Neurology Asia 2023; 28(2) : 273 – 282

The predictors of prognosis in endovascular treatment of basilar artery occlusion

[1]Ramazanoglu Leyla *MD*, [1]Aslan Kalyoncu Isil *MD*, [2]Gunkan Ahmet *MD*, [2]Onal Yilmaz *MD*, [2]Velioglu Murat *MD*, [3]Topcuoglu Osman Melih *MD*, [1]Gozke Eren *MD*

[1]Department of Neurology and [2]Department of Radiology, University of Health Sciences Fatih Sultan Mehmet Training and Research Hospital, Istanbul; [3]Department of Radiology, Yeditepe University Medical School, Istanbul, Turkey

Abstract

Background & Objective: Data about outcomes of endovascular treatment (EVT) in basilar artery occlusion (BAO) are limited. The aim of this study is to evaluate the predictors of functional outcome and to investigate the benefit of bridging intravenous thrombolysis (IVT) and the impact of first-pass effect (FPE) on prognosis. *Methods:* A total of 57 consecutive BAO patients who received EVT at our tertiary stroke center between January 2018 and March 2021 were retrospectively analyzed. The primary outcome was to evaluate excellent prognosis (mRS 0-1) and mortality (mRS 6) at day 90. The secondary outcome was to define the benefit of bridging IVT and the impact of FPE on prognosis. The safety outcome was symptomatic intracranial hemorrhage (sICH). National Institutes of Health Stroke Scale (NIHSS) at admission and at 24 hours, collateral scores, successful recanalization, asymptomatic ICH, embolization, malignant infarction and decompression were also evaluated. *Results:* The mean age of the patients was 64.1 ± 14.5 years. Male-to-female ratio was 1.7. Hypertension (HT) was the most common risk factor. Bridging IVT was performed in nine patients (15.8%). The FPE rate was 56.1%. NIHSS scores at admission and at 24 hours were found to be statistically significant predictors of prognosis (P=0.023 and P<0.001, respectively). Bridging IVT, FPE, successful recanalization and collateral status did not significantly predict outcome.
Conclusion: Lower NIHSS scores at admission and at 24 hours were significantly associated with excellent prognosis. NIHSS scores at admission and at 24 hours were significantly higher in mortality group. sICH did not predict mortality.

Keywords: Basilar artery occlusion, endovascular treatment, National Institutes of Health Stroke Scale

INTRODUCTION

Basilar artery occlusion (BAO) is a rare and devastating type of stroke because of poor outcomes and high mortality.[1] The superiority of endovascular treatment (EVT) has been demonstrated in large-scale trials for anterior circulation stroke (ACS). Therefore, EVT also seems to be useful in BAO, although the selection of appropriate patients for the maximal benefit is still unclear.[2]

Complete revascularization by first-pass effect (FPE) is associated with a higher rate of good functional outcomes.[3] Regardless of FPE, successful recanalization is a predictor of better clinical outcomes.[4-8] Initial stroke severity, age, underlying atherosclerosis, fewer lesions on initial diffusion-weighted imaging, Pc-ASPECTS (posterior circulation-Alberta Stroke Program Early CT Score) or BATMAN (Basilar Artery on Computed Tomography Angiography) scores have been associated with response to EVT in previous studies.[2,5-11] In addition to these conflicting results, the benefit of intravenous thrombolysis (IVT) in BAO is still controversial.[12,13] A new trial Endovascular Treatment in Ischemic Stroke (ETIS) study showed that, in patients with excellent early reperfusion; age, initial NIHSS score, first pass mTICI 2c-3 reperfusion and hemorrhagic transformation on post-interventional imaging were the independent predictors.[14]

In the present study, we aimed to evaluate the predictors of functional outcome and to investigate the benefit of bridging IVT and the impact of FPE on prognosis.

Address correspondence to: Leyla Ramazanoglu, MD, University of Health Sciences Fatih Sultan Mehmet Training and Research Hospital, Department of Neurology, Istanbul, Turkey. Tel: +90 532 364 31 61, E-mail: afleylaak@hostmail.com

Date of Submission: 20 December 2022; Date of Acceptance: 18 February 2023

https://doi.org/10.54029/2023aea

METHODS

This single-center, retrospective study was conducted between January 2018 and March 2021 in the neurology department of a tertiary stroke center. A total of 57 consecutive patients with acute BAO undergoing EVT were included. The inclusion criteria were as follows: Age ≥18 years; presence of non-contrast computed tomography (CT), CT angiography at the time of admission and having BAO; and neurological deficit of ≥2 scores according to the National Institutes of Health Stroke Scale (NIHSS). In clinical practice, having a Modified Rankin Scale (mRS) score of ≤2 before stroke is the routine criterion; however, in these consecutive patients, mRS scores were 0 and 1 at the time of admission.

