Original Article

Independent risk factors of hypoxemia in patients after surgery with acute type A aortic dissection

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Background: This study aimed to investigate independent risk factors of postoperative hypoxemia in patients with acute type A aortic dissection (ATAAD).

Methods: A single-center retrospective study was conducted with enrolled 75 ATAAD patients following surgery, which were stratified into three groups on the basis of the postoperative PaO_2/FiO_2 ratio: severe hypoxemia group (PaO_2/FiO_2 ratio ≤100 mmHg); moderate hypoxemia group (100 mmHg < PaO_2/FiO_2 ratio ≤200 mmHg); and non-hypoxemia group (PaO_2/FiO_2 ratio >200 mmHg). The patient's demography, perioperative laboratory results, operative details, clinical outcomes were collected and analyzed. Univariable and multivariable analyses were performed and logistic regression model was established.

Results: The incidence of postoperative severe hypoxemia and hypoxemia was 32% and 52%, respectively. Among the three groups, severe hypoxemia group exhibited a high significance of body mass index (BMI) and preoperative white blood cell (WBC) and main distribution of hypertension; meanwhile, Marfan syndrome was mainly distributed in non-hypoxemia group. On intensive care unit (ICU) admission, severe hypoxemia group exhibited a high significance of Acute Physiology and Chronic Health Evaluation (APACHE II) score of postoperative patients, and more patients would present shock. Moreover, severe hypoxemia group patients had a higher incidence of postoperative acute kidney injury (AKI) and usage of renal replacement therapy, longer length of stay (LOS) of ICU, and shorter 28 days ventilator-free days (VFDs).

Conclusions: The incidence of postoperative hypoxemia was high in ATAAD patients owing to comprehensive high-risk factors. Besides, postoperative complications negatively impacted their clinical outcomes.

Keywords: Acute type A aortic dissection (ATAAD); postoperative; hypoxemia; risk factor

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Introduction

Acute type A aortic dissection (ATAAD) is a life-threatening condition associated with severe morbidity and mortality (1) and risk factors for AAD have been evaluated, such as gender, age, hypertension, smoking, aneurysm, congenital disorders, and inflammatory disease (2). Despite improved surgical technical and perioperative management, the incidence of postoperative complications remains high (3). Postoperative hypoxemia, one of the most common complications, is followed by prolonged mechanical ventilation duration, increased length of stay (LOS) of intensive care unit (ICU), even increased mortality. For postoperative severe postoperative hypoxemia (PaO_2/FiO_2 ratio <100 mmHg) of ATAAD, even rescue therapy is required, such as prone position ventilation (PPV) and extracorporeal membrane oxygenation (ECMO) (4,5). Therefore, it is crucial to identify patients who will develop such a critical condition, making medical resource assignments more reasonable and improving the prognosis for such a population.

Several risk factors of postoperative hypoxemia for ATAAD patients, such as obesity, female, preoperative PaO_2/FiO_2 ratio ≤300 mmHg, blood transfusion, have been investigated in some studies; however, the results remain controversial (6-12). Through retrospective analysis of patients' data, to determine the risk factors of hypoxemia and its severity can help clinicians to adjust treatment strategies and avoid the occurrence of hypoxemia. As mentioned above, we conducted a retrospective study to assess the incidence, risk factors, as well as impact on clinical outcome of postoperative hypoxemia and severe postoperative hypoxemia of ATAAD. We present the following article in accordance with the SROBE reporting checklist (available at https://dx.doi.org/10.21037/apm-21-1428).

Methods

Study design

A single-center retrospective study was conducted in a 37 beds general ICU of the 1st affiliated hospital of Guangzhou Medical University. From January 2016 to May 2020, the patients diagnosed as ATAAD confirmed by enhanced computed tomographic scan and underwent urgent operation were included. However, patients were excluded if they died during operation or within 24 hours after surgery. The study was conducted as per the Declaration of Helsinki (as revised in 2013). The study was granted approval by the ethics committee at The 1st affiliated hospital of Guangzhou Medical University (Medical research ethics review: 2021NO. K-12), and individual consent for this retrospective analysis was waived.

