

# Comparative perioperative outcomes associated with anesthetic technique for total hip arthroplasty: a retrospective cohort study

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## Research article

**Keywords:** Total hip arthroplasty, General anesthesia, Spinal anesthesia, Perioperative outcome, Complications

**Posted Date:** July 12th, 2019

**DOI:** <https://doi.org/10.21203/rs.2.11320/v1>

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# Abstract

**Background** The influence of anesthetic technique on perioperative outcomes for total hip arthroplasty remains poorly elucidated. We studied a sample of total hip arthroplasty recipients, hypothesizing that spinal anesthesia has a superior impact on perioperative outcomes. **Methods** We conducted a retrospective cohort study of patients undergoing total hip arthroplasty between December 1, 2012 and October 31, 2018 in Zhongnan Hospital of Wuhan University. The primary outcome was cardiorespiratory complications. Secondary outcomes were intraoperative hypotension, packed red blood cells (pRBCs) transfusion, prolonged hospital length of stay, intensive care unit (ICU) use, life-threatening event, and mortality. Multivariable regression analyses were used to identify the impact of anesthetic technique on perioperative outcomes. **Results** Among the 1,233 patients, 561 had general anesthesia, and 672 had spinal anesthesia. Patients were averagely younger in general group than in spinal anesthesia group, (69.0 and 72.1 years, respectively;  $P < 0.001$ ), with insignificant difference in comorbidity burden. When spinal anesthesia was used, the hospital length of stay, ICU times, and volume of pRBCs transfusion were significant decreased ( $P < 0.05$ ). Life-threatening event and in-hospital mortality occurred frequently in general anesthesia, but with insignificant difference. After adjusting for covariates, spinal anesthesia was associated with 54.3% reduction in cardiorespiratory complications (adjusted odds ratio [OR]: 0.457, 95% confidence interval [CI]: 0.320–0.652;  $P < 0.001$ ). Spinal anesthesia was favorably associated with decreased odds for intraoperative hypotension (OR: 0.653, 95% CI: 0.494–0.863;  $P = 0.003$ ) and ICU use (OR: 0.371, 95% CI: 0.268–0.514;  $P < 0.001$ ). The use of spinal anesthesia was not found to influence the risk of pRBCs transfusion (adjusted odds ratio [OR]: 0.823, 95% CI: 0.631–1.073;  $P = 0.149$ ) and prolonged hospital length of stay (adjusted odds ratio [OR]: 0.886, 95% CI: 0.684–1.148;  $P = 0.360$ ). **Conclusions** Compared with general anesthesia, spinal anesthesia for total hip arthroplasty was associated with decreased rates of cardiorespiratory complications, intraoperative hypotension, and ICU use.

## Background

Total hip arthroplasty is one of the most effective surgical interventions aiming to relieve severe hip pain and improve functional limitation for patients suffering from advanced degenerative joint disease. As the population ages over time, the incidence of symptomatic osteoarthritis is increasing and so does the hip arthroplasty [1]. Indeed, the demand for primary total hip arthroplasty is estimated to increase to 572,000 by 2030 in the United States [2].

Spinal anesthesia and general anesthesia are both commonly performed for total hip arthroplasty. Spinal anesthesia hopefully have potential benefits in patients undergoing orthopedic surgery [3]. Available data suggest that spinal anesthesia has been associated with reduced overall morbidity and mortality [4, 5], a reduction of blood transfusion [6, 7], decreased rate of postoperative venous thromboembolism [8], and decreased operating room time [9], compared to general anesthesia, for total hip arthroplasty.

Despite multiple findings suggest that better outcomes are associated with spinal anesthesia, clear and consistent evidence regarding the relationship between anesthesia technique and cardiorespiratory complications is still missing. Therefore, we conducted a retrospective cohort study to elucidate whether the perioperative outcomes differ by anesthesia type and identify patients who may be at risk among patients undergoing total hip arthroplasty, over a 6-year period. The primary outcome of interest was the association of anesthetic technique with cardiorespiratory complications. We hypothesized that use of spinal anesthesia will have improved cardiorespiratory outcomes than general anesthesia.