Demographic data were obtained from hospital and the national health registry. Age, sex, comorbidities, time of onset at admission, initial stroke severity and door to-needle time were recorded. Intravenous thrombolysis (IVT) was initiated in eligible patients. For mechanical thrombectomy (MT), interventionalists did not use time-window cut-off.

The primary functional outcome was to evaluate excellent prognosis (mRS 0-1) and mortality (mRS 6) at day 90.[15] Patients were seen during their routine clinical checkup in the outpatient setting or reached by telephone The secondary functional outcome was to define the benefit of bridging IVT and the impact of FPE on prognosis as an independent predictor. Patients received IVT (0.9 mg/kg) with a maximum dose of 90 mg over 1 hour. Patients underwent MT without waiting for the effect of IVT. FPE is defined as achieving a complete recanalization with a single thrombectomy device pass. The safety outcome was symptomatic intracranial hemorrhage (sICH). In general, sICH was defined as a new intracranial hemorrhage associated with an increase in NIHSS score (> 4 points) from the score immediately before the exacerbation. Hemorrhage was graded according to the method used in the European Cooperative Acute Stroke Trials.[16] NIHSS at admission and at 24 hours was used to assess the severity of neurological deficit. The basilar artery on computed tomography angiography (BATMAN) and the posterior circulation collateral score (PC-CS) were noted in all patients for evaluating the collateral status. Successful recanalization was defined as modified thrombolysis in Cerebral Ischemia Scale (mTICI) = 2c-3.[17] Asymptomatic intracranial hemorrhage (aICH), embolization (distal/new territory), malignant infarction or edema, and decompression were also analyzed. All procedures were performed under regional (n=34) or general (n=23) anesthesia.

Both A Direct Aspiration First Pass Technique (ADAPT) and stent retriever (SR) techniques are applicable in our center for strokes in the posterior system. A 90 cm long sheath (NeuronMax™; Penumbra, Alameda, CA, USA or Ballast; Balt USA, Irvine, CA, USA) reinforced with a long 125 cm diagnostic catheter is placed in the most distal position of the dominant vertebral artery. The Sofia™ 6F (Microvention Inc., Tustin, CA, USA) is used as an aspiration catheter, and navigation to the occlusion site is usually performed using a microcatheter and a microwire. If recanalization with the ADAPT technique is unsuccessful, a stent retriever is used as salvage therapy. The SR technique again uses a long sheath and distal access catheter as the primary set-up. The occlusion is bypassed with a microcatheter and SR deployed over the occluded segment. The stent was retrieved under distal aspiration. In case of distal embolism, thrombectomy is performed with a low-profile stent retriever (CatchView mini; Balt USA, Irvine, CA, USA). The duration of MT, and extra- or intracranial stenting during MT were analyzed. The number of runs was generally limited to four attempts.

Written informed consent was obtained from each patient. The study protocol was approved by the local ethics committee (2022/127). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Statistical analysis

Statistical analysis was performed using the Jamovi Project (2020), Jamovi (version 1.6.16.0), and JASP (version 0.14.1.0). Descriptive data were reported as mean ± standard deviation (SD) or median (min-max) for continuous variables and as counts and frequencies for categorical variables. Normal distribution of numeric variables was analyzed with the Shapiro-Wilk, Kolmogorov-Smirnov, and Anderson-Darling tests. The independent samples t-test was used to compare two independent groups in which the numerical variables had a normal distribution. The Mann-Whitney U test was used for variables without a normal distribution. The Pearson chi-square test and Fisher exact test were used to compare differences between categorical variables. Fisher-Freeman-Halton test was used in RxC tables. A P value of < 0.05 was considered statistically

significant. Multivariate logistic regression was performed for the relation between collateral scores and mRS at 90 days.

RESULTS

The baseline clinics of the patients, the treatments performed, and the results are shown in Table 1. The mean age of the patients was 64.1 ± 14.5 (range, 98 to 26) years. The male-to-female ratio was 1.7. Hypertension (HT) was the most common condition in 39 patients (68.4%). We evaluated diabetes mellitus (DM), HT and atrial fibrillation (AF) as comorbidity. Other risk factors such as hyperlipidemia and smoking were not examined due to insufficient data. Median admission time and door-to-needle time were 150 and 139 minutes, respectively. The median NIHSS on admission was 16. Twenty-three patients were underwent thrombectomy under general anesthesia (GA). Direct MT (d-MT) was applied in 84.2% of cases. Bridging IVT was performed in nine patients (15.8%). The ADAPT approach was performed in 30 patients (52.6%) whereas SR was used in 27 patients. The FPE rate was 56.1%. Final TICI recanalization scores showed that treatment was successful in 49 patients (86.0%) (TICI 2c-3). The median NIHSS score at 24 hours was 6. Three patients were defined as intracranial atherosclerotic disease (ICAD). Two of the ICAD patients were treated by intracranial stenting and one was treated with balloon angioplasty. There were 12 patients (21.1%) in the study group with an excellent prognosis (mRS score 0 and 1). The mortality (mRS 6) rate was 47.4% in the study group. The symptomatic ICH rate was 8.8%.

