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Outcomes of Mechanical Thrombectomy for Patients With Stroke Presenting With Low Alberta Stroke Program Early Computed Tomography Score in the Early and Extended Window

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Abstract

IMPORTANCE Limited data are available about the outcomes of mechanical thrombectomy (MT) for real-world patients with stroke presenting with a large core infarct.

OBJECTIVE To investigate the safety and effectiveness of MT for patients with large vessel occlusion and an Alberta Stroke Program Early Computed Tomography Score (ASPECTS) of 2 to 5.

DESIGN, SETTING, AND PARTICIPANTS This retrospective cohort study used data from the Stroke Thrombectomy and Aneurysm Registry (STAR), which combines the prospectively maintained databases of 28 thrombectomy-capable stroke centers in the US, Europe, and Asia. The study included 2345 patients presenting with an occlusion in the internal carotid artery or M1 segment of the middle cerebral artery from January 1, 2016, to December 31, 2020. Patients were followed up for 90 days after intervention. The ASPECTS is a 10-point scoring system based on the extent of early ischemic changes on the baseline noncontrasted computed tomography scan, with a score of 10 indicating normal and a score of 0 indicating ischemic changes in all of the regions included in the score.

EXPOSURE All patients underwent MT in one of the included centers.

MAIN OUTCOMES AND MEASURES A multivariable regression model was used to assess factors associated with a favorable 90-day outcome (modified Rankin Scale score of 0-2), including interaction terms between an ASPECTS of 2 to 5 and receiving MT in the extended window (6-24 hours from symptom onset).

RESULTS A total of 2345 patients who underwent MT were included (1175 women [50.1%]; median age, 72 years [IQR, 60-80 years]; 2132 patients [90.9%] had an ASPECTS of ≥6, and 213 patients [9.1%] had an ASPECTS of 2-5). At 90 days, 47 of the 213 patients (22.1%) with an ASPECTS of 2 to 5 had a modified Rankin Scale score of 0 to 2 (25.6% [45 of 176] of patients who underwent successful recanalization [modified Thrombolysis in Cerebral Ischemia score ≥2B] vs 5.4% [2 of 37] of patients who underwent unsuccessful recanalization; *P* = .007). Having a low ASPECTS (odds ratio, 0.60; 95% CI, 0.38-0.85; *P* = .002) and presenting in the extended window (odds ratio, 0.69; 95% CI, 0.55-0.88; *P* = .001) were associated with worse 90-day outcome after controlling for potential confounders, without significant interaction between these 2 factors (*P* = .64).

(continued)

Key Points

Question What is the 90-day outcome for patients with stroke presenting with an Alberta Stroke Program Early Computed Tomography Score (ASPECTS) of 2 to 5 who underwent mechanical thrombectomy?

Findings In this multicenter cohort study of 2345 patients presenting with an intracranial internal carotid artery or M1 occlusion who underwent mechanical thrombectomy, 213 [9.1%] had an ASPECTS of 2 to 5, and 22% of these patients achieved favorable 90-day outcomes (modified Rankin scale score of 0-2). Patients who achieved successful recanalization were nearly 5 times more likely to achieve favorable outcomes compared with patients who had unsuccessful recanalization.

Meaning This study suggests that patients with a low ASPECTS on presentation may achieve 90-day functional independence after mechanical thrombectomy if they achieve successful recanalization.

+ Supplemental content

Author affiliations and article information are listed at the end of this article.

Abstract (continued)

CONCLUSIONS AND RELEVANCE In this cohort study, more than 1 in 5 patients presenting with an ASPECTS of 2 to 5 achieved 90-day functional independence after MT. A favorable outcome was nearly 5 times more likely for patients with low ASPECTS who had successful recanalization. The association of a low ASPECTS with 90-day outcomes did not differ for patients presenting in the early vs extended MT window.

