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Predictors of early neurological deterioration after endovascular thrombectomy for anterior cerebral large-vessel occlusion

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Abstract

Aim Endovascular thrombectomy (EVT) proves to be beneficial for acute ischemic stroke (AIS) due to large vessel occlusion (LVO). However, post-thrombectomy patients may experience early neurological deterioration (END) after treatment. We sought to determine the predictors of END following EVT among patients with LVO in the anterior circulation.

Methods A single-center retrospective observational study was performed on patients who underwent thrombectomy between January 2020 and March 2024. Univariable and multivariable logistic regression was performed to determine independent predictors of END within 24 h post EVT which was defined as an increase of National Institutes of Health Stroke Scale (NIHSS) scores ≥ 4 points or death.

Results In-hospital END occurred in 22 (29.3%) of 75 included patients. The more prevalent variables were ASPECT score < 6 (OR 3.42, $p = 0.01$), collateral CIS 0–1 (OR 3.40, $p = 0.01$), unsuccessful recanalization (mTICI 0-2a) (OR 4.33, $p = 0.01$), and intracranial hemorrhage (OR 2.85, $p = 0.048$). According to multivariable regression analysis, unsuccessful recanalization was identified as an independent predictor of END post-EVT (aOR 4.25, $p = 0.04$).

Conclusions Unsuccessful recanalization is an independent predictor of END following EVT for LVO in the anterior circulation. Improving techniques to ensure successful recanalization may lead to favorable outcomes.

Keywords Endovascular thrombectomy, Large-vessel occlusion, Intracranial hemorrhage, Early neurological deterioration

Introduction

Globally, stroke is the third-major cause of death and disability [1]. Prevalence of ischemic stroke in Southeast Asia has been steadily increasing in most nations since 1990 and accountable for more than 40% of the worldwide stroke mortality [2,3]. Ischemic stroke due to large-vessel occlusion (LVO) generates severe symptoms and catastrophic consequences if not treated appropriately. Prior to the advent of endovascular thrombectomy (EVT), the rate of disability and death was 64% and 26.2% respectively [4].

Over the past ten years, EVT has been recognized as an effective treatment for acute LVO. Previous study showed that thrombectomy decreased the number of morbidities and mortalities In addition, thrombectomy

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has shown a substantial increase in the likelihood of patients achieving functional independence compared to standard medical treatment alone [5]. Nevertheless, despite the treatment being generally successful, a significant number of patients experienced a poor outcome [6]. Enhanced comprehension of deteriorating indicators will be useful in the meticulous identification of patients with LVO and enable practitioners to prevent the occurrence of unnecessary interventions and complications.

A previous study demonstrated that risk factors of early neurological deterioration (END) post EVT were age, admission systolic blood pressure, initial National Institutes of Health Stroke Scale (NIHSS) scores, hyperlipemia, and location of occlusion [7]. END following an EVT is primarily attributed to unsuccessful recanalization and reperfusion hemorrhages [8]. Several studies have investigated the variables that influence the results of EVT. However, there is a scarcity of studies focusing on the predictors of deterioration following EVT. This study sought to determine the predictors of END after EVT in patients with LVO in the anterior circulation.

Materials and methods

Study design and setting

A retrospective single-center study was conducted at advanced stroke center, National Brain Center Hospital Mahar Mardjono, Jakarta, Indonesia. The study enrolled patients who received EVT for acute ischemic stroke between January 2020 and March 2024. Inclusion criteria were as follows: (i) acute ischemic stroke within 0–12 h of symptom onset, (ii) patients underwent EVT during hospitalization, and (iii) subjects had complete data registry. Exclusion criteria were posterior circulation thrombectomy and missing data.

Variables

END was defined as an increase in NIHSS score ≥ 4 points or death during hospitalization after thrombectomy whitin 24 h. Data being collected were; demographic (age and sex), medical history (hypertension, diabetes mellitus, smoking, previous stroke/transient ischemic attack (TIA), coronary artery disease, and atrial fibrillation based onelectrocardiography findings), clinical data; systolic blood pressure on admission (SBP > 180 mmHg), admission NIHSS score, platelet count, leukocytes count, blood glucose admission, and respiratory, imaging data Alberta Stroke Program Early CT (ASPECT) score, occlusion site (ICA or MCA), and collateral status), and treatment-related characteristics (EVT technique, recanalization status (modified Thrombolysis in Cerebral Infarction Scale (mTICI 0-2a or 2b-3)), door-to-puncture time, onset-to-puncture time, retrieval attempt, puncture-to-recanalization time, intracranial hemorrhage (ICH), and intravenous thrombolysis).

Statistical analysis

We presented the baseline demographics, medical history, clinical data, imaging data, and treatment-related characteristics of the overall study population and stratified by the occurrence of END. We presented continuous variables as means and SDs, whereas continuous variables as frequencies and percentages. All variables were categorized and compared using the chi-square test and the Fisher's exact test. The independent predictors of END after endovascular thrombectomy were determined using a binary logistic regression analysis. We used multivariable logistic regression analysis with the backward stepwise method to identify the predictors. Confounders and variables with a p-value < 0.05 were included in the multivariable logistic regression model. The statistical analysis was performed using IBM SPSS statistics version 27.

Standard protocol approvals, registrations, and patient consents

The study authorized by the Ethics Committee of National Brain Center Hospital Mahar Mardjono (No. DP.04.03/D.XXIII.9/050/2024). Considering the retrospective nature, patient consent was waived. The study was performed in accordance with the principles stated in the Declaration of Helsinki.

Results

A total of 75 patients underwent endovascular thrombectomy at Advanced Stroke Center, National Brain Center Hospital Mahar Mardjono, Jakarta, Indonesia, between January 2020 and March 2024 (Fig. 1). Baseline characteristics are presented in Table 1. Mean age was 58.48 ± 12.45 year, 69.3% of patients were male. The admission NIHSS score was 13.59 ± 3.40. The most prevalent vascular risk factor was hypertension (91.5%). Reperfusion was successfully achieved in 40.0% of the patients. ICH occurred in 29.3% of patients.

END occurred in 22 patients (29.3%). In univariable analysis, the END group had a significantly higher prevalence of ASPECTS < 6 (OR 3.42 (95% CI 1.19–9.81), $p = 0.019$), poor collateral CIS 0–1 (OR 3.40 (95% CI 1.20–9.61), $p = 0.018$), unsuccessful recanalization mTICI (0-2a) (OR 4.33 (95% CI 1.29–14.53), $p = 0.013$), and ICH (OR 2.85 (95% CI 0.99–8.20), $p = 0.048$) (Table 2).

According to multivariable logistic regression adjusting for potential confounders age and sex, unsuccessful recanalization was identified as an independent predictor of END after EVT (OR 4.258 [95% CI 1.078–16.828], $p = 0.039$) (Fig. 2; Table 3).

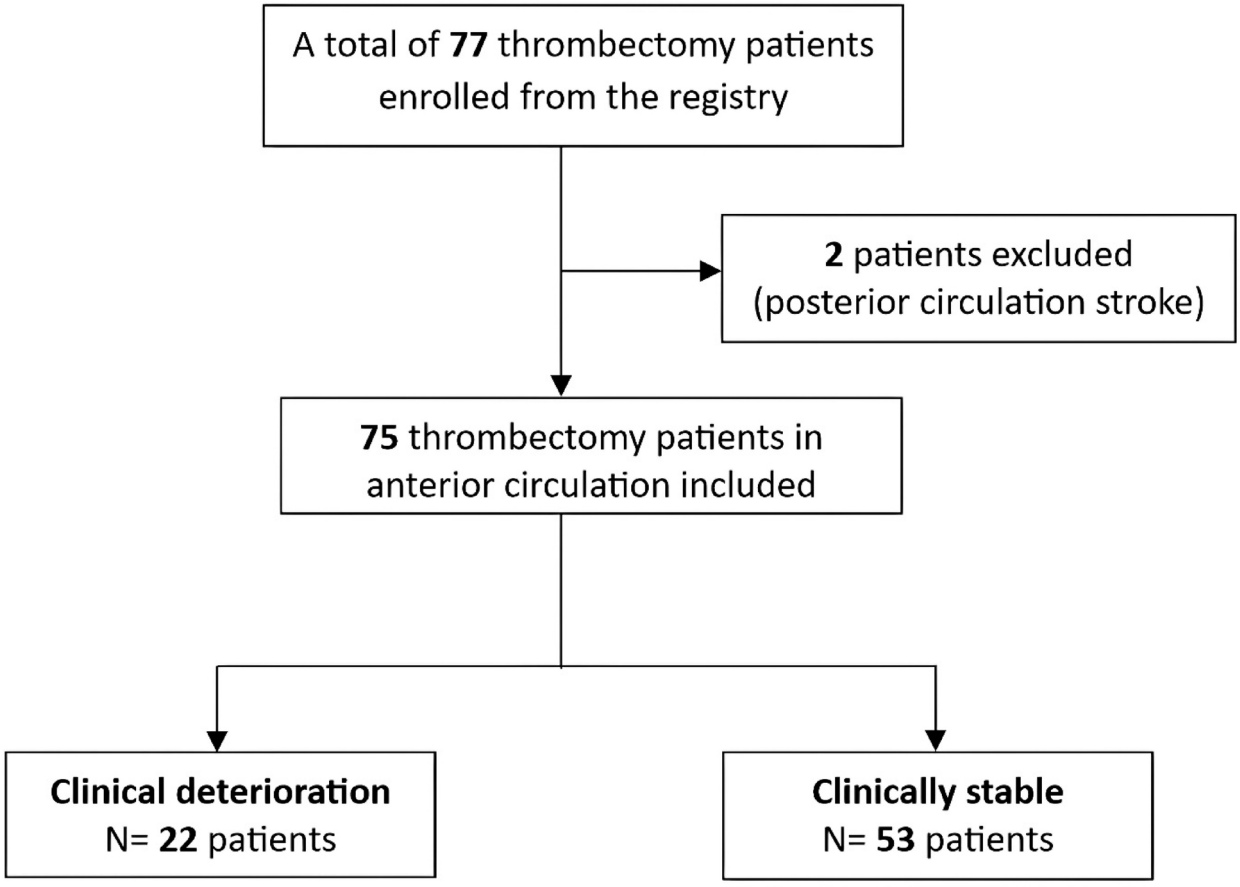

Fig. 1 Subject flow chart

Discussion

This study showed END occurred in 22 of 75 patients (29.3%) within 24 h following EVT. A meta-analysis of randomized controlled trials reported that the incidence of poor prognosis following EVT is 54% [9]. Greater rates of functional outcome following EVT are related to near full or successful recanalization [10]. Unfavorable outcome due to unsuccessful recanalization attributable to several underlying mechanisms. Therefore, investigating recanalization failure is critical. Our findings and recent studies confirmed that recanalization failure plays an important role in the EVT procedure leading to END.

Several previous studies have examined the factors that independently predict the unfavorable outcome and mortality after endovascular thrombectomy. Wu et al. [11]. reported that END after thrombectomy was independently associated with age, admission systolic blood pressure, admission NIHSS, hyperlipidemia, and location of occlusion. A higher NIHSS score upon admission was recently associated with adverse results following endovascular therapy [12]. A retrospective study by Soomro et al. [13] found that high blood glucose admission is an independent predictor of neurological worsening 24 h after EVT. Our study assessed outcomes at different points compared to other studies. In this study, we tried to explore a relationship among many factors such as age, admission NIHSS score, previous stroke or TIA, occlusion site, collateral grade, door-to-puncture time, reperfusion grade, and admission blood glucose. In our study, the only predictors that showed significant associations to END in univariable analysis were unsuccessful recanalization status (mTICI <2b), poor collateral grade, ICH, and low ASPECTS score.

The sole independent predictor of END following endovascular thrombectomy in our study was unsuccessful recanalization based on multivariable analysis. Numerous studies demonstrated the importance of recanalization in EVT. Jeon et al. [14] recently showed that failed reperfusion is associated with unfavorable functional outcome (mRS ≥ 4). In addition, Chen et al. [15]. reported that recanalization failure is associated with early mortality. Broocks et al. [16] discovered a substantial correlation between full recanalization and a greater likelihood of achieving a favorable outcome (mRS score ≤ 3). Wollenweber et al. [17] also revealed that the strong predictor for a favorable outcome was successful reperfusion. According to Winkelmeier et al. [18] complete reperfusion on any attempt decreased the

Table 1 Baseline characteristics

Variables	*n* (%)
Demographic, n(%)	
Age, **years**, **mean ± SD**	58.48 ± 12.45
> 70 years	15 (20.0)
≤ 70 years	60 (80.0)
Sex	
Male	52 (69.3)
Female	23 (30.7)
Medical History, n (%)	
Hypertension	
Yes	69 (92)
No	6 (8)
Diabetes mellitus	
Yes	24 (32.0)
No	51 (68.0)
Smoking history	
Yes	22 (29.3)
No	53 (70.7)
Previous stroke or TIA	
Yes	17 (22.7)
No	58 (77.3)
Coronary artery disease	
Yes	13 (17.31)
No	62 (82.7)
Atrial fibrillation	
Yes	28 (37.3)
No	47 (62.7)
Clinical data, n(%)	
Admission SBP (mmHg), **mean ± SD**	158.03 ± 28.60
> 180	16 (21.3)
≤ 180	59 (78.7)
Admission NIHSS score, **mean ± SD**	13.59 ± 3.40
≥ 10	68 (90.7)
< 10	7 (9.3)
Platelet count (cells/μL)	
< 150.000 cells	2 (2.7)
≥ 150.000 cells	73 (97.3)
Leukocytes, **cells/μL**	
≥ 10.000	38 (50.7)
< 10.000	37 (49.3)
Admission blood glucose (mg/dL)	
≥ 200	20 (26.7)
< 200	55 (73.3)
Respiratory failure	
Yes	8 (10.7)
No	67 (89.3)
Imaging Data, n(%)	
ASPECTS score	
< 6	23 (30.7)
≥ 6	52 (69.3)
Occlusion site	
ICA	32 (42.7)
MCA (M1 and M2)	43 (57.3)
Capillary Index Score (CIS)	

Table 1 (continued)

Variables	*n* (%)
0–1	32 (47.7)
2–3	43 (57.3)
Treatment-related characteristics, n(%)	
Thrombectomy technique	
Stent retriever	40 (53.3)
Contact aspiration	13 (17.3)
Combination	22 (29.3)
Recanalization status	
mTICI 0-2a	45 (60.0)
mTICI 2b-3	30 (40.0)
Door-to-puncture time (hours)	
> 3	37 (49.3)
≤ 3	38 (50.6)
Onset-to-puncture time (hours)	
> 6	39 (52.0)
≤ 6	36 (48.0)
Retrieval attempts number	
> 3	25 (33.3)
1–3	50 (66.7)
Puncture-to-recanalization time (minutes)	
> 60	58 (77.3)
≤ 60	17 (22.7)
Intracranial hemorrhage	
Yes	22 (29.3)
No	53 (70.7)
rtPA administration	
No	40 (53.3)
Yes	35 (46.7)

TIA: transient ischemic attack; SBP: systolic blood pressure; ASPECTS: Alberta stroke programme early CT score, mTICI: modified Treatment in Cerebral Infarction, EVT: Endovascular thrombectomy, ICA: Internal carotid artery; MCA: Middle cerebral artery; NIHSS: National Institutes of Health Stroke Scale, rtPA: recombinant tissue plasminogen activator

likelihood of death compared to failure of reperfusion. Therefore, our findings confirmed the result of previous studies that unsuccessful recanalization is strongly linked with unfavourable outcome post EVT.

A number of investigations have been conducted to explore the impact of collateral status, symptomatic ICH, and lower ASPECTS score regarding the outcome thrombectomy. Our multivariable analysis showed that collateral status and symptomatic ICH were not found to be significantly associated with END. Considering that our sample size may not possess the statistical power to identify the genuine effect. Poor collateral status was associated with unfavorable outcomes, mortality, and malignant brain edema after EVT [14,19,20]. The main role of the collateral circulation is to maintain blood flow to the tissue which usually supplied by an occluded vessel, thereby delaying the progression of tissue from penumbra to infarct. Additionally, ICH is a mortality predictor post EVT [15,19]. A systematic review and meta-analysis by Harker et al. [21] revealed that asymptomatic intracerebral hemorrhage is associated with worse functional outcomes and higher mortality. Furthermore, a previous study reported that lower ASPECTS score was associated with END after EVT. Yoo et al. [22] found that a lower ASPECTS score significantly linked with a higher risk of worse neurological outcomes, symptomatic ICH, and mortality following endovascular treatment of acute ischemic stroke.

Unsuccessful recanalization will result in a more severe stroke and increased cerebral infarct within 24 h [23] Cerebral infarcts that continue to grow after EVT, even if near-complete reperfusion is achieved, lead to a poorer prognosis [24]. In many cases, repeated attempts at recanalization might cause injury to the vessel wall, increasing the risk of a blood vessel tear and bleeding in the brain [25]. However, a study indicates that the benefits of recanalization on outcomes persist without a significant increase in complications [23]. Therefore, it is essential to pursue optimal recanalization in every patient with anterior LVO to reduce significantly higher mortality and disability rates.

Table 2 Univariable analysis

Variables	END *n* (%)	Clinically stable *n* (%)	Odds ratio	95% CI	*p*-value
Demographic, n (%)					
Age > 70 years ≤ 70 years	6 (27.27%) 16 (72.73%)	9 (16.98%) 44 (83.02%)	1.83	0.56–5.97	0.350
Sex Male Female	14 (63.64%) 8 (36.36%)	38 (73.08%) 15 (28.30%)	0.69	0.24–1.980	0.491
Medical History, n (%)					
Hypertension Yes No	22 (100%) 0 (0.0%)	47 (89%) 6 (11%)			0.099
Diabetes mellitus Yes No	8 (36.36%) 14 (63.64%)	16 (30.19%) 37 (69.81%)	1.32	0.46–3.77	0.602
Smoking Yes No	8 (36.36%) 14 (63.64%)	14 (26.42%) 39 (73.58%)	1.59	0.55–4.60	0.389
Previous stroke or TIA Yes No	7 (31.82%) 15 (68.18%)	10 (18.87%) 43 (81.13%)	2.01	0.65–6.22	0.223
Coronary artery disease Yes No	6 (27.27%) 16 (72.73%)	7 (13.21%) 46 (86.79%)	2.46	0.183	0.72–8.43
Atrial fibrillation Yes No	8 (36.36%) 14 (63.64%)	20 (37.74%) 33 (62.26%)	0.94	0.34–2.64	0.911
Clinical Data, n (%)					
Admission SBP (mmHg) > 180 ≤ 180	8 (36.36%) 14 (63.64%)	8 (15.09%) 45 (84.91%)	3.21	1.02–10.14	0.062
Admission NIHSS score ≥ 10 < 10	19 (86.36%) 3 (13.64%)	49 (92.45%) 4 (7.55%)	0.52	0.11–2.53	0.412
Platelet count(cells/μL) < 150.000 ≥ 150.000	0 (0%) 22 (100%)	2 (3.77%) 51 (96.23%)			0.358
Leukocyte (cells/μL) ≥ 10.000 < 10.000	12 (54.55%) 10 (45.45%)	26 (49.06%) 27 (50.94%)	1.25	0.46–3.38	0.665
Admission blood glucose (mg/dL) ≥ 200 < 200	7 (31.82%) 15 (68.18%)	13 (24.53%) 40 (75.47%)	1.44	0.48–4.29	0.516
Respiratory failure Yes No	3 (13.64%) 19 (86.36%)	5 (9.43%) 48 (90.57)	1.52	0.33–6.98	0.686
Imaging Data, n(%)					
ASPECTS score < 6 ≥ 6	11 (50%) 11 (50%)	12 (22.64%) 41 (77.36%)	3.42	1.19–9.81	0.019
Occlusion site ICA MCA (M1 and M2)	11 (50%) 11 (50%)	21 (39.62%) 32 (60.38%)	1.52	0.56–4.14	0.408
Capillary Index Score (CIS) 0–1 2–3	14 (63.64%) 8 (36.36%)	18 (33.96%) 35 (66.04%)	3.40	1.20–9.61	0.018
Treatment-related characteristics, n (%)					

Table 2 (continued)

Variables	END *n* (%)	Clinically stable *n* (%)	Odds ratio	95% CI	*p*-value
Thrombectomy technique	10 (45.45%)	30 (56.60%)	ref	0.497–7.07	0.349
Stent retrieval (ref)	5 (22.73%)	8 (15.10%)	1.87	0.44–4.41	0.567
Contact aspiration	7 (31.82%)	15 (28.30%)	1.4		
Combination					
Recanalization status (mTICI)	18 (81.82%)	27 (50.94%)	4.33	1.29–14.53	0.013
0-2a	4 (18.18%)	26 (49.06%)			
2b-3					
Door-to-puncture time (hours)	13 (59.09%)	24 (45.28%)	1.74	0.64–4.78	0.276
> 3	9 (40.91%)	29 (54.72%)			
≤ 3					
Onset-to-puncture time (hours)	11 (50%)	28 (52.83%)	0.89	0.33–2.41	0.823
> 6	11 (50%)	25 (47.17%)			
≤ 6					
Attempts	9 (40.91%)	16 (30.19%)	1.60	0.57–4.50	0.370
> 3	13 (59.09%)	37 (69.81%)			
1–3					
Puncture-to-recanalization time (minutes)	19 (86.36%)	39 (73.58%)	2.27	0.58–8.88	0.229
> 60	3 (13.64%)	14 (26.42%)			
≤ 60					
Intracranial hemorrhage	10 (45.45%)	12 (22.64%)	2.85	0.99–8.20	0.048
Yes	12 (54.55%)	41 (77.36%)			
No					
rtPA administration	13 (59.09%)	27 (50.94%)	1.39	0.51–3.80	0.920
No	9 (40.91%)	26 (49.06%)			
Yes					

TIA: transient ischemic attack; SBP: Systolic Blood Pressure, ASPECTS: Alberta stroke programme early CT score, CIS: Capillary Index Score, mTICI: modified Treatment In Cerebral Infarction, EVT: Endovascular thrombectomy, END: Early Neurological Deterioration, ICA: Internal carotid artery; MCA: Middle cerebral artery, NIHSS: National Institutes of Health Stroke Scale, rtPA: recombinant tissue plasminogen activator

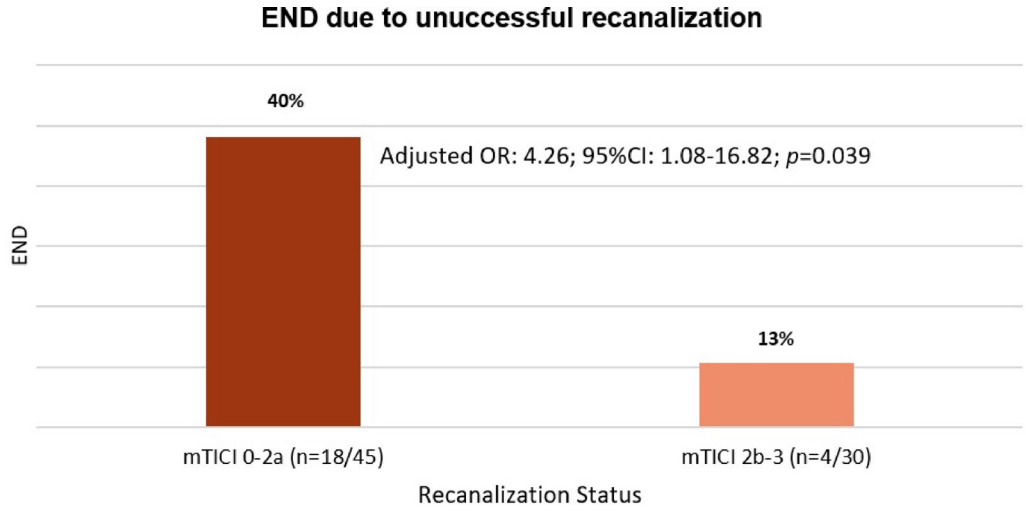

Fig. 2 END due to unsuccessful recanalization

Limitation

This study has several limitations. As a retrospective study, it is susceptible to recall bias and misclassification, especially in medical history. Another limitation of this study is that it is a single-center study with a limited sample size. EVT was performed according to local hospital protocols, mostly using plain CT without perfusion imaging, and the onset from symptoms was less than 12 h. Further investigation is required, including prospective designs, multicenter studies, and a larger sample size to confirm these findings.

Conclusion

Unsuccessful recanalization is an independent predictor of END following EVT for large vessel occlusion in the anterior circulation. Fostering better devices or

Table 3 Multivariable logistic regression analysis

Variable	Adjusted Odds Ratio	95% CI	*p*-value
ASPECTS score < 6	2.85	0.86–9.47	0.087
Poor collateral	2.28	0.69–7.54	0.175
Unsuccessful recanalization	4.26	1.08–16.82	0.039
Intracranial hemorrhage	3.08	0.89–10.65	0.075

* Adjusted for age and sex

techniques to achieve successful recanalization is crucial to enhance the favorable outcomes for patients with anterior LVO.

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Author contributions
RGK, BR, CW, NMR, BTP, and AA contributed to the conception and design of the study, as well as data acquisition. RGK and CW conducted the data analysis and wrote the manuscript. BR and NMR contributed to the data interpretation and manuscript revision. BTP and AA reviewed the results and approved the final version of the manuscript. All authors contributed to reading and approved the submitted version of the manuscript.

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Data availability
The data that support the findings of this study are available from the corresponding author, upon reasonable request.

Declarations

Conflict of interest
The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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References

1. Abbafati C, Abbas KM, Abbasi M, et al. Global burden of 369 diseases and injuries in 204 countries and territories, 1990–2019: a systematic analysis for the global burden of disease study 2019. Lancet. 2020;396(10258). https://doi.org/10.1016/S0140-6736(20)30925-9.
2. The Lancet Regional Health – Southeast Asia. Stroke care in Southeast asia: moving forward. Lancet Reg Health - Southeast Asia. 2023;17. https://doi.org/10.1016/J.LANSEA.2023.100298.
3. VizHub - GBD Compare. Accessed June 7. 2024. https://vizhub.healthdata.org/gbd-compare/#
4. Rennert RC, Wali AR, Steinberg JA, et al. Epidemiology, natural History, and clinical presentation of large vessel ischemic stroke. Clin Neurosurg. 2019;85. https://doi.org/10.1093/neuros/nyz042.
5. Oliveira AJF, Viana SMN, Santos AS. Endovascular thromb ectomy for acute ischemic stroke: systematic review and meta-analysis. Einstein (Sao Paulo). 2022;20. https://doi.org/10.31744/einstein_journal/2022RW6642.
6. Olivot JM, Heit JJ, Mazighi M, et al. What predicts poor outcome after successful thrombectomy in early time window? J Neurointerv Surg. 2022;14(11). https://doi.org/10.1136/neurintsurg-2021-017946.
7. Wu K, Yuan Z, Chen W, et al. A nomogram predicts early neurological deterioration after endovascular thrombectomy in patients with ischemic stroke. Front Neurol. 2023;14:1255476. https://doi.org/10.3389/FNEUR.2023.1255476/BIBTEX.
8. Heitkamp C, Winkelmeier L, Heit JJ, et al. Early neurological deterioration in patients with acute ischemic stroke is linked to unfavorable cerebral venous outflow. Eur Stroke J. 2024;9(1):162. https://doi.org/10.1177/23969873231208277.
9. Goyal M, Menon BK, Van Zwam WH, et al. Endovascular thrombectomy after large-vessel ischaemic stroke: a meta-analysis of individual patient data from five randomised trials. Lancet. 2016;387(10029):1723–31. https://doi.org/10.1016/S0140-6736(16)00163-X.
10. Ghozy S, Kacimi SEO, Azzam AY, et al. Successful endovascular thrombectomy in acute ischemic stroke: revascularization grade and functional independence. J Neurointerv Surg. 2022. https://doi.org/10.1136/neurintsurg-2021-018436.
11. Wu K, Yuan Z, Chen W, et al. A nomogram predicts early neurological deterioration after endovascular thrombectomy in patients with ischemic stroke. Front Neurol. 2023;14:1255476. https://doi.org/10.3389/FNEUR.2023.1255476/BIBTEX.
12. Yoon W, Kim SK, Park MS, Baek BH, Lee YY. Predictive factors for good outcome and mortality after Stent-Retriever thrombectomy in patients with acute anterior circulation stroke. J Stroke. 2017;19(1):97. https://doi.org/10.5853/JOS.2016.00675.
13. Soomro J, Zhu L, Savitz SI, Sarraj A. Predictors of acute neurological worsening after endovascular thrombectomy. Interv Neurol. 2020;8(2–6). https://doi.org/10.1159/000499973.
14. Jeon YS, Kim HJ, Roh HG, et al. Impact of collateral circulation on futile endovascular thrombectomy in acute anterior circulation ischemic stroke. J Korean Neurosurg Soc. 2024;67(1). https://doi.org/10.3340/jkns.2023.0139.
15. Chen Y, Zhou S, Yang S, et al. Developing and predicting of early mortality after endovascular thrombectomy in patients with acute ischemic stroke. Front Neurosci. 2022. https://doi.org/10.3389/fnins.2022.1034472.
16. Broocks G, Hanning U, Bechstein M, et al. Association of thrombectomy with functional outcome for patients with ischemic stroke who presented in the extended time window with extensive signs of infarction. JAMA Netw Open. 2022;5(10):e2235733–2235733. https://doi.org/10.1001/JAMANETWORKOPEN.2022.35733.
17. Wollenweber FA, Tiedt S, Alegiani A, et al. Functional outcome following stroke thrombectomy in clinical practice. Stroke. 2019;50(9):2500–6. https://doi.org/10.1161/STROKEAHA.119.026005/SUPPL_FILE.
18. Winkelmeier L, Faizy TD, Broocks G, et al. Association between recanalization attempts and functional outcome after thrombectomy for large ischemic stroke. Stroke. 2023;54(9):2304–12. https://doi.org/10.1161/STROKEAHA.123.042794/SUPPL_FILE/STR_STROKE-2023-042794_SUPP2.PDF.
19. Zhang X, Yuan K, Wang H, et al. Nomogram to predict mortality of endovascular thrombectomy for ischemic stroke despite successful recanalization. J Am Heart Assoc. 2020. https://doi.org/10.1161/JAHA.119.014899.
20. Huang X, Yang Q, Shi X, et al. Predictors of malignant brain edema after endovascular thrombectomy for acute ischemic stroke. J Neurointerv Surg. 2019. https://doi.org/10.1136/neurintsurg-2018-014650.
21. Harker P, Aziz YN, Vranic J, et al. Asymptomatic intracerebral hemorrhage following endovascular stroke therapy is not benign: a systematic review and Meta-Analysis. J Am Heart Assoc. 2024. https://doi.org/10.1161/JAHA.123.031749.
22. Yoo AJ, Zaidat OO, Chaudhry ZA, et al. Impact of pretreatment Noncontrast CT Alberta stroke program early CT score on clinical outcome after intra-arterial stroke therapy. Stroke. 2014;45(3):746–51. https://doi.org/10.1161/STROKEAHA.113.004260.
23. Guo Y, Guo C, Yang D, Fan S, Xu X, Ma J, Li Z, Yang S, Shi X, Wang Z, Zi W, Zeng G, Huang X. The number of recanalization attempts, procedure time and endovascular therapy outcomes in acute large core stroke patients. J Neuroradiol. 2025;52(2):101241. https://doi.org/10.1016/j.neurad.2024.101241.
24. Ospel JM, Rex N, Oueidat K, McDonough R, Rinkel L, Baird G, Collins S, Jindal G, Alvin MD, Boxerman J, Barber P, Jayaraman M, Smith W, Amirault-Capuano A, Hill MD, Goyal M, McTaggart R. Infarcts due to large vessel occlusions

continue to grow despite Near-Complete reperfusion after endovascular treatment. J Stroke. 2024;26(2):260–8. https://doi.org/10.5853/jos.2023.02621.
25. Uchida K, Sowlat MM, Matsukawa H, Elawady SS, Alawieh MD, Cunningham C A, et al. Impact of successful recanalization and clinical outcomes of patients with acute ischemic stroke with 5 or more thrombectomy passes. Stroke Vasc Interv Neurol. 2024;4:e001107. https://doi.org/10.1161/SVIN.123.001107.

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