E-049 THROMBECTOMY FORCES AND MECHANICAL PROPERTIES OF EMBOLI IN LARGE VESSEL OCCLUSION STROKE

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Introduction Mechanical thrombectomy using a suction catheter, a stent or the combination of both has recently become a standard of care for large vessel occlusion (LVO) stroke. However, complete recanalization (mTICI=3) with the best neurological outcome can be achieved in only 50% of the cases. In addition, multiple devices and passes are usually needed to recanalize, prolonging procedure times, increasing the risks of vessel damage. To improve our understanding of the interaction between the embolus and thrombectomy devices, in this study we first created a test bed of LVO and analyzed the forces during recanalization. We provided mechanistic explanations of the observations and failure modes by mechanically characterizing a range of emboli retrieved from patients with LVO stroke.

Materials and Methods An LVO test bed with anatomically accurate glass model of an MCA bifurcation was created with physiological flow and pressure. Thrombectomy procedures to remove embolus analogs (EAs) were performed 10 times each using the ADAPT and CAPTIVE techniques. The mechanical responses of the EAs to the action of the thrombectomy devices were recorded and analyzed and deemed to be mostly due to tensile load. To quantify the tensile properties of emboli, 37 emboli retrieved from 20 patients were collected and tested on a customized tensile test machine. The machine applied uniaxial tensile load to the emboli to mimic the vacuum suction and stent pull during thrombectomy procedure. The elongation, thinning, and dissociation were quantified to calculate the embolus strength, represented by ultimate strain (maximum elongation) and ultimate stress (maximum force per unit cross-sectional area).

Results The forces involved in the embolus removal process were categorized into: 1) retrieval forces including vacuum suction or stent pull, 2) resistance forces including static friction and adhesion at the embolus-vascular interface, the pre-load of the embolus protruding into branching arteries, and the pressure difference proximal and distal to the embolus, and 3) emboligenic forces including dynamic friction at the embolus-vascular interface and the blood pressure and shear at the embolus interface. In order to remove emboli, retrieval

forces need to be larger than the resistance forces. If the retrieval force is larger than the strength of the embolus, the embolus will undergo multistage fracture, leading to embolization. The tensile testing of patients' emboli revealed similar behavior, including elongation under tension and multi-stage fracture patterns. The ultimate strain ranged from 1.05 to 4.89 (2.41 ± 1.04 [mean $\pm$ SD]) and the ultimate stress ranged from 63 to 2396 kPa (569 ± 695 kPa). The ultimate strain of the emboli increased with a higher platelet percentage, and the ultimate stress increased with a higher fibrin percentage and decreased with a higher red blood cell percentage.

Conclusion Suction catheters and the stents recanalize by applying tensile force to dislodge and remove the emboli. The tensile force leads to embolus elongation and thinning until dissociation, which may cause iatrogenic embolization. The ability to resist dissociation is determined by embolus strength, which significantly correlates with composition and varies within and among patients and within the same embolus.

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E-050 UTILITY OF HOUNSFIELD UNIT IN PREDICTING FAILED MECHANICAL THROMBECTOMY

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Background and Purpose Despite advancement in technique, around 30% of mechanical thrombectomies (MT) for acute large vessel occlusion (LVO) are unsuccessful. Current prediction models fail to address the association between patient's specific factors and post-procedural reperfusion. In the present study, we aim to evaluate pre-thrombectomy clinical and radiological features and their association with failed MT.

Methods We retrospectively analyzed consecutive, adult, MT patients with anterior circulation LVO (2012–2017) treated at two large comprehensive stroke centers. We collected clinical and procedural data and reviewed imaging features from non-contrast enhanced head computed tomography (CT), CT

Abstract E-050 Table 1

Multivariate Model 1: including delta HU				Multivariate Model 2: including HU ratio			
Variables	OR	95% OR CI	P value	Variables	OR	95% OR CI	P value
Smokers	1.84	1.23–2.74	0.0029	Smokers	1.81	1.21–2.7	0.003
Vessel Tortuosity	2.73	1.16–6.43	0.0216	Vessel Tortuosity	2.75	1.16–6.50	0.02
Diminutive vessels	2.57	1.36–4.85	0.0035	Diminutive vessels	2.51	1.33–4.74	0.004
Truncal Type of Occlusion	1.79	0.945–3.41	0.0738	Truncal Type of Occlusion	1.80	0.94–3.42	0.07
Difficult arch	4.84	1.49–15.66	0.0084	Difficult arch	4.61	1.43–14.85	0.01
Delta HU < 6	2.07	1.09–3.92	0.0253	HU ratio ≤ 1.1	2.003	1.05–3.81	0.0034
Calcification and clot location match	1.00	0.515–1.94	0.9956	Calcification and clot location match	1.03	0.544–2.00	0.92

angiography (CTA) and digital subtraction angiography (DSA). We performed a quantitative assessment of hyperdense vessel on CT, measuring Hounsfield unit (HU) in the occluded side and its counterpart. The primary outcome was unsuccessful recanalization measured by the Thrombolysis in Cerebral Infarction (TICI) score (0-2A). We utilized univariate and multivariate logistic regression to examine these associations.

