Effect of short-term blood pressure variability on functional outcome after intra-arterial treatment in acute stroke patients with large-vessel occlusion

Tianli Zhang
Taiyuan Central Hospital
Weirong Li (tyszxyysci@163.com)
Taiyuan Central Hospital https://orcid.org/0000-0002-7834-9144
Xiaolong Wang
Taiyuan Central Hospital
Chao Wen
Taiyuan Central Hospital
Feng Zhou
Taiyuan Central Hospital
Shengwei Gao
Taiyuan Central Hospital
Xiaodong Zhang
Taiyuan Central Hospital
Shiqin Lin
Taiyuan Central Hospital
Jing Shi
Taiyuan Central Hospital

Research article

Keywords: Blood pressure, Acute ischemic stroke, Large vessel occlusion, Functional outcome

Posted Date: May 14th, 2019

DOI: https://doi.org/10.21203/rs.2.9582/v1

Version of Record: A version of this preprint was published on September 26th, 2019. See the published version at https://doi.org/10.1186/s12883-019-1457-5.

Abstract

Background: Endovascular treatment (EVT) is advocated for acute ischemic stroke with large-vessel occlusion (LVO), but perioperative periods are challenging.This study investigated the relationship between post-EVT short-term blood pressure variability (BPV) and early outcomes in LVO patients. Methods: We retrospectively reviewed 72 LVO patients undergoing EVT between June 2015 and June 2018. Hourly systolic and diastolic blood pressures (SBP and DBP, respectively) were recorded in the first 24 hours post-EVT. BPV were evaluated as standard deviation (SD), coefficient of variation (CV), and successive variation (SV) separately for SBP and DBP. Patients were categorized into favorable (mRS 0-2) and unfavorable (mRS 3-6) outcome groups based on 3-month modified Rankin Scale (mRS) scores. Results: For 58.3% patients with favorable outcomes, median National Institutes of Health Stroke Scale and Alberta Stroke Program Early CT scores on admission were 14 and 8, respectively. The maximum SBP ([154.3±16.8] vs. [163.5±15.6], P=0.02), systolic CV ([8. 8%±2.0%] vs. [11.0%±1.8%], P<0.001), SV ([11.4±2.3] vs. [14.6±2.0], P<0.001), and SD ([10.5±2.4] vs. [13.8±3.9], P<0.001) were lower in patients with favorable outcomes. On multivariable logistic regression analysis, systolic SV (OR: 4.273, 95% CI: 1.030 to 17.727, P=0.045) independently predicted unfavorable prognosis (area under the curve = 0.868 [95% CI: 0.781 to 0.955, P<0.001]. Sensitivity and specificity were 93.3% and 73.8%, respectively, showing excellent value for 3-month-poor-outcome predictions. Conclusions: Decreased maximum SBP and systolic CV, SV, and SD following intra-arterial therapies result in favorable 3-month outcomes. Systolic SV may be a novel predictor of functional prognosis in LVO patients.

Background

Early endovascular treatment (EVT) for patients who had acute ischemic stroke with large-vessel occlusion (AIS-LVO) is highly recommended based on the findings of six randomized controlled clinical trials [1-6]. However, several factors during the perioperative period of EVT, including blood pressure (BP) management, need urgent attention. The optimal range of BP following EVT remains unclear. The 2018 American Heart Association and American Stroke Association guidelines for the early management of patients with AIS recommends maintaining the BP at <180/105 mm Hg (IIb, B-NR) in patients who underwent mechanical thrombectomy (MT) with successful reperfusion [7]. The 2018 Chinese guidelines also recommend a target BP of 140/90 or a BP of 20 mmHg lower than that at baseline, but it should also not be less than 100/60 mmHg (II, C) [8]. However, although the BP is maintained within the target range, reperfusion injury still occurs.

Blood pressure variability (BPV) is the fluctuation of BP in a certain period of time. In the acute stage of cerebrovascular disease, the fluctuation of cerebral perfusion pressure is aggravated by short-term BPV due to impaired automatic regulation of cerebral blood flow [9]. Hypertension during the perioperative period may lead to adverse events such as reperfusion syndrome and cardiovascular complications, while hypotension may lead to hypoperfusion and increases the risk of infarction. A recent systematic review reported that increased BPV after stroke is associated with higher rates of intracranial hemorrhage and disability [10]. However, there is limited epidemiological evidence to evaluate the relationship between BP level and early functional prognosis after EVT. Thus, this study aimed to explore the association of short-term BPV in the first 24 hours following EVT with functional outcome in patients with AIS-LVO.

