Admission Hyperglycemia in Acute Type A Aortic Dissection Predicts for a Prolonged Duration of Mechanical Ventilation

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Summary

Previous studies have demonstrated that admission hyperglycemia is a predictor of mortality and poor prognosis in patients with cardiovascular diseases, such as acute myocardial infarction. However, the prognostic value of admission hyperglycemia in patients with acute type A aortic dissection (AAAD) has never been explored. To clarify the association between hyperglycemia and in-hospital outcomes, we retrospectively analyzed 734 patients with AAAD. The interest endpoints were in-hospital mortality rate, the duration of intensive care unit and hospital stays, the occurrence of prolonged mechanical ventilation (PMV), and other complications. All patients were divided into the normal blood glucose group (≤ 140 mg/dL) and hyperglycemia group (> 140 mg/dL), to compare the in-hospital outcomes rate in the two groups. There were 531 (72.3%) patients with normal blood glucose levels and 203 (27.7%) patients with hyperglycemia. The in-hospital mortality rate was 21.1%, and no statistically significant differences were found between the two groups (20.3% versus 23.2%, $P = 0.403$). PMV is the most frequent postoperative complication, the incidence of which was significantly higher in the hyperglycemia group than in the normal blood glucose group (59.6% versus 50.8%, $P = 0.040$). The logistic regression analysis revealed that hyperglycemia (odds ratio (OR): 1.492; 95% CI: 1.014 to 2.197; $P = 0.042$) was an independent risk factor for PMV after adjusting for confounding factors. Age (OR: 1.021; 95% CI: 1.006-1.037; $P = 0.007$) and body mass index (OR: 1.101; 95% CI: 1.051-1.153; $P < 0.001$) were also associated with PMV. In conclusion, our study showed for the first time that a strong correlation between admission hyperglycemia and increased postoperative PMV in patients with AAAD, but not with in-hospital mortality rate. (Int Heart J 2022; 63: 106-112)

Key words: Cardiac surgery, Glucose, Outcomes

Acute type A aortic dissection (AAAD) is one of the most complex and disastrous cardiovascular diseases with acute onset and rapid progress, for which surgical repair is the only current treatment.¹⁾ Although various treatments for AAAD have been significantly improved, the prognosis of patients with AAAD is still very poor.²⁾ The International Registry of Acute Aortic Dissection in 2018 reported that the in-hospital mortality rate in patients undergoing surgical repair of AAAD was as high as 22%.³⁾ From this, early identification of risk factors associated with its poor prognosis is clinically important.

A large number of studies have demonstrated that abnormal glucose metabolism is closely linked to the progression and outcomes of cardiovascular disease.^{4,5)} Recently, admission blood glucose (ABG) has become an intense focus of research. It has been studied that elevated

glucose levels on admission are associated with a worse prognosis in non-diabetic patients with acute myocardial infarction (AMI) or patients who underwent acute coronary bypass grafting (CABG).⁶⁻⁸⁾ Various studies have elucidated the pathophysiology mechanisms of its effect,^{5,9,10)} including vascular inflammation, platelet aggregation, microvascular endothelial dysfunction, myocardial glucose metabolism dysfunction, or enhanced fatty acid oxidation. AAAD is a clinical emergency, in which the pathophysiological change results in inducing intensive stress responses that can cause damage to the stability of the body's intracellular environment and finally to glycometabolism disorders of patients.¹¹⁾ Our previous study¹²⁾ uncovered that high glycemic variability increases the risk of postoperative delirium. However, the influence of admission hyperglycemia on patients with AAAD has not yet been reported.

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In this study, we aimed to investigate the predictive value of admission hyperglycemia on in-hospital outcomes in patients undergoing AAA surgery.

