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Original Article

Predictors of a Good Outcome in Endovascular Treatment for Basilar Artery Occlusion with a Direct Aspiration First-Pass Technique

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Objective: There is limited evidence for mechanical thrombectomy in patients with basilar artery occlusion. Despite recanalization, there are several reports on poor outcomes. Therefore, we retrospectively evaluated the outcomes and examined the predictors of mechanical thrombectomy in patients with basilar artery occlusion.

Methods: We recruited 22 consecutive patients who had received mechanical thrombectomy for basilar artery occlusion with a direct aspiration first-pass technique at our hospital between January 2016 and April 2020. The subjects were divided into good (modified Rankin Scale [mRS] ≤2) and poor outcome groups (mRS ≥3) and compared with one another. We conducted ROC analysis to identify the cut-off value that revealed a statistically significant difference in the univariate analysis.

Results: Of the 22 patients, the average age ± standard deviation (SD), median pretreatment NIHSS (interquartile range [IQR]), and median pretreatment posterior circulation acute stroke progression early CT score (pc-ASPECTS) (IQR) were 76 ± 10 years, 21 (8–31), and 8 (5–9), respectively. The predictors that showed statistically significant differences in the univariate analysis were age, pretreatment NIHSS score, and pretreatment pc-ASPECTS. Based on the ROC analysis, age (area under the curve [AUC] of 0.782, cutoff <74, and P = 0.028), pretreatment pc-ASPECTS (AUC of 0.850, cutoff ≥7, and P = 0.006), and pretreatment NIHSS (AUC of 0.803, cutoff <19, and P = 0.018) were significant prognostic factors.

Conclusion: In this study, aged <74 years, pc-ASPECTS ≥7, and NIHSS <19 were significant prognostic factors in endovascular treatment for basilar artery occlusion with a direct aspiration first-pass technique.

Keywords ▶ mechanical thrombectomy, basilar artery occlusion, direct aspiration first-pass technique

Introduction

Several randomized controlled trials (RCTs) have reported the efficacy of thrombectomy for acute cerebral infarction due to occlusion of the major artery of the anterior circulation, and thrombectomy is currently an established treatment.[1–7] However, adequate scientific evidence has not been provided for thrombectomy for basilar artery occlusion, and even in cases where recanalization is achieved, the prognosis is often poor.[8] In this study, we retrospectively evaluated the outcome of thrombectomy for basilar artery occlusion at our hospital and examined the prognostic factors.

Materials and Methods

A total of 22 consecutive patients who underwent thrombectomy for basilar artery occlusion at our hospital between January 2016 and April 2020 were enrolled. Patients with MRA-confirmed basilar artery occlusion less than 6 hours after onset were considered suitable for the treatment. Patients with extensive brainstem or cerebellar infarction (infarction of at least two-thirds of the area in the midbrain, pons, or unilateral cerebellum) or hemorrhagic changes on MRI were excluded. If possible and indicated based on the

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time after onset, treatment with a recombinant tissue type-plasminogen activator (rt-PA) was provided upfront.

The occluded sites were classified as proximal, mid, or distal according to the criteria of Archer et al.[9] MRI was assessed using the posterior circulation acute stroke progression early CT score (pc-ASPECTS) on DWI images,[10] and collateral flow was assessed using the posterior circulation collateral score (PC-CS) on MRA.[11]

Operative procedures were performed under local anesthesia. A direct aspiration first-pass technique (ADAPT) with a suction catheter was the first choice. Stent retrievers were also used when the suction catheter failed to reach the occlusion site or when recanalization was not achieved by three passes with the ADAPT.

Recanalization was evaluated using the thrombolysis in cerebral infarction (TICI) classification, with a TICI of 2b or higher being defined as successful recanalization. We evaluated outcomes by using the modified Rankin Scale (mRS) at 90 days. Patients with an mRS of 2 or lower at 90 days were defined as a good outcome group, and patients with an mRS of 3 or higher a poor outcome group. Safety was evaluated based on death and symptomatic intracranial hemorrhage (National Institute of Health Stroke Scale [NIHSS] of 4 or higher) up to 90 days.

