Original Article

The association of coagulation indicators with in-hospital acute kidney injury and malignant events of patients with acute aortic dissection: a retrospective cohort study

Shiyan Jiang[1], Yinhua Li[2], Chenlin Li[1], Zhouwu Shu[1], Shiwan Wu[1], Xiaojia Lu[1], Yue Liu[1], Yinlong Deng[1], Yequn Chen[1], Peiwei Cai[3]*, Bin Wang[1,4]*

[1]Department of Cardiology, the First Affiliated Hospital of Shantou University Medical College, Shantou, China; [2]Department of Critical Care Medicine, Xiaolan Hospital of Southern Medical University, Zhongshan, China; [3]Department of Ultrasound, the First Affiliated Hospital of Shantou University Medical College, Shantou, China; [4]Clinical Research Center, the First Affiliated Hospital of Shantou University Medical College, Shantou, China

Contributions: (I) Conception and design: S Jiang, B Wang, P Cai, Y Li; (II) Administrative support: B Wang; (III) Provision of study materials or patients: B Wang, P Cai, Y Chen; (IV) Collection and assembly of data: Y Li, S Jiang, Z Shu, S Wu, Y Liu; (V) Data analysis and interpretation: C Li, S Jiang, X Lu, Y Deng; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

*These authors have contributed equally to this work and are co-corresponding authors.

Correspondence to: Bin Wang. Department of Cardiology, the First Affiliated Hospital of Shantou University Medical College, 57 Changping Road, Shantou 515041, China. Email: asch369@126.com; Peiwei Cai. Department of Ultrasound, the First Affiliated Hospital of Shantou University Medical College, 57 Changping Road, Shantou 515041, China. Email: 1010308205@qq.com.

Background: Acute kidney injury (AKI) is a prevalent complication of acute aortic dissection (AAD) and is associated with poor outcomes. The onset of AAD may result in endothelial injury due to the formation of the false lumen, which can activate the coagulation pathway and lead to coagulation dysfunction. It serves as a valuable diagnostic and prognostic marker for AAD, but also plays a role in the pathological mechanisms underlying AKI. We aimed to investigate the potential value of coagulation indicators at admission for assessing in-hospital AKI and malignant events after AAD.

Methods: We identified patients with AAD admitted to the First Affiliated Hospital of Shantou University Medical College from January 2015 to October 2020 and divided them into two groups according to coagulation function. Univariable and multivariable analyses were used to analyze the association between coagulation indicators and AKI and malignant events in patients with AAD. Chi-squared or Fisher exact test and receiver operating characteristic (ROC) curve analysis was conducted to assess the value of coagulation indicators in predicting in-hospital AKI and malignant events.

Results: A total of 487 patients were enrolled in this study, including 309 cases with normal coagulation. After the multivariable adjustment, the incidence of in-hospital AKI in the abnormal coagulation group was significantly higher [model 1: 2.061 (1.214–3.501), P=0.007; model 2: 1.833 (1.058–3.177), P=0.031; model 3: 1.836 (1.048–3.216), P=0.034]. The incidence of malignant events was higher in the abnormal prothrombin time (PT) group [model 1: 4.283 (0.983–18.665), P=0.053; model 2: 7.342 (1.467–36.749), P=0.015; model 3: 6.996 (1.377–35.537), P=0.019]. Chi-squared and Fisher exact test showed that PT and abnormal coagulation score (ACS) were statistically different among the AKI groups and malignant event groups. Under ROC analysis, coagulation indicators were helpful to predict AKI (AUC =0.668; P<0.001).

Conclusions: Our study confirmed the presence of coagulation dysfunction is associated with an increased risk of AKI and malignant events. It suggested the severity of coagulation dysfunction is positively correlated with the incidence of in-hospital AKI in AAD patients. These results highlight the importance of considering coagulation dysfunction as a potential mechanism underlying AKI and malignant events after AAD.

Keywords: Coagulation; acute aortic dissection (AAD); acute kidney injury (AKI); propensity score matching (PSM)

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Introduction

Acute aortic dissection (AAD) is one of the most devastating cardiovascular diseases and causes death in about 1–2% of patients in the first 24–48 hours after AAD (1,2). In previous reports, the prevalence of acute kidney injury (AKI) was noted to be 25–55% in AAD (3,4), with AKI complicating the course of 50% to 60% of those admitted to the intensive care unit (ICU); AKI was also reported to lead to poor prognosis, with increased short-term mortality and multi-organ failure (3,5,6).

