Original Article

Clinical outcomes of mechanical thrombectomy for acute ischemic stroke with large vessel occlusion: Insights from an Eastern Thailand mechanical thrombectomy center

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Abstract

Background: Mechanical thrombectomy (MT) is the standard treatment for acute ischemic stroke with large-vessel occlusion (LVO), but regional data from Thailand are limited, particularly regarding factors influencing long-term outcomes.

Objective: To evaluate 90-day functional independence (modified Rankin Scale [mRS] ≤2) after MT at a single center in Eastern Thailand and identify predictors of functional independence.

Materials and Methods: We retrospectively analyzed all MT procedures from March 2019 to December 2023 at Bangkok Pattaya Hospital. Inclusion followed AHA guidelines and DAWN criteria, with adjustments for early presentations. Baseline demographics, imaging, angiography, and procedural data were collected. The primary endpoint was functional independence at 90 days. Associations were examined using univariate and multivariable logistic regression.

Results: Of 141 MT cases, 132 were included (mean age 64.2 years; 87.8% Thai). Anterior circulation strokes accounted for 87.9%. Successful reperfusion (mTICI ≥2b) occurred in 81.1%, and functional independence at 90 days in 70.5%. Lower baseline NIHSS showed borderline association with functional independence (p=0.059). Post-procedural aICH or no ICH significantly reduced odds of functional independence compared with sICH (aICH: OR 0.09, 95% CI 0.02-0.45, p=0.006; no ICH: OR 0.05, 95% CI 0.01-0.20, p<0.001). Age, sex, atrial fibrillation, onset-to-recanalization time, and first-pass success were not significant predictors. sICH was more frequent with IVT+MT than MT alone (17.4% vs. 1.6%, p=0.006).

Conclusion: MT at our center achieved high reperfusion and functional independence rates comparable to international benchmarks. Hemorrhagic transformation was a strong predictor, whereas age, sex, and treatment strategy were not. Careful imaging selection and individualized bridging therapy may optimize outcomes.

Keywords: Acute ischemic stroke, Clinical factor, Mechanical thrombectomy.

Introduction

Stroke continues to pose a significant global health burden. According to the 2025 World Stroke Organization Global Factsheet, it remains the world's second leading cause of mortality—responsible for approximately 7 million deaths per year—and, when accounting for both mortality and morbidity, ranks third overall, contributing to upwards of 160 million DALYs annually [1,2]. Thailand's Ministry of Public Health reports that stroke accounts for around 50,000 deaths per year, ranking as the leading cause of death nationally [3].

Large vessel occlusion (LVO) refers to the blockage of the major proximal cerebral arteries and, when including both the A2 and P2 segments of the anterior and posterior cerebral arteries, is present in approximately 24-46% of acute ischemic stroke cases [4]. Because LVO typically carries a poor prognosis, intravenous thrombolysis (IVT) alone often fails to restore patency—in many cohorts, successful recanalization rates with IVT alone have been reported to be as low as around 20 percent [5-8].

Guidelines updated in 2018 established mechanical thrombectomy (MT) as the standard of care for patients with acute ischemic stroke due to LVO [9]. Although prognostic factors differ among studies, commonly reported variables include patient age, baseline stroke severity assessed with the NIHSS, the site of arterial occlusion (e.g., ICA, M1, or M2 segments of the MCA), administration of IVT, initial Alberta Stroke Program Early CT Score (ASPECTS), and onset-to-treatment time [10].

Thailand's first MT procedures were performed at Siriraj Hospital in 2009. Reported results included a 92.7 % rate of successful recanalization (modified Thrombolysis in Cerebral Infarction, mTICI 2b-3) and 34.15 % of patients achieving functional independence (modified Rankin Scale, mRS ≤2) at an average follow-up of 16 months [11]. At the Prasat Neurological Institute, 90-day outcomes showed an 85 % recanalization rate and a 53 % rate of functional independence [12]. In 2019, Bangkok Pattaya Hospital became the first center in Eastern Thailand to offer MT, and has since seen rapid growth in case volume alongside encouraging patient outcomes. This study reviews MT performance at this center and examines factors influencing patient prognosis.

The objective of this study was to evaluate the clinical outcomes of MT performed at Bangkok Pattaya Hospital, focusing on the rate of functional independence (mRS ≤2) at 90 days post-stroke. Additionally, we aimed to identify factors influencing successful outcomes, including imaging characteristics, procedural success rates, and the impact of complications such as intracranial hemorrhage (ICH).

Materials and methods

This study included all patients who underwent mechanical thrombectomy (MT) at Bangkok Pattaya Hospital between March 2019 and December 2023, excluding those with incomplete medical records. MT was performed within 24 hours of symptoms, following the recommendations outlined in the 2019 American Heart Association (AHA) guidelines [13].

Eligibility criteria were adapted from the AHA guideline recommendations and included:

- Age >18 years,
- Large vessel occlusion (LVO) involving the internal carotid artery (ICA) or M1 segment of the middle cerebral artery (MCA),
- ASPECTS. >6 or clinical-imaging mismatch per the DAWN trial criteria [14] for anterior circulation strokes or presentation in the very early window with no FLAIR hyperintensity on MRI,
- Diffusion-weighted imaging (DWI) brainstem score (BSS) ≤3 for posterior circulation LVO [15].

While the protocol adhered closely to the AHA guidelines, strict compliance with DAWN trial imaging criteria for anterior circulation strokes was achieved in 93.2% of cases. The remaining 6.8% underwent MT despite not meeting DAWN criteria due to early presentation with negative FLAIR sequences, which suggested minimal established infarction. These patients were treated at the discretion of the stroke team, based on clinical judgment and favorable imaging findings, reflecting real-world practice patterns.