Methods

Patient selection

This is a retrospective study was approved by the Institution review board of of Taiyuan Central Hospital, Shanxi, People's Republic of China. Consecutive AIS-LVO patients who underwent emergency EVT in the tertiary care stroke center of Taiyuan Central Hospital between June 2015 and June 2018 were enrolled. The inclusion criteria were as follows: (1) age of ≥18 years; (2) AIS confirmed via head computed tomography (CT) or magnetic resonance imaging at admission; (3) occlusion of the internal carotid artery or M1 of the middle cerebral artery diagnosed within 6 hours after onset by digital subtraction angiography; (4) preoperative Alberta Stroke Program Early CT Score (ASPECTS) of ≥6, prestroke modified Rankin Scale (mRS) score of <2, and National Institutes of Health Stroke Scale (NIHSS) score of ≥6; (5) treatment initiated (groin puncture) within 6 hours of symptom onset; (6) clinical features and BP recorded at baseline and hourly for at least 24 hours after EVT; and (7) follow up by phone or face-to-face consultations at 3 months with complete documents. Patients were excluded if they had active bleeding or bleeding tendency, serious lung disease or heart disease, glucose <50 mg/dL or >400 mmol/L, severe hypertension beyond drug control, and severe non-cardiovascular events that occurred within 3 months of follow-up. The management of patients with AIS-LVO was based on the Chinese guidelines for diagnosis and treatment of AIS 2014 and Chinese guidelines for the endovascular treatment of acute ischemic stroke 2015 [11, 12].

Data collection

Baseline characteristics such as demographics, vascular risk factors, previous use of anti-platelet aggregation drugs, Trial of ORG 10172 in acute stroke treatment (TOAST) types on admission, NIHSS scores on admission, ASPECTS on admission, systolic BP (SBP) and diastolic BP (DBP) on admission, laboratory values, and type of treatment for the EVT were collected. The degree of recanalization at the end of EVT was measured using the Thrombolysis in Cerebral Infarction (TICI) score [13] as obtained from the reports of interventional specialists (C.W. and F.Z.). All patients were examined via brain CT in the first 24 hours after EVT to determine any changes in intracranial hemorrhage using the criteria developed by the European Cooperative Acute Stroke Study (ECASS) [14]: HI1, small petechiae with an indistinct border within the vascular territory; HI2, more confluent petechiae, no mass effect; PHI, hematoma within infarcted tissue, occupying <30% of the infarcted area, no substantive mass effect; and PH2, >30% of the infarcted area with significant space-occupying effect or parenchymal hematoma distant from the infarcted brain tissue.

BP monitoring and BPV presentation post EVT

The hourly SBP and DBP of all patients were recorded during the first 24 hours following EVT. We documented the maximum, minimum, and mean arterial BP (MAP, SBP + 2 × DBP)/3) levels for each individual. Based on previously published studies, BPV was calculated using the following equation:

Due to technical limitations, Equation 1 has been placed in the Supplementary Files section.

Evaluation of functional prognosis

Functional outcome was evaluated at 3 months by certified neurologists using the mRS score. The patients were then divided into two groups based on the functional outcome score: the favorable and unfavorable outcome groups comprised patients with mRS 0-2 and mRS 3-6, respectively. The mRS scores were determined based on the findings on follow-up.

Statistical analysis

All data analyses were performed using SPSS V. 25.0 software. Bilateral P values of <0.05 were considered significant. Continuous variables were expressed as means±SD (normal distribution) or median with interquartile range (IQR) (skewed distribution). Comparisons between groups were conducted using the Students t-test, Mann-Whitney U test, or χ^2 test, as appropriate. Univariable and multivariable logistic regression models were used to explore the association between BPV indexes during the first 24 hours post EVT with 3-month functional outcome. Odds ratio (OR) and 95% confidence interval (CI) were calculated to determine any associations. To determine the predictive capabilities according to SBP SV, the receiver operating characteristic (ROC) curves were generated, and the area under the curve (AUC) was described to determine the sensitivity and accuracy of systolic SV.