Data collection

Overall, 75 subjects were enrolled, and data were extracted from our electronic hospital information system (HIS). The patient's demography [age, gender, body mass index (BMI), and comorbidities], perioperative laboratory results, operative details (operation time, CPB time, clamping time, intraoperative blood and plasma transfusions), postoperative P/F rate (the worst value from blood gas analysis within 72 hours after ICU admission), and clinical outcomes [28 days ventilator-free days (VFD), mechanical ventilation time, LOS of ICU, LOS of hospital, occurrence of acute kidney injury (AKI) and mortality] were collected and analyzed. We divided the patients into three groups according to postoperative PaO_2/FiO_2 ratio, selecting the worst condition according to blood gas analysis within 72 hours after surgery: group severe (severe hypoxemia group, PaO_2/FiO_2 ratio ≤100 mmHg); group moderate (moderate hypoxemia group,100 mmHg < PaO_2/FiO_2 ratio ≤200 mmHg); and group mild (non-hypoxemia group, PaO_2/FiO_2 ratio >200 mmHg).

Surgical procedure

After standard anaesthetic management, patients were provided a total arch replacement and descending aorta stent implantation which was conducted according to the Sun's produce (13). Briefly, a median sternotomy procedure was used in all the operations. For the arterial perfusion, routine exposure of the right axillary artery was done, and for venous drainage, cannulation of the inferior of superior vena cava or the right atrium was performed. The patients were then heparinized, followed by establishment of the cardiopulmonary bypass (CPB). When the CPB started, we initiated systemic cooling. Clamping of the ascending aorta was done, followed by longitudinal opening, and subsequent infusion of cardioplegic solution consisting of cold-blood into the right and left coronary artery separately. Surgery of the aortic root, entailing David or Bentall surgery or replacement of the ascending aorta was done based on the lesions of the aortic root during the cooling process. At a temperature of between 17 ℃ and 26 ℃

in the nasopharynx, and 19 ℃ and 29 ℃ in the rectum, the brachiocephalic artery, left common carotid artery, as well as left subclavian artery were sequentially clamped, followed by initiation of the DHCA (deep hypothermic circulatory arrest) along with SCP (selective cerebral perfusion) via the right axillary artery (5–10 mL/kg). Transection of the aortic arch was done between the left subclavian artery and the left common carotid artery. After that, a stented elephant graft (MicroPort Medical Co. Ltd., China) was first released in the descending aorta. Direct saturation of the left subclavian artery residual in the arch was performed. Thereafter, the three parts consisting of the stented graft, four-branch prosthetic graft, and the descending aorta were anastomosised, followed by immediate lower body reperfusion via perfusion with half of the normal flow in one limb of the four-branch prosthetic graft. Bilateral perfusion of the brain was done at the end of the anastomosis action on the left common carotid artery. Thereafter, normal flow was resumed in the CPB gradually and began to rewarm, then saturation of the bleeding was done on the distal anastomosis. Resuscitation of the heart was done after the area between the proximal aortic arch and the ascending aorta was anastomosed. Afterwards, we separately anastomosed the brachiocephalic artery along with the left subclavian artery and the respective branch of the four-branch prosthetic graft. Finally, drainage was made to the right atrium with the arterial wall residual or the pericardium or biological patch about the artificial graft. After completion of the repair and adequate rewarming, the patient was weaned from CBP.

Management after surgery

After surgery, the patients were placed in ICU and received comprehensive care according to our protocol: volume-controlled ventilation was performed in the ICU with a minimum FiO_2 and a PEEP (positive end expiratory pressure) of 6–10 cmH_2O to achieve SpO_2 95–97%. For patients who suffered from respiratory distress or moderate to severe hypoxemia (P/F <150 mmHg, deep sedation or even neuromuscular block (Richmond agitation sedation scale, RASS -5) and protective ventilatory strategy were performed. If the condition was not improved, prone positioning ventilation, even ECMO was applied to the patients. Furthermore, renal replacement therapy (RRT) was used to the patients who suffered from oliguria caused by AKI and required liquid management.

Statistical analysis

Descriptive data are given as mean, ranges, standard deviation, and median for continuous variables and as percentages and counts for categorical variables. A χ^2 test with Fisher's exact test or ANOVA test was used to compare groups as appropriate. A two-tailed P value less than 0.05 was considered statistically significant. Variables with a P value less than 0.1 or less at univariate analysis were included in a logistic regression multivariate analysis with a stepwise forward conditional approach, estimates of odds ratio (OR), 95% CI and P values are displayed. All analyses were implemented in SPSS V. 20 (IBM Corp, Armonk, NY). All P values are based on 2-sided tests and considered statistically significant at P<0.05.

