

RECOVERY PROGNOSIS OF ASPECTS IN PATIENTS WITH ACUTE ANTERIOR CIRCULATION CEREBRAL INFARCTION UNDERGOING MECHANICAL THROMBECTOMY

*Nguyen Thanh Tam**, *Vu Dang Luu**, *Tran Anh Tuan***,
*Le Hoang Kien***, *Nguyen Quang Anh**, *Nguyen Cong Tien***

SUMMARY

Aim: Comparison of the prognostic value of recovery of the ASPECTS score compared with perfusion imaging in patients with acute anterior circulation cerebral infarction undergoing thrombectomy.

Materials and methods: Retrospective cross-sectional descriptive study combined with a prospective study of 82 cases undergoing CT scan without injection, CTA, and CTP, using RAPID software to calculate core and penumbra values and mechanical thrombectomy within 6-24 hours. Good (0-2 points) and poor (3-6 points) stroke outcomes were assessed at 3 months by the modified Rankin functional recovery score (mRS). Use the ROC curve and AUC value to compare the good and bad stroke prognostic value of ASPECTS and the core, penumbra, mismatch ratio values.

Results: From January 2022 to May 2023, 82 patients were included in the study. At 90 days, the independent outcome rate of good mRS function (0-2) was 57.3%, and poor mRS function (3-6) was 42.7%. The ROC curve showed that, among the ASPECTS, core, penumbra, and mismatch ratio indices, only ASPECTS could predict stroke outcome well ($p = 0.001 < 0.05$), the area under the curve was 0.709 with J - point cutoff index at threshold ASPECTS = 6 with sensitivity 93.6% and specificity 57.1%.

Conclusion: ASPECTS ≥ 6 can predict good functional recovery after stroke in patients with acute anterior circulation cerebral infarction undergoing thrombectomy at the extended window.

Keywords: *stroke after 6 hours, mechanical thrombectomy, ASPECTS, core, penumbra, mismatch ratio*

* Hanoi Medical University

** Radiology Center, Bach Mai Hospital, Hanoi, Vietnam

I. INTRODUCTION

Stroke is the most common cause of disability in developed countries [1]. Treatment decisions for acute ischemic stroke patients depend on the time of onset [2]. The current global recommendations limit treatment to within 4.5 hours for intravenous thrombolysis and 6 hours for mechanical clot retrieval. Beyond these timeframes, the risk of intracerebral hemorrhage upon vessel reperfusion increases. However, due to traffic conditions and transportation limitations, the percentage of stroke patients reaching the hospital in time for these critical windows is very low, even in advanced countries. Approximately 90% of patients arrive at the hospital after 4.5 hours from onset.

Recent studies, such as DAWN and DEFUSE3, have demonstrated the efficacy of clot retrieval interventions beyond 6 hours from onset, based on infarct core CT perfusion and MRI diffusion [3], [4]. Nevertheless, accessibility to MRI diffusion or CT perfusion imaging is limited in many stroke centers worldwide, particularly in Vietnam. Research on clot retrieval beyond 6 hours primarily focuses on the effectiveness of intervention methods, with minimal emphasis on fundamental imaging studies. Therefore, the question of whether non-contrast CT (NCCT) imaging alone can be sufficient for selecting mechanical clot retrieval patients in an extended time window remains unanswered. If the prognostic value of NCCT imaging is comparable or superior to CT perfusion, could it replace CT perfusion in patient selection for clot retrieval? Thus, we conducted this study with the objective: "To compare the prognostic value of the ASPECTS score with CT perfusion imaging in acute ischemic stroke patients undergoing mechanical thrombectomy before the extended time window".