Neuroimaging was performed using either a Philips Ingenuity Core-128 CT scanner or a Philips Ingenia 3.0 T MRI system. For patients arriving within 4.5 hours of symptom onset, the initial study was a non-contrast CT (NCCT) of the brain (axial slice thickness 2 mm; multiplanar reconstructions 3 mm), followed by CT angiography (CTA) from the aortic arch to the vertex. CTA acquisition parameters included a 1 mm collimation, 0.5 mm reconstruction interval, 120 kVp tube voltage, 400 mAs tube current, and automated exposure control. A 100 mL bolus of non-ionic iodinated contrast was administered through an 18-20 G peripheral line at 4-4.5 mL/s, followed by a 50 mL saline chaser; bolus tracking was initiated when contrast reached a pre-defined region of interest in the aortic arch. MRI was the preferred imaging modality for patients presenting between 4.5 and 24 hours after onset, or when posterior circulation stroke was suspected. The MRI protocol comprised axial diffusion-weighted imaging (b = 0 and 1000 s/mm^2), ADC maps, T2*-weighted gradient echo, and fluid-attenuated inversion recovery (FLAIR) sequences. Time-of-flight (TOF) MR angiography was performed without contrast from the foramen magnum to the roof of the lateral ventricles, using a 1.8 mm slice thickness, TR/TE of approximately 23/3.5 ms, and an 18° flip angle. When both CT and MRI were available, the most recent examination—typically MRI—was used for analysis.

All MT procedures were conducted in a hybrid operating room equipped with a single-plane angiographic system. Five interventional neuroradiologists, each with between 2 and 10 years of neurovascular intervention experience, performed the cases. Intravenous thrombolysis (IVT) was administered to eligible patients presenting within 4.5 hours of symptom onset, except when contraindications were present or the patient declined treatment. Patients who received IVT were transferred directly for cerebral angiography, irrespective of any observed neurological improvement. If large-vessel occlusion was confirmed, MT was undertaken using aspiration alone, a stent retriever alone, or a combination of both approaches (Figure 1).

Procedural success was defined as achieving an mTICI score of ≥2b [16]. Following successful recanalization, control angiograms were obtained after 10-15 minutes to assess for high-grade intracranial atherosclerotic disease (ICAD), which was diagnosed when either ≥70 % luminal narrowing or evidence of hemodynamic compromise within the affected vascular territory was present [17]. High-grade extracranial atherosclerotic disease (ECAD) or tandem lesions encountered during MT were classified using the North American Symptomatic Carotid Endarterectomy Trial (NASCET) definition of ≥70 % stenosis [18].

A post-procedure XperCT was obtained in all patients who had received IVT. In cases where follow-up angiography revealed re-occlusion due to high-grade ICAD, treatment consisted of intra-arterial or intravenous eptifibatide. If vessel patency could not be restored despite antiplatelet infusion, stent placement was subsequently performed (Figure 2). For high-grade ECAD, angioplasty was carried out immediately if the stenosis hindered advancement of the guiding catheter into the distal artery; when the lesion was not flow-limiting, carotid angioplasty was planned within two weeks after the thrombectomy.

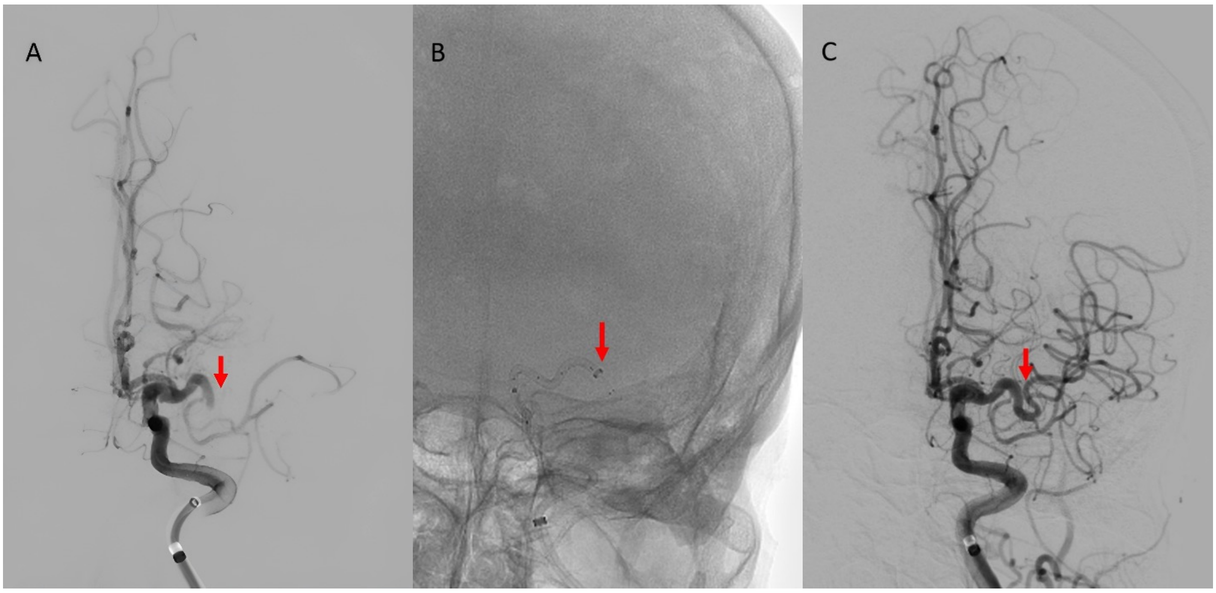

Figure 1. *MT in a 78-year-old female patient presenting with acute right hemiparesis, global aphasia and acute left MCA occlusion at the M1 segment with marked vessel tortuosity, treated using a combined aspiration and stent retriever technique. All angiograms were obtained in Towne 25° projection.*
(A) Left ICA injection demonstrating complete occlusion of the left M1 segment.
(B) Combined MT performed at the M1 segment of the left MCA.
(C) Post-procedure angiogram showing successful recanalization (mTICI 2c) of the left MCA, with persistent vessel tortuosity.
At the 3-month clinical follow-up, the patient had improved with only mild residual hemiparesis and an mRS of 2.

