A direct aspiration first-pass technique vs stentriever thrombectomy in emergent large vessel intracranial occlusions

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OBJECTIVE Endovascular thrombectomy in patients with acute ischemic stroke caused by occlusion of the proximal anterior circulation arteries is superior to standard medical therapy. Stentriever thrombectomy with or without aspiration assistance was the predominant technique used in the 5 randomized controlled trials that demonstrated the superiority of endovascular thrombectomy. Other studies have highlighted the efficacy of a direct aspiration first-pass technique (ADAPT).

METHODS To compare the angiographic and clinical outcomes of ADAPT versus stentriever thrombectomy in patients with emergent large vessel occlusions (ELVO) of the anterior intracranial circulation, the records of 134 patients who were treated between June 2012 and October 2015 were reviewed.

RESULTS Within this cohort, 117 patients were eligible for evaluation. ADAPT was used in 47 patients, 20 (42.5%) of whom required rescue stentriever thrombectomy, and primary stentriever thrombectomy was performed in 70 patients. Patients in the ADAPT group were slightly younger than those in the stentriever group (63.5 vs 69.4 years; $p = 0.04$); however, there were no differences in the other baseline clinical or radiographic factors. Procedural time (54.0 vs 77.1 minutes; $p < 0.01$) and time to a Thrombolysis in Cerebral Infarction (TICI) scale score of 2b/3 recanalization (294.3 vs 346.7 minutes; $p < 0.01$) were significantly lower in patients undergoing ADAPT versus stentriever thrombectomy. The rates of TICI 2b/3 recanalization were similar between the ADAPT and stentriever groups (82.9% vs 71.4%; $p = 0.19$). There were no differences in the rates of symptomatic intracranial hemorrhage or procedural complications. The rates of good functional outcome (modified Rankin Scale Score 0–2) at 90 days were similar between the ADAPT and stentriever groups (48.9% vs 41.4%; $p = 0.45$), even when accounting for the subset of patients in the ADAPT group who required rescue stentriever thrombectomy.

CONCLUSIONS The present study demonstrates that ADAPT and primary stentriever thrombectomy for acute ischemic stroke due to ELVO are equivalent with respect to the rates of TICI 2b/3 recanalization and 90-day mRS scores. Given the reduced procedural time and time to TICI 2b/3 recanalization with similar functional outcomes, an initial attempt at recanalization with ADAPT may be warranted prior to stentriever thrombectomy.

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KEY WORDS acute ischemic stroke; ADAPT; emergent large vessel occlusion; stentriever; thrombectomy; vascular disorders

ABBREVIATIONS ADAPT = a direct aspiration first-pass technique; ASPECTS = Alberta Stroke Program Early CT Score; CASPER = combined aspiration and stentriever; CTA = CT angiography; DWI = diffusion-weighted imaging; ELVO = emergent large vessel occlusion; ICA = internal carotid artery; MCA = middle cerebral artery; mRS = modified Rankin Scale; NIHSS = National Institutes of Health Stroke Scale; sICH = symptomatic intracranial hemorrhage; TICI = Thrombolysis in Cerebral Infarction; tPA = tissue plasminogen activator.

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RECENT randomized controlled trials have changed the landscape of stroke care. These studies have demonstrated the superiority of mechanical thrombectomy over medical therapy alone for patients presenting within 6 hours of symptom onset after stroke secondary to emergent large vessel occlusion (ELVO) of the anterior intracranial circulation.^{1,5,11,15,22} This development was notable because it followed the 2013 publication of 3 trials that failed to detect an outcome difference between medical therapy and mechanical thrombectomy in this patient population.^{2,7,16} Compared with the 2013 publications, the more recent trials incorporated refined patient selection algorithms with accelerated treatment times and next-generation devices. The use of these next-generation thrombectomy devices, specifically stentriever and large-bore aspiration catheter systems with their associated efficacies of reperfusion, was likely a powerful driver in the positive results in these studies. These systems have been refined since their introduction into clinical practice, and with this technical evolution has come advancements in technique and the incorporation of combination approaches, such as proximal flow arrest in the cervical vasculature with a balloon guide catheter¹⁸ or combined stentriever-aspiration maneuvers,¹⁴ which are termed CASPER (combined aspiration and stentriever) in our practice environment. There is active debate as to which thrombectomy technique is superior for the acute treatment of ELVO, with no randomized trials yet performed to provide guidance. Our institution began using primary stentriever thrombectomy in 2012, which evolved to CASPER in 2014, and currently uses a direct aspiration first-pass technique (ADAPT) as a first-line approach for the majority of cases. We present a detailed analysis of our institutional experience using these approaches.