The patients were divided into two groups, the good outcome group and the poor outcome group, and factors for a good prognosis were explored. The following patient characteristics were investigated: age, sex, mRS before onset, medical history (hypertension, diabetes, hyperlipidemia, atrial fibrillation, ischemic stroke, hemorrhagic stroke, and coronary artery disease), antithrombotic medication history, NIHSS before treatment, pc-ASPECTS before treatment, PC-CS, site of occlusion, and the cause of basilar artery occlusion.

Regarding treatment, t-PA administration, puncture to reperfusion (P2R) time, onset to reperfusion (O2R) time, therapeutic device, recanalization with a TICI of 2b or higher, and symptomatic intracranial hemorrhage were examined.

Statistical analysis was performed using SPSS version 23.0 (IBM, Armonk, NY, USA). The Mann–Whitney test, chi-square test, and Fisher's exact test were performed. The items with significant differences in univariate analysis were subjected to receiver operating characteristic (ROC) curve analysis, and cutoff values were obtained. For calculation of cutoff values, we used the point that was the minimum distance from the upper left corner of the ROC curve.

The study was reviewed and approved by the ethics committee of our hospital.

Results

The characteristics and clinical course of the patients are shown in **Table 1**. The mean age of the 22 patients (±standard deviation [SD]) was 76 ± 10 years, and 12 (55%) were male. The median pretreatment NIHSS (interquartile range [IQR]) was 21 (8–31), the median pretreatment pc-ASPECTS (IQR) was 8 (5–9), and the median PC-CS (IQR) was 5 (4–6). The site of occlusion was mid in 4 patients (18%) and distal in 18 patients (82%). The cause of basilar artery occlusion was embolism in 21 patients (95%) and thrombosis in 1 patient (1%).

The ADAPT was employed as the first choice in all patients, and a stent retriever was used in only one patient in whom the suction catheter could not reach the site of occlusion.

Successful recanalization, which was defined as a TICI of 2b or higher, was achieved in 18 patients (82%). There were nine patients (41%) in the good outcome group, defined as those with an mRS of 2 or lower at 90 days. Two patients (9%) died by day 90, while no symptomatic intracranial hemorrhage occurred.

Comparison between the good outcome group (mRS of 2 or lower) and the poor outcome group (mRS of 3 or higher) identified age, pretreatment NIHSS, and pretreatment pc-ASPECTS as factors for a good prognosis with a statistically significant difference ($P < 0.05$). No significant differences were found in the other items.

Age (mean ± SD) was 70 ± 10 years and 79 ± 8 years in the good outcome group and the poor outcome group, respectively, indicating that age was significantly lower in the good outcome group. Pretreatment NIHSS (median and IQR) was 8 (4–16) and 27 (21–31) in the good outcome group and the poor outcome group, respectively, indicating that pretreatment NIHSS was significantly lower in the good outcome group. Pretreatment pc-ASPECTS (median and IQR) was 8 (8–9) and 5 (4–6) in the good outcome group and the poor outcome group, respectively, indicating that pretreatment pc-ASPECTS was significantly higher in the good outcome group.

ROC analysis was performed for age, pretreatment pc-ASPECTS, and pretreatment NIHSS, which showed significant differences in univariate analysis. For age, area under the curve (AUC) was 0.782, 95% confidence interval (CI) was 0.575–0.989, P-value was 0.028, and cutoff value was 74, with a sensitivity of 84.6% and a specificity of 66.7% (**Fig. 1**). For pc-ASPECTS, AUC was 0.850, 95% CI was 0.682–1.000, P-value was 0.006, and cutoff value was 7, with a sensitivity of 88.9% and a specificity of