Results Out of 348 anterior LVO patients, 87 had failed MT. In univariate analysis, smoking, difficult arch, vessel tortuosity, vessel calcification specifically matching the LVO location, diminutive vessels, truncal M1 occlusion and quantitative measures for hyperdense MCA (delta HU and HU ratio) were significantly associated with failed MT. When we fitted 2 separate multivariate models delta HU or HU ratio; both delta HU < 6 (OR: 2.07, 95% CI: 1.09–3.92, $p=0.0253$) and HU ratio ≤ 1.1 (OR: 2.003, 95% CI: 1.05–3.81, $p=0.0034$) were independently associated with failed MT after adjusting by smoking, diminutive vessels, vessel tortuosity, and difficult arch. (Table 1) Our final model ROC plots presented an AUC of 0.717.

Conclusions Quantitative assessment of HU utilizing delta HU and HU ratio may help identify patients refractory to standard thrombectomy strategies.

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E-051 CAN COMPUTED TOMOGRAPHIC ANGIOGRAPHY BE USED TO PREDICT WHO WILL NOT BENEFIT FROM ENDOVASCULAR TREATMENT IN PATIENTS WITH ACUTE ISCHEMIC STROKE? THE CTA-ABC SCORE

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Objective The objective of this study was to develop a score to predict patients with acute ischemic stroke (AIS) who will not benefit from endovascular treatment (EVT) using computed tomographic angiography (CTA) parameters.

Methods The CTA-ABC score was developed from 3 scales previously described in the literature: the Alberta Stroke Program Early CT Score (0–5 points = 3, 6–10 points = 0), the clot Burden score (0–3 points = 1, 4–10 points = 0), and the leptomeningeal Collateral score (0–1 points = 2, 2–3 points = 0). We evaluated the predictive value of CTA parameters associated with symptomatic intracranial hemorrhage (sICH) or malignant middle cerebral artery infarction (MMCAI) after EVT and developed the score using logistic regression coefficients. The score was then validated. Performance of the score was tested with an area under the receiver operating characteristic curve (AUC-ROC).

Results The derivation cohort consisted of 115 and the validation cohort consisted of 40 AIS patients. The AUC-ROC was 0.97 (95% CI, 0.94–0.99; $P<0.001$) in the derivation cohort. The proportions of patients with sICH and/or MMCAI in the derivation cohort were 96%, 73%, 6% and 0% for scores of 6, 5, 1 and 0 points, respectively. In the validation group, the proportions were similar (90%, 100%, 0% and 0%,

respectively) with an AUC-ROC of 0.96 (95% CI, 0.90–1.00; $P<0.001$).

Conclusion Our CTA-ABC score reliably assessed risk for sICH and/or MMCAI in patients with AIS who underwent EVT. It can support clinical decision-making, especially when the need for EVT is uncertain.

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E-052 SAFETY AND EFFICACY OF STENTING POST FAILED THROMBECTOMY: MULTI-INSTITUTIONAL EXPERIENCE

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Introduction Even in the era of stent-retrievers, complete recanalization is often not achieved.

Methods In this multi-institutional effort, we retrospectively evaluated 101 consecutive patients across 6 centers who underwent placement of a self-expanding stent during thrombectomy, either as a rescue strategy for intracranial recanalization or for tandem extracranial/intracranial occlusion. We aimed to evaluate recanalization, complications, clinical outcomes, and antithrombotic regimens in these patients.

Results Occlusive thrombus was located in the internal carotid artery (ICA) in 23.8%, in the middle cerebral artery in 59.4% and in the vertebro-basilar circulation in 16.8% of cases. Indications for stenting included persistent occlusion/failed recanalization in 42.6% of cases, tandem occlusions with proximal flow limiting stenosis in 19.8%, vessel reocclusion after initial recanalization in 14.9%, vessel dissection in 15.8% cases, and underlying intracranial stenosis in 6.9% patients. 48.5% of patients had a stent deployed intracranially, 41.6% of stents were deployed within the extracranial ICA/vertebral artery while 9.9% extended from an extracranial to an intracranial vascular segment. Multiple stents were deployed in 9.9% of cases. Successful recanalization (TICI

Abstract E-052 Table 1 Antiplatelet/antithrombotic regimens

Antiplatelet agent loading	
Aspirin	6.9%
Aspirin and plavix	19.8%
Tirofiban	20.8%
Abciximab	3%
Aspirin/Plavix and tirofiban	3%
Aspirin/tirofiban	1%
Eptifibatide	2%
Aspirin/Plavix and eptifibatide	6.9%
Aspirin and eptifibatide	5%
Prasugrel	1%
Aspirin and ticagrelor	1%
Aspirin, Ticagrelor and Eptifibatide	1%
Use of a glycoprotein IIb/IIIa inhibitor	41.6%
Antiplatelet/Antithrombotic agent maintenance	
Dual antiplatelet treatment	68.3%
Aspirin	9.9%
Antiplatelet + Anticoagulation	18.8%