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 preload 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