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Introduction

Clinical trials have shown that mechanical thrombectomy (MT) is associated with improved functional outcomes for patients with acute ischemic stroke presenting with proximal anterior circulation, large vessel occlusion, and salvageable brain tissue.[1-5] As a result, MT has become the standard of care for these patients since 2015.[1,6] The Alberta Stroke Program Early Computed Tomography Score (ASPECTS) is a 10-point scoring system based on the extent of early ischemic changes detected on the baseline noncontrasted computed tomography scan, with a score of 10 indicating normal and 0 indicating ischemic changes in all of the regions included in the score.[7] Patients with an ASPECTS lower than 6 were excluded from most clinical trials[8]; therefore, data about their outcomes remain scarce, and whether these patients could still achieve benefits from MT remains unknown.[4] The rationale behind excluding this group of patients stems from the knowledge that patients with a large core infarct at presentation are unlikely to benefit from reperfusion to the same degree as those with either a small core infarct or no core infarct.[9] However, the infarct size threshold for futility remains unknown.

Results from the HERMES (Highly Effective Reperfusion Evaluated in Multiple Endovascular Stroke) collaboration suggested potential benefits associated with MT for patients with a low baseline ASPECTS, but the results were limited by the small number of patients with low ASPECTS.[4,8] Other observational studies have suggested potential benefits associated with MT in this group.[10-14] Similarly, these studies were limited by the small sample size and the limited number of patients treated in the extended MT window (6-24 hours from symptom onset to groin puncture). In this study, we sought to investigate the safety and effectiveness of MT in a real-world cohort of patients with large vessel occlusion and large core infarct in the early thrombectomy window (<6 hours from symptom onset to groin puncture) and an extended thrombectomy window. We compared the outcomes of MT for patients with a low vs high ASPECTS using a cutoff of 5 or less for a low ASPECTS given that this cutoff was used in most of the MT clinical trials, including ESCAPE (Endovascular Treatment for Small Core and Anterior Circulation Proximal Occlusion With Emphasis on Minimizing CT to Recanalization Times)[15] and DEFUSE 3 (Endovascular Therapy Following Imaging Evaluation for Ischemic Stroke).[5] Then, we assessed the MT outcomes of patients with a low ASPECTS based on reperfusion status and treatment in the early vs extended window, hypothesizing that both of these factors modify the outcome associated with MT.

Methods

Study Design

In this retrospective cohort study, we reviewed the prospectively maintained databases of 28 stroke centers in the Stroke Thrombectomy and Aneurysm Registry. We included patients with acute stroke presenting with an occlusion in the internal carotid artery (ICA) or M1 segment of the middle cerebral artery who received MT within 24 hours of witnessed symptom onset between January 1, 2016, and December 31, 2020. All patients with an ICA or M1 occlusion underwent MT regardless of their perfusion status. After MT, patients were admitted to the neurologic intensive care unit in each of the included centers. Follow-up head images were obtained 24 hours after MT to assess the presence of hemorrhagic transformation and cerebral edema. The study was approved by the institutional review board at each of the included centers (Medical University of South Carolina; Emory University School of Medicine; Thomas Jefferson University Hospitals; University of Miami Health System; Wake Forest School of Medicine; University of Tennessee Health Science Center; University of Iowa Hospitals and Clinics; University Medical Center Göttingen; West Virginia School of Medicine; University of Texas Health Science Center at San Antonio; University of Basel; Mount Sinai Health System; University of Arizona; University of Washington; University of Florida; Washington University in St Louis; Endovascular Neurological Center, Montevideo, Uruguay; Chonnam National University Hospital; Hospital Juan Fernandez; Hyogo College of Medicine; Yale School of Medicine; University of Texas Medical Branch; Allegheny Health Network; Centre Hospitalier Régional Universitaire de Nancy; Centre Hospitalier Régional Universitaire de Nancy; Hospital São José Centro Hospitalar; Bon Secours Mercy Health St Vincent Medical Center; and Texas Stroke Institute), and the need for informed consent was waived given its minimal risk design. This study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guideline.

