Similar Outcomes for Contact Aspiration and Stent Retriever Use According to the Admission Clot Burden Score in ASTER

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Background and Purpose—The clot burden score (CBS) at admission reliably evaluates the thrombus burden in acute ischemic stroke patients with anterior circulation large vessel occlusion. Mechanical thrombectomy has been diversified, especially with contact aspiration technique, and its efficiency with respect to the thrombus burden is not known. We compared reperfusion, adverse events, neurological recovery, and 90-day functional outcome of stent retriever use versus contact aspiration according to the admission CBS.

Methods—This is a post hoc analysis of the ASTER (Contact Aspiration Versus Stent Retriever for Successful Revascularization) randomized trial. The primary outcome was successful reperfusion after all procedures, defined as modified Thrombolysis in Cerebral Infarction scores 2b/3. Secondary outcomes were 90-day functional outcome, assessed with the modified Rankin Scale. Safety outcomes included 90-day mortality and any intracerebral hemorrhage.

Results—A total of 231 randomized patients were included in this study: 114 patients had a CBS of 0 to 6 and 117 a CBS ≥7 at admission. Successful reperfusion at procedure end was achieved more frequently in patients with CBS ≥7 (88.9%) than patients with a CBS 0 to 6 (81.6%; fully adjusted risk ratio, 1.09; 95% confidence interval, 1.01–1.28). Favorable outcome (modified Rankin Scale score, 0–2) at 90 days was achieved in significantly more patients with CBS ≥7 (61.9%) than in patients with CBS 0 to 6 (41.8%; fully adjusted risk ratio, 1.19; 95% confidence interval, 1.02–1.40). No outcome differences of first-line mechanical thrombectomy strategy (aspiration versus stent) on any angiographic or clinical outcomes were observed between the 2 groups. We also found no evidence of interaction between first-line mechanical thrombectomy strategy and CBS groups regarding safety.

Conclusions—First-line mechanical thrombectomy with contact aspiration compared with stent retriever did not result in an increased successful reperfusion rate in acute ischemic stroke patients with large vessel occlusion of the anterior circulation according to the admission CBS. The latter, however, seems to be a reliable prognostic indicator of angiographic and clinical outcome. **(*Stroke*. 2018;49:1669-1677. DOI: 10.1161/STROKEAHA.118.021120.)**

Key Words: clot burden score ■ endovascular treatment ■ ischemic stroke ■ outcomes ■ thrombectomy

The clot burden score (CBS), evaluated at admission on computed tomography or magnetic resonance imaging, characterizes simply and reliably the intracranial arterial thrombus extent, located in the proximal anterior circulation.[1,2] A relationship between CBS and recanalization success has been demonstrated but mainly for intravenous thrombolysis. Concerning mechanical thrombectomy, the impact of CBS is not well known and is still under debate. Several trials have demonstrated the additional benefits of mechanical thrombectomy based on stent retrievers. The advent of new

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thrombectomy techniques, such as contact aspiration, has diversified endovascular approaches and raises the question of the optimal approach for a large intracranial clot burden.[2] There are currently no comparative studies assessing and comparing the efficiency of these 2 different techniques according to the intracranial thrombus extent. This post hoc study of the randomized ASTER trial (Contact Aspiration Versus Stent Retriever for Successful Revascularization) aims to evaluate the efficiency of mechanical thrombectomy according to the admission CBS, on the 2 approaches, stent retriever versus contact aspiration.

Methods

The authors declare that all supporting data are available within the article.

Patient Selection

ASTER trial[2] was a prospective, multicenter, randomized trial comparing efficacy and adverse events using the contact aspiration technique versus the standard stent retriever technique as first-line therapy in acute ischemic stroke patients with a large vessel occlusion, within 8 hours of symptom onset. The ASTER trial protocol[3] and consent form was approved by a central medical ethics committee. Additional inclusion and exclusion criteria have been reported previously.

Outcomes

The primary study outcome was the percentage of patients who achieved a successful reperfusion at the procedure end, defined as an modified Thrombolysis in Cerebral Infarction 2b/3. Secondary angiographic efficacy outcomes included the percentage of patients with near-complete reperfusion (modified Thrombolysis in Cerebral Infarction 2c/3) and complete reperfusion (modified Thrombolysis in Cerebral Infarction 3) at the end of the assigned first-line procedure, the successful, near-complete and complete revascularization at the end of all endovascular procedures, the rate of >2 passes of the device, and the rate of use of rescue therapy. The secondary efficacy clinical outcomes were 24-hour change in National Institutes of Health Stroke Scale (NIHSS) score, favorable and excellent outcomes (defined as a modified Rankin Scale score 0–2 and a modified Rankin Scale score 0–1, respectively) at 90 days, 90-day all-cause mortality, and hemorrhagic complications (any intracranial hemorrhage and parenchymal hematoma).

Data Analysis

All patients underwent computed tomography or magnetic resonance angiography at admission, before thrombectomy, to confirm occlusion of the intracranial carotid artery or the M1 or M2 branches of the middle cerebral artery. The clot burden was scored on a scale of 0 to 10, according to Puetz et al,[1] by an independent core laboratory, with a score of 2 subtracted if the thrombus was found in either of the supraclinoid intracranial carotid arteries, the proximal or the distal half of the middle cerebral artery trunk, and a score of 1 subtracted if the thrombus was found in the infraclinoid intracranial carotid artery, anterior cerebral artery, and for each affected M2 branch. Thus, a score of 10 indicates the absence of thrombus and a score of 0, a complete multisegment occlusion of the anterior circulation.