Methods

We performed an observational, retrospective, single-center study to assess the comparative efficacy of ADAPT and stentriever mechanical thrombectomy techniques to treat ELVOs of the anterior intracranial circulation. Following institutional review board approval at Massachusetts General Hospital, the records of 134 patients who were treated with mechanical thrombectomy for ELVO between June 2012 and October 2015 were reviewed. The study sample was formed after reviewing a prospectively maintained acute ischemic stroke database within the study period. All historical, clinical, radiographic, and follow-up information was obtained from the electronic medical records in accordance with the Health Insurance Portability and Accountability Act.

Patient and Data Selection

All patients underwent unenhanced head CT to exclude intracranial hemorrhage or an established large-territory infarct, as assessed by the Alberta Stroke Program Early CT Score (ASPECTS),¹⁹ and CT angiography (CTA) to detect ELVO and evaluate collateral circulation. In instances in which the time from last seen well could not be established, a large-territory infarct was suspected based on ASPECTS, and collateral vascular supply on CTA appeared insufficient, MRI with diffusion-weighted

imaging (DWI), FLAIR, and gradient echo sequences was performed. All patients were evaluated by a stroke neurologist and neuroendovascular specialist prior to proceeding with intraarterial mechanical thrombectomy, in accordance with the criteria below. Intravenous tissue plasminogen activator (tPA) was administered per established protocols.

The criteria for study inclusion were 1) time from stroke onset or last seen well to groin puncture of less than 8 hours; 2) no acute hemorrhage; 3) occlusion of the terminal internal carotid artery (ICA) or middle cerebral artery (MCA) on CTA; 4) National Institutes of Health Stroke Scale (NIHSS) score of 8 or higher; 5) infarct volume less than 100 ml and/or ASPECTS greater than 4; 6) baseline modified Rankin Scale (mRS) score of 3 or less; 7) life expectancy greater than 6 months; and 8) anatomy permitting catheterization of the intracranial vessels.

Of the 134 patients reviewed, 5 patients had posterior circulation occlusions, 9 patients had occlusions that could not be accessed due to proximal large-vessel tortuosity or severe atherosclerotic disease, and 3 patients underwent failed primary stentriever thrombectomy followed by successful aspiration thrombectomy and were subsequently excluded from further analysis. The remaining 117 patients with demonstrated proximal anterior circulation occlusions were included in the study and were dichotomized into 2 cohorts based on the initial thrombectomy approach that was chosen: ADAPT versus stentriever. Within the ADAPT group, patients were further categorized as "ADAPT success" if intraarterial recanalization was successful with aspiration thrombectomy alone, or "ADAPT failure/stentriever rescue" if recanalization of the primary lesion was not achieved with aspiration or if following successful recanalization of the primary lesion a distal lesion was deemed inappropriate for aspiration thrombectomy.

Reperfusion Assessment and Outcome Measures

Reperfusion was graded using the modified Thrombolysis in Cerebral Infarction (TICI) scale. Successful reperfusion was defined as a TICI score of 2b/3 on the final postthrombectomy cerebral angiography. Symptomatic intracranial hemorrhage (sICH) was defined using the European Cooperative Acute Stroke Study II criteria. The primary outcome measure was the 90-day mRS score, which was obtained through direct neurology clinic evaluation or by physician telephone interview.

Procedural Details

A standard approach was used as a base for all cases. A long sheath (Neuron MAX 088 [Penumbra, Inc.] or 7-Fr Flexor Shuttle Guiding Sheath [Cook Medical]) was positioned in the distal common or proximal ICA using either a 5-Fr Davis (Cook Medical) or 6-Fr Neuron Select (Penumbra) catheter. A 0.025-inch Velocity microcatheter (Penumbra) loaded with a 0.014-inch Synchro2 micro-wire (Stryker Corp.) was introduced into a 5MAX ACE or ACE64 (Penumbra) large-bore aspiration catheter, and this triaxial unit was loaded into the long sheath. The microcatheter was then advanced past the thrombus over the

microwire, and the aspiration catheter was advanced over this coaxial system up to the thrombus.

