivariable logistic regression to pinpoint independent predictors of the study outcomes. The goodness of fit for the model was assessed using the Hosmer-Lemeshow test, with a p-value > 0.05 indicating no significant deviation between predicted and observed values. Statistical significance was set at a p-value < 0.05.

3. Results

3.1 Baseline characteristics

The study included a total of 660 patients aged 65 years or older who underwent elective TJA (Fig. 1, Table 1). The average age of participants was 72.50 ± 4.91 years, with 366 (55.45%) being male and 182 (27.58%) classified as frail. Anesthesia was administered as GA in 252 patients and IA in 408 patients. Incidences of postoperative delirium were reported in 95 cases (14.39%) during the hospitalization period following surgery. Mortality rates were 0.30% (2 cases) at 90 days postoperative and 11.82% (78 cases) at one year postoperative.

3.2 Comparison of general information and perioperative conditions

Gender, BMI, smoking, ASA classification, comorbidities, anesthesia method, blood loss, total rehydration, hospitalization duration, and hospitalization cost was not significantly different between the Healthy group, Pre-frailty group, and Frailty group ($p > 0.05$, Table 2). In contrast, statistically significant differences were observed in age, surgical duration, preoperative albumin levels, and preoperative hemoglobin levels among these groups ($p < 0.05$, Table 2). Furthermore, the analysis of postoperative complications indicated that the incidences of postoperative delirium and surgical site infections differed significantly across the Healthy, Pre-frailty, and Frailty groups ($p < 0.05$, Table 2).

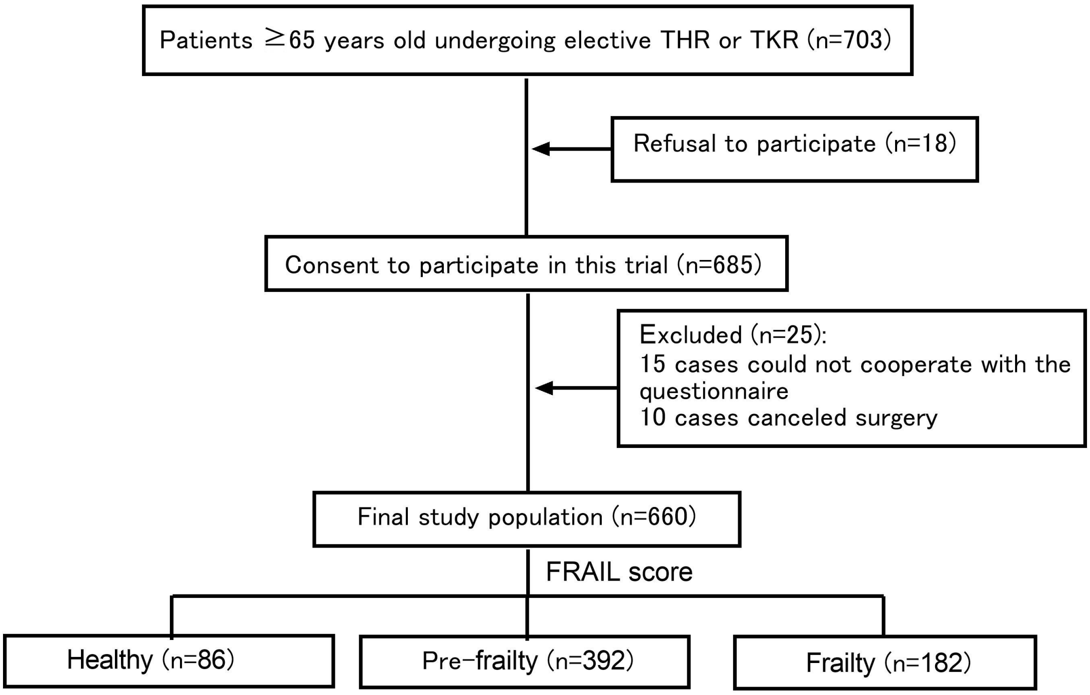

FIGURE 1. Diagram for participant flow. THR: total hip replacement; TKR: total hip replacement; FRAIL: Fatigue, Resistance, Ambulation, Illness, and Loss of Weight.

