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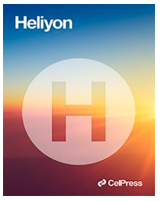

Research article

The addition of peripheral nerve blocks to routine spinal or general anesthesia was associated with decreased risks of major adverse events after total hip or knee arthroplasty: A retrospective, propensity score-matched cohort study

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ABSTRACT

Background: Although total joint arthroplasty is the most effective procedures for end-stage arthritis, the incidence of postoperative death and complications remains high. The association of additional peripheral nerve blocks (PNBs) to routine spinal or general anesthesia with major adverse events (including mortality and complication rates) in elective total hip arthroplasty (THA) or total knee arthroplasty (TKA) has been subject to inconclusive findings.

Methods: This retrospective observational single institution study included all patients ≧ 18 years undergoing their first elective THA or TKA from January 1, 2012 to December 31, 2021. A 1:2 propensity score matching (PSM) was performed to account for the baseline differences between two groups that were accepted to PNB or not. Kaplan–Meier curves were employed to estimate the effects of PNB on mortality. The associations of PNB and the complications were assessed by logistic regression models.

Results: We identified 1328 patients, among whom 197 had PNB and 1131 had not. The 90-day all-cause mortality was significantly reduced in patients with PNBs (0 % vs 2.79 %, P = 0.041) after THA or TKA, when compared to the non-PNB group. PNB was also associated with a lower risk of pulmonary complications (odds ratio [OR], 0.430; 95%confidence interval [CI],0.216–0.857) and deep vein thrombosis (OR, 0.103; 95%CI, 0.011–0.954).

Interpretation: The results of this observational, propensity score–matched cohort study suggested a strong association between the addition of PNBs to routine spinal or general anesthesia and decreased risks of major adverse events.

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1. Introduction

As the portion of elderly in the total population steadily increases, the prevalence of end-stage arthritis continues to rise. It is estimated that one million lower extremity arthroplasty surgeries are performed in the U.S. every year, with the number expected to increase to four million by 2030 [1]. In current practice, total knee arthroplasty (TKA) and total hip arthroplasty (THA) are the most effective procedures for alleviating pain and improving motor function in patients with end-stage arthritis [2]. Despite significant advancements in anesthesia and surgical techniques, the major adverse events and all-cause mortality rates after total arthroplasty are still as high as 5.7 % and 0.12 %, respectively [3,4].

Available evidence indicates that postoperative adverse outcomes are not only associated with the patient's physical condition and surgical techniques, but also are affected by different anesthesia methods [5–7]. Several studies have shown a significantly lower risk of death and pneumonia with spinal anesthesia compared to general anesthesia for arthroplasties [4,8,9], but the debate about the superiority of regional anesthesia over general anesthesia has been going on for decades, and there is still no abundant evidence affirming the superiority of one over other. Peripheral nerve blocks (PNBs) have been widely used as an alternative or addition to general and spinal anesthesia because of special advantages such as rapid onset, site-specific action [10], and excellent analgesic effects [11–15]. It has been shown that PNBs are effective in reducing perioperative opioid consumption [16–18], improving motor function [19] and lowering postoperative mortality [20,21] in patients with hip fracture surgeries.

There is still the limited evidence about effect of PNB on postoperative outcomes in patients with elective THA or TKA. In one retrospective study, Memtsoudis et al. reported that the use of PNBs resulted in decreased occurrence of postoperative adverse events and opioid consumption in patients undergoing elective THA or TKA [22]. However, their study included the patients that used PNB alone as the regimen of anesthesia. Thus, it is unclear whether the addition of PNB to routine general or spinal anesthesia improves postoperative outcomes. We conducted a single-center retrospective study to further evaluate the association between the addition of preoperative ultrasound-guided PNBs to routine spinal or general anesthesia and major adverse events after elective total hip or knee arthroplasty.

2. Materials and methods

2.1. Study design

This study was a retrospective observational single-center design. Following the approval of the ethics committee at Fujian Provincial Hospital (approval number: K2022-10-010, approval data:2019.05.20), Clinical information and laboratory data spanning 2012 to 2021 were accessed through the hospital's electronic patient record system, and the data were cross-referenced with the perioperative anesthesia database of the same institution to enhance accuracy. The findings were reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement.

The adult ($\geq$18 years) patients who underwent their first elective THA or TKA were enrolled in this study. The exclusion criteria were as follows: (1) Patients who were not undergoing arthroplasties for the first time. (2) refusal of participation or lost to follow-up.