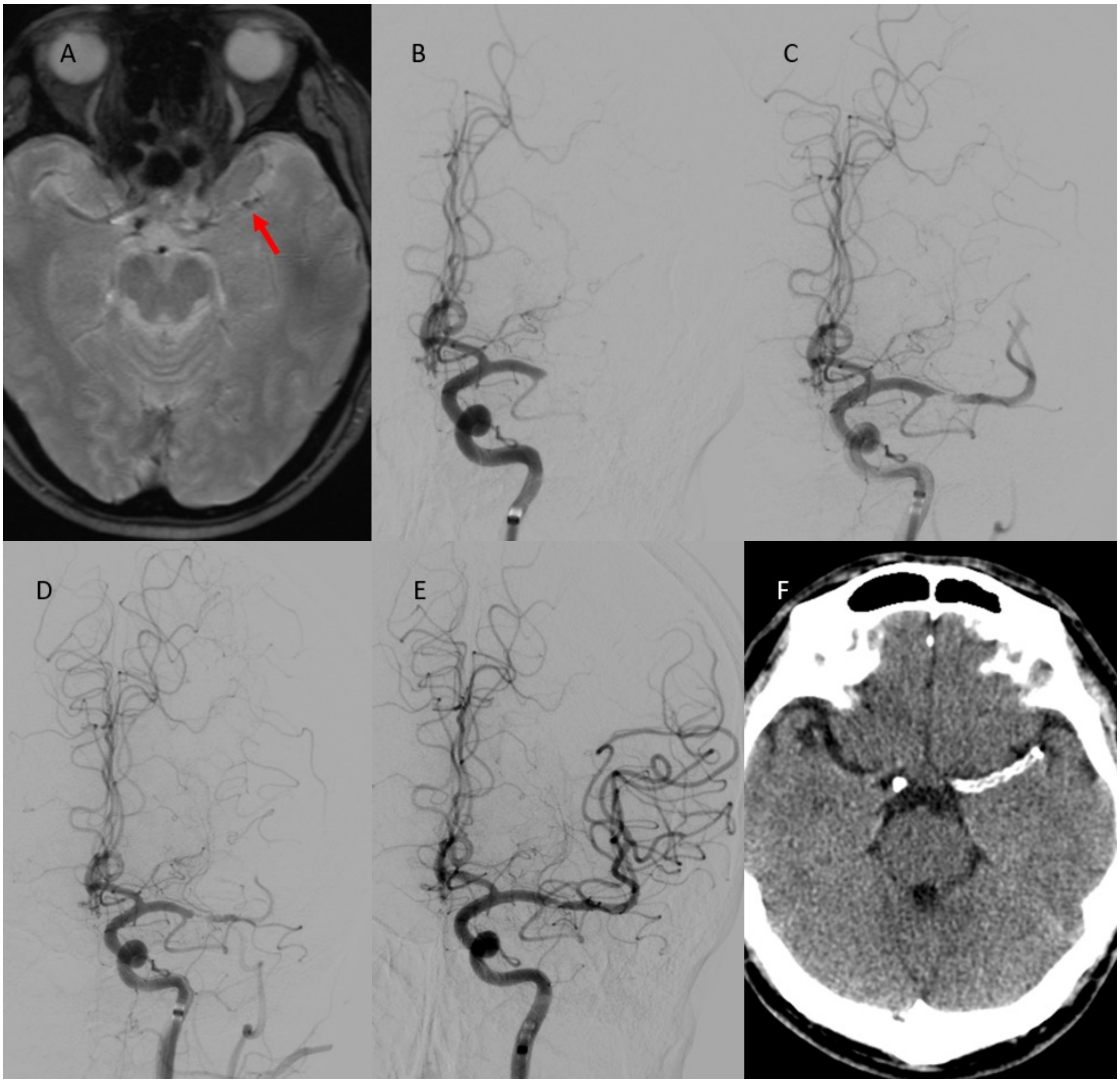

Figure 2. *MT in a 42-year-old male heavy smoker with acute left M1 MCA occlusion and high-grade ICAD, presenting with right hemiparesis and sensory aphasia, treated with a combined aspiration and stent retriever approach.*
(A) T2-GRE MRI demonstrated absence of a susceptibility vessel sign, suggesting a non-red blood cell thrombus, a finding often associated with ICAD.
(B) Left ICA injection showed complete occlusion of the left M1 segment MCA.

(C) Ten minutes after MT, angiography revealed severe residual stenosis with insufficient antegrade flow.
(D) After an IA bolus of eptifibatide was administered, persistent poor flow was still noted.
(E) Post-stent placement across the high-grade ICAD lesion, left ICA injection demonstrated complete recanalization and reperfusion (mTICI 3).
(F) 12-hour Follow-up CT scan showed no hemorrhagic transformation as well as stent placement in the left M1 segment MCA.
At the 3-month follow-up, the patient achieved complete recovery with an mRS of 0.

