Comparison of the Effects of Different Regional Blockade Techniques on Occurrence of Acute Kidney Injury (AKI) After Major Thoracic and Abdominal Surgeries Under General Anesthesia: A Propensity Matching Analysis

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Abstract

Background: Recently, it has been under consideration that the anesthetic techniques used during general anesthesia may have influence over the development of acute kidney injury and other postoperative outcomes. For this reason, we aimed to compare the effects of different regional blockade techniques (peripheral nerve blockade versus neuraxial epidural) on occurrence of acute kidney injury (AKI) after thoracic and abdominal surgeries under general anesthesia.

Methods: In a single-center retrospective cohort study, 2846 patients undergoing elective thoracic or abdominal surgery during a period of seven years were included into the study. The primary endpoint was the occurrence of AKI postoperatively within a seven-day period in-hospital. Perioperative data were obtained and analyzed to provide data for secondary endpoints that include all other outcome related parameters. To reduce the influence of potential confounding factors, propensity score (PS) analysis was performed. Multivariate logistic regression models examined the selection of an epidural or PNB in general anesthesia before and after propensity score weighting analysis.

Results: Of the 2846 patients, 7.3% (207 cases) suffered AKI. The odds ratio of AKI for PNB (epidural as reference) was 0.61 (0.40~0.83), P = 0.006. After propensity score matching, the odds ratio for PNB was [0.49 (0.28~0.70), P = 0.001]. All other outcome related parameters were considered and evaluated.

Conclusions: After PS matching analysis, there is no difference in secondary outcome analysis of groups that received PNB or epidural neuraxial blockade who were both under general anesthesia. However, patients who received PNB under general anesthesia showed lower incidence of AKI within seven days postoperatively.

Background

Acute kidney injury (AKI) commonly occurs in patients after noncardiac surgery and in 17.9% of patients following major surgery.[1−9] The mortality rate of patients experiencing AKI increases significantly.[3−5] Many risk factors such as body mass index (BMI), gender, age, African American race, preexisting hypertension, active congestive heart failure, chronic kidney disease, pulmonary disease, insulin-dependent diabetes mellitus, peripheral vascular disease, presence of ascites and complexity of the surgery advanced age cannot be modified. Factors that can be changed (preoperative albumin levels, duration of hypotension, colloid use[1−7]) are the key to lowering the incidence rate of AKI in patients after surgery.

Studying the effects of anesthesia on the prognosis of patients has always been an important field in perioperative research. Previous studies have focused on comparing the effects of general anesthesia, and general anesthesia combined with an epidural or peripheral nerve block (PNB), or general and intrathecal anesthesia. The purpose of this retrospective study was to investigate the relationship between epidurals or PNBs, as an analgesic technique in general anesthesia, and the development of AKI in adult patients that underwent thoracic and abdominal surgery at a large tertiary medical care center.

Methods

Study design, setting, population, and data collection

This single center retrospective cohort study was conducted at a teaching hospital in China with 1500 beds. The Ethics Committee approved this study. This study extracted data get from the database.[1] This study analyzed data from adults patients (age ≥ 18 years old) who underwent elective thoracic and abdominal surgery between January 1, 2013, and December 31, 2018. The procedures that were included in the present study were abdominal or thoracic surgery because these involve both epidural and PNB techniques. In the current study, we only included information from the first procedure for patients operated on more than twice within one year. If one patient received two surgeries in separate years, two surgeries were counted. Cardiac, obstetric, or emergency surgery was also excluded from the present study. Additionally, estimated preoperative glomerular filtration rate of less than 60 mL/min/1.73 m^2, preoperative serum creatinine (sCr) levels greater than 176 μmol/L, or a previous history of renal dysfunction were also excluded from the present study.

Exposures of cohorts

The exposure of cohorts in this study was different regional blockade techniques (peripheral nerve blockade versus neuraxial epidural) under general anesthesia.