Data Collection and Clinical Outcome

Collected data included baseline demographic characteristics, location of occlusion, baseline core infarct as determined by the ASPECTS, time from symptom onset to groin puncture, MT technique, procedure time, thrombectomy passes, devices used, rescue therapy used, complications, and final modified Thrombolysis in Cerebral Ischemia score. Patients with an ASPECTS of 2 to 5 were divided into early window and extended window groups. Baseline imaging, recanalization rates, and postprocedural imaging were reviewed by local investigators at each participating site. Successful recanalization was defined as a modified Thrombolysis in Cerebral Ischemia score of 2B or more. The 90-day modified Rankin Scale (mRS) score was used as the primary outcome measure and was recorded during a follow-up visit or telephone encounter at a mean (SD) of 90 (14) days after stroke by a stroke neurologist or registered nurse.[16] Favorable outcome was defined as an mRS score of 0 to 2 at 90 days. Symptomatic intracranial hemorrhage was defined as postprocedural hemorrhage with an associated decrease of 4 points or more in the National Institutes of Health Stroke Scale (NIHSS) score.

Statistical Analysis

We used descriptive statistics to report patients' demographic and clinical characteristics, using median (IQR) values for continuous variables and percentages for categorical variables. The characteristics of the 2 groups were compared using the Wilcoxon rank sum (Mann-Whitney) test and the χ^2 test as appropriate. We used a multivariable logistic regression model to assess the factors associated with 90-day outcomes for all patients undergoing MT who presented with ICA or M1 occlusion, and interaction terms between an ASPECTS of 2 to 5 and receipt of MT in the extended window were used. Variables included in the regression model include age, location of occlusion, admission NIHSS score, intravenous thrombolysis, successful recanalization, an ASPECTS of 2 to 5, and treatment in the extended window. Finally, to assess whether the association between an ASPECTS of 2 to 5 and a favorable outcome is modified by the center in which the thrombectomy was performed, we used the Cochran-Mantel-Haenszel test. All *P* values were from 2-sided tests, and results were deemed statistically significant at $P < .05$.

Results

A total of 6660 patients who underwent MT were included in the Stroke Thrombectomy and Aneurysm Registry at the time of the study. Of those, 2351 patients had an occlusion in the ICA or M1 segment of the middle cerebral artery. Patients who presented with an ASPECTS of 0 to 1 (n = 6) were excluded given that all of them had an mRS score of 5 to 6 on 90-day follow-up, resulting in a final sample of 2345 patients who underwent MT. Among included patients, the median age was 72 years (IQR, 60-80 years), 1175 (50.1%) were women, 2132 (90.9%) had ASPECTS of 6 or higher, and 213 (9.1%) had an ASPECTS of 2 to 5.

Characteristics and Outcomes for Patients With an ASPECTS of 2 to 5 vs 6 to 10

Patients with an ASPECTS of 2 to 5 were younger (median age, 70 years [IQR, 59-77 years] vs 72 years [IQR, 60-81 years]; *P* = .003), had a higher median NIHSS score on presentation (18 [IQR, 14-22] vs 16 [IQR, 12-20]; *P* < .001), and were more likely to present with an ICA occlusion (102 of 213 [47.9%] vs 614 of 2132 [28.8%]) compared with patients presenting with an ASPECTS of 6 to 10 (**Table 1**). Patients in the low ASPECTS group had a worse 90-day median mRS score than those in the high ASPECTS group (4 [IQR, 3-6] vs 4 [IQR, 1-5]; *P* < .001) and higher 90-day mortality (70 of 213 [32.9%] vs 464 of 2132 [21.8%]; *P* < .001). At 90 days, 47 of the 213 patients (22.1%) with an ASPECTS of 2 to 5 had an mRS score of 0 to 2, whereas 771 of the 2132 patients (36.2%) with an ASPECTS of 6 to 10 had an mRS score of 0 to 2.