Results

Patient demographics and clinical characteristics

Of the 83 patients who underwent emergency EVT in our stroke unit, 11 patients were excluded because of non-cardiovascular death or missing data in the 3-month follow-up. Thus, 72 patients with AIS-LVO within the anterior circulation were enrolled in this study. For 58.3% patients with 3-month favorable outcomes. The mean age was 64.8±10.9 years, and 27 (37.5%) were women. The median NIHSS score at admission was 14 points [IQR, 9-19], while the median ASPECTS was 8 points [IQR, 7-9]. Of the 72 patients, 86.1% patients achieved recanalization (TICI 2b or 3). In total, 26.4% patients received combined intravenous thrombolysis and thrombectomy, while 16.7% patients were treated with intra-arterial thrombolysis alone. Intracranial hemorrhagic transformation occurred in 12 patients (16.6%). The baseline clinicodemographic characteristics of the study population are summarized in

Compared with those in the unfavorable outcome group, the NIHSS scores and ASPECT at admission, mean SBP level, and frequency of MT were significantly lower in the favorable outcome group (all P<0.05). Patients with a 3-month favorable outcome had higher rates of successful recanalization

(P=0.008). The rates of vascular risk factors, time of symptom onset to groin puncture, and HI were not significantly different between the two groups.

BPV and 3-month functional outcome

In this study (Fig. 1), we detected the difference in maximum SBP, systolic CV, SV, and SD between the two groups. Patients with unfavorable prognosis had higher maximum SBP ([163.5±15.6] vs. [154. 3±16.8], P=0.02), systolic CV ([11.0%±1.8%] vs. [8.8%±2.0%], P<0.001), SV ([14.6±2.0] vs. [11. 4±2.3], P<0.001), and SD ([13.8±3.9] vs. [10. 5±2.4], P<0.001). We found no significant difference in the level of MAP, mean SBP, minimum SBP, and dates of DBP variability between the two groups (P>0.05).

Influencing factors of 3-month functional independence

Table 2. summarizes the univariable and multivariable associations of BP measurements after EVT and other clinical characteristics with the 3-month functional prognosis. The following variables were significantly related (P<0.05) to 3-month functional independence in the initial univariable analyses: NIHSS score at admission; SBP at admission; ASPECTS at admission; M1of the MCA occlusion; Frequency of mechanical thrombectomy; measurement of EVT; successful recanalization; maximum SBP and systolic SD, CV, and SV post MT. After adjusting for potential confounders, multivariable logistic regression revealed that systolic SV (OR: 4.273, 95% CI: 1.030 to 17.727, P=0.045) was an independent predictor of unfavorable outcome, and a high ASPECTS was independently associated with a better likelihood of favorable outcome (OR: 0.200, 95% CI: 0.054 to 0.744, P=0.016).

ROC analysis

ROC analysis demonstrated that areas under the curve (AUC) of systolic SV for predicting unfavorable outcome was 0.868 (95% CI: 0.781 to 0.955, P<0.001; Fig. 2). The optimal cut-off value was 12.499, which had a sensitivity and specificity of 93.3% and 73.8%, respectively. This indicates that an systolic SV of 12.499 had an excellent predictive value for 3-month poor outcome.

Discussion

The clinical outcome in patients with ischemic stroke is affected by many factors, including age, severity of stroke, collateral compensation, time of successful reperfusion, and device selected for EVT. BP management and its effect on functional outcome is particularly controversial. A previous study showed that increased systolic BPV positively contributed to symptomatic intracerebral hemorrhage and death after intravenous thrombolysis [16]. However, less is known about the effect of short-term BPV after EVT on the early outcomes of AIS-LVO patients. Our study shows that lower maximum SBP and systolic CV, SV, and SD levels during the first 24 hours after EVT are related to a better 3-month functional outcome, which was consistent with the results reported by Bennett [17].

BPV is divided into physiological and pathological variability, which fluctuates with physiological regulation, environmental changes, pathological influence. The increase of BPV accordingly increases the risk of cardiovascular events. In our research, we used the BPV index of SD because it is less affected by nocturnal decrease of BP. We also used SV as it can reflect the time-series variability of BP. Using multivariable logistic regression and ROC analysis, we confirmed that the systolic SV is closely associated with 3-month functional outcome. Lower systolic SV level may be beneficial to achieving 3-month functional independence.

A study of 217 patients who underwent MT showed that a higher maximum SBP was closely related to 3-month mortality and poor outcome. Each 10 mmHg increase in maximum SBP during the first 24 hours post MT was associated with a lower 3-month functional prognosis and a higher odds of 3-month mortality [18]. Our research found that the rate of successful recanalization was higher in the favorable outcome group, which also had lower maximum SBP. Patients with successful reperfusion are more likely to benefit from lower SBP [19]. Some studies showed that BP within the first 48 hours after a stroke showed a U-shaped correlation with clinical outcome [17, 20], particularly in patients with non-recanalization. The authors argued that patients with unsuccessful recanalization had larger infarct size and ischemic penumbra, and impaired cerebral autoregulation led to further enlargement of the ischemic penumbra [17]. In addition, cerebral ischemia and MT itself can lead to the destruction of blood-brain barrier, resulting in vasogenic edema and hemorrhagic transformation after infarction. Moreover, iatrogenic injury to endothelial cells during MT can cause a series of reperfusion-related injuries [21] that not only increase intracranial hemorrhage associated with SBP, but also lead to adverse functional prognosis. Another study also showed that the peak level of SBP was closely related to poor outcome regardless of LVO recanalization was achieved or not. The authors suggested that this is probably because abnormally elevated BP may be associated with potential collateral circulation damage [22].