The primary factor was whether a patient received preoperative PNB. Our primary study outcomes were all-cause mortality, including 30-day, 90-day, and one-year all-cause mortality. 30-day, 90-day, and one-year mortality were defined as deaths occurring within 30 days, 90 days, and one-year post-surgery, respectively. Secondary outcomes included: (1) major postoperative complications, such as cardiovascular, respiratory, and urinary complications, as well as cerebrovascular accidents and deep vein thrombosis [DVT]; (2) perioperative blood loss and erythrocytes transfusion $>$2 unites; (3) readmission within 30 days; (4) Length of hospital stay and hospital costs.; (5) intensive care unit (ICU) admission and length of ICU stay. Cardiovascular complications included cardiac arrest, myocardial infarction (MI), heart failure, and cardiac arrhythmias. Respiratory complications included pulmonary infections, acute respiratory distress syndrome (ARDS), bronchospasm, pulmonary atelectasis, hypoxemia, pulmonary insufficiency, and pulmonary embolism. Urinary complications included acute renal failure, renal dysfunction, and urinary tract infection. Postoperative all-cause mortality was identified through follow-up telephone calls.

Demographic data extracted included the information about patients' age, sex, the type of surgical procedure (TKA or THA), type of anesthesia (general anesthesia or spinal anesthesia), their American Society of Anesthesiologists (ASA) physical status classification (ASA grade), and use of cardiovascular medications. Baseline clinical data also included information about preexisting comorbidities such as hypertension, diabetes, anemia (as per the World Health Organization definition, less than 110 g/l for women and less than 120 g/l for men), cancer, metastatic cancer, chronic obstructive pulmonary disease, and preexisting cardiovascular diseases such as congestive heart failure, cerebrovascular disease, and peripheral vascular disease. Pre-operative laboratory data included blood glucose, serum creatinine, albumin, hemoglobin, D-dimer, and Alanine Transaminase/Aspartate Transaminase (ALT/AST) levels.

The standard surgical practice involved cemented TKAs and non-cemented THAs. The standard general anesthesia protocol consisted of intravenous infusion with propofol, opioids (sufentanil or remifentanil), and muscle relaxants, with or without inhalational agents (sevoflurane or desflurane). For spinal anesthesia, the standard approach utilized 1.5–2.5 ml of 0.75 % ropivacaine and the sensory block level reached T8 level. The PNBs used in this study included femoral nerve block, adductor canal block, fascia iliaca block, quadratus lumborum block, obturator nerve block, and pericapsular nerve group block, and their selection was determined on the discretion of the attending anesthesiologist according to the patient's physical status, and patient preferences. To ensure accuracy and effectiveness, all the PNBs were executed by utilizing a single injection under ultrasound guidance.

2.2. Statistical analyses

Patient demographics were summarized using descriptive statistics. Kolmogorov–Smirnov test was used for normality tests. Normally distributed continuous variables were expressed as means± standard deviations (SD), while non-normally distributed continuous variables were expressed as medians (25th, 75th percentile). Categorical variables were reported as counts (%). The initial between-group comparisons of categorical variables were performed by the bivariate tests, including the Mann–Whitney *U* test, chi-square test, and Fisher exact test. 1:2 propensity score matching (PSM) was utilized to reduce treatment selection bias and enhance the comparability between groups. To determine the relationship between nerve blocks and both primary outcomes (30-day, 90-day, or one-year all-cause mortality) and secondary outcomes, the PSM model integrated all variables from the demographic, baseline clinical, and laboratory data described above, including age, gender, type of surgery, type of anesthesia, ASA grade, comorbidities, laboratory data, and long-term medication uses. A caliper value of 0.02 was used. Kaplan–Meier survival analysis was performed to estimate the survival function. To determine the association between PNB and all-cause mortality across different subgroups, subgroup analysis was performed according to age, sex, type of surgery, type of anesthesia, ASA grade, preoperative comorbidities, and surgical year.

A multivariate logistic regression model was performed to estimate odds ratios (ORs) using 95 % confidence intervals (95 % CI) for major postoperative complications. The model was further adjusted for several covariates, including: age (≥65 years or <65 years); sex (male or female); presence or absence of nerve block; type of surgery (TKA or THA); type of anesthesia (spinal anesthesia or general anesthesia); ASA grade (1–2 or 3–4); comorbidities (hypertension, diabetes, etc.); laboratory data (blood glucose, serum creatinine, albumin hemoglobin). Receiver operating characteristic (ROC) curve analysis was performed to calculate the area under the curve (AUC), allowing for an evaluation of the model's validity in identifying major postoperative complications.

