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Inflammatory Markers for Predicting Post-operative Acute Kidney Injury in Patients with Acute Type A Aortic Dissection

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Abstract

Background

Acute kidney injury (AKI) is one of the most common peri-operative complications of acute aortic dissection. It contributes to in-hospital mortality and exerts adverse impacts on patients' long-term survival.

Objective

To explore the predictive value of inflammatory markers for post-operative acute kidney injury in patients with acute type A aortic dissection.

Methods

Clinical data of 135 patients diagnosed with acute type A aortic dissection admitted to Anhui Provincial Chest Hospital from November 2022 to September 2025 were retrospectively analyzed. Patients were divided into the AKI group and non-AKI group. Logistic regression and receiver operating characteristic (ROC) curves were applied to evaluate the predictive performance of inflammatory markers for AKI.

Results

Among the 135 enrolled patients, 69 (51.1%) developed post-operative AKI. Compared with the non-AKI group, the AKI group presented significantly higher interleukin-6 (IL-6), neutrophil-to-lymphocyte ratio (NLR) and platelet-to-lymphocyte ratio (PLR). Logistic regression showed that IL-6 (OR = 1.13, 95%CI: 1.01–1.04, $P < 0.01$), NLR (OR = 1.28, 95%CI: 1.13–1.47, $P < 0.01$) and PLR (OR = 1.02, 95%CI: 1.01–1.03, $P = 0.013$) were independent risk factors for AKI in patients with acute type A aortic dissection. ROC curve analysis demonstrated that NLR, PLR and IL-6 possessed favourable predictive accuracy.

Conclusion

IL-6, NLR and PLR are correlated with AKI occurrence in patients with acute type A aortic dissection and have good reference value for predicting post-operative AKI.

Introduction

Acute Stanford type A aortic dissection (ATAAD) is a critical cardiovascular disease in cardiac surgery characterized by acute onset, rapid progression and high mortality[1]. Acute kidney injury (AKI) represents one of the most frequent peri-operative complications of ATAAD. It contributes to in-hospital

mortality and negatively affects patients' long-term survival[2]. Serum creatinine and urine output are commonly used indices for diagnosing post-operative AKI in ATAAD patients. Nevertheless, creatinine is a late biomarker of AKI; relying solely on creatinine for AKI diagnosis has limitations in sensitivity and specificity. Therefore, early identification of high-risk patients and timely intervention are of great clinical significance. Recent studies have indicated that inflammatory responses are closely related to the initiation and progression of ATAAD, yet evidence regarding whether inflammatory markers can predict post-operative AKI remains insufficient. This retrospective study aimed to investigate the predictive value of inflammatory markers for post-operative AKI in patients with acute type A aortic dissection.

Materials and Methods

General data

Clinical data of patients hospitalized for acute aortic dissection at Anhui Provincial Chest Hospital between November 2022 and September 2025 were retrospectively collected.

Inclusion criteria

(1) Age > 18 years old; (2) Definite diagnosis of acute type A aortic dissection confirmed by aortic CTA and echocardiography; (3) Complete and reliable clinical records.

Exclusion criteria

(1) Pre-existing definite infection; (2) Complicated with malignant tumours; (3) Recent administration of non-steroidal anti-inflammatory drugs such as aspirin; (4) Pre-existing chronic renal insufficiency; (5) Complicated with chronic thromboembolic diseases; (6) Incomplete or missing clinical data.

This study was conducted in accordance with the Declaration of Helsinki. Written informed consent to participate in this study was obtained from every human participant prior to enrollment. All participants were informed of the study objectives, procedures, foreseeable risks and benefits. Participation was voluntary, and participants were entitled to withdraw from the study at any time without any adverse consequences. All data collected were anonymized to protect participants' confidentiality.

Study methods

Clinical information was extracted from the hospital electronic medical record system.

1. Baseline data: height, weight, age, gender and history of hypertension.
2. Surgery-related parameters: cardiopulmonary bypass time, aortic cross-clamp time, circulatory arrest time.
3. Pre-operative laboratory tests: interleukin-6 (IL-6), neutrophil count, lymphocyte count, platelet count; post-operative serum creatinine, blood urea nitrogen and urine output within one week after surgery.

The neutrophil-to-lymphocyte ratio (NLR) was calculated as neutrophil count divided by lymphocyte count. The platelet-to-lymphocyte ratio (PLR) was calculated as platelet count divided by lymphocyte count.

Grouping

Patients were classified into AKI group (n = 69) and non-AKI group (n = 66) according to whether post-operative AKI occurred. AKI was diagnosed in accordance with the 2012 KDIGO (Kidney Disease: Improving Global Outcomes) criteria[2], AKI is confirmed when any of the following items is satisfied: Serum creatinine increases by ≥ 26.7 μmol/L within 48 hours; Serum creatinine rises to ≥ 1.5 times the baseline value within 7 days; Urine output decreases to 0.5 mL/(kg·h) and persists for more than 6 hours.

Statistical analysis

SPSS 25.0 software was used for statistical analyses. Normally-distributed measurement data were expressed as mean ± standard deviation and compared by independent-samples t-test. Categorical variables were presented as case number (percentage), and compared using χ^2 test or Fisher's exact test. Univariate and multivariate Logistic regression analyses were performed to identify independent risk factors. ROC curves were plotted to calculate optimal cut-off values, sensitivity and specificity. The DeLong test was used for comparison among ROC curves. Calibration curves and decision curve analysis (DCA) were generated in R software to assess model performance. $P < 0.05$ was defined as statistically significant.

Results

Comparison of pre-operative baseline characteristics between the two groups

Table 1
Comparison of pre-operative baseline characteristics between non-AKI group and AKI group: No statistically significant inter-group differences were observed in gender, age, height, weight, history of hypertension and pre-operative serum creatinine

Variable	Non-AKI group	AKI group	*P* value
Height (m)	1.69 ± 0.09	1.68 ± 0.06	0.90
Weight (kg)	71.72 ± 16.88	74.71 ± 15.37	0.28
Age (years)	54.92 ± 12.67	59.19 ± 12.54	0.06
Gender (Male/Female)	44/22	52/17	0.26
Hypertension (Yes/No)	56/10	55/14	0.44
Pre-operative creatinine	96.21 ± 55.76	89.51 ± 31.06	0.38

Table 2
Comparison of surgery-related parameters: Table 2 Comparison of surgery-related parameters **Comparison of pre-operative biomarker levels**

Variable	AKI group	Non-AKI group	*P* value
Cardiopulmonary bypass time (min)	196.00 ± 78.06	173.95 ± 65.80	0.25
Aortic cross-clamp time (min)	117.95 ± 44.46	108.24 ± 41.69	0.41
Circulatory arrest time (min)	17.71 ± 5.55	19.06 ± 5.34	0.41

Table 3
Pre-operative IL-6, NLR and PLR levels in two groups: IL-6, NLR and PLR were continuous variables. No obvious multicollinearity existed among these three indices (variance inflation factor VIF ≤ 2). Pre-operative IL-6, NLR and PLR levels were significantly higher in the AKI group than those in the non-AKI group ($P < 0.05$)

Variable	Non-AKI group	AKI group	*P* value
IL-6 (ng/L)	37.76 ± 32.61	81.53 ± 53.19	< 0.01
NLR	8.58 ± 4.38	17.93 ± 7.37	< 0.01
PLR	141.46 ± 57.80	240.38 ± 100.65	< 0.01

ROC curve analysis for predicting post-operative AKI

ROC curve analysis revealed that pre-operative IL-6 (AUC = 0.842), NLR (AUC = 0.902) and PLR (AUC = 0.843) exhibited good predictive performance for post-operative AKI among ATAAD patients. For IL-6, the optimal cut-off value was 57.0 ng/L, with sensitivity of 66.7% and specificity of 87.9%. For NLR, the optimal cut-off value was 10.9, with sensitivity of 91.3% and specificity of 80.3%. For PLR, the optimal

cut-off value was 153.7, with sensitivity of 92.8% and specificity of 63.6%. The combined model yielded an AUC of 0.936 (95%CI:0.896–0.976) according to DeLong test (Table 4, Fig. 1).

Table 4 ROC-curve analysis of IL-6, NLR and PLR

Marker	AUC	95%CI	Sensitivity (%)	Specificity (%)	Optimal cut-off value
IL-6	0.842	0.775-0.909	66.7	87.9	57.0
NLR	0.902	0.849-0.955	91.3	80.3	10.9
PLR	0.843	0.780-0.909	92.8	63.6	153.7

Multivariate Logistic regression for risk-factor analysis

Table 5
Independent risk factors for post-operative AKI in ATAAD patients: Multivariate Logistic regression demonstrated that IL-6, NLR and PLR were independent risk factors for post-operative AKI in ATAAD patients ($P < 0.05$) (Table 5).

Variable	Exp(B) (Odds Ratio)	95%CI	*P* value
IL-6	1.13	1.01–1.04	< 0.01
NLR	1.28	1.13–1.47	< 0.01
PLR	1.02	1.01–1.03	0.013

Model validation

The calibration curve was close to the ideal reference curve, indicating favourable calibration of this predictive model (Fig. 2). Decision-curve analysis suggested that this prediction model achieved satisfactory net clinical benefit for predicting post-operative AKI in ATAAD patients, further verifying its validity and clinical practicability (Fig. 3).

Discussion

Acute Stanford type A aortic dissection (ATAAD) is associated with high morbidity and mortality[3]. Surgical repair is the primary treatment. Mortality increases by approximately 1% per hour in patients without surgical intervention[4]. According to the Summary of China Cardiovascular Health and Disease Report 2023, the in-hospital mortality of ATAAD reaches 9.2%, and the non-rehabilitation discharge rate is up to 24.0%[5]. Even after successful surgery, severe post-operative complications remain important prognostic determinants. AKI is a common complication after ATAAD surgery with reported incidence ranging from 20%-67%, which worsens prognosis and elevates post-operative mortality[6–8]. At present, no consensus has been reached regarding risk factors for post-operative AKI in ATAAD patients. Current AKI diagnostic criteria rely mainly on serum creatinine and urine output, which are delayed markers.

There is still a lack of simple, sensitive and specific early biomarkers for AKI, resulting in delayed diagnosis and intervention for ATAAD-related AKI. Previous meta-analyses reported that gender, body-mass index, hypertension, smoking, pre-operative creatinine and prolonged cardiopulmonary bypass might correlate with post-operative AKI after ATAAD surgery[9], yet supporting evidence remains insufficient. Hence, identifying high-risk patients before surgery and implementing early interventions are clinically imperative.

Inflammatory responses play vital roles in the onset, progression and prognosis of ATAAD. Inflammatory reactions degrade extracellular matrix within aortic media, impair aortic wall integrity and increase dissection risk[10]. After ATAAD onset, severe systemic inflammatory response syndrome is triggered. Activated neutrophils and macrophages release abundant pro-inflammatory cytokines including tumour necrosis factor-α and interleukin-6. These mediators aggravate aortic injury and systemic inflammation and further worsen clinical status[11].Cytokines are core mediators of inflammation. Excessive release of pro-inflammatory cytokines can induce multiple-organ dysfunction. IL-6 is a typical pro-inflammatory cytokine participating in vascular inflammation and cardiovascular thrombotic events. IL-6 up-regulates matrix metalloproteinases, accelerates degradation of aortic medial components, impairs aortic wall stability and exacerbates disease progression[12]. Furthermore, IL-6 can be secreted by renal tubular epithelial cells upon kidney injury and participates in the pathophysiology of AKI[13].

NLR and PLR are composite inflammatory indices integrating neutrophil, lymphocyte and platelet counts. They are less affected by physiological fluctuations and simultaneously reflect systemic inflammation and immune status. Multiple studies have linked elevated NLR and PLR to severity and poor prognosis of cardiovascular diseases such as acute coronary syndrome and heart failure. ATAAD triggers strong stress responses which substantially raise NLR levels[14,15]. NLR has been reported as a promising biomarker for early diagnosis and prognostic evaluation in aortic-dissection patients[16–18]. Increased PLR is positively correlated with in-hospital mortality in ATAAD patients[19]. Nevertheless, few studies have explored whether combining pre-operative IL-6, NLR and PLR can predict post-operative AKI after ATAAD surgery.

Our study indicated that pre-operative serum IL-6, NLR and PLR levels were significantly higher in patients who developed post-operative AKI. These three markers exhibited acceptable sensitivity and specificity in ROC analyses. Higher pre-operative IL-6, NLR and PLR corresponded to higher probability of post-operative AKI, implying their potential predictive value.

This study has several limitations. First, it is a single-centre retrospective investigation; exclusion of patients with incomplete records may bring selection bias. Second, sample size is relatively small and group sizes are imbalanced, which may distort statistical results. Third, long-term follow-up regarding renal functional recovery was not performed. Large-sample prospective studies are required for further external validation.

In conclusion, elevated pre-operative IL-6, NLR and PLR are associated with post-operative AKI in ATAAD patients. Pre-operative detection of these inflammatory markers provides predictive reference for post-operative AKI risk.

Declarations

Fund and Clinical Trial Number

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Ethical approval and consent to participate:

This study was approved by the Ethics Committee of Anhui Provincial Chest Hospital (Approval No. KJ2024-128).

Author Contribution

Xu Yu conceived and designed the study. XuYu,Nieyongchun,Yang Zhao, Qikui Wang,Zhu Shibo, Liang Zhang, performed theexperiments and data analysis. Xu Yu, and Liang Zhang drafted andrevised the manuscript critically. All authors agreed to be responsiblefor the content of the work.

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