Several limitations of the present study need to be acknowledged. First, this was a single-center retrospective study with a relatively small sample size. Thus, selection bias in baseline data could not be avoided. Second, a recent study demonstrated that BPV post MT may increase the rate of symptomatic intracranial hemorrhage (sICH) [10], but we did not evaluate the relationship between BPV and sICH because the patients who developed intracranial hemorrhage during follow-up were classified according to ECASS criteria without the clinical classification for sICH. Third, variable reasons such as the varying time from stroke onset to arrival at our hospital for first BP measurement and differences in time intervals between BP measurements may cause bias in our results. However, we exerted every effort to provide reliable dates to mitigate the inherent limitations. Fourth, SD and SV are not suitable for the long-term evaluation of BPV after EVT. Therefore, additional well-designed and larger randomized cohort studies are required to confirm the association of BPV and functional prognosis and to determine strategies to reduce the BPV.

Conclusions

Decreased maximum SBP and systolic CV, SV, and SD following intra-arterial therapies are associated with 3-month favorable outcome. This shows that systolic SV may be a novel predictor of functional prognosis in LVO patients.

Abbreviations

EVT: Endovascular treatment; LVO: Large-vessel occlusion; BP: Blood pressure; BPV: Blood pressure variability; SBP: Systolic blood pressure; DBP: Diastolic blood pressure; SD: Standard deviation; CV: Coefficient of variation; SV: Successive variation; mRS: Modified Rankin Scale; AIS: Acute ischemic stroke; MT: Mechanical thrombectomy; ASPECTS: Alberta Stroke Program Early CT Score; NIHSS: National Institutes of Health Stroke Scale; TOAST: Trial of ORG 10172 in acute stroke treatment; TICI: Thrombolysis in Cerebral Infarction; ECASS: European Cooperative Acute Stroke Study; MCA: middle cerebral artery; LDL-C: Low-density lipoprotein cholesterol; IQR: Interquartile range; OR: Odds ratio; CI: confidence interval; ROC: Receiver operating characteristic; AUC: Area under the curve; HI: Petechial infarction without space-occupying effect; PH: Hemorrhage (coagulum) with mass effect.

Declarations

Acknowledgements

This work was supported by the Science and Technology infrastructure platform of Shanxi Province: Establishment of Information Service for Stroke Treatment in Taiyuan Central Hospital (Grant No. 2015091012).

Funding

None.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Authors' contributions

WRL conceived the study and revised the manuscript. TLZ wrote the manuscript and analyzed the data. XLW, CW, FZ, and SWG performed intra-arterial treatment and collected the data and interpreted the analysis. SQL, XDZ and JS critically revised the manuscript for important intellectual content. All authors read and approved the final manuscript.

Ethics approval and consent to participate

This study was approved by the ethic committee of the Taiyuan Central Hospital, ShanXi, China. Patient's consents were waived by the ethic committee of the ethic committee of the Taiyuan Central Hospital, due to the retrospective design of the study.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

Disclosures

The authors declare no conflicts of interest.