Missing values were handled using the multiple imputation method. This assumed that data were missing at random. The predictive mean matching method was used for continuous variables, while for categorical variables, logistic regression was applied. This process generated five complete datasets. Results were pooled using Rubin's rules.

Finally, a sensitivity analysis was performed using the PSM on the raw data of complete cases to assess the robustness of the findings. As the complete case data were relatively limited, a 1:1 PSM method was employed to minimize the total within-pair differences. All reported P values were two-tailed, with differences $P < 0.05$ considered statistically significant. All data were analyzed using SPSS 26.0 and R 3.33.

3. Results

A total of 1418 patients with elective TKA/THA were enrolled. According to the inclusion and exclusion criteria, 90 patients were excluded because of refusal or lost to follow-up (n = 62), multiple surgeries (n = 23) and age <18 years (n = 5), and 1328 patients (296 TKA/1032 THA) were included in the final analysis. The details of included and excluded patients are shown in Fig. 1. Among these patients, 197 (14.8 %) received PNBs and 1131 (85.2 %) did not. The baseline characteristics of patients with and without PNBs prior to matching are summarized in Table 1. The PNBs were more commonly administered during TKA. Patients with PNBs were more likely to undergo spinal anesthesia and exhibited a higher prevalence of comorbidities, characterized by increased rates of higher ASA grades (3–4), advanced age, and elevated D-dimer levels compared to those without PNBs. After propensity-score matching, two well-balanced groups were obtained (Table 2).

As shown in Table 3, within the matched cohort, 90-days mortality was significantly lower in the PNB group than in the non-PNB

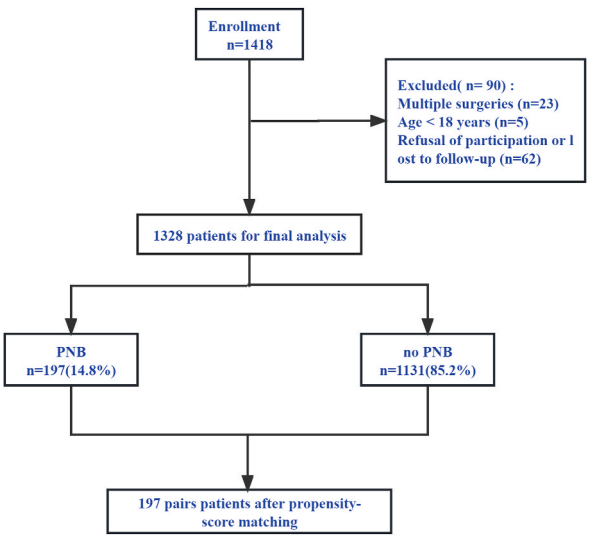

Fig. 1. Patient flowchart.

Table 1
Baseline characteristics of all patients in the study period.

	PNB(n = 197)	Non-PNB(n = 1131)	P value
Age, years	64.49 ± 12.75	60.97 ± 13.86	<0.050
Gender, n (%)			
male	80 (40.6)	470 (41.6)	0.223
female	117 (59.4)	661 (58.4)	
Type of surgery, n (%)			
THA	135 (68.5)	899 (79.5)	<0.050
TKA	62 (31.5)	234 (20.7)	
Type of anesthesia, n (%)			
General anesthesia	167 (84.8)	1101 (97.3)	<0.050
Spinal anesthesia	30 (15.2)	30 (2.7)	
ASA physical status, n (%)			
1–2	118 (59.9)	867 (76.7)	<0.050
3–4	79 (40.1)	264 (23.3)	
Comorbidities, n (%)			
Hypertension	68 (34.5)	346 (30.6)	0.168
Diabetes	18 (9.1)	129 (11.4)	0.349
Anemia	2 (1.0)	8 (0.7)	0.856
Congestive heart failure	1 (0.5)	3 (0.3)	0.567
peripheral vascular disease	2 (1.0)	8 (0.7)	0.236
Cerebrovascular disease	3 (1.5)	20 (1.8)	0.807
Cancer	3 (1.5)	16 (1.4)	0.906
Metastatic cancer	1 (0.5)	0 (0)	1.000
COPD	1 (0.5)	2 (0.2)	0.367
Laboratory data			
Glucose, mmol/l	5.74 ± 1.63	5.64 ± 1.48	0.400
Serum creatinine, ummol/l	71.37 ± 67.37	67.92 ± 43.65	0.352
Hemoglobin, g/l	130.41 ± 17.85	131 ± 17.85	0.658
D-dimer, mg/l	3.11 ± 6.70	2.21 ± 4.34	<0.050
Albumin, g/l	41.41 ± 4.45	41.82 ± 5.16	0.292
AST/ALT	1.2 ± 0.44	1.23 ± 0.51	0.446
Medications, n (%)			
β-blockers	8 (4.1)	62 (5.5)	0.400
Calcium channel blockers	41 (20.8)	177 (15.5)	0.071
ACEI/ARB	20 (10.2)	121 (10.7)	0.818
Statin	3 (1.5)	33 (2.9)	0.266
Aspirin	5 (2.5)	23 (2.0)	0.649
Insulin	6 (3.0)	57 (5.0)	0.224

