Procedural complications during early versus late endovascular treatment in acute stroke: Frequency and clinical impact

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Abstract

Background and Purpose

Endovascular treatment (EVT) in acute ischemic stroke (AIS) is effective in the late time window in selected patients. However, the frequency and clinical impact of procedural complications in the early vs. late time window has received little attention.

Methods

We retrospectively studied all AISs from 2015-2019 receiving EVT in the Acute STroke Registry and Analysis of Lausanne (ASTRAL). We compared the procedural EVT complications in the early (<6 hours) vs. late (6-24 hours) window, and correlated them with short-term clinical outcome.

Results

Among 695 AISs receiving EVT (of which 202 were in the late window), 113 (16.3%) had at least one procedural complication. The frequency of each single, and for overall procedural complications was similar for early vs. late EVT (16.2% vs. 16.3%, P_{adj}=0.90). Procedural complications lead to a significantly less favourable short-term outcome, reflected by the absence of NIHSS improvement in late EVT (delta-NIHSS-24h = -2.5 vs 2, P_{adj}=0.01).

Conclusion

In this retrospective analysis of consecutive EVT, the frequency of procedural complications was similar for early and late EVT patients but very short-term outcome seemed less favourable in late EVT patients with complications.

Keywords: Endovascular treatment, ASTRAL registry, acute ischemic stroke, procedural complications

Non-standard Abbreviations and Acronyms

EVT = Endovascular Treatment

AIS = Acute Ischemic Stroke

SAH = Subarachnoid Hemorrhage

RCT = Randomized Controlled Trial

ASTRAL = Acute STroke Registry and Analysis of Lausanne

NIHSS = National Institutes of Health Stroke Scale

Introduction

Endovascular treatment (EVT) is the most effective treatment for acute ischemic stroke (AIS) with proximal intracranial large vessel occlusion (1-3), despite reported complication rates of 4%-29% (4). The prolongation of the time window up to 24 hours in highly radiologically selected AIS was effective in three randomized controlled trials (RCT) (5-7). Prolonged ischemia potentially leads to higher procedural complication rates such as arterial perforation due to necrotic vessels; on the other hand, this could be balanced by stricter radiological selection criteria for late patients. Current data on access and procedural cerebrovascular complications in late EVT are scarce and essentially limited to the three randomized controlled trials (RCTs), i.e. DEFUSE-3, DAWN and ESCAPE. There, they amounted to 2.4%-7%.

Given the paucity of data in this field, we aimed to compare the frequency of access and procedural cerebrovascular complications in early vs. late EVT patients of the modern thrombectomy era in a consecutive series and to assess their impact on short-term outcome in order to evaluate the interventional safety of the procedure in the late time window.

Methods

The anonymized data that support the findings of this study are available from the corresponding author upon reasonable request.

Applying the Strengthening the Reporting of Observational Studies in Epidemiology checklist (8), we reviewed all patients with AIS arriving within 24 hours from 2015-2019 in the prospectively constructed Acute STroke Registry and Analysis of Lausanne (ASTRAL)(9).

Multiple co-variates were collected and analysed in an anonymous way: demographics, medical history, risk factors, comorbidities, medications, process-oriented

data, stroke characteristics including stroke mechanism and the National Institutes of Health Stroke Scale (NIHSS), metabolic and physiological parameters, and multimodal brain imaging.

Brain imaging and indications for early and late EVT are described in the supplemental material. EVT initiated within 6 hours after onset was considered "early", and within 6-24 hours "late". The interventional neuroradiology team consisted of 3 senior NRI until 2019 and of 4 thereafter. Femoral access for EVT was performed throughout the study period under ultrasound guidance; this method was also used for the two patients with brachial artery and carotid artery access, respectively. At the end of the procedure, we routinely perform sealing of the artery with a sealing device (Angioseal®). We collected treatment delays, device type, total number of passes and degree of recanalization according to the modified Thrombolysis in Cerebral Infarction score (mTICI) (10).

We defined EVT-related complications according to the current literature (11) into two groups: A) *Access complications* (i.e. hemorrhage in puncture area and arterial access damage) and B) *Procedural cerebrovascular complications* (i.e. embolization in non-ischemic territory, dissections of cervical or intracranial arteries, and arterial perforation or post-procedural subarachnoid hemorrhage (SAH)). For detailed definitions, see supplemental material. We did not examine post-EVT re-occlusion or reperfusion injury in the current project due to the specific focus on intra-procedural complications. Still, we plan to assess these events in a future analysis.

The impact of complications on functional outcome was evaluated per complication and only in patients with procedural cerebrovascular complications, as local access complications should have little influence on the neurological handicap. The short-term

outcome was delta-NIHSS at 24 hours and was defined as the difference between NIHSS at 24 hours and at admission, with negative values reflecting a neurological improvement.

Statistically, we assessed two primary outcomes (frequency and early outcome) with linear or logistic regression models, depending on the nature of the variable. The ethics committee of Vaud approved the use of the ASTRAL registry for scientific studies.

Results

Among 695 EVT, 202 (29.1%) were treated in the late time window. The baseline characteristics are summarised in table 1, supplemental table I and II. The late group had similar age, sex, admission NIHSS, clot burden score and successful recanalization, but more prestroke handicap, preceding thrombolysis, and higher ASPECTS score (table 1). The majority of late EVT patients were wake-up strokes (59.9%) and thus the exact time of stroke onset remains unknown.