Table 1 Clinical characteristics of patients with good and poor outcomes

	All patients (n = 22)	Good outcome (n = 9)	Poor outcome (n = 13)	P-value
Age (years), mean (SD)	75 (10)	70 (10)	79 (8)	0.025
Male sex (%)	12 (55)	4 (44)	8 (62)	NS
Hypertension (%)	9 (41)	3 (33)	6 (46)	NS
Diabetes mellitus (%)	5 (23)	1 (11)	4 (31)	NS
Dyslipidemia (%)	2 (9)	2 (22)	0	NS
Atrial fibrillation (%)	10 (45)	4 (44)	6 (46)	NS
Old cerebral infarction (%)	5 (23)	1 (11)	4 (31)	NS
Old cerebral hemorrhage (%)	1 (5)	0	1 (8)	NS
Coronary heart disease (%)	1 (5)	0	1 (8)	NS
Anticoagulant drug (%)	9 (41)	3 (33)	6 (46)	NS
Baseline mRS (%)				
0	11 (50)	8 (89)	3 (23)	NS
1	1 (5)	1 (11)	0	
2	4 (18)	0	4 (31)	
3	2 (9)	0	2 (15)	
4	4 (18)	0	4 (31)	
Admission NIHSS, median (IQR)	21 (8–31)	8 (4–16)	27 (21–31)	0.017
DWI pc-ASPECTS, median (IQR)	8 (5–9)	8 (8–9)	5 (4–6)	0.001
DWI pc-ASPECTS, ≥7 (%)	12 (55)	9 (100)	3 (23)	<0.001
Median PC-CS (IQR)	5 (4–6)	6 (4–6)	4 (4–5)	NS
Location of occlusion (%)				
Mid BA	4 (18)	2 (22)	2 (15)	NS
Distal BA	18 (82)	7 (78)	11 (85)	
Stroke cause (%)				
Cardioembolism	21 (95)	9 (100)	12 (92)	NS
Atherosclerosis	1 (5)	0	1 (8)	
IV-tPA use (%)	7 (32)	4 (44)	3 (23)	NS
Time course				
Median time from P to R (IQR) (min)	30 (23–41)	30 (9–40)	34 (24–40)	NS
Median time from O to R (IQR) (min)	179 (128–235)	157 (138–276)	188 (139–229)	NS
Device (%)				
Aspiration tube	21 (95)	9 (100)	12 (92)	NS
Stent retriever	1 (5)	0	1 (8)	
mTICI, 2b or 3 (%)	18 (82)	9 (100)	9 (69)	NS
Clinical outcome				
mRS ≤2 after 90 days	9 (41)			
mRS6 after 90 days	2 (9)			
Symptomatic hemorrhage	0	0	0	

BA: basilar artery; BAO: basilar artery occlusion; DWI: diffusion weighted image; IQR: interquartile range; IV-tPA: intravenous tissue-type plasminogen activator; mRS: modified Rankin Scale; NIHSS: National Institute of Health Stroke Scale; NS: non-significant; O: onset; P: puncture; pc-ASPECTS: posterior circulation acute stroke progression early CT score; PC-CS: posterior circulation collateral score; R: recanalization; SD: standard deviation; TICI: thrombolysis in cerebral infarction

84.6% (**Fig. 2**). For NIHSS, AUC was 0.803, 95% CI was 0.604–1.000, P-value was 0.018, and cutoff value was 19, with a sensitivity of 76.9% and a specificity of 77.8% (**Fig. 3**). Age <74 years, pc-ASPECTS ≥7, and NIHSS <19 were significant prognostic predictors.

Discussion

Reports have shown that the prognosis of patients with a natural history of basilar artery occlusion is extremely poor, with the mortality rate being high. Schonewille et al.[12] reported that the proportion of patients with an mRS of 3 or lower was 21%, and the mortality rate was 40% in patients receiving medical treatment with an antithrombotic agent alone during a mean observation period of 28 days. Considering the seriousness and high mortality rate of basilar artery occlusion, we have proactively performed thrombectomy at our hospital.