Previous research has shown the potential utility of abnormal coagulation indicators as diagnostic and prognostic markers for AAD (7-11). The onset of AAD may result in endothelial injury due to the formation of the false lumen, which can activate the coagulation pathway and lead to coagulation dysfunction. When coagulation factors and fibrinolytic substances are continuously consumed, abnormal coagulation function inevitably occurs, putting the body in a state of hypocoagulability as reflected by coagulation indicators (12). More evidence is needed on the relationship between coagulopathy and in-hospital AKI and malignant events in AAD patients.

Furthermore, coagulation indicators have also been identified as potential mechanisms of AKI in other diseases, such as sepsis and poisoning (12,13). Coagulation dysfunction, together with inflammation, hypoperfusion injury and other mechanisms, may contribute to the development of AKI and increase the risk of mortality (5,14,15). While current research on the mechanisms of AKI and mortality in patients with AAD has primarily focused on renal injury, hypoperfusion, ischemia/reperfusion, inflammation, and the use of contrast agents in interventional therapy (5,13-16), the role of coagulation dysfunction has yet to be fully explored, which provides new insights into the relationship between coagulation dysfunction and in-hospital AKI and malignant events in patients with AAD.

Therefore, to determine whether coagulopathy contributes to in-hospital AKI and malignant events in patients with AAD, we aimed to determine whether it contributes to the development of AKI and malignant events after AAD by assessing the presence of coagulation dysfunction at admission. The results of this study provide valuable clinical insights for the diagnosis and treatment of patients with AAD by allowing for the timely detection and intervention of those at risk of in-hospital AKI and malignant events. We present the following article in accordance with the STARD reporting checklist (available at https://jtd.amegroups.com/article/view/10.21037/jtd-23-38/rc).

Highlight box

Key findings

- The coagulation indicators had a correlation with in-hospital AKI and malignant events in patients with AAD.
- The worse the coagulation dysfunction is, the higher the possibility of AKI in patients with AAD.

What is known and what is new?

- Coagulation dysfunction serves as a valuable diagnostic and prognostic marker for AAD, but also plays a role in the pathological mechanisms underlying AKI.
- The presence of coagulation dysfunction is associated with an increased risk of AKI and malignant events and the severity of coagulation dysfunction is positively correlated with the incidence of in-hospital AKI in AAD patients.

What is the implication, and what should change now?

- For those patients with AAD and coagulation dysfunction, kidney protection and treatment measures should be taken to avoid AKI.
- Coagulation indicators can be used for the early identification of patients at high-risk for AKI.

Methods

Study design and population

This was a single-center, observational study conducted from January 2015 to October 2020 that enrolled consecutive patients with AAD admitted to the First Affiliated Hospital of Shantou University Medical College. All patients with acute aortic syndromes (e.g., intramural hematoma, penetrating atherosclerotic ulcer) referred to the First Affiliated Hospital of Shantou University Medical College during the study period were registered. Adult patients with AAD symptom duration <48 hours as confirmed by computed tomography for first AAD

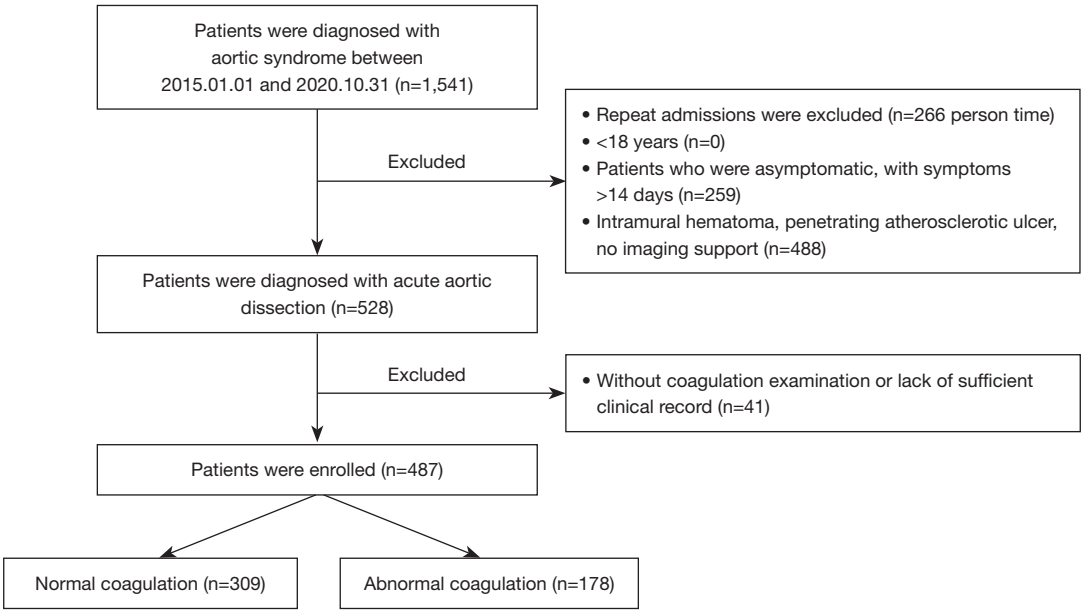

Figure 1 Flowchart of the study selection process.

Table 1 Diagnostic criteria for coagulopathy

Indicator	Reference value	Diagnostic criteria
PT	10.5–14 s	Extension >3 s
TT	14–21 s	Extension >3 s
INR	0.8–1.2	>1.3
APTT	23.3–32.5 s	Extension >10 s
Fib	2–4 g/L	<2 g/L
PLT	[125–350]×10^9/L	<125×10^9/L

PT, prothrombin time; TT, thrombin time; INR, international normalized ratio; APTT, activated partial thromboplastin time; Fib, fibrinogen content; PLT, platelet count.

diagnosis were included. Patients were excluded if they lacked a coagulation examination or had insufficient clinical record. The inclusion flowchart is presented in *Figure 1*.

Coagulation dysfunction was considered present when one or more of the coagulation indicators, including prothrombin time (PT), thrombin time (TT), international normalized ratio (INR), activated partial thromboplastin time (APTT), fibrinogen content (Fib), and platelet count (PLT) as shown in *Table 1*, were found to be abnormal (17). The patients with coagulation dysfunction were grouped as the abnormal coagulation group. Abnormal coagulation score (ACS) corresponded with the sum of abnormal coagulation indicator scores. D-dimer and fibrin degradation products were not included, as these have been confirmed to be part of the diagnostic basis for AAD (8,18).

Previous studies have not systematically investigated the incidence of AKI in patients with AAD in relation to coagulation dysfunction. Data collected were validated by patient acceptable symptom status (PASS) at a two-sided 5% significance level and adequate statistical power (1-β ≥0.90) was ensured.

Variables and end points

We collected patient data from electronic medical records and recorded them on a previously designed e-sheet with 4 parts: (I) demographic data, including age and sex; (II) admission status data, including diagnosis, comorbidities (hypertension, etc.), and clinical features, such as ischemia performance and number of involved renal arteries, which are known confounding factors in clinic (5,6); (III) admission laboratory data, including serum creatinine (SCr), APTT, PT, INR, TT, Fib, and PLT; and (IV) the primary outcome of AKI at admission. We defined patients with AKI according to the criteria of the Kidney Disease Improving Global Outcomes (KDIGO) classification criteria during admission (19). The lowest SCr recorded at the hospital 1 year earlier was used as baseline. If no baseline SCr was recorded, baseline SCr was estimated according to the

KDIGO guideline, with an assumed baseline estimated glomerular filtration rate of 75 mL/min per 1.73 m^2 (12). The secondary outcomes included in-hospital all-cause mortality, interlayer fracture, and cardiac arrest or the need for ventricular fibrillation for cardiopulmonary resuscitation, which were defined as malignant events.

Ethical considerations

The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the Ethics Committee for Clinical Research at the First Affiliated Hospital of Shantou University Medical College (No. B-2023-003). Individual consent for this retrospective analysis was waived.

Statistical analysis

All the data were divided into two categories: continuous variables and categorical data. The measurement data are expressed as the mean ± SD or median [interquartile range (IQR)]. Categorical data are expressed as the number (percentage). Continuous variables were analyzed using Student *t* test, and categorical variables were analyzed using chi-squared or Fisher exact test. To estimate the coagulation dysfunction of AKI and malignant events, odds ratios (ORs) and 95% CIs were calculated with univariable analysis and multivariable adjustments in the following models to reduce the effect of known possible confounders: model 1—adjusted for age, gender, acute aortic dissention (Stanford classification), smoking history, drinking history, systolic blood pressure (SBP), diastolic blood pressure (DBP), and comorbidities (including hypertension, Marfan syndrome, heart surgery history, arteriosclerosis, coronary heart disease, aortic valve disease, and diabetes mellitus type 2); model 2—adjusted model 1 + murmur in the aortic valve auscultation area, organ or limb ischemia, hypotensive shock, number of renal arteries involved, aneurysm on imaging, ulcer of the aorta, and aortic intermural hematoma; and model 3—adjusted model 2 + white blood cell count.

In addition, propensity score matching (PSM), using nearest-neighbor matching (1:1) within a caliper width of 0.02 SD without replacement, was performed between the coagulation dysfunction groups based on the estimated propensity scores. Furthermore, to confirm the robustness of the results, PSM was performed on the same results as a sensitivity analysis.

To further clarify the contribution rate of each coagulation indicator, chi-squared or Fisher exact test was used to compare the dysfunction of each coagulation indicator across the different prognosis groups. Receiver operating characteristic (ROC) curve analysis was then used to evaluate the value of each coagulative indicator and ACS for predicting the in-hospital AKI and malignant events.

Statistical analyses were performed with SPSS version 27.0 and PASS version 15. A two-sided P value of <0.05 was considered to denote the presence of a statistically significant difference.

Results

Patients' baseline characteristics

Table 2 shows the demographics, medical history, clinical features, and laboratory data of the participants. Ultimately, with a two-side 5% significance level, the sample size of 309 and 178 patients and the incidence of AKI was 0.71 and 0.84 in the normal and abnormal coagulation groups, respectively, the statistical power (1-β) was 0.93. Men were in the majority with a percentage of 80%. The Stanford classification was roughly symmetrical, and the proportion of Stanford A in the abnormal coagulation group was significantly higher than that the normal coagulation group. Before PSM, these two groups appeared similar in terms of age, gender ratio, and medical history. The percentage of patients with poor ischemia performance and involved renal was not different between the coagulation groups. However, a greater portion of patients in the abnormal coagulation group had AAD (Stanford A), hyperuricemia, a history of heart surgery history, and lower blood pressure. After PSM, baseline characteristics were balanced between the two groups (Table S1).

Clinical outcomes

Univariate analysis (unadjusted) was carried out for all variables, from which we selected variables with statistical difference (P<0.05) for multivariate logistic regression analysis. The independent influence factors on in-hospital AKI included age, male sex, organ or limb ischemia, and ACS. AAD (Stanford A), hypotensive shock, blood type, and abnormal PT tended to influence the incidence of malignant events (*Figure 2*).

The incidence of AKI in the abnormal coagulation group was significantly higher than that in the normal coagulation

Table 2 Baseline clinical characteristics

Characteristics	Value (n=487)	Normal coagulation (n=309)	Abnormal coagulation (n=178)	P value
Age (years), median [IQR]	57 [48–64]	57 [48–64]	57 [49–64]	0.638
Male, n (%)	394 (80.9)	245 (79.3)	149 (83.7)	0.232
Stanford A, n (%)	270 (55.4)	147 (47.6)	123 (69.1)	0.000***
Previous history, n (%)				
Smoking	324 (66.5)	204 (66.0)	120 (67.4)	0.753
Drinking	78 (16.0)	46 (14.9)	32 (18.0)	0.370
Hypertension	431 (88.5)	280 (90.6)	151 (84.8)	0.054
Marfan syndrome	11 (2.3)	7 (2.3)	4 (2.2)	0.990
Heart surgery history	8 (1.6)	1 (0.3)	7 (3.9)	0.003**
Arteriosclerosis	36 (7.4)	25 (8.1)	11 (6.2)	0.438
Coronary heart disease	36 (7.4)	23 (7.4)	13 (7.3)	0.955
Cardiac insufficiency	17 (3.5)	11 (3.6)	6 (3.4)	0.913
Atrial fibrillation	14 (2.9)	6 (1.9)	8 (4.5)	0.104
Aortic valve disease	27 (5.5)	18 (5.8)	9 (5.1)	0.721
Diabetes mellitus type 2	42 (8.6)	32 (10.4)	10 (5.6)	0.073
COPD/asthma	11 (2.3)	9 (2.9)	2 (1.1)	0.201
Cerebrovascular disease	21 (4.3)	13 (4.2)	8 (4.5)	0.881
Anemia	167 (34.3)	100 (32.4)	67 (37.6)	0.201
Hypoproteinemia	412 (84.6)	267 (86.4)	145 (81.5)	0.145
Hyperuricemia	206 (42.3)	113 (36.6)	93 (52.2)	0.000***
Clinical feature				
Systolic blood pressure (mmHg), mean ± SD	164±34.1	167.2±33.4	158.7±34.7	0.008**
Diastolic blood pressure (mmHg), mean ± SD	91.9±23.0	94.3±22.0	87.8±24.1	0.003**
BP asymmetry in extremities, n (%)	391 (80.3)	247 (79.9)	19.1 (80.9)	0.797
Pulse press (beat/min), mean ± SD	72.2±21.2	72.9±20.9	70.9±21.6	0.473
Heart rate (beat/min), mean ± SD	78.8±16.9	79.5±15.5	77.7±19.0	0.087
Chest pain, n (%)	398 (81.7)	247 (79.9)	151 (84.8)	0.178
Back pain, n (%)	355 (72.9)	217 (70.2)	138 (77.5)	0.081
Abdominal pain, n (%)	110 (22.6)	77 (24.9)	33 (18.5)	0.105
Murmur in aortic valve auscultation area, n (%)	100 (20.5)	53 (17.2)	47 (26.4)	0.015*
Organ or limb ischemia, n (%)	162 (33.3)	98 (31.7)	64 (36.0)	0.339
Hypotensive shock, n (%)	20 (4.1)	9 (2.9)	11 (6.2)	0.080

Table 2 (*continued*)

Table 2 (*continued*)

Characteristics	Value (n=487)	Normal coagulation (n=309)	Abnormal coagulation (n=178)	P value
Laboratory findings				
ABO blood type, n (%)				0.161
A	126 (26.6)	84 (27.9)	42 (24.3)	
B	124 (26.2)	75 (24.9)	49 (28.3)	
AB	30 (6.3)	24 (8.0)	6 (3.5)	
O	194 (40.9)	118 (39.2)	76 (43.9)	
White blood cell (10^9/L), mean ± SD	14.1±4.4	13.6±4.2	15.1±4.7	0.000***
Hemoglobin (g/L), median (IQR)	133.0 (122.0–145.0)	133.0 (121.0–144.0)	133.0 (122.8–147.3)	0.512
Number of renal arteries involved, n (%)				0.396
1	244 (50.1)	157 (50.8)	87 (48.9)	
2	41 (8.4)	22 (7.1)	19 (10.7)	
Thrombosis, n (%)	129 (27.6)	176 (59.3)	81 (47.4)	0.013*
Aneurysm on imaging, n (%)	57 (12.2)	37 (12.5)	20 (11.7)	0.808
Ulcer of aorta, n (%)	46 (9.8)	34 (11.4)	12 (7.0)	0.121
Aortic intermural hematoma, n (%)	179 (38.2)	119 (40.1)	60 (35.1)	0.286
Pericardial effusion, n (%)	70 (15.0)	38 (12.8)	32 (18.7)	0.084
Pleural effusion, n (%)	111 (23.7)	74 (24.9)	37 (21.6)	0.422
Renal cyst, n (%)	165 (35.2)	108 (36.2)	57 (33.3)	0.526
End point, n (%)				
Acute kidney injury	369 (75.8)	219 (70.9)	150 (84.3)	0.000***
Malignant events	60 (12.3)	28 (9.1)	32 (18.0)	0.004**
In-hospital all-cause mortality	51 (10.5)	23 (7.4)	28 (15.7)	0.040*
Interlayer fracture	42 (8.6)	19 (6.1)	23 (12.9)	0.010*
Cardiac arrest/ventricular fibrillation	38 (7.8)	16 (5.2)	22 (12.4)	0.040*

*, P<0.05; **, P<0.01; ***, P<0.001. IQR, interquartile range; SD, standard deviation; COPD, chronic obstructive pulmonary disease; BP, blood pressure.

group. ORs were calculated for AKI after adjustments were made for possible confounders in 3 models (model 1: OR 2.061, 95% CI: 1.214–3.501, P=0.007; model 2: OR 1.833, 95% CI: 1.058–3.177, P=0.031; model 3: OR 1.836, 95% CI: 1.048–3.216, P=0.034; PSM: OR 4.419, 95% CI: 2.650–7.370, P<0.001) (see in *Table 3*).

After adjustments were made for the covariates, the incidence of malignant events was found to be higher in the abnormal PT group (model 1: OR 4.283, 95% CI: 0.983–18.665, P=0.053; model 2: OR 7.342, 95% CI: 1.467–36.749, P=0.015; model 3: OR, 6.996, 95% CI: 1.377–35.537, P=0.019; PSM: OR 8.969, 95% CI: 2.312–34.796, P=0.002).

To compare the dysfunction of each coagulation indicator among the AKI groups and malignant events groups, Chi-squared and Fisher exact tests were used. These revealed PT, Fib, PLT, and abnormal coagulation to be statistically significant. In general, the higher the proportion of abnormal indicators was, the greater the possibility was of poor prognosis (*Figure 3*). To measure the contribution rate of each indicator, ROC analysis was conducted, which indicated that Fib was a useful prognostic method (AUC

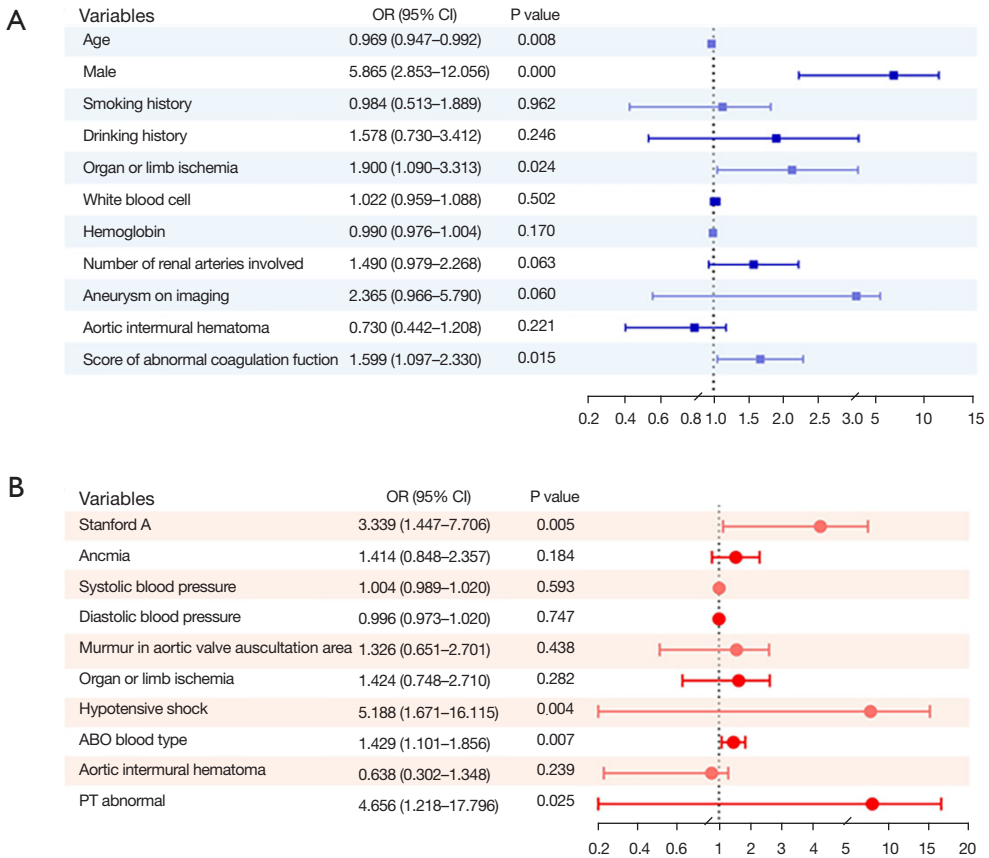

Figure 2 Multivariable logistic regression analyses for the effect of the intervention on the incidence of acute kidney injury and malignant events. (A) Multivariable analyses for the effect of the intervention on the incidence of acute kidney injury; (B) multivariable analyses for the effect of the intervention on the incidence of malignant events. OR, odds ratio; PT, prothrombin time.

Table 3 Odds ratios of in-hospital AKI in patients with AAD with abnormal coagulation *vs.* those with normal coagulation and the odds ratios of malignant events in patients with AAD and abnormal PT *vs.* those with normal PT

	AKI group		Malignant events group	
	OR (95% CI)	P value	OR (95% CI)	P value
Univariable	2.202 (1.373–3.530)	0.001**	6.379 (1.884–21.598)	0.003**
Multivariable				
Model 1	2.061 (1.214–3.501)	0.007**	4.283 (0.983–18.665)	0.053
Model 2	1.833 (1.058–3.177)	0.031*	7.342 (1.467–36.749)	0.015*
Model 3	1.836 (1.048–3.216)	0.034*	6.996 (1.377–35.537)	0.019*
PSM	4.419 (2.650–7.370)	<0.001***	8.969 (2.312–34.796)	0.002**

*, P<0.05; **, P<0.01; ***, P<0.001. AKI, acute kidney injury; AAD, acute aortic dissection; PT, prothrombin time; PSM, propensity score matching; OR, odds ratio; CI, confidence interval.

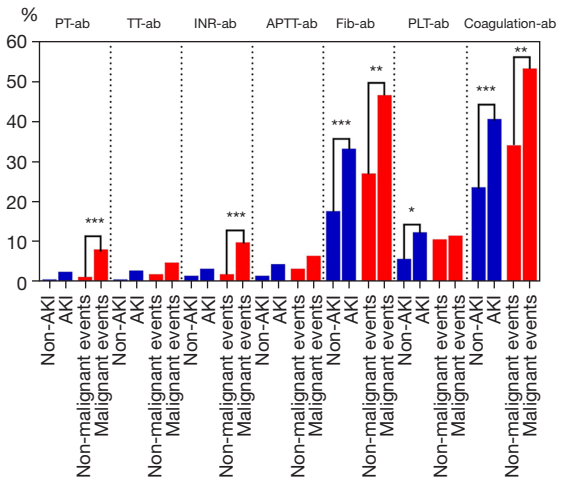

Figure 3 The proportion of coagulation dysfunction in different prognosis groups. *, P<0.05; **, P<0.01; ***, P<0.001. PT, prothrombin time; TT, thrombin time; INR, international normalized ratio; APTT, activated partial thromboplastin time; Fib, fibrinogen content; PLT, platelet count; ab, abnormal; AKI, acute kidney injury.

Table 4 The incidence of AKI according to the coagulation indicators

Indicators	AUC	P value
PT abnormal	0.519	0.570
TT abnormal	0.519	0.580
INR abnormal	0.521	0.537
APTT abnormal	0.523	0.506
Fib abnormal	0.649	<0.001***
PLT abnormal	0.563	0.063
Abnormal coagulation score	0.688	<0.001***

***, P<0.001. AKI, acute kidney injury; PT, prothrombin time; TT, thrombin time; INR, international normalized ratio; APTT, activated partial thromboplastin time; Fib, fibrinogen content; PLT, platelet count; AUC, area under the receiver operating characteristic curve.

=0.649; P<0.001) for the coincidence of AKI but that ACS was even more valuable (AUC =0.688; P<0.001). There were no significant results in malignant event groups after ROC curve analysis was performed (*Table 4*).

Discussion

In this cohort study of patients with AAD undergoing AKI and malignant events, we demonstrated that abnormal coagulation was significantly associated with a poor prognosis. The results were consistent after multivariable adjustments in 3 models that considered comorbidities, hypoperfusion, inflammation, and ischemia/reperfusion, among other factors. After PSM, we found that patients with abnormal coagulation had about a 4.4 times greater possibility to develop AKI while patients with abnormal PT had an almost 9.0 times greater possibility to develop malignant events compared to their normal counterparts.

Coagulation dysfunction is not only a characteristic of AAD (5,7-11), but is the physiopathologic mechanism of AKI (6,13,14,16,20). Theoretically, when AAD occurs, endothelial injury may be accompanied by the formation of a false lumen, which may activate the coagulation pathway, precipitate a cascade reaction, and then activate the fibrinolytic system (12). When coagulation factors and fibrinolytic substances are consumed continuously, abnormal coagulation function will inevitably occur, placing the body in a state of hypocoagulability (21). It has also been found that aneurysms that consume platelets and generate coagulation fibers, PT, APTT, and TT may be prolonged, while fibrin degradation products may be reduced (21). This is consistent with the decline in Fib and PLT found in our study, which is suggestive of hyperfibrinolysis (12).

In addition, coagulation dysfunction may further produce microthrombi, which may produce thrombus deposits as they pass through renal vessels (14) and may further contribute to the AKI. Moreover, thrombin can participate in the activation of endothelial cells after injury. In an experiment using an animal model of AKI, it was confirmed that coagulation dysfunction could limit medullar capillary perfusion, leading to prolonged regional ischemia/hypoxia and hindering the repair and regeneration of tubular cells. In other studies, on thrombin targeted therapy, the improvement of renal microvascular circulation through the antithrombin effect could reflect the influence of abnormal coagulation on AKI (22). Thrombin production is higher in patients with worsening renal function, which is an independent risk factor for AKI in patients with anemia and may lead to microcirculation disturbance and tubule cell damage (23).

Other indicators in our study, including the prolonged APTT and TT, showed no significant difference, which is inconsistent with other research (7,9). This may be explained by the characteristics of coagulation. Coagulation is a cascade reaction, and various indicators influence and interact with each other. Considering a single factor

in isolation makes it difficult to analyze its most salient characteristics. Moreover, further ROC analysis showed ACS to have the best performance in predicting the in-hospital AKI.

This paper identified a simple but useful system for predicting AKI by clinical coagulation dysfunction in patients with AAD. Above all, this will provide clinical ideas regarding the diagnosis and treatment of patients with AAD. For patients with coagulation dysfunction, kidney protection and treatment measures should be taken as soon as possible to avoid the occurrence of AKI. This system can be used for the early identification of high-risk patients, the early diagnosis of AKI, the stabilization of the hemodynamic parameters, the avoidance of nephrotoxic drugs, and the optimization of the use of contrast agents (6) which may be useful in preventing renal failure, reducing the length of hospital stay, and saving medical resources. Nevertheless, the mechanism of AKI is still controversial (5,13,16), while the mechanism underlying the association between coagulopathy and AKI is still unclear and should be investigated further.

Limitations

We used a single-center, retrospective design with a small sample size. It is necessary to conduct a prospective, multicenter trial to evaluate the relationship between coagulation indicators and AKI. Some literature shows that the KDIGO criteria are the most widely used for the definition of AKI, but the incidence of AKI calculated by the KDIGO appears to be too high.

Conclusions

Our study confirmed that the presence of coagulation dysfunction is associated with an increased risk of AKI and malignant events. It suggested that the severity of coagulation dysfunction is positively correlated with the incidence of in-hospital AKI in AAD patients. These results highlight the importance of considering coagulation dysfunction as a potential mechanism underlying the poor prognosis of AKI and malignant events in patients with AAD. Further research is needed to better understand the underlying mechanisms of coagulation dysfunction in this context, and to develop effective interventions for mitigating the risk of these adverse outcomes in AAD patients.

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Footnote

Reporting Checklist: The authors have completed the STARD reporting checklist. Available at https://jtd.amegroups.com/article/view/10.21037/jtd-23-38/rc

Data Sharing Statement: Available at https://jtd.amegroups.com/article/view/10.21037/jtd-23-38/dss

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://jtd.amegroups.com/article/view/10.21037/jtd-23-38/coif). BW reports that the study was partially supported by the 2020 Li Ka Shing Foundation Cross-Disciplinary Research Grant (No. L1111 2004). The other authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the Ethics Committee for Clinical Research at the First Affiliated Hospital of Shantou University Medical College (No. B-2023-003). Individual consent for this retrospective analysis was waived.

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Supplementary

Table S1 Baseline clinical characteristics after propensity matching cohorts

Characteristic	Normal coagulation (n=168)	Abnormal coagulation (n=168)	P value
Age (years), median [IQR]	59 [48-65]	57 [49-65]	0.973
Male, n (%)	126 (75.0)	140 (83.3)	0.060
Stanford A	113 (67.3)	114 (67.9)	0.907
Previous history, n (%)			
Smoking	105 (62.5)	115 (68.5)	0.251
Drinking	24 (14.3)	31 (18.5)	0.302
Hypertension	152 (90.5)	143 (85.1)	0.134
Marfan syndrome	3 (1.8)	4 (2.4)	1.000
Heart surgery history	1 (0.6)	1 (0.6)	1.000
Arteriosclerosis	8 (4.8)	10 (6.0)	0.628
Coronary heart disease	9 (5.4)	12 (7.1)	0.499
Cardiac insufficiency	6 (3.6)	3 (1.8)	0.502
Atrial fibrillation	3 (1.8)	6 (3.6)	0.502
Aortic valve disease	12 (7.1)	8 (4.8)	0.356
Diabetes mellitus type 2	17 (10.1)	10 (6.0)	0.160
COPD/asthma	7 (4.2)	2 (1.2)	0.174
Cerebrovascular disease	6 (3.6)	8 (4.8)	0.585
Anemia	53 (31.5)	61 (36.3)	0.357
Hypoproteinemia	144 (85.7)	137 (81.5)	0.302
Hyperuricemia	82 (48.8)	84 (50.0)	0.827
Clinical feature			
Systolic blood pressure, mean ± SD	158.5±30.9	160.2±33.5	0.643
Diastolic blood pressure, mean ± SD	89.0±21.4	88.7±23.8	0.897
BP asymmetry in extremities, n (%)	131 (78.0)	136 (81.0)	0.500
Pulse press, mean ± SD	70.0±20.1	71.5±21.1	0.386
Heart rate, mean ± SD	80.2±15.8	77.5±18.6	0.150
Chest pain, n (%)	139 (82.7)	143 (85.1)	0.552
Back pain, n (%)	113 (67.3)	129 (76.8)	0.052
Abdominal pain, n (%)	41 (24.4)	30 (17.9)	0.142
Murmur in aortic valve auscultation area, n (%)	35 (20.8)	45 (26.8)	0.200
Organ or limb ischemia, n (%)	52 (31.0)	60 (35.7)	0.355
Hypotensive shock, n (%)	7 (4.2)	8 (4.8)	0.792

IQR, interquartile range; SD, standard deviation; COPD, chronic obstructive pulmonary disease; BP, blood pressure.

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