The comparison between patients with and without excellent prognosis at day 90 is shown in Table 2. NIHSS scores at admission and at 24 hours were significantly higher in patients without excellent prognosis (P=0.023 and P<0.001, respectively). Comparison of patients showed that the NIHSS score at the time of admission, and the NIHSS score after 24 hours were significantly higher in patients with mortality (P=0.012, P=0.005, and P=0.026, respectively). Collateral scores (BATMAN and PC-CS) did not predict the mRS score on day 90 (P=0.538 and P=0.105, respectively).

Table 3 shows the comparison of patients with d-MT and IVT+MT. There were no GA patients in the IVT+MT group (P=0.008). The other variables were similar between the two modalities. There was no association between treatment modalities and groups based on mRS scores.

FPE patients had a significantly higher ADAPT rate related to technique (Table 4) (P<0.001). The duration of MT was shorter in the FPE group (P<0.001). The incidence of embolization was significantly higher in the non-FPE cases (P=0.032). The prognosis did not differ between FPE and non FPE groups.

DISCUSSION

The current study demonstrated that lower NIHSS scores at admission and at 24 hours were statistically significant predictors of excellent prognosis (p=0.023 and p<0.001, respectively). A significant difference was also found in mortality groups. Baseline NIHSS scores and 24-hour NIHSS scores were higher in the mortality group (p=0.012 and p=0.026, respectively). The recently published studies showed that lower NIHSS score was the independent predictor of favorable functional outcome.[1,5-14,18-22]

In recent studies; the functional outcome was defined as favorable or good prognosis group (mRS 0-2).[20-25] In our study, functional outcome was an excellent prognosis (mRS 0-1) and the rate was 21.1%. Meinel *et al*. mentioned excellent prognosis in their study and the rate was 25%.[26] The predictors for excellent prognosis were lower NIHSS scores at admission and at 24 hour (p=0.023 and p< 0.001). In previous studies mentioned above, lower NIHSS scores were significantly associated with favorable prognosis.[18,20-25]

The other functional outcome of this paper was mortality (mRS 6). The rate was 47.4%. sICH, unsuccessful recanalization (TICI 0-2a), older age, higher NIHSS scores, decreased PC-ASPECT scores, absence of IVT, longer duration of MT were associated with poor outcome and mortality.[18,20-22,24,25,27] In our study, only higher NIHSS score at admission and at 24 hour was significantly associated with mortality (p= 0.012 and p= 0.026).

As recently published, sICH is associated with an unfavorable outcome and mortality.[22] Ravidren *et al*. showed that sICH rate was 6% in their study and mortality was statistically significant in sICH group.[22] In this paper the sICH was 8.8 %. In mortality group the rate of sICH was higher but statistically non-significant.

Asymptomatic intracranial hemorrhage, embolization (distal/new territory), malignant infarction and decompression were also evaulated in this study. Kang *et al*. showed that hemorrhagic infarction and parencymal hematoma were

Table 1: Baseline, clinical, and technical characteristics and outcomes of patients

Baseline characteristics	*Overall (n=57)*
Age (year) †	64.1 ± 14.5
Sex §	
Male	36 (63.2)
Female	21 (36.8)
Coexisting disease §	
Diabetes mellitus	24 (42.1)
Hypertension	39 (68.4)
Atrial fibrillation	5 (8.8)
Clinical characteristics of the patients on admission.	
Admission time (min) ‡	150.0 [40.0 – 600.0]
Door to needle time (min) ‡	139.0 [8.0 – 664.0]
mRS on admission‡	0.0 [0.0 – 1.0]
NIHSS on admission ‡	16.0 [2.0 – 26.0]
General anesthesia ‡	23 (40.4)
Treatment characteristics	
D-mechanical thrombectomy §	48 (84.2)
Intravenous thrombolysis + mechanical thrombectomy §	9 (15.8)
Stent in basilary system §	2 (3.5)
Technical approach §	
Stent retriever	27 (47.4)
ADAPT	30 (52.6)
First pass reperfusion ‡	32 (56.1)
Duration of mechanical thrombectomy (min) ‡	21.0 [8.0 – 127.0]
Final TICI recanalization results §	
0-2a	2 (3.5)
2b	6 (10.5)
2c-3	49 (86.0)
NIHSS 24th hour ‡	6.0 [0.0 – 24.0]
Complications §	
Symptomatic ICH	5 (8.8)
Asymptomatic ICH	11 (19.3)
Embolization (distal/new territory)	4 (7.0)
Edema-malignant infarction	4 (7.0)
Decompression	1 (1.8)
mRS, 90th day ‡	
Excellent (mRS 0 and 1) §	12 (21.1)
Mortality (mRS 6) §	27 (47.4)

§: n (%), ‡: median [min-max]
†: mean ± standard deviation, §: n (%). TICI: thrombolysis in cerebral infarction, NIHSS: National Institute of Health Stroke Scale, ICH: intracranial hemorrhage, mRS: modified Rankin Scale.

associated with poor outcome.[24] Embolization were mentioned in two studies but the number of patients were small and was not associated with mortality.[24,26] In our study, four of the patients had embolization. Meinel *et al*. found the craniectomy rate 2.5 %.[26] In our study, the rate was 1.8%. The ratios of the parameters mentioned above were all higher in mortality group but none of them was statistically significant.