ACE, angiotensin-converting enzyme inhibitors; ARB, angiotensin receptor blocker; ASA, American Society of Anesthesiologists; AST/ALT, aspartate aminotransferase/alanine transaminase; COPD, chronic obstructive pulmonary disease; THA, total hip arthroplasty.
TKA, total knee arthroplasty.

group (0 % vs. 2.79 %, P < 0.05), but 30-days mortality (0 % vs. 2.03 %, P = 0.102) or one-year mortality (1.52 % vs. 3.05 %, P = 0.408) did not significantly differ between groups. The detailed causes of 30-days death are shown in Supplemental Table 1. Cardiac arrest, the major cause of death, accounted for 37.5 % of all causes of death and sepsis accounted for 25 %. The stratified analysis of patient subgroups revealed that PNBs had a protective effect on 90-days mortality for most subgroups. In the elderly, ASA grades 3–4, THA, general anesthesia, and non-diabetes subgroup, the risk of 90-days mortality was significantly reduced in patients with PNBs (Fig. 2). PNBs also showed a protective effect in the 2012–2015, 2015–2018, 2019–2021 subgroups of the surgical years. The Kaplan-Meier survival analysis demonstrated that patients receiving the PNBs exhibited significantly higher cumulative 30-day and 90-day survival rates compared to those without the PNB (log-rank P < 0.05; Fig. 3A–B). However, no significant difference in the one-year survival rate between groups was observed (Fig. 3C).

Regarding secondary outcomes, the PNB group showed a significantly lower risk of postoperative arrhythmias (1.0 % vs 4.0 %, P < 0.05), pulmonary infection (5.1 % vs 11.7 %, P < 0.05), renal dysfunction (0.0 % vs 2.0 %, P < 0.05), and the occurrence of lower extremity DVT (0.5 % vs 3.3 %, P < 0.05) (Table 4). Perioperative blood loss (241.1 ± 206.8 vs 281.1 ± 241.9, P < 0.05) and total hospital cost (8654.7 ± 1532.3 vs 10234.9 ± 2256.2, P < 0.05) were both lower in PNB group than non-PNB group. Notably, pulmonary infections accounted for the largest proportion of complications in the two groups. In the logistic regression model focusing on major systemic complications, the PNB group exhibited a significantly lower odds of pulmonary complications (OR: 0.430; 95 % CI: 0.216–0.857) and lower extremity DVT (OR: 0.103; 95 % CI: 0.011–0.954) in comparison to the non-PNB group (Table 5).

The results from sensitivity analysis consistently supported the observed trends in all-cause mortality. A 1:1 PSM was performed on complete data and showed a significant reduction in 30-days mortality (0 % vs. 3.7 %, P < 0.05) and 90-days mortality (0 % vs. 3.7 %, P < 0.05) in patients with PNBs. The matched cohort of complete case data and all-cause mortality is available in Supplemental Tables 2–3.

Table 2
Baseline patient characteristics in the propensity score–matched cohorts.

