Elevated Preoperative Neutrophil-to-lymphocyte Ratio Predicts Early Adverse Outcomes in Uncomplicated Type B Aortic Dissection Undergoing TEVAR

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Research article

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Abstract

Background: Thoracic aortic endovascular repair (TEVAR) of uncomplicated type B aortic dissection (uTBAD) has favorable long-term outcomes but higher early adverse events compared with the optimal medical treatment. Recently, clinical evidence concerning vascular surgery indicates that elevated preoperative systemic inflammatory response predicts adverse clinical events. The aim of our study was to evaluate the relationship between preoperative neutrophil lymphocyte ratio (NLR) and early outcomes of (uTBAD) patients undergoing (TEVAR).

Results: 216 patients diagnosed with uTBAD were included in this retrospective study between January 2015 and December 2018. The median (IQR) follow-up period was 21 (15-33) months. An early adverse event was defined as occurring within 2 years after the procedure. Median patient age was 60 (IQR, 48-68) years and 78.7% were male. Early adverse events occurred in 24 patients (11.3%). In the multivariable analysis, preoperative NLR (HR per SD, 1.10; 95% CI, 1.03-1.18; P = 0.003) was associated with 2-year adverse events.

Conclusions: NLR is an independent predictive factor of early adverse events in uTBAD patients undergoing TEVAR.

Background

Acute type B aortic dissection (TBAD), one kind of acute aortic syndromes, featured with sudden onset, rapid progression, and high mortality.\(^1\)\(^,\)\(^2\) Despite its name, “uncomplicated” TBAD (uTBAD) is still a problematic disorder that is associated with high long-term mortality when treated medically alone.\(^3\) With the advantages in exclusion of primary entry tear and remodeling of affected aorta, thoracic endovascular aortic repair (TEVAR) was attempted in the uTBAD combined with optimal medical treatment.\(^4\) Clinical researches based on retrospective cohort suggest that TEVAR is beneficial in long-term outcomes for uTBAD.\(^3\),\(^5\)

However, there are still debates about timing and indications of TEVAR on uTBAD because of disappointing early outcomes compared with optimal medical treatment.\(^6\) Recently, there has been a significant body of work which has investigated the use of systemic inflammatory marker neutrophil-to-lymphocyte ratio (NLR) to both prognosticate patients and to guide treatment.\(^7\)\(^,\)\(^8\)\(^,\)\(^9\) In a cross-section study containing 1021 patients receiving major vascular surgery, elevated preoperative NLR (> 5) was an independent risk factor of 2-year mortality.\(^10\) It would therefore be of great interest to clearly define the association with baseline NLR and early clinical outcomes in uTBAD patients undergoing TEVAR.

The study aimed to determine whether elevated baseline NLR is correlated to early poor outcomes of uTBAD patients after TEVAR.

Methods
Patient Selection

A total of 216 consecutive patients at the Department of Vascular and Endovascular Institution (Changhai Hospital, Shanghai, China) who underwent TEVAR of their primary uTBAD between January 2015 and December 2018 were included in the current study.

Overall exclusion criteria were: patients who were < 18 years old; had aortic dissection secondary to iatrogenic injury, trauma, intramural hematoma or penetrating aortic ulcer; had genetic disease such as Marfan syndrome or Ehlers-Danlos syndrome.\textsuperscript{11}

Additionally, the following susceptible factors and clinical conditions that may affect baseline systemic inflammatory status or postoperative status were excluded: (1) Patients with proximal landing zone 1 demanding for a hybrid or multi-fenestration technique; (2) Any Peripheral artery disease or coronary artery disease being treated with dual anti-platelet therapy; (3) Any malignant disease or end-stage disease like uremia; (4) Any chronic infectious disease being treated with antibiotics; (5) Any autoimmune disease being treated with glucocorticoid.\textsuperscript{12}

According to the criteria above, 33 patients were excluded, which composed of 5 cases diagnosed with Marfan Syndrome, 8 cases diagnosed with cancer, 12 cases treated with hybrid technique, 1 case with AMI treated with dual anti-platelet therapy, 3 cases treated with dialysis and 4 cases suspected with sign of infection.

The follow-up period ended on February 1, 2020.

Medical Management

Medical treatment aimed to relieve the stress of aortic adventitia and reduce the volume of false lumen.\textsuperscript{6} Aggressive antihypertensive therapy by oral or intravenous route was used to keep the systolic blood pressure < 120 mmHg and the heart rate < 70 beat/min.\textsuperscript{6,11} Adequate analgesia was administered when patients still felt pain after antihypertensive therapy.

TEVAR Procedure

All patients received general anesthesia in order to administrate blood pressure and heart rate during the procedure. All procedures were performed with patients using total endovascular techniques under fluoroscopic guidance. The proximal landing zone was considered to be at least > 2 cm.\textsuperscript{13} If the landing zone was inadequate, reconstruction of the left subclavian artery (LSCA) was performed to preserve the blood to the brain and reduce the complications.\textsuperscript{14}

Follow-up

Patients were advised to check up annually in our hospital. Health conditions of patients who did not return were contacted via telephone.

Baseline Blood Count
Samples of 216 patients’ complete blood count with differential (CBC-diff) with normal WBC counts 24 hours before the TEVAR procedure were accessed from the electronic medical record in Changhai Hospital.

Statistics Analysis

Continuous variables were expressed as the mean ± standard deviation or median (with interquartile range, IQR); categorical variables were expressed as frequencies and percentages. A time-dependent receiver operating characteristic curve was utilized to identify a cutoff value NLR associated with 2-year adverse events. Study cohort was then divided into two groups by cutoff value of NLR 4.8. Patients were then grouped into ‘low NLR’ (< 4.8) and ‘high NLR’ (≥ 4.8) groups to identify the differences of clinical characteristics and outcomes. Difference between the two groups were compared by Student’s t-test or Mann-Whitney U test for Continuous variables and a chi-square test for categorical variables. To analyze the relationship between variates and outcomes, univariate and multivariate Cox proportional hazards regression models was used. Variables found to be susceptible (P < 0.2) in univariate analysis were entered into a Cox regression multivariate model using a backwards conditional method. A P value < 0.05 was considered statistically significant and all estimates were two-tailed. All analyses were performed with R (http://www.R-project.org) and Empower Stats software (www.empowerstats.com, X&Y Solutions, Inc., Boston, MA, USA).

Definition of Terms and Outcomes

Phase of TBAD was according to the VIRTUE Registry and ESC guideline. “Uncomplicated” is a relatively stable status administrated by optimal medicine, on which the patients are expected to survive without severe comorbidities. The definition of procedure success was to exclude the primary entry tear in the premise that there was no type I or III endoleak at the end of the operation. The definition of an early adverse event was occurrence within 2 years after the procedure. The primary endpoint was early adverse events, which included all-cause mortality, type I/II endoleak, retrograde aortic dissection (RTAD), stent graft-induced new entry (SINE), paraplegia, major stroke, aortic rupture.

Results

Baseline Characteristics

The median follow-up time was 21 months (interquartile range, IQR 15–33). The baseline characteristics of this cohort are documented in Table 1. Briefly, 50% of patients were older than 60, 21.3% were females. Additional characteristics of the patients included smoking in 27.8%, alcohol use in 18.1%, hypertension in 66.2%, diabetes in 4.6%, chronic obstructive pulmonary disease (COPD) in 3.7%, renal insufficiency in 5.1%, stroke in 4.6%, and coronary artery disease (CAD) in 6.5% (Table 1). For the inflammatory status, 48.1% had high NLR and 51.9% had low NLR (Table 1). Significant differences was shown between the high and low NLR group in median age (year) (54 vs. 62; P = 0.018), portion of partial thrombosis (%) (30.8% vs. 16.1%; P = 0.02), median systolic blood pressure on admission (mmHg) (148 vs. 140; P =
0.007), median serum creatinine before procedure (μmol/L) (81 vs. 76; \( P = 0.03 \)), median platelet count before procedure (×10^9/L) (170 vs. 221; \( P < 0.001 \)) (Table 1).

**Medical Managements**

Details of medical treatment was shown in Table 3. There was no difference between the two groups.

**TEVAR Procedure**

27 adjunctive stents were implanted to reconstruct the LSCA. Details of the procedure were shown in Table 2.

**3-month Adverse events**

Table 4 showed the clinical outcomes between the low and high NLR groups. The 3-month ARAEs rates in the high NLR group were significantly higher than that of in the low NLR group (9.6% vs. 0.9%; \( P = 0.05 \)) (Table 4).

**Early Adverse Events**

Early adverse events occurred in 24 patients (11.3%), which included 3 cases of all-cause mortality (one died from stroke and the others died from stent-related aortic rupture), 12 cases of type I/II endoleak, 7 cases of retrograde aortic dissection, 4 cases of aortic rupture and one case of stent graft-induced new entry. The overall probability of freedom from adverse events in the high NLR group at 2 years were 82.7% while low NLR group was 94.6% (\( P = 0.005 \)). (Figure 1).

Univariate and multivariable Cox-hazard regression analyses of early adverse events in the study population were shown in Table 5. Univariate analysis indicated that platelet count preoperatively, preoperative diastolic blood pressure and NLR preoperatively were the susceptible risk factors for early adverse events (\( P < 0.2 \)). Multivariable regression analysis showed that the NLR preoperatively (HR per SD, 1.10; 95% CI, 1.03-1.18; \( P = 0.003 \)), diastolic blood pressure on admission (HR, 0.95; 95% CI, 0.91-1.00; \( P = 0.039 \)) had independent influences on 2-year overall event-free survival.

**Discussion**

The aim of this study was to evaluate the relationship between preoperative NLR and early outcomes of TEVAR. For every increase of 4.44 in preoperative NLR value, the risk of early adverse events increased by 10% (95%CI, 1.03–1.18) in the multivariate adjusted model. To the best knowledge of us, this is the first
research to access the predictive role of NLR in the uTBAD patients receiving TEVAR with a cut off value 4.8.

Although long-term safety and efficacy of TEVAR have been confirmed with multiple studies, early adverse events still attract controversy and impede the extensive application of TEVAR in uTBAD. In 2019, Professor Adams and his colleagues suggested that high-risk subgroup of uTBAD patients may benefit from early intervention. However, most areas in China do not have a sound medical system, which would bring difficulties to follow-up and timely risk assessment of aortic dissection. It is therefore of great value to determine the optimal timing of TEVAR procedure to evade the early adverse events.

Previous studies focused on the association between NLR value and poor clinical outcomes of type A aortic dissection or severe aortic events after TEVAR or open surgery. In our study, we found significant difference of early outcomes between the high NLR group and low NLR group (adverse events, 17.3% vs. 5.4%, P = 0.005) despite that systemic inflammatory response of uTBAD is relatively lower than complicated aortic dissection or type A aortic dissection considering the lesion and comorbidities.

The effect of inflammatory markers in cardiovascular diseases has been studied routinely and a credible relationship between inflammatory markers and cardiovascular diseases has been confirmed. Although the exact mechanisms of these markers are not well understood, it is thought that they reflect the complex interaction between the local immune response at the microenvironment of aortic dissection and the systemic inflammatory response (SIR). The etiology of AD is complex, in which inflammation plays an important role. After onset, the systemic response to injury causes neutrophilia and massive neutrophil accumulation in the tunica adventitia of the dissected aorta, leading to aortic expansion and rupture. Clinical evidence has confirmed that systemic inflammatory markers like NLR is independently associated with mortality of AD patients. Taken together, inflammatory markers show promise in the diagnosis, timing of treatment and prognosis of AD. However, inflammatory markers are not factored into any risk stratification model of AAD until now. It would be of interest to take the NLR value into consideration of predictive model of AAD for secondary prevention.

**Limitations**

Firstly, due to the retrospective study cohort from single center, results may be biased. Secondly, details of adverse events can not be demonstrated via telephone. Thirdly, indications of TEVAR for uTBAD is still on debate, which might cause the worries of ethics.

**Conclusions**

Current study revealed that high preoperative NLR value is an independent risk factor of early adverse events in uTBAD patients undergoing TEVAR. Further studies focused on predictive model combined with NLR value should be conducted to open new perspectives in the field of secondary prevention.
**Abbreviations**

TEVAR
thoracic aortic endovascular repair
uTBAD
uncomplicated type B aortic dissection
IQR
interquartile range
NLR
neutrophil lymphocyte ratio
LSCA
left subclavian artery
COPD
chronic obstructive pulmonary disease
CAD
coronary artery disease

**Declarations**

**Ethics approval and consent to participate:**

This retrospective study was approved by the ethical review board of Changhai Hospital.

**Consent for Publication:**

All authors approved the publication of this study.

**Availability of data and material:**

Only for review.

**Competing interests:**

The authors have no potential conflicts of interest relevant to this study.

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**Authors' contributions:**
Hongqiao Zhu: Investigation and Writing – original draft. Lei Zhang: Writing – original draft. Taiping Liang: Writing and Data curation. Yiming Li: Data curation. Jian Zhou: Writing – review & editing, Supervision. Zaiping Jing: Conceptualization, Project administration.

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Tables

**TABLE 1. The baseline preoperative characteristics of uTBAD patients receiving TEVAR grouped by NLR value < 4.8 and ≥ 4.8**
| Variable                          | Overall | Low NLR (< 4.8) | High NLR (≥ 4.8) | Standardized difference | P-value |
|----------------------------------|---------|-----------------|------------------|-------------------------|---------|
| N (%)                            | 216     | 112 (51.9%)     | 104 (48.1%)      |                         |         |
| Age (year)                       | 60 48-68 | 62 (50-70)     | 54 (46-66)        | 0.32                    | 0.018   |
| Age group (year)                 |         |                 |                  | 0.27                    | 0.146   |
| <40                              | 20 (9.3%)| 10 (8.9%)       | 10 (9.6%)        |                         |         |
| 40-60                            | 88 (40.7%) | 39 (34.8%)     | 49 (47.1%)       |                         |         |
| ≥60                              | 108 (50.0%) | 63 (56.3%)     | 45 (43.3%)       |                         |         |
| Male                             | 170 (78.7%) | 83 (74.1%)     | 87 (83.7%)       | 0.24                    | 0.087   |
| BMI                              | 24.9 (3.9) | 24.9 (4.0)     | 25.0 (3.8)       | 0.04                    | 0.764   |
| Smoking                          | 60 (27.8%) | 30 (26.8%)     | 30 (28.9%)       | 0.05                    | 0.736   |
| Drinking                         | 39 (18.1%) | 20 (17.9%)     | 19 (18.3%)       | 0.01                    | 0.937   |
| Hypertension                     | 143 (66.2%) | 73 (65.2%)     | 70 (67.3%)       | 0.05                    | 0.741   |
| Diabetes                         | 10 (4.6%) | 5 (4.5%)       | 5 (4.8%)         | 0.02                    | 0.904   |
| COPD                             | 8 (3.7%)  | 3 (2.7%)       | 5 (4.8%)         | 0.11                    | 0.408   |
| Renal insufficiency              | 11 (5.1%) | 8 (7.1%)       | 3 (2.9%)         | 0.2                     | 0.155   |
| Coronary artery diseases         | 14 (6.5%) | 9 (8.0%)       | 5 (4.8%)         | 0.13                    | 0.336   |
| Stroke                           | 10 (4.6%) | 4 (3.6%)       | 6 (5.8%)         | 0.10                    | 0.442   |
| Dissection morphology            |         |                 |                  | 0.04                    | 0.747   |
| Confined in thoracic aorta       | 56 (25.9%) | 28 (25.0%)     | 28 (26.9%)       |                         |         |
| Extended to abdominal aorta      | 160 (74.1%) | 84 (75.0%)     | 76 (73.1%)       |                         |         |

**TABLE 1. cont.**
| Categorical variable                                      | < 4.8 | ≥ 4.8 |
|-----------------------------------------------------------|-------|-------|
| False lumen patency                                      | 0.38  | 0.021 |
| Patent false lumen                                       | 156 (72.2%) | 90 (80.4%) | 66 (63.5%) |
| Partial thrombosis                                       | 50 (23.2%) | 18 (16.1%) | 32 (30.8%) |
| Complete thrombosis                                      | 10 (4.6%) | 4 (3.6%) | 6 (5.8%) |
| Symptoms on admission                                    | 0.09  | 0.81  |
| Chest/back pain                                           | 156 (72.2%) | 79 (70.6%) | 77 (74.0%) |
| Abdominal pain                                            | 52 (24.1%) | 29 (25.9%) | 23 (22.1%) |
| Other symptoms                                            | 8 (3.7%) | 4 (3.6%) | 4 (3.9%) |
| Location of the primary entry tear                        | 0.16  | 0.231 |
| >2cm from the LSCA                                        | 169 (78.2%) | 84 (75.0%) | 85 (81.7%) |
| ≤2cm from the LSCA                                        | 47 (21.8%) | 28 (25.0%) | 19 (18.3%) |
| Maximum diameter of thoracic aorta (cm)                   | 40.7 (35.2-44.3) | 39.7 (35.0-44.1) | 40.8 (36.5-44.3) |
| Maximum diameter of abdominal aorta (cm)                  | 28.7 (26.6-32.9) | 28.5 (26.5-32.4) | 29.4 (26.6-32.9) |
| SBP on admission (mmHg)                                   | 143 (132-154) | 140 (130-150) | 148 (136-157) |
| DBP on admission (mmHg)                                   | 80 (75-89) | 82 (75-89) | 80 (75-88) |
| Temperature preoperatively (°C)                           | 36.6 (36.4-36.8) | 36.6 (36.4-36.9) | 36.6 (36.4-36.8) |
| Creatinine preoperatively (μmol/L)                        | 79 (64-91) | 76 (59-86) | 81 (65-95) |
| Platelet count preoperatively (×10^9/L)                   | 200 (152-272) | 221 (169-302) | 170 (149-225) |

Categorical variables are reported as frequency and percentage; continuous variables are reported as median (25th-75th percentile). uTBAD, uncomplicated type B aortic dissection; TEVAR, thoracic endovascular aortic repair; NLR, neutrophil-to-lymphocyte ratio; BMI, body mass index; COPD, chronic obstructive pulmonary disease; LSCA, left subclavian artery; SBP, systolic blood pressure; DBP, diastolic blood pressure.

**TABLE 2. The details of medical managements grouped by NLR value < 4.8 and ≥ 4.8**
| Variable    | Overall   | Low NLR (< 4.8) | High NLR (≥ 4.8) | Standardized difference | P value |
|------------|-----------|-----------------|------------------|-------------------------|---------|
| Alpha-blockers | 166 (76.9%) | 87 (77.7%) | 79 (76.0%) | 0.04 | 0.765 |
| Beta-blockers   | 140 (64.8%) | 69 (61.6%) | 71 (68.3%) | 0.14 | 0.306 |
| ARBs           | 78 (36.1%) | 43 (38.4%) | 35 (33.7%) | 0.1 | 0.469 |
| ACEIs          | 32 (14.8%) | 15 (13.4%) | 17 (16.4%) | 0.08 | 0.542 |
| CCBs           | 166 (76.9%) | 78 (69.6%) | 88 (84.6%) | 0.36 | 0.009 |
| Statins        | 86 (39.8%) | 44 (39.3%) | 42 (40.4%) | 0.02 | 0.869 |

Values are n (%). ARBs, Angiotensin II Receptor Blockers; ACEIs, Angiotensin-converting enzyme inhibitors; CCBs, Calcium-Channel Blockers; NLR, neutrophil-to-lymphocyte ratio.

**TABLE 3. The details of TEVAR procedure grouped by NLR value < 4.8 and ≥ 4.8**
| Variable                              | Overall   | Low NLR (< 4.8) | High NLR (≥ 4.8) | Standardized difference | P-value |
|--------------------------------------|-----------|-----------------|------------------|-------------------------|---------|
| Length of hospital stay (days)       | 10 (8-14) | 10 (7-14)       | 10 (9-15)        | 0.24                    | 0.076   |
| Timing of procedure                  |           |                 |                  | 0.05                    | 0.713   |
| Acute phase                          | 126 (58.3%) | 64 (57.1%)     | 62 (59.6%)       |                         |         |
| Subacute phase                       | 90 (41.7%) | 48 (42.9%)      | 42 (40.4%)       |                         |         |
| ASA Classification                    |           |                 |                  | 0.24                    | 0.205   |
| I                                    | 68 (31.5%) | 33 (29.4%)      | 35 (33.7%)       |                         |         |
| II                                   | 140 (64.8%) | 77 (68.8%)     | 63 (60.6%)       |                         |         |
| III                                  | 8 (3.7%)   | 2 (1.8%)        | 6 (5.7%)         |                         |         |
| Length of procedure (minutes)        | 95(75-110)| 95(80-122)      | 85(72-105)       | 0.31                    | 0.025   |
| Types of stentgraft                  |           |                 |                  |                         |         |
| Cook Zenith                          | 93 (43.1%) | 48 (42.9%)      | 45 (43.3%)       | 0.4                     | 0.044   |
| Gore TAG                             | 54 (25.0%) | 33 (29.4%)      | 21 (20.2%)       |                         |         |
| Medtronic Valiant                    | 55 (25.5%) | 21 (18.8%)      | 34 (32.7%)       |                         |         |
| Microport Hercules                   | 14 (6.4%)  | 10 (8.9%)       | 4 (3.9%)         |                         |         |
| Adjunctive stents                    | 27 (12.5%) | 15 (13.4%)      | 12 (11.5%)       | 0.06                    | 0.681   |

Values are median (25th-75th percentile) or n (%). TEVAR, thoracic endovascular aortic repair; NLR, neutrophil-to-lymphocyte ratio; ASA, American Society of Anesthesiologists.

**TABLE 4. Early outcomes of patients grouped by NLR value < 4.8 and ≥ 4.8**
| Variable            | Overall | Low NLR (< 4.8) | High NLR (≥ 4.8) | Standardized difference | P-value |
|---------------------|---------|-----------------|------------------|-------------------------|---------|
| All-cause mortality | 5 (2.3%)| 0 (0.0%)        | 5 (4.8%)         | 0.3                     | 0.019   |
| ARAEs               | 11 (5.1%)| 1 (0.9%)       | 10 (9.6%)        | 0.4                     | 0.051   |
| Type I endoleak     | 3 (1.4%)| 1 (0.9%)        | 2 (1.9%)         |                         |         |
| RTAD                | 4 (1.9%)| 0 (0.0%)        | 4 (3.8%)         |                         |         |
| Rupture             | 3 (1.4%)| 0 (0.0%)        | 3 (2.9%)         |                         |         |
| SINE                | 1 (0.5%)| 0 (0.0%)        | 1 (1.0%)         |                         |         |

Values are n (%). NLR, neutrophil-to-lymphocyte ratio; ARAEs, aortic-related adverse events; RTAD, retrograde aortic dissection; SINE, stent graft-induced new entry.

**TABLE 5. Univariate and multivariable analysis of all-cause death of patients**
| Variable                                      | Univariate analysis | Multivariate analysis |
|----------------------------------------------|---------------------|-----------------------|
|                                              | HR (95% CI)         | P value               |
|                                              | HR (95% CI)         | P value               |
| Age                                          | 1.02 (1.00, 1.07)   | 0.296                 |
| Male gender                                  | 0.40 (0.13, 1.22)   | 0.105                 |
|                                              | 0.49 (0.10, 2.31)   | 0.363                 |
| BMI                                          | 0.94 (0.81, 1.11)   | 0.479                 |
| Smoking                                      | 0.84 (0.23, 3.06)   | 0.792                 |
| Alcohol                                      | 2.82 (0.92, 8.61)   | 0.069                 |
|                                              | 0.98 (0.23, 4.16)   | 0.980                 |
| Hypertension                                 | 1.60 (0.44, 5.81)   | 0.476                 |
| False lumen patency                          | Reference           | 1                     |
| Patent false lumen                           | 0.67 (0.15, 3.10)   | 0.608                 |
|                                              | 0.50 (0.07, 3.28)   | 0.466                 |
| Partial thrombosis                           | 3.43 (0.74, 15.89)  | 0.115                 |
|                                              | 4.14 (0.51, 33.35)  | 0.182                 |
| Complete thrombosis                          | 1.02 (0.28, 3.71)   | 0.976                 |
| Distance of LSCA ≤ 2cm                       | 1.07 (0.97, 1.18)   | 0.159                 |
|                                              | 1.09 (0.92, 1.29)   | 0.316                 |
| Maximum diameter of abdominal aorta (cm)     | 1.00 (0.97, 1.03)   | 0.907                 |
| SBP on admission (mmHg)                      | 0.91 (0.83, 0.96)   | 0.003                 |
|                                              | 0.86 (0.78, 0.95)   | 0.003                 |
| Temperature preoperatively (°C)              | 0.64 (0.14, 2.85)   | 0.558                 |
| Creatinine preoperatively (μmol/L)           | 1.00 (0.98, 1.02)   | 0.741                 |
| Platelet count preoperatively (×10^9/L)      | 0.99 (0.99, 1.00)   | 0.107                 |
| Preoperative NLR per SD                      | 1.58 (1.11, 2.26)   | 0.011                 |
|                                              | 1.98 (1.14, 3.44)   | 0.015                 |

**TABLE 5. cont.**
|                | Hazard ratio | 95% CI        | P-value |
|----------------|--------------|--------------|---------|
| Alpha-blockers | 3.60         | (0.47, 7.68) | 0.219   |
| Beta-blockers  | 0.95         | (0.31, 2.91) | 0.929   |
| ARBs           | 1.06         | (0.24, 4.79) | 0.939   |
| ACEIs          | 1.12         | (0.23, 4.81) | 0.939   |
| CCBs           | 0.47         | (0.16, 1.46) | 0.193   |
|               | 0.78         | (0.14, 4.40) | 0.776   |
| Statins        | 0.67         | (0.21, 2.16) | 0.497   |
| **Timing of procedure** |                  |              |         |
| Acute (1-14 days) | Reference     |              |         |
| Subacute (14-92 days) | 1.16 (0.39, 3.46) | 0.787   |
| **ASA classification** |                |              |         |
| I              | Reference     | Reference    |         |
| II             | 0.54 (0.17, 1.77) | 0.309   |
|                | 0.51 (0.10, 2.73) | 0.433   |
| III            | 2.96 (0.57, 15.36) | 0.195   |
|                | 3.19 (0.22, 46.42) | 0.395   |
| Adjunctive stents | 3.48 (1.07, 11.32) | 0.038   |
|                | 0.79 (0.13, 4.79) | 0.800   |

HR, Hazard ratio; CI, confidence interval; BMI, body mass index; LSCA, left subclavian artery; NLR, neutrophil-to-lymphocyte ratio; SBP, systolic blood pressure; DBP, diastolic blood pressure; ASA, American Society of Anesthesiologists.