3.3 Univariate analysis of 1-year postoperative mortality after TJA in the overall elderly population

At the 1-year follow-up, there were a total of 78 deaths, with 3 in the Healthy group, 16 in the Pre-frailty group, and 59 in the Frailty group ($p < 0.05$, Table 3). Statistically significant differences were observed between the deceased and surviving patients in terms of type of surgery, age, BMI, preoperative albumin levels, and preoperative hemoglobin levels ($p < 0.05$, Table 3). Furthermore, the incidence of postoperative complications such as delirium, sepsis, myocardial infarction, and surgical site infection was significantly higher in the deceased group compared to the surviving group ($p < 0.05$, Table 3).

3.4 Multivariate logistic regression analysis of the risk of death one year after TJA in the overall elderly population

Multivariate logistic regression analysis revealed that frailty, age, preoperative albumin levels and surgical site infection were independent predictors of the risk of 1-year postoperative mortality following TJA in the elderly population ($p < 0.05$). Specifically, compared to the healthy population, the frailty group exhibited a 2.674-fold increased risk of 1-year postoperative mortality (Table 4).

3.5 Univariate and multivariate analysis of the risk of 1-year postoperative mortality after TJA in the frailty elderly population

In the subsequent analysis focusing on risk factors for 1-year postoperative mortality after TJA in elderly patients with frailty, univariate logistic regression analysis identified age, anesthetic modality, preoperative albumin levels, preoperative hemoglobin levels, pulmonary complications, surgical site infection, and perioperative blood transfusion as associated with increased mortality risk ($p < 0.05$, Table 5). Then, multivariate logistic regression analysis determined that age, GA, preoperative albumin levels, preoperative hemoglobin levels, surgical site infection, and perioperative blood transfusion were independent predictors of 1-year postoperative mortality risk in this group ($p < 0.05$, Table 5). Notably, compared to IA, the use of intraoperative GA was associated with a 2.958-fold higher risk of 1-year postoperative death in elderly patients with frailty.

4. Discussion

Using perioperative interventions to reduce postoperative complications and mortality in TJA can decrease hospitalization costs and secondary morbidity while enhancing patient satisfaction and quality of life. The choice of anesthesia plays an important role in optimizing surgical outcomes and facilitating postoperative recovery. Anesthesia techniques for TJA patients can be categorized based on the site of action into GA and IA. Compared to GA, IA is associated with faster operation times, reduced postoperative complications, shorter hospital stays, and decreased hospital expenses. Nonetheless, the selection of anesthesia involves complex decision-making that must account for the patient's health status, the expertise of the surgeon and anesthesiologist, and the recommendations of various clinical guidelines. Moreover, certain patient-specific factors, which are challenging to ascertain from systematically managed databases, limit the precision of information available to patients and their healthcare teams when choosing an anesthesia modality.

TABLE 1. Baseline characteristics of the investigated cohort.