	PNB(n = 197)	Non-PNB(n = 394)	P value
Age, years	64.49 ± 12.75	65.25 ± 12.26	0.484
Gender, n (%)			
male	80 (40.6)	158 (40.1)	0.906
female	117 (59.4)	236 (59.9)	
Type of surgery, n (%)			
THA	135 (68.5)	288 (73.1)	0.246
TKA	62 (31.5)	106 (26.9)	
Type of anesthesia, n (%)			
General anesthesia	167 (84.8)	346 (87.8)	0.302
Spinal anesthesia	30 (15.2)	48 (12.2)	
ASA physical status, n (%)			
1–2	118 (59.9)	241 (61.2)	0.766
3–4	79 (40.1)	153 (38.8)	
Comorbidities, n (%)			
Hypertension	68 (34.5)	136 (34.5)	1.000
Diabetes	18 (9.1)	37 (9.4)	0.920
Anemia	2 (1.0)	0 (0.0)	0.211
Congestive heart failure	1 (0.5)	3 (0.8)	0.723
peripheral vascular disease	2 (1.0)	0 (0.0)	0.102
Cerebrovascular disease	3 (1.5)	3 (0.8)	0.663
Cancer	3 (1.5)	7 (1.8)	0.822
Metastatic cancer	0 (0)	0 (0)	1.000
COPD	1 (0.5)	2 (0.5)	1.000
Laboratory data			
Glucose, mmol/l	5.74 ± 1.63	5.82 ± 1.70	0.549
Serum creatinine, ummol/l	71.37 ± 67.37	69.40 ± 45.90	0.678
Hemoglobin, g/l	130.41 ± 17.85	129.32 ± 16.65	0.469
D-dimer, mg/l	3.11 ± 6.70	2.67 ± 4.78	0.358
Albumin, g/l	41.41 ± 4.45	40.68 ± 5.64	0.110
AST/ALT	1.2 ± 0.44	1.20 ± 0.48	0.971
Medications, n (%)			
β-blockers			
Calcium channel blockers	8 (4.1)	21 (5.3)	0.501
ACEI/ARB	41 (20.8)	63 (16.0)	0.147
Statin	20 (10.2)	39 (9.9)	0.923
Aspirin	3 (1.5)	5 (1.3)	0.801
Insulin	6 (3.0)	15 (3.8)	0.637

ACE, angiotensin-converting enzyme inhibitors; ARB, angiotensin receptor blocker; ASA, American Society of Anesthesiologists; AST/ALT, aspartate aminotransferase/alanine transaminase; COPD, chronic obstructive pulmonary disease; THA, total hip arthroplasty.
TKA, total knee arthroplasty.

Table 3
Comparison of 30-day, 90-day, and one-year all-cause mortality.

	PNB (n = 197)		Non-PNB (n = 394)			
	n	%	n	%	OR (95%CI)	P Value
30-day mortality	0	0 %	8	2.0 %	0.98 (0.97, 1.00)	0.102
90-day mortality	0	0 %	11	2.8 %	0.97 (0.96, 0.99)	0.041
1-year mortality	3	1.5 %	12	3.1 %	0.49 (0.14, 1.77)	0.408

CI, confidence interval; OR, odds ratio; PNB, peripheral nerve block.

4. Discussion

This retrospective study including 1,328 patients who underwent elective THA or TKA demonstrated that the addition of PNBs to routine spinal or general anesthesia decreased the risks of postoperative adverse events including 90-days mortality and major complications. This was particularly for patients characterized by advanced age or higher ASA grades, both of which are recognized risk factors for the occurrence of postoperative adverse events [23–25].

It has been shown that the risk of major adverse events after emergency arthroplasty was much higher than that of elective surgery [12,26–28]. Jin et al. [27] reported that the 30-day mortality and cardiovascular comorbidities incidence in patients underwent emergency THA were as high as 12.4 % and 30.2 %, respectively, which were much higher than the incidence of 1.4 % and 4.3 % in our study. Fu et al. [21] found that postoperative 30-day and 90-day mortality of patients underwent THA for hip fracture were 6.2 % and 7.9 %, respectively, and the 30-day and 90-day mortality for patients receiving the PNB were lower than those without the PNB. A

