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D-Dimer/Platelet Ratio Predicts in-Hospital Death in Patients with Acute Type a Aortic Dissection

Ani Zhao[1,*], Yanchun Peng[2,*], Baolin Luo[2], Yaqin Chen[1], Liangwan Chen[3,4], Yanjuan Lin[2,3]

[1]School of Nursing, Fujian Medical University, Fuzhou, Fujian, People's Republic of China; [2]Department of Nursing, Fujian Medical University Union Hospital, Fuzhou, Fujian Province, 350001, People's Republic of China; [3]Department of Cardiovascular Surgery, Fujian Medical University Union Hospital, Fuzhou, Fujian Province, 350001, People's Republic of China; [4]Key Laboratory of Cardio-Thoracic Surgery (Fujian Medical University) Fujian Province University, Fuzhou, Fujian Province, 350001, People's Republic of China

*These authors contributed equally to this work

Correspondence: Liangwan Chen; Yanjuan Lin, Email fjxhlwc@163.com; fjxhyjl@163.com

Purpose: Acute Type A aortic dissection (ATAAD) is a rare and life-threatening aortic disease. This study was aimed at the potential of the D-dimer to platelet count ratio (DPR) as a prognostic indicator of ATAAD.

Patients and Methods: This study retrospectively analyzed ATAAD patients who were admitted to the Department of Cardiac Surgery, Fujian Medical University Union Hospital from January 2022 to April 2023. Patients were divided into survival (n = 173) and death (n = 24) groups based on whether death occurred. The primary outcome was death, and the secondary outcome was adverse hospitalization, including new postoperative arrhythmias, acute renal insufficiency, acute liver insufficiency, pleural effusion, length of ICU stay, mechanical ventilation length, and length of stay. The logistic regression model was used to analyze the relationship between DPR and in-hospital death, and the receiver operating characteristic curve (ROC) was drawn to analyze the predictive value of DPR for in-hospital death of ATAAD patients.

Results: Of the 197 patients included, 24 died, and the in-hospital mortality rate was 12.2%. There was a significant difference in diastolic blood pressure ($P < 0.05$). In terms of laboratory indexes, total bilirubin, direct bilirubin, indirect bilirubin, D-dimer, red blood cell volume distribution width, and DPR in the death group were higher than those in the survival group, with statistical significance ($P < 0.05$). Operation duration, hospital stay, ICU stay, mechanical ventilation time, and acute renal insufficiency in the death group were higher than those in the survival group ($P < 0.05$). Univariate analysis and multivariate analysis showed that DPR > 0.0305 ug/mL was an independent risk factor for death in ATAAD patients.

Conclusion: Increased DPR is independently associated with in-hospital death in patients with ATAAD.

Keywords: acute type A aortic dissection, death, D-dimer/platelet ratio, prognosis

Introduction

Acute type A aortic dissection (ATAAD) is a serious and life-threatening cardiovascular disease.[1] Aortic dissection allows blood to flow between the layers of the aortic wall, forcing the layers apart, and about 18–30% of patients die on admission to the hospital.[2] Without surgical treatment, the mortality rate of ATAAD increases by 1%-2% per hour within 24 hours of onset and exceeds 70% within 1 week of onset.[3,4] Emergency surgery is the only effective treatment. In recent years, with the improvement of medical staff's understanding of aortic diseases, the progress of anesthesia and cardiopulmonary bypass technology, the diagnosis rate of AD continues to increase, but the mortality rate and post-operative complications are still high, and the in-hospital mortality rate is still 18%-22%.[5,6] Its prevention and treatment have become the focus and difficulty in the diagnosis and treatment of ATAAD. Currently, predictive biomarkers used to identify the risk of death in patients with ATAAD are important for risk stratification, and these predictors will enable optimization of treatment strategies, improved early surgical treatment of ATAAD, and reduced severe postoperative complications.

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The mechanisms of coagulation and inflammation are important in the pathogenesis and prognosis of ATAAD.[7] D-dimer is a soluble fibrin degradation product, which can be used as a marker to activate coagulation and fibrinolysis processes.[8] Studies have shown that increased D-dimer levels are associated with adverse outcomes in critically ill patients.[9,10] However, its accuracy is not enough to use as a single indicator. Therefore, it is necessary to conduct a systematic evaluation in combination with other indicators.[11] A very common laboratory measure is a platelet count, which is a small cell circulating in the bloodstream that helps clot blood. Platelet count, in addition to its clotting function, is an important factor in inflammation and promotes inflammation by signaling immune cell interactions to activate and recruit white blood cells to the site of inflammation.[12] Given the potential combined effects of D-dimer and platelet count, it can be assumed that the combined assessment of D-dimer to platelet count ratio (DPR) can be used as a reliable and practical prognostic indicator for certain clinical diseases. Notably, recent studies have shown that DPR has been shown to be an early prognostic factor for death from certain diseases, including sepsis,[13] pregnant women,[14] and Hepatitis B virus-related decompensated cirrhosis (HBV-DC) associated decompensated cirrhosis.[7] However, the clinical value of D-dimer combined with platelets in the treatment of cardiovascular diseases remains to be further explored.

DPR is a relatively new rate that can be easily obtained with routine blood tests. Therefore, the purpose of this study was to investigate the clinical application value of DPR in predicting hospital death of ATAAD.

Material and Methods

Study Design, Setting, and Participants

In this study, 197 patients with ATAAD who were treated in the Department of Cardiac Surgery of Fujian Medical University Union Hospital from January 2022 to April 2023 were selected as the study objects. Our inclusion criteria are as follows: (1) ATAAD diagnosed by computed tomography, thoracic aortography, or magnetic resonance imaging; (2) at least 18 years old; (3) Emergency surgical treatment after the patient enters the hospital: The operation was carried out under general anesthesia and with the support of extracorporeal circulation. Exclusion criteria: (1) patients whose duration from onset to hospitalization exceeded 48 hours; (2) Absence of D-dimer and platelet count in preoperative data; (3) Patients suffer from malignant tumors, immune diseases, infectious diseases, and chronic organ dysfunction. All patients were admitted to the cardiac surgical ICU, and serological samples were drawn from venous blood prior to emergency surgery without the need for medication. This study follows the Declaration of Helsinki and was approved by the Ethics Committee of Fujian Medical University Union Hospital (Number: 2021KY096).

Collect the following data from patients' electronic medical records: (1) General baseline data (age, sex, height, weight, BMI: calculated as weight divided by height squared, Systolic Blood Pressure [SBP], Diastolic Blood Pressure [DBP], Heart rate); (2) Clinical data including medical history (Hypertension: Systolic blood pressure of 140 mmHg or higher, diastolic blood pressure of 90 mmHg or higher, utilization of antihypertensive medications, or self-reported hypertension;[15] Diabetes mellitus: characterized by fasting blood glucose levels equal to or exceeding 7.0 mmol/L, or glycosylated hemoglobin levels equal to or exceeding 6.5%, Administration of oral anti-diabetic medications or insulin, or previous diabetes diagnosis, cerebrovascular disease, coronary heart disease); (3) Biochemical indicators of the first admission (total bilirubin, direct bilirubin, indirect bilirubin, total protein, Blood Platelet Count [PLT], D-dimer, albumin, total cholesterol, low-density lipoprotein [LDL], high-density lipoprotein [HDL], glucose, white blood cells [WBC], neutrophils, lymphocyte count, red blood cells [RBC], hemoglobin, platelet volume distribution width [PDW], red cell distribution width [RDW], D-dimer to platelet count ratio [DPR]; (4) Surgical data (operation duration, duration of cardiopulmonary bypass [CPB], duration of aortic occlusion duration [ACC].

Outcomes and Covariates

In this study, the primary outcome was in-hospital death, while the secondary outcome was adverse in-hospital outcomes, including new postoperative arrhythmia (NOA), acute renal insufficiency, acute liver insufficiency, pleural effusion, the duration of stay in both the Intensive Care Unit (ICU) and the hospital and mechanical ventilation duration (MV).

Relevant definitions or diagnostic criteria: (1) Acute renal insufficiency was defined as a 50% increase in SCr for 7 days or a 0.3 mg/dL (26.5 μmol/L) increase in SCr for 2 days or oliguria for ≥6 hours.[16] (2) Acute hepatic insufficiency

was defined as postoperative ALT (0–46 IU/L) and/or AST (0–46 IU/L) exceeding normal values; Increased TBIL (2–22 umol/L) and/or DBIL (0–5.9 umol/L).[17]

Statistical Analysis

SPSS25.0 statistical software was used for data entry and analysis. Measurement data conforming to normal distribution were represented by mean ± standard deviation (Mean ± SD). Independent sample *T*-test and analysis of variance were used for inter-group comparison. Measurement data that do not conform to normal distribution are represented by median and quartile. Counting data were described by frequency and component ratio, and the Chi-square test or rank sum test was used for comparison between groups. Univariate logistic regression analysis found potential risk factors for in-hospital death ($P < 0.1$), and multivariate logistic regression analysis found that previously significant variables were independent factors ($P < 0.05$). With results were expressed as odds ratio (OR) and corresponding 95% confidence interval (CI). To evaluate the predictive effect of DPR on death in patients with ATAAD, a receiver operating characteristic (ROC) curve was also constructed and the area under the curve (AUC), sensitivity, and specificity were calculated to show the predictive value of DPR. Statistical significance was defined as $P < 0.05$.

Result

Study Population and Baseline Characteristics

Figure 1 shows a flow chart of the study population. Finally, 197 subjects were included in the study for analysis, and the patients were divided into survival group (n = 173) and death group (n = 24) according to whether death occurred. The mean age of death was (55.25 ± 14.83) years. Physiological indexes such as age, heart rate, SPB, and DPB were compared between the two groups. The preoperative DPB of the survival group was (76.06 ± 14.22) mmHg, and that of the death group was (69.42 ± 13.67) mmHg, and the difference in diastolic blood pressure between the two groups was statistically significant ($P < 0.05$).

There was no significant difference in other preoperative data ($P > 0.05$). In terms of laboratory indicators: In the survival group, total bilirubin was (9.09 ± 4.72) umol/L, direct bilirubin was (3.16 ± 1.50) umol/L, indirect bilirubin was (5.93 ± 3.53) umol/L, D-dimer was (6.15 ± 5.17) ug/mL and RDW was (44.59 ± 4.28) %. In the death group, total

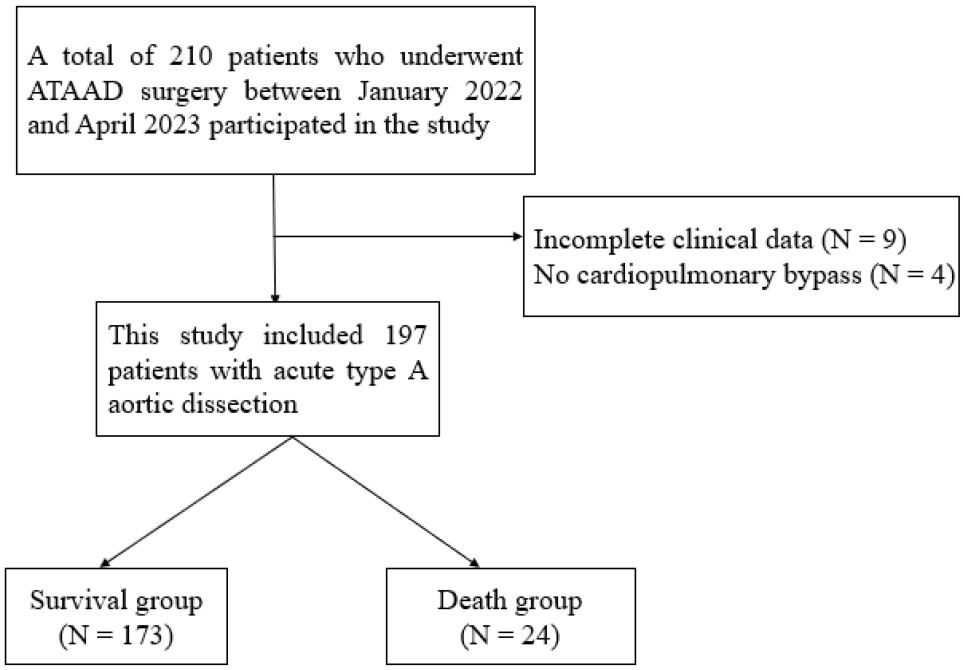

Figure 1 Flowchart of the study population.

bilirubin was (13.03 ± 12.32) umol/L, direct bilirubin was (3.95 ± 2.73) umol/L, indirect bilirubin was (9.07 ± 10.02) umol/L, D-dimer was (10.07 ± 4.91) umol/L and RDW was (46.63 ± 6.19) %. There were significant differences in total bilirubin, direct bilirubin, indirect bilirubin, D-dimer, and RDW between the two groups. Intraoperative comparison results showed that there was no statistical significance in CPB time or ACC time between the two groups ($P > 0.05$). However, the operation duration of the patients in the death group was longer than that in the survival group ($P < 0.05$). The baseline characteristics of the two groups are shown in Tables 1 and 2.

Table 1 Preoperative Baseline Characteristics of Patients in the Two Groups

Baseline characteristics	Total	Survival Group	Death group	*P*-value
Age (years)	53.64 ± 12.86	53.4 ± 12.59	55.25 ± 14.83	0.514
BMI (kg/m^2)	24.51 ± 13.45	24.84 ± 14.29	22.13 ± 2.93	0.356
SBP (mmHg)	129.63 ± 20.43	130.38 ± 20.56	124.29 ± 19.01	0.172
DBP (mmHg)	75.25 ± 14.29	76.06 ± 14.22	69.42 ± 13.67	0.032
Heart rate	84.07 ± 15.24	84.45 ± 14.93	81.33 ± 17.38	0.349
Male	145 (73.6)	130 (66.0)	15 (7.6)	0.143
Female	52 (26.4)	43 (21.8)	9 (4.6)	
Hypertension	96 (48.7)	81 (41.1)	15 (7.6)	0.111
Diabetes	11 (5.6)	10 (5.1)	1 (0.5)	0.603
Coronary heart disease	10 (5.1)	9 (4.6)	1 (0.5)	0.650
Cerebrovascular disease	8 (4.1)	6 (3.0)	2 (1.0)	0.253
Total bilirubin (umol/L)	9.57 ± 6.25	9.09 ± 4.72	13.03 ± 12.32	0.004
Direct bilirubin (umol/L)	3.25 ± 1.71	3.16 ± 1.50	3.95 ± 2.73	0.033
Indirect bilirubin (umol/L)	6.31 ± 4.88	5.93 ± 3.53	9.07 ± 10.02	0.003
Total protein (g/L)	68.67 ± 5.53	68.93 ± 5.47	66.78 ± 5.71	0.075
PLT (10^9/L)	227.00 ± 67.68	229.26 ± 67.58	210.71 ± 67.58	0.209
D-dimer (umol/L)	6.63 ± 5.29	6.15 ± 5.17	10.07 ± 4.91	0.001
Albumin (g/dl)	38.42 ± 3.99	38.57 ± 4.05	37.33 ± 3.46	0.154
Total cholesterol (mmol/L)	4.43 ± 1.14	4.43 ± 1.11	4.45 ± 1.32	0.945
HDL (mmol/L)	1.06 ± 0.31	1.07 ± 0.31	0.99 ± 0.30	0.258
LDL (mmol/L)	2.88 ± 1.01	2.86 ± 0.98	3.00 ± 1.20	0.536
Glucose (mg/dl)	5.0 ± 1.28	5.03 ± 1.31	4.86 ± 1.05	0.542
WBC (10^9/L)	7.30 ± 2.32	7.37 ± 2.35	6.81 ± 2.10	0.273
Neutrophil (10^9/L)	4.71 ± 2.24	4.72 ± 2.26	4.60 ± 2.09	0.809
Lymphocyte count	1.83 ± 1.01	1.87 ± 1.04	1.51 ± 0.61	0.101
RBC (10^12/L)	4.26 ± 0.72	4.28 ± 0.71	4.11 ± 0.77	0.263
Hemoglobin (g/L)	123.08 ± 21.12	123.65 ± 21.07	118.92 ± 21.44	0.305
RDW (%)	44.85 ± 4.59	44.59 ± 4.28	46.63 ± 6.19	0.041
PDW (%)	12.31 ± 2.89	12.26 ± 2.88	12.67 ± 2.90	0.522
DPR (ug/mL)	95 (48.2)	20 (10.2)	75 (38.1)	0.000

Abbreviations: *SBP*, Systolic Blood Pressure; *DBP*, Diastolic Blood Pressure; *PLT*, Blood Platelet Count; *LDL*, Low-Density Lipoprotein Cholesterin; *HDL*, High-Density Lipoprotein cholesterol; *WBC*, White Blood Cell; *RBC*, Red Blood Cell; *RDW*, Red Cell Distribution Width; *PDW*, Platelet Distribution Width; *DPR*; D-dimer to platelet count ratio.

Table 2 Intraoperative Baseline Characteristics of Patients in the Two Groups

Variable	Total	Survival Group	Death group	*P*-value
Duration of CPB (Minutes)	167.39 ± 67.89	164.77 ± 66.09	186.25 ± 78.65	0.147
Operation duration	326.74 ± 92.11	319.54 ± 89.09	378.63 ± 98.69	0.003
Duration of ACC (Minutes)	93.58 ± 59.52	91.67 ± 60.403	107.33 ± 51.75	0.228

Abbreviations: *CPB*, Cardiopulmonary bypass; *ACC*, Aortic occlusion duration.

Postoperative Clinical Features of Patients in the Two Groups

Of 197 patients with ATAAD, 24 (12.2%) died, including 15 men (7.6%) and 9 women (4.6%). The length of hospital stay, ICU stay, mechanical ventilation time, and acute renal insufficiency in the death group were significantly higher than those in the survival group ($P < 0.05$). There was no significant difference in acute liver dysfunction, new arrhythmia, and pleural effusion between the two groups ($P > 0.05$). As shown in Table 3.

Results of univariate analysis of adverse outcomes

The results of the single-factor analysis are shown in Table 4. Univariate analysis showed that: DBP (OR=0.965, 95% CI: 0.034–0.997, $P < 0.05$), BMI (OR=0.870, 95% CI: 0.766–0.989, $P < 0.05$), direct bilirubin (OR=1.235, 95% CI: 1.007–1.515, $P < 0.05$), indirect bilirubin (OR=1.098, 95% CI: 1.007–1.197, $P < 0.05$), lymphocyte count (OR=0.463, 95% CI: 0.223–1.188, $P < 0.05$), RDW (OR=1.090,95% CI: 1.002–1.187, $P < 0.05$), D-dimer (OR=1.152,95% CI: 1.057–1.254, $P < 0.01$), DPR (OR=6.533,95% CI: 2.143–19.921, $P < 0.01$), and operation duration (OR=1.006,95% CI: 1.002–1.011, $P < 0.01$) were associated with increased hospital death after ATAAD.

Multifactorial Results of in-Hospital Deaths

After excluding other factors, the results of multivariate analysis showed that: lymphocyte count (OR=0.372, 95% CI: 0.161–0.858, $P < 0.05$), DPR > 0.0305 ug/mL (OR=5.552, 95% CI: 1.574–19.570, $P < 0.05$) and operation duration (OR=1.006, 95% CI: 1.001–1.011, $P < 0.05$) increased the risk of hospital death in ATAAD patients. Our study shows that DPR > 0.0305ug/mL can independently predict hospital death in patients with ATAAD. This is shown in Table 5.

Table 3 Postoperative Clinical Features of Patients in the Two Groups

Variable	Total	Survival Group	Death group	*P*-value
Length of stays (days)	18.52 ± 9.95	17.61 ± 8.35	25.08 ± 16.46	0.000
ICU stays (hours)	106.27 ± 159.00	75.510 ± 63.40	328.02 ± 356.32	0.000
MV (hours)	37.52 ± 43.89	29.07 ± 31.75	98.45 ± 66.84	0.000
Acute renal insufficiency	27 (13.7)	8 (4.1)	19 (9.6)	0.007
Acute liver insufficiency	13 (6.6)	9 (4.6)	4 (2.0)	0.057
NOA	10 (5.1)	8 (4.1)	2 (1.0)	0.350
Pleural effusion	33 (6.8)	6 (3.0)	27 (13.7)	0.190

Abbreviations: *MV*, mechanical ventilation duration; *NOA*, New Postoperative Arrhythmia.

Table 4 Results of Univariate Analysis of Adverse Outcomes

Variable	OR (95% CI)	*P*-value
Age (years)	1.011 (0.978–1.047)	0.512
Gender	0.551 (0.225–1.350)	0.192
Heart rate	0.986 (0.956–1.016)	0.347
SBP (mmHg)	0.984 (0.962–1.007)	0.171
DBP (mmHg)	0.965 (0.934–0.997)	0.035
BMI (kg/m^2)	0.870 (0.766–0.989)	0.033
Total bilirubin (umol/L)	1.074 (1.007–1.146)	0.029
Direct bilirubin (umol/L)	1.235 (1.007–1.515)	0.043
Indirect bilirubin (umol/L)	1.098 (1.007–1.197)	0.035
Total protein (g/L)	0.927 (0.852–1.008)	0.076
Albumin (g/dl)	0.929 (0.840–1.028)	0.156
Total cholesterol (mmol/L)	1.013 (0.697–1.473)	0.945

(*Continued*)

Table 4 (Continued).

Variable	OR (95% CI)	*P*-value
HDL (mmol/L)	0.421 (0.094–1.886)	0.258
LDL (mmol/L)	1.14 (0.754–1.724)	0.534
Glucose (mg/dl)	0.888 (0.607–1.300)	0.541
WBC (10^9/L)	0.892 (0.727–1.094)	0.273
Neutrophils (10^9/L)	0.976 (0.802–1.188)	0.808
Lymphocyte count (10^9/L)	0.463 (0.223–0.961)	0.039
RBC (10^12/L)	0.715 (0.398–1.284)	0.262
Hemoglobin (g/L)	0.990 (0.970–1.010)	0.304
RDW (%)	1.090 (1.002–1.187)	0.046
PLT (10^9/L)	0.996 (0.989–1.002)	0.209
PDW (%)	1.050 (0.904–1.220)	0.520
D-dimer (umol/L)	1.152 (1.057–1.254)	0.001
DPR (ug/mL)	6.533 (2.143–19.921)	0.001
Operation duration	1.006 (1.002–1.011)	0.005
Duration of CPB (Minutes)	1.004 (0.998–1.010)	0.150
Duration of ACC (Minutes)	1.003 (0.998–1.009)	0.246

Abbreviations: *OR*, Odds Ratio; *CI*, Confidence Interval; *SBP*, Systolic Blood Pressure; *DBP*, Diastolic Blood Pressure; *PLT*, Blood Platelet Count; *LDL*, Low-Density Lipoprotein Cholesterin; *HDL*, High-Density Lipoprotein cholesterol; *WBC*, White Blood Cell; *RBC*, Red Blood Cell; *RDW*, Red Cell Distribution Width; *PDW*, Platelet Distribution Width; *DPR;* D-dimer to platelet count ratio; *CPB*, Cardiopulmonary bypass; *ACC*, Aortic occlusion duration.

Table 5 Multifactorial Results of in-Hospital Deaths

Variable	OR (95% CI)	*P*-value
DBP (mmHg)	0.964 (0.926–1.004)	0.080
BMI (kg/m^2)	0.956 (0.821–1.113)	0.560
Total bilirubin (umol/L)	1.182 (0.985–1.420)	0.073
Direct bilirubin (umol/L)	0.657 (0.372–1.158)	0.146
Lymphocyte count (10^9/L)	0.372 (0.161–0.858)	0.020
DPR (ug/mL)	5.552 (1.574–19.57)	0.008
Operation duration	1.006 (1.001–1.011)	0.031
RDW (%)	1.073 (0.962–1.196)	0.206

Abbreviations: *OR*, Odds Ratio; *CI*, Confidence Interval; *DBP*, Diastolic Blood Pressure; *DPR;* D-dimer to platelet count ratio; *RDW*, Red Cell Distribution Width. Adjusted covariates included D-dimer and Indirect bilirubin.

Based on univariate and multivariate logistic regression analysis, the forest map with odds ratio (OR) and 95% confidence interval (CI) was described, as shown in Figures 2 and 3. The ROC curve was also drawn to intuitively represent the predictive value of DPR for in-hospital death in ATAAD patients. The AUC under the curve was 0.721, indicating that DPR > 0.0305ug/mL was the best critical value for predicting in-hospital death in ATAAD patients, with a sensitivity of 83.3% and a specificity of 58.4%. Figure 4. The results showed that DPR could independently predict ATAAD hospital death. The distribution of DPR between the two groups is shown in Figure 5.

Discussion

ATAAD is an extremely dangerous cardiovascular disease. Early detection of risk factors in patients with ATAAD can effectively reduce the risk of death. This study is the first to evaluate the relationship between DPR and in-hospital

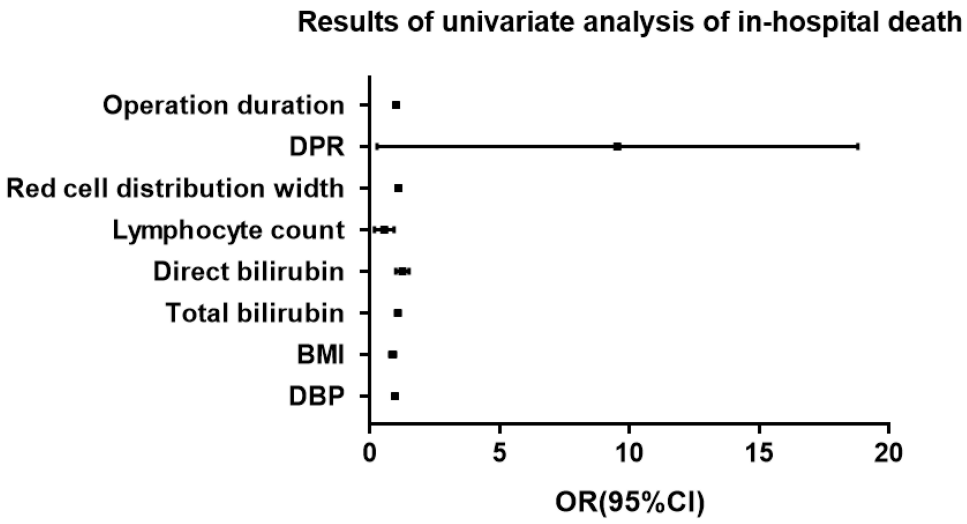

Figure 2 Forest map of univariate analysis of in-hospital death.

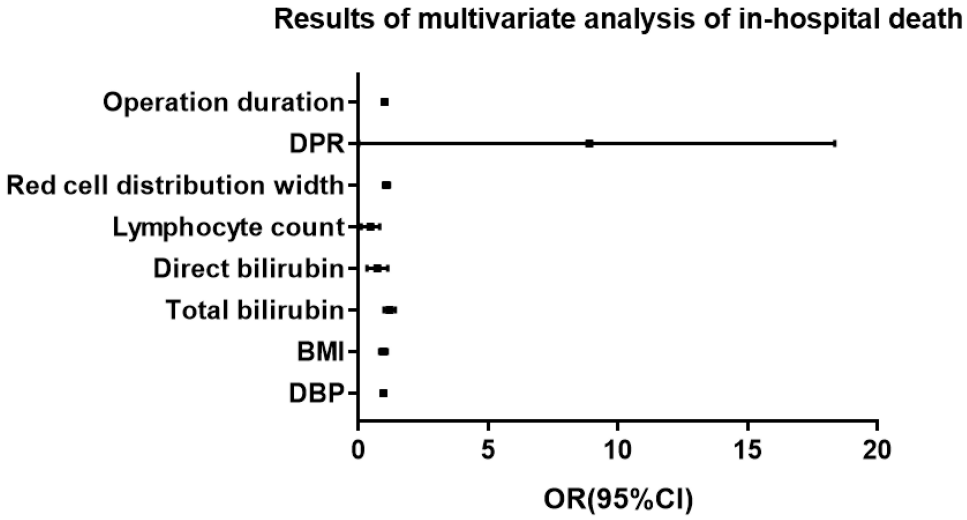

Figure 3 Forest map of multivariate analysis of in-hospital death.

mortality in ATAAD patients. The results showed that ATAAD patients with high DPR at admission had an increased risk of postoperative hospital death. DPR can independently predict ATAAD in-hospital death.

At present, it has been proved that new biomarkers can predict the prognosis of patients with ATAAD. For example, in the study of Konig KC et al,[18] aggrecan (ACAN) can detect ATAAD, but it is difficult to obtain in the clinic, and the detection of ACAN is easy to be confused due to osteoarthritis. Evangelista et al[19] systematically reviewed the influence of factors such as old age, pericardial tamponade, hypotension, myocardial ischemia, and neurological function damage on ATAAD, but these factors could not meet the requirements of clinical practice development. However, because D-dimer is a highly sensitive but low-specific indicator of detection, its levels increase significantly in cancer, infection, or any disease that may affect the body's blood clotting function.[20] Therefore, its reliability as a prognostic indicator of AAAD still needs to be further verified.[21] Also, the clinical accuracy of prediction with a single indicator needs to be improved. Studies have shown that in Acute Ischemic Stroke (AIS) patients, the combined treatment of D-dimer level and platelet count has a higher prognostic value on prognosis, in-hospital mortality, discharge outcome, and long-term

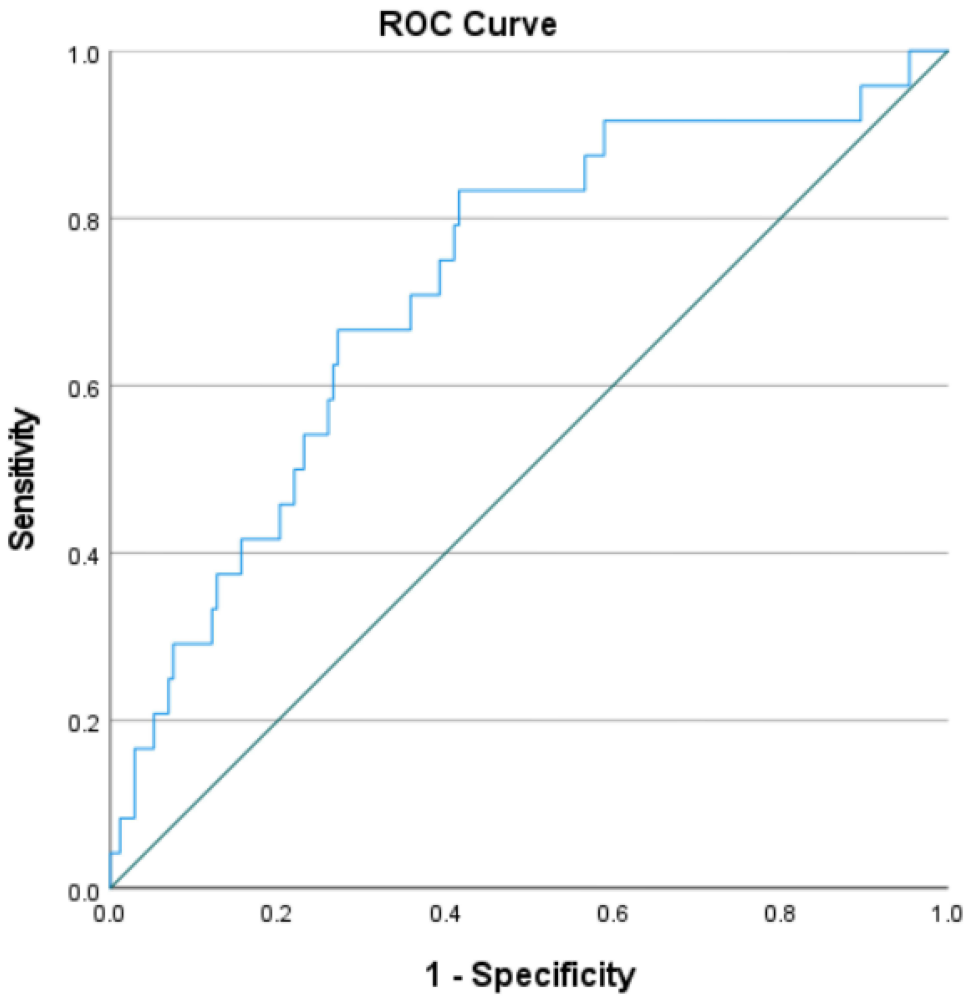

Figure 4 ROC curve of in-hospital death in DPR and ATAAD patients.

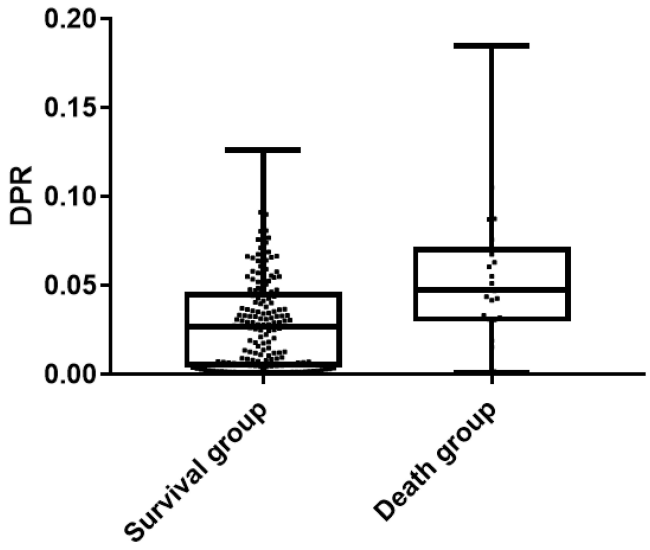

Figure 5 Distribution of DPR between the two groups.

outcome than a single indicator.[10] Elevated DPR has been shown to be associated with HBV-DC,[7] sepsis,[13] and adverse outcomes in pregnant women.[14]

In this study, the in-hospital mortality rate for ATAAD patients was 12.2%, consistent with other studies.[19,22] There may be differences in the clinical features and prognosis of ATAAD in patients of different genders, but the related results are inconsistent. In this study, there were 15 males and 9 females in the death group, with no statistical significance ($P > 0.05$). In Zhang et al 's study,[23] men were a factor in the risk of premature death in patients with ATAAD after surgery, and the immune system of men was more prone to overactivation, leading to an intensification of the inflammatory response. However, a meta-analysis by Meccanici F et al[24] showed that compared with men, the complexity of surgical repair received by women at ATAAD was lower, and the frequency of aortic replacement was also lower. Therefore, attention should be paid to female patients in the early stage. The mechanical ventilation time, ICU stay time, and hospitalization days in the death group were significantly higher than those in the survival group ($P < 0.05$). Mechanical ventilation can help patients quickly recover cardiopulmonary and circulatory function after prolonged, traumatic, and complex surgery,[25] however, during mechanical ventilation, the patient's airway is exposed to the external environment and is vulnerable to bacterial and viral infections. Airway infection and inflammation may lead to an increased inflammatory response, which in turn affects the deterioration of aortic dissection and accelerates the risk of death.[26] ATAAD is an aggressive and life-threatening heart disease, with postoperative death more common than other cardiovascular procedures, longer and more traumatic surgery, and resulting in longer ICU stays and longer hospital stays.[25,27] Acute renal insufficiency is a common complication after ATAAD surgery, and the incidence of acute kidney injury (AKI) after ATAAD ranges from 20.2 to 66.7%.[28] In this study, there were also statistical differences in acute renal insufficiency between the survival group and the death group of ATAAD patients ($P < 0.05$). Longer operation time is usually accompanied by longer CPB time, and both operation and CPB can cause an inflammatory response and oxidative stress, which may lead to AKI.[29]

During the occurrence of ATAAD, due to the tear and injury of the inner aortic layer, the coagulation system is rapidly activated, forming a false lumen thrombosis, triggering a cascade of clotting reactions, activating the fibrinolytic system, and resulting in a rapid increase in serum D-dimer levels.[30] At present, it has been found that D-dimer, C-reactive protein (CPR), and matrix metalloproteinases (MMP9) can predict the in-hospital mortality of ATAAD patients, but CPR, D-dimer, and MMP9 may have multicollinearity.[31] Platelets play an important role in the process of clotting blood. Due to the use of heparin and protamine during the patient's CPB, the function of platelets is also affected. After the trauma, platelets rapidly adhere to the wound and then gather into a group to form a hemostatic embolus. Secondly, platelets can activate, secrete, and interact with clotting factors.[32] Previous studies have shown that platelet counts can predict death in patients with ATAAD.[33] As a new biomarker, DPR combines D-dimer and platelet count, and its predictive value should be further explored. In the study of HeX et al[7] it was found that the cut-off value of DPR was 57.6ug/L, with specificity of 86% and sensitivity of 57%. Elevated DPR may indicate a complex interaction of HBV-DC coagulation disorder, inflammatory response, liver dysfunction, and fibrosis. It has also been shown that the DPR shows a significantly higher area under the curve in distinguishing preeclampsia from normal pregnancy.[14] In the study on the prediction of sepsis by DPR,[13] the cut-off value was 0.07ug/mL, and compared with other values, the predictive value of DPR was higher than other indicators. Consistent with previous studies, the ROC curve in our study showed that the optimal cut-off value was 0.0305ug/mL, and the in-hospital mortality increased with the gradual increase of the DPR value. This suggests that clinicians can improve patient outcomes through better treatment.

At present, the pathogenesis of aortic dissection is unknown. Many studies have suggested that the degradation of the extracellular matrix in the middle layer of the aorta is closely related to the occurrence of ATAAD.[34] Activated lymphocytes can induce the expression of matrix metalloproteinases in aortic smooth muscle cells, which is an important factor promoting the degradation of extracellular matrix and plays an important role in the inflammatory response of AD, which is closely related to the prognosis.[35,36] Lymphocyte is the main inflammatory cell of AD, the occurrence of AD will cause a strong stress response in the body, promote the activation of neurohumoral, and release inflammatory mediators. This results in a change in the number of lymphocytes. Patients with poor prognosis are often accompanied by significant and persistent lymphocytopenia.[37] Meanwhile, previous studies have shown that lymphocytopenia is a predictor of adverse outcomes in chronic ischemic disease, heart failure, and acute coronary syndrome.[38] In this

study, lymphocyte count also played an important role in predicting the death outcome of ATAAD. Most of the clinical symptoms of ATAAD patients are sudden chest and back pain but are affected by anatomical factors, some patients present with parochial abdominal pain, low back pain, dizziness, weakness, weakness of both lower limbs, and other symptoms, which do not only increase the difficulty of diagnosis but also easy to misdiagnose and miss diagnosis. DPR can be used in combination with D-dimer and platelet count, and DPR has obvious advantages in predicting the outcome of hospital death in patients with ATAAD. Similarly, these clinical indicators will not increase the medical cost or trauma of patients and can be easily obtained in practical operations, which can increase the clinical application value.

Limitations: (1) This study only assessed the D-dimer/platelet ratio of ATAAD patients before admission, and did not record and analyze arterial changes in DPR. (2) This study is a single-center retrospective study with a small sample size, and a multicenter study is needed to further validate the current findings in a broader population. (3) The present study was a retrospective study, which mainly assessed the influence of blood biochemical indexes, general clinical features, and surgery-related factors on the prognosis of patients with aortic dissection before admission. The use of drugs was not collected. The prognostic value of drug therapy for ATAAD needs to be further validated.

Conclusions

This study suggests that higher DPR is an independent risk factor for in-hospital death in patients undergoing ATAAD surgery. Simple and feasible DPR may be an effective preoperative assessment and screening tool.

Data Sharing Statement

The data for this study were available by contacting the corresponding author upon reasonable request.

Ethics Statement

This study follows the Declaration of Helsinki and was approved by the Ethics Committee of Fujian Medical University Union Hospital (Number: 2021KY096). Due to the study's retrospective nature and the data's anonymity, the Ethics Committee waived the informed consent requirement.

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Author Contributions

Aai Zhao and Yanchun Peng should be considered joint first authors. All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis, and interpretation, or in all these areas; took part in drafting, revising, or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors report no conflicts of interest in this work.

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