References

1. Saver JL, Goyal M, Bonafe A, et al. Stent-retriever thrombectomy after intravenous t-PA vs. t-PA alone in stroke. N Engl J Med. 2015;372:2285-95.
2. Goyal M, Demchuk AM, Menon BK, et al. Randomized assessment of rapid endovascular treatment of ischemic stroke. N Engl J Med. 2015;372:1019-30.
3. Campbell BC, Mitchell PJ, Kleinig TJ, et al. Endovascular therapy for ischemic stroke with perfusion-imaging selection. N Engl J Med. 2015;372:1009-18.
4. Berkhemer OA, Fransen PS, Beumer D, et al. A randomized trial of intraarterial treatment for acute ischemic stroke. N Engl J Med. 2015;372:11-20.
5. Jovin TG, Chamorro A, Cobo E, et al. Thrombectomy within 8 hours after symptom onset in ischemic stroke. N Engl J Med. 2015;372:2296-306.
6. Bracard S, Ducrocq X, Mas JL, et al. Mechanical thrombectomy after intravenous alteplase versus alteplase alone after stroke (THRACE): a randomised controlled trial. Lancet Neurol. 2016;15:1138-47.
7. Powers WJ, Rabinstein AA, Ackerson T, et al. 2018 Guidelines for the Early Management of Patients With Acute Ischemic Stroke: A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association. Stroke. 2018;49:e46-e110.
8. Chinese Sociaty of Neurology, Chinese Stroke Society, Neurovascular Intervention Group of Chinese Society of Neurology. Chinese guidelines for the endovascular treatment of acute ischemic stroke 2018. Chin J Neurol. 2018;51:683-691.
9. Dawson SL, Panerai RB, Potter JF. Serial changes in static and dynamic cerebral autoregulation after acute ischaemic stroke. Cerebrovasc Dis. 2003;16:69-75.
10. Manning LS, Rothwell PM, Potter JF, et al. Prognostic Significance of Short-Term Blood Pressure Variability in Acute Stroke: Systematic Review. Stroke. 2015;46:2482-90.
11. Chinese Sociaty of Neurology, Chinese Stroke Society, Chinese guidelines for diagnosis and treatment of acute ischemic stroke 2014.Chin J Neurol. 2015;48:246-257.
12. Chinese Sociaty of Neurology, Chinese Stroke Society, Neurovascular Intervention Group of Chinese Society of Neurology. Chinese guidelines for the endovascular treatment of acute ischemic stroke 2015. Chin J Neurol. 2015;48:356-361.

13. Higashida RT, Furlan AJ, Roberts H, et al. Trial design and reporting standards for intra-arterial cerebral thrombolysis for acute ischemic stroke. Stroke. 2003;34:e109-37.
14. Yaghi S, Willey JZ, Cucchiara B, et al. Treatment and Outcome of Hemorrhagic Transformation After Intravenous Alteplase in Acute Ischemic Stroke: A Scientific Statement for Healthcare Professionals From the American Heart Association/American Stroke Association. Stroke. 2017;48:e343-e361.
15. Endo K, Kario K, Koga M, et al. Impact of early blood pressure variability on stroke outcomes after thrombolysis: the SAMURAI rt-PA Registry. Stroke. 2013;44:816-8.
16. De Havenon A, Bennett A, Stoddard GJ, et al. Determinants of the impact of blood pressure variability on neurological outcome after acute ischaemic stroke. Stroke Vasc Neurol. 2017;2:1-6.
17. Bennett AE, Wilder MJ, McNally JS, et al. Increased blood pressure variability after endovascular thrombectomy for acute stroke is associated with worse clinical outcome. J Neurointerv Surg. 2018 ;10:823-827.
18. Goyal N, Tsivgoulis G, Pandhi A, et al. Blood pressure levels post mechanical thrombectomy and outcomes in large vessel occlusion strokes. Neurology. 2017;89:540-547.
19. Maier IL, Tsogkas I, Behme D, et al. High Systolic Blood Pressure after Successful Endovascular Treatment Affects Early Functional Outcome in Acute Ischemic Stroke. Cerebrovasc Dis. 2018;45:18-25.
20. Leonardi-Bee J, Bath PM, Phillips SJ, et al. Blood pressure and clinical outcomes in the International Stroke Trial. Stroke. 2002;33:1315-20.
21. Teng D, Pannell JS, Rennert RC, et al. Endothelial trauma from mechanical thrombectomy in acute stroke: in vitro live-cell platform with animal validation. Stroke. 2015;46:1099-106.
22. Goyal N, Tsivgoulis G, Pandhi A, et al. Blood pressure levels post mechanical thrombectomy and outcomes in non-recanalized large vessel occlusion patients. J Neurointerv Surg. 2018;10:925-931