Variables	Data
Healthy, n (%)	86 (13.03%)
Pre-frailty, n (%)	392 (59.39%)
Frailty, n (%)	182 (27.58%)
Surgery type, n (%)	
THR	373 (56.52%)
TKR	287 (43.48%)
Age (yr)	72.50 ± 4.91
Gender, n (%)	
Male	366 (55.45%)
Female	294 (44.55%)
BMI (kg/m^2)	23.07 ± 3.03
Smoking, n (%)	409 (61.97%)
ASA, n (%)	
I	21 (3.18%)
II	267 (40.45%)
III	354 (53.64%)
IV	18 (2.73%)
Hypertensive, n (%)	493 (74.70%)
Diabetes, n (%)	450 (68.18%)
Arrhythmia, n (%)	3 (0.45%)
Chronic obstructive pulmonary disease, n (%)	5 (0.15%)
Chronic pneumonia, n (%)	11 (1.67%)
Coronary heart disease, n (%)	12 (1.82%)
Chronic renal insufficiency, n (%)	8 (1.21%)
Immune diseases, n (%)	36 (5.45%)
Central nervous system diseases, n (%)	12 (1.82%)
Asthma, n (%)	5 (0.15%)
Acute bronchitis, n (%)	6 (0.91%)
Anemia, n (%)	12 (1.82%)
Cancer, n (%)	12 (1.82%)
Anesthesia method, n (%)	
GA	252 (38.18%)
IA	408 (61.82%)
Albumin (g/L)	39.30 ± 8.20
Hemoglobin (g/L)	118.45 ± 17.91
Surgical time (min)	77.88 ± 18.39
Length of hospitalization (d)	12.58 ± 4.41
Hospitalization cost (¥)	69,261.13 ± 12,389.78
Postoperative delirium, n (%)	95 (14.39%)
Pulmonary complications, n (%)	49 (7.42%)
Sepsis, n (%)	2 (0.30%)
Urinary tract infection, n (%)	8 (1.21%)
Myocardial infarction, n (%)	3 (0.45%)
Surgical site infection, n (%)	47 (7.12%)
Perioperative blood transfusion, n (%)	28 (4.24%)
Lower extremity deep vein thrombosis, n (%)	25 (3.78%)
Reoperation, n (%)	17 (2.58%)
Deaths at 30 days, n (%)	0 (0)
Deaths at 90 days, n (%)	2 (0.30%)
Deaths 1 year after surgery, n (%)	78 (11.82%)

THR: total hip replacement; TKR: total hip replacement; GA: general anesthesia; IA: intraspinal anesthesia; BMI: body mass index; ASA: American Society of Anesthesiology sore; ¥: Chinese yuan (CNY).

TABLE 2. Comparison of general information and perioperative condition between the investigated cohorts.

Variables	Healthy (n = 86)	Pre-frailty (n = 392)	Frailty (n = 182)	t/χ^2	*p*
Surgery type					
THR	57	231	85	2.307	0.316
TKR	39	168	80		
Age (yr)	70.84 ± 2.17	72.68 ± 5.20	72.89 ± 5.04	5.870	0.003
Gender					
Male	46	222	98	0.545	0.761
Female	40	170	84		
BMI (kg/m^2)	22.94 ± 3.19	23.22 ± 3.00	22.83 ± 3.01	1.132	0.323
Smoking	59	234	116	2.709	0.258
ASA					
I	3	12	6	9.838	0.132
II	26	157	84		
III	53	216	85		
IV	4	7	7		
Hypertensive	59	293	141	2.431	0.297
Diabetes	62	268	120	1.037	0.596
Arrhythmia	1	0	2	4.413	0.110
Chronic obstructive pulmonary disease	0	3	2	0.939	0.625
Chronic pneumonia	2	2	1	1.793	0.408
Coronary heart disease	5	4	3	6.582	0.037
Chronic renal insufficiency	3	3	2	4.394	0.111
Immune diseases	3	26	7	2.613	0.271
Central nervous system diseases	0	7	5	2.475	0.290
Asthma	0	2	3	2.896	0.235
Acute bronchitis	0	3	3	1.983	0.371
Anemia	0	7	5	2.475	0.290
Cancer	2	9	1	2.266	0.322
Albumin (g/L)	45.85 ± 5.37	38.52 ± 7.91	37.89 ± 8.51	35.189	<0.001
Hemoglobin (g/L)	132.07 ± 10.76	117.18 ± 17.85	114.77 ± 17.91	32.541	<0.001
Anesthesia method					
GA	39	144	69	2.225	0.329
IA	47	248	113		
Surgical time (min)	76.11 ± 18.60	76.95 ± 18.46	80.71 ± 17.93	3.076	0.047
Length of hospitalization (d)	12.65 ± 4.31	12.45 ± 4.41	12.82 ± 4.46	0.450	0.638
Hospitalization Cost (¥)	69,574.94 ± 11,965.11	68,711.42 ± 12,472.22	70,296.82 ± 12,403.73	1.049	0.351
Postoperative delirium	4	21	70	118.161	<0.001
Pulmonary Complications	3	33	13	2.523	0.283
Sepsis	0	0	2	5.185	0.075
Urinary tract infection	1	5	2	0.034	0.983
Myocardial infarction	0	1	2	2.407	0.300
Surgical site infection	3	12	32	41.599	<0.001
Perioperative blood transfusion	5	14	9	1.178	0.555
Lower extremity deep vein thrombosis	4	16	5	0.809	0.667
Reoperation	0	11	6	2.734	0.255
Deaths at 30 days	0	0	0	-	-
Deaths at 90 days	0	0	2	5.169	0.075