## Methods

### Study Design

Before conducting this study, we received Medical Ethics Committee approval from Zhongnan Hospital of Wuhan University (2019001) and the requirement for written informed consent was waived by the Medical Ethics Committee. We used the operation query function in Operation Anesthesia Management System (OAMS) from the anesthetic department to obtain demographic, anesthesia-related, and operation-related data about all patients undergoing total hip arthroplasty. We further performed a detailed medical record review of all the entries by checking the Hospital Information System (HIS) for electronic patient information, including clinical, laboratory, outcome data, discharge dates, and dates of death. For each group, patients with preexisting comorbidities and major complications were identified by International Classification of Diseases, tenth revision (ICD-10) diagnosis codes, consistent with such diagnosis (Additional file 1). Some clinical records not available in the electronic patient database were obtained from the Medical Record Department where we have access on the missing information from the paper records. For the databases, OAMS is an integrative operation anesthesia system realizing the acquisition, display, editing, analysis, transmission, and reporting of operating room data. HIS is a widely used information management system that covers all the clinical data and records the whole process of the hospital.

### Study Cohort

We conducted a retrospective cohort study of patients who underwent total hip arthroplasty between December 1, 2012 and October 31, 2018 in Zhongnan Hospital of Wuhan University. Patients were excluded if they underwent hemiarthroplasty procedure, the first admission was not for total hip arthroplasty, or they received any form of anesthesia other than spinal or general anesthesia alone. Patients are grouped according to the type of anesthesia initiated at the start of the surgery. The primary outcome was cardiorespiratory complications, including the newly diagnosed arrhythmia, cardiogenic shock, acute heart failure, myocardial infarction, pneumonia, pulmonary embolism, respiratory failure, and other conditions (e.g., hypertensive crisis and pleural effusion). Secondary outcomes were intraoperative hypotension, pRBCs transfusion, prolonged hospital length of stay, ICU use, life-threatening event and mortality.

We compared the demographic, operation–related characteristics, preoperative comorbidities, and perioperative outcomes of all recipients undergoing total hip arthroplasty under different anesthesia types. Extracted demographic data included the age, sex, weight, height, and American Society of Anesthesiologists (ASA) classification. Patient age was categorized into the following groups: < 45, 45–54, 55–64, 65–74, 75–84, and > 84 years old. Body mass index (BMI) was calculated from height and weight. Operation-related data included the admission type (emergency or routine), surgical pathology (fracture or non-fracture), type of total hip replacement (revision or primary), operative site (bilateral or unilateral), fixation technique (cement or uncemented), and surgical duration. Emergency surgery refers to the urgent condition after the doctor's assessment that the need for surgery in the shortest possible time or there is a risk of life surgery. Surgical duration was defined as the time from the beginning of skin cutting to the end of suture. The preoperative comorbidities included the preexisting diagnosis of anemia (as per the World Health Organization definition, < 120 g/l for women and < 130 g/l for men) [10], chronic obstructive pulmonary disease (COPD), diabetes, congestive heart failure, renal insufficiency, cerebral infarction, and myocardial infarction.

### Patient Management

All patients entering the operating room received conventional standard monitoring, including noninvasive, automatic arterial blood pressure measurement every 5 min, respiratory frequency and heart rate monitoring, continuous electrocardiography (lead II), and pulse oximetry. Some patients were subjected to invasive procedures, such as central venipuncture and catheterization, and continuous blood pressure monitoring. General anesthesia was induced according to our local standard of care with intravenous sufentanil or fentanyl, and propofol, followed by muscle relaxation to facilitate tracheal intubation. Afterward, general anesthesia was maintained with intravenous target-controlled infusion of anesthetics consisting of remifentanyl and propofol. According to heart rate, blood pressure, and other clinical signs, anesthesiologist properly adjusted the anesthesia depth, and the intraoperative bispectral index (BIS) value was maintained between 45 and 60. Meanwhile, local anesthetics with or without morphine or sufentanil both administered intrathecally via L4–L5 or L3–L4 interspace. Antibiotics were administered intravenously for 24 to 48h as part of local standard care for prophylaxis of surgical site infection. Topical tranexamic acid (3g) within our blood-saving protocol was used routinely intraoperatively. In addition, patients undergoing total hip arthroplasty received a surgical incision infiltration of 200mg of ropivacaine.