One of the cornerstones in the treatment of acute ischemic stroke (AIS) is IVT. The current guideline recommends initiating IVT as soon as possible in patients who are eligible.[28] Gory *et al*. reported in their study that the absence of IVT increased the mortality rate.[18] On another aspect, Shu *et al*. concluded that patients with BAO should preferentially be treated with stent retriever thrombectomy.[29] In our study, we compared the bridging group (IVT+MT) and the d-MT group. Although not statistically significant, the mortality rate was lower in the bridging group; however, the number of patients in this group was very small (9/57).

The main goal of EVT is rapid and complete

Table 2: Predictors of excellent prognosis (mRS 0 and 1) and mortality (mRS 6) on Day 90

	Excellent prognosis		p
	No (n=45)	**Yes (n=12)**	
Age (year) ‡	66.4 ± 13.0	55.3 ± 17.2	0.056
Sex §			
Male	26 (57.8)	10 (83.3)	0.177
Female	19 (42.2)	2 (16.7)	
Coexisting disease §			
Diabetes mellitus	19 (42.2)	5 (41.7)	0.999
Hypertension	30 (66.7)	9 (75.0)	0.734
Atrial fibrillation	5 (11.1)	0 (0.0)	0.573
Admission time (min) ‡	144.0 [40.0 – 600.0]	285.0 [45.0 – 550.0]	0.131
Door to needle time (min) ‡	104.0 [8.0 – 664.0]	193.5 [13.0 – 255.0]	0.145
NIHSS on admission ‡	17.0 [2.0 – 26.0]	10.0 [2.0 – 18.0]	**0.023**
General anesthesia§	21 (46.7)	2 (16.7)	0.097
D-mechanical thrombectomy	38 (84.4)	10 (83.3)	0.999
Intravenous thrombolysis + mechanical thrombectomy	7 (15.6)	2 (16.7)	0.999
Stent in basilary system §	1 (2.2)	1 (8.3)	0.380
Technical approach §			
Stent retriever	19 (42.2)	8 (66.7)	0.237
ADAPT	26 (57.8)	4 (33.3)	
First pass reperfusion §	25 (55.6)	7 (58.3)	0.999
Duration of mechanical thrombectomy (min) ‡	22.0 [10.0 – 113.0]	25.5 [8.0 – 86.0]	0.652
Final TICI recanalization results §			
0-2a	2 (4.4)	0 (0.0)	0.999
2b	5 (11.1)	1 (8.3)	
2c-3	38 (84.4)	11 (91.7)	
NIHSS 24th hour ‡	12.0 [1.0 – 24.0]	2.0 [0.0 – 4.0]	**<0.001**
Complications §			
Symptomatic ICH	5 (11.1)	0 (0.0)	0.573
Asymptomatic ICH	10 (22.2)	1 (8.3)	0.426
Embolization (distal/new territory)	4 (8.9)	0 (0.0)	0.569
Edema-malignant infarction	4 (8.9)	0 (0.0)	0.569
Decompression	1 (2.2)	0 (0.0)	0.999
BATMAN score	<7 (n=34)	<7 (n=10)	0.538
PC-CS score	0-3 (n=5), 4-5 (n=16)	0-3 (n=1), 4-5(n=3)	0.105

	Mortality		p
	No (n=30)	**Yes (n=27)**	
Age (year) ‡	60.8 ± 14.9	67.8 ± 13.3	0.067
Sex §			
Male	18 (60.0)	18 (66.7)	0.806
Female	12 (40.0)	9 (33.3)	
Coexisting disease §			
Diabetes mellitus	10 (33.3)	14 (51.9)	0.252
Hypertension	21 (70.0)	18 (66.7)	0.999
Atrial fibrillation	2 (6.7)	3 (11.1)	0.660
Admission time (min) ‡	165.0 [40.0 – 600.0]	150.0 [45.0 – 540.0]	0.486
Door to needle time (min) ‡	160.0 [8.0 – 664.0]	109.0 [10.0 – 584.0]	0.384
NIHSS on admission ‡	12.0 [2.0 – 24.0]	20.0 [7.0 – 26.0]	**0.012**
General anesthesia§	8 (26.7)	15 (55.6)	0.051