Methods

Design and setting: The study was designed as a retrospective observational study. All patients aged ≥ 18 years who only underwent AAA surgery without CABG or aortic valve surgery at the time at Fujian Province Cardiac Medical Research Center from January 2014 to December 2020 were consecutively selected. Patients were excluded from the study if they (1) had diabetes, autoimmune diseases, fever, and tumor at admission; (2) received steroid or other immunosuppressants before the operation; and (3) had no collecting blood glucose immediately at admission and had incomplete medical records. All patients were admitted directly to the intensive care unit (ICU) postoperatively and on mechanical ventilation. The patients were extubated if they meet the following criteria for extubation¹³⁻¹⁵: (1) are fully awake and grip recovery; (2) with acceptable arterial blood gas parameters (i.e., partial pressure of arterial oxygen (PaO_2)/fraction of inspired oxygen (FiO_2) > 150 - 200 mmHg, PEEP ≤ 5 - 8 cmH $_2$ O, $\text{FiO}_2 \leq 0.4$ - 0.5 , pH ≥ 7.25); (3) with sustained hemodynamic stability with no need for or low dose of vasoactive drugs and without excessive bleeding; and (4) have spontaneous breathing and cough activation recovery, respiratory rate < 30 breaths per minute. The study was approved by the ethics committee of Fujian Medical University Union Hospital (approval number: 2019KY019) and conformed to the Declaration of Helsinki. There is no need for informed consent because this was a retrospective study.

Clinical data collection: Demographic and clinical data for the enrolled patient were collected retrospectively from the hospital electronic patient record system. Demographic characteristics, such as age, gender, body mass index (BMI), history of smoking, pulmonary disease, and complications, were gathered. The vital signs (heart rate, systolic blood pressure, and diastolic blood pressure) and blood glucose level were collected at admission. The laboratory indicators taken from the first laboratory results after admission and the indicators related to extubation were also collected. The interest endpoints were in-hospital mortality rate and the occurrence of postoperative complications, including gastrointestinal hemorrhage, pulmonary infection, acute renal failure, aortic dissection rupture, arrhythmia, multiple organ dysfunction syndromes (MODS), and prolonged mechanical ventilation (PMV). Besides, the duration of ICU and hospital stays were also recorded. According to the American Diabetes Association and the American Association of Clinical Endocrinologists consensus,^{16,17} ABG levels > 140 mg/dL were considered hyperglycemia. Acute renal failure was defined as an increase in serum creatinine by ≥ 0.3 mg/dL (≥ 26.5 $\mu\text{mol/L}$) within 48 hours or an increase in serum creatinine to ≥ 1.5 times the baseline level within 7 days after surgery or urine volume < 0.5 mL/kg/hour for 6 hours.¹⁸ MODS was defined as having a Sequential Organ Failure Assessment score of ≥ 6 on ≥ 2 consecutive days after surgery.¹⁹ PMV was defined as the duration of mechanical ventilation use

for > 48 hours.²⁰

Statistical analysis: To evaluate the characteristics of patients with different levels of ABG, patients were categorized into the normal blood glucose group (≤ 140 mg/dL), and hyperglycemia group (> 140 mg/dL). Demographic characteristics and clinical data were calculated using counts and percentages for categorical variables. Tests of normality were done using the Shapiro-Wilk normality test. The continuous data of normal distribution were described as mean $\pm$ standard deviation, and non-normally data were represented by the median and interquartile range (IQR). Comparisons between groups were performed using *t*-test or the Mann-Whitney *U* test for continuous variables and chi-squared test or Fisher's exact test for categorical variables. Multivariable logistic regression analyses were used to confirm the independent relationship between hyperglycemia and PMV after adjusting for possible confounders that were judged by their statistical significance in univariate analysis and subject matter knowledge, including age, BMI, pulse pressure, cardiopulmonary bypass (CPB) time, cross-clamp time and neutrophil count. All statistical analyses were performed using the SPSS statistical package version 25.0 (IBM SPSS Inc., Chicago, IL, USA). All tests were two sided, with $P < 0.05$ considered statistically significant.

Results

A total of 820 patients underwent AAA repair between January 2014 and June 2020. Among them, 86 patients were excluded (diabetes in 32 patients, autoimmune diseases in 4 patients, tumor in 4 patients, fever in 2 patients, long-term use of steroids or immunosuppressants in 6 patients, and incomplete clinical data in 38 patients). Finally, 734 patients were enrolled in the study (Figure).