ADAPT was performed in the following manner. The primed aspiration tubing was connected to the hub of the aspiration catheter, and the pump was turned on. The microcatheter and microwire were then removed while the aspiration catheter was advanced to ensure apposition to the thrombus, which was defined as the cessation of flow through the aspiration system. Further forward tension was applied to the aspiration catheter when this occurred. A timer was started. After 3 minutes, the aspiration catheter was slowly withdrawn into the long sheath under continuous pump aspiration with the aid of supplementary manual aspiration of the long sheath. The use of a stentriever was additionally used if recanalization of the primary lesion was not achieved or if, following successful recanalization of the primary lesion, a distal lesion was deemed inappropriate for aspiration thrombectomy. In select cases, a second ADAPT attempt was made if successful debulking of the clot occurred with the first attempt and an accessible target thrombus remained.

Primary stentriever thrombectomy was performed in the following manner. After confirmation of intravascular microcatheter access across the thrombus, a stentriever (Solitaire FR [Medtronic] or Trevo XP ProVue [Stryker]) was deployed across the thrombus by slowly retracting the microcatheter to expose the distal device and then pushing the stentriever out of the microcatheter into the thrombus. For CASPER cases, the aspiration tubing was connected to the aspiration catheter and the pump was turned on. After 3–5 minutes, the stentriever was withdrawn into the aspiration catheter under continuous aspiration, and the entire system was then withdrawn into the long sheath with the aid of supplementary manual aspiration of the long sheath. This process was repeated until successful recanalization of the primary lesion and/or any distal thrombi amenable to intervention was achieved.

Statistical Analyses

Descriptive statistics were calculated for the clinical and radiographic factors using the mean as a measure of central tendency. A univariate analysis of the clinical characteristics and outcomes was performed. Comparisons of the continuous variables with nonnormal distributions were made using the nonparametric Mann-Whitney U-test. Contingency statistics of the categorical variables were performed using the Fisher exact test. Logistic regression was used to analyze the relationship between multiple variables and functional outcome as defined by the 90-day mRS scores using the factors that were found to be statistically significant on the screening univariate analyses in order to create the most parsimonious model. All statistical tests were 2-sided, and $p < 0.05$ was prospectively determined to establish statistical significance. All analyses were performed using JMP Pro 12 (SAS) or MedCalc 16 (MedCalc Software).

Results

Table 1 summarizes the baseline clinical, radiographic, and preprocedural characteristics of the study groups. A

total of 117 patients met the criteria for inclusion in this study. Forty-seven patients underwent primary ADAPT thrombectomy, and 70 patients underwent primary stentriever thrombectomy for acute intracranial large vessel occlusions. Of the 47 patients in the ADAPT cohort, 27 (57.4%) patients had successful recanalization of the primary lesion, while 20 (42.6%) patients required the subsequent use of a stentriever. Patients in the ADAPT group were slightly younger than patients in the stentriever group (mean 63.5 vs 69.4 years; $p = 0.04$), and the subset of patients with successful recanalization following ADAPT had fewer patients with atrial fibrillation than the stentriever group (25.9% vs 50%; $p = 0.04$). Patient sex, presenting NIHSS score, baseline mRS score, and history of hypertension, diabetes mellitus, smoking, coronary artery disease, and cerebrovascular accident/transient ischemic attack did not differ significantly between the study groups. There were no significant differences in rates of preprocedural intravenous tPA administration or the times from when the patients were last seen well to tPA administration. The location and side of anterior intracranial circulation occlusion did not differ between the study groups, and there were no significant differences between baseline CT ASPECTS or the volume of the core infarcts as assessed by DWI on MRI between the ADAPT and stentriever cohorts.