All patients without contraindications were started on dual antiplatelet therapy for at least three months. After MT, patients were admitted to the neuro-intensive care unit (NICU). A non-contrast CT scan was repeated between 12 and 24 hours after stroke onset. If intraparenchymal hyperattenuation was detected, another CT was performed after 24 hours to distinguish post-thrombectomy contrast staining from hemorrhage. Symptomatic intracerebral hemorrhage (sICH) was defined according to the ECASS II/III framework: radiological evidence of intracerebral bleeding after treatment accompanied by a ≥4-point deterioration on the NIH Stroke Scale, with the hemorrhage judged to be the primary cause of neurological decline [6]. Selected patients with sICH underwent decompressive craniectomy and hematoma evacuation based on the treating neurosurgeon's clinical assessment.

Baseline characteristics, imaging, angiographic findings, number of patients receiving IVT, onset to recanalization time and number of passes to achieve successful recanalization were reviewed by the interventional neuroradiologist and clinical outcomes were reviewed by two stroke neurologists. Clinical outcomes were recorded in hospital records or via phone follow-up at 3 months post-stroke onset.

The primary outcome was the rate of functional independence, defined as mRS ≤2 at 90 days. Multiple logistic regression was used to analyze factors influencing functional independence rates, with odds ratios calculated for key variables.

Descriptive statistics were applied to summarize baseline data. Continuous variables are presented as means with standard deviations (SD) or as medians with interquartile ranges (IQR), while categorical variables are expressed as counts and percentages. Stroke onset was grouped into two-time windows: <4.5 hours and 4.5-24 hours. Infarct sites were classified into anterior or posterior circulation territories. Univariate analyses were first conducted to examine relationships between patient characteristics and 90-day outcomes, where a favorable result was defined as a modified Rankin Scale (mRS) score of ≤2. Comparisons of categorical variables were made using either Pearson's chi-squared test or Fisher's exact test, and continuous variables were assessed with the Wilcoxon rank-sum test. Multivariable logistic regression was then used to determine independent predictors of good functional independence. Odds ratios (ORs) with corresponding 95% confidence intervals (CIs) were calculated to measure association strength. The regression model was adjusted for potential confounding factors, including age, sex, NIHSS at admission, and the occurrence of post-procedural intracranial hemorrhage (ICH). All statistical analyses were carried out in RStudio. This study received ethics approval from the Bangkok Pattaya Hospital Ethics Committee (approval no. 1/2023).

Results

Out of 141 MT cases, 9 were excluded due to incomplete records, leaving 132 cases for analysis. The average patient age was 64.2 years (range: 25-95 years), and all patients had a pre-stroke mRS ≤2. Most patients are Thai 116/132 cases (87.8%). Stroke onset was within 4.5 hours in 77/132 cases (58.3%) and between 4.5-24 hours in 55/132 cases (41.7%). Baseline demographics and clinical characteristics are summarized in Table 1.

Table 1. *Baseline characteristics within the thrombectomy group.*

Variable	n/N	% or value
Age(years) (n=132)		
Range	25-95	
Mean (SD)	64.2 (14.1)	
Onset time		
<4.5 hours	77.0 / 132	58.3%
4.5-24 hours	55.0 / 132	41.7%
Infarction location		
Anterior circulation	116.0 / 132	87.9%
Posterior circulation	16.0 / 132	12.1%
Anterior circulation stroke (n=116)		
ASPECTS (n=42)		
ASPECT (<6)	0.0 / 42.0	0.0%
ASPECT (>/=6)	42.0 / 42.0	100.0%
DWI volume infarction(ml) (n=74)		
Mean, (SD)	22.2, (32.1)	
Median (Q1, Q3)	12.0 (6.2, 25.0)	
Range	0.0-205.0	
Small infarction (<30 mL)	60.0 / 74.0	81.1%
Moderate infarction (31-50 mL)	9.0 / 74.0	12.2%
Large infarction (>50 mL)	5.0 / 74.0	6.8%

Variable	n/N	% or value
Posterior circulation stroke (n=16)		
ASPECTS (n=16)		
4	1.0 / 16	6.3%
5	4.0 / 16	25.0%
6	4.0 / 16	25.0%
7	2.0 / 16	12.5%
8	4.0 / 16	25.0%
10	1.0 / 16	6.3%
DWI BSS (n=16)		
1	2.0 / 16	12.5%
2	8.0 / 16	50.0%
3	6.0 / 16	37.5%
mTICI		
0, 1, 2A	25.0 / 132	18.9%
2B, 2C, 3	107.0 / 132	81.1%
Present high-grade ICAD or ECAD (n=132)		
No	79/132	59.8%
ICAD	32/132	24.2%
ECAD	12/132	9.1%
Unspecified	9/132	6.8%
Pre-stroke mRS		
0	128/132	(97.0%)
1	1/132	(0.8%)
2	3/132	(2.3%)
Post stroke mRS		
Independent (≤2)	93/132	70.5%
Dependent (>2)	39/132	29.5%