	Mortality		p
	No (n=30)	Yes (n=27)	
Mechanical thrombectomy	24 (80.0)	24 (88.9)	0.476
Intravenous thrombolysis + mechanical thrombectomy	6 (20.0)	3 (11.1)	0.476
Stent in basilary system §	1 (3.3)	1 (3.7)	0.999
Technical approach §			
Stent retriever	14 (46.7)	13 (48.1)	0.999
ADAPT	16 (53.3)	14 (51.9)	
First pass reperfusion §	19 (63.3)	13 (48.1)	0.375
Duration of mechanical thrombectomy (min) ‡	19.5 [8.0 – 103.0]	31.0 [13.0 – 127.0]	0.371
Final TICI recanalization results §			
0-2a	1 (3.3)	1 (3.7)	0.719
2b	2 (6.7)	4 (14.8)	
2c-3	27 (90.0)	22 (81.5)	
NIHSS 24th hour ‡	4.0 [0.0 – 24.0]	16.0 [2.0 – 23.0]	**0.026**
Complications §			
Symptomatic ICH	1 (3.3)	4 (14.8)	0.179
Asymptomatic ICH	4 (13.3)	7 (25.9)	0.386
Embolization (distal/new territory)	2 (6.7)	2 (7.4)	0.999
Edema-malignant infarction	1 (3.3)	3 (11.1)	0.336
Decompression	0 (0.0)	1 (3.7)	0.474

§: n (%), ‡: median [min-max] TICI: thrombolysis in cerebral infarction, NIHSS: National Institute of Health Stroke Scale, ICH: intracranial hemorrhage, mRS: modified Rankin scale.

recanalization, which may lead to a good prognosis. Recently, Zaidat *et al*.[3] defined FPE, which seems to be associated with good clinical outcomes, especially in anterior LVO. Moreover, two recent studies have shown that FPE is an independent predictor of favorable outcomes in BAO.[30,31] In our study, FPE was achieved in 32 of 57 (56.1%) patients. The mean duration was significantly shorter in the FPE groups (12.5 min and 47 min, respectively). Excellent prognosis was higher and mortality was lower in the FPE group, although those findings did not reach statistical significance. In previous studies, successful recanalization was achieved but, clinical outcomes were not predicted by recanalization.[1,10] On the contrary, most studies claimed that successful recanalization is a predictor of better clinical outcomes.[4-8] In this series, the rate of successful recanalization (TICI 2c-3) was 86% however; it did not significantly result in good functional outcomes as Pasarikovski's study[10] with 72% successful reperfusion rate. However, in the mortality group, the rate of successful recanalization was lower but statistically non significant. The reason for not having improved outcomes despite successful reperfusion rates might be due to not using a time-window cut-off for MT and readily established infarction at the time of intervention. Recent studies found that shorter time from stroke onset to recanalization especially the first 6 hours is associated with favorable functional outcome.[6-8,32] Furthermore, 77.2% of the patients had poor collateral status (44/57, BATMAN score<7) in this series and this was also another important factor. Alemseged *et al*. stated that severe disability or death was noted in 76% of patients with poor collaterals despite successful recanalization in their study harboring 124 patients.[33]

The association between collateral flow scores and the prognosis were evaluated previously. Alemseged *et al*. claimed that the basilar artery on computed tomography angiography, BATMAN score had greater accuracy compared with the posterior circulation collateral score, PC-CS in BAO patients and score of <7 was associated with poor outcome.[33] PC-CS was found to predict poor outcome at one month.[34] Ouyang *et al*. showed that lower pc-ASPECTS score was associated with poor outcome.[11] In the current study, BATMAN score and PC-CS were examined and none of them had a significant value for predicting outcome but the proportion of the BATMAN score <7 was lower in excellent prognosis group.