We found no significant difference in individual (table 2) or overall complication rates between early and late EVT cohorts (16.2% vs 16.3%, OR adjusted for: age, sex, admission NIHSS, pre-EVT-thrombolysis, arterial territory, total passes with the EVT device, tandem lesions, proximal occlusion, atheromatous etiology, groin puncture start time, weekend admission, year that the procedure was performed, presence of peripheral artery disease and premedication with anticoagulation = 0.96(CI 95%=0.53-1.77), p_{adj}=0.90).

When comparing early vs. late EVT with complications, adjusted short-term outcome was better in early EVT (delta-NIHSS-24h=-2.5 vs 2, beta coefficient adjusted for: age, admission NIHSS, pre-EVT-thrombolysis, groin puncture start time, weekend admission, year that the procedure was performed, presence of peripheral artery disease and premedication with anticoagulation =-8.47(CI 95%=-14.22--2.73), p_{adj}=0.01).

Discussion

In this large consecutive series of EVT, we did not find a difference in the complication rates between early and late EVT. Early complicated EVT had a better early course than late complicated EVT.

Results from late endovascular trials (5-7) suggest lower procedural complication rates than in early thrombectomy (4), but we could not confirm this in a real world sample. This absence of difference in complication rates between early and late patients could have been attenuated by the stricter neuroradiological criteria applied for late EVT. Furthermore, the majority of late EVT patients were sleep-onset strokes (59.9%), many of which may occur close to waking up; therefore, the delay from the real stroke onset to EVT in the "late" group was not much longer than in the early group.

Our relatively high overall complication rate in both groups of about 16% may be explained by our liberal definition for some complications, in particular post-procedural incidental SAH. This complication may not be related to procedural perforation but to arterial lacerating during device pull-back, or to thrombolysis-facilitated rupture of a superficial artery.

The 24-hour course in patients with complications was worse in late EVT, despite a similarly high recanalization rate. Therefore, prevention, monitoring for, and rapid management of procedural complications may even be more important in late than in early EVT.

The main limitations of our study are its retrospective and non-randomized character. Second, procedural complications are not uniformly defined in the current literature (11) and therefore debatable. Another limitation of our study is the relatively small number of patients with procedural complications assessed for the long-term outcome, particularly in the late window; this could lead to a type I statistical error.

Finally our population consists of a single center primary and tertiary elderly Caucasian population.

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Supplemental Materials

Expanded methods and results

Online tables I-II

TABLES AND FIGURES

Table 1: Patient baseline characteristics, reported as frequencies and percentages for binary data, and as medians with interquartile range for continuous variables.

Variable	Overall population (n=695)	Early EVT (N = 493)	Late EVT (N = 202)	p-value
Age	74.5(63.4-83.1)	74.2(63.4-82.9)	75.3(63.5-84.1)	0.557
Female sex	332(47.8%)	224(45.5%)	108(53.5%)	0.066
mRS pre-stroke	1(0-2)	1(0-1)	1(0-2)	0.008*
NIHSS	13(7-19)	14(8-19)	12(6-19)	0.111
Anterior circulation stroke	592(88%)	431(89.6%)	161(83.8%)	0.097
Time metrics				
Onset-to-groin-puncture time (min)	245(180-414.7)	205(160-258)	641(455-880)	<0.001*
Groin-puncture-to-recanalization time (min)	50(31-81)	47(30-79)	51(35-90)	0.038*
Initial radiological features				
ASPECTS	9(8-10)	9(8-10)	9(7-10)	0.012*
Clot burden score	6(4-9)	6.5(4.9-9)	6(4-9)	0.491
Tandem lesion	151(24.4%)	101(22.4%)	50(29.6%)	0.074
Acute recanalization treatment				
Preceding thrombolysis	425(61.1%)	361(73.2%)	64(31.7%)	<0.001*

Variable	Overall population (n=695)	Early EVT (N = 493)	Late EVT (N = 202)	p-value
Number of device passes	2(1-3)	1(1-3)	2(1-3)	0.126
Recanalization at end of procedure (mTICI≥2b)	610(92.7%)	432(92.9%)	178(92.2%)	0.744

* Significant in univariate analysis.

ASPECTS=Alberta Stroke Program Early CT Score.

Table 2: Frequency of *access and procedural cerebrovascular* complications related to EVT.

Complication	Total EVT (n=695)	Early EVT (N = 493)	Late EVT (N = 202)	p-value (unadjusted)
Access complications				
Significant hemorrhage in arterial puncture area	12(1.7%)	7(1.4%)	5(2.5%)	0.34
Arterial access damage	**15(2.2%)**	**10(2.0%)**	**5(2.5%)**	**0.71**
o Pseudo-aneurysm, arterial dissection	7(46.7%)	5(50%)	2(40%)	
o Occlusion, local floating thrombus, peripheral embolization	4(26.6%)	3(30%)	1(20%)	
o Other	4(26.7%)	2(20%)	2(40%)	
Any (at least one) access complication	27(3.9%)	17(3.5%)	10(5%)	0.35
Procedural cerebrovascular complications				
Embolization in non-ischemic territory	18(2.6%)	15(3.0%)	3(1.5%)	0.25

Iatrogenic dissection, vasospasms requiring therapeutic interventions	27(3.9%)	20(4.0%)	7(3.5%)	0.71
Procedural cerebral arterial perforation, post-procedural SAH	41(5.9%)	28(5.7%)	13(6.4%)	0.7
Any (at least one) cerebrovascular complication	86(12.4%)	63(12.8%)	23(11.4%)	0.61
Summary				
Any EVT procedural complication	113(16.3%)	80(16.2%)	33(16.3%)	1.000

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