Infarction location was in the anterior circulation in 116/132 cases (87.9%) and in the posterior circulation in 16/132 cases (12.1%). For anterior circulation strokes within 4.5 hours of onset, ASPECTS was used to select candidates for MT. Among the 42 patients evaluated, all had an ASPECTS of 6 or higher. No patients presented with an ASPECTS less than 6. Thus, the proportion of patients with ASPECTS ≥6 was 100% (42/42), indicating that all included cases had relatively favorable early ischemic changes on initial imaging. Of the 74 patients with DWI data, the mean infarct volume was 22.2 mL (SD: 32.1), with a median of 12.0 mL (interquartile range [IQR]: 6.2-25.0). Infarct volumes ranged from 0.0 to 205.0 ml. Based on the DAWN trial criteria [14], patients were classified into three groups according to DWI infarct volume: small (<30 mL), moderate (31-50 mL), and large (>50 mL). The large infarction group (>50 mL) represents a large core that would have been excluded from the DAWN trial. Of these patients with available DWI data, 81.1% (60/74) had small infarctions, 12.2% (9/74) had moderate infarctions, and 6.8% (5/74) had large infarctions. In several cases (6.8%), mechanical thrombectomy was performed following early presentation with negative FLAIR imaging. Despite achieving successful reperfusion (mTICI ≥2b), all of these patients had poor clinical outcomes. Among the 16 patients with posterior circulation stroke, the distribution of posterior circulation ASPECTS (PC-ASPECTS) was as follows: a score of 4 in 1 patient (6.3%), 5 in 4 patients (25.0%), 6 in 4 patients (25.0%), 7 in 2 patients (12.5%), 8 in 4 patients (25.0%), and 10 in 1 patient (6.3%). Regarding the DWI BSS, 2 patients (12.5%) had a score of 1, 8 patients (50.0%) had a score of 2, and 6 patients (37.5%) had the maximum score of 3. Among the 132 patients, 59.8% (79/132) had no evidence of high-grade ICAD or ECAD. High-grade ICAD was observed in 24.2% (32/132), while high-grade ECAD was identified in 9.1% (12/132). In 6.8% of cases (9/132), the presence of ICAD could not be determined due to failed recanalization of the occluded vessel. Of the 132 patients, 79 (59.8%) had no evidence of high-grade ICAD or ECAD. High-grade ICAD was identified in 32 patients (24.2%), and high-grade ECAD in 12 patients (9.1%). In nine cases (6.8%), the presence of ICAD could not be assessed due to unsuccessful recanalization of the occluded vessel. Among patients with high-grade ICAD, rescue therapy with intra-arterial or intravenous eptifibatide was performed in 10 cases, while one patient underwent combined eptifibatide administration and stent placement. The remaining patient with ICAD was managed with oral dual antiplatelet therapy alone. In the high-grade ECAD group, four patients underwent angioplasty and stenting, while the remaining patients were treated with dual antiplatelet therapy alone. Successful reperfusion (mTICI 2b-3 or spontaneous recanalization) was observed in 107 cases (81.1%), as demonstrated in Figures 1 and 2. This included 103 patients who achieved mTICI 2b-3 after MT and 4 patients (3.0%) with spontaneous recanalization identified during initial angiography. The remaining 25 patients (18.9%) had poor or incomplete reperfusion (mTICI 0-2a).

At 90 days, functional independence was achieved in 70.5% of patients, with the distribution of mRS shown in Figure 3. Univariate analysis (Table 2) revealed that a lower baseline NIHSS was significantly associated with functional independence at 90 days ($p = 0.024$). Patients with moderate stroke severity (NIHSS 5-15) were more frequently found in the independent group (69.9%) compared to the dependent group (46.2%). In contrast, higher stroke severity (NIHSS ≥21) was more prevalent among patients with poor outcomes (23.1% vs. 10.8%). There were no statistically significant associations between functional independence and age ($p = 0.119$), age category (<80 vs. ≥80 years; $p = 0.766$), sex ($p = 0.091$), or presence of atrial fibrillation (AF) ($p = 0.883$). In terms of treatment approach, MT alone was performed in 63 patients (47.7%), with 42 (67.0%) achieving functional independence at 90 days. The remaining 21 (33.0%) had poor outcomes. Among the 69 patients (52.3%) treated with IVT + MT, 51 (74.0%) achieved functional independence, while 18 (26.0%) had poor outcomes. The difference between the two groups was not statistically significant ($p = 0.362$). The mean onset-to-recanalization time was 486.1 minutes (SD: 267.1), with a median of 432.5 minutes. Among patients with successful recanalization, the number of device passes required had a mean of 2.3 (SD: 1.7) and a median of 2.0. There was no significant association between the number of passes and functional independence at 90 days ($p = 0.537$). After excluding 4 cases with spontaneous recanalization following IVT, 47 out of 128 patients (36.7%) achieved successful recanalization on the first pass. However, first-pass success did not result in a statistically significant difference in clinical outcomes compared to multiple-pass recanalization. Post-procedural hemorrhage occurred in 33.3% of patients (44/132) and was significantly associated with worse functional outcomes at 90 days (p = 0.001). Among patients who remained functionally independent, 75.3% had no hemorrhagic complications, compared to only 46.2% in the dependent group. Further classification revealed that sICH occurred in 9.8% of the total study, with a markedly higher rate in the dependent group (25.6%) than in the independent group (3.2%). Asymptomatic ICH (aICH) was observed in 23.5% of patients and showed less variation between outcome groups (28.2% vs. 21.5%). The association between sICH and unfavorable outcomes was statistically significant (p < 0.001), while aICH did not demonstrate a clear correlation. In cases of sICH, 4 of 13 patients (30.8%) underwent decompressive craniectomy with hematoma evacuation. Among these, two patients remained functionally dependent (mRS >2) and two died, indicating a poor overall prognosis in this subgroup.