Table 3: Comparison of IVT

	IVT+MT (n=9)	d-MT (n=48)	p
Age (year) ‡	71.0 [26.0 – 87.0]	65.5 [35.0 – 98.0]	0.669
Sex §			
Male	5 (55.6)	31 (64.6)	0.712
Female	4 (44.4)	17 (35.4)	
Coexisting disease §			
Diabetes mellitus	1 (11.1)	23 (47.9)	0.064
Hypertension	4 (44.4)	35 (72.9)	0.124
Atrial fibrillation	0 (0.0)	5 (10.4)	0.582
Admission time (min) ‡	120.0 [60.0 – 240.0]	175.0 [40.0 – 600.0]	0.145
Door to needle time (min) ‡	170.0 [51.0 – 664.0]	112.0 [8.0 – 584.0]	0.171
NIHSS on admission ‡	17.0 [3.0 – 24.0]	16.0 [2.0 – 26.0]	0.754
General anesthesia§	0 (0.0)	23 (47.9)	**0.008**
Stent in basilary system §	0 (0.0)	2 (4.2)	0.999
Technical approach §			
Stent retriever	6 (66.7)	21 (43.8)	0.283
ADAPT	3 (33.3)	27 (56.2)	
First pass reperfusion §	4 (44.4)	28 (58.3)	0.485
Duration of mechanical thrombectomy (min) ‡	22.0 [10.0 – 113.0]	20.5 [8.0 – 127.0]	0.288
Final TICI recanalization results §			
0-2a	0 (0.0)	2 (4.2)	0.999
2b	1 (11.1)	5 (10.4)	
2c-3	8 (88.9)	41 (85.4)	
NIHSS 24th hour ‡	5.5 [0.0 – 12.0]	6.0 [0.0 – 24.0]	0.188
Complications §			
Symptomatic ICH	1 (11.1)	4 (8.3)	0.999
Asymptomatic ICH	1 (11.1)	10 (20.8)	0.673
Embolization (distal/new territory)	1 (11.1)	3 (6.2)	0.507
Edema-malignant infarction	1 (11.1)	3 (6.2)	0.507
Decompression	0 (0.0)	1 (2.1)	0.999
mRS. 90th day ‡			
Excellent (mRS 0 and 1) §	2 (22.2)	10 (20.8)	0.999
Mortality (mRS 6) §	3 (33.3)	24 (50.0)	0.476

§: n (%), ‡: median [min-max]
TICI: thrombolysis in cerebral infarction, NIHSS: National Institute of Health Stroke Scale, ICH: intracranial hemorrhage, mRS: modified Rankin scale. IVT: intravenous thrombolysis, MT: mechanical thrombectomy

There are several limitations. First, the study was a retrospective study conducted in a single center and this could result in a relatively small sample size. Second, the magnetic resonance imaging (MRI) of the exact location of the infarction was unable to record. Third, there were no strict exclusion criteria for the study. Furthermore, outcome assessors were not blinded to the initial status of the patients. Finally, we evaluated the predictors for excellent prognosis (mRS 0-1) and for BAO, excellent prognosis can be difficult to achieve.

In conclusion, bridging IVT, FPE, successful recanalization may be associated with good functional outcomes in anterior LVOs but are not predictors of good clinical outcomes in BAO. In our study, lower NIHSS scores at admission and at 24 hours were statistically associated with excellent prognosis. NIHSS scores at admission and at 24 hours were significantly higher in patients with mortality. sICH did not differ between groups in excellent prognosis. sICH did not predict mortality We believe that further large-scale, prospective, randomized controlled studies will draw more reliable conclusions on this topic.

DISCLOSURE

Financial support: None

Conflict of interest: None

Table 4: Comparison of FPE

	With FPE (n=32)	Without FPE (n=25)	p
Age (year) ‡	65.8 ± 14.7	61.9 ± 14.3	0.314
Sex §			
Male	19 (59.4)	17 (68.0)	0.694
Female	13 (40.6)	8 (32.0)	
Coexisting disease §			
Diabetes mellitus	16 (50.0)	8 (32.0)	0.273
Hypertension	23 (71.9)	16 (64.0)	0.728
Atrial fibrillation	3 (9.4)	2 (8.0)	0.999
Admission time (min) ‡	155.0 [40.0-600.0]	120.0 [45.0-550.0]	0.735
Door to needle time (min) ‡	139.0 [12.0 –664.0]	104.0 [8.0 – 279.0]	0.546
NIHSS on admission ‡	17.0 [2.0 – 26.0]	116.0 [2.0 – 24.0]	0.457
General anesthesia§	14 (43.8)	9 (36.0)	0.749
D-mechanical thrombectomy §	28 (87.5)	20 (80.0)	0.485
Intravenous thrombolysis + mechanical thrombectomy §	4 (12.5)	5 (20.0)	0.485
Stent in basilary system §	0 (0.0)	2 (8.0)	0.188
Technical approach §			
Stent retriever	5 (15.6)	22 (88.0)	**<0.001**
ADAPT	27 (84.4)	3 (12.0)	
Duration of mechanical thrombectomy (min) ‡	12.5 [8.0 – 60.0]	47.0 [16.0 – 127.0]	**<0.001**
Final TICI recanalization results §			
0-2a	0 (0.0)	2 (8.0)	**0.001**
2b	0 (0.0)	6 (24.0)	
2c-3	32 (100.0)	17 (68.0)	
NIHSS 24th hour ‡	6.0 [0.0 – 24.0]	4.0 [0.0 – 16.0]	0.386
Complications §			
Symptomatic ICH	1 (3.1)	4 (16.0)	0.157
Asymptomatic ICH	7 (21.9)	4 (16.0)	0.739
Embolization (distal/new territory)	0 (0.0)	4 (16.0)	**0.032**
Edema-malignant infarction	2 (6.2)	2 (8.0)	0.999
Decompression	0 (0.0)	1 (4.0)	0.439
mRS. 90th day ‡			
Excellent (mRS 0 and 1) §	7 (21.9)	5 (20.0)	0.999
Mortality (mRS 6) §	13 (40.6)	14 (56.0)	0.375

§: n (%), ‡: median [min-max]

FPE: first pass effect, TICI: thrombolysis in cerebral infarction, NIHSS: National Institute of Health Stroke Scale, ICH: intracranial hemorrhage, mRS: modified Rankin scale.