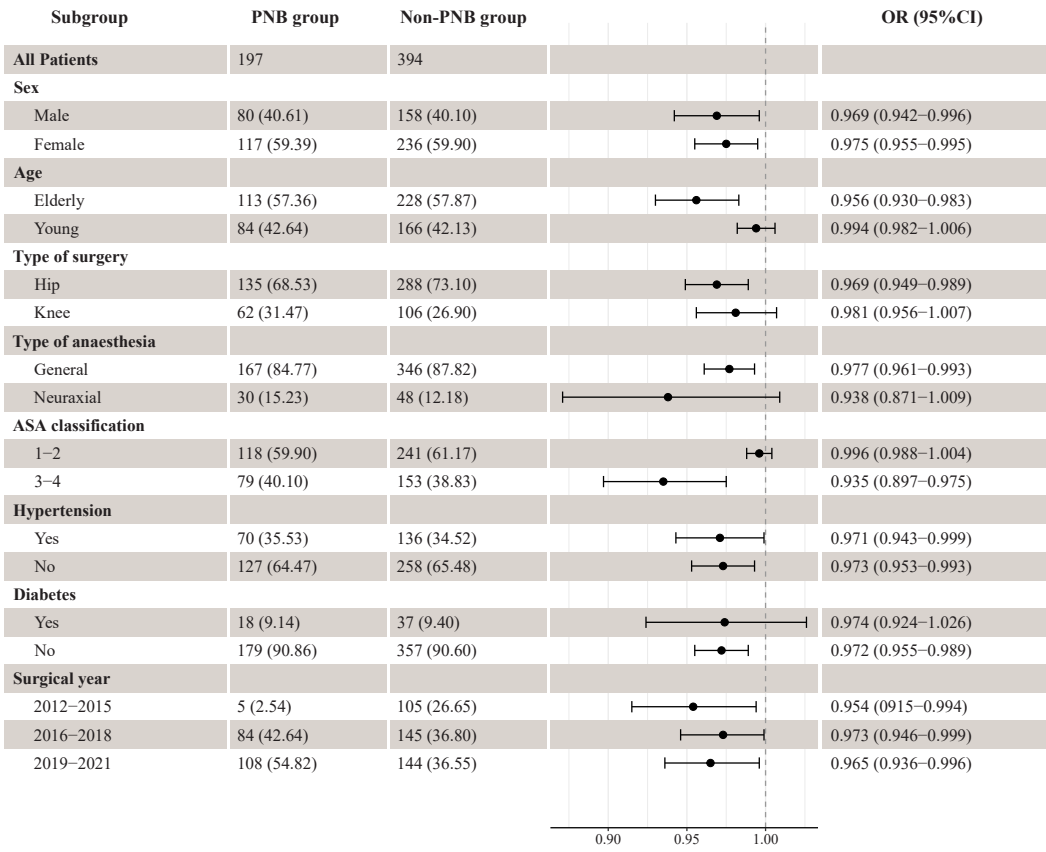

Fig. 2. Forest plots with subgroup analyses of 90-Day all-cause mortality Elderly, age≧65 years; Young, age<65 years.

retrospective study by Karaca et al. [26] also showed that a significant decrease in 30-day mortality among emergency THA patients who received PNBs compared to those undergoing general anesthesia. All of these findings indicate the beneficial effect of PNB on major adverse events in emergency arthroplasty. In contrast, elective THA and TKA have a lower risk of postoperative major adverse events compared to emergency surgery due to adequate preoperative preparation and better baseline conditions. Only a retrospective study by Memtsoudis et al. [22] has explored the effect of PNB on postoperative outcomes in patients underwent elective THA or TKA. They demonstrated that the rate of major adverse events is 6.9 %, and the risks of in-hospital death and adverse events are significantly lower when PNB is used alone or in combination with general or spinal anesthesia compared with conventional anesthesia. Differing from the work of Memtsoudis et al. [22], our study was focused on the relationship between addition of preoperative PNBs to routine spinal or general anesthesia and the risks of major postoperative adverse events in patients undergoing THA and TKA. Propensity score matching was used to limit selection bias, and the final results showed that the addition of peripheral nerve blocks to routine spinal or general anesthesia was associated with significantly decreased risks of major adverse events after THA or TKA.

Notably, the results derived from multiple regression models closely align with those obtained through propensity-score matching (PSM). This congruence underscores the role of PNB in significantly reducing the risk of postoperative pulmonary complications and lower extremity DVT. This decreased risk is likely attributable to the ability of PNBs that alleviates acute postoperative pain, shortens off-bed time and improves motor function [12].

The risk of postoperative arrhythmias was also lower in the PNB group. Several studies have suggested that combining peripheral nerve blocks with general anesthesia can significantly reduce the dose of general anesthetics [29,30], thereby decreasing their impact on blood pressure fluctuations and myocardial depression. Furthermore, peripheral nerve blocks suppress stress responses and systemic inflammatory reactions [31,32], leading to a reduced risk of perioperative arrhythmias in patients undergoing THA or TKA. Finally, although there were no significant differences in postoperative ICU admission rates and length of stay between two groups due to relatively good baseline condition (average age: 65.0 ± 12.4; proportion of ASA I-II: 60.7 %) and adequate preoperative preparations, the lower total hospital costs in the PNB group indicated the potential economic benefits of incorporating peripheral nerve blocks into routine spinal or general anesthesia. This may be associated with a lower incidence of postoperative complications.