Statistical Analysis

Quantitative variables were expressed as means (SD) in the case of normal distribution or medians (interquartile range) otherwise. Categorical variables were expressed as numbers (percentage). Normality of distributions was assessed using histograms and the Shapiro-Wilk test. To assess the selection bias because of absence of CBS assessment by the core laboratory (n=105), baseline characteristics and outcomes were described according to patients with and without core laboratory CBS assessment and the magnitude of the between-group differences was assessed by calculating the absolute standardized differences; an absolute standardized difference >20% was interpreted as a meaningful difference.[4] Further analyses were performed on 231 patients who were treated with a first-line mechanical thrombectomy device and who underwent core laboratory assessment of CBS.

Primary analysis was conducted by dividing patients into 2 groups at a CBS value of 6 (0–6 versus ≥7). Bivariate comparisons in baseline characteristics between the 2 study groups were made using the Student *t* test for Gaussian continuous variables, the Mann-Whitney *U* test for non-Gaussian continuous variables, and the χ^2 test (or Fisher exact test when expected cell frequency was <5) for categorical variables, as appropriate. In addition, absolute standardized differences were calculated. Comparisons in angiographic and clinical binary outcomes between the 2 study groups were performed using generalized estimating equation models to take into account the center effect[4]; in addition to center, a prespecified adjustment for use of intravenous thrombolysis before mechanical thrombectomy and first-line strategy was applied. Adjusted relative risks for CBS ≥7 versus 0 to 6 were derived from the generalized estimating equation model as effect size using a Poisson distribution and a log function. Comparison in 24-hour changes in NIHSS score was performed using a linear mixed model with center as a random effect, intravenous thrombolysis before mechanical thrombectomy, first-line strategy, and baseline NIHSS as fixed effects; the mean difference in 24-hour change in NIHSS was derived from a linear mixed model as effect size. Comparisons between outcomes were further adjusted for meaningful baseline differences (except the site of intracranial occlusion because CBS incorporates occlusion location in its calculation). To avoid case deletion in multivariate analyses because of missing data, missing values were handled by multiple imputation using a regression switching approach (chained equations with m=10).[5] The imputation procedure was performed under the missing at random assumption using all variables listed in Table 1 and outcomes with a predictive mean matching method for continuous variables and multinomial or binary logistic regression model for categorical variables. Estimates obtained in the different imputed data sets were combined using Rubin rules.[6]

Finally, we assessed the effect of the first-line strategy (contact aspiration versus stent retriever) on each outcome according to clot burden subgroups using generalized estimating equation or linear mixed models adjusted for center and intravenous thrombolysis before mechanical thrombectomy by including in models the corresponding multiplicative term. Statistical testing was conducted at the 2-tailed α-level of 0.05. No adjustment for multiple testing was applied, and thus results are considered exploratory. Data were analyzed using the SAS software, version 9.3 (SAS Institute, Cary, NC).

Results

From October 2015 to October 2016, a total of 381 patients were randomized in the ASTER trial, and 336 were treated by either contact aspiration or stent retriever as a first-line device. Of these, 231 patients with a CBS assessed by core laboratory were included in the present study after excluding patient with poor quality images, incomplete exams, or nondetected clot (Figure 1). One hundred sixty-eight patients were assessed by magnetic resonance imaging, 48 by computed tomography, and 15 by both. Baseline characteristics and outcomes of patients treated by first-line strategy with and without core laboratory assessment of CBS are available in the Table 1.

A total of 114 patients had a CBS of 0 to 6 and 117, a CBS ≥7. Baseline characteristics according to the 2 study groups are shown in Table 2, and several meaningful differences were found. Patients in the lower CBS group were older, had a higher baseline NIHSS, and a longer time from symptom

Table 1. Baseline Characteristics and Outcomes in Patients With and Without Assessment of CBS by Core Laboratory