Successful vs Unsuccessful Recanalization in Patients With an ASPECTS of 2 to 5

For the 213 patients with an ASPECTS of 2 to 5, 176 (82.6%) achieved successful recanalization after MT. No significant difference between the 2 groups was noted in the baseline characteristics, admission NIHSS score, location of occlusion, intravenous tissue plasminogen activator use, MT technique, intra-arterial tissue plasminogen activator use, or the number of MT passes (**Table 2**). A favorable outcome (90-day mRS score of 0-2) was seen in 45 of 176 patients (25.6%) in the successful recanalization group compared with only 2 of 37 patients (5.4%) in the unsuccessful recanalization group (*P* = .007). There was no significant difference in 90-day mortality between the

Table 1. Characteristics of Patients Who Underwent Mechanical Thrombectomy Presenting With ICA or M1 Occlusion

Characteristic	Patients, No. (%) ASPECTS of 6-10 (n = 2132)	Patients, No. (%) ASPECTS of 2-5 (n = 213)	*P* value[a]
Age, median (IQR), y	72 (60-81)	70 (59-77)	.003
Sex			
Female	1072 (50.3)	103 (48.4)	.59
Male	1060 (49.7)	110 (51.6)	
Admission NIHSS score, median (IQR)	16 (12-20)	18 (14-22)	<.001
Location of occlusion			<.001
ICA	614 (28.8)	102 (47.9)	
M1	1518 (71.2)	111 (52.1)	
IV-tPA used	1114 (52.3)	98 (46.0)	.08
Time from symptom onset to groin puncture, median (IQR), min	240 (155-424)	305 (201-566)	<.001
Thrombectomy passes, median (IQR), No.	2 (1-3)	2 (2-3)	<.001
mTICI score			
≥2B	1812 (85.0)	176 (82.6)	.36
≥2C	1148 (53.8)	99 (46.5)	.04
Procedure duration, median (IQR), min	38 (23-63)	45 (22-77)	.09
Periprocedural complications	115 (5.4)	16 (7.5)	.20
Symptomatic intracerebral hemorrhage	125 (5.9)	24 (11.3)	.002
Parenchymal hematoma type II	155 (7.3)	33 (15.5)	<.001
90-d mRS score			
Median (IQR)	4 (1-5)	4 (3-6)	<.001
0-2	771 (36.2)	47 (22.1)	<.001
0-3	1051 (49.3)	78 (36.6)	<.001
90-d Mortality	464 (21.8)	70 (32.9)	<.001

Abbreviations: ASPECTS, Alberta Stroke Program Early Computed Tomography Score; ICA, internal carotid artery; IV-tPA, intravenous tissue plasminogen activator; mRS, modified Rankin scale; mTICI, modified Thrombolysis in Cerebral Ischemia; NIHSS, National Institutes of Health Stroke Scale.

[a] Calculated using the χ^2 test for categorical variables and the Wilcoxon rank sum test for continuous variables.

successful recanalization group and the unsuccessful recanalization group (54 of 176 [30.7%] vs 16 of 37 [43.2%]; *P* = .14).

An ASPECTS of 2 to 5 in the Early and Extended Windows

We divided patients with a low ASPECTS undergoing MT into early (≤6 hours) and extended (6-24 hours) window groups (**Table 3**). There was no significant difference between patients in the early window group and patients in the extended window group in 90-day favorable outcome (30 of 123 [24.4%] vs 17 of 90 [18.9%]; *P* = .34) or 90-day mortality (46 of 123 [37.4%] vs 24 of 90 [26.7%]; *P* = .10).