The preoperative and intraoperative data of the two groups are presented in Table I. There were 531 (72.3%) patients with normal blood glucose levels and 203 (27.7%) patients with hyperglycemia in this study. The mean age of all patients was 52.5 ± 11.7 years, 77.5% were men, and 74.5% had hypertension. Compared with patients with normal blood glucose levels, those with hyperglycemia were older ($P = 0.019$) and had a significantly longer CPB time ($P = 0.048$) and aortic cross-clamping time ($P = 0.023$). Additionally, the two groups demonstrated no statistically significant differences in gender, BMI, history of hypertension, chronic obstructive pulmonary disease, asthma, bronchiectasis, and other preoperative and intraoperative variables ($P > 0.05$). The laboratory findings are shown in Table II. The number of neutrophils in the normal blood glucose group was much higher ($P = 0.025$) compared with that in the hyperglycemia group. No significant differences were observed among other laboratory findings ($P > 0.05$).

Table III showed a comparison of the two groups in terms of extubation indicators. There was no significant difference in the Richmond Agitation-Sedation Scale score, $\text{PaO}_2/\text{FiO}_2$, pH, systolic blood pressure, diastolic blood pressure, heart rate, respiratory rate, hemoglobin count, and red blood cell count between the two groups ($P > 0.05$), which demonstrated that the indications for

Figure. The flow chart for the selection process of patients with AAAD. AAAD, acute type A aortic dissection.

extubation were similar in both groups.

As shown in Table IV, a total of 155 patients died during hospitalization (in-hospital mortality rate 21.1%), but there were no significant differences between these two groups on the in-hospital mortality rate (20.3% versus 23.2%, $P = 0.403$). The median ICU length of stay was 6 (IQR 4-11) days, and the median hospital stays were 21 (IQR 15-28) days, and no statistically significant differences were identified between the two groups concerning the ICU and hospital stays ($P > 0.05$). PMV is the most frequent postoperative complication, the incidence of which was significantly higher in the hyperglycemia group than in the normal blood glucose group (59.6% versus 50.8%, $P = 0.040$). In addition, the proportion of gastrointestinal hemorrhage, pulmonary infection, acute renal failure, arrhythmia, and MODS were greater in the hyperglycemia group than in the normal blood glucose group; however, the difference was not statistically significant ($P > 0.05$).

In Table V, logistic regression analysis was used to adjust for the confounding factors to identify the independent effect of hyperglycemia on PMV. The crude odds ratio (OR) was 1.410, and it increased slightly (OR: 1.492; 95% CI: 1.014-2.197; $P = 0.042$) after adjusting for pulse pressure, CPB time, cross-clamp time, and neutrophil count. Other variables associated with PMV were age (OR: 1.021; 95% CI: 1.006-1.037; $P = 0.007$) and BMI (OR: 1.101; 95% CI: 1.051-1.153; $P < 0.001$).

Discussion

We investigated the correlation between admission

hyperglycemia and in-hospital outcomes in Chinese patients with AAAD. The findings can be summarized as follows: (1) Admission hyperglycemia is not associated with in-hospital mortality rate or length of ICU stay; (2) patients with hyperglycemia showed a significantly higher proportion of PMV than patients with normal blood glucose levels; (3) hyperglycemia is an independent risk factor of postoperative PMV after adjusting for confounding factors; and (4) age and BMI are also risk factors for postoperative PMV.

Admission hyperglycemia, also known as stress hyperglycemia, is a self-protection mechanism of the body.⁽¹¹⁾ Whereas some studies have shown that stress hyperglycemia may exacerbate the condition, and influence the prognosis of patients, particularly those with cardiovascular diseases.⁽²¹⁾ At present, most studies on ABG effect on prognosis were conducted on patients with AMI and those who underwent CABG,^(6-8,22) which demonstrate that high blood glucose levels are associated with poor prognosis; however, the impact of hyperglycemia on the outcomes of patients with AAAD remains unclear. Because the majority of patients with AAAD were emergency admissions, evaluating the glycometabolic state immediately after admission via fasting blood glucose and postprandial glucose tests is difficult. Therefore, ABG, which is simple and easy to perform, was treated as the main indicator of early glycometabolic state for patients with AAAD in our study.