General anesthesia

In the operation room, standard monitoring was carried out, including electrocardiogram (ECG), SpO2, non-invasive or invasive blood pressure, end tidal CO2, and body temperature. In patients receiving surgeries under general anesthesia, intravenous propofol (1–3 mL/kg) or Etomidate (0.2-0.6 mg/kg) with rocuronium (0.6–1.0 mg/kg) or cis-atracurium (0.1–0.2 mg/kg) and sufentanil at induction (0.25-1ug/Kg) was used for induction. After induction, Patients with inhalation anesthesia was maintained with 1–1.5 minimum alveolar concentration of inhalational agents (sevoflurane) with or without 50% nitrous oxide. After the procedure was completed, the inhalation agent and nitrous oxide were turned off and the lung was ventilated with 100% oxygen. Patients with total intravenous anesthesia (TIVA) were infused with propofol (1%,20-40 ml/h), intraoperative analgesic included sufentanil (5-10 ug/time or TCI 0.1-0.3 ng/ml) or remifentanil (TCI 2-3 ng/ml) were used for maintaining. The fresh gas flow rate was kept constant at 2-3 L/min, and minute ventilation was regulated based on ETCO2. The tidal volume and respiratory rate were set at 6–8 mL/kg and 10–12/min, without positive end-expiratory pressure (PEEP). In patients with decreased SpO2, 5 cm H2O PEEP was applied. When an attempt of self-respiration appeared, a cholinesterase inhibitor with anticholinergics was administered and extubation was performed. Self-controlled post-operative analgesic infusion pump (sufentanil 1-1.5ug/ml, bollus at 2ml, lock time 8-10 min) was used when necessary or patient requested. Blood pressure was kept within a normal range in both groups. If systolic blood pressure dropped below 90 mmHg or 30% from baseline, ephedrine (3–12 mg) or phenylephrine (50–100 μg) was injected. In the case of persistent hypotension, continuous infusion of phenylephrine or non-adrenaline was administered. When the blood pressure was high despite the adequate anesthetic depth and sufficient analgesia, calcium channel blocker or beta blocker was administered considering the underlying disease of the patients and other vital signs upon the decision-making of a staff anesthesiologist. When severe bradycardia (HR < 45 BPM/min) was observed, atropine (0.2 mg) was applied. Calculating the maintenance volume and bleeding, as well as the patient's volume status, crystalloid and colloid solution was infused. Blood transfusion was carried out based on the amount of hemorrhage and the hematocrit level.

Regional blockade techniques

PNB consisted of 0.375 – 0.5% ropivacaine 10-40 ml after needle head satisfiedly reached target zone with ultrasound guidance. Epidural was performed at the lateral decubitus position, a loss of resistance technique was used for identification. A plastic tube was inserted into the epidural space, and continuous or intermittent 0.375 – 0.5% ropivacaine or 1% lidocaine was injected.

Variables used in the present study

This study retrospectively extracted demographic, surgical, preoperative disorders, Intraoperative variables and outcome data of all patients from the perioperative database. The demographic data included age, sex, body mass index (BMI), smoking and alcohol habits. Surgical data included the operator, The modified John Hopkins Hospital criteria (MJHSC), whether or not intraperitoneal surgery. Preoperative disorders data included medical history, including the presence of hypertension, coronary artery disease, cerebrovascular disease, diabetes, pulmonary disease, adrenal insufficiency, and the use of the following medications: angiotensin converting enzyme inhibitor/angiotensin receptor blocker, beta blocker, calcium channel blocker, antiplatelet agent, HMG-CoA reductase inhibitors, non-steroidal anti-inflammatory drugs (NSAIDS), selective COX-2 inhibitor, other analgesics, and steroids. In addition, preoperative laboratory findings, including anemia, platelet, white blood cells, blood sodium level, C-reactive protein (CRP), alanine aminotransferase (ALT), aspartate aminotransferase (AST), albumin, uric acid and creatinine, as well as transthoracic echocardiographic, were also documented. Intraoperative variables including the use of vasopressor, calcium channel blocker, and beta blocker, the total volume of infused crystalloid and colloid, intraoperative packed red blood cell transfusion, and the intraoperative hypotension, lowest mean blood pressure (MBP), hypoxemia, level of end-tidal CO2, mean heart rate were evaluated. In addition, the operation and anesthesia time were also calculated.

Primary Outcome

The primary outcome of this study was the association of the anesthetic technique with the occurrence of AKI in patients following thoracic and abdominal surgeries. AKI was defined based on the Kidney Disease Improving Global Outcomes (KDIGO) criteria defined as postoperative serum creatinine level increase to no less than 26.5 μmol/l within 48 hours, or 1.5 times from the baseline 7 days after surgery, or initialization of blood dialysis.[2-8]

Secondary outcome

Secondary outcome variables were classified postoperatively as follows: cardiovascular complications: composed of Acute myocardial infarction (STEMIs & NSTEMIs), new congestive heart failure, non-fatal cardiac arrest and death within 7 days postoperatively.[9-12]

Statistical analysis

Patients were divided into two cohorts according to the anesthetic technique that was used on them. Continuous variables with a normal or non-normal distribution were compared using the Student t-test or Mann-Whitney U-test, respectively. The Kolmogorov-Smirnov test was used to determine whether the data was normally distributed. Categorical variables were compared by the Chi-Square test or the continuity-corrected Chi-Square test or exact Fishers' test. Rank variables were compared using the Kruskal-Wallis H-test. Statistical significance was defined by a two-tailed $P < 0.05$.