Results

Baseline characteristics

A total of 75 enrolled patients, comprising 61 males (81.3%), with a mean age of (53.53±13.98) years, were divided into three groups: group severe (24 patients), group moderate (39 patients), and group mild (12 patients). The incidence of postoperative severe hypoxemia and hypoxemia was 32% and 52%, respectively, and only 16% of patients did not develop such complications. Among the three groups, BMI and preoperative white blood cell (WBC) were remarkably higher in group severe (26.20±3.40 *vs.* 22.98±4.94 *vs.* 20.75±4.03 kg/m^2, P=0.001, and 12.48±3.97 *vs.* 10.5±3.80 *vs.* 8.69±2.48 kg/m^2, P=0.014, respectively). Hypertension was mainly distributed in group severe (91.67% *vs.* 82.05% *vs.* 50%, P=0.015). Meanwhile, Marfan syndrome was mainly distributed in group mild (0% *vs.* 2.56% *vs.* 25%, P=0.01). The other variables, such as age, gender, medical history, and preoperative laboratory test results, were not remarkably different. More details are shown in *Table 1*.

Intraoperative and postoperative characteristics of patients

The intraoperative details were similar among the three groups. The Acute Physiology and Chronic Health Evaluation (APACHE II) score of postoperative patients on ICU admission was remarkably greater in group severe (21.75±6.27 *vs.* 18.18±7.38 *vs.* 15.75±6.00, P=0.033), and more patients would present shock on ICU admission in group severe (37.5% *vs.* 28.2% *vs.* 0%, P=0.042). The other postoperative patient's characteristics and laboratory test

Table 1 Characteristics of patients with acute type A aortic dissection

Characteristics	Severe (n=24)	Moderate (n=39)	Mild (n=12)	P value
Demographic data				
Age, year	51.79±11.35	55.92±16.03	49.25±10.52	0.271
Male	21, 87.5%	31, 79.49%	9, 75%	0.565
BMI, kg/m^2	26.20±3.40	22.98±4.94	20.75±4.03	0.001
Medical history				
Hypertension	22, 91.67%	32, 82.05%	6, 50%	0.015
Smoking history	10, 41.67%	22, 56.41%	5, 41.67%	0.467
Diabetes mellitus	0	1, 2.56%	1, 8.33%	0.394
Cerebrovascular disease	0	2, 5.13%	0	0.663
Coronary artery disease	2, 8.33%	6, 15.38%	0	0.359
Marfan syndrome	0	1, 2.56%	3, 25%	0.01
COPD	0	1, 2.56%	1, 8.33%	0.394
Preoperative condition				
WBC, 10^9/L	12.48±3.97	10.5±3.80	8.69±2.48	0.014
Hemoglobin, g/dL	122.83±17.72	118.44±18.28	122.17±16.72	0.599
PLT, 10^9/L	190.83±55.29	187.33±89.16	207.17±94.61	0.767
Scr, umol/L	154.4±96.80	128.22±82.57	85.18±19.06	0.067
PT, s	15.02±1.37	15.13±1.54	15.86±2.77	0.384
APTT, s	41.16±5.87	41.12±5.79	44.18±5.84	0.274
Fibrinogen, g/L	4.54±1.65	4.37±1.91	3.62±1.50	0.338

Values are presented as mean ± standard deviation or (n, %). BMI, body mass index; COPD, chronic obstructive pulmonary disease; WBC, white blood cell; PLT, platelet; PT, prothrombin time; APTT, activated partial prothrombin time; Scr, serum creatinine.

results were similar among the three groups. More details are presented in *Table 2*.

Clinical outcomes

The subjects in group severe had a higher incidence of postoperative AKI and usage of renal replacement therapy, longer LOS of ICU, and shorter 28 days VFDs (P=0.002, 0.027, and 0.043, respectively). Notably, though there was no remarkable difference in mortality among the three groups, group mild patients were all survived. More details are displayed in *Table 3*.

Risk factors for postoperative hypoxemia, severe hypoxemia and the prediction models

In the first step, we compared group (severe and moderate) with group mild to evaluate the risk factor for postoperative hypoxemia (PaO_2/FiO_2 ratio ≤200 mmHg). In the univariate analysis, BMI, preoperative WBC, preoperative serum creatinine, and intraoperative CPB time were remarkably higher in group (severe and moderate) (P=0.019, 0.035, 0.047, and 0.024, respectively). Hypertension and postoperative shock were mainly distributed in group (severe and moderate) (P=0.011 and 0.029, respectively); meanwhile, Marfan syndrome was mainly distributed in group mild (P=0.012). Although postoperative APACHE II score was not remarkably higher in group (severe and moderate) (P=0.089), we included this variable into the logistic regression according to our predefined statistical analysis protocol. We found that only hypertension was (OR 0.117, 95% CI: 0.023–0.589, P=0.009) independent risk factors using logistic regression. More details are presented in *Tables 4* and *5*.