Univariate analysis and survival analysis revealed consistent mortality findings, with both suggesting that PNB is an independent protective factor for postoperative survival. However, no significant between-group difference in the 30-day mortality was observed, which may be the result of an insufficient sample size. Previous studies have shown that PNB effectively shortens the off-bed time and

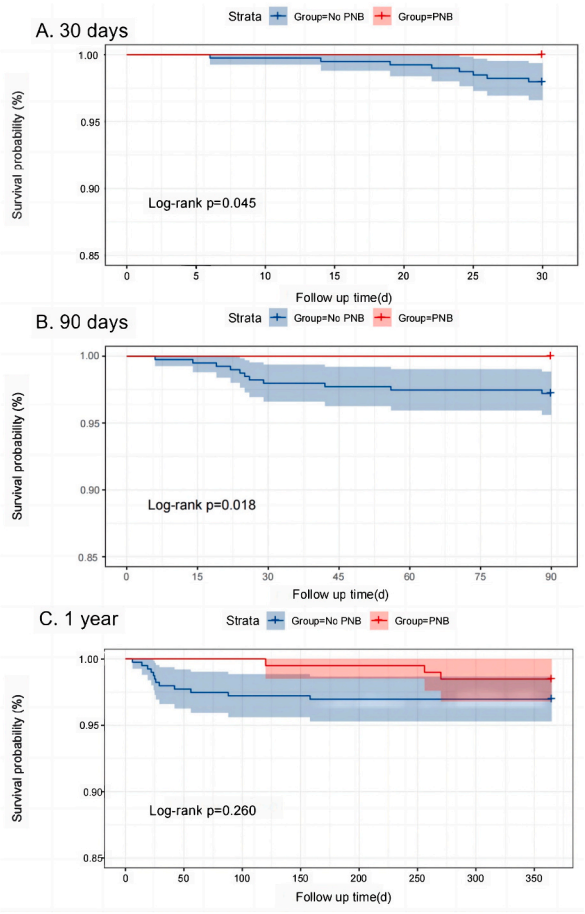

Fig. 3. Kaplan–Meier plots of the cumulative postoperative survival rates for 30 days, 90 days and 1 year after elective TKA or THA. The red curve corresponds to patients who underwent peripheral nerve blocks, while the blue curve corresponds to those who did.

improves postoperative motor function in patients who have underwent lower extremity joint arthroplasties, especially within the first 1.5 months post-surgery [33,34]. For most patients, motor function is fully or at least partially restored within six months following surgery, and within one year, patients typically regain the ability to lead a normal life [35]. Therefore, we believe that the impact of PNB on mortality diminishes one year after surgery. This would also explain why there was no significant difference in mortality after one year between patients with and without the PNB.

Based on the above, our study possesses the following strengths: (a) The application of the PSM method effectively mitigated the baseline disparities between the two groups, thereby lowering the risk of selection bias; (b) By employing a stratified analysis, we explored the effect of PNB within distinct age and ASA grade patient subgroups.

Despite these strengths, our study design does possess some limitations that deserve special attention. First, the study's single-center nature inevitably resulted in a small sample size and might have some potential confounders due to the retrospective study. Although a variety of statistical methods were used to minimize bias, a larger sample size would have been preferable. Additionally, because of long time horizon, it is difficult to obtain information on the causes of death in all patients. The information could help us further understand how PNB reduces mortality. Therefore, a randomized controlled trial (RCT) on this issue should be performed in the future.

In conclusion, the results of this observational, propensity score–matched cohort study suggested a strong association between the addition of PNBs to routine spinal or general anesthesia and decreased risks of major adverse events, including 90-days mortality and major complications.

Funding

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Table 4
Comparison of the secondary outcomes.

Dichotomous outcomes	PNB (197)		No PNB (394)		P value
	n	%	n	%	
Cardiovascular complications	5	2.5	21	5.3	1.000
Cardiac arrest	0	0	0	0	1.000
Myocardial infarction	3	1.5	7	1.8	0.822
Heart failure	2	1.0	6	1.5	0.615
Arrhythmia	2	1.0	16	4.0	<0.050
Respiratory complications	11	5.6	51	12.9	<0.050
Pulmonary infections	10	5.1	46	11.7	<0.050
Bronchospasm	0	0	1	0.3	1.000
ARDS	1	0.5	0	0	1.000
Pulmonary atelectasis	0	0	4	1.0	0.375
Hypoxemia	2	1.0	9	2.3	0.282
pulmonary insufficiency	1	0.5	9	2.3	0.114
Pulmonary embolism	1	0.5	0	0	0.333
Urinary complications	1	0.5	14	3.6	<0.050
Acute renal failure	0	0	2	0.5	0.802
renal dysfunction	0	0	8	2.0	<0.050
urinary tract infection	1	0.5	9	2.3	0.114
Cerebrovascular accident	0	0	4	1.0	0.375
DVT	1	0.5	13	3.3	<0.050
Blood transfusion >2 unites	23	11.7	48	12.2	0.858
ICU admission	3	1.5	8	2.0	0.667
Readmission	1	0.5	7	1.8	0.208
Continuous outcomes	Mean	SD	Mean	SD	P Value
Perioperative blood loss (ml)	241.1	206.8	281.1	241.9	<0.050
Total hospital cost ($)	8654.7	1532.3	10234.9	2256.2	<0.050
Length of ICU stay (days)	0.2	1.6	0.1	0.5	0.092
Length of stay (days)	14.6	7.6	16.1	11.0	0.270

ARDS, acute respiratory distress syndrome; DVT, deep vein thrombosis; ICU, Intensive Care Unit; PNB, peripheral nerve block.

Table 5
Odds ratio (95 % confidence interval) for four major complications.

	Cardiovascular complications	Respiratory complications	Urinary complications	DVT
PNB (reference: non-PNB)	0.479	0.430*	0.076	0.103*
	(0.171,1.341)	(0.216,0.857)	(0.004,1.377)	(0.011,0.954)
Type of surgery:	0.628	0.708	0.739	5.326*
TKA (reference: THA)	(0.228,1.733)	(0.350,1.432)	(0.177,3.085)	(1.429,19.848)
Type of anesthesia:	2.608*	0.877	1.097	1.144
General anesthesia (reference: spinal anesthesia)	(1.039,6.545)	(0.386,1.994)	(0.257,4.687)	(0.204,6.417)
Sex: female	0.897	0.980	0.560	1.562
(reference: male)	(0.351,2.292)	(0.532,1.807)	(0.150,2.095)	(0.488,5.981)
ASA PS: 3–4	1.284	1.143	0.978	2.214
(reference: 1–2)	(0.544,3.027)	(0.643,2.032)	(0.299,3.200)	(0.675,7.258)
Age: ≥65yr old	6.351*	1.818	3.483	1.570
(reference: <65yr old)	(1.384,29.138)	(0.955,3.462)	(0.641,18.914)	(0.374,6.589)
Comorbidities (reference: no comorbidities)				
Hypertension	1.910	0.728	1.821	0.508
	(0.801,4.558)	(0.391,1.355)	(0.542,6.122)	(0.146,1.766)
Diabetes	0.820	0.708	0.108	0.508
	(0.213,3.154)	(0.248,2.025)	(0.007,1.764)	(0.071,3.613)
Baseline laboratory values				
Hemoglobin	1.015	1.014	0.989	0.963
	(0.985,1.046)	(0.994,1.034)	(0.953,1.027)	(0.927,1.000)
Creatinine	0.997	1.003	1.012*	1.002
	(0.985,1.010)	(0.998,1.007)	(1.004,1.021)	(0.992,1.011)
Albumin	0.957	0.941*	0.909*	1.127
	(0.879,1.041)	(0.894,0.991)	(0.836,0.988)	(0.980,1.297)
Fasting blood glucose	1.153	1.175*	1.236	1.375
	(0.947,1.405)	(1.021,1.352)	(0.950,1.608)	(1.059,1.787)
AUC	0.798	0.700	0.852	0.830

ASA, American Society of Anesthesiologists; AUC, area under the curve; DVT, deep vein thrombosis; PNB, peripheral nerve block; THA, total knee arthroplasty; TKA, total hip arthroplasty; AUC, area under the receiver operating curve. *$P < 0.05$.

Data availability

The datasets generated and/or analyzed during the current study are not publicly available due to limitations of ethical approval involving the patient data and anonymity but data will be made available on request.

Ethics approval

The study protocol has been authorized by the ethical committee of Fujian Provincial Hospital (K2022-10-010). All patients provided written informed consent prior to their participation in the study. Complete study protocol and research data can be obtained from the corresponding authors.

CRediT authorship contribution statement

Yingjie Chen: Writing – original draft, Software, Methodology, Investigation. **Jingfang Lin:** Formal analysis, Data curation. **Xiaoying Chen:** Investigation, Funding acquisition, Data curation. **Cansheng Gong:** Software, Resources, Project administration, Methodology, Investigation. **Fushan Xue:** Writing – review & editing, Visualization, Validation, Conceptualization. **Yongxin Huang:** Validation, Supervision, Software, Resources. **Yawen Xie:** Writing – original draft, Data curation. **Jundan Jiang:** Writing – review & editing, Visualization, Validation, Conceptualization. **Xiaochun Zheng:** Writing – review & editing, Visualization, Validation, Conceptualization. **Yanling Liao:** Writing – review & editing, Supervision, Software, Resources, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2024.e32441.

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