Multivariable Analysis

Using a binary regression model that included all patients who presented with an ICA or M1 occlusion and underwent MT, both a low ASPECTS and treatment in the extended window were associated with lower odds of achieving a favorable 90-day outcome (low ASPECTS: odds ratio [OR], 0.60; 95%

Table 2. Characteristics of Patients Who Underwent Mechanical Thrombectomy Presenting With ICA or M1 Occlusion and an ASPECTS of 2 to 5 Who Had Successful vs Unsuccessful Recanalization

Characteristic	Patients, No. (%)		*P* value[a]
	Successful recanalization (n = 176)	Unsuccessful recanalization (n = 37)	
Age, median (IQR), y	70 (60-77)	67 (54-76)	.24
Sex			
Female	82 (46.6)	21 (56.8)	.26
Male	94 (53.4)	16 (43.2)	
Race			
Black	12 (6.8)	3 (8.1)	.11
White	156 (88.6)	29 (78.4)	
Other[b]	8 (4.5)	5 (13.5)	
Hypertension	114 (64.8)	28 (75.7)	.20
Type 1 or 2 diabetes	54 (30.7)	13 (35.1)	.60
Atrial fibrillation	57 (32.4)	16 (43.2)	.21
Hyperlipidemia	60 (34.1)	14 (37.8)	.66
Admission NIHSS score, median (IQR)	18 (14-22)	18 (14-21)	.50
Location of occlusion			
ICA	82 (46.6)	20 (54.1)	.41
M1	94 (53.4)	17 (45.9)	
IV-tPA used	81 (46.0)	17 (45.9)	.99
Time from symptom onset to groin puncture, median (IQR), min	299 (200-519)	345 (224-629)	.36
Technique			
ADAPT	128 (72.7)	25 (67.6)	.65
Stent retriever	15 (8.5)	5 (13.5)	
Solumbra	5 (2.8)	2 (5.4)	
Combination of techniques	28 (15.9)	5 (13.5)	
IA-tPA used	9 (5.1)	2 (5.4)	.94
Thrombectomy passes, median (IQR), No.	2 (2-3)	2 (2-3)	.23
Procedure duration, median (IQR), min	39 (19-77)	65 (40-78)	.01
Periprocedural complications	10 (5.7)	6 (16.2)	.03
Symptomatic intracerebral hemorrhage	21 (11.9)	3 (8.1)	.50
90-d mRS score			
Median (IQR)	4 (2-6)	5 (4-6)	.001
0-2	45 (25.6)	2 (5.4)	.007
0-3	74 (42.0)	4 (10.8)	<.001
90-d Mortality	54 (30.7)	16 (43.2)	.14

Abbreviations: ADAPT, A Direct Aspiration First Pass Technique; ASPECTS, Alberta Stroke Program Early Computed Tomography Score; IA-tPA, intra-arterial tissue plasminogen activator; ICA, internal carotid artery; IV-tPA, intravenous tissue plasminogen activator; mRS, modified Rankin scale; NIHSS, National Institutes of Health Stroke Scale.

[a] Calculated using the χ^2 test for categorical variables and the Wilcoxon rank sum test for continuous variables.

[b] Includes American Indian, Asian, and Other Pacific Islander.

CI, 0.38-0.85; *P* = .002; extended window: OR, 0.69; 95% CI, 0.55-0.88; *P* = .001), controlling for age, location of occlusion, admission NIHSS score, intravenous thrombolysis, and successful recanalization. However, the interaction between a low ASPECTS and treatment in the extended window was not significant (OR, 0.85; 95% CI, 0.39-1.78; *P* = .64) regarding the association with favorable 90-day outcome. Other factors associated with favorable 90-day mRS score include younger age (OR, 1.04; 95% CI, 1.03-1.05; *P* < .001), lower admission NIHSS score (OR, 1.12; 95% CI, 1.10-1.14; *P* < .001), intravenous thrombolysis (OR, 1.32; 95% CI, 1.07-1.63), and modified Thrombolysis in Cerebral Ischemia score of 2B or more (OR, 6.64; 95% CI, 4.56-9.66; *P* < .001). The eTable in Supplement 1 summarizes results of regression analysis for a 90-day mRS score of 0 to 3.