REFERENCES

1. Singer OC, Berkefeld J, Nolte CH, *et al*. Mechanical recanalization in basilar artery occlusion: the ENDOSTROKE study. *Ann Neurol* 2015;77(3):415-24. doi: 10.1002/ana.24336.
2. Gramegna LL, Requena M, Dinia L, *et al*. Predictors of response to endovascular treatment of posterior circulation stroke. *Eur J Radiol* 2019;116:219-24. doi: 10.1016/j.ejrad.2019.05.001.
3. Zaidat OO, Castonguay AC, Linfante I, *et al*. First pass effect: A new measure for stroke thrombectomy devices. *Stroke* 2018;49(3):660-6. doi: 10.1161/STROKEAHA.117.020315.
4. Tonetti DA, Desai SM, Casillo S, *et al*. Successful reperfusion, rather than number of passes, predicts clinical outcome after mechanical thrombectomy. *J Neurointerv Surg* 2020; 12(6):548-551. doi: 10.1136/neurintsurg-2019-015330.
5. Dias FA, Alessio-Alves FF, Castro-Afonso LH, *et al*. Clinical outcomes of patients with acute basilar artery occlusion in Brazil: An observational study. *J Stroke Cerebrovasc Dis* 2017;26(10):2191-8. doi: 10.1016/j.jstrokecerebrovasdis.2017.04.043.
6. Wu L, Zhang D, Chen J, *et al*. Long-term outcome of endovascular therapy for acute basilar artery occlusion. *J Cereb Blood Flow Metab* 2021;41(6):1210-8. doi: 10.1177/0271678X20958587.

