Article published online: 2022-12-14

Treatment Outcomes of Mechanical Thrombectomy in Patients with Acute Posterior Circulation Stroke

Boonrerk Sangpetngam[1] Suwit Maicharoen[1] Pattarawit Withayasuk[1] Anchalee Churojana[1] Ekawut Chankaew[2] Thaweesak Aurboonyawat[2] Atthaporn Roongsitthichai[3] Jirapong Vongsfak[1,4]

[1] Division of Diagnostic Radiology, Department of Radiology, Faculty of Medicine, Siriraj Hospital, Mahidol University, Bangkok, Thailand
[2] Division of Neurosurgery, Department of Surgery, Faculty of Medicine, Siriraj Hospital, Mahidol University, Bangkok, Thailand
[3] Faculty of Veterinary Sciences, Mahasarakham University, Mahasarakham, Thailand
[4] Division of Neurosurgery, Department of Surgery, Faculty of Medicine, Chiang Mai University, Chiang Mai, Thailand

AJNS 2022;17:606–613.

Address for correspondence Boonrerk Sangpetngam, MD, Division of Diagnostic Radiology, Department of Radiology, Faculty of Medicine, Siriraj Hospital, Mahidol University, Bangkok, 10700, Thailand (e-mail: dboonrerk@gmail.com).

Abstract

Objective The benefits of mechanical thrombectomy (MT) in patients with acute posterior circulation stroke remain unclear. Currently, there is no evidence from randomized control trials to show the safety and effectiveness of MT in patients with posterior circulation stroke. This study was to evaluate the treatment outcomes of MT in posterior circulation stroke patients enrolling in our hospital during 2010 to 2020.

Materials and Methods Between January 2010 and December 2020, 66 patients with acute posterior circulation stroke underwent MT. Data collected and analyzed included demographics, comorbidity, National Institutes of Health Stroke Scale (NIHSS), procedure time, site of occlusion, presence of posterior communicating artery (PCoA), endovascular technique, and modified Rankin Scale (mRS). Good clinical outcome was defined by mRS at 2 or less at 90 days after MT.

Statistical Analysis Variables with normal distribution were reported with mean ± standard deviation, meanwhile those with nonnormal distribution were demonstrated with median and range. Fisher's exact test for categorical variables or Mann–Whitney *U* test for continuous variables was performed. Multivariate logistic regression analysis with binary logistic regression method was used analyze the association between the prognosis factor and good outcome. Statistical significance was defined when *p*-value less than 0.05.

Results The mean age of patients was 65.2 years with male predominance. The median NIHSS was 18.5. Successful recanalization (modified thrombolysis in cerebral infarction 2b-3) was achieved in 61/66 cases (92.42%) and postprocedure symptomatic intracerebral hemorrhage occurred in 5/66 cases (7.60%). Successful recanalization with good clinical outcome was obtained from 30 of 61 cases (49.18%); it was also

Keywords
- posterior circulation stroke
- mechanical thrombectomy
- acute stroke

article published online
December 14, 2022

DOI https://doi.org/10.1055/s-0042-1758848.
ISSN 2248-9614.

Thieme Medical and Scientific Publishers Pvt. Ltd., A-12, 2nd Floor, Sector 2, Noida-201301 UP, India

associated with distal basilar artery occlusion ($p = 0.035$) and PCoA patency presence ($p = 0.024$). Our study showed the correlation between good treatment outcomes with initial NIHSS less than 20, intravenous recombinant tissue-type plasminogen activator, pre-MT magnetic resonance imaging Q5 brain, and contact aspiration MT technique.
Conclusion MT is beneficial to patients with posterior circulation stroke. A good clinical outcome was significantly associated with distal basilar artery occlusion and PCoA patency presence within a group of successful recanalization.

Introduction

Acute posterior circulation stroke is found in approximately 1% of patients with ischemic stroke and contributes to a high mortality rate (85–95%) if untreated.[1] The previous studies demonstrated that treatment with intravenous recombinant tissue plasminogen activator (rt-PA) administration and mechanical thrombectomy (MT) is still limited due to incidents and unfavorable outcomes of treatment.[2,3] The Endovascular Stroke Treatment (ENDOSTROKE) registry revealed that functional outcomes after endovascular treatment which is widely applied in German and Austrian stroke centers contributed to poor safety, technical success, and clinical efficacy.[4]

In our hospital guideline for MT was established in 2015. The patient selection for MT has been protocoled by using computed tomography angiography (CTA) or CT perfusion for anterior circulation and magnetic resonance imaging (MRI) core infarction for posterior circulation. According to guidelines of the early management of patients with acute ischemic stroke, patients with posterior circulation stroke are advisable to receive MT if they are indicated in class IIb based on Class of Recommendations and Class C on Level of Evidence (LOE).[5]

Good or poor outcomes after MT procedure in patients with posterior circulation strokes are associated with several factors, such as age, gender, and pre-stroke modified Rankin Scale (mRS) of patients including intravenous thrombolysis administration, initial National Institutes of Health Stroke Scale (NIHSS), comorbidity diseases, smoking or alcohol consumptions, imaging data, mode of anesthesia, devices, number of attempts, occlusion location, onset to groin puncture time, and recanalization time.[6–11] The purpose of this study is to evaluate primary clinical outcomes of patients with acute posterior circulation stroke who underwent MT treatment and to assess factors associated with the good outcome of treatment.

Materials and Method

Study Design

The institutional ethics review board committee approved this retrospective analysis to use patient charts, imaging data, and waived informed consent on this basis of the study design (SIRB protocol No. IRB4–948/2563 [2019]).

Inclusion and Exclusion Criteria

A total of 549 medical records of patients with acute ischemic stroke who underwent cerebral angiogram from January 2010 to December 2020 were investigated. The inclusion criteria consisted of clinical signs, imaging data, angiographic findings, and outcome data from patients diagnosed with acute stroke with or without undergoing MT and followed up at 90 days. The exclusion criteria were those with incomplete clinical and/or imaging data and without large vessel occlusion (LVO) from the cerebral angiogram. As a result, 80 patients with acute anterior circulation ischemic stroke and 6 patients with acute posterior circulation ischemic stroke were excluded because LVO did not exist in the cerebral angiogram and MT was not performed. Finally, 463 medical records were retrospectively investigated. They were composed of 397 patients with acute anterior circulation ischemic stroke and 66 patients with acute posterior circulation ischemic stroke treated with MT.

Mechanical Thrombectomy for Posterior Circulation Stroke Guideline in our Hospital

According to our guideline for MT in patients with acute posterior circulation stroke, the criteria for patient selection were LVO of posterior circulation (vertebrobasilar system) without clinical signs or images of extensive brainstem infarction within 24 hours of symptom onset, NIHSS of 6 or greater, age of 18 years or less, and prestroke mRS less than 2.

All patients were initially investigated with a noncontrast CT scan to exclude any contraindication for MT, such as intracranial hemorrhage and large area of infarction. The MRI brain stroke protocol emergency was always performed in suspected cases of posterior circulation stroke in the same protocol for examining the presence or absence of extensive brainstem infarction that defined as clinical that involved large area of brainstem and cerebellar such as comatose condition, contralateral hemiparesis, multiple cranial nerve involvement, cerebellar deficit, or ataxia. However, in the case that MRI is not available because of coronavirus disease 2019 since 2020 or the patient who had alteration of consciousness and not cooperated during MRI, either single-phase CTA or multiphase CTA was accepted in the patients without clinical signs of brainstem infarction according to the decision of the intervention neuroradiologist consultant.

In our institute, the MT procedure was performed by four interventional neuroradiologists. Based on an economic concern, aspiration technique was considered the primary procedure in the selected case. The stent retrieval technique was a rescue treatment in cases where the occlusion persisted after the attempt of aspiration technique. However, the stent retrieval technique could be primarily performed in those with the site of occlusion or occlusion pattern from reviews of noninvasive imaging at segment occlusion, or dependent on the operator's justification.

General anesthesia was applied in selected cases to secure the airway during the procedure especially in noncooperative patient and depended on the operator's preference. All post-MT patients were closely observed at the stroke unit.

A noncontrast CT was routinely performed within the first 24 hours after MT to rule out any kind of hemorrhage. Antiplatelet or anticoagulation therapy was then initiated. The alternatives of therapy were dependent on neurologist's guideline based on the suspected etiology of the stroke.

Post-MT follow-up was performed either at the outpatient department (OPD) or via telephone for surveying the clinical signs either with patients or their caregivers. This approach was routinely scheduled at 30 and 90 days post-MT for assessing the treatment outcomes.

Outcome Measurements

Case record forms were used to collect information on clinical signs, imaging data, angiographic findings, and treatment outcomes. Follow-up data of the investigated patients included gender, age, comorbidity (diabetes mellitus, hypertension, dyslipidemia, atrial fibrillation, old cerebrovascular accident, coronary artery disease, cigarette smoking), initial NIHSS, initial Glasgow Coma Scale (GCS), baseline mRS score, intravenous alteplase administration, mode of anesthesia, MT procedure, rescue procedures, post-MT NIHSS, stroke subtype according to the TOAST classification, clot pathology result, postprocedural symptomatic intracranial hemorrhage (sICH) 24-hour, and length of hospital stay.

Location of the clot was divided into the distal basilar artery (involvement of P1 or P2 segments of the posterior cerebral artery [PCA] to the distal origin of the superior cerebellar arteries [SCAs]), the mid-basilar artery (involvement of the segment between origins of the anterior inferior cerebellar arteries [AICAs] to the origins of SCA), the proximal basilar artery (involvement of the vertebrobasilar junction to the origins of the AICA), and the vertebral artery. The presence of posterior communicating artery (PCoA) for this study included the presence of P1 segment of the PCA attaching to the basilar artery apex and fetal origin PCA. The posterior circulation-Alberta Stroke Program Early CT Score (pc-ASPECTS) was assessed by retrospective review of the PCoA to visualize the PCoA artery of pre-MT CTA, magnetic resonance angiography, and/or cerebral angiography.

Postprocedural sICH was defined as blood found at any site of the brain within 24 hours after noncontrast CT scan. Stroke subtype was defined according to the TOAST classification. Successful revascularization was recognized when score of modified thrombolysis in cerebral infarction (mTICI) reached 2b or 3.

The clinical outcome was assessed with mRS at 90 days by clinical follow-up at OPD or telephone interview with the patients or caregivers. A good outcome at 90 days was considered when mRS was scored 0 to 2.

Statistical Analysis

All categorical data, including gender, comorbidity, smoking status, imaging modality and evaluation, occlusion site, history of intravenous alteplase administration, general anesthesia, primary procedural MT, first-pass success, rescue procedures, complete reperfusion, postprocedural sICH, stroke subtype, clot pathology, post-24-hour NIHSS, and dead, were collected and analyzed statistically with SPSS Statistics version 18.0. Continuous variables consisted of age, initial NIHSS score, initial GCS, initial mRS, initial systolic blood pressure (SBP), pc-ASPECTS, onset to puncture, onset to recanalization, CT to puncture, puncture to recanalization, mTICI score, and length of stay. Variables with normal distribution were reported with mean ± standard deviation, meanwhile those with nonnormal distribution were demonstrated with median and range. Data between good (mRS 0–2) and poor outcome (mRS 3–6) groups were assessed either by Fisher's exact test for categorical variables or Mann–Whitney *U* test for continuous variables. Multivariate logistic regression analysis with binary logistic regression method was performed to analyze the association between the prognosis factor and good outcome. Statistical significance was defined when *p*-value less than 0.05.

Results

MT was performed in a total of 463 patients. Of those, 397 (86%) patients were diagnosed with acute anterior circulation stroke; meanwhile, 66 (14%) patients were acute posterior circulation stroke as demonstrated in ►**Fig. 1**. For acute anterior circulation stroke, the number of patients with a good outcome (mRS 0–2) was 213 out of 397 (53.66%), whereas those with poor outcome (mRS 3–6) were 184 from 397 (46.34%). According to posterior circulation stroke,

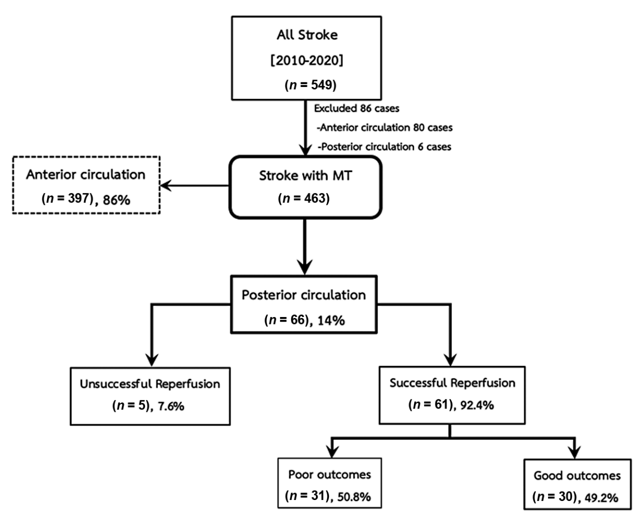

Fig. 1 Flowchart of patient selection and outcomes.

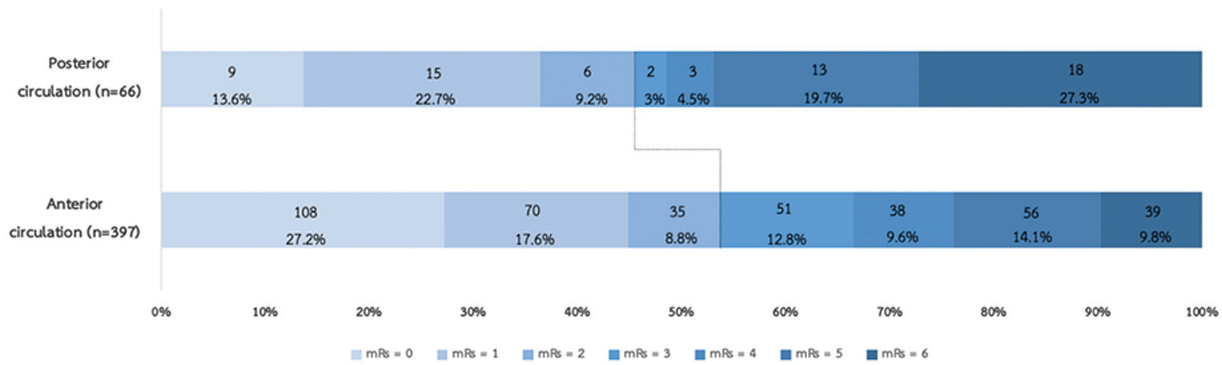

Fig. 2 Distribution of 90-day modified Rankin Scale (mRS) scores stratified by stroke location.

the patients with a good outcome were 30 out of 66 (45.45%) where those with poor outcome were 36/66 (54.55%). The outcomes of MT between both groups were not statistically different from each other ($p = 0.21$), as illustrated in ►**Fig. 2**.

According to the demographic data, it was found that 39 (59.1%) men and 27 (40.9%) women underwent posterior circulation stroke. The mean age at onset of stroke was 65.21 ± 12.72 years old, and the initial NIHSS mean was 18.5. Most common comorbidities of patients were hypertension (92.4%), dyslipidemia (62.1%), atrial fibrillation (47%), diabetes mellitus (45.5%), old cerebrovascular accident (25.8%), and coronary artery disease (18.2%). Note that 33.3% of the patients were smokers and received intravenous rt-PA administration during observation and general anesthesia was applied in most cases (87.9%). Stent retriever MT (51.5%) technique was considered as a primary procedure, on the other hand, contact aspiration MT (48.5%), which made first-pass success 40.9% and need for rescue procedure was 59.1%.

Successful reperfusion (mTICI = 2b-3) was achieved in 61/66 (92.42%), which is 30/61 (49.18%) for good outcome and 31/61 (50.82%) for poor outcome; on the other hand, unsuccessful reperfusion (mTICI = 0–2a) occurred in 5/66 (7.6%), which is 2/5 (40%) for bedridden status and 3/5 (60%) for dead. Also, the rate of postprocedural sICH was 5/66 (7.6%), mortality rate was 19/66 (31.18%), and length of hospital stay was 12.5 days (►**Table 1**).

For patients with successful reperfusion (mTICI = 2b–3), our results also showed males and age over 60 years were predominated, initial NIHSS mean was 19 (good outcome 14 vs. poor outcome 21, $p = 0.001$), which showed statistical significance. For comorbidity, history of smoking, intravenous rt-PA administration, and mode of anesthesia showed no statistical significance, except for the presence of PCoA which is 50/61 (82%) of our case and showed statistical significance (96.7% vs. 67.7%, $p = 0.004$). Fifteen of 30 (50%) distal basilar artery occlusion cases showed good outcomes while 10/31 (32.3%) of middle basilar artery occlusion cases showed poor outcomes, which is statistically significant (50% vs. 32.3%, $p = 0.023$). About the timing of intervention, primary procedural MT, first-pass success, rescue procedure, reperfusion grade, post-procedural sICH, stroke subtype, and clot pathology, no statistically significant relation was observed. Lastly, patients who were clinically the same or Additionally, for the patients with stable or worsening clinical symptoms after treatment compared with the initial NIHSS within 24 hours presenting poor outcomes with statistically significant. A good clinical outcome has a shorter length of hospital stay (10 days) while poor clinical outcome is associated with longer length of hospital stay (20 days), which showed statistical significance (10 vs. 20 days, $p = 0$) (►**Table 2**).

In multivariate logistic regression analysis with binary logistic regression method, distal basilar artery occlusion (adjusted odds, 9.393; 95% confidence interval, 1.176–75.018; $p = 0.035$) and PCoA patency presentation (adjusted odds, 17.397; 95% confidence interval, 1.449–208.939; $p = 0.024$) were significantly related to 90 days with good outcome after successful reperfusion (►**Table 3** and ►**Fig. 3**).

Discussion

The effectiveness of MT for acute posterior circulation stroke patients was achieved in up to 92.4% by successful recanalization (mTICI 2b–3); of those, good clinical outcome (mRS 0–2) was 45.45%. The reason for 45.45% of good clinical outcomes despite 92.4% successful recanalization was probably due to a natural history of posterior circulation usually presented with higher initial NIHSS which is associated with poor outcome. Moreover, our study demonstrates a higher successful recanalization rate and good outcomes compared with other studies.[4,12] This corresponded with a previous study in China reporting that successful recanalization accounted for 89.9% with 36.2% good outcome at 90 days.[6] Based on the initial NIHSS, the present study demonstrated that it was significantly associated with good outcome. Correspondingly, a former study in the U.S. indicated that the NIHSS score is a factor associated with a favorable prognosis.[7] Moreover, the ENDOSTROKE study, based on the univariate analysis, showed that the NIHSS score, absence of hemorrhagic transformation, and MRI compared with CT in the preoperative imaging were significantly relevant to favorable outcomes. Meanwhile, the multivariate analysis revealed that the NIHSS score, implementation of MRI, and the presence of favorable collateral circulation were significant parameters.[4] This study showed statistical significance only on NIHSS score, suggesting that low initial NIHSS score contribute to a good outcome. Khatibi et al reported

Table 1 Demographics as well as procedural and clinical outcomes of patients undergoing mechanical thrombectomy after acute posterior circulation stroke

Variables	Over All ($n=66$)	Good outcome ($n=30$)	Poor outcome ($n=36$)	*p*-Value
Male, *n* (%)	39 (59.09)	17 (56.6)	22 (61.1)	0.714
Age (y), mean ± SD	65.21 ± 12.72	64.13 ± 13.04	66.11 ± 12.55	0.534
Initial NIHSS, mean (range)	18.5 (4–32)	14 (4–31)	21 (8–32)	0.001[a]
Comorbidity				
Diabetes mellitus, *n* (%)	30 (45.50)	11 (36.7)	19 (52.8)	0.191
Hypertension, *n* (%)	61 (92.40)	26 (86.7)	35 (97.2)	0.169
Dyslipidemia, *n* (%)	41 (62.10)	17 (56.7)	24 (66.7)	0.404
Atrial fibrillation, *n* (%)	31 (47)	18 (60)	13 (36.1)	0.053
Old cerebrovascular accident, *n* (%)	17 (25.80)	8 (26.7)	9 (25)	0.877
Coronary artery disease, *n* (%)	12 (18.20)	4 (13.3)	8 (22.2)	0.351
History of smoking, *n* (%)	22 (33.33)	9 (30)	13 (36.1)	0.6
IV rt-PA administration, *n* (%)	22 (33.30)	14 (46.7)	8 (22.2)	0.036[a]
General anesthesia, *n* (%)	58 (87.9)	24 (80)	34 (94.4)	0.128
Contact aspiration MT, *n* (%)	32 (48.50)	17 (56.7)	15 (41.7)	0.471
Stent retriever MT, *n* (%)	34 (51.50)	13 (43.3)	21 (58.3)	0.471
First-pass success, *n* (%)	27 (40.90)	13 (43.3)	14 (38.9)	0.715
Rescue procedures, *n* (%)	39 (59.10)	17 (56.6)	22 (61.1)	0.715
Successful recanalization (mTICI = 2b–3), *n* (%)	61 (92.40)	30 (100)	31 (86.1)	0.145
Unsuccessful recanalization (mTICI = 0–2a), *n* (%)	5 (7.60)	0	5 (13.9)	0.145
NIHSS of post-MT 24 hour, median (range)	12 (0–37)	6 (0–17)	22 (5–37)	0[a]
Postprocedural sICH, *n* (%)	5 (7.60)	1 (3.3)	4 (11.1)	0.366
Dead, *n* (%)	19 (31.18)	0	19 (52.8)	0[a]
LOS (d), median (range)	12.5 (1–121)	10 (1–50)	17 (1–121)	0.046[a]

Abbreviations: IV, intravenous; LOS, length of stay; MT, mechanical thrombectomy; mTICI, modified thrombolysis in cerebral infarction; NIHSS, National Institutes of Health Stroke Scale; rt-PA, recombinant tissue-type plasminogen activator; SD, standard deviation; sICH, symptomatic intracerebral hemorrhage.
[a]Statistical significance.

that the use of MRI as the initial imaging modality can prolong time to intervention in case of posterior circulation stroke, though it provides valuable additional prognostic information which can lead to a more informed approach to acute stroke intervention decision.[8] In addition, MRI was also useful to select patients for this study to get good outcome. However, such association was not statistically significant. It might be due to the limited number of patient participation.

pc-ASPECTS on diffusion-weighted imaging (DWI) in predicting functional outcome in acute posterior circulation ischemic stroke patients appeared to be a powerful marker according to the report of Tei et al and Garg and Biller.[9,10] It was documented that DWI pc-ASPECTS of 8 or higher is the only independent predictor for favorable outcomes in patients with acute basilar artery occlusion.[11] In our study, provided that MRI was unavailable, single-phase CTA or multiphase CTA were acceptable for deciding if MT should be conducted in those without clinical signs of brainstem infarction and area of large infarction from noncontrast CT.

The presence of bilateral PCoA on pretreatment CTA appears to be associated with more decent outcome in patients affected with basilar artery occlusion and received endovascular treatment.[13] A previous study demonstrated that an appearance of one or more patent PCoA is associated with a lower risk of poor outcome.[10] This corresponded to the current study that the presence of PCoA patency correlated with good outcome. By retrospective review, PCoA was used to visualize the PCoA artery of pre-MT CTA and/or cerebral angiography. The relationship between clot location and outcome after basilar artery thrombolysis was also reported by Cross et al, who found that the single best predictor of survival after basilar thrombosis and intra-arterial thrombolysis is distal clot location.[14] Likewise, the present study

Table 2 Comparison between good and poor outcomes at 90 days in patients with successful revascularization after mechanical thrombectomy

Variables	Overall ($N=61$)	Good outcome ($n=30$)	Poor outcome ($n=31$)	*p*-Value
Male, *n* (%)	35 (57.40)	17 (56.70)	18 (58.10)	0.912
Age > 60, *n* (%)	38 (62.30)	18 (60)	20 (64.50)	0.718
Initial NIHSS score, mean (range)	19 (4–32)	14 (4–31)	21 (8–32)	0.001[a]
Comorbidity				
Diabetes mellitus, *n* (%)	27 (44.30)	11 (36.70)	16 (51.60)	0.24
Hypertension, *n* (%)	56 (91.80)	26 (86.70)	30 (96.60)	0.195
Dyslipidemia, *n* (%)	36 (59)	17 (56.70)	19 (61.30)	0.714
Atrial fibrillation, *n* (%)	30 (49.20)	18 (60)	12 (38.70)	0.096
Old cerebrovascular accident, *n* (%)	16 (26.20)	8 (26.70)	8 (25.80)	0.939
Coronary artery disease, *n* (%)	11 (18)	4 (13.30)	7 (22.60)	0.348
History of smoker, *n* (%)	18 (29.50)	9 (30)	9 (29)	0.934
IV rt-PA administration, *n* (%)	22 (36.10)	14 (46.70)	8 (25.80)	0.09
Cord sign on NCCT, *n* (%)	44 (72.10)	20 (66.70)	24 (77.40)	0.353
PCoA patency presentation, *n* (%)	50 (82)	29 (96.70)	21 (67.70)	0.004[a]
pc-ASPECTS, median (range)	9 (5–10)	9 (6–10)	8 (5–10)	0.14
General anesthesia, *n* (%)	53 (86.90)	24 (80)	29 (93.50)	0.147
Occlusion site				
Distal BA, *n* (%)	23 (37.70)	15 (50)	8 (25.80)	0.023[a]
Middle BA, *n* (%)	18 (29.50)	8 (26.70)	10 (32.30)	
Proximal BA, *n* (%)	11 (18)	6 (20)	5 (16.10)	
VA, *n* (%)	9 (14.80)	1 (3.3)	8 (25.80)	
Timing of intervention				
Onset to puncture, median (range)	285 (95–895)	325.50 (110–895)	244 (95–880)	0.323
Onset to recanalization, median (range)	350 (129–1,050)	411 (170–960)	296 (129–1,050)	0.466
CT to puncture, median (range)	88 (32–400)	93.5 (40–400)	81 (32- 205)	0.126
Puncture to recanalization, median (range)	45 (7–182)	41 (8–182)	52 (7–170)	0.767
Primary procedural MT				
Contact aspiration MT, *n* (%)	31 (50.80)	17 (56.70)	14 (45.20)	0.396
Stent MT, *n* (%)	30 (49.20)	13 (43.30)	17 (54.8)	
Solitaire stent retriever MT, *n* (%)	28 (93.30)	12 (92.30)	16 (94.10)	1
Trevo stent retriever MT, *n* (%)	2 (6.70)	1 (7.70)		1 (5.90)
First-pass success, *n* (%)	26 (42.60)	13 (43.30)	13 (41.90)	0.835
Rescue procedures, *n* (%)	35 (57.40)	17 (56.70)	18 (58.10)	0.913
Aspiration MT, *n* (%)	12 (19.70)	5 (16.70)	7 (22.60)	0.835
Stent retriever MT, *n* (%)	23 (37.70)	12 (40)	11 (35.50)	
Incomplete reperfusion (mTICI = 2b), *n* (%)	23 (37.70)	12 (40)	11 (35.50)	0.718
Completed reperfusion (mTICI = 3), *n* (%)	38 (62.30)	18 (60)	20 (64.50)	
Postprocedural sICH, *n* (%)	4 (6.60)	1 (3.30)	3 (9.70)	0.612
Dead, *n* (%)	16 (26.2)	0	16 (51.6)	0[a]
Stroke subtype (TOAST classification)				
Cardioembolic, *n* (%)	41 (67.20)	20 (66.70)	21 (67.70)	0.223
Large vessel arterosclerosis (ICAD), *n* (%)	17 (27.90)	7 (23.30)	10 (32.30)	
Undetermined etiology, *n* (%)	3 (4.90)	3 (10)	0 (0)	

(*Continued*)

Table 2 (*Continued*)

Variables	Overall ($N=61$)	Good outcome ($n=30$)	Poor outcome ($n=31$)	*p*-Value
Clot pathology				
Fibrin thrombus, *n* (%)	7 (11.5)	2 (6.70)	5 (16.10)	0.395
Recent thrombus, *n* (%)	44 (72.10)	24 (80)	20 (64.50)	
Post-24-h NIHSS equally or increased, *n* (%)	25 (41)	5 (16.70)	20 (64.5)	0[a]
LOS (d), median (range)	13 (1–121)	10 (1–50)	20 (1–121)	0[a]

Abbreviations: BA, basilar artery; CT, computed tomography; ICAD, intracranial atherosclerotic disease; IV, intravenous; LOS, length of stay; MT, mechanical thrombectomy; mTICI, modified thrombolysis in cerebral infarction; NCCT, noncontrast computed tomography; NIHSS, National Institutes of Health Stroke Scale; pc-ASPECTS, posterior circulation Alberta Stroke Program Early CT Score; PCoA, posterior communicating artery; rt-PA, recombinant tissue-type plasminogen activator; sICH, symptomatic intracerebral hemorrhage; VA, vertebral artery.
[a]Statistical significance.

Table 3 Association between prognosis factor and outcome in patients with acute posterior circulation stroke

Risk factors	Good outcome	Poor outcome	Adjusted odds (95% CI lower–upper limit)	*p*-Value
Initial NIHSS < 20 ($n=31$)	22 (73.5%)	9 (29%)	1.731 (0.247–12.139)	0.581
IV rt-PA administration ($n=22$)	14 (46.7%)	8 (25.8%)	2.621 (0.449–15.299)	0.284
MRI brain performed ($n=14$)	9 (30%)	5 (16.1%)	1.078 (0.152–7.651)	0.940
Distal basilar artery occlusion ($n=23$)	15 (50%)	8 (25.8%)	9.393 (1.176–75.018)	0.035[a]
PCoA patency presentation ($n=50$)	29 (96.7%)	21 (67.7%)	17.397 (1.449–208.939)	0.024[a]
Aspiration MT ($n=31$)	17 (56.7%)	14 (45.2%)	3.188 (0.554–18.342)	0.194

Abbreviations: CI, confidence interval; IV, intravenous; MRI, magnetic resonance imaging; MT, mechanical thrombectomy; NIHSS, National Institutes of Health Stroke Scale; PCoA, posterior communicating artery; rt-PA, recombinant tissue-type plasminogen activator.
[a]Statistical significance.

also indicated that the basilar artery occlusion is significantly associated with good outcome, whereas the occlusion at the middle basilar artery resulted in poor outcome. According to the etiology of clot defined by TOAST's classification, our cases correlated with cardioembolism which the distal basilar artery occlusion was easier to recanalize; meanwhile, that at proximal and middle basilar artery is in association with intracranial atherosclerotic disease which was difficult and required rescue procedures for recanalization.

In the multivariate analysis, distal basilar artery occlusion and presence of PCoA patency were significantly related to good outcome after successful recanalization as shown in ►**Table 3** and ►**Fig. 3**. In addition, aspiration MT, intravenous rt-PA administration, initial NIHSS below 20, and MRI brain image were associated with a good outcome but not significant statistically.

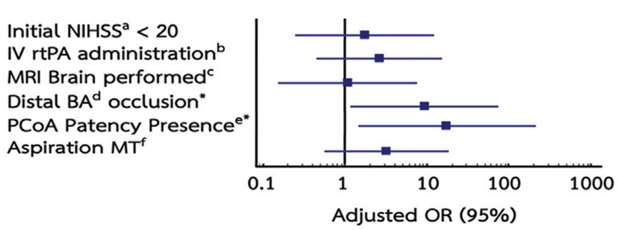

Fig. 3 Multivariate assessment for the association between prognosis factors and good outcome in patients with acute posterior circulation stroke.

The direct-aspiration first-pass technique may be a good option as the first-line strategy to improve the rate of complete reperfusion and reduce procedure duration.[15] Our results in the current study also demonstrated a good outcome with aspiration since the primary MT with first-pass success was 42.6%. However, the aspiration and outcome from stent retrieval MT in this study was not statistically significant.

A good outcome, in this study, was not influenced by age, gender, comorbidity, intravenous rt-PA administration, mode of anesthesia, timing of intervention, primary procedure, rescue procedure, stroke subtype, and clot pathology. The overall safety outcome in the present study was 7.6% for postprocedural sICH and 31.18% for mortality, which were similar to 6.3% for postprocedural sICH and 25% for mortality as reported by Gilberti et al.[11] However, those lower proportions might be due to the fewer patients than those in our study.

Conclusion

The present study demonstrated the efficient outcomes of MT in patients with acute posterior circulation stroke. Factors associated with good outcome were distal basilar artery occlusion and PCoA patency presentation which also helped reduce the hospitalization length in our patient.

Authors' Contributions

B.S. and A.C. contributed to conceptualization; S.W. performed data collection; S.W., B.S., P.W. contributed to formal analysis; S.W., B.S. contributed to writing-original draft; S.W., B.S., T.A., E.C., A.R., A.C., and J.V. contributed to writing-review and editing.

Funding

None.

Conflict of Interest

The authors declared no potential conflicts of interest for the research, authorship, and/or publication of this article.

Acknowledgments

The authors were grateful to all our stroke patients, clinician staff, colleague's fellows, nurses, and radiology technicians for their perseverance and dedication to the present study.

References

1 Mattle HP, Arnold M, Lindsberg PJ, Schonewille WJ, Schroth G. Basilar artery occlusion. Lancet Neurol 2011;10(11):1002–1014

2 Strbian D, Sairanen T, Silvennoinen H, Salonen O, Kaste M, Lindsberg PJ. Thrombolysis of basilar artery occlusion: impact of baseline ischemia and time. Ann Neurol 2013;73(06):688–694

3 Schonewille WJ, Wijman CA, Michel P, et al; BASICS study group. Treatment and outcomes of acute basilar artery occlusion in the Basilar Artery International Cooperation Study (BASICS): a prospective registry study. Lancet Neurol 2009;8(08):724–730

4 Singer OC, Berkefeld J, Nolte CH, et al; ENDOSTROKE Study Group. Mechanical recanalization in basilar artery occlusion: the ENDOSTROKE study. Ann Neurol 2015;77(03):415–424

5 Powers WJ, Rabinstein AA, Ackerson T, et al. Guidelines for the early management of patients with acute ischemic stroke: 2019 update to the 2018 guidelines for the early management of acute ischemic stroke: a guideline for healthcare professionals from the American Heart Association/American Stroke Association. Stroke 2019;50(12):e344–e418

6 Luo G, Mo D, Tong X, et al. Factors associated with 90-day outcomes of patients with acute posterior circulation stroke treated by mechanical thrombectomy. World Neurosurg 2018; 109:e318–e328

7 Mokin M, Sonig A, Sivakanthan S, et al. Clinical and procedural predictors of outcomes from the endovascular treatment of posterior circulation strokes. Stroke 2016;47(03):782–788

8 Khatibi K, Nour M, Tateshima S, et al. Posterior circulation thrombectomy-pc-ASPECT score applied to preintervention magnetic resonance imaging can accurately predict functional outcome. World Neurosurg 2019;129:e566–e571

9 Tei H, Uchiyama S, Usui T, Ohara K. Posterior circulation ASPECTS on diffusion-weighted MRI can be a powerful marker for predicting functional outcome. J Neurol 2010;257(05):767–773

10 Garg R, Biller J. Neuroimaging predictors of clinical outcome in acute basilar artery occlusion. Front Neurol 2017;8:293

11 Gilberti N, Gamba M, Premi E, et al. Endovascular mechanical thrombectomy in basilar artery occlusion: variables affecting recanalization and outcome. J Neurol 2016;263(04):707–713

12 Rentzos A, Karlsson J-E, Lundqvist C, Rosengren L, Hellström M, Wikholm G. Endovascular treatment of acute ischemic stroke in the posterior circulation. Interv Neuroradiol 2018;24(04): 405–411

13 Goyal N, Tsivgoulis G, Nickele C, et al. Posterior circulation CT angiography collaterals predict outcome of endovascular acute ischemic stroke therapy for basilar artery occlusion. J Neurointerv Surg 2016;8(08):783–786

14 Cross DT III, Moran CJ, Akins PT, Angtuaco EE, Diringer MN. Relationship between clot location and outcome after basilar artery thrombolysis. AJNR Am J Neuroradiol 1997;18(07): 1221–1228

15 Gory B, Mazighi M, Blanc R, et al. Mechanical thrombectomy in basilar artery occlusion: influence of reperfusion on clinical outcome and impact of the first-line strategy (ADAPT vs stent retriever). J Neurosurg 2018;129(06):1482–1491