In this study, successful recanalization was achieved in 82% of patients, while 41% were in the good outcome

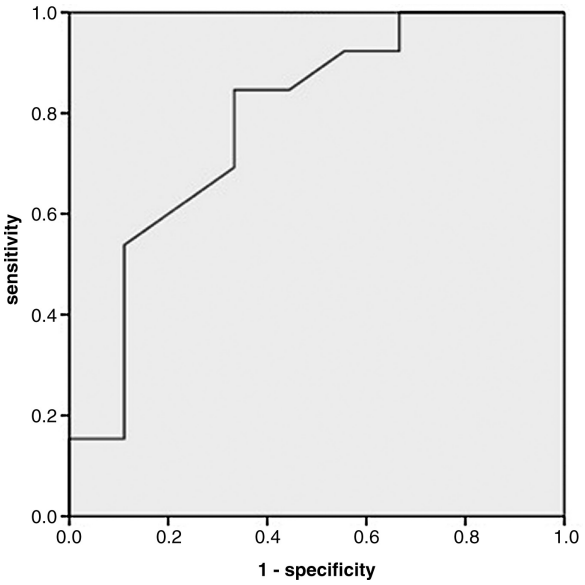

Fig. 1 Receiver operating characteristic curve for 90-day good outcome by age.

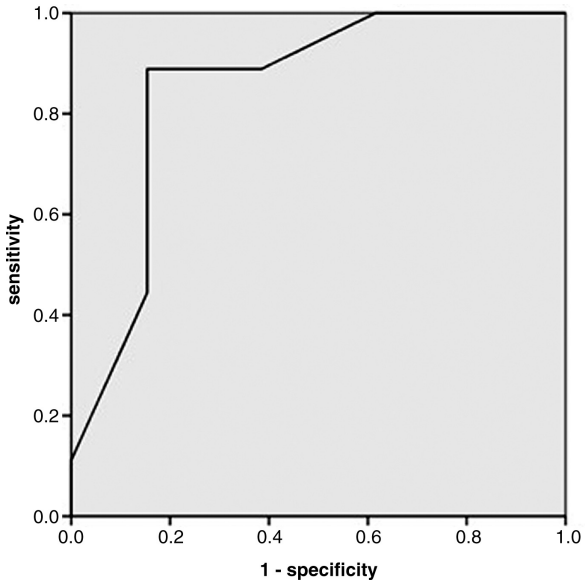

Fig. 2 Receiver operating characteristic curve for 90-day good outcome by posterior circulation acute stroke prognosis early CT score.

group and 9% died. These were comparable to the results reported in previous studies of thrombectomy for basilar artery occlusion.[13,14]

Compared with previous reports on the natural history of basilar artery occlusion, thrombectomy may be an effective treatment modality. However, all patients with basilar artery occlusion were treated with thrombectomy in this study, with no comparison being carried out vis-à-vis medical therapy, which makes it impossible to evaluate treatment efficacy. To date, there have been several studies comparing thrombectomy and medical therapy for basilar artery occlusion.

As a prospective registry study, the BASILAR study has been reported.[15] In the BASILAR study, patients with basilar artery occlusion within 24 hours after onset were divided into a medical therapy group and a thrombectomy group, and the primary endpoint was the mRS at 90 days and the secondary endpoint was an mRS of 3 or lower at 90 days. The proportion of patients with an mRS of 3 or lower at 90 days was 32.0% in the thrombectomy group and 9.3% in the medical therapy group, indicating that the thrombectomy group had a significantly better outcome. The safety endpoints were symptomatic intracranial hemorrhage and mortality at 90 days, and there was no increase in the incidence of symptomatic intracranial hemorrhage and the mortality rate was reduced, suggesting the usefulness and safety of thrombectomy.

However, in the BEST study,[16] an RCT that compared medical therapy with thrombectomy for basilar artery

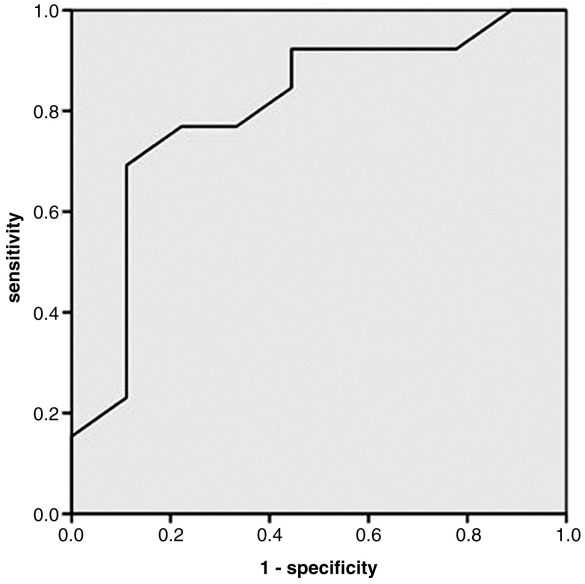

Fig. 3 Receiver operating characteristic curve for 90-day good outcome by National Institute of Health Stroke Scale

occlusion, the primary endpoint, which was an mRS of 3 or lower at 90 days, was achieved in 42.4% and 32.3% of patients in the thrombectomy group and the medical therapy group, respectively, demonstrating no clear usefulness. In that study, however, treatment crossover was allowed, and 22% of patients who were assigned to the medical therapy group switched to the thrombectomy group later on. In fact, as-treated analysis showed that the proportion of patients achieving an mRS of 3 or lower at 90 days was 46.8% in the thrombectomy group and 24.1% in the medical therapy

group, indicating that the thrombectomy group had a significantly better outcome. As far as the as-treated analysis is concerned, the usefulness of thrombectomy is suggested.

As such, while the usefulness of thrombectomy for basilar artery occlusion has been suggested and many reports suggest its safety, the evidence is still insufficient. This may be explained by the fact that cerebral infarction due to basilar artery occlusion varies greatly in severity from patient to patient, and that the seriousness of the disease is quite high.

Against this background, we investigated the factors for a good prognosis in thrombectomy for basilar artery occlusion. Univariate analysis identified age, pretreatment NIHSS, and pretreatment pc-ASPECTS as significant prognostic factors.

Other reports have also suggested NIHSS and pc-ASPECTS as factors for a good prognosis. Nagel et al.[17] defined a good outcome group as patients with an mRS of 2 or lower at 90 days, and identified a pc-ASPECTS of 8 or higher as a factor for a good prognosis. Yoon et al.[18] reported that a pc-ASPECTS of 7 or higher was associated with an mRS of 2 or lower at 90 days, concluding that a low NIHSS and a high pc-ASPECTS are favorable prognostic factors. Furthermore, Luo et al.[19] reported that an NIHSS of less than 22 and a pc-ASPECTS of 6 or higher were associated with an mRS of 2 or lower at 90 days. While all of these reports examined the prognostic factors of thrombectomy using a stent retriever alone or in combination as the first choice, we investigated the prognostic factors of thrombectomy with the ADAPT as the first choice.

In our study, ROC analysis showed that age <74 years, pc-ASPECTS ≥7, and NIHSS <19 were favorable prognostic factors. Thrombectomy does not always lead to a good outcome in patients with cerebral infarction due to basilar artery occlusion, whether or not recanalization is achieved. Nonetheless, a good prognosis, defined as an mRS of 2 or lower at 90 days, can be expected in patients who are aged less than 74 years, have a pc-ASPECTS of 7 or higher, or have an NIHSS of less than 19, and active intervention may be considered in these patients.

Conclusion

We retrospectively evaluated the outcome of thrombectomy with the ADAPT as the first choice for basilar artery occlusion at our hospital and examined the prognostic factors. Age less than 74 years, pc-ASPECTS of 7 or higher, and NIHSS of less than 19 were found to be significant prognostic predictors, and a good prognosis can be expected in patients who meet these conditions.

Disclosure Statement

The authors declare no conflict of interest.

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