In addition, a low ASPECTS was associated with a higher risk of 90-day mortality (OR, 2.20; 95% CI, 1.37-3.31; *P* < .001), controlling for age, location of occlusion, admission NIHSS score, intravenous thrombolysis, time from symptom onset to groin puncture, and successful recanalization. However, treatment in the extended window was not independently associated with

Table 3. Characteristics of Patients Who Underwent Mechanical Thrombectomy Presenting With ICA or M1 Occlusion and an ASPECTS of 2 to 5 Who Presented in the Early vs Extended Window

Characteristic	Time from onset of symptoms to groin puncture, No. (%)		
	<6 h (n = 123)	6-24 h (n = 90)	*P* value[a]
Age, median (IQR), y	72 (62-78)	66 (55-76)	.01
Sex			
Female	54 (43.9)	49 (54.4)	.13
Male	69 (56.1)	41 (45.6)	
Race			
Black	10 (8.1)	5 (5.6)	.75
White	106 (86.2)	79 (87.8)	
Other[b]	7 (5.7)	6 (6.7)	
Hypertension	79 (64.2)	63 (70.0)	.38
Type 1 or 2 diabetes	35 (28.5)	32 (35.6)	.27
Atrial fibrillation	52 (42.3)	21 (23.3)	.004
Hyperlipidemia	38 (30.9)	36 (40.0)	.17
Admission NIHSS score, median (IQR)	18 (14-22)	18 (13-22)	.64
Location of occlusion			.26
ICA	63 (51.2)	39 (43.3)	
M1	60 (48.8)	51 (56.7)	
IV-tPA used	90 (73.2)	8 (8.9)	<.001
Time from symptom onset to groin puncture, median (IQR), min	221 (130-276)	607 (440-864)	NA
Technique			
ADAPT	87 (70.7)	66 (73.3)	.90
Stent retriever	11 (8.9)	9 (10.0)	
Solumbra	4 (3.3)	3 (3.3)	
Combination of techniques	21 (17.1)	12 (13.3)	
IA-tPA used	6 (4.9)	5 (5.6)	.83
Thrombectomy passes, median (IQR), No.	2 (2-3)	2 (2-3)	.78
mTICI score ≥2B	103 (83.7)	73 (81.1)	.62
mTICI score ≥2C	59 (48.0)	40 (44.4)	.61
Procedure duration, median (IQR), min	50 (27-92)	34 (18-65)	.007
Periprocedural complications	10 (8.1)	6 (6.7)	.69
Symptomatic intracerebral hemorrhage	18 (14.6)	6 (6.7)	.07
90-d mRS score			
Median (IQR)	5 (3-6)	4 (3-6)	.38
0-2	30 (24.4)	17 (18.9)	.34
0-3	42 (34.1)	36 (40.0)	.38
90-d Mortality	46 (37.4)	24 (26.7)	.10

Abbreviations: ADAPT, A Direct Aspiration First Pass Technique; ASPECTS, Alberta Stroke Program Early Computed Tomography Score; IA-tPA, intra-arterial tissue plasminogen activator; ICA, internal carotid artery; IV-tPA, intravenous tissue plasminogen activator; mRS, modified Rankin scale; mTICI, modified Thrombolysis in Cerebral Ischemia; NA, not applicable; NIHSS, National Institutes of Health Stroke Scale.

[a] Calculated using the χ^2 test for categorical variables and the Wilcoxon rank sum test for continuous variables.

[b] Includes American Indian, Asian, and Other Pacific Islander.

90-day mortality (OR, 0.95; 95% CI, 0.74-1.23; P = .89). The interaction between a low ASPECTS and treatment in the extended window was not significant (OR, 0.88; 95% CI, 0.44-1.61; P = .60) regarding the association with 90-day mortality.