THR: total hip replacement; TKR: total hip replacement; GA: general anesthesia; IA: intraspinal anesthesia; BMI: body mass index; ASA: American Society of Anesthesiology sore; ¥: Chinese yuan (CNY).

TABLE 3. Univariate analysis of the risk of 1-year postoperative mortality after TJA in the overall elderly population.

Variables	Survive (n = 582)	Death (n = 78)	t/χ^2	p
Preoperative status				
Healthy	83	3		
Pre-frailty	376	16	90.503	<0.001
Frailty	123	59		
Surgery type				
THR	328	45	0.050	0.823
TKR	254	33		
Age (yr)	72.30 ± 4.91	74.01 ± 4.65	2.920	0.004
Gender				
Male	255	39	1.065	0.302
Female	327	39		
BMI (kg/m^2)	23.16 ± 3.04	22.44 ± 2.91	1.975	0.049
Smoking	357	52	0.828	0.363
ASA				
I	18	3		
II	231	36	1.476	0.688
III	317	37		
IV	16	2		
Hypertensive	432	61	0.576	0.448
Diabetes	399	51	0.319	0.572
Arrhythmia	2	1	1.339	0.274
Chronic obstructive pulmonary disease	4	1	0.324	0.569
Chronic pneumonia	8	3	2.564	0.109
Coronary heart disease	9	3	2.038	0.153
Chronic renal insufficiency	6	2	1.350	0.245
Immune diseases	30	36	0.859	0.354
Central nervous system diseases	10	2	0.276	0.600
Asthma	5	0	0.675	0.411
Acute bronchitis	5	1	0.137	0.712
Anemia	9	3	2.038	0.153
Cancer	10	2	0.276	0.600
Albumin (g/L)	40.31 ± 7.97	31.79 ± 5.57	9.135	<0.001
Hemoglobin (g/L)	119.17 ± 17.88	113.10 ± 17.35	2.824	0.005
Anesthesia				
GA	215	35	1.838	0.175
IA	367	43		
Surgical time (min)	77.71 ± 18.15	79.14 ± 20.14	0.647	0.518
Length of hospitalization (d)	12.64 ± 4.41	12.09 ± 4.37	1.040	0.299
Hospitalization Cost (¥)	69,238.36 ± 12,474.25	69,431.01 ± 11,816.07	−0.129	0.898
Postoperative delirium	67	28	33.193	<0.001
Pulmonary complications	39	10	3.748	0.053
Sepsis	0	2	7.793	0.013
Urinary tract infection	6	2	1.350	0.245
Myocardial infarction	1	2	4.216	0.040
Surgical Site infection	28	19	36.838	<0.001
Perioperative blood transfusion	22	6	2.591	0.107
Lower extremity deep vein thrombosis	21	4	0.436	0.509
Reoperation	13	4	2.296	0.130
Deaths at 30 days	0	0	-	-
Deaths at 90 days	1	1	0.334	0.563

THR: total hip replacement; TKR: total hip replacement; GA: general anesthesia; IA: intraspinal anesthesia; BMI: body mass index; ASA: American Society of Anesthesiology sore; ¥: Chinese yuan (CNY).