Table 2 The intraoperative and postoperative characteristics of patients

	Severe (n=24)	Moderate (n=39)	Mild (n=12)	P value
Operation details				
The duration of operation, hour	8.60±2.01	8.58±1.93	7.76±1.24	0.390
Aortic clamping time, min	148±36.18	145.77±32.66	131.67±40.2	0.408
CPB time, min	259.38±66.23	246±66.04	204.17±49.64	0.058
Plasma transfusion, mL	818.75±489.22	724.36±385.95	587.5±150.17	0.274
RBCs transfusion, u	4.65±3.59	4.5±4.64	3.79±2.14	0.831
PLTs transfusion, u	1.04±0.68	1.05±0.68	0.75±0.43	0.360
Intraoperative blood loss, mL	1,564.79±1,339.74	1,477.18±932.72	1,300.0±1,055.75	0.800
Postoperative condition				
PaO_2/FiO_2, mmHg	80.93±11.71	146.6±23.81	241.0±19.4	0.000
PCT, ng/mL	43.97±54.01	28.78±37.33	16.94±11.9	0.161
WBC, 10^9/L	20.10±7.88	19.18±5.63	19.45±6.01	0.867
Shock	9, 37.5%	11, 28.2%	0	0.042
Cardiogenic shock	4, 16.67%	8, 20.51%	0	0.267
Obstructive shock	0	0	0	NS
Septic shock	5, 20.83%	2, 5.13%	0	0.083
Hemorrhagic shock	3, 12.5%	5, 12.82%	0	0.605
APACHE II	21.75±6.27	18.18±7.38	15.75±6.00	0.033
SOFA	11.33±3.48	9.95±3.91	9.33±3.03	0.217

Values are presented as mean ± standard deviation or (n, %). CPB, cardiopulmonary bypass; RBCs, red blood cells; WBC, white blood cell, PLT, platelet, PCT, procalcitonin; APACHE II, acute physiology and chronic health evaluation; SOFA, sequential organ failure assessment.

Table 3 Patients' clinical outcome

	Severe (n=24)	Moderate (n=39)	Mild (n=12)	P value
Renal replacement therapy	18, 75%	16, 41.03%	2, 16.67%	0.002
MV duration, days	9 (6.00, 11.75)	7 (4.00, 13.00)	4.5 (3.00, 8.00)	0.180
LOS of ICU	11 (8.25, 26.75)	10 (6.00, 19.00)	7 (4.25, 9.75)	0.027
LOS of hospital	32.70 (30.00, 58.27)	39.28 (26.00, 57.00)	34.5 (23.96, 42.75)	0.770
28 days VFD	15.50±8.26	17.67±7.92	22.33±3.39	0.043
Mortality	3, 12.5%	2, 5.13%	0	0.454

Values are presented as mean ± standard deviation, (n, %), or median (interquartile range). MV, mechanical ventilation; LOS, length of stay; 28 days VFD, numbers of ventilator-free days at 28 days.

In the second step, we used the same strategy to compare group severe with group (moderate and mild) to evaluate the risk factor for severe postoperative hypoxemia (PaO_2/FiO_2 ratio ≤100 mmHg). In the univariate analysis, BMI, preoperative WBC, and postoperative APACHE II score were remarkably higher in group severe (P=0.001, 0.011 and 0.017, respectively). Although preoperative serum creatinine, postoperative PCT, and postoperative SOFA

Table 4 Univariate analysis of postoperative hypoxemia risk factors (severe and moderate groups *vs.* mild group)