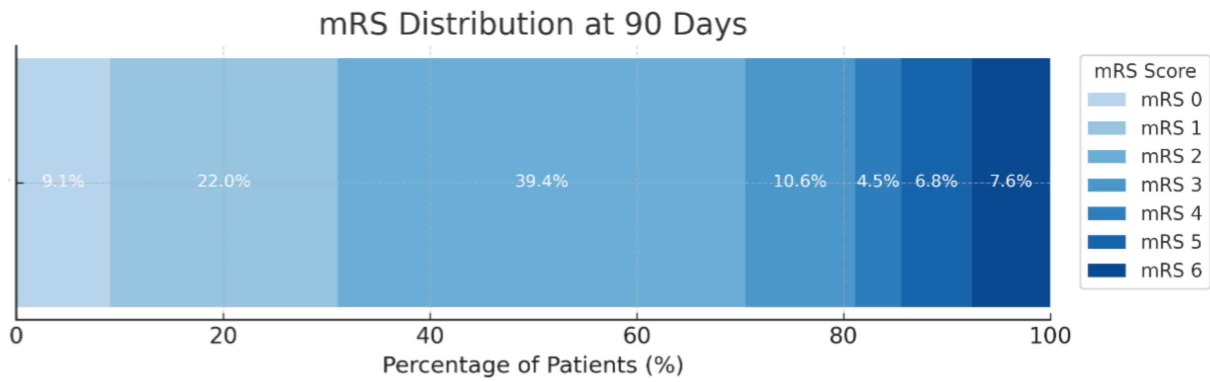

Figure 3. *Clinical outcome post-MT.*

Table 2. *Predictors of outcome data (n=132).*

Variable	Overall	Outcome (mRS 90) Independent (≤2), N = 93	Outcome (mRS 90) Dependent (>2), N = 39	p-value
Age (N = 132)				0.119[1]
Mean (SD)	64.2(14.1)	63.3(13.7)	66.3(15.1)	
Range	25.0, 95.0	30.0, 95.0	25.0, 86.0	
Age category, n / N (%)				0.672[2]
<80	111/132 (84.1%)	79/93 (84.9%)	32/39 (82.1%)	
>/=80	21/132 (15.9%)	14/93 (15.1%)	7/39 (17.9%)	
Sex, n / N (%)				0.091[2]
Male	79/132 (59.8%)	60/93 (64.5%)	19/39 (48.7%)	
Female	53/132 (40.2%)	33/93 (35.5%)	20/39 (51.3%)	
Risk factors: AF, n / N (%)	35/132 (26.5%)	25/93 (26.9%)	10/39 (25.6%)	0.883[2]
NIHSS (admission)				0.024[3]
Mild (1-4)	1/132 (0.8%)	0/93 (0.0%)	1/39 (2.6%)	
Moderate (5-15)	83/132 (62.9%)	65/93 (69.9%)	18/39 (46.2%)	
Moderate to severe (16-20)	29/132 (22.0%)	18/93 (19.4%)	11/39 (28.2%)	
Severe (21-42)	19/132 (14.4%)	10/93 (10.8%)	9/39 (23.1%)	
Treatment, n / N (%)				0.362[2]
MT alone	63/132 (47.7%)	42 / 63 (67%)	21 / 63 (33%)	
IVT+MT	69/132 (52.3%)	51 / 69 (74%)	18 / 69 (26%)	
Onset to recanalization (min.)				0.409[1]
Mean,(SD)	486.1,(267.1)	475.3,(262.2)	514.8,(281.8)	
Median (Q1, Q3)	432.5 (316.5, 551.0)	412.5 (312.0, 530.0)	442.5 (337.0, 555.0)	
Min, Max	155.0, 1,647.0	155.0, 1,647.0	165.0, 1,420.0	

Variable	Overall	Outcome (mRS 90)		p-value
		Independent (≤2), N = 93	Dependent (>2), N = 39	
Number of passes				0.537[1]
Mean, (SD)	2.3,(1.7)	2.2,(1.5)	2.7,(2.1)	
Median (Q1, Q3)	2.0 (1.0, 3.0)	2.0 (1.0, 3.0)	2.0 (1.0, 4.0)	
Min, Max	0.0, 6.0	0.0, 6.0	0.0, 6.0	
Number of passes, n / N (%)				0.985[2]
1	47 / 128 (37%)	33 / 90 (37%)	14 / 38 (37%)	
>1 or Fail	81 / 128 (63%)	57 / 90 (63%)	24 / 38 (63%)	
Post-procedure hemorrhage				0.001[2]
No	88/132 (66.7%)	70/93 (75.3%)	18/39 (46.2%)	
Yes	44/132 (33.3%)	23/93 (24.7%)	21/39 (53.8%)	
Post-procedure hemorrhage				<0.001[2]
No	88/132 (66.7%)	70/93 (75.3%)	18/39 (46.2%)	
Symptomatic ICH	13/132 (9.8%)	3/93 (3.2%)	10/39 (25.6%)	
Asymptomatic ICH	31/132 (23.5%)	20/93 (21.5%)	11/39 (28.2%)	

[1] *Wilcoxon rank sum test*
[2] *Pearson's chi-squared test*
[3] *Fisher's exact test*

In the multivariate logistic regression analysis (Table 3), both post-procedural aICH and the absence of any hemorrhage were independently associated with a lower likelihood of achieving functional independence at 90 days. Specifically, aICH was linked to decreased odds of functional independence (OR 0.09; 95% CI, 0.02-0.45; p = 0.006), and the absence of ICH showed an even stronger inverse association (OR 0.05; 95% CI, 0.01-0.20; p < 0.001), when compared to sICH as the reference group. Although lower baseline NIHSS was significant in the univariate analysis (p = 0.024), it only showed a borderline association in the multivariable model (p = 0.059). Patients with moderate stroke severity on admission (NIHSS 5-15) demonstrated a trend toward better functional outcomes compared to those with severe scores (NIHSS >20), although this did not reach statistical significance (OR 0.31; 95% CI, 0.09-1.06; p = 0.059). Age, sex, and presence of AF were not significantly associated with clinical outcome in the adjusted model.