	Core Laboratory Assessment of CBS		
	Yes (n=231)	No (n=105)	ASD, %
Age, y; mean (SD)	69.3 (14.7)	69.9 (14.5)	4.0
Men	124/231 (53.7)	50/105 (47.6)	12.4
Direct admission	84/231 (36.4)	31/105 (29.5)	14.6
Medical history			
Hypertension	134/226 (59.3)	64/104 (61.5)	4.6
Diabetes mellitus	44/226 (19.5)	24/104 (23.1)	8.8
Hypercholesterolemia	87/225 (38.7)	33/103 (32.0)	13.9
Current smoking	42/194 (21.6)	15/88 (17.0)	11.7
Previous antithrombotic medications	107/225 (47.6)	54/105 (51.4)	7.7
Antiplatelet use	77/225 (34.2)	27/105 (25.7)	18.7
Anticoagulation	36/225 (16.0)	29/105 (27.6)	28.4
Coronary artery disease	38/222 (17.1)	21/105 (20.0)	7.4
Previous stroke or TIA	39/228 (17.1)	20/104 (19.2)	5.5
Current stroke event			
NIHSS score, median (IQR)*	18.0 (12.0 to 20.0)	18.0 (13.0 to 20.0)	10.6
ASPECTS, median (IQR)†	7.0 (5.0 to 9.0)	8.0 (6.0 to 9.0)	13.3
Prestroke Rankin Scale score ≥1	35/230 (15.2)	22/105 (21.0)	14.9
Site of occlusion			7.1
M1-MCA	167/231 (72.3)	76/105 (72.4)	
M2-MCA	28/231 (12.1)	11/105 (10.5)	
ICA	31/231 (13.4)	16/105 (15.2)	
Other†	5/231 (2.2)	2/105 (1.9)	
Favorable collaterals	44/183 (24.0)	22/82 (26.8)	6.4
Suspected stroke cause			5.3
Large-artery atherosclerosis	20/231 (8.7)	8/105 (7.6)	
Cardioembolic	96/231 (41.6)	46/105 (43.8)	
Others	115/231 (49.8)	51/105 (48.6)	
Endovascular treatment			
Onset to groin puncture, min; median (IQR)‡	219 (180 to 270)	251 (187 to 298)	30.2
Onset to imaging§	110 (82 to 146)	115 (83 to 151)	3.1
Imaging to groin puncture‖	107 (63 to 142)	118(70 to 164)	24.6
General anesthesia	25/231 (10.8)	20/105 (19.0)	23.2
First-line stent retriever strategy	112/231 (48.5)	57/105 (54.3)	11.6
Angiographic outcomes			
Reperfusion after first-line strategy			
mTICI 3	85/231 (36.8)	34/105 (32.4)	9.3
mTICI 2c/3	117/231 (50.6)	49/105 (46.7)	8.0
mTICI 2b/3	154/231 (66.7)	71/105 (67.6)	2.0
No. of passes >2	102/231 (44.2)	39/105 (37.1)	14.3
Use of rescue therapy	67/231 (29.0)	32/105 (30.5)	3.2
Reperfusion at the end of procedure			

(*Continued*)

Table 1. Continued

	Core Laboratory Assessment of CBS		
	Yes (n=231)	No (n=105)	ASD, %
mTICI 3	101/231 (43.7)	38/105 (36.2)	15.4
mTICI 2c/3	142/231 (61.5)	59/105 (56.2)	10.8
mTICI 2b/3	197/231 (85.3)	93/105 (88.6)	9.8
Procedural complications	44/231 (19.0)	15/105 (14.3)	12.8
Clinical outcomes			
ΔNIHSS at 24 h, mean (95% CI)¶	6.0 (0 to 11.0)	4.0 (–1.0 to 11.0)	21.4
Favorable outcome	116/223 (52.0)	37/99 (37.4)	29.8
Excellent outcome	92/223 (41.3)	29/99 (29.3)	25.2
90-d mortality	37/223 (16.6)	25/99 (25.3)	21.4
Hemorrhagic complications			
Any ICH	109/230 (47.4)	49/100 (49.0)	3.2
Parenchymal hematoma	37/230 (16.1)	15/100 (15.0)	3.0

ASD indicates absolute standardized difference; ASPECTS, Alberta Stroke Program Early CT Score; CBS, clot burden score; CI, confidence interval; ICA, intracranial carotid artery; ICH, intracerebral hemorrhage; IQR, interquartile range; MCA, middle cerebral artery; mTICI, modified Thrombolysis in Cerebral Infarction score; NIHSS, National Institutes of Health Stroke Scale; and TIA, transient ischemic attack.

*Three missing values (2 group with clot burden score).

†Four missing values in group with missing clot burden score.

‡Three missing values (in group with clot burden score).

§One missing values in group with missing clot burden score.

‖Two missing values in group with clot burden score.

¶Twenty-two missing values (8 in group with missing clot burden score).

onset to groin puncture, with a higher incidence diabetes mellitus, prior antithrombotic medications, and favorable collaterals (all absolute standardized differences >20%).

Angiographic Outcomes

Figure 2 shows the distribution of the reperfusion grades and the 90-day functional outcome according to the study groups. Successful reperfusion at the procedure end was achieved more frequently in patients with CBS ≥7 (88.9%) than in patients with CBS 0 to 6 (81.6%). This difference was significant after prespecified adjustment (center, intravenous thrombolysis, and first-line strategy) and after additional adjustment for meaningful baseline differences with a fully adjusted risk ratio (RR) of 1.09 (95% confidence interval [CI], 1.01–1.28). The number of patients with modified Thrombolysis in Cerebral Infarction 2c/3 reperfusion after

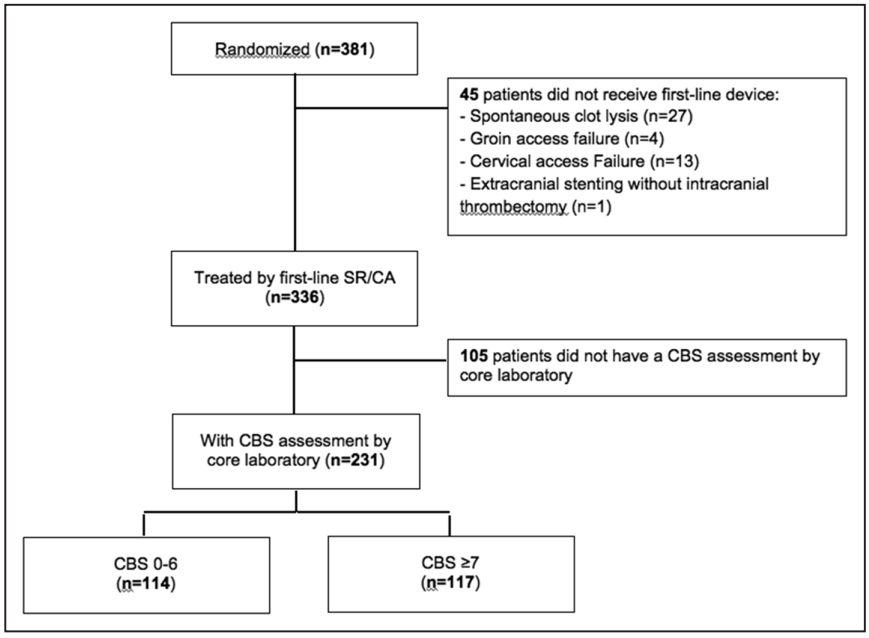

Figure 1. Study flowchart. CA indicates contact aspiration; CBS, clot burden score; and SR, stent retriever.

Table 2. Baseline Characteristics According to CBS in the ASTER Trial

Characteristics	CBS 0–6 (n=114)	CBS ≥7 (n=117)	ASD, %	*P* Value
Age, y; mean (SD)	71.1 (14.5)	67.5 (14.7)	25.1*	0.058
Men	61/114 (53.5)	63/117 (53.8)	0.7	0.96
Direct admission	33/114 (28.9)	51/117 (43.6)	30.8*	0.021
Medical history				
Hypertension	72/114 (63.2)	62/112 (55.4)	15.9	0.23
Diabetes mellitus	28/112 (25.0)	16/114 (14.0)	27.9*	0.037
Hypercholesterolemia	48/112 (42.9)	39/113 (34.5)	17.2	0.20
Current smoking	15/101 (14.9)	27/93 (29.0)	34.8*	0.017
Previous antithrombotic medications	61/112 (54.5)	46/113 (40.7)	27.8*	0.039
Antiplatelet use	44/112 (39.3)	33/113 (29.2)	21.4	0.11
Anticoagulations	20/112 (17.9)	16/113 (14.2)	10.1	0.45
Coronary artery disease	21/111 (18.9)	17/111 (15.3)	9.6	0.48
Previous stroke or TIA	21/113 (18.6)	18/116 (15.7)	7.8	0.56
Current stroke event				
NIHSS score, median (IQR)†	18.0 (14.0–21.0)	16.0 (10.0–19.0)	42.1*	0.002
ASPECTS, median (IQR)	7.0 (5.0–9.0)	7.0 (5.0–9.0)	12.1	0.36
Prestroke Rankin Scale score ≥1	21/114 (18.4)	14/116 (12.1)	17.7	0.18
Site of occlusion				
M1-MCA	81/114 (71.1)	86/117 (73.5)	51.5	0.002
M2-MCA	7/114 (6.1)	21/117 (17.9)		
ICA	22/114 (19.3)	9/117 (7.7)		
Other‡	4/114 (3.5)	1/117 (0.9)		
Favorable collaterals	28/87 (32.2)	16/96 (16.7)	36.7*	0.014
Suspected stroke cause				
Large-artery atherosclerosis	8/114 (7.0)	12/117 (10.3)	18.0	0.40
Cardioembolic	52/114 (45.6)	44/117 (37.6)		
Others	54/114 (47.4)	61/117 (52.1)		
Endovascular treatment				
Onset to groin puncture, min; median (IQR)§	230 (190–278)	210 (166–267)	30.4*	0.023
Onset to imaging	116 (83.0–150)	105 (81.0–136)	16.5	0.21
Imaging to groin puncture‖	117 (76.0–154)	95 (55.0–137)	33.6	0.012
General anesthesia	13/114 (11.4)	12/117 (10.3)	3.7	0.78
First-line stent retriever strategy	58/114 (50.9)	61/117 (52.1)	2.5	0.85

Values expressed as n/total n (%) unless otherwise indicated. ASD indicates absolute standardized difference; ASPECTS, Alberta Stroke Program Early CT Score; ASTER, Contact Aspiration Versus Stent Retriever for Successful Revascularization; CBS, clot burden score; ICA, intracranial carotid artery; IQR, interquartile range; MCA, middle cerebral artery; NIHSS, National Institutes of Health Stroke Scale; and TIA, transient ischemic attack.

*Factors with absolute standardized difference >20% used as confounding factors in adjustment models.

†Two missing values (1 in clot burden <7 group).

‡Tandem extracranial carotid artery stenosis/occlusion and intracranial proximal occlusion.

§‖Two missing values in clot burden ≥7 group.

the procedure was also significantly higher in the CBS ≥7 group with an adjusted RR of 1.24 (95% CI, 1.01–1.54). There was no significant difference in other secondary angiographic outcomes in both prespecified and fully adjusted models (Table 3).