Table 2 highlights the procedural data from the study cohorts. Compared with the ADAPT group, a greater percentage of patients in the stentriever group was treated under general endotracheal anesthesia as opposed to conscious sedation; however, this difference did not meet statistical significance. Patients in the ADAPT group had significantly shorter times from last seen well to TICI 2b/3 recanalization (mean 294.3 minutes vs 346.7 minutes; $p < 0.01$) and shorter procedural times (mean 54.0 minutes vs 77.1 minutes; $p < 0.01$) as compared with the stentriever group. These differences were further magnified when examining only the ADAPT success cohort, with a mean time to TICI 2b/recanalization from last seen well of 251.9 minutes and a mean procedural time of 41.8 minutes. Patients in the ADAPT success and ADAPT failure/stentriever rescue groups received a mean of 1.3 primary aspiration thrombectomy attempts. For the patients in the ADAPT failure/stentriever rescue group, a mean of 1.7 passes with a stentriever were performed, while a mean of 1.9 passes with a stentriever were performed in patients undergoing primary stentriever thrombectomy ($p = 0.27$). While all patients in the ADAPT failure/stentriever rescue cohort underwent CASPER, aspiration assistance was employed in only 55.7% of patients in the primary stentriever group ($p < 0.01$), which was largely a by-product of the technology available when the individual patient was treated. The rates of TICI 2b/3 recanalization were similar between the ADAPT and stentriever cohorts (83.0% vs 71.4%; $p = 0.19$). There were no differences in the rates of tandem cervical ICA stenosis/occlusion or procedural complications.

Table 3 reports the outcome data following ADAPT and stentriever thrombectomy. There were no significant differences in the rates of radiographic or symptomatic intracranial hemorrhage. The location of disposition (home

TABLE 1. Patient, clinical, radiographic, and preprocedural data

Variable	ADAPT			Stentriever	p Value*	p Value†	p Value‡
	ADAPT Success	ADAPT Failure/Stentriever Rescue	Total				
Patient data							
No. of patients	27	20	47	70			
Mean age	60.3	67.7	63.5	69.4	0.04	<0.01	0.63
Male sex	18 (66.7)	9 (45)	27 (57.4)	34 (48.6)	0.45	0.12	0.81
Mean NIHSS	16.7	16.2	16.5	16.5	0.94	0.89	0.76
Baseline mRS score >1	2 (7.4)	1 (5)	3 (6.4)	5 (7.1)	>0.99	>0.99	>0.99
Hypertension	19 (70.3)	18 (90)	37 (78.7)	50 (71.4)	0.40	>0.99	0.14
Diabetes mellitus	9 (33.3)	3 (15)	12 (25.5)	20 (28.6)	0.83	0.63	0.26
Smoking (current or past)	5 (18.5)	6 (30)	11 (23.4)	10 (14.3)	0.23	0.75	0.18
Atrial fibrillation	7 (25.9)	9 (45)	16 (34.0)	35 (50)	0.13	0.04	0.80
Coronary artery disease	6 (22.2)	6 (30)	12 (25.5)	22 (31.4)	0.30	0.46	>0.99
Previous stroke	6 (22.2)	2 (10)	8 (17.0)	14 (20)	0.81	0.77	0.51
Preprocedural data							
Intravenous tPA	20 (74.1)	14 (70)	34 (72.3)	40 (57.1)	0.56	0.16	0.44
Mean onset to intravenous tPA, mins	109.6	154.7	128.9	132.1	0.78	0.08	0.14
Mean ASPECTS	8.4	7.6	8	8.3	0.34	0.92	0.12
Mean DWI vol, ml	35.4	30.5	33.4	21.8	0.06	0.10	0.34
Location of intracranial occlusion							
ICA	6 (22.2)	6 (30)	12 (25.5)	13 (18.6)	0.15	0.61	0.15
M ₁ MCA	19 (70.4)	14 (70)	33 (70.2)	43 (61.4)			
M ₂ MCA	2 (7.4)	0	2 (4.3)	14 (20)			
Left side	14 (51.9)	10 (50)	24 (51.1)	35 (50)	>0.99	>0.99	>0.99

All values are presented as the number of patients (%) unless indicated otherwise. Boldface type indicates statistical significance.

* ADAPT versus stentriever.

† ADAPT success versus stentriever.