Tables

Table 1. Baseline characteristics of patients in the two outcome groups

Variable	Total	Favorable outcome group (n=42, 58.3%)	Unfavorable outcome group (n=30, 41.7%)	P value
Age (years), mean±SD	64.8±10.9	64.5±11.8	65.1±9.8	0.820
Male, n (%)	45 (62.5)	27 (64.3)	18 (60.0)	0.711
Hypertension, n (%)	48 (66.7)	28 (66.7)	20 (66.7)	1.000
Diabetes mellitus, n (%)	23 (31.9)	17 (40.5)	6 (20.0)	0.066
Coronary heart disease, n (%)	21 (29.2)	12 (28.6)	9 (30.0)	0.895
Atrial fibrillation, n (%)	24 (33.3)	16 (31.8)	8 (26.7)	0.310
Previous history of cerebrovascular disease, n (%)	10 (13.9)	5 (11.9)	5 (16.7)	0.565
Previous antiplatelet therapy, n (%)	14 (19.4)	9 (21.4)	5 (16.7)	0.615
Current smoker, n (%)	34 (47.2)	21 (50.0)	13 (43.3)	0.576
NIHSS score at admission, median (IQR)	14 (9-19)	13 (8-17)	17 (12-20)	0.015*
Glucose level at admission (mg/dL), mean±SD	152.3±85.0	9.1±6.0	7.5±1.7	0.157
SBP level at admission (mmHg), mean±SD	153.8±23.5	146.9±18.5	163.5±25.5	0.003*
DBP level at admission (mmHg), mean±SD	85.2±13.4	83.4±12.8	87.6±14.0	0.189
LDL-C at admission (mg/dL), median (IQR)	44.73 (34.97-55.71)	45.18(34.43-53.15)	44.01 (35.19-57.60)	0.541
TOAST type, n (%)				
Large artery atherosclerosis	44 (61.1)	23 (54.8)	21(70.0)	0.442
Cardioembolism	23 (31.9)	16 (38.1)	7 (23.3)	
Clear reason	4 (5.6)	2 (4.8)	2 (6.7)	
Unknown reason	1 (1.4)	1 (2.4)	0 (0.0)	
ASPECT at admission, median (IQR)	8 (7-9)	8 (8~9)	7 (6.75-8)	<0.001*
Vascular lesion				
M1 of the middle cerebral artery	51 (70.8)	35 (83.3)	16 (53.3)	0.006*
Internal carotid	21 (29.2)	7 (16.7)	14 (46.7)	
Toponarcosis, n (%)	63 (87.5)	38 (90.5)	25 (83.3)	0.366
Time from stroke onset to groin puncture (min), mean±SD	290.5±80.5	297.0±72.5	281.4±91.1	0.421
Combined intravenous thrombolysis and thrombectomy, n (%)	19 (26.4%)	8 (19.0)	11 (36.7)	0.094
Intra-arterial thrombolysis, n (%)	12 (16.7)	11 (26.2)	1 (3.3)	0.010*
Frequency of mechanical thrombectomy, median (IQR)	2 (2-3)	2 (1-3)	3 (2-3)	0.024*
Rates of successful recanalization, n (%)	62 (86.1)	40 (95.2)	22 (73.3)	0.008*
Intracranial hemorrhagic transformation, n (%)				
HI1	5 (6.9)	4 (9.5)	1 (3.3)	0.197
HI2	5 (6.9)	2 (4.8)	3 (10.0)	
PH1	2 (2.8)	0 (0.0)	2 (6.7)	
PH2	1 (1.4)	0 (0.0)	1 (3.3)	

*Statistically significant.

NIHSS National Institutes of Health Stroke Scale, *SBP* systolic blood pressure, *DBP* diastolic blood pressure, *LDL-C* low-density lipoprotein cholesterol, *ASPECT* Alberta Stroke Program Early CT Score, *HI* petechial infarction without space-occupying effect, *PH* hemorrhage (coagulum) with mass effect

Table 2 Univariate and multivariate analyses of the favorable outcomes after EVT

Variable	Univariable logistic regression analysis		Multivariable logistic regression analysis*	
	OR (95% CI)	P value*	OR (95% CI)	P value
Age	1.005 (0.963-1.050)	0.875		
Male	0.556 (0.457-3.151)	0.711		
Hypertension	1.000 (0.370-2.702)	1.000		
Coronary heart disease	1.071 (0.383-2.997)	0.895		
Atrial fibrillation	0.591 (0.213-1.641)	0.313		
Diabetes mellitus	0.368 (0.124-1.089)	0.071		
Smoking	0.765 (0.298-1.962)	0.577		
Glucose level at admission	0.893 (0.755-1.057)	0.189		
NIHSS at admission	1.072 (1.002-1.148)	0.045	0.931 (0.808-1.073)	0.325
SBP level at admission	1.036 (1.010-1.063)	0.006	1.045 (0.993-1.100)	0.092
DBP level at admission	1.025 (0.988-1.063)	0.189		
LDL-C at admission	1.170 (0.724-1.891)	0.521		
Toponarcosis	1.900 (0.465-7.769)	0.372		
ASPECT at admission	0.268 (0.138-0.522)	<0.001	0.200 (0.054-0.744)	0.016
Time from stroke onset to groin puncture	0.998 (0.992-1.003)	0.415		
M1of the MCA occlusion	0.229 (0.077-0.675)	0.008	0.076 (0.005-1.078)	0.057
Frequency of mechanical thrombectomy	0.098 (0.011-0.860)	0.036	1.499 (0.038-59.877)	0.830
Combined intravenous thrombolysis and thrombectomy	2.461 (0.844-7.172)	0.099		
Intra-arterial thrombolysis	0.097 (0.012-0.801)	0.030	0.012 (0.000-1.457)	0.071
Successful recanalization	0.138 (0.027-0.075)	0.017	0.030 (0.001-1.842)	0.095
Maximum SBP post EVT**	1.036 (1.004-1.069)	0.803	0.894 (0.777-1.028)	0.116
Maximum DBP post EVT**	0.953 (0.901-1.008)	0.091		
Minimum SBP post EVT**	0.983 (0.952-1.015)	0.297		
Minmum DBP post EVT**	0.983 (0.939-1.030)	0.482		
Mean SBP post EVT**	1.006 (0.976-1.037)	0.686		
Mean DBP post EVT**	0.980 (0.929-1.034)	0.456		
Systolic SD post EVT**	1.531 (1.203-1.948)	0.001	1.217 (0.803-1.842)	0.355
Systolic CV post EVT**	2.732E+28 (8.024E+12-9.303E+43)	<0.001	0.000 (0.000-7.704E+24)	0.221
Systolic SV post EVT**	2.046 (1.444-2.898)	<0.001	4.273 (1.030-17.727)	0.045

*Cut-off of P<0.05 was used for selection of candidate variables for inclusion in multivariable losistic regression models.

**During the 24 hours following the endovascular treatment

NIHSS National Institutes of Health Stroke Scale, *SBP* Systolic blood pressure, *ASPECT* Alberta Stroke Program Early CT Score, *MCA* Middle cerebral artery, *EVT* Endovascular treatment; *LDL-C* Low-density lipoprotein cholesterol; *DBP* Diastolic blood pressure; *SD* Standard deviation; *CV* Coefficient of variation; *SV* Successive variation

Figures

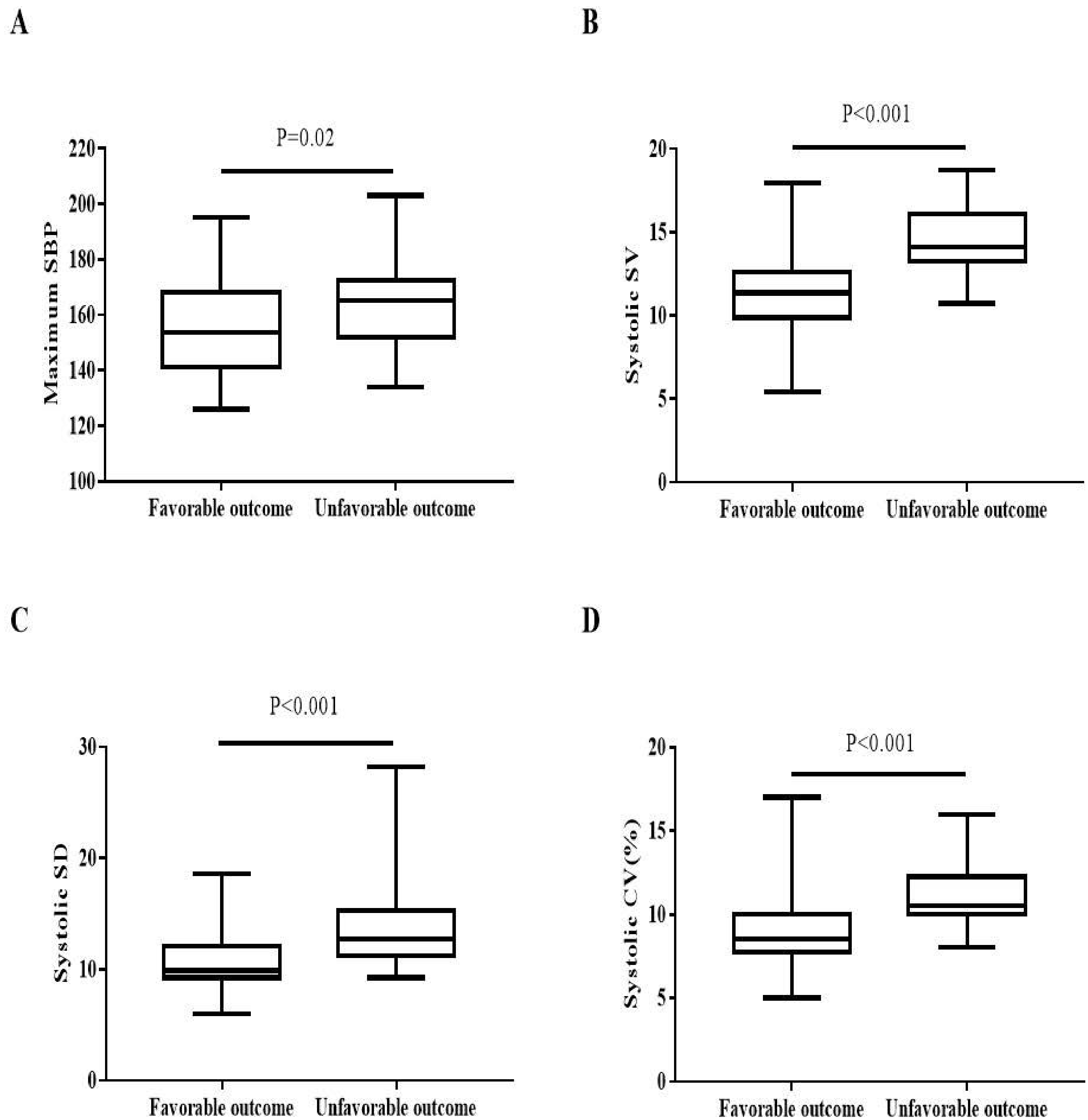

Figure 1

Comparison of maximum SBP and systolic SV, SD, and CV in the first 24 hours post-EVT in the two groups. EVT endovascular treatment; SBP systolic blood pressure; SV successive variation; SD standard deviation; CV coefficient of variation

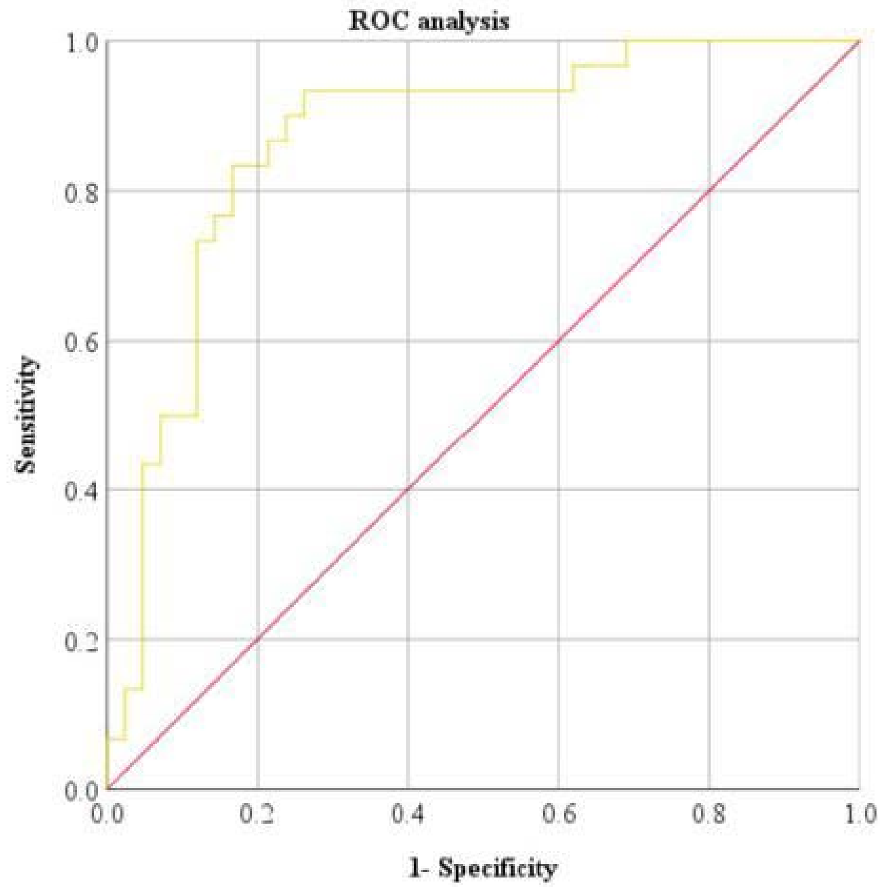

Figure 2

Systolic SV and 3-month unfavorable outcomes. SBP systolic blood pressure; SV successive variation

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- supplement1.png