In addition, there was no significant difference in time from groin puncture to successful reperfusion, with a median time of 37 minutes (interquartile range, 26–57) in patients with CBS 0 to 6 and 46 minutes (interquartile range, 26–70) in patients with CBS ≥7 (*P*=0.19).

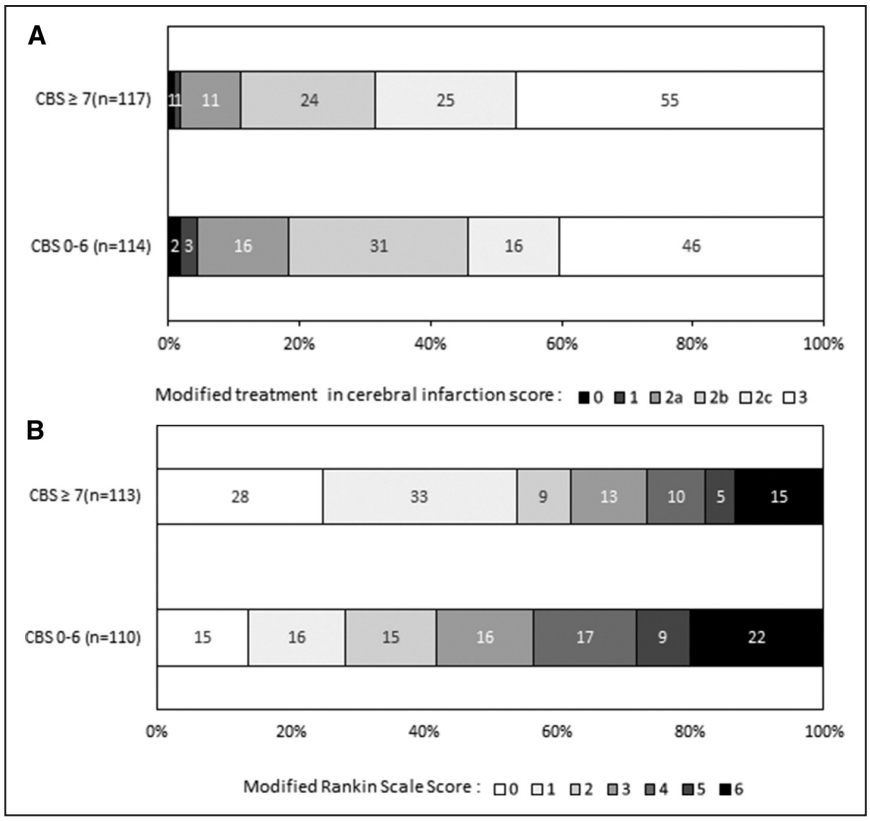

Figure 2. Distribution of modified Thrombolysis in Cerebral Infarction grades (**A**) and 90-day modified Rankin Scale (**B**) according to admission clot burden score (CBS).

Clinical Outcomes

Similar to successful reperfusion outcome, 90-day favorable outcome was significantly more often achieved in patients with CBS ≥7 than in patients with CBS 0 to 6 (with a prespecified adjusted RR of 1.48; 95% CI, 1.24–1.77). After additional adjustment for meaningful baseline differences, the difference was attenuated but remained significant (fully adjusted RR, 1.19; 95% CI, 1.02–1.40). The rate of excellent outcome was also greater in the CBS ≥7 group in both prespecified and fully adjusted models (Table 3). We found no difference between the 2 study groups regarding the change in NIHSS score at 24 hours, 90-day mortality, and hemorrhagic complication rates (Table 3).

Impact of CBS on Efficacy/Safety of First-Line Strategy

When efficacy of first-line strategy was compared according to the CBS subgroups (0–6 and ≥7), no heterogeneity was found on any angiographic or clinical outcomes (Figure 3). The mean difference in 24-hour change in NIHSS score between first-line contact aspiration versus first-line stent retriever was similar in patients with CBS 0 to 6 (1.0; 95% CI, −2.3 to 4.3) and those with CBS ≥7 (0.7; 95% CI, −2.5 to 4.0; *P* for heterogeneity, 0.92). Regarding the safety outcomes (mortality and hemorrhagic complications), we also found no evidence of interaction between first-line strategy and CBS subgroups (Figure 3).

Discussion

In this post hoc study, we found a higher rate of reperfusion and 90-day favorable outcome after mechanical thrombectomy for small thrombus burden (CBS, ≥7) and that similar angiographic and clinical outcomes were observed after first-line strategy and at the end of all procedures with stent retriever and contact aspiration for both small and large thrombus burdens (CBS, 0–6 and ≥7).

At the end of all the endovascular procedures, reperfusion rate was overall significantly greater in patients with high CBS in our study. This association has already been demonstrated, and essentially after intravenous thrombolysis,[7–10] but the debate is still ongoing after thrombectomy. Outcomes reported in other ancillary studies are inconsistent and are less clear-cut for thrombectomy than for intravenous thrombolysis. In the post hoc analysis of the MR CLEAN trial (Multicenter Randomized Clinical Trial of Endovascular Treatment for Acute Ischemic Stroke in the Netherlands), authors found similar results, that is, that a higher CBS is associated with a higher likelihood of reperfusion.[11] On the other hand, Mokin et al[12] reported that combined therapy by intravenous thrombolysis and stent retriever thrombectomy was highly effective throughout the entire range of CBS values in the SWIFT PRIME trial (Solitaire™ With the Intention for Thrombectomy as Primary Endovascular Treatment Trial). Contact aspiration was evaluated by Yoo et al,[13] and the authors found no significant relationship between thrombus length and successful angiographic reperfusion in the THERAPY trial (The Randomized, Concurrent Controlled Trial to Assess the Penumbra System's Safety and Effectiveness in the Treatment of Acute Stroke). The disparity in these findings could be related to the different types and generations of thrombectomy devices used, the small number of cases included, and the different methods used to determine thrombus size.[14]

Table 3. Outcomes in the ASTER Trial According to CBS

Outcomes	CBS 0–6 (n=114)	CBS ≥7 (n=117)	RR (95% CI)*	*P* Value	RR (95% CI)†	*P* Value
Angiographic outcomes						
Reperfusion after first-line strategy						
mTICI 3	44/114 (38.6)	41/117 (35.0)	0.91 (0.57 to 1.43)	0.67	0.92 (0.57 to 1.47)	0.73
mTICI 2c/3	59/114 (51.8)	58/117 (49.6)	0.96 (0.72 to 1.27)	0.77	0.98 (0.69 to 1.41)	0.92
mTICI 2b/3	79/114 (69.3)	75/117 (64.1)	0.93 (0.77 to 1.12)	0.43	0.93 (0.73 to 1.18)	0.54
First-pass mTICI 2b/3	44/114 (38.6)	39/117 (33.3)	0.87 (0.65 to 1.14)	0.31	0.79 (0.54 to 1.15)	0.22
No. of passes >2	44/114 (38.6)	58/117 (49.6)	1.28 (0.89 to 1.85)	0.18	1.22 (0.84 to 1.79)	0.30
Use of rescue therapy	29/114 (25.4)	38/117 (32.5)	1.27 (0.79 to 2.06)	0.32	1.36 (0.79 to 2.35)	0.27
Reperfusion at the end of procedure						
mTICI 3	46/114 (40.4)	55/117 (47.0)	1.16 (0.78 to 1.72)	0.47	1.12 (0.79 to 1.60)	0.53
mTICI 2c/3	62/114 (54.4)	80/117 (68.4)	1.25 (1.04 to 1.51)	0.017	1.24 (1.01 to 1.54)	0.045
mTICI 2b/3	93/114 (81.6)	104/117 (88.9)	1.09 (1.01 to 1.19)	0.049	1.09 (1.01 to 1.18)	0.018
Procedural complications	20/114 (17.5)	24/117 (20.5)	1.17 (0.69 to 1.97)	0.56	1.31 (0.59 to 2.92)	0.51
Clinical outcomes						
ΔNIHSS at 24 h, mean (95% CI)‡	5.2 (3.1 to 7.3)§	6.1 (4.2 to 8.0)§	0.9 (−1.5 to 3.3)‖	0.47	1.1 (−1.4 to 3.6)‖	0.38
Favorable outcome	46/110 (41.8)	70/113 (61.9)	1.48 (1.24 to 1.77)	<0.0001	1.19 (1.02 to 1.40)	0.028
Excellent outcome	31/110 (28.2)	61/113 (54.0)	1.92 (1.52 to 2.43)	<0.0001	1.48 (1.24 to 1.77)	<0.001
90-d mortality	22/110 (20.0)	15/113 (13.3)	0.66 (0.30 to 1.49)	0.32	0.82 (0.43 to 1.54)	0.54
Hemorrhagic complications						
Any ICH	50/113 (44.2)	59/117 (50.4)	1.14 (0.89 to 1.46)	0.29	1.25 (0.93 to 1.67)	0.14
Parenchymal hematoma	19/113 (16.8)	18/117 (15.4)	0.92 (0.50 to 1.69)	0.78	1.05 (0.49 to 2.22)	0.91

Values expressed as n/total n (%), unless otherwise stated. RR and mean difference were calculated using patients with CBS <7 as reference group. ASTER indicates Contact Aspiration Versus Stent Retriever for Successful Revascularization; CBS, clot burden score; CI, confidence interval; ICH, intracranial hemorrhage; IVT, intravenous thrombolysis; mTICI, modified Thrombolysis in Cerebral Infarction score; NIHSS, National Institutes of Health Stroke Scale; RR, risk ratio; and TIA, transient ischemic attack.

*Adjusted for center, first-line strategy and IVT.

†Calculated after multiple imputation procedure and adjustment on center, first-line strategy, IVT, age, direct admission, diabetes mellitus, current smoking, previous use of antithrombotic medications, admission NIHSS favorable collaterals, and time from onset to groin puncture.

‡Fourteen missing values (8 in CBS <7 group).

§Mean change (95% CI) adjusted for admission NIHSS, center, first-line strategy, and IVT.

‖Adjusted mean between-group difference.