Table 3. *Multivariable logistic regression between patient factors and outcome (mRS 90 days) (n=131*).*

Variable	Event N[1]	OR (95% CI)[2]	p-value
Age	69.5 (62.3, 77.0)	1.02 (0.99 to 1.06)	0.167
NIHSS (admission)			
Severe (21-42)	9/19 (47.4%)	Reference	
Moderate to Severe (16-20)	11/29 (37.9%)	0.70 (0.18 to 2.76)	
Moderate (5-15)	18/83 (21.7%)	0.31 (0.09 to 1.06)	0.059
Post-procedure hemorrhage			
Symptomatic ICH	10/13 (76.9%)	Reference	
Asymptomatic ICH	11/31 (35.5%)	0.09 (0.02 to 0.45)	0.006
No	17/87 (19.5%)	0.05 (0.01 to 0.20)	<0.001

[1]Event N = the number of patients who had an mRS >2
[2]OR = odds ratio, CI = confidence interval
Adjusted by age, gender, post-procedure hemorrhage
** Excluding a case with mild NIHSS (< 5)*

The relationship between treatment modality and post-procedural hemorrhage, including symptomatic ICH, is summarized in Table 4. The incidence of post-procedural hemorrhage significantly differed between treatment groups (p = 0.027). Patients who received IVT+ MT had a higher rate of post-procedural hemorrhage (42.0%) compared to those treated with MT alone (23.8%). When classified further, sICH occurred in 17.4% of the IVT+MT group, significantly higher than in the MT-alone group (1.6%) (p = 0.006). The rate of aICH was similar between the two groups: 22.2% in the MT-alone group and 24.6% in the IVT+MT group. Patients who underwent thrombectomy without preceding IV thrombolysis were more likely to remain free of any hemorrhagic complication (76.2% vs. 58.0%).

Table 4. *Association between treatment modality and post-procedural hemorrhage and aymptomatic ICH.*

Variable	Overall N = 132[1]	Group		p-value
		MT alone N = 63[1]	IVT+MT N = 69[1]	
Post-procedure hemorrhage	44/132 (33.3%)	15/63 (23.8%)	29/69 (42.0%)	0.027[2]
Post-procedure hemorrhage				0.006[2]
No	88/132 (66.7%)	48/63 (76.2%)	40/69 (58.0%)	
Asymptomatic ICH	31/132 (23.5%)	14/63 (22.2%)	17/69 (24.6%)	
Symptomatic ICH	13/132 (9.8%)	1/63 (1.6%)	12/69 (17.4%)	

[1] *n/N (%)*
[2] *Pearson's chi-squared test*

Discussion

This study evaluates the clinical outcomes of MT, focusing on the 90-day functional independence rate and factors influencing success. Our findings demonstrate a high rate of procedural success (81%) and functional independence (70.5%) post-MT, which are consistent with outcomes reported in global MT registries and randomized clinical trials [10, 14, 19-20].

Imaging Selection and Procedural Success Rate

Patients presenting within 4.5 hours were selected based on ASPECTS, and nearly all (98%) had scores indicating small-to-moderate infarction cores, reflecting adherence to standard guidelines [9]. For the 4.5-24-hour window, DWI was a main tool for precise patient selection, with the majority demonstrating small core infarctions and clinical imaging mismatch [14]. This emphasizes the critical role of advanced imaging in extending treatment eligibility while maintaining functional independence (70.5%).

The high successful recanalization rate (81%) was consistent with outcomes reported in major randomized trials [10, 19-20]. Patients who received IVT were transferred directly for cerebral angiography, enabling prompt assessment and rapid initiation of MT if LVO persisted. This streamlined workflow allowed for vessel status confirmation within 30 minutes and revealed spontaneous recanalization in 4 of 132 patients (3%).

This finding aligns with results from the EXTEND-IA trial, which reported early recanalization in approximately 10% of patients receiving IVT before MT [20]. Although our observed rate was slightly lower, both findings underscore the potential for IVT to achieve timely reperfusion in a subset of patients, highlighting the importance of immediate post-IVT angiographic assessment to avoid unnecessary intervention and minimize procedural risks.

Clinical Outcomes and Predictors

Our analysis did not find a significant association between onset-to-recanalization time and 90-day functional independence (p = 0.409). Although patients who achieved functional independence had a slightly shorter mean time to recanalization (475.3 minutes) compared to those with poor outcomes (514.8 minutes), this difference was not statistically significant and did not appear to impact outcomes in a clinically meaningful way. This contrasts with prior meta-analyses and multicenter trials that have highlighted time to reperfusion as a key determinant of outcome. For example, the HERMES collaboration found that shorter time from symptom onset to reperfusion was strongly associated with higher odds of functional independence, particularly when treated within the early window of under 6 hours [10]. Similarly, analyses from the DAWN and DEFUSE-3 trials emphasized that even in extended time windows, timely intervention in well-selected patients still conferred benefit [14, 19]. There are several possible reasons for the divergence from previous findings. First, the average time to recanalization in our study was considerably longer than in earlier trials, with broad variability (ranging from 155 to 1,647 minutes), potentially obscuring any true time-dependent effect. Second, other factors—such as infarct core volume, collateral status, presence of hemorrhagic complications, or procedural details—may have played a more substantial role in determining outcome. Lastly, unlike many prior studies that used strict imaging selection criteria, our study included a more heterogeneous population, reflective of real-world clinical practice. These findings suggest that while time remains a critical factor in stroke intervention, its predictive power may diminish when other variables are more influential.