TABLE 4. Multivariate analysis of the risk of 1-year postoperative mortality after TJA in the overall elderly population.

Variables	B	S.E.	Wald	*p*	OR	95% CI
Healthy			55.004		1.000	
Pre-frailty	1.589	0.712	4.981	0.326	0.204	0.051–0.824
Frailty	0.984	0.658	2.235	0.005	2.674	0.736–9.710
Age	0.073	0.029	6.586	0.010	1.076	1.018–1.138
Albumin	−0.169	0.024	51.300	<0.001	0.845	0.807–0.885
Surgical Site Infection	0.917	0.440	4.339	0.037	2.501	1.056–5.927

S.E.: standard error; OR: Odds Ratio; CI: confidence interval.

TABLE 5. Univariate and multivariate analysis of the risk of 1-year postoperative mortality after TJA in the frailty elderly population.

Variables	Univariate analysis			Multivariate analysis		
	p	OR	95% CI	*p*	OR	95% CI
Age	0.011	1.085	1.019–1.156	0.018	1.100	1.016–1.190
Male	0.380	0.757	0.406–1.410	-	-	-
BMI	0.072	0.907	0.816–1.009	-	-	-
Smoking	0.431	1.302	0.676–2.509	-	-	-
ASA						
I	0.951	1.000		-	-	-
II	0.953	1.055	0.182–6.105	-	-	-
III	0.888	0.881	0.152–5.118	-	-	-
IV	0.853	0.800	0.076–8.474	-	-	-
Hypertensive	0.625	1.208	0.566–2.580	-	-	-
Diabetes	0.302	1.425	0.728–2.792	-	-	-
Arrhythmia	0.601	2.103	0.129–34.225	-	-	-
Chronic obstructive pulmonary disease	0.601	2.103	0.129–34.225	-	-	-
Chronic pneumonia	0.239	4.281	0.380–48.187	-	-	-
Coronary heart disease	0.601	2.103	0.129–34.225	-	-	-
Chronic renal insufficiency	0.601	2.103	0.129–34.225	-	-	-
Immune diseases	0.172	2.909	0.630–13.443	-	-	-
Central nervous system diseases	0.715	1.404	0.228–8.634	-	-	-
Asthma	0.601	2.103	0.129–34.225	-	-	-
Acute bronchitis	0.973	1.043	0.093–11.740	-	-	-
Anemia	0.205	3.241	0.527–19.944	-	-	-
Cancer	0.601	2.103	0.129–34.225	-	-	-
Albumin (g/L)	<0.001	0.834	0.787–0.884	<0.001	0.826	0.772–0.883
Hemoglobin (g/L)	0.019	0.978	0.961–0.996	0.050	0.976	0.952–1.001
GA	0.005	2.477	1.308–4.689	0.013	2.958	1.262–6.934
Surgical time (min)	0.859	0.999	0.994–1.005	-	-	-
Length of hospitalization (d)	0.282	0.962	0.895–1.033	-	-	-
Hospitalization cost (¥)	0.601	2.103	0.129–34.225	-	-	-
Postoperative delirium	0.282	1.415	0.752–2.663	-	-	-
Pulmonary Complications	0.028	3.702	1.155–11.864	-	-	-
Sepsis	0.601	2.103	0.129–34.225	-	-	-
Urinary tract infection	0.601	2.103	0.129–34.225	-	-	-
Myocardial infarction	0.601	2.103	0.129–34.225	-	-	-
Surgical Site infection	0.001	4.019	1.819–8.881	0.022	3.286	1.188–9.092
Perioperative blood transfusion	0.038	4.528	1.091–18.792	0.027	6.154	1.233–30.706
Lower extremity deep vein thrombosis	0.715	1.404	0.228–8.634	-	-	-
Reoperation	0.093	4.400	0.782–24.746	-	-	-

GA: general anesthesia; OR: Odds Ratio; CI: confidence interval; BMI: body mass index; ASA: American Society of Anesthesiology sore; ¥: Chinese yuan (CNY).

Modern medicine has advanced to the point where age is not considered a limiting factor for surgical intervention. However, older adults often present with multiple chronic conditions, such as cancer, diabetes, hypertension, coronary artery disease, and osteoarthritis. Data indicate that the occurrence of chronic disease comorbidity in Chinese individuals aged over 50 years reaches 61.9% [8]. The concept of frailty has emerged as a significant area of interest within geriatric research, highlighting its role in predicting adverse surgical outcomes [9]. Preoperative frailty has been linked to poorer postoperative results and represents a critical determinant of surgical risk [10–12]. Thus, in 2012, the American College of Surgeons and the American Geriatrics Society collectively advocated for a thorough preoperative frailty assessment in elderly patients [13]. Given that frailty in older adults significantly increases surgical risks, assessing a patient's preoperative physiological condition is essential for minimizing the risks associated with surgery and anesthesia.

Frailty is prevalent among the elderly and is characterized by a reduced multisystem physiological reserve and a diminished ability to maintain homeostasis. Community-based cross-sectional studies indicate that the prevalence of frailty in individuals aged 65 years and older varies widely, ranging from 4.0% to 59.1%, a variation partly due to the use of different assessment tools [14]. The incidence of frailty is notably higher in hospitalized elderly patients [15, 16]. Furthermore, frailty is prevalent among elderly patients undergoing elective spinal surgery, with a 24% prevalence rate observed in individuals aged 70 years and above when assessed using the FRAIL screening scale. The rate of pre-frailty in this demographic reaches up to 54% [17]. This study's findings reveal that individuals identified as frail were older than those in the pre-frail category ($p = 0.036$), aligning with the understanding that frailty is a clinical syndrome increasingly associated with age.

Preoperative assessment of frailty is an important predictor of adverse outcomes in patients undergoing major orthopedic surgery. McIsaac *et al.* [18] retrospectively analyzed 125,163 patients aged 65 years and older who underwent THA and TKA between July 2003 and April 2012. They diagnosed frailty using the Johns Hopkins University Comprehensive Geriatric Evaluation case-mix system, identifying 3023 (2.4%) patients as frail, and found a fourfold increase in the 1-year postoperative mortality rate among frail patients compared to their non-frail counterparts (6.8% *vs.* 1.6%). Even after adjusting for confounders such as age, sex, surgery type and duration of surgery, frailty was independently associated with a higher risk of 1-year postoperative mortality (Hzzard ratio = 3.03, 95% confidence interval: 2.62 to 3.51). Further, after the least stressful elective surgery, the 180-day mortality rate was more than ten times higher in frail and very frail patients compared to healthy individuals [19]. Long-term survival post-surgery also seemed to be influenced by preoperative frailty status. A substantial prospective cohort study demonstrated a significant association between preoperative frailty and an increased risk of 5-year postoperative mortality following elective vascular surgeries [20]. The severity of frailty is directly linked to higher postoperative mortality rates, and the evaluation of preoperative frailty can predict poorer postoperative outcomes. Our study corroborates these findings, showing that the 1-year postoperative mortality rate is significantly elevated in frail patients compared to those identified as healthy or pre-frail. Additionally, multivariate logistic regression analysis revealed that frail patients have a 2.674-fold increased risk of 1-year postoperative mortality compared to healthy individuals. Hence, assessing the physiological status of elderly patients before TJA holds significant clinical importance.