Analysis Based on the Thrombectomy Center

The percentage of patients with an ASPECTS of 2 to 5 who underwent MT compared with all patients with ICA or M1 occlusion who underwent MT ranged between 4.4% (5 of 113) and 15.2% (48 of 316) (P = .12). With the Cochran-Mantel-Haenszel test, the association between an ASPECTS of 2 to 5 and a favorable outcome was not modified by the center in which the MT was performed.

Discussion

In this large, multicenter study assessing the outcomes of patients with large vessel occlusion and a low ASPECTS treated with MT, patients who achieved successful recanalization were 5 times more likely to achieve a favorable outcome compared with patients who had an unsuccessful recanalization, supporting the benefit associated with MT, despite a higher rate of symptomatic intracranial hemorrhage among patients with a low ASPECTS treated with MT. Furthermore, the interaction between an ASPECTS of 2 to 5 and treatment in the extended window was not significant, which reflects that both of these factors are independently associated with outcomes, suggesting that patients with a larger infarct volume may potentially still achieve benefits associated with MT even beyond 6 hours from symptom onset.

Although there are 5 ongoing clinical trials—TENSION (NCT03094715), IN EXTREMIS-LASTE (NCT03811769), TESLA (NCT03805308), SELECT 2 (NCT03876457), and RESCUE-Japan LIMIT (NCT03702413)—to answer the question about the effectiveness of MT for patients with acute stroke and a low ASPECTS, our study presents real-world outcome observations from a large, multicenter registry in the absence of strong evidence for or against MT in this group of patients. Even though symptomatic intracranial hemorrhage after MT was encountered more often in the low ASPECTS group, approximately 22% of these patients achieved 90-day functional independence (mRS score of 0-2) with MT compared with 9% of patients with an ASPECTS of 0 to 7 in the control group of the MR CLEAN (Multicenter Randomized Clinical Trial of Endovascular Treatment for Acute Ischemic Stroke in the Netherlands) trial.[17]

Several studies have evaluated outcomes among patients with a large baseline infarct volume undergoing MT. Most of these studies are limited by small numbers of patients. Yoo et al[17] found no association between size of ischemic core and treatment effect of endovascular therapy in a post hoc analysis of the MR CLEAN trial. In addition, a recent meta-analysis of patients undergoing endovascular therapy within 6 hours of symptom onset demonstrated no reduction in treatment effect of endovascular therapy with increase in ischemic core volume.[18] That meta-analysis also demonstrated a greater likelihood of favorable functional outcomes across every ischemic core volume level for endovascular intervention compared with medical therapy alone. In addition, the clinical benefit associated with a 1-point improvement in the mRS score was maintained up to 150 mL of estimated ischemic core volume. Our study supports these findings given that approximately 1 in 5 of the patients with an ASPECTS of 2 to 5 achieved a favorable 90-day mRS score of 0 to 2.

Although time from symptom onset and its association with outcome has been studied in great detail, data regarding the outcomes of patients with a low baseline ASPECTS in the extended MT window (6-24 hours) are limited. Patients with a low ASPECTS were excluded from both the DAWN (DWI or CTP Assessment With Clinical Mismatch in the Triage of Wake-Up and Late Presenting Strokes Undergoing Neurointervention With Trevo)[3] and DEFUSE 3 trials,[5] and even in trials that included these patients, such as the Optimizing Patient Selection for Endovascular Treatment in Acute Ischemic Stroke (SELECT) study[19]—a prospective observational study that assessed the outcomes of MT for patients with a large core infarction—only 11 patients with an ASPECTS of lower than 6 were treated with MT in the extended window. Of those patients, only 18% achieved a favorable outcome (90-day mRS score of 0-2) compared with 42% of patients with an ASPECTS of lower than 6 presenting in the early window who underwent MT. Although MT performed in the extended window was independently associated with a lower likelihood of a favorable outcome in our study, the interaction between an ASPECTS of 2 to 5 and MT performed in the extended window was not statistically significant, further demonstrating that both variables are independently associated with MT outcomes, supporting a more permissive criteria for extended window treatment selection than those used in DAWN and DEFUSE 3.