Characteristics	Severe and moderate (n=63)	Mild (n=12)	P value
Demographic data			
Age, year	54.35±14.47	49.25±10.52	0.249
Male	52, 82.5%	9, 75%	0.686
BMI, kg/m^2	24.20±4.66	20.75±4.03	0.019
Medical history			
Hypertension	54, 85.7%	6, 50%	0.011
Smoking history	32, 50.8%	5, 41.67%	0.754
Diabetes mellitus	1, 1.6%	1, 8.33%	0.296
Cerebrovascular disease	2, 3.2%	0	1.0
Coronary artery disease	8, 12.7%	0	0.341
Marfan syndrome	1, 1.6%	3, 25%	0.012
COPD	1, 1.6%	1, 8.33%	0.296
Preoperative condition			
WBC, 10^9/L	11.25±3.95	8.69±2.48	0.035
Hemoglobin, g/dL	120.11±18.05	122.17±16.72	0.716
PLT, 10^9/L	188.67±78.65	207.17±94.61	0.476
Scr, umol/L	138.2±89.89	85.18±19.06	0.047
PT, s	15.08±1.49	15.86±2.77	0.171
APTT, s	41.13±5.86	44.18±5.84	0.106
Fibrinogen	4.43±1.83	3.62±1.50	0.154
Intraoperative condition			
The duration of operation, hour	8.58±1.98	7.76±1.24	0.169
Aortic clamping time, min	146.62±34.3	131.67±40.2	0.186
CPB time, min	251.10±66.58	204.17±49.64	0.024
Plasma transfusion, mL	760.3±434.14	587.5±150.17	0.179
RBCs transfusion, u	4.56±4.30	3.79±2.14	0.552
PLTs transfusion, u	1.05±0.68	0.75±0.43	0.152
Intraoperative blood loss, mL	1,510.6±1,115.29	1,300.0±1,055.75	0.550
Postoperative condition			
PCT, ng/mL	34.57±45.4	16.94±11.9	0.188
WBC, 10^9/L	19.53±6.65	19.45±6.01	0.968
Shock	20, 31.7%	0	0.029
APACHE II	19.54±7.14	15.75±6.00	0.089
SOFA	10.48±3.78	9.33±3.03	0.327

Values are presented as mean ± standard deviation or (n, %). BMI, body mass index; COPD, chronic obstructive pulmonary disease; WBC, white blood cell; PLT, platelet; PT, prothrombin time; APTT, activated partial prothrombin time; Scr, serum creatinine; CPB, cardiopulmonary bypass; RBCs, red blood cells; PCT, procalcitonin; APACHE II, acute physiology and chronic health evaluation; SOFA, sequential organ failure assessment.

Table 5 Risk factors of postoperative hypoxemia (severe and moderate groups *vs.* mild group) in multivariate logistic regression analysis

Clinical variables	OR	95% CI	P value
Hypertension	0.117	0.023–0.589	0.009

CI, confidence interval; OR, odds ratio.

score were not remarkably higher in group severe (P=0.084, 0.086, and 0.093, respectively), we included these variables in the logistic regression as mentioned above. Using logistic regression, we found that BMI (OR 0.758, 95% CI: 0.640–0.897, P=0.001) and postoperative APACHE II score (OR 0.900, 95% CI: 0.828–0.978, P=0.013) were independent risk factors. More details are shown in *Tables 6* and 7.

Discussion

Hypoxemia is a common postoperative complication in ATAAD patients. Our study illustrated that the incidence of such complication was 84% (63/75), much higher than previous studies (30–50%) (6-11). However, the incidence of severe hypoxemia (P/F <100 mmHg) was 32% (24/75) in our study, slightly lower than a recent study (36.6%) (12). We reasoned that since most of our patients transported from other hospitals takes a long time from symptom onset to entering the operating room, which would put the patients at a higher risk to develop the postoperative hypoxemia.

Herein, we illustrated that higher BMI was linked to developing postoperative hypoxemia and severe hypoxemia in line with previous studies (8-12). Obesity, defined as BMI >25 kg/m^2, had significant adverse effects on cardiopulmonary physiology. Obese patients often showed a decreased functional residual capacity (FRC), total lung capacity (TLC), expiratory reserve volume (ERV), as well as vital capacity (VC), and severity was inversely proportional to BMI. In addition, obesity could lead to abdominal distention, resulting in decreased chest wall compliance, increased respiratory resistance, pleural pressure, and upper and lower airway resistance (14). Besides, obesity was associated with chronic increased proinflammatory cytokines and mediators, leading to cell membrane damage (15). Consequently, obesity was considered as an independent high-risk factor of postoperative pulmonary complications, and improved intra and postoperative ventilation strategies should be crucial in such populations (16,17).

The mechanical and physical effects, such as inflammatory cascade reaction and pulmonary ischemia-reperfusion injury, caused by CPB were considered a significant cause of postoperative hypoxemia (10,12). Our result showed that CPB time was longer in severe and moderate groups (P/F ratio ≤200 mmHg) in contrast with the mild group (P/F ratio >200 mmHg).