II. MATERIALS AND METHODS

1. Materials

Selection criteria: Patients with acute anterior circulation infarction undergoing NCCT and CTP, have the following inclusion criteria:

- Age ≥ 18
- There are signs of clear neurological deficits NIHSS ≥ 6

- Clinical diagnosis of acute ischemic stroke with onset 6 – 24 hours.
- mRS ≤ 2 before onset
- CTA: occlusion of the internal carotid artery or proximal middle cerebral artery (M1 or M2 segment).
- Get a computed tomography perfusion scan before treatment.
- Qualified for thrombectomy intervention using mechanical devices (DEFUSE 3 and DAWN)
- Agree to participate in the study

Exclusion criteria:

- The stroke has passed the acute stage
- There is bleeding on CT scan or MRI
- Patients with pseudo-occlusion of the internal carotid artery on CTA: are patients with severe narrowing of the proximal part of the internal carotid artery, gradually reducing the flow of the distal part of the internal carotid artery, causing the image of pseudo-occlusion on CTA, but on DSA the image of the internal carotid artery is still visible.
- Cerebral infarction due to basilar artery occlusion.

2. Method: Retrospective and prospective cross-sectional descriptive study.

3. Establish research process: Patients with symptoms suspected of stroke are admitted to the hospital after 6 hours of clinical evaluation, NIHSS scoring, and basic tests. Patients underwent brain NCCT, ASPECTS scoring, and cerebral multi-array computed tomography (CTA). When there is a result of a large vessel occlusion in the anterior circulation, a computed tomography perfusion scan will be performed. RAPID software helps calculate the infarct core volume, penumbra volume, and mismatch ratio and patients receive mechanical thrombectomy if the conditions are met. Assess mRS after 90 days of treatment.

4. Data processing: Data were entered and analyzed using descriptive statistics on SPSS 2.0 software. Qualitative variables were described by frequency and

percentage. Use the ROC curve and AUC value to determine and compare the prognostic value of clinical recovery after 3 months of the variables ASPECTS, core, penumbra, and mismatch ratio.

There were 82 acute ischemic stroke patients with anterior circulation large vessel occlusion who underwent mechanical thrombectomy within the 6 - 24 hours window. The detailed results are shown in the tables below.

III. RESULTS

Table 1. General characteristics of the research sample

Gender	Number of cases (N = 82)	Ratio (%)
Male	45	55
Female	37	45
Age (year)	65.5 ± 11.6	
Medical history		
Hypertension	55	67.1
Atrial fibrillation	30	36.6
Diabetes	38	46.3

Comments: The study patient group had an average age of 65.5 ± 11.6 years old, with the highest rate of underlying disease being hypertension.

Table 2. Location of vessel occlusion

Location vessel occlusion	N	Ratio (%)
ICA occlusion	23	28.0
M1 occlusion	46	56.1
Tandem occlusion	8	9.8
M2 occlusion	5	6.1
Total	82	100

Comments: In our study, occlusion of the M1 branch of the middle cerebral artery had the highest rate (56.1%).

Table 3. Imaging characteristics

Cerebral infarct area	N	Maximum (ml)	Minimum (ml)	Mean (ml)	Median (ml)
Infarct core	82	62	0	15.00 ± 19.59	15(4-36)
Penumbra tissue	82	248	4	115.50 ± 49.11	115.5 (78.75-144.25)
Mismatch ratio	82	191.0	2.3	8.26 ± 40.99	
ASPECTS	82	10	3	6.93 ± 1.83	7 (6-8)