Multivariate logistic regression to detect anyassociation between theanesthetic techniqueand AKI

A logistic regression model was constructed, and confounders were assessed based on a priori knowledge and other studies.[2-8,13,14] The following covariates were considered: AKI risk index, which defined as: age 56 years old or older, male sex, emergency surgery, intraperitoneal surgery, diabetes mellitus necessitating oral therapy, diabetes mellitus necessitating insulin therapy, active congestive heart failure, ascites, hypertension, mild preoperative renal insufficiency, and moderate preoperative renal insufficiency. Other variables included preoperative hemoglobin, creatinine and albumin, cancer surgery, surgical complexity (Modified John Hopkins hospital criteria, MJHSC [11]), intraoperative hypotension, intraoperative blood transfusion,intraoperative colloid use. Multicollinearity among these variables was assessed by the variance inflation factor, with a reference value of 2. le Cessie - van Houwelingen - Copas - Hosmer unweighted sum of squares test was used for the goodness of fit. Discrimination of the multivariate model was assessed based on the c-statistic. A heterogeneity analysis was used to determine if there were any differences in the treatments' effects between the different subgroups defined by covariates included in the model. The adjusted odds ratio for AKI in both subgroup was calculated, and the interaction effect of covariates was tested for the relationship between anesthesia type and outcomes. Sensitivity logistic regression models were constructed as following: (i) adjusting for the duration of the surgery.

Analysis of the propensity score matching

To reduce the influence of potential confounding factors, Propensity score (PS) matching analysis was performed to modify intergroup differences according to the anesthetic technique. Table 2 shows demographic and perioperative variables used for estimating the PS. Using greedy matching algorithms, this study used a caliper of 0.25 SD of the logit of the PS to match patients at a ratio of 1:1. Logistic Model discrimination and model calibration were evaluated with c statistics (0.729) and le

Cessie - van Houwelingen - Copas - Hosmer unweighted sum of squares test (p = 0.224). This study evaluated the balancing in demographic, surgical, and preoperative covariates of the PS-matched cohort by the standardized mean difference. All absolute standardized differences after PS were less than 10%. The risk of outcome variables, including occurrence of morbidity, were re-analyzed by logistic regression in the total and PS-matched cohort. Statistically significance was set at $p < 0.05$.

Statistical Packages

All data management and statistical analysis were performed using the R programming language (v.3.6.2).

Results

For the time period January 2013-December 2018. A total of 3249 elective noncardiac surgeries were screened, and a total of 2846 surgeries were ultimately analyzed (Figure 1). The median age was 62 years old, with 62.0% of the population being female, and the mean body mass index was 24.0±3.4 kg/m2, with the majority being ASA class II or III. With a median operation duration of 200 (127-284 interquartile range, IQR) minutes, the most common surgeries were digestive tract (38.3%) and thoracic surgery (32.0%) (Table 1).

Table 1

Baseline characteristics of all patients included in the total set.

Demographic Data	Epidural (n=2046)	PNB (n=800)	ALL (n=2846)	P value
Age [yr; median (IQR)]	62(53-70)	60(51-68)	62(52-69)	<.001
female gender, [n (%)]	1274 (62.3%)	491 (61.4%)	1765 (62.0%)	0.659
Body mass index, kg/m^2	23.9 ± 3.4	24.3 ± 3.5	24.0 ± 3.4	0.002
smoking, [n (%)]	497 (24.3%)	139 (17.4%)	636 (22.3%)	<.001
drinking, [n (%)]	62(53-70)	60(51-68)	62(52-69)	<.001
Surgical Data				
Surgical complexity, (low/moderate/high)	90/866/1090	95/429/276	185/1295/1366	<.001
Surgery type, (Genital-urinary / Digestive / Respiratory/ Other)	367/779/693/207	207/312/219/62	574/1091/912/269	<.001
Cancer surgery	1730 (84.6%)	531 (66.4%)	2261 (79.4%)	<.001
Preoperative Medical History				
AKI risk index, (I/II/III/IV/V; n)	1643/162/150/80/11	608/74/77/35/6	2251/236/227/115/17	0.130
hypertension	684 (33.4%)	293 (36.6%)	977 (34.3%)	0.107
Ischemic heart disease	284 (13.9%)	113 (14.1%)	397 (13.9%)	0.866
CABG	4 (0.2%)	3 (0.4%)	7 (0.2%)	0.385
PCI	32 (1.6%)	20 (2.5%)	52 (1.8%)	0.094
Heart failure	38 (1.9%)	16 (2.0%)	54 (1.9%)	0.802
Arrhythmia	62 (3.0%)	34 (4.2%)	96 (3.4%)	0.105
PAD	48 (2.3%)	28 (3.5%)	76 (2.7%)	0.086
Stroke	159 (7.8%)	84 (10.5%)	243 (8.5%)	0.019
diabetes mellitus	389 (19.0%)	142 (17.8%)	531 (18.7%)	0.437
Chronic Renal disease	10 (0.5%)	3 (0.4%)	13 (0.5%)	0.686
Dyslipidemia	93 (4.5%)	35 (4.4%)	128 (4.5%)	0.844
Anemia	28 (1.4%)	13 (1.6%)	41 (1.4%)	0.606
COPD	55 (2.7%)	23 (2.9%)	78 (2.7%)	0.784
Respiratory failure	3 (0.1%)	3 (0.4%)	6 (0.2%)	0.232
Ascites	1 (0.0%)	2 (0.2%)	3 (0.1%)	0.137
Adrenal disease	84 (4.1%)	48 (6.0%)	132 (4.6%)	0.031
Preoperative Laboratory Data				
Thrombocytopenia/normal/thrombocytosis	1752/275/19	674/116/10	2426/391/29	0.554
Leukopenia/normal/leukocytosis	1748/176/122	676/79/45	2424/255/167	0.546
Hyponatremia/normal/hypernatremia	1912/55/79	766/25/9	2678/80/88	<.001
serum creatinine, mmol/L	83.5 ± 17.4	78.1 ± 16.4	82.0 ± 17.3	<.001
Hemoglobin (g/dL)	132.9 ± 20.4	135.0 ± 19.8	133.5 ± 20.2	0.015