Achieving first-pass success did not correlate with better functional independence at 90 days. Both the independent and dependent outcome groups demonstrated a 37% rate of first-pass success, with a similar distribution between single and multiple retrieval attempts. No significant statistical difference was observed (p = 0.985). These results imply that, within our study, procedural efficiency alone may not necessarily lead to improved clinical outcomes. This contrasts with several previous meta-analyses and observational studies, which have consistently found a positive relationship between first-pass effect (FPE) and functional independence.

For instance, Abbasi et al. reported that roughly one-third of patients experience FPE, and this was linked with better outcomes across thrombectomy techniques [21]. Several factors may account for the discrepancy between our findings and prior literature. Firstly, while our first-pass rate aligns with pooled data from other studies, the sample size may not have been large enough to detect a modest effect. Secondly, clinical outcomes may have been more heavily influenced by other variables, such as infarct size, collateral status, or the presence of complications like sICH. Lastly, technical aspects including device selection, operator technique, or patient characteristics could have altered the impact of FPE. Despite the absence of a significant association in our study, previous meta-analyses, including that of Jang et al., have consistently reported that achieving FPE is linked to higher rates of favorable neurologic recovery, shorter procedural duration, and lower complication rates, including vessel injury, distal embolization, and mortality [22].

The 90-day functional independence rate (70.5%) aligns with benchmarks reported in major trials [10]. Post-procedural aICH or absence of ICH significantly reduced the dependence rate, consistent to Pinckaers, et al [23]. According to the Koopmans, et al [24]. who proposed that large ischemic core volume is associated with poor outcome and post-MT ICH, careful imaging selection of MT candidates is very important. Age was not a significant factor compared to Winkelmeier, et al. [25], this divergence could be attributed to the relatively small sample size or the specific characteristics of the population treated at our center. The other factors, including sex and AF also did not significantly impact clinical outcomes, consistent with several studies [26-28]. Interestingly, admission NIHSS demonstrated a borderline significant association with outcomes ($p=0.059$), suggesting that moderate strokes tended to have better clinical outcomes than severe strokes. We hypothesize that moderate stroke patients recover faster than severe stroke patients.

In our retrospective analysis, functional independence was achieved at 90 days in 67.0% of patients treated with MT alone and 74.0% of those receiving IVT + MT, with no statistically significant difference between the two groups ($p = 0.362$). This is consistent with the results of the DIRECT-MT and DEVT trials, which found that direct thrombectomy was not inferior to bridging therapy with IVT

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+ MT in terms of functional independence at 90 days [29,30]. However, our data also showed a higher rate of symptomatic intracranial hemorrhage in the IVT + MT group compared to MT alone (17.4% vs. 1.6%; p = 0.006), a finding that warrants careful consideration in light of the balance between potential benefits and hemorrhagic risks. The significantly higher rate of symptomatic intracerebral hemorrhage (sICH) in the IVT + MT group may reflect several procedural and patient-specific factors. A recent systematic review identified the number of thrombectomy passes, age, serum glucose, AF and NIHSS score as predictors of any intracranial hemorrhage following reperfusion therapy [31].

Procedural Variables and Treatment Strategies

Approximately half of the patients received combined MT and IVT, reflecting real-world variability in treatment approaches. While our study did not directly compare outcomes between MT alone and MT with IVT, the high recanalization and functional independence rates suggest that both strategies are effective when guided by appropriate imaging.

Additionally, the incidence of high-grade ICAD in 24.2% of cases highlights its significant prevalence in the Thai population (87.8%) which is relatively high in Asia people with sICH [32]. These patients were mainly rescued by stent retrieval MT, combined MT or adjunctive IA/IV eptifibatide.

Limitations and Future Directions

This study has several limitations. Its retrospective, single-center design may limit the generalizability of the findings, and incomplete data from nine cases highlights the need for more comprehensive data collection in future work. Previous research has shown that well-controlled blood pressure is associated with improved outcomes after ischemic stroke [33] and that the absence of diabetes mellitus or optimal glycemic control is linked to better prognosis [34]. As our study did not collect information on these variables, their potential impact on clinical outcomes could not be evaluated. Prospective, multicenter studies with larger sample sizes are warranted to confirm these results and to further investigate the role of other factors, such as ICAD, ECAD, or population-specific characteristics, in influencing MT outcomes.

Conclusion

MT at our single-center stroke unit in Thailand achieved outcomes comparable to international benchmarks, with 81% successful reperfusion and 70.5% functional independence at 90 days. Imaging-based selection with ASPECTS and DWI likely contributed to these results. Post-procedural aICH or the absence of any hemorrhage was independently associated with a lower likelihood of achieving functional independence compared with sICH, highlighting the complex interplay between hemorrhagic patterns and recovery. Predictive factors such as age, sex, and AF were not independently associated with outcome, though admission NIHSS showed borderline significance, suggesting that moderate deficits may offer greater recovery potential. Time to reperfusion and FPE were not significant predictors in this study, indicating that other clinical and procedural variables may outweigh timing in certain real-world settings. The higher hemorrhage risk observed with bridging therapy underscores the importance of careful patient selection when considering IVT before MT.

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