### Definition of Complications

Cardiogenic shock referred to a disorder of cardiac function caused by systolic or diastolic dysfunction, leading to a reduced ejection fraction or impaired ventricular filling. Myocardial infarction was diagnosed on the basis of electrocardiographic changes and/or an increased troponin level. Acute heart failure was defined as an abrupt decline in heart function with reduced myocardial contractility and aggravation of cardiac load. Pneumonia was diagnosed according to chest radiographs and pathogen detection. Respiratory failure is a serious disorder characterized with hypoxia with (or without) carbon dioxide retention. Patient with presence of emboli in the pulmonary vasculature as determined by multidetector

computerized tomography was diagnosed as pulmonary embolism. Intraoperative hypotension was defined as a mean arterial pressure (MAP) reduction of more than 20% from baseline MAP. Hospital length of stay and ICU times were also dichotomized into categorical variates. Hospital length of stay was defined as the day of the admission until discharge. Entries above the 75th percentile of the hospital length of stay were defined as prolonged hospital length of stay. Any complication that needs epinephrine administration to rescue life and maintain the stability of circulation and respiratory system was defined as a life-threatening adverse event.

## Statistical Analysis

The goal of this current study was to elucidate whether anesthetic technique has an impact on perioperative outcomes for patients undergoing total hip arthroplasty. All statistical analyses were performed using the IBM SPSS Statistics 22 software (IBM, Armonk, NY, USA).

Weighted means and percentages were described for continuous and categorical variables, respectively. Interquartile range and median were performed to estimate the variates that had a skewed distribution. Chi-squared test or Fisher exact test for categorical variates and Mann–Whitney U test for continuous variates were conducted with a significance level of  $P < 0.05$  to compare the demographic characteristics, preoperative comorbidities, and postoperative complications between spinal and general anesthesia groups. For a continuous variable, 95% confidence intervals (CIs) were the measure of variability.

Next, univariate logistic regression analyses were performed to estimate the association between all risk factors and perioperative outcomes. The binary outcomes of the incidence of cardiorespiratory complications, intraoperative hypotension, pRBCs transfusion, prolonged hospital length of stay, and ICU use as defined above were considered. All variables that were deemed clinically important were considered and those with  $P < 0.1$  in the univariate logistic analyses were included in the final multivariable logistic regressions. Multivariable logistic regression analyses were used to evaluate the association between each outcome and anesthetic technique while controlling for other confounding factors selected from the univariate logistic regression analyses results, with a significant difference of  $P < 0.05$ . Cases from general anesthesia were used as reference. Adjusted odds ratio [OR], 95% CI, and  $P$ -value were also reported.

## Results

The study cohort consisted of 1,233 patients undergoing total hip arthroplasty, of whom 45.5% (561) received general anesthesia and the remaining 54.5% (672) received spinal anesthesia. Table 1 shows the patient demographic characteristics and operation-related information compared between anesthesia groups. As seen in the table, patients receiving general anesthesia were younger ( $P = 0.001$ ) and had increased BMI ( $P = 0.001$ ) than those receiving spinal anesthesia. The difference of the six age groups was also statistically significant in the two anesthesia types ( $P < 0.001$ ). Bilateral total hip arthroplasty

was more likely to be performed under general anesthesia ( $P = 0.029$ ). Patients receiving general anesthesia experienced longer surgical duration ( $P < 0.001$ ).

Table 2 The show that the differences in the rates of overall preoperative comorbidities were insignificant.