Our results demonstrated that hyperglycemia was not associated with the in-hospital mortality rate, which was different from its association with other cardiovascular diseases.⁽⁶⁻⁸⁾ There are several possible explanations for this

Table I. Preoperative and Intraoperative Baseline Data of the Two Groups

Variable	Total	Blood glucose		<i>t/z</i> / χ^2	<i>P</i> -value
		Normal blood glucose group ≤ 140 mg/dL (<i>n</i> = 531)	Hyperglycemia group > 140 mg/dL (<i>n</i> = 203)		
Age (years), mean (SD)	52.5 $\pm$ 11.7	51.9 $\pm$ 11.9	54.1 $\pm$ 11.2	−2.350	0.019
Male, <i>n</i> (%)	569 (77.5)	417 (78.5)	152 (74.9)	1.125	0.289
BMI (kg/m ²), mean (SD)	24.96 $\pm$ 4.46	25.16 $\pm$ 4.82	24.51 $\pm$ 3.34	1.759	0.079
Hypertension, <i>n</i> (%)	547 (74.5)	397 (74.8)	150 (73.9)	0.059	0.808
COPD, <i>n</i> (%)	7 (1.0)	3 (0.6)	4 (2.0)	-	0.097
Asthma, <i>n</i> (%)	5 (0.7)	4 (0.8)	1 (0.5)	-	0.577
Bronchiectasis, <i>n</i> (%)	2 (0.3)	1 (0.2)	1 (0.5)	-	0.477
Smoker, <i>n</i> (%)	356 (48.5)	267 (50.3)	89 (43.8)	2.439	0.118
Drinker, <i>n</i> (%)	275 (37.5)	204 (38.4)	71 (35.0)	0.743	0.389
Marfan's syndrome, <i>n</i> (%)	39 (5.3)	30 (5.6)	9 (4.4)	0.432	0.511
Previous cardiac surgery, <i>n</i> (%)	17 (2.3)	10 (1.9)	7 (3.4)	-	0.161
Coronary artery heart disease, <i>n</i> (%)	3 (0.4)	3 (0.6)	0 (0)	-	0.378
Extension of AAAD, <i>n</i> (%)				4.252	0.235
Ascending aorta	29 (4.0)	21 (4.0)	8 (3.9)		
Aortic arch	259 (35.3)	186 (35.0)	73 (36.0)		
Descending aorta	27 (3.7)	15 (2.8)	12 (5.9)		
Abdominal aorta and/or beyond	419 (57.1)	309 (58.2)	110 (54.2)		
EF (%)				0.417	0.519
< 50	31 (4.2)	24 (4.5)	7 (3.4)		
≥ 50	703 (95.8)	507 (95.5)	196 (96.6)		
ABG (mg/dL), median (IQR)	112.32 (95.22–148.14)	100.62 (95.22–116.64)	157.14 (148.32–190.26)	−26.660	< 0.001
SBP (mm/Hg), mean (SD)	140.06 $\pm$ 29.17	140.77 $\pm$ 29.56	138.33 $\pm$ 28.41	1.014	0.311
DBP (mm/Hg), mean (SD)	75.02 $\pm$ 16.42	75.03 $\pm$ 16.59	75.17 $\pm$ 16.03	−0.102	0.919
PP (mm/Hg), mean (SD)	65.04 $\pm$ 22.07	65.73 $\pm$ 22.45	63.15 $\pm$ 21.16	1.413	0.158
Heart rate, mean (SD)	81.49 $\pm$ 16.55	81.81 $\pm$ 16.36	80.73 $\pm$ 17.02	0.789	0.430
Operating time (minutes), median (IQR)	303.0 (262.0–360.0)	305.0 (260.0–360.0)	300.0 (265.0–365.0)	−0.068	0.946
CPB time (minutes), median (IQR)	150.0 (128.0–188.0)	149.0 (125.0–185.0)	158.0 (130.0–202.0)	−1.980	0.048
Aortic cross-clamping time (minutes), median (IQR)	66.0 (49.0–100.0)	64.0 (48.0–96.0)	71.0 (50.0–107.0)	−2.276	0.023

SD indicates standard deviation; IQR, interquartile range; BMI, body mass index; COPD, chronic obstructive pulmonary disease; AAAD, acute type A aortic dissection; EF, ejection fraction; ABG, admission blood glucose; SBP, systolic blood pressure; DBP, diastolic blood pressure; PP, pulse pressure; and CPB, cardiopulmonary bypass.