Elevated APACHE II score and occurrence of postoperative shock were identified to contribute to postoperative hypoxemia development in our study. Given that these indexes were developed to represent disease's seriousness, it was unsurprising to discover this connection. It worth noting that both hypertension and Marfan syndrome were recognized as risk factors of AAD. Our study illustrated that hypertension was associated with postoperative hypoxemia development; however, Marfan syndrome seemed to be a protective factor. Also, hypertension was mainly distributed in groups severe and group moderate, and Marfan syndrome was all in group mild. It seemed that if AAD was induced by Marfan syndrome rather than hypertension, it might develop postoperative hypoxemia.

Our study showed that severe postoperative hypoxemia would negatively impact clinical outcomes, including higher RRT usage, longer LOS of ICU, and shorter 28 days VFDs. The incidence of AKI, which manifests through rapid loss of renal function with high morbidity and mortality (18), remained high in such a population (19,20). The postoperative low oxygen supply and high oxygen might play a vital role in this progression (21). Interestingly, the linear relationship between obesity and AKI was illustrated (22) as an essential contributor to postoperative hypoxemia.

There were two limitations in our study. First, it was a single-center retrospective observational study, and the sample size was limited. Secondly, the impact of factors, including individual surgeon's experience along with institutional philosophy with regards to treatment decision was not considered in this analysis.

Conclusions

Herein, we established that postoperative moderate and severe hypoxemia were high in ATAAD patients. The

Table 6 Univariate analysis of the risk factors of postoperative hypoxemia (moderate and mild groups *vs.* severe group)

Characteristics	Severe (n=24)	Moderate and mild (n=51)	P value
Demographic data			
Age, year	51.79±11.11	54.35±15.09	0.463
Male	21, 87.5%	40, 78.4%	0.527
BMI, kg/m^2	26.20±3.33	22.45±4.80	0.001
Medical history			
Hypertension	22, 91.67%	38, 74.5%	0.123
Smoking history	10, 41.67%	27, 52.9%	0.460
Diabetes mellitus	0	2, 3.9%	1.00
Cerebrovascular disease	0	2, 3.9%	1.00
Coronary artery disease	2, 8.33%	6, 11.8%	1.00
Marfan syndrome	0	4, 7.8%	0.299
COPD	0	2, 3.95	1.000
Preoperative condition			
WBC, 10^9/L	12.48±3.89	10.07±3.59	0.011
Hemoglobin, g/dL	122.83±17.34	119.31±17.84	0.427
PLT, 10^9/L	190.83±55.29	192.00±91.77	0.954
Scr, umol/L	154.4±96.80	118.09±75.79	0.084
PT, s	15.02±1.37	15.30±1.95	0.534
APTT, s	41.16±5.87	41.84±6.00	0.65
Fibrinogen, g/L	4.54±1.65	4.19±1.87	0.432
Intraoperative condition			
The duration of operation, hour	8.60±2.01	8.39±1.85	0.647
Aortic clamping time, min	148±36.18	142.45±35.45	0.535
CPB time, min	259.38±66.23	236.16±65.69	0.159
Plasma transfusion, mL	818.75±489.22	692.16±353.61	0.211
RBCs transfusion, u	4.65±3.59	4.33±4.24	0.757
PLTs transfusion, u	1.04±0.68	0.98±0.65	0.709
Intraoperative blood loss, mL	1,564.79±1,339.74	1,435.49±975.62	0.641
Postoperative condition			
PCT, ng/mL	43.97±54.01	26.00±33.87	0.086
WBC, 10^9/L	20.10±7.88	19.24±5.78	0.601
Shock	9, 37.5%	11, 21.6%	0.169
APACHE II	21.75±6.14	17.61±7.10	0.017
SOFA	11.33±3.41	9.80±3.70	0.093

Values are presented as mean ± standard deviation or (n, %). BMI, body mass index; COPD, chronic obstructive pulmonary disease; WBC, white blood cell; PLT, platelet; PT, prothrombin time; APTT, activated partial prothrombin time; Scr, serum creatinine; CPB, cardiopulmonary bypass; RBCs, red blood cells; PCT, procalcitonin; APACHE II, acute physiology and chronic health evaluation; SOFA, sequential organ failure assessment.

Table 7 Risk factors of postoperative severe hypoxemia (moderate and mild groups *vs.* severe group) in multivariate logistic regression analysis

Clinical variables	OR	95% CI	P value
BMI	0.758	0.640–0.897	0.001
APACHE II	0.900	0.828–0.978	0.013

BMI, body mass index; APACHE II, acute physiology and chronic health evaluation.

high-risk factors had been evaluated. Meanwhile, such postoperative complications negatively impacted the clinical outcomes.

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Footnote

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