Table 3 depicts the perioperative outcomes for total hip arthroplasty recipient. Patients receiving spinal anesthesia were less likely to suffer from cardiorespiratory complications, intraoperative hypotension, and pRBCs transfusion than those receiving general anesthesia ( $P < 0.001$ ). The length of hospital stays and ICU times were longer for patients receiving general anesthesia ( $P < 0.05$ ). The rates of prolonged hospital length of stay and ICU use were also lower in spinal anesthesia group ( $P < 0.05$ ). For the occurrence of life-threatening adverse event and mortality, the difference between the two groups was insignificant ( $P > 0.05$ ). Seven patients died before discharge, of whom 2 were under spinal anesthesia, and 5 were under general anesthesia, with the overall in-hospital mortality of 0.56% (Table 3). For the cause of death, three died of multiple organ dysfunction syndrome (MODS), two of myocardial infarction, one of respiratory failure, and one of pulmonary embolism. Among all the cardiorespiratory complications, pneumonia had highest incidence.

Tables 4 show the results of univariate regression analyses. Spinal anesthesia was associated with improved perioperative outcomes. Table 5 show the results of the multivariable regression analyses. In the multivariable analysis, spinal anesthesia was associated with lower odds for cardiorespiratory complications compared with general anesthesia (OR: 0.457, 95%CI: 0.320-0.652;  $P < 0.001$ ). Patients receiving spinal anesthesia had a 34.7% decrease in the odds for experiencing intraoperative hypotension (OR: 0.653, 95%CI: 0.494–0.863;  $P = 0.003$ ). The adjusted risk for ICU use was significantly lower in patients receiving spinal anesthesia (OR: 0.371, 95% CI: 0.268–0.514;  $P < 0.001$ ). However, the use of spinal anesthesia was not found to influence the risk of prolonged hospital length of stay (OR: 0.886, 95% CI: 0.684–1.148;  $P = 0.360$ ) and pRBCs transfusion (OR: 0.823, 95% CI: 0.631–1.073;  $P = 0.149$ ).

## Discussion

Rodgers et al.[3] was the first to demonstrate evidence of superior outcomes associated with spinal anesthesia. Since Rodgers et al.'s paper was published, similar studies for patients undergoing total hip arthroplasty have increased. Nevertheless, outcome data particularly about cardiorespiratory complications are limited, and some of these studies are even inconsistent. The current study collected data over a 6-year period to compare perioperative outcomes between spinal and general anesthesia.

Our results indicated an overall beneficial trend toward the outcome of spinal anesthesia over the general approach, which are consistent with previous studies [4, 6, 11, 12]. Spinal anesthesia was independently associated with decreased odds for cardiorespiratory complications, intraoperative hypotension, and ICU use. There was no impact of the choice of anesthetic technique on the odds for pRBCs transfusion or prolonged hospital length of stay.

General anesthesia was associated with the frequent occurrence of cardiorespiratory complications. Cardiorespiratory complications are major perioperative complications [13] and predominant causes of death in elderly patients following hip fracture surgery [14]. Juliane Carow et al [15] identified risk factors for mortality and cardiorespiratory complications in trochanteric femur fractures over a 10-year analysis and indicated that high ASA classification and blood transfusion are risk factors for cardiorespiratory complications. However, the association with anesthetic technique was excluded in their study. Although a few studies have reported on the association of perioperative complications related to cardiovascular and respiratory system, researchers mainly focused on the risk factors of specific complications, which were not as comprehensive as that in our study [9, 16–18]. Among all the cardiorespiratory complications, perioperative pulmonary infection had highest incidence, which was consistent with the result of a previously mentioned study [13]. Hence, the high incidence of pulmonary infection in general anesthesia patients may be attributed to the procedure of tracheal intubation and mechanical ventilation, intraoperative opioid use, and postoperative opioid use following imperfect analgesia, especially for patients with preoperative pulmonary infection or COPD [19, 20].

General anesthesia was associated with more frequent intraoperative hypotension. Orghi et al [21] first evaluated the frequency of hypotension and bradycardia by using different anesthesia types for total hip replacement. Findings suggested that general anesthesia was associated with increased odds for hypotension, both at induction and intraoperative. Intraoperative blood loss and the use of anesthetics at general anesthesia induction may increase the incidence of hypotension. Sevoflurane can cause a considerable depressant effect on baroreflex activity, which is considerably apparent in elderly patients [22]. Meanwhile, central nervous system and cardiovascular depression induced by propofol [23, 24] and a direct vasodilatory effect in response to sufentanil or fentanyl [25, 26] also adds to this effect. Patients receiving general anesthesia experienced longer surgery time and more bilateral surgery, which might increase the risk for intraoperative hypotension in our study. However, controlled hypotension is also a medical intervention by lowering blood pressure between a certain margin of safety to reduce intraoperative blood loss and blood transfusion [27], which made it difficult to illustrate the impact of intraoperative hypotension.

In our study, patients receiving spinal anesthesia required less pRBCs transfusion. Multiple studies have concluded that neuraxial anesthesia has a clear and definite beneficial effect on surgical blood loss and reduction in blood transfusion for total hip arthroplasty [6, 9, 28, 29]. Multifactorial mechanisms may interpret the benefits seen for spinal anesthesia, including improved analgesia, altered coagulation, decreased vascular tone, and reduction in surgical stress responses, but no conclusive data are available to date. Therefore, coupled with the knowledge on the risk factors associated with blood transfusion, early multidisciplinary interventions should be conducted toward high-risk patients.

Patients receiving spinal anesthesia experienced a shorter hospital length of stay, which was similar to previous studies [4, 16, 30, 31]. There was no association found between anesthesia type and prolonged hospital length of stay. Reducing the hospital length of stay has always been a common healthcare-related focus for surgeons and hospitals, and it considerably attenuates the cost for total joint arthroplasty on hospital level [32].

Patients receiving spinal anesthesia had decreased odds for ICU use and shorter ICU times than those receiving general anesthesia. Data from a large-sampled, multicenter research suggested that the presence of cardiorespiratory complications exert a negative effect on the rate of ICU use [33]. Patients under general anesthesia were more likely to experience cardiorespiratory complications in our study. Not only the avoidance and reduction of potential adverse effects associated with general anesthesia, but the intrinsic benefit from neuraxial anesthesia that contribute to the lower rate of ICU use [34].

Perioperative mortality and life-threatening event are rare but clinically important. In the present study, patients under general anesthesia had insignificant higher rate of combined life-threatening adverse event and mortality, which was similar to previous reports [35–37]. However, some evidence demonstrated a lower mortality for spinal anesthesia than general anesthesia [5, 15]. According to the cause of death in our study, severe cardiorespiratory adverse events were also related to high mortality. Given the low mortality in our patient population, a large sample size and multicenter research should be conducted to detect the intrinsic relationship between anesthesia type and mortality.

Our study has several strengths. We compared comprehensive cardiorespiratory complications between general and spinal anesthesia types. Multivariable logistic regression was used to correct confounding variables and explore the risk factors for each outcome. We also recorded the in-hospital cause of death for all patients who died in hospital, reports on such cause of death was previously lacking.

The current study also has several limitations. First, the patient-related data were collected from historical procedural data, which contained limitations inherent of a retrospective study. Second, our research was conducted in a single institution, which largely limited the generalizability of our conclusions to other centers. The sample size of our study was also relatively small, thereby lacking enough statistical power to detect a potential difference in some outcomes, such as mortality. Third, preoperative medicine administration and postoperative care were not recorded in our study. Long-term outcomes, such as readmission, 30-day mortality, and 90-day mortality were also disregarded in our study.

## Conclusion

In conclusion, spinal anesthesia was associated with decreased odds for cardiorespiratory complications, intraoperative hypotension, and ICU use. Further research is needed to explore the mechanism of these results.

## Abbreviations

**1. Abbreviations:** ASA: American Society of Anesthesiologists; BMI: Body Mass Index; BIS: Bispectral Index; COPD: Chronic Obstructive Pulmonary Disease; CI: Confidence Interval; HIS: Hospital Information System; ICU: Intensive Care Unit; ICD-10: International Classification of Diseases, tenth revision; MAP: Mean Arterial Pressure; MODS: Multiple Organ Dysfunction Syndrome; MI: Myocardial Infarction; OAMS: Operation Anesthesia Management System; OR: Odds Ratio; pRBCs: packed Red Blood Cells; SD: Standard Deviation; THA: Total Hip Arthroplasty.

## Declarations

**2. Ethics approval and consent to participate:** This study was approved by Medical Ethics Committee from Zhongnan Hospital of Wuhan University (2019001) and the requirement for written informed consent was waived by the Medical Ethics Committee **3. Consent for publication:** Not applicable.

**4. Availability of data and material:** The datasets generated and analyzed in the current study are available from the corresponding author on reasonable request.

**5. Competing interests:** The authors declare that they have no competing interests.

**6. Funding:** None

**7. Authors' contributions:** XMS: This author helped designed the experiments and study. QF: This author helped conduct the study, collect the data, processed the experimental data, and prepare the manuscript. HYW: This author helped design the study and prepare the manuscript. HL: This author helped design the study and prepare the manuscript. YLW, ZZZ: These authors helped design the study and discussed the results. All authors read and approved the final manuscript.

**8. Acknowledgements:** Not applicable

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## Tables

Table 1. Demographic Characteristics and Operation-related Variables of All Patients.

Variable	General (n = 561)	Spinal (n = 672)	<i>P</i> Value
Age (yr), mean (SD)	69.0 (15.8%)	72.1 (14.2%)	0.001
Age group (yr)			0.013
< 45	39 (7.0%)	28 (4.2%)	
45-54	54 (9.6%)	51 (7.6%)	
55-64	107 (19.1%)	98 (14.6%)	
65-74	117 (20.9%)	148 (22%)	
75-84	149 (26.6%)	203 (30.2%)	
> 85	95 (16.9%)	144 (21.4%)	
Gender			0.096
Female	377 (67.2%)	421 (62.6%)	
Male	184 (32.8%)	251 (37.4%)	
BMI (kg/m <sup>2</sup> ), mean (SD)	22.4 (3.8%)	21.7 (3.8%)	0.001
Operation-related variables			
ASA classification			0.322
I	32 (5.7%)	34 (5.1%)	
II	333 (59.4%)	396 (58.9%)	
III	180 (32.1%)	232 (34.5%)	
IV	16 (2.9%)	10 (1.5%)	
Admission type			0.933
Routine	651 (96.9%)	543 (96.8%)	
Emergency	21 (3.1%)	18 (3.2%)	
Surgical pathology			0.002
Non-fracture	240 (42.8%)	230 (34.2%)	
Fracture	321 (57.2%)	442 (65.8%)	
Type of THA			0.379
Primary	553 (98.6%)	666 (99.1%)	

Revision	8 (1.4%)	4 (0.9%)	
Operative site			0.029
Unilateral	550 (98.0%)	668 (99.4%)	
Bilateral	11 (2.0%)	4 (0.6%)	
Fixation technique			0.819
Uncemented	458 (81.6%)	552 (82.1%)	
Cement	103 (18.4%)	120 (17.9%)	
Surgical duration	140.2 ± 61.6	116.6 ± 48.9	< 0.001

*ASA = American Society of Anesthesiologists; BMI = body mass index; THA = total hip arthroplasty; SD = standard deviation.*

Table 2. Preoperative Comorbidities of All Patients

Comorbidity	General
Anemia	
mild	181 (32.3%)
moderate	20 (3.6%)
severe	7 (1.2%)
COPD	13 (2.3%)
Diabetes	90 (16.0%)
Congestive heart fail	4 (0.7%)
Renal insufficiency	12 (2.1%)
Cancer	9 (1.6%)
Dementia	3 (0.5%)
Peripheral vascular disease	19 (3.4%)
Cerebrovascular disease	81 (14.4%)
Previous MI	4 (0.7%)

*COPD = chronic obstructive pulmonary disease; MI = myocardial infarction*

Table 3. Patient Perioperative Outcomes in the Study Period

	General	Spinal	<i>P</i> Value
<b>Dichotomous outcomes</b>			
Cardiorespiratory complications	119 (21.2%)	80 (11.9%)	< 0.001
Arrhythmia	10 (1.8%)	6 (0.9%)	0.169
Cardiogenic shock	1 (0.2%)	2 (0.3%)	1
Acute heart failure	5 (0.9%)	2 (0.3%)	0.317
Myocardial infarction	3 (0.5%)	2 (0.3%)	0.840
Pneumonia	94 (16.8%)	63 (9.4%)	< 0.001
Respiratory failure	2 (0.4%)	1 (0.1%)	0.875
Pulmonary embolism	4 (0.7%)	3 (0.4%)	0.810
MODS	0 (0%)	1 (0.1%)	1
Intraoperative hypotension	157 (28%)	127 (18.9%)	< 0.001
pRBCs transfusion	209 (37.3%)	190 (28.3%)	< 0.001
Prolonged hospital length of stay	186 (33.2%)	183 (27.2%)	0.024
ICU use	153 (27.3%)	108 (16.1%)	< 0.001
Life-threatening adverse event	13 (0.02%)	7 (0.01%)	0.077
Death	5 (0.9%)	2 (0.3%)	0.317
<b>Continuous outcomes</b>			
			<i>P</i> Value
pRBCs transfusion (u)	1.2 ± 2.0	0.8 ± 1.6	< 0.001
Hospital length of stay (d)	20.0 (15-23)	18 (14-22)	0.001
ICU times (h)	8.6 ± 21.6	5.1 ± 20.2	< 0.001

*MODS = Multiple organ dysfunction syndrome; pRBCs = packed red blood cells;*

*Prolonged hospital length of stay indicates > 75th percentile of hospital length of stay;*

*ICU = intensive care unit.*

Table 4. Univariate Regression Analysis of Association Between Spinal Anesthesia and Perioperative Outcomes

Outcome Variable	General vs. spinal	
	OR (95% CI)	P Value
Cardiorespiratory complications	0.527 (0.381-0.729)	< 0.001
Intraoperative hypotension	0.600 (0.459-0.783)	< 0.001
pRBCs transfusion	0.664 (0.522-0.844)	0.001
Prolonged hospital length of stay	0.755 (0.591-0.963)	0.024
ICU use	0.511 (0.387-0.674)	< 0.001

*CI = confidence interval; OR = odds ratio; pRBCs = packed red blood cells; Prolonged hospital length of stay indicates > 75th percentile of hospital length of stay; ICU = intensive care unit.*

Table 5. Multivariable Regression Analysis of Association Between Spinal Anesthesia and Perioperative Outcomes

Outcome Variable	General vs. spinal	
	Adjusted OR (95% CI)	Adjusted P Value
Cardiorespiratory complications	0.457 (0.320-0.652)	< 0.001
Intraoperative hypotension	0.653 (0.494-0.863)	0.003
pRBCs transfusion	0.823 (0.631-1.073)	0.149
Prolonged hospital length of stay	0.886 (0.684-1.148)	0.360
ICU use	0.371 (0.268-0.514)	< 0.001

*CI = confidence interval; OR = odds ratio; pRBCs = packed red blood cells; Prolonged hospital length of stay indicates > 75th percentile of hospital length of stay; ICU = intensive care unit.*

## Additional File Legend

**File name:** Additional file 1

**File format:** docx

**Title of data:** Additional file 1

**Description of data:** International Classification of Diseases, tenth revision (ICD-10) diagnosis codes

## Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [Additionalfile1.doc](#)