The association between anesthesia type and postoperative mortality risk in elderly patients undergoing TJA remains a debatable topic in clinical practice [21]. Calkins *et al.* [22] indicated that GA was not independently associated with increased postoperative mortality in elderly patients with hip fractures. Similarly, research by Heckmann *et al.* [23] and Harris *et al.* [24] suggested that regional block anesthesia could lower the risk of postoperative mortality in elderly patients with hip fractures when compared to GA. In our study, analyses of the entire patient cohort revealed no significant link between the anesthesia method and postoperative mortality risk following TJA in the elderly. However, when focusing specifically on patients identified as frail, we observed that the choice of anesthesia was a significant factor influencing mortality after TJA. Notably, the risk of mortality was 2.95 times higher in frail elderly patients undergoing TJA with GA compared to those receiving IA. Consequently, for frail elderly patients in need of TJA, opting for IA over GA as the intraoperative anesthesia method may be more advantageous.

This study has several limitations. Firstly, it is a single-center study, which might introduce selection bias. Secondly, the evaluation of preoperative frailty was conducted solely using the FRAIL screening scale. Future research could benefit from comparing this approach with other methods of frailty assessment, such as the modified frailty index (mFI) and clinical frailty score (CFS), to offer a broader reference for anesthesiologists in clinical practice. Additionally, this research was concentrated on mortality at one year postoperatively. Subsequent studies could explore a wider range of postoperative complications and extend the duration of follow-up to capture more comprehensive outcomes.

5. Conclusions

In conclusion, our results showed that when feasible, IA should be favored over GA for elderly frail patients to reduce the long-term associated risks of mortality.

AVAILABILITY OF DATA AND MATERIALS

The authors declare that all data supporting the findings of this study are available within the paper and any raw data can be obtained from the corresponding author upon request.

AUTHOR CONTRIBUTIONS

JFS and XPY—designed the study and carried them out; prepared the manuscript for publication and reviewed the draft of the manuscript. JFS, CWZ, ZHL, MMC and JJM—supervised the data collection, analyzed the data, interpreted the data. All authors have read and approved the manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Ethical approval was obtained from the Ethics Committee of Nantong First People's Hospital (approval no. 2021KT082). Written informed consent was obtained from the legally authorized representatives for anonymized patient information to be published in this article.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

[1] Bhushan S, Huang X, Duan Y, Xiao Z. The impact of regional versus general anesthesia on postoperative neurocognitive outcomes in elderly patients undergoing hip fracture surgery: a systematic review and meta-analysis. International Journal of Surgery. 2022; 105: 106854.

[2] Morrison C, Brown B, Lin DY, Jaarsma R, Kroon H. Analgesia and anesthesia using the pericapsular nerve group block in hip surgery and hip fracture: a scoping review. Regional Anesthesia and Pain Medicine. 2021; 46: 169–175.

[3] Dent E, Martin FC, Bergman H, Woo J, Romero-Ortuno R, Walston JD. Management of frailty: opportunities, challenges, and future directions. The Lancet. 2019; 394: 1376–1386.

[4] Johnson RL, Abdel MP, Frank RD, Chamberlain AM, Habermann EB, Mantilla CB. Impact of frailty on outcomes after primary and revision total hip arthroplasty. The Journal of Arthroplasty. 2019; 34: 56–64.e5.

[5] Johnson RL, Abdel MP, Frank RD, Chamberlain AM, Habermann EB, Mantilla CB. Frailty index is associated with periprosthetic fracture and mortality after total knee arthroplasty. Orthopedics. 2019; 42: 335–343.

[6] Pervaiz SS, Douglas SJ, Sax OC, Nabet A, Monarrez RG, Remily EA, *et al*. Phenotypic frailty score predicts perioperative outcomes for geriatric total joint arthroplasty. Orthopedics. 2022; 45: e315–e320.

[7] Gosselink R. Appraisal of clinical practice guideline: physical frailty: ICFSR international clinical practice guidelines for identification and management. Journal of Physiotherapy. 2022; 68: 75.

[8] Zhao Y, Atun R, Oldenburg B, McPake B, Tang S, Mercer SW, *et al*. Physical multimorbidity, health service use, and catastrophic health expenditure by socioeconomic groups in China: an analysis of population-based panel data. The Lancet Global Health. 2020; 8: e840–e849.