Aspartate aminotransferase (IU/L)	25.5 ± 42.0	23.2 ± 25.6	24.8 ± 38.1	0.147
Alanine amino-transferase (IU/L)	25.3 ± 41.0	21.8 ± 19.4	24.3 ± 36.3	0.021
Albumin (g/dL)	40.0 ± 6.4	41.5 ± 6.0	40.4 ± 6.3	<.001
Uric acid (mg/dL)	301.0 ± 90.6	318.7 ± 92.5	306.0 ± 91.5	<.001
Abnormality on echocardiogram	784 (38.3%)	326 (40.8%)	1110 (39.0%)	0.232
Preoperative Medication History				
ACEI	69 (3.4%)	30 (3.8%)	99 (3.5%)	0.621
ARB	147 (7.2%)	63 (7.9%)	210 (7.4%)	0.527
Beta blocker	106 (5.2%)	56 (7.0%)	162 (5.7%)	0.06
CCB	307 (15.0%)	137 (17.1%)	444 (15.6%)	0.161
Diuretic	52 (2.5%)	20 (2.5%)	72 (2.5%)	0.949
Insulin	82 (4.0%)	31 (3.9%)	113 (4.0%)	0.87
Sulfonylureas	75 (3.7%)	32 (4.0%)	107 (3.8%)	0.673
Metformin	44 (2.2%)	16 (2.0%)	60 (2.1%)	0.802
Aspirin	105 (5.1%)	55 (6.9%)	160 (5.6%)	0.070
Clopidogrel	15 (0.7%)	6 (0.8%)	21 (0.7%)	0.962
HMG-CoA reductase inhibitors	53 (2.6%)	44 (5.5%)	97 (3.4%)	<.001
Antibiotics	164 (8.0%)	69 (8.6%)	233 (8.2%)	0.594
NSAIDs	6 (0.3%)	2 (0.2%)	8 (0.3%)	0.845
Selective cyclooxygenase-2 inhibitor	1 (0.0%)	0 (0.0%)	1 (0.0%)	0.532
Other analgesics	1 (0.0%)	1 (0.1%)	2 (0.1%)	0.491
Steroids	13 (0.6%)	7 (0.9%)	20 (0.7%)	0.492
a: All values are reported as No. (%) unless otherwise specified.				

207 [7.3%; 95% CI 6.8% - 8.3%] of the 3,916 surgery patients developed AKI; patients with AKI had a similar in-hospital mortality and a longer hospitalization (0.6 vs 0.2%; P =0.202; median, 7 vs 5 days; P < 0.001).

PNB (epidural as reference) had an odds ratio of 0.61 (0.40~0.83), P = 0.006. After PS weighting, the recalculated logistic odds ratio for PNB was 0.49 (0.28~0.70), P = 0.001 (Table 3,4). An analysis of patients' subgroups based on their characteristics revealed an interaction between preoperative albumin level and whether they were undergoing intraperitoneal surgery. Patients with low albumin level, and non-intraperitoneal surgery appeared to be more susceptible to the effects of the various anesthetics and favored PNB (Figure 2). The qualitative relationship between anesthetic types and AKI was maintained across sensitivity analyses.

Table 2

Baseline characteristics of the patients included in the propensity score match set.