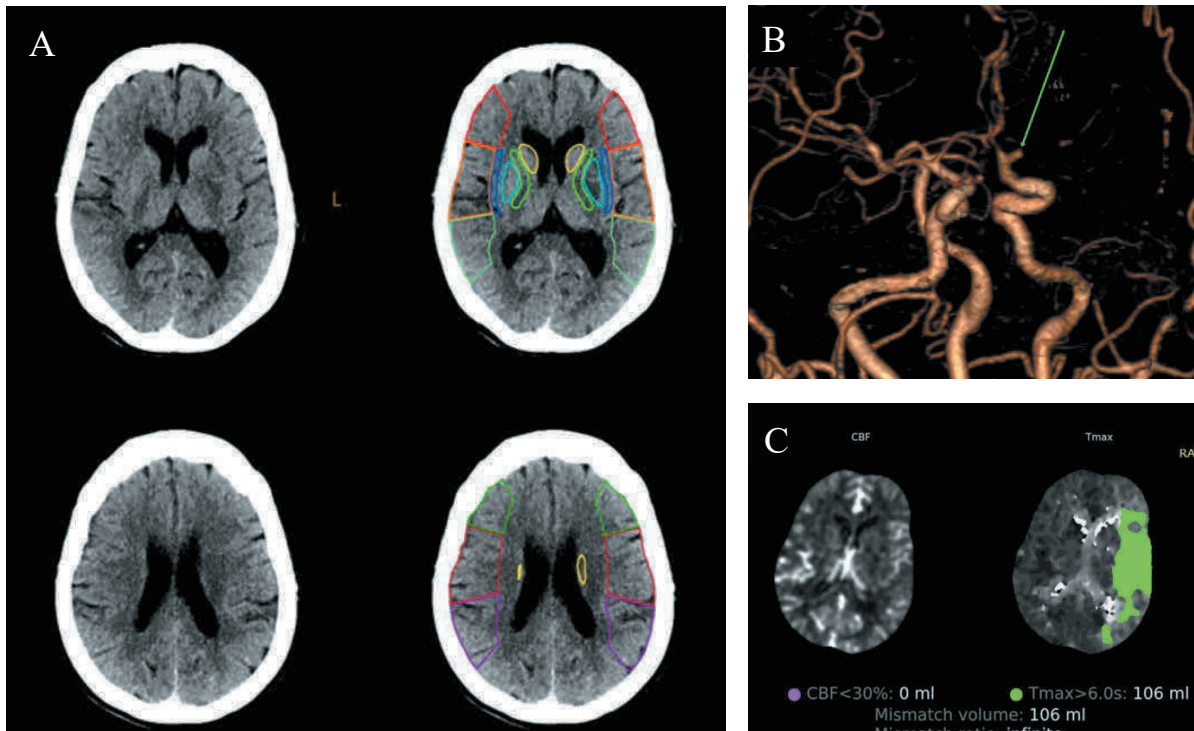


Figure 1. An 67 year-old man, I63/4, arrived at the hospital 15 hours after onset stroke. On non-contrast CT (A), there is no image of brain parenchymal damage, ASPECTS value is 10 points; CTA image (B) shows left middle cerebral artery occlusion from the M1 segment (green arrow); On the CTP image (C), the core value is 0ml, penumbra corresponds to the mismatch volume value of 106ml.

Table 4. Relationship of ASPECTS with Infarct core, Penumbra tissue, and mismatch ratio

	<i>p-value</i>	R
Infarct core 0.000		- 0.569
Penumbra tissue	0.119	- 0.174
Mismatch ratio	0.000	0.513

Comments: In the univariate regression correlation, only infarct core and mismatch ratio were correlated with ASPECTS with a p-value of 0.000 < 0.05. In which, infarct core value has a negative correlation and mismatch ratio has a positive correlation with ASPECTS value.

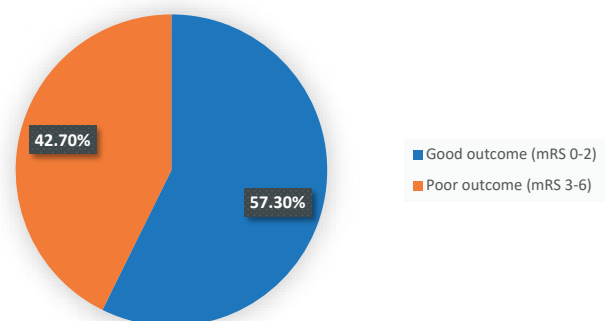


Figure 2. Clinical results after 90 days according to the mRS scale

Comments: In the study group, the rate of good clinical recovery was higher (57.3%).

Table 5. Relationship between imaging characteristics and mRS after 3 months

	Good mRS (0-2)	Poor mRS (3-6)	p-value
Core (median, ml)	10	21	0.139
Penumbra (median, ml)	109	117	0.288
Mismatch ratio (median)	10.8	6.7	0.357
ASPECTS (median)	8.0	6.0	0.001

Comments: Univariate analysis found that among the factors ASPECTS, core, penumbra, and mismatch ratio, only ASPECTS had $p < 0.05$, with a statistically significant association with clinical outcome after stroke.

Thus, ASPECTS is a potential factor in predicting stroke outcomes in patients with acute anterior circulation cerebral infarction with onset after 6 hours.

Table 6. Correlation between ASPECTS and mRS after 3 months

ASPECTS	mRS after 3 months				OR (95%)	p-value
	0-2 (good)		3-6 (poor)			
	N	Ratio (%)	N	Ratio (%)		
≥6	44	53.6	20	24.4	11.000 (2.859 – 42.329)	0.000
<6	3	3.7	15	18.3		
Total	47	57.3	35	42.7		

Comments: The likelihood of a good outcome of mRS after 3 months of the group with ASPECTS ≥6 is 11 times higher than the group with ASPECTS < 6.

Good recovery prognostic value of the ASPECTS score

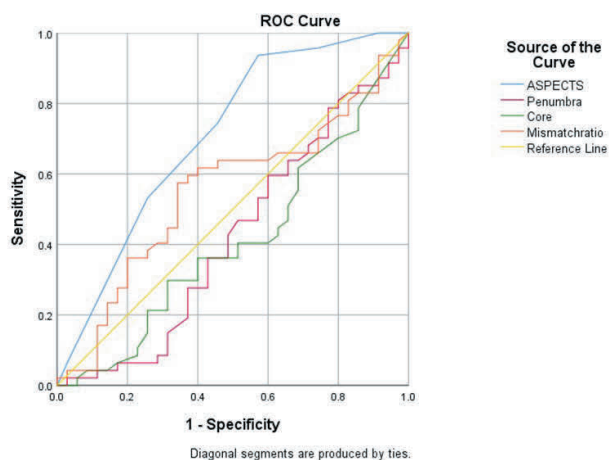


Figure 3. ROC curves for estimation of the cutoff value of ASPECTS, CTP for the outcome of acute ischemic stroke

Comments: On the ROC curve chart of the values of the ASPECTS, core, penumbra and mismatch ratio indices, only ASPECTS has good prognostic ability, the area under the curve is 0.709 with the J - point cutoff index at the ASPECTS threshold. = 6 with a sensitivity of 93.6% and specificity 57.1%.

IV. DISCUSSION

The group of patients receiving extended thrombectomy included 82 cases, the highest ASPECTS score was 10 points, and the lowest was 3 points, corresponding to the number of infarct areas from 0 to 7 areas. ASPECTS has a median value of 7 and an interquartile range of 6-8. The ASPECTS value in our study is smaller than that of domestic and foreign studies, author Pham Quang Tho's is 7 (7-8), the DEFUSE3 study's median value is 8 (7-9) and the CLEAR study by Thanh N. Nguyen is 8 (7-9) [3], [5], [6]. The average ASPECTS value in our study is 6.93 ± 1.83 , this value is also smaller than author Tran Anh Tuan's study, with the average ASPECTS value = 7.59 ± 0.9 [7]. The reason is that the studies by authors Tran Anh Tuan, Nguyen Quang Tho and Thanh N. Nguyen mostly selected

patients with ASPECTS scores greater than or equal to 6 [3], [5], [6]. In our study group of patients with thrombectomy over 6 hours, the ASPECTS rate ≥ 6 accounted for a high proportion (about 78%), in E. Natera-Villalba's study, the ASPECTS rate ≥ 6 also accounted for a high rate (94.9%) [8]. Thus, most patients selected for mechanical thrombectomy in the extended window have high ASPECTS scores, corresponding to little parenchymal damage on unenhanced computed tomography images. In our study, the highest occlusion rate was in the middle cerebral artery segment M1 (56.1%), followed by the internal carotid artery (28%), occlusion of two locations in the internal carotid artery (9.8%) and the M2 (6.1%). Other domestic and international studies have shown that the highest occlusion rate is the middle cerebral artery segment M1: DAWN study 77.6%, CLEAR study 56.5%, TREVO 60% or the author's study by author Nguyen Quang Anh 41.9% [4], [5], [9], [10]. Our results are quite similar to our study and are quite similar to Thanh N. Nguyen's CLEAR study.

The necrotic area "infarct core" is the matching area on the CBV/MTT map. The "penumbra" risk tissue area is located next to the core area, that is, the area does not match the CBV/MTT map. The average hematoma core volume of the study was 15.00 ± 19.59 , the median value was 15 (4-36), this value was higher than the DAWN 7.6 (2.0-18.0) and DEFUSE3 studies which were 9.4 (2.3- 25.6) [3], [4]. Compared with domestic studies on thrombectomy in an extended window, our core ratio is lower than that of author Tran Anh Tuan (average core 22.9 ± 13.1) [7]. The average risk area volume of the study is 115.50 ± 49.11 , the median value is 115.5 (78.75-144.25), this value is higher than the DAWN 67 study (62.6) and similar to DEFUSE3 which is 114.7 (79.3) -146.3) [3], [4]. Compared with domestic studies on thrombectomy in an extended window, our penumbra rate is higher than that of author Tran Anh Tuan (average penumbra 81.8 ± 27.6) and equivalent to the author's study Pham Quang Tho (median 114.7 (79.3-146.3) [6], [7]. In our study, in the univariate regression correlation between core, penumbra, and mismatch ratio, only core and mismatch ratio were correlated with ASPECTS, index $p < 0.05$. In particular, there is a moderate negative correlation between core and ASPECTS with coefficient

$r = -0.569$. Our results are similar to the results of author Voleti, studying 52 patients with anterior circulation cerebral infarction, and thrombectomy at the extended window, the results had a moderate negative correlation between ASPECTS and core with value $r = -0.55$ [11]. In Jelle Demeestere's study, there was a correlation between ASPECTS and core with $p = 0.004$, however, the correlation coefficient was weak with $r = -0.23$ [12].

Our study sample included 82 patients. After 3 months of follow-up, the number of patients with good clinical outcomes (mRS 0-2) was 57.3%, and poor outcomes (mRS 3-6) was 42.7%. The favorable clinical outcomes observed in this study were higher than in the DAWN (49%) and DEFUSE3 (45%) studies or the CLEAR study (42.1%) [3-5]. Compared with domestic research, this rate is lower than the study by author Vu Dang Luu (72.4%), higher than the study by author Tran Anh Tuan (47%), and equivalent to the rate by author Tran Thi Minh Hang (51.2%) [7], [13], [14]. Between the two mRS recovery outcomes after 3 months, there was no difference in core, penumbra, or mismatch ratio. However, between the two good and bad mRS groups, there is a difference in ASPECTS (with $p = 0.001 < 0.05$). In particular, good mRS outcomes (0-2) after 3 months in the ASPECTS ≥ 6 and ASPECTS < 6 groups were 68.8% and 31.3%, respectively, a statistically significant difference between these two rates with $p = 0.000 < 0.05$. The likelihood of a good outcome of mRS after 3 months of the group with ASPECTS ≥ 6 is 11 times higher than the group with ASPECTS < 6 , specifically in our study ASPECTS from 3 - 5 points. On the ROC curve chart of the values of the ASPECTS, core, penumbra, and mismatch ratio indices, only ASPECTS has good prognostic ability, the area under the curve is 0.709 with the J - point cutoff index at the ASPECTS threshold. = 6 with a sensitivity of 93.6% and specificity of 57.1%. Thus, an ASPECTS score ≥ 6 can predict a good prognosis in patients with acute anterior circulation cerebral infarction undergoing thrombectomy at the extended window. This value is independent of core, penumbra, or mismatch ratio.

V. CONCLUSIONS

ASPECTS demonstrates a strong predictive ability for good functional recovery after stroke in patients with

acute anterior circulation cerebral infarction undergoing thrombectomy within the extended time window. This suggests that ASPECTS ≥ 6 may be considered as an

alternative to CTP in selecting patients for mechanical thrombectomy in medical facilities lacking advanced imaging diagnostic capabilities.

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Correspondent: Nguyen Thanh Tam Email: maimai1232107@gmail.com

Received: 13/10/2023. Assessed: 15/10/2023. Accepted: 23/12/2023