‡ ADAPT failure/stentriever rescue versus stentriever.

vs rehabilitation) did not differ between the ADAPT and stentriever groups. Importantly, the rates of good functional outcome at 90 days, as defined by an mRS score of 0–2, were similar between the ADAPT and stentriever cohorts (48.9% vs 41.4%; $p = 0.45$). This finding held true even when the ADAPT success and ADAPT failure/stentriever rescue groups were compared individually to the stentriever group. The rates of death were similar between the study cohorts. Logistic regression was performed to identify the factors that were predictive of a good functional outcome (mRS Score 0–2) at 90 days (Table 4). The thrombectomy technique (ADAPT vs stentriever) was not a significant predictor of functional outcome ($p = 0.47$). Among multiple variables, age (OR 0.95; coefficient -0.05 ; $p < 0.01$), history of previous stroke (OR 0.11; coefficient -2.22 ; $p < 0.01$), admission NIHSS (OR 0.85; coefficient -0.16 ; $p = 0.01$), TICI 2b/3 recanalization (OR 23.37; coefficient 3.15; $p < 0.01$), and time to groin puncture (OR 0.1; coefficient -0.005 ; $p = 0.03$) were significant predictors of 90-day mRS scores of 0–2.

Discussion

Our findings demonstrate a 57% success rate of achieving adequate reperfusion (TICI 2b/3) with a single pass of ADAPT as the primary thrombectomy approach with

a mean number of 1.3 aspiration attempts. ADAPT success was accomplished faster than in the stentriever cases. Of note, in cases requiring stentriever rescue, the additional time required for stentriever use was equivalent to the time required for primary stentriever treatment in our series. The rates of TICI 2b/3 reperfusion (83%), sICH (12%), and 90-day clinical outcomes of mRS Scores 0–2 (48.9%) are within the range of previously published mechanical thrombectomy studies, and a recent meta-analysis of 4 of the 5 published trials defined a recanalization rate of 71.1% using Solitaire thrombectomy.⁴ Much attention has been paid to the ADAPT approach since the early experiences of the technique²⁴ and the possibility of “faster, better, cheaper” recanalization.²⁴ A recent survey identified the ADAPT technique as the first-line approach for almost 40% of respondents, with CASPER used by approximately 28% and a stentriever with a balloon guide catheter in the cervical vasculature used by approximately 23%. Nearly two-thirds of respondents indicated an increase in pursuing thrombectomy, treating older stroke patients, treating more mildly affected patients, and/or providing treatment later in the treatment window.⁹ With an anticipated increase in stroke treatment volumes and therapeutic aggression, it is of great importance to determine the optimal technique for thrombectomy.

Our technical approach differs from other aspiration

TABLE 2. Procedural data

Characteristic	ADAPT			Stentriever	p Value*	p Value†	p Value‡
	ADAPT Success	ADAPT Failure/Stentriever Rescue	Total				
No. of patients	27	20	47	70			
General endotracheal anesthesia	4 (14.8)	3 (15)	7 (14.9)	21 (30)	0.08	0.19	0.25
Mean onset to groin puncture, mins	219.3	272.5	241.9	284.7	0.02	<0.01	0.58
Mean no. of ADAPT attempts	1.3	1.3	1.3	NA	NA	NA	NA
Mean no. of stentriever attempts	NA	1.7	1.7	1.9	NA	NA	0.27
CASPER	NA	20 (100)	NA	39 (55.7)	NA	NA	<0.01
Tandem cervical ICA stenosis/occlusion	3 (11.1)	3 (15)	6 (12.8)	7 (10)	0.77	>0.99	0.67
TICI 2b/3 recanalization	22 (81.4)	17 (85)	39 (83.0)	50 (71.4)	0.19	0.44	0.26
Mean onset to TICI 2b/3 recanalization, mins	251.9	345.5	294.3	346.7	<0.01	<0.01	0.74
Mean procedural time, mins	41.8	70.4	54.0	77.1	<0.01	<0.01	0.33
Procedural complication	2 (7.4)	1 (5)	3 (6.4)	5 (7.1)	>0.99	>0.99	>0.99

NA = not applicable.

All values are presented as the number of patients (%) unless indicated otherwise. Boldface type indicates statistical significance.

* ADAPT versus stentriever.

† ADAPT success versus stentriever.

‡ ADAPT failure/stentriever rescue versