Risk factor analysis of postoperative cerebral infarction in thoracic surgery patients by propensity-score matching-a single institution retrospective cohort study

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Background: Postoperative cerebral infarction (PCI) is serious complication for thoracic surgery patients, however, the risk factors still unclear. This study sought to investigate the incidence risk factors of postoperative cerebral infarction after thoracic surgery.

Methods: Patients who underwent thoracic surgery from 2011 to 2022 at Beijing Chaoyang Hospital were identified and followed-up for 30 days postoperatively to determine the primary outcome of PCI. Patients with PCI were identified as the PCI cohort, and those without PCI were identified as the non-PCI cohort. The clinical data of all the patients were collected. The Mann-Whitney U test and chi-square test were used to analyze the baseline differences. Propensity-score matching (PSM) at a ratio of 1:4 was used to match the variables between the 2 cohorts, and a stepwise univariate conditional logistic regression was used to analyze the risk factors of PCI.

Results: We enrolled 8,448 consecutive patients who underwent thoracic surgeries, including 21 with PCI and 8,827 without PCI. Among the 21 PCI patients, 6 patients died. A history of cerebral infarction [odds ratio (OR) = 4.38, P=0.037], perioperative blood transfusion (OR =6.22, P=0.013), a history of deep vein thrombosis (DVT) (OR =5.25, P=0.022), and hyperlipidemia (OR =13.76, P<0.01) were identified as independent risk factors among all the factors by the univariate logistical analysis after the PSM of the other covariates at a ratio of 1:4.

Conclusions: PCI patients who undergo thoracic surgery have a poor prognosis. A history of cerebral infarction, perioperative blood transfusion, a history of DVT, and hyperlipidemia are risk factors of PCI. Patients with risk factors may need prevention measure and assist clinician for early diagnosis of PCI.

Keywords: Thoracic surgery; postoperative cerebral infarction; risk factor; propensity-score matching

Introduction

Perioperative ischemic stroke is a devastating complication of thoracic surgery, and its incidence and effect on postoperative mortality has been greatly underestimated (1).

The incidence of perioperative ischemic stroke after pneumonectomy is approximately 0.4–0.6% (2,3), and it appears to be increasing with time, despite declines in the incidence of stroke in the community (4). Thoracic surgery

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as a surgery-specific variable is an important risk factor of perioperative ischemic stroke (1,3). In addition, the increasing incidence of perioperative stroke may be attributable to an aging surgical population relating to the rapid development of minimally invasive video-assisted thoracoscopic surgery.

Perioperative stroke is an independent predictor of 30-day in-hospital morbidity and mortality following non-vascular, non-neurological surgery (1). Retrospective data analyses have shown that perioperative overt stroke increases the risk of death with an absolute in-hospital mortality of approximately 20% (3,5,6). About 58.5% of patients who suffer from a non-fatal stroke will subsequently either require help to perform everyday activities or be incapacitated (7). The higher disability and mortality rates associated with perioperative stroke compared to strokes unrelated to surgery are due to overdued diagnose, and there are surgical concerns about the management of stroke in the perioperative period.

Few studies focus on the risk factor analysis and the risk factors was not well identified, especially among patients after thoracic surgery. We describe perioperative ischemic stroke cases to help to identify high-risk patients and manage this complication. We present the following article in accordance with the STROBE reporting checklist (available at https://jtd.amegroups.com/article/view/10.21037/jtd-22-1832/rc).

Methods

Patients

The study was conducted in accordance with the

Highlight box

Key findings
- We identified 4 risk factors of postoperative cerebral infarction (PCI) in thoracic surgery patients.

What is known and what is new?
- A history of cerebral infarction and a history of deep vein thrombosis had been recognized as risk factors of PCI in previous studies.
- Perioperative blood transfusion and hyperlipidemia were first identified as the risk factors of PCI in thoracic surgery patients in this study.

What is the implication, and what should change now?
- The identification of the risk factors of PCI in thoracic surgery patients will enable PCI to be more effectively prevented.

Declaration of Helsinki (as revised in 2013). This single-institution, retrospective cohort study was approved by the institutional review board of Beijing Chaoyang Hospital (No. 2021-KE-135), and the requirement for written informed consent was waived due to the retrospective nature of the study. None of the material related to this manuscript has been published before. We reviewed all the medical records of consecutive patients at the Thoracic Surgery Department of Beijing Chaoyang Hospital from August 1, 2011 to August 1, 2022. To be eligible for inclusion in this study, patients had to meet the following inclusion criteria: (I) be aged between 18 and 80 years; and (II) have undergone thoracic surgery, including lung resection, esophagostomy, and mediastinal operation. Patients were excluded from the study if they met any of the following exclusion criteria: (I) had not undergone thoracic surgery after hospitalization; and/or (II) had undergone a brain computed tomography (CT)/magnetic resonance imaging (MRI) examination that confirmed a cerebral hemorrhage, brain metastasis, neurological infection, or other disease when primary intraoperative/postoperative neurological symptoms were observed.

PCI identification

All the postoperative cerebral infarction (PCI) patients were first diagnosed based on their clinic symptoms, including physical inactivity, speech dysfunction, and sensory dysfunction. Each diagnosis was then confirmed by brain MRI/CT during hospitalization. The patients who were confirmed to have a diagnosis of PCI were classified as the PCI cohort and those without brain symptoms were classified as the non-PCI cohort.

Analysis of risk factors of PCI

The following clinical data were collected: (I) demographic characteristics: gender, age, primary disease, and blood transfusion; (II) comorbidity/comorbidities: hypertension, diabetes, hyperlipidemia, coronary heart disease (CHD), chronic heart failure, atrial fibrillation, a history of cerebral infarction, deep vein thrombosis (DVT), renal dysfunction, liver dysfunction, anemia, hypoproteinemia, and second surgery after primary operation; and (III) PCI occurrence and the time interval between surgery. We use propensity-score matching (PSM) at ratio 4:1 for the non-PCI cohort and the PCI cohort to balance the clinic characteristics between the 2 cohorts. A conditional logistic regression

was used for the univariate analysis, and all the covariates were matched when the main risk factor was used for the univariate analysis.

Statistical analysis

The clinical differences were compared using the Mann-Whitney U test or chi-square test. PSM was used to match the PCI patients to the non-PCI patients, and each non-PCI patient was assigned the same index data as their matched case. A conditional logistic regression was used to calculate the odds ratios (ORs). P values <0.05 were considered statistically significant. All the analyses were conducted with SAS version 9.1 for Windows (SAS Institute, Cary, North Carolina, USA).

Results

Patients

From August 1, 2011 to August 1, 2022, a total of 8,448 patients underwent thoracic surgery at our hospital, including 6,430 patients who underwent lung resections, 480 who underwent esophagectomies, and 1,538 patients who underwent other types of thoracic surgeries. The average age of the patients was 55.46±14.98 years. In total, 21 patients had PCI (of whom 19 had undergone lung resections and 2 had undergone esophagectomies), and 6 of these 21 patients died. The mean operation time was 204.3±112.7 mins, and the mean intraoperative blood loss volume was 268.1±330.3 mL.

PCI symptoms occurred in all 21 patients within 14 days of the surgery, and the time interval was from surgery day to 13 days (3.6±3.4 days) after surgery, with a median time of 2 days after surgery. None of the perioperative cerebral infarction patients received intra-arterial thrombolysis, and only 1 patient underwent decompressive craniectomy. The patient characteristics for the non-PCI and PCI cohorts are listed in *Table 1*.

We chose age, gender, hypertension, diabetes, CHD, hyperlipidemia, a history of DVT, atrial fibrillation, a history of cerebral infarction, a history of myocardial infarction, blood transfusion, hemostasis surgery after the primary operation, and the operation approach as the matched variables to eliminate any bias between the PCI and non-PCI cohorts. The clinical characteristics between 2 cohorts with the matched covariates are listed in Tables S1-S4. A conditional logistic regression was used for

the univariate analysis and the following factors statistical differed significantly between the 2 cohorts: a history of cerebral infarction, perioperative blood transfusion, a history of DVT, and hyperlipidemia. The ORs and P values are set out in *Table 2*.

Discussion

PCI that develops within 30 days of surgery has significant morbidity and mortality rates (6,8). Among all the types of surgeries, patients who undergo vascular-related surgery have the highest incidence of PCI (6,8-11). The symptoms of slight perioperative ischemic stroke are difficult to identify. About 15% of patients who suffer from PCI present with mental status changes only, which makes it difficult to distinguish the symptoms of perioperative ischemic stroke from residual anesthesia symptoms (12).

To the best of our knowledge, only a few small-sample size studies have previously focused on PCI in patients who have undergone thoracic surgery. Conversely, the risk factors of PCI in other types of surgery have been identified in numerous publications, and include old age (1), a history of stroke (4), hypertension (5), a history of atrial fibrillation (3,13), cardiovascular disease (1,3), diabetes (14), renal failure/disease (5), smoking (5), and left upper lung lobectomy (15,16), and patients with multiple comorbidities have a higher incidence of PCI (10). In our study, a history of cerebral infarction, perioperative blood transfusion, a history of DVT, and hyperlipidemia were identified as risk factors of PCI, and these factors differed slightly to those identified in previous studies.

Some previous studies reported that a history of cerebral infarction increased patients' mortality rates from 26% to as high as 87% compared to those without a history of cerebral infarction in the general population among surgery (2,3,5,8). Further, patients with a history of cerebral infarction <3 months and patients with a history of cerebral <12 months had a 67.6-fold higher risk and an 8.2-fold higher risk of PCI, respectively (17). In this study, 23.8% of the PCI patients had a history of cerebral infarction, and about 4% of the patients with a history of cerebral infarction suffered from PCI, which is similar to the findings reported by a previous study (6,8,11).

Perioperative blood transfusion was identified as a risk factor of PCI, and is a risk factor that has not been reported previously. In previous study, hypoxemia and hypotension were reported as 2 risk factors of massive PCI in thoracic patients (18). Many anesthetists believe that intraoperative hypotension is a common cause of PCI for high-risk

Table 1 The clinical characteristics of the non-PCI and PCI cohorts

Characteristics	Non-PCI cohort (N=8,427), n (%)	PCI cohort (N=21), n (%)	Total (N=8,448), n (%)	P value
Gender				0.42
Male	4,742 (56.3%)	10 (47.6%)	4,752 (56.3%)	
Female	3,685 (43.7%)	11 (52.4%)	3,696 (43.8%)	
Age (years), mean (SD)	55.4 (15.0)	63.0 (11.5)	55.5 (15.0)	0.02
Primary disease				0.18
Lung	6,411 (76.1%)	19 (90.5%)	6,430 (76.1%)	
Esophagus	478 (5.7%)	2 (9.5%)	480 (5.7%)	
Mediastinum	497 (5.9%)	0 (0.0%)	497 (5.9%)	
Other	1,041 (12.4%)	0 (0.0%)	1041 (12.3%)	
Blood transfusion				<0.01
Negative	8,250 (97.9%)	16 (76.2%)	8,266 (97.8%)	
Positive	177 (2.1%)	5 (23.8%)	182 (2.2%)	
Hypertension				0.03
Negative	6,178 (73.3%)	11 (52.4%)	6,189 (73.3%)	
Positive	2,249 (26.7%)	10 (47.6%)	2,259 (26.7%)	
Diabetes				0.38
Negative	7,363 (87.4%)	17 (81.0%)	7,380 (87.4%)	
Positive	1,064 (12.6%)	4 (19.0%)	1,068 (12.6%)	
hyperlipidemia				<0.01
Negative	7,998 (94.9%)	12 (57.1%)	8,010 (94.8%)	
Positive	429 (5.1%)	9 (42.9%)	438 (5.2%)	
Coronary heart disease history				<0.01
Negative	8,378 (99.4%)	19 (90.5%)	8,397 (99.4%)	
Positive	49 (0.6%)	2 (9.5%)	51 (0.6%)	
Chronic heart failure				0.09
Negative	7,702 (91.4%)	17 (81.0%)	7,719 (91.4%)	
Positive	725 (8.6%)	4 (19.0%)	729 (8.6%)	
Atrial fibrillation				<0.01
Negative	8,303 (98.5%)	19 (90.5%)	8,322 (98.5%)	
Positive	124 (1.5%)	2 (9.5%)	126 (1.5%)	
A history of cerebral infarction				<0.01
Negative	8,092 (96.0%)	16 (76.2%)	8,108 (96.0%)	
Positive	335 (4.0%)	5 (23.8%)	340 (4.0%)	

Table 1 (*continued*)

Table 1 (*continued*)

Characteristics	Non-PCI cohort (N=8,427), n (%)	PCI cohort (N=21), n (%)	Total (N=8,448), n (%)	P value
Deep venous thrombosis				<0.01
Negative	8,289 (98.4%)	18 (85.7%)	8,307 (98.3%)	
Positive	138 (1.6%)	3 (14.3%)	141 (1.7%)	
Renal dysfunction				0.71
Negative	8,371 (99.3%)	21 (100.0%)	8,392 (99.3%)	
Positive	56 (0.7%)	0 (0.0%)	56 (0.7%)	
Liver dysfunction				<0.01
Negative	8,324 (98.8%)	19 (90.5%)	8,343 (98.8%)	
Positive	103 (1.2%)	2 (9.5%)	105 (1.2%)	
Anemia				<0.01
Negative	8,270 (98.1%)	18 (85.7%)	8,288 (98.1%)	
Positive	157 (1.9%)	3 (14.3%)	160 (1.9%)	
hypoproteinemia				<0.01
Negative	8,239 (97.8%)	18 (85.7%)	8,257 (97.7%)	
Positive	188 (2.2%)	3 (14.3%)	191 (2.3%)	
Second surgery after primary operation				<0.01
Negative	8,421 (99.9%)	19 (90.5%)	8,440 (99.9%)	
Positive	6 (0.1%)	2 (9.5%)	8 (0.1%)	

PCI, postoperative cerebral infarction; SD, standard deviation.

Table 2 Univariate conditional logistic regression results after the PSM of all the other covariates

Variable	A history of cerebral infarction	Perioperative blood transfusion	Deep venous thrombosis history	Hyperlipidemia
OR	4.38	6.22	5.25	13.76
P	0.037	0.013	0.022	<0.01

OR, odds ratio; PSM, propensity-score match.

patients, as general anesthesia affects perioperative arterial blood pressure and cerebral perfusion (19). However, there are conflicting reports on the association between intraoperative hypotension and PCI in the current literature (2,20), and mass blood loss was not identified as a risk factor in the present study. We believe that the blood transfusion procedure may broke clotting mechanism balance which result in massive PCI.

Many previous studies have recognized DVT as a risk factor of PCI (4,6,8,21). In the largest study of postoperative stroke, which included 540,717 patients, 4.41% of the patients with DVT suffered a postoperative stroke compared to 0.71% of the patients without DVT (8). In this study, about 14.3% of the PCI patients had a history of DVT, which is much higher than that reported in a previous study. (8)

Hyperlipidemia has not been reported to be a risk factor of PCI in previous studies. However, hyperlipidemia has been reported to be a risk factor of DVT in a number of previous studies (8,9). Patients with hyperlipidemia are more likely to develop DVT and cerebral infarction. Thus, hyperlipidemia could be a risk factor of PCI. Notably, in this study, no patients suffered from DVT and hyperlipidemia simultaneously; thus, we could not perform

a multicollinearity analysis to exclude any association between hyperlipidemia and DVT.

This study had several limitations. First, as not all of the postoperative patients underwent brain MRI/CT examinations, PCI may have been underdiagnosed. Second, due to the nature of retrospective studies, selection bias was unavoidable. Third, the number of PCI patients was small due to the low incidence of PCI. Thus, a multicenter prospective cohort study with a larger sample size needs to be conducted to further verify the risk factors for PCI in postoperative stroke patients.

Conclusions

In summary, a history of cerebral infarction, perioperative blood transfusion, a history of DVT, and hyperlipidemia are significant risk factors for PCI. Perioperative ischemic stroke is a rare but devastating complication of thoracic surgery; thus, its early identification and the implementation of preventive measures are of vital importance.

Acknowledgments

Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at https://jtd.amegroups.com/article/view/10.21037/jtd-22-1832/rc

Data Sharing Statement: Available at https://jtd.amegroups.com/article/view/10.21037/jtd-22-1832/dss

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://jtd.amegroups.com/article/view/10.21037/jtd-22-1832/coif). The 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). This single-institution, retrospective cohort study was approved by the institutional review board of Beijing Chaoyang Hospital (No. 2021-KE-135), and the requirement for written informed consent was waived due to the retrospective nature of the study.

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Table S1 The clinical characteristics of the non-PCI and PCI cohorts after PSM (1:4) for a history of cerebral infarction

Characteristics	Non-PCI cohort (N=84), n (%)	PCI cohort (N=21), n (%)	Total (N=105), n (%)	P value
Age, years				0.9872
Mean (SD)	63.0 (11.2)	63.0 (11.5)	63.0 (11.2)	
Gender				0.4324
Male	48 (57.1%)	10 (47.6%)	58 (55.2%)	
Female	36 (42.9%)	11 (52.4%)	47 (44.8%)	
Hypertension				0.8447
Negative	46 (54.8%)	11 (52.4%)	57 (54.3%)	
Positive	38 (45.2%)	10 (47.6%)	48 (45.7%)	
Hyperlipidemia				0.8427
Negative	50 (59.5%)	12 (57.1%)	62 (59.0%)	
Positive	34 (40.5%)	9 (42.9%)	43 (41.0%)	
Coronary heart disease				0.8991
Negative	69 (82.1%)	17 (81.0%)	86 (81.9%)	
Positive	15 (17.9%)	4 (19.0%)	19 (18.1%)	
Deep venous thrombosis history				0.2956
Negative	78 (92.9%)	18 (85.7%)	96 (91.4%)	
Positive	6 (7.1%)	3 (14.3%)	9 (8.6%)	
Atrial fibrillation				0.2519
Negative	81 (96.4%)	19 (90.5%)	100 (95.2%)	
Positive	3 (3.6%)	2 (9.5%)	5 (4.8%)	
Anemia				0.5239
Negative	76 (90.5%)	18 (85.7%)	94 (89.5%)	
Positive	8 (9.5%)	3 (14.3%)	11 (10.5%)	
Hypoproteinemia				1.0000
Negative	72 (85.7%)	18 (85.7%)	90 (85.7%)	
Positive	12 (14.3%)	3 (14.3%)	15 (14.3%)	
Perioperative blood transfusion				0.3648
Negative	71 (84.5%)	16 (76.2%)	87 (82.9%)	
Positive	13 (15.5%)	5 (23.8%)	18 (17.1%)	

PCI, postoperative cerebral infarction; SD, standard deviation.

Table S2 The clinical characteristics of the non-PCI and PCI cohorts after PSM (1:4) for a history of deep venous thrombosis

Characteristics	Non-PCI cohort (N=84), n (%)	PCI cohort (N=21), n (%)	Total (N=105), n (%)	P value
Age, years				0.9808
Mean (SD)	63.0 (11.3)	63.0 (11.5)	63.0 (11.3)	
Gender				0.4324
Male	48 (57.1%)	10 (47.6%)	58 (55.2%)	
Female	36 (42.9%)	11 (52.4%)	47 (44.8%)	
Hypertension				0.9221
Negative	45 (53.6%)	11 (52.4%)	56 (53.3%)	
Positive	39 (46.4%)	10 (47.6%)	49 (46.7%)	
Hyperlipidemia				0.9212
Negative	49 (58.3%)	12 (57.1%)	61 (58.1%)	
Positive	35 (41.7%)	9 (42.9%)	44 (41.9%)	
Coronary heart disease				1.0000
Negative	68 (81.0%)	17 (81.0%)	85 (81.0%)	
Positive	16 (19.0%)	4 (19.0%)	20 (19.0%)	
Atrial fibrillation				0.2519
Negative	81 (96.4%)	19 (90.5%)	100 (95.2%)	
Positive	3 (3.6%)	2 (9.5%)	5 (4.8%)	
A history of cerebral infarction				0.7377
Negative	63 (75.0%)	15 (71.4%)	78 (74.3%)	
Positive	21 (25.0%)	6 (28.6%)	27 (25.7%)	
Deep venous thrombosis history				0.1979
Negative	79 (94.0%)	18 (85.7%)	97 (92.4%)	
Positive	5 (6.0%)	3 (14.3%)	8 (7.6%)	
Anemia				0.4059
Negative	77 (91.7%)	18 (85.7%)	95 (90.5%)	
Positive	7 (8.3%)	3 (14.3%)	10 (9.5%)	
Hypoproteinemia				0.5239
Negative	76 (90.5%)	18 (85.7%)	94 (89.5%)	
Positive	8 (9.5%)	3 (14.3%)	11 (10.5%)	

PCI, postoperative cerebral infarction; SD, standard deviation.

Table S3 The clinical characteristics of the non-PCI and PCI cohorts after PSM (1:4) for a history of deep venous thrombosis

Characteristics	Non-PCI cohort (N=84), n (%)	PCI cohort (N=21), n (%)	Total (N=105), n (%)	P value
Age, years				0.9744
Mean (SD)	62.9 (11.2)	63.0 (11.5)	62.9 (11.2)	
Gender				0.3761
Male	49 (58.3%)	10 (47.6%)	59 (56.2%)	
Female	35 (41.7%)	11 (52.4%)	46 (43.8%)	
Hypertension				1.0000
Negative	44 (52.4%)	11 (52.4%)	55 (52.4%)	
Positive	40 (47.6%)	10 (47.6%)	50 (47.6%)	
Hyperlipidemia				0.8427
Negative	50 (59.5%)	12 (57.1%)	62 (59.0%)	
Positive	34 (40.5%)	9 (42.9%)	43 (41.0%)	
Coronary heart disease				0.6911
Negative	71 (84.5%)	17 (81.0%)	88 (83.8%)	
Positive	13 (15.5%)	4 (19.0%)	17 (16.2%)	
Atrial fibrillation				0.1262
Negative	82 (97.6%)	19 (90.5%)	101 (96.2%)	
Positive	2 (2.4%)	2 (9.5%)	4 (3.8%)	
A history of cerebral infarction				1.0000
Negative	60 (71.4%)	15 (71.4%)	75 (71.4%)	
Positive	24 (28.6%)	6 (28.6%)	30 (28.6%)	
Anemia				0.4059
Negative	77 (91.7%)	18 (85.7%)	95 (90.5%)	
Positive	7 (8.3%)	3 (14.3%)	10 (9.5%)	
Hypoproteinemia				0.5239
Negative	76 (90.5%)	18 (85.7%)	94 (89.5%)	
Positive	8 (9.5%)	3 (14.3%)	11 (10.5%)	
Perioperative blood transfusion				0.2217
Negative	73 (86.9%)	16 (76.2%)	89 (84.8%)	
Positive	11 (13.1%)	5 (23.8%)	16 (15.2%)	

PCI: postoperative cerebral infarction; SD: standard deviation.

Table S4 The clinical characteristics of the non-PCI and PCI cohorts after PSM (1:4) for hyperlipidemia

Characteristics	Non-PCI cohort (N=84), n (%)	PCI cohort (N=21), n (%)	Total (N=105), n (%)	P value
Age, years				0.9872
Mean (SD)	63.0 (11.3)	63.0 (11.5)	63.0 (11.3)	
Gender				0.3761
Male	49 (58.3%)	10 (47.6%)	59 (56.2%)	
Female	35 (41.7%)	11 (52.4%)	46 (43.8%)	
Hypertension				0.8452
Negative	42 (50.0%)	11 (52.4%)	53 (50.5%)	
Positive	42 (50.0%)	10 (47.6%)	52 (49.5%)	
Coronary heart disease				0.3891
Negative	74 (88.1%)	17 (81.0%)	91 (86.7%)	
Positive	10 (11.9%)	4 (19.0%)	14 (13.3%)	
Atrial fibrillation				0.2519
Negative	81 (96.4%)	19 (90.5%)	100 (95.2%)	
Positive	3 (3.6%)	2 (9.5%)	5 (4.8%)	
Deep venous thrombosis history				0.1176
Negative	80 (95.2%)	18 (85.7%)	98 (93.3%)	
Positive	4 (4.8%)	3 (14.3%)	7 (6.7%)	
A history of cerebral infarction				0.6511
Negative	64 (76.2%)	15 (71.4%)	79 (75.2%)	
Positive	20 (23.8%)	6 (28.6%)	26 (24.8%)	
Anemia				0.4059
Negative	77 (91.7%)	18 (85.7%)	95 (90.5%)	
Positive	7 (8.3%)	3 (14.3%)	10 (9.5%)	
Hypoproteinemia				0.1979
Negative	79 (94.0%)	18 (85.7%)	97 (92.4%)	
Positive	5 (6.0%)	3 (14.3%)	8 (7.6%)	
Perioperative blood transfusion				0.1632
Negative	74 (88.1%)	16 (76.2%)	90 (85.7%)	
Positive	10 (11.9%)	5 (23.8%)	15 (14.3%)	

PCI, postoperative cerebral infarction; SD, standard deviation.