The CBS scoring system provides an easy and rapid estimation of thrombus burden in patients with acute ischemic stroke, and was initially described with the use of computed tomographic angiography. It is based on the lack of contrast opacification and is also influenced by backflow from the collateral circulation on computed tomographic angiography but can be overestimated.[15] In contrast, here, we assessed the CBS with the susceptibility vessel sign on T2*-magnetic resonance imaging[16] in addition to computed tomographic angiography. CBS subgroups were defined according a cutoff value of 7 for comparison with previous studies evaluating the association of CBS with clinical outcomes.[8,16,17] Moreover, we dichotomized CBS into 2 groups, losing the semicontinuous variable. Another limitation concerns a possible selection bias because of the lack of core laboratory assessment for 105 patients. In fact, T2*-CBS is assessed according to the susceptibility vessel sign. However, it depends on clot composition, especially by high red blood cells burden, and it is not systematically present. In another ancillary study of ASTER trial, the absence of susceptibility vessel sign was noticed in 29.2%.[18] This raises the question of the estimation of the thrombus burden in magnetic resonance imaging for these kinds of clots. In addition, regarding the study sample size and the low incidence in several outcomes, we could not exclude that some differences could have been overlooked because of the lack of adequate statistical power. In a posterior power calculation, we calculated the smallest significant between-group difference (expressed as RR) that our study sample size allowed us to detect with a 80% power. Assuming an incidence of outcome of 10% and 50% in reference group, we could respectively detect an odds ratio of 2.38 and 1.36 (or 0.15 and 0.64 for protective effect).

Thrombus imaging is now an integral part of imaging assessment in patients with acute ischemic stroke and is used in clinical practice to guide physicians to the best reperfusion strategy. Reperfusion strategy is no longer limited to the choice between mechanical thrombectomy and intravenous thrombolysis.

Outcomes	CBS	First-line Strategy SR	First-line Strategy CA	RR (95%CI)[a]	P	P het
Angiographic outcomes						
Reperfusion after first-line strategy						
mTICI 3	0-6	22/56 (39.3)	22/58 (37.9)	0.96 (0.66 to 1.40)	0.83	0.77
	≥7	21/56 (37.5)	50/61 (32.8)	0.88 (0.59 to 1.30)	0.52	
mTICI 2c/3	0-6	30/56 (53.6)	29/58 (50.0)	0.93 (0.74 to 1.17)	0.55	0.94
	≥7	29/56 (53.6)	29/61 (47.5)	0.92 (0.69 to 1.23)	0.56	
mTICI 2b/3	0-6	37/56 (66.1)	42/58 (72.4)	1.10 (0.98 to 1.24)	0.12	0.40
	≥7	38/56 (67.9)	37/61 (60.7)	0.89 (0.46 to 1.42)	0.63	
Number of passes>2	0-6	22/56 (39.3)	22/58 (37.9)	0.97 (0.70 to 1.34)	0.84	0.29
	≥7	24/56 (42.9)	34/61 (55.7)	1.30 (0.73 to 2.30)	0.37	
Use of rescue therapy	0-6	15/56 (26.8)	14/58 (24.1)	0.89 (0.70 to 1.14)	0.36	0.42
	≥7	16/56 (28.6)	22/61 (36.1)	1.27 (0.56 to 2.88)	0.56	
Reperfusion at end of procedure						
mTICI 3	0-6	22/56 (39.3)	24/58 (41.4)	1.04 (0.74 to 1.45)	0.82	0.99
	≥7	26/56 (46.4)	29/61 (47.5)	1.03 (0.72 to 1.47)	0.86	
mTICI 2c/3	0-6	30/56 (53.6)	32/58 (55.2)	1.02 (0.83 to 1.26)	0.84	0.64
	≥7	39/56 (69.6)	41/61 (67.2)	0.97 (0.84 to 1.10)	0.65	
mTICI 2b/3	0-6	44/56 (78.6)	49/58 (84.5)	1.08 (0.95 to 1.22)	0.25	0.22
	≥7	51/56 (91.1)	53/61 (86.9)	0.95 (0.80 to 1.13)	0.59	
Procedural complications	0-6	9/56 (16.1)	11/58 (19.0)	1.18 (0.72 to 1.94)	0.52	0.85
	≥7	11/56 (19.6)	13/61 (21.3)	1.09 (0.38 to 3.08)	0.88	
Clinical outcomes						
Favorable outcome	0-6	21/54 (38.9)	25/56 (44.6)	1.16 (0.90 to 1.49)	0.25	0.51
	≥7	35/54 (64.8)	35/59 (59.3)	0.91 (0.64 to 1.29)	0.60	
Excellent outcome	0-6	15/54 (27.8)	16/56 (28.6)	1.04 (0.73 to 1.48)	0.83	0.42
	≥7	33/54 (61.1)	28/59 (47.5)	0.77 (0.50 to 1.18)	0.24	
90-day mortality	0-6	12/54 (22.2)	10/56 (17.9)	0.80 (0.36 to 1.78)	0.58	0.23
	≥7	5/54 (9.3)	10/59 (17.0)	1.84 (0.68 to 5.02)	0.23	
Hemorrhagic complications						
Any ICH	0-6	23/55 (41.8)	27/58 (46.6)	1.12 (0.83 to 1.51)	0.48	0.54
	≥7	29/56 (51.8)	30/61 (49.2)	0.95 (0.60 to 1.49)	0.82	
Parenchyma hematoma	0-6	11/55 (20.0)	8/58 (13.8)	0.69 (0.37 to 1.29)	0.25	0.19
	≥7	8/56 (14.3)	10/61 (16.4)	1.14 (0.80 to 1.63)	0.46	

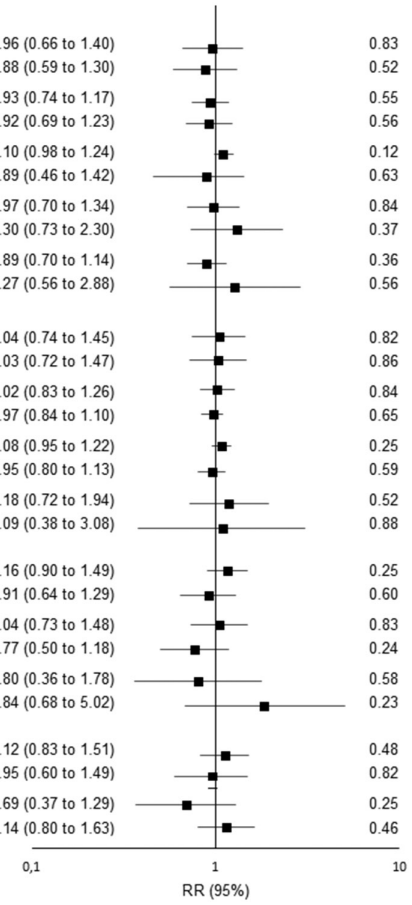

Figure 3. Outcomes in the ASTER trial (Contact Aspiration Versus Stent Retriever for Successful Revascularization) according to clot burden score (CBS) and first-line strategy (contact aspiration vs stent retriever). Values expressed as n/total n (%) unless otherwise indicated. P het indicates *P* values for heterogeneity in first-line strategy effect sizes across CBS subgroups. CA indicates contact aspiration; CI, confidence interval; ICH, intracranial hemorrhage; mTICI, modified Thrombolysis in Cerebral Infarction score; RR, risk ratio; and SR, stent retriever. [a] Calculated using first-line stent retriever group as reference after adjustment for center and intravenous thrombolysis.

Mechanical devices are now diversified, and their efficiency is being studied in various clinical situations. On the angiographic outcomes, despite the mechanical differences between the 2 approaches, the efficiency of neither stent retriever nor contact aspiration was shown to depend on the CBS. Moreover, CBS was not associated with the difficulty of endovascular procedure because the number of passes and use of rescue therapy rates are approximately the same in the 2 arms. Finally, there were no differences in procedural complications according to the CBS or according to the endovascular technique. These findings are also consistent with the published reports, in particular from studies comparing the 2 approaches.[19] Concerning clinical outcomes, strongly related to reperfusion rates,[20] we found that a higher CBS was associated with a favorable and excellent outcome at 90 days confirming the prognostic value of the initial thrombus burden[1,8,16] and the endovascular treatment benefits combined with intravenous thrombolysis.[21] In this context, where the choice of the mechanical thrombectomy technique of reperfusion is still left up to the physician, recent publications do not lead up to one or the other. The first results of the COMPASS trial[22] showed that the aspiration was not inferior to stent retriever use as a first-line strategy for treatment of large vessel occlusion of the anterior circulation. Combined therapy with stent retriever and contact aspiration in first-line strategy are evaluated on the ongoing ASTER 2 trial.

Conclusions

The CBS at admission, which seems to be a reliable prognostic indicator, is associated with reperfusion efficiency and 90-day favorable outcome after mechanical thrombectomy in patients with acute ischemic stroke. No difference was observed between contact aspiration and stent retriever used as first-line strategies.

Appendix

ASTER Trial (Contact Aspiration Versus Stent Retriever for Successful Revascularization) Investigators: Rothschild

Foundation: Michel Piotin, Raphael Blanc, Hocine Redjem, Gabriele Ciccio, Stanislas Smajda, Mikael Mazighi, Robert Fahed, Jean Philippe Desilles, Malek Ben Maacha; Foch Hospital: Bertrand Lapergue, Georges Rodesch, Arturo Consoli, Oguzhan Coskun, Federico Di Maria, Frédéric Bourdain, Jean Pierre Decroix, Adrien Wang, Maya Tchikviladze, Serge Evrard; Hospices Civils de Lyon: Francis Turjman, Benjamin Gory, Paul Emile Labeyrie, Roberto Riva; Limoges University Hospital: Charbel Mounayer, Suzanna Saleme; Montpellier University Hospital: Vincent Costalat, Alain Bonafé, Omer Eker, Grégory Gascou, Cyril Dargazanli; Nancy University Hospital: Serge Bracard, Romain Tonnelet, Anne Laure Derelle, René Anxionnat; Nantes University Hospital: Hubert Desal, Romain Bourcier, Benjamin Daumas-Duport; Bordeaux University Hospital: Jérome Berge, Xavier Barreau, Gauthier Marnat; University Hospital Lille: Lynda Djemmane, Julien Labreuche, Alain Duhamel.

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Similar Outcomes for Contact Aspiration and Stent Retriever Use According to the Admission Clot Burden Score in ASTER

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