7. Wang Y, Ke Y, Wang L, *et al*. Safety and efficacy of endovascular treatment for progressive stroke in patients with acute basilar artery occlusion. *Front Neurol* 2021; 12:774443. doi: 10.3389/fneur.2021.774443.
8. Dorňák T, Herzig R, Kuliha M, *et al*. Endovascular treatment of acute basilar artery occlusion: time to treatment is crucial. *Clin Radiol* 2015;70(5):e20-7. doi: 10.1016/j.crad.2015.01.008.
9. Son S, Kim YW, Oh MK, *et al*. Initial factors affecting the clinical outcome after successful recanalization via MR-based mechanical thrombectomy in patients with acute ischemic stroke due to basilar artery occlusion. *J Neurointerv Surg* 2016; 8(9):889-93. doi: 10.1136/neurintsurg-2015-011912.
10. Pasarikovski CR, Khosravani H, da Costa L, *et al*. Outcomes of endovascular thrombectomy for basilar artery occlusion. *Can J Neurol Sci* 2020; 47(4):479-85. doi: 10.1017/cjn.2020.51.
11. Ouyang K, Kang Z, Liu Z, *et al*. Posterior circulation ASPECTS on CT angiography predicts futile recanalization of endovascular thrombectomy for acute basilar artery occlusion. *Front Neurol* 2022;13:831386. doi: 10.3389/fneur.2022.831386.
12. Lee SH, Han JH, Jung I, Jung JM. Do thrombolysis outcomes differ between anterior circulation stroke and posterior circulation stroke? A systematic review and meta-analysis. *Int J Stroke* 2020;15(8):849-57. doi: 10.1177/1747493020909634.
13. Schonewille WJ, Wijman CA, Michel P, *et al*. Treatment and outcomes of acute basilar artery occlusion in the Basilar Artery International Cooperation Study (BASICS): a prospective registry study. *Lancet Neurol* 2009; 8(8):724-30. doi: 10.1016/S1474-4422(09)70173-5.
14. Pop R, Finitsis SN, Arquizan C, *et al*. Poor clinical outcome despite successful basilar occlusion recanalization in the early time window: incidence and predictors. *J Neurointerv Surg* 2022: 018769. doi: 10.1136/neurintsurg-2022-018769.
15. van Swieten JC, Koudstaal PJ, Visser MC, Schouten HJ, van Gijn J. Interobserver agreement for the assessment of handicap in stroke patients. *Stroke* 1988;19(5):604-7. doi: 10.1161/01.str.19.5.604.
16. Pereira VM, Gralla J, Davalos A, *et al*. Prospective, multicenter, single-arm study of mechanical thrombectomy using Solitaire Flow Restoration in acute ischemic stroke. *Stroke* 2013; 44(10):2802-7. doi: 10.1161/STROKEAHA.113.001232. Erratum in: *Stroke* 2013; 44(12):e239. Moreno, Alfredo [corrected to Moreno, Antonio]. Erratum in: *Stroke* 2021; 52(1):e48.
17. Zaidat OO, Yoo AJ, Khatri P, *et al*. STIR Thrombolysis in Cerebral Infarction (TICI) Task Force. Recommendations on angiographic revascularization grading standards for acute ischemic stroke: a consensus statement. *Stroke* 2013; 44(9):2650-63. doi: 10.1161/STROKEAHA.113.001972.
18. Gory B, Mazighi M, Labreuche J, *et al*. Predictors for mortality after mechanical thrombectomy of acute basilar artery occlusion. *Cerebrovasc Dis* 2018;45(1-2):61-7. doi: 10.1159/000486690.
19. Tong X, An J, Sun X, *et al*. A pre-intervention 4-item scale for predicting poor outcome despite successful recanalization in basilar artery occlusion. *Transl Stroke Res* 2020;11(6):1306-13. doi: 10.1007/s12975-020-00813-0.
20. Lee WJ, Jung KH, Ryu YJ, *et al*. Impact of stroke mechanism in acute basilar occlusion with reperfusion therapy. *Ann Clin Transl Neurol* 2018;5(3):357-68. doi: 10.1002/acn3.536.
21. Weber R, Minnerup J, Nordmeyer H, *et al*. Thrombectomy in posterior circulation stroke: differences in procedures and outcome compared to anterior circulation stroke in the prospective multicentre REVASK registry. *Eur J Neurol* 2019;26(2):299-305. doi: 10.1111/ene.13809.
22. Ravindren J, Aguilar Pérez M, Hellstern V, Bhogal P, Bäzner H, Henkes H. Predictors of outcome after endovascular thrombectomy in acute basilar artery occlusion and the 6hr time window to recanalization. *Front Neurol* 2019;10:923. doi: 10.3389/fneur.2019.00923.
23. 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(3):782-8. doi: 10.1161/STROKEAHA.115.011598.
24. Kang DH, Jung C, Yoon W, *et al*. Endovascular thrombectomy for acute basilar artery occlusion: A multicenter retrospective observational study. *J Am Heart Assoc* 2018; 7(14):e009419. doi: 10.1161/JAHA.118.009419.
25. Alexandre AM, Valente I, Consoli A, *et al*. Posterior circulation endovascular thrombectomy for large-vessel occlusion: Predictors of favorable clinical outcome and analysis of first-pass effect. *AJNR Am J Neuroradiol* 2021; 42(5):896-903. doi: 10.3174/ajnr.A7023.
26. Meinel TR, Kaesmacher J, Chaloulos-Iakovidis P, *et al*. Mechanical thrombectomy for basilar artery occlusion: efficacy, outcomes, and futile recanalization in comparison with the anterior circulation. *J Neurointerv Surg* 2019;11(12):1174-80. doi: 10.1136/neurintsurg-2018-014516.
27. Rentzos A, Karlsson JE, Lundqvist C, Rosengren L, Hellström M, Wikholm G. Endovascular treatment of acute ischemic stroke in the posterior circulation. *Interv Neuroradiol* 2018;24(4):405-11. doi: 10.1177/1591019918762320.
28. 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. doi: 10.1161/STR.0000000000000211.
29. Shu L, Salehi Ravesh M, Jansen O, Jensen-Kondering U. Stent retriever thrombectomy potentially increases the recanalization rate, improves clinical outcome, and decreases mortality in acute basilar occlusion: A systematic review and meta-analysis. *Cerebrovasc Dis Extra* 2019;9(2):46-56. doi: 10.1159/000499665.

30. Aubertin M, Weisenburger-Lile D, Gory B, *et al*. First-pass effect in basilar artery occlusions: Insights from the Endovascular Treatment of Ischemic Stroke Registry. *Stroke* 2021;52(12):3777-85. doi: 10.1161/STROKEAHA.120.030237.
31. Abdullayev N, Maus V, Behme D, *et al*. True first-pass effect in basilar artery occlusions: First-pass complete reperfusion improves clinical outcome in stroke thrombectomy patients. *J Clin Neurosci* 2021;89:33-8. doi: 10.1016/j.jocn.2021.04.020.
32. Yang J, Li F, Qiu Z, *et al*. Effect of endovascular treatment within 6 hours for acute basilar artery occlusion. *J Neurosurg* 2022;138(1):205-14. doi: 10.3171/2022.4.JNS22355.
33. Alemseged F, Shah DG, Diomedi M, *et al*. The basilar artery on computed tomography angiography prognostic score for basilar artery occlusion. *Stroke* 2017;48(3):631-7. doi: 10.1161/STROKEAHA.116.015492.
34. van der Hoeven EJ, McVerry F, Vos JA, *et al*. Collateral flow predicts outcome after basilar artery occlusion: The posterior circulation collateral score. *Int J Stroke* 2016;11(7):768-75. doi: 10.1177/1747493016641951.