Table II. Preoperative Laboratory Test Data of the Two Groups

Variable	Total	Blood glucose		<i>t/z</i>	<i>P</i> -value
		Normal blood glucose group ≤ 140 mg/dL (<i>n</i> = 531)	Hyperglycemia group > 140 mg/dL (<i>n</i> = 203)		
WBC ($\times 10^9$ /L), mean (SD)	12.30 $\pm$ 4.16	12.34 $\pm$ 4.27	12.27 $\pm$ 4.00	0.188	0.851
Neutrophil ($\times 10^9$ /L), median (IQR)	10.60 (7.84–14.10)	10.57 (8.00–13.98)	10.51 (7.60–13.89)	2.241	0.025
Lymphocyte ($\times 10^9$ /L), median (IQR)	1.09 (0.76–1.64)	1.09 (0.73–1.70)	1.00 (0.71–1.50)	0.767	0.443
Monocyte ($\times 10^9$ /L), median (IQR)	0.80 (0.54–1.33)	0.85 (0.53–1.40)	0.76 (0.53–1.10)	1.680	0.094
Platelet ($\times 10^9$ /L), median (IQR)	176.00 (139.00–220.00)	174.00 (138.00–218.00)	181.00 (142.00–225.00)	−1.221	0.222
RBC ($\times 10^9$ /L), median (IQR)	4.26 (3.90–4.66)	4.28 (3.92–4.70)	4.20 (3.79–4.55)	−0.854	0.394
Serum albumin (g/dL), mean (SD)	3.66 $\pm$ 0.53	3.67 $\pm$ 0.52	3.62 $\pm$ 0.53	1.286	0.199
BUN (mmol/L), median (IQR)	6.20 (4.80–8.33)	6.30 (4.90–8.30)	6.20 (4.80–8.50)	0.618	0.537
Creatinine (μ mol/L), median (IQR)	87.00 (69.00–123.00)	88.00 (69.00–123.15)	85.6 (69.45–124.45)	−1.695	0.091
PT (seconds), median (IQR)	13.80 (13.20–14.70)	13.80 (13.20–14.70)	13.80 (13.15–14.50)	0.908	0.364
Hemoglobin (g/L), mean (SD)	127.50 $\pm$ 19.47	127.60 $\pm$ 19.83	127.26 $\pm$ 18.80	0.213	0.832

SD indicates standard deviation; IQR, interquartile range; WBC, white blood cell; RBC, red blood cell; BUN, blood urea nitrogen; and PT, prothrombin time.

discrepancy. First, the heart whether ischemic have exhibited different responses to hyperglycemia. The ischemia

and reperfusion injury that occurs in patients with AMI or patients who underwent CABG could be exacerbated by

Table III. Extubation Indicators of the Two Groups

Variable	Blood glucose		<i>t/z</i>	<i>P</i> -value
	Normal blood glucose group ≤ 140 mg/dL (<i>n</i> = 531)	Hyperglycemia group > 140 mg/dL (<i>n</i> = 203)		
RASS score, mean (SD)	0.96 ± 0.72	1.04 ± 0.98	−1.211	0.226
PaO ₂ /FiO ₂ (mmHg), mean (SD)	175.3 ± 22.9	178.1 ± 18.2	−1.563	0.118
pH, mean (SD)	7.40 ± 0.06	7.39 ± 0.10	1.654	0.098
SBP (mm/Hg), mean (SD)	134.72 ± 17.74	133.42 ± 18.20	0.882	0.378
DBP (mm/Hg), mean (SD)	73.85 ± 11.23	75.50 ± 13.89	−1.663	0.097
Heart rate (beats/minute), mean (SD)	77.84 ± 15.82	77.95 ± 12.15	−0.089	0.929
Respiratory rate (breaths/minute), mean (SD)	17.63 ± 5.41	18.29 ± 6.37	−1.405	0.160
RBC (× 10 ⁹ /L), median (IQR)	4.33 (3.99–5.00)	4.34 (4.11–4.70)	0.863	0.390
Hemoglobin (g/L), mean (SD)	135.51 ± 19.65	129.16 ± 17.75	1.648	0.103

RASS indicates Richmond Agitation-Sedation Scale; PaO₂, partial pressure of arterial oxygen; FiO₂, fraction of inspired oxygen; SD, standard deviation; SBP, systolic blood pressure; DBP, diastolic blood pressure; RBC, red blood cell; and IQR, interquartile range.

Table IV. In-Hospital Outcomes of the Two Groups

Variable	Total	Blood glucose		<i>t/z</i>	<i>P</i> -value
		Normal blood glucose group ≤ 140 mg/dL (<i>n</i> = 531)	Hyperglycemia group > 140 mg/dL (<i>n</i> = 203)		
In-hospital mortality, <i>n</i> (%)	155 (21.1)	108 (20.3)	47 (23.2)	0.698	0.403
Gastrointestinal hemorrhage, <i>n</i> (%)	66 (9.0)	45 (8.5)	21 (10.3)	0.628	0.428
Pulmonary infection, <i>n</i> (%)	213 (29.0)	148 (27.9)	65 (32.0)	1.680	0.094
Acute renal failure, <i>n</i> (%)	163 (22.2)	117 (22.0)	46 (22.7)	−1.221	0.222
Aortic dissection rupture, <i>n</i> (%)	8 (1.1)	7 (1.3)	1 (0.5)	0.929	0.335
Arrhythmia, <i>n</i> (%)	14 (1.9)	9 (1.7)	5 (2.5)	0.463	0.496
MODS, <i>n</i> (%)	26 (3.5)	15 (2.8)	11 (5.4)	2.892	0.089
PMV (> 48 hours), <i>n</i> (%)	391 (53.3)	270 (50.8)	121 (59.6)	4.228	0.040
Duration of ICU stays (days), median (IQR)	6.0 (4.0–11.0)	6.0 (4.0–10.0)	6.0 (4.0–11.0)	−1.641	0.102
Duration of hospital stays (days), median (IQR)	21.0 (15.0–28.0)	21.0 (15.0–27.0)	20.0 (15.0–31.0)	−1.158	0.248

IQR indicates interquartile range; MODS, multiple organ dysfunction syndromes; PMV, prolonged mechanical ventilation; and ICU, intensive care unit.

Table V. Crude and Adjusted Association Between Hyperglycemia and Prolonged Mechanical Ventilation by Logistic Regression Analysis

Variable	Crude		Adjusted	
	OR (95% CI)	<i>P</i> value	OR (95% CI)	<i>P</i> value
Age (years)	-	-	1.021 (1.006–1.037)	0.007
BMI (kg/m ²)	-	-	1.101 (1.051–1.153)	< 0.001
PP (mm/Hg)	-	-	1.006 (0.998–1.015)	0.119
CPB time (minutes)	-	-	1.000 (0.097–1.004)	0.896
Cross-clamp time (minutes)	-	-	1.003 (0.998–1.008)	0.185
Neutrophil	-	-	1.000 (0.993–1.007)	0.996
Hyperglycemia (≤ 7.8 mmol/L versus > 7.8 mmol/L)	1.410 (1.016–1.958)	0.040	1.492 (1.014–2.197)	0.042

OR indicates odds ratio; CI, confidence interval; BMI, body mass index; PP, pulse pressure; and CPB, cardiopulmonary bypass.

hyperglycemia, but are less of an issue in patients undergoing surgical repair for AAAD. Second, animal studies have shown hyperglycemia is associated with reduced aortic neovessel formation, aortic mural macrophage infiltration, and medial elastolysis; and inhibited aortic dissection enlargement,^{23,24} thereby decelerating the progression of the disease. We may speculate that this phenomenon could also occur in humans. Finally, considering the aspects of glycemic management, although patient glycemic control is in accordance with the updated international standards, there are also individual differences. The aforementioned reasons may be the cause of hyperglycemia not affecting

the mortality rate.

In this study, we showed that the proportion of PMV among patients with AAAD was 53.3%. The results are consistent with those of Maisat, *et al.*,²⁵ who reported that the incidence of PMV was 48.5%. In addition, we also found that admission hyperglycemia was an independent risk factor of PMV, which may be a valuable indicator for predicting PMV. Currently, the causes of hyperglycemia with a higher incidence of PMV have not been elucidated, and one of the most likely explanations is that the inflammatory response leads to reduced lung function. First, the hyperglycemic conditions suppress TNF-α and nitric ox-

ide released from macrophages, which reduce the production of immunomodulatory mediators, causing a decrease in the body's immunity, weakening the anti-infective ability of the lungs,²⁶⁾ and thus leading to reduced lung function. In addition, it may be caused by widespread collagen and elastin abnormalities.²⁷⁾ It has been reported that hyperglycemia would induce nonenzymatic glycosylation of collagen and elastin, which leads to increased amounts of advanced glycation end products,²⁸⁾ and this would pose hazards to lung function. Further, hyperglycemia induces injury to vascular endothelial cells, which leads to basement membrane thickening in capillaries, sclerosis of the pulmonary arterioles, and microcirculation abnormalities, and this consequently results in ventilation-perfusion disorder.²⁹⁻³¹⁾ The aforementioned reasons may be the cause of hyperglycemia contributing to PMV. It should be noted that clinicians should pay attention to the risk of PMV for patients with AAAD with admission hyperglycemia and, if necessary, correct the abnormal glucose metabolism.

Another remarkable finding of this study was that increased age was an independent risk factor for PMV, in which an increase in 1 year of age yielded a 2.4% increase in the risk of PMV. A similar result was reported in the study of Li, *et al.*,³²⁾ who indicated the risks of PMV of patients ≥ 48.5 years were 3.85 times higher than those of lower age. The immune function would decrease with age owing to the reduced pulmonary elasticity and the lung gas exchange surface.³³⁾ In particular, elderly patients show a higher prevalence of comorbidities, for example, hypertension, lower cardiopulmonary reserve, and poor responses to CPB surgery, than young patients. Thus, we speculate that elderly patients have a greater risk of developing respiratory complications, thereby increasing the risk of PMV. BMI was also an important predictor for PMV, which is consistent with the findings of Li, *et al.*³⁴⁾ This could be in part due to the challenging anatomy and subsequent longer CPB time in patients with higher BMI, which may evoke a broad range of inflammatory responses, thus leading to more impaired lung function and prolonged intubation time.³⁵⁾

There are some limitations to this study. First, this study was a single-center, retrospective study, and prospective, multicenter studies with a large sample size are needed to further evaluate the clinical applicability and deficiencies of our results. Second, although ABG is closer to the real clinical situation due to its simplicity and feasibility for patients with AAAD, it may be affected by factors such as drugs, diet, and circadian rhythms. Third, many reports have shown that diabetes was identified to correlate negatively with aortic dissection³⁶⁻³⁸⁾ and was associated with a significantly decreased risk of mortality. Individuals with diabetes have thicker aortic walls due to specific metabolic pathways than those with normal glycemic index values, and this would prevent the development of aortic dissection. On the basis of this, we excluded patients who were diabetic to reduce the effect on the results of this study. Further studies are still needed in the future to explore the role of hyperglycemia on in-hospital outcomes in patients with AAAD and diabetes.

Conclusions

The present study demonstrates a strong correlation between admission hyperglycemia and increased postoperative PMV in patients with AAAD, but not with in-hospital mortality rate. This study provides a foundation for determining the optimal referent for blood glucose control in patients with AAAD; however, further research is still needed and more focus should be directed toward the impact of active treatment of hyperglycemia on the patient prognosis.

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Disclosure

Conflicts of interest: The author reports no conflicts of interest in this work.

Ethics approval and informed consent: All procedures performed in this study were by the ethical standards of the Union Hospital, Fujian Medical University, and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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