[9] Gottesman D, McIsaac DI. Frailty and emergency surgery: identification and evidence-based care for vulnerable older adults. Anaesthesia. 2022; 77: 1430–1438.

[10] Kennedy CA, Shipway D, Barry K. Frailty and emergency abdominal surgery: a systematic review and meta-analysis. The Surgeon. 2022; 20: e307–e314.

[11] Gallo L, Gallo M, Augustine H, Leveille C, Murphy J, Copeland AE, *et al*. Assessing patient frailty in plastic surgery: a systematic review. Journal of Plastic, Reconstructive & Aesthetic Surgery. 2022; 75: 579–585.

[12] Cappe M, Laterre P, Dechamps M. Preoperative frailty screening, assessment and management. Current Opinion in Anaesthesiology. 2023; 36: 83–88.

[13] Chow WB, Rosenthal RA, Merkow RP, Ko CY, Esnaola NF. Optimal preoperative assessment of the geriatric surgical patient: a best practices guideline from the American college of surgeons national surgical quality improvement program and the American geriatrics society. Journal of the American College of Surgeons. 2012; 215: 453–466.

[14] Qiu Y, Li G, Wang X, Zheng L, Wang C, Wang C, *et al*. Prevalence of cognitive frailty among community-dwelling older adults: a systematic review and meta-analysis. International Journal of Nursing Studies. 2022; 125: 104112.

[15] Lv J, Li R, Yuan L, Yang X, Wang Y, Ye Z, *et al*. Research on the frailty status and adverse outcomes of elderly patients with multimorbidity. BMC Geriatrics. 2022; 22: 560.

[16] Yüceler Kaçmaz H, Döner A, Kahraman H, Akin S. Prevalence and factors associated with frailty in older hospitalized patients. Revista Clínica Española. 2023; 223: 67–76.

[17] Susano MJ, Grasfield RH, Friese M, Rosner B, Crosby G, Bader AM, *et al*. Brief preoperative screening for frailty and cognitive impairment predicts delirium after spine surgery. Anesthesiology. 2020; 133: 1184–1191.

[18] McIsaac DI, Beaulé PE, Bryson GL, Van Walraven C. The impact of frailty on outcomes and healthcare resource usage after total joint arthroplasty. The Bone & Joint Journal. 2016; 98-B: 799–805.

[19] Shinall MC, Youk A, Massarweh NN, Shireman PK, Arya S, George EL, *et al*. Association of preoperative frailty and operative stress with mortality after elective vs emergency surgery. JAMA Network Open. 2020; 3: e2010358.

[20] Banning LBD, El Moumni M, Visser L, van Leeuwen BL, Zeebregts CJ, Pol RA. Frailty leads to poor long-term survival in patients undergoing elective vascular surgery. Journal of Vascular Surgery. 2021; 73: 2132–2139.e2.

[21] Schwenk ES, McCartney CJ. General anesthesia is an acceptable choice for hip fracture surgery. Regional Anesthesia & Pain Medicine. 2023; 48: 428–429.

[22] Calkins TE, Johnson EP, Eason RR, Mihalko WM, Ford MC. Spinal versus general anesthesia for outpatient total hip and knee arthroplasty in the ambulatory surgery center: a matched-cohort study. To be published in The Journal of Arthroplasty. 2023. [Preprint].

[23] Heckmann ND, De A, Porter KR, Stambough JB. Spinal versus general anesthesia in total knee arthroplasty: are there differences in complication and readmission rates? The Journal of Arthroplasty. 2023; 38: 673–679.e1.

[24] Harris AB, Valenzuela J, Andrade N, Agarwal A, Gu A, Golladay G, *et al*. Comparison of pneumonia and major complications after total joint arthroplasty with spinal versus general anesthesia: a propensity-matched cohort analysis. Journal of the American Academy of Orthopaedic Surgeons. 2024; 32: 33–40.

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