Demographic Data	Epidural (n=635)	PNB (n=635)	smd
Age [yr; median (IQR)]	60 [50-69]	60 [51-68]	2.1
female gender, [n (%)]	378(59.5%)	371(58.4%)	2.2
Body mass index, kg/m^2	24.1 (3.5)	24.2 (3.5)	3.8
smoking, [n (%)]	125(19.7%)	124(19.5%)	0.4
drinking, [n (%)]	108(17%)	115(18.1%)	2.9
Surgical Data			
Surgical complexity, (low/moderate/high)	45/308/282	46/321/268	4.5
Surgery types, (Genital-urinary / Digestive / Respiratory/ Other)	146/217/213/59	143/230/209/53	4.9
Cancer surgery	461(72.6%)	469(73.9%)	2.8
Preoperative Medical History			
AKI risk index, (I/II/III/IV/V; n)	501/52/51/27/4	491/56/57/26/5	4.7
hypertension	210(33.1%)	222(35%)	4.0
Ischemic heart disease	82(12.9%)	91(14.3%)	4.1
CABG	2(0.3%)	2(0.3%)	0
PCI	16(2.5%)	14(2.2%)	2.1
Heart failure	13(2%)	11(1.7%)	2.3
Arrhythmia	21(3.3%)	25(3.9%)	3.4
PAD	18(2.8%)	21(3.3%)	2.7
Stroke	73(11.5%)	64(10.1%)	4.6
diabetes mellitus	123(19.4%)	122(19.2%)	0.4
Chronic Renal disease	4(0.6%)	3(0.5%)	2.1
Dyslipidemia	28(4.4%)	28(4.4%)	0
Anemia	12(1.9%)	10(1.6%)	2.4
COPD	16(2.5%)	20(3.1%)	3.8
Respiratory failure	2(0.3%)	3(0.5%)	2.5
Ascites	1(0.2%)	0(0%)	5.6
Adrenal disease	38(6%)	34(5.4%)	2.7
Preoperative Laboratory Data			
Thrombocytopenia/normal/thrombocytosis	536/90/9	541/87/7	3.2
Leukopenia/normal/leukocytosis	535/62/38	533/63/39	0.9
Hyponatremia/normal/hypernatremia	606/18/11	606/20/9	3.1
serum creatinine, mmol/L	79.48 (17.12)	79.04 (16.91)	2.6
Hemoglobin (g/dL)	133.2 (20)	133.72 (20.15)	2.6
Aspartate aminotransferase (IU/L)	23.75 (50.6)	22.65 (23.5)	2.8

Alanine amino-transferase (IU/L)	22.2 (41.71)	21.46 (19.18)	2.3
Albumin (g/dL)	40.94 (6.02)	41.04 (6.13)	1.6
Uric acid (mg/dL)	308.44 (85.9)	312.36 (91.42)	4.4
Abnormality on echocardiogram	255(40.2%)	260(40.9%)	1.6
Preoperative Medication History			
ACEI	22(3.5%)	24(3.8%)	1.7
ARB	44(6.9%)	47(7.4%)	1.8
Beta blocker	38(6%)	38(6%)	0
CCB	97(15.3%)	103(16.2%)	2.6
Diuretic	13(2%)	16(2.5%)	3.2
Insulin	158(24.9%)	178(28%)	7.1
Sulfonylureas	27(4.3%)	27(4.3%)	0
Metformin	27(4.3%)	26(4.1%)	0.8
Aspirin	13(2%)	14(2.2%)	1.1
Clopidogrel	38(6%)	41(6.5%)	2.0
HMG-CoA reductase inhibitors	6(0.9%)	5(0.8%)	1.7
Antibiotics	26(4.1%)	30(4.7%)	3.1
NSAIDs	58(9.1%)	53(8.3%)	2.8
Selective cyclooxygenase-2 inhibitor	2(0.3%)	1(0.2%)	3.2
Other analgesics	1(0.2%)	1(0.2%)	0
Steroids	3(0.5%)	5(0.8%)	4.0
a: All values are reported as No. (%) unless otherwise specified.			

Table 3

Intraoperative data of the study groups by anesthetic technique in total and matched sets.

	Total Set			Match Set		
Intraoperative Data	**Epidural (n=2575)**	**PNB (n=855)**	**P value**	**Epidural (n=635)**	**PNB (n=635)**	**SMD**
Surgery time, [min; (IQR)]	222 [157-302]	140 [85-220]	<.001	180 [119-257]	160 [97-234]	3.4
Use of vasopressor	550(26.9%)	104(13%)	<.001	141(22.2%)	91(14.3%)	20.5
Use of calcium channel blocker	66(3.2%)	50(6.2%)	<.001	19(3%)	44(6.9%)	18.2
Use of beta blocker	1159(56.6%)	568(71%)	<.001	344(54.2%)	452(71.2%)	35.7
Intraoperative fluid administration, [ml kg-1; (IQR)]						
Infusion volume	35.2 [24.2-51.3]	23.6 [16.7-36.2]	<.001	30.1 [21-44.9]	25.6 [17.8-38.4]	20.3
Crystal	28 [20-38.5]	21.1 [15.3-29.4]	<.001	25.8 [18.3-35.4]	22.2 [15.7-31]	21.5
Colloid	7.5 [0-13.5]	0 [0-7.8]	<.001	5.8 [0-9.4]	0 [0-8.3]	15.0
Intraoperative blood infusion	236(11.5%)	175(21.9%)	<.001	102(16.1%)	108(17%)	2.5
Intraoperative hypotension	127(6.2%)	18(2.2%)	<.001	8(1.3%)	16(2.5%)	9.3
mean intraoperative HR	69.2 (9.6)	65 (9.1)	<.001	68.5 (9.2)	65.2 (9.2)	36.2
The lowest mean blood pressure (mmHg)	51 (2)	51 (3)	0.83	51 (2)	51 (3)	2.7
The lowest pulse oximeter (%)	88 (9)	91 (8)	<.001	89 (9)	90 (8)	20.1
Mean End-tidal CO2	34.7 (4.7)	36.3 (4.4)	<.001	34.8 (4.9)	35.9 (4.4)	25.5

Table 4

Comparison of postoperative clinical outcomes in the study groups by anesthetic technique.

	Total Set				Match Set			
	Epidural (n=2046)	**PNB (n=800)**	**OR (95% CI)**	**P value**	**Epidural (n=635)**	**PNB (n=635)**	**OR (95% CI)**	**P value**
Acute kidney injury	166(8.1%)	41(5.1%)	0.61 (0.40~0.83)	0.006	66(10.4%)	34(5.4%)	0.49 (0.28~0.70)	0.001
Cardiovascular complication	149(7.3%)	51(6.4%)	0.87 (0.58~1.15)	0.395	39(6.1%)	42(6.6%)	1.08 (0.59~1.57)	0.731

Discussion

The present study showed that postoperative AKI occurred in 7.3% of adult patients undergoing major elective thoracic and abdominal surgery. Multivariable adjustment before or after propensity score matching showed that PNB was strongly associated with reduced AKI following thoracic and abdominal surgery.

Sehoon Park et al. compared the effects of using general anesthesia and non-general anesthesia for total knee arthroplasty (TKA).[15] They found no significant difference between the creatinine and AKI occurrence, but significantly less frequent lab tests were conducted on patients that received non-general anesthesia. Using propensity scores matching, Danielle M. Nash et al. compared general anesthesia and general anesthesia combined with a spinal or an epidural and found no difference in postoperative complications.[16] Ha-Jung Kim et al. compared general anesthesia and spinal anesthesia in TKA patients. They found that patients that received spinal anesthesia had a reduced incidence rate of AKI; however, the difference was not statistically significant.[17] In their meta-analysis, Joanne Guay et al. found that compared with general anesthesia, there was a reduction in postoperative mortality when spinal anesthesia was used. [18] However, the difference in patients' mortality rate after the use of general anesthesia and general anesthesia plus spinal anesthesia was not statistically significant. None of the above studies involved comparing the differences in the outcomes between using an epidural or PNB in general anesthesia patients. The present research contributes to answering this question.

As we all know, an epidural as a supplement to general anesthesia dramatically reduces the amount of general anesthesia used on patients during surgery. It provides sufficient analgesia and significantly inhibits sympathetic and stress responses. Many anesthesiologists have highly praised its use. In recent years PNB has developed rapidly, it offers adequate analgesia, and it is easy and fast to operate assisted by ultrasound and is becoming more popular. The difference between these two analgesia methods is mainly in the distance between the blocked sites and the spinal cord. An epidural generally blocks the bilateral sympathetic and sensory nerves, while a PNB naturally only blocks unilaterally.

Previous studies have focused on the comparison between general anesthesia and intrathecal anesthesia.[15–20] They hypothesized that perioperative hemodynamic instability and nephrotoxic agents are considered the major causes of postoperative AKI. [2–8, 15-20] According to this theory, an epidural, which could dramatically reduce the use of potentially nephrotoxic drugs while providing relatively stable hemodynamics, should be far superior to the use of general anesthesia alone. However, this approach remains controversial. Moreover, we did not find a significant difference using our dataset in the outcome between general anesthesia and general anesthesia combined with an epidural.