In our study, patients with a low ASPECTS who underwent MT in the extended window had shorter procedure duration compared with those who underwent MT in the early window (34 vs 50 minutes; $P = .007$). These results can be explained by the fact that patients in the extended window were younger and that younger patients usually have less tortuous anatomy and fewer access difficulties.[20,21]

In our study, younger age was associated with favorable outcomes of MT independently of the ASPECTS and presenting in the early vs extended window. Similar results were reported in previous studies that demonstrated that patients younger than 80 years were twice as likely to achieve functional independence compared with patients older than 80 years of age.[22,23] Given the importance of age in modifying the association of MT with outcomes, it should be considered in planning and interpretation of clinical trials that study the outcome of MT for patients with a low ASPECTS.

Collateral status represents a potential factor associated with MT outcomes for patients with a low ASPECTS. A study by Broocks et al[24] included 100 patients with an ASPECTS of 5 or lower undergoing MT and found that those with a good collateral score were more likely to experience benefits associated with successful recanalization. In addition, the authors found that good collateral scores were associated with attenuated edema progression. Unfortunately, collateral scores were not collected in our study, and future studies are needed to confirm the above-mentioned observations.

Our study did not assess perfusion status and included patients with a low ASPECTS regardless of perfusion status because of the various perfusion vendors and thresholds used in different centers depending on local institutional guidelines. Many of our centers use RAPID software, while others use Viz.ai or Siemens software. Current guidelines support using ASPECTS only for patients in the early window and the addition of perfusion images for patient selection in the extended window.[1] There is an ongoing debate, however, regarding whether perfusion images are required to select patients with large vessel occlusion in the extended window given that they may result in excluding patients who otherwise may experience benefits associated with thrombectomy when perfusion images are used.[18,25,26] A secondary analysis of 591 patients in the HERMES data set showed a constant benefit associated with thrombectomy among patients with a computed tomography perfusion–estimated core infarct up to 150 mL.[18] Furthermore, 4 of 5 ongoing clinical trials evaluating MT for patients with a large core define a large core using the ASPECTS alone.

Finally, post-MT care represents another factor that modifies the outcomes of MT in general. This care includes blood pressure control, decompressive hemicraniectomy protocols, and the use of antiplatelets.[27-29] Future studies are needed to evaluate the association of these factors with MT for patients with a low ASPECTS.

Limitations

This study has some limitations, including the retrospective and observational design. In addition, this was a multicenter study; therefore, management and procedural protocols were likely heterogenous. Also, we did not have data regarding patients with a low ASPECTS treated with medical management without MT in our database. Other limitations include that we did not have data regarding diffusion images, the interrater agreement in scoring ASPECTS, or the breakdown of ASPECTS points. Last, the ASPECTS was calculated by the investigators at the included sites and was not adjudicated by a core laboratory.

Conclusions

This cohort study suggests that more than 1 of 5 patients with an ASPECTS of 2 to 5 may achieve 90-day functional independence (mRS score of 0-2) with MT. Patients with an ASPECTS of 2 to 5 who had successful recanalization were 5 times more likely to achieve a favorable 90-day outcome compared with patients with unsuccessful recanalization. The association of a low ASPECTS with 90-day outcome did not differ between patients presenting in the early vs extended MT window.

ARTICLE INFORMATION

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Group Information: The Stroke Thrombectomy and Aneurysm Registry (STAR) Collaborators are listed in Supplement 2.

Additional Information: Anonymized data not published within this article will be made available by request from any qualified investigator. Investigators interested in working with the data should contact the corresponding author.

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SUPPLEMENT 1.

eTable. Multivariable Regression Analysis for Predictors of 90-Day mRS 0-3

SUPPLEMENT 2.

Nonauthor Collaborators