Some scholars have put forward the hypothesis that compared with general anesthesia, spinal anesthesia can entirely block the sympathetic nerves at the surgical site, reduce the tension of the renin-angiotensin system, increase renal blood flow and urine output.[16,17]

The PNB technique can also soothe the sympathetic tension by blocking the peripheral nerve afferent while maintaining the blood vessels' self-regulating capabilities, preserving the stability of the circulatory system, and maintaining perfusion of the vital organs.

Another hypothesis regarding AKI is that inflammation damages the kidneys. Because epidural and PNB both have intrinsic anti-inflammatory effects, they could both reduce postoperative AKI. [19,20] There may be other unknown mechanisms for the protective effect of PNB on postoperative AKI, and more research is needed. The present study provides a direction for further in-depth analyses.

Abnormal preoperative creatinine level and more complicated surgery often override the effects of other risk factors for AKI. In the subgroup analysis, we revealed that patients with a moderate or mild risk of AKI seemed more vulnerable to the selection of the anesthesia technique, providing hints for further clinical practice.

AKI results in a higher mortality rate, extended hospitalization, and increased expense. It is vital to identify the potential risk factors associated with AKI that can be managed. For those at high risk of AKI, full awareness, frequent lab tests, and determination of specific medication required may improve their prognosis at a relatively low cost and ultimately reduce the medical resources they need.

The authors made every effort to follow an improved research design and improve the quality of the present study's database. However, specific inadequacies were unavoidable and include: 1. This investigation was retrospective, which may result in errors. 2. Postoperative examinations were not performed routinely every day on each patient but were based on clinical symptoms and signs, resulting in an underestimation. A few patients were discharged from the hospital within seven days of having surgery, which means that a small number of primary outcome events were not detected.

Conclusion

After PS analysis, there is no difference in secondary outcome analysis of groups that received PNB or epidural neuraxial blockade who were both under general anesthesia. However, patients who received PNB under general anesthesia showed lower incidence of AKI within seven days postoperatively.

Abbreviations

AKI: acute kidney injury

PNB: peripheral nerve block

PS: propensity score

ICD-9-v3: International Classification of diseases and procedures, Ninth Revision Clinical Revision volume 3

ICD: International Classification of diseases and procedures

eGFR: Estimated Glomerular Filtration Rate

MJHSC: Modified John Hopkins hospital criteria

Declarations

Ethics approval and consent to participate:

This study was approved by the Peking University First Hospital Ethics Committee Review Board, and written informed consent was exempt due to its retrospective nature. All methods were performed in accordance with the relevant guidelines and regulations by including a statement in the 'Ethical Approval and Consent to participate'. IRB Contact Information: Peking University First Hospital Ethics Committee. Tel: 010-82805563

Consent for publication:

Not applicable.

Availability of data and material:

The data that support the findings of this study are available from [Peking University First Hospital], but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. However, data are available from the authors upon reasonable request and with permission of [Peking University First Hospital].

Competing interests

Funding:

None.

Authors' contributions:

F Z, MD: This author conceived and designed the study, performed data collection and analysis, drafted and critically revised the manuscript.

Y Z, MD: This author co-designed the study and revised the manuscript, contributing equally to F Z.

S L, MD: This author revised the manuscript.

All authors have read and approved the manuscript.

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None

Conflict of interest:

None

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Figures

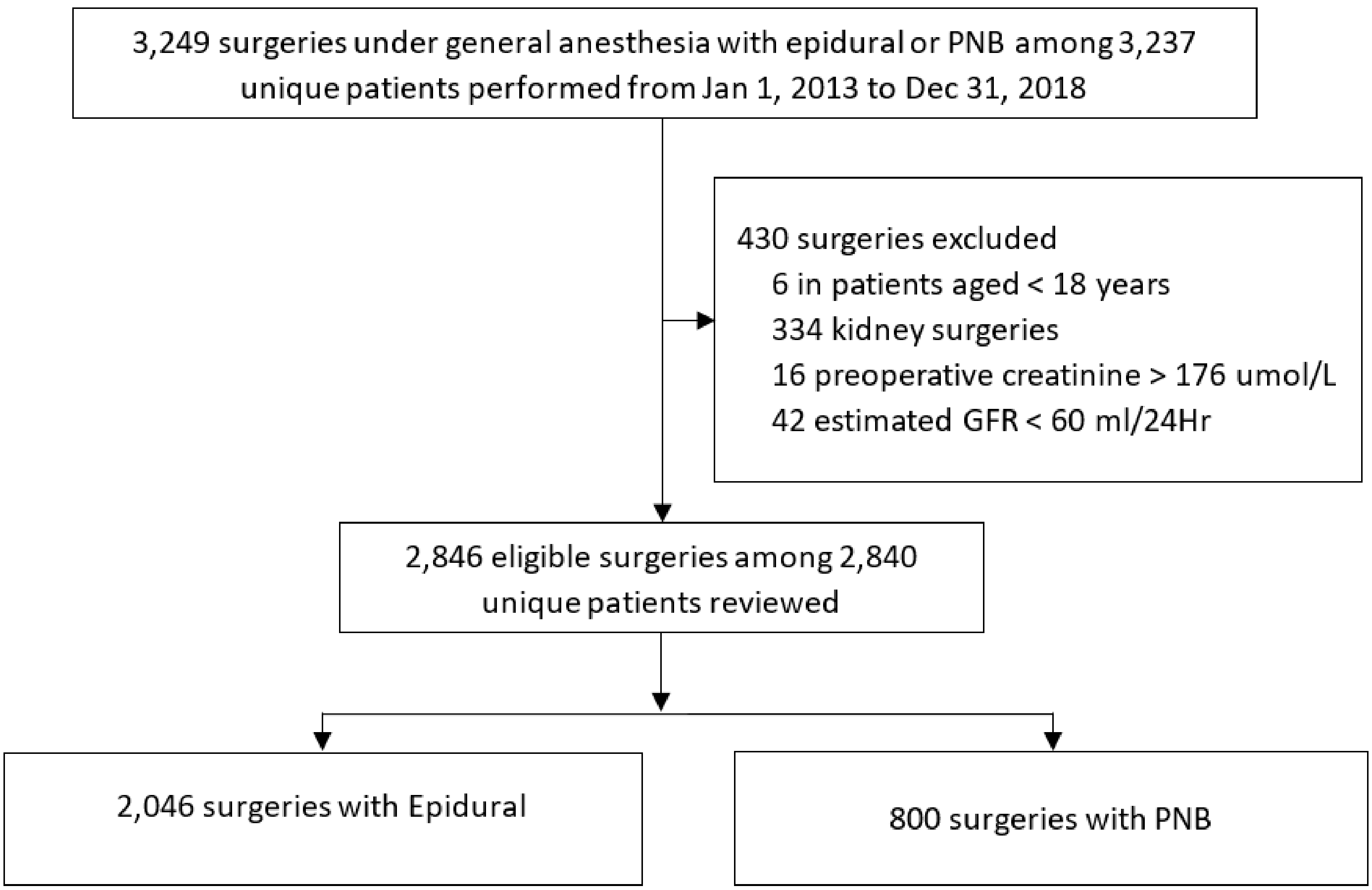

Figure 1

Flow diagram of the study population. PNB: peripheral nerve block AKI: acute kidney injury

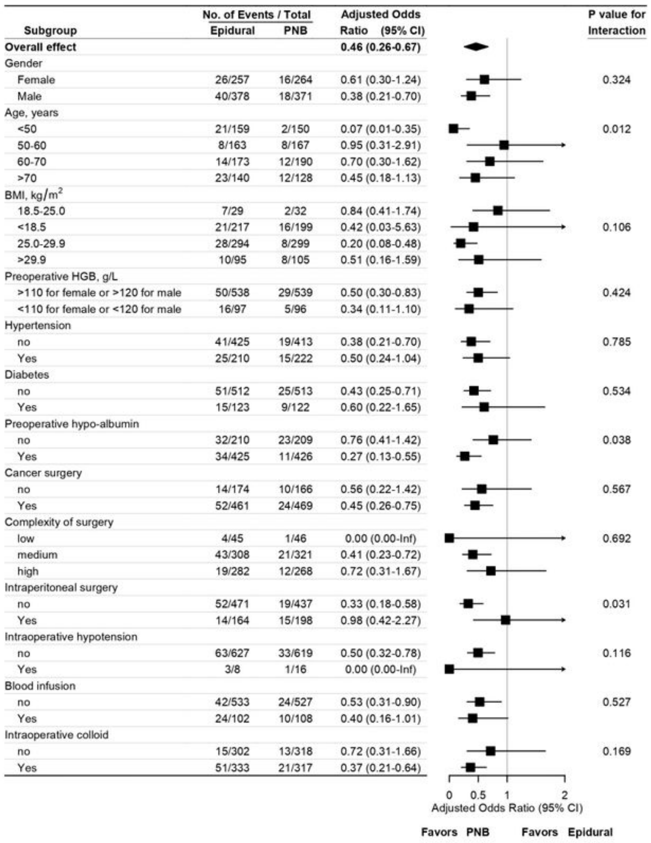

Figure 2

Subgroup analyses stratified by patient and operative variables. The adjusted covariates included: AKI risk, BMI, preoperative hemoglobin, albumin level, cancer surgery, surgical complexity, intraoperative blood transfusion, intraoperative hypotension, intraoperative colloid use.

Supplementary Files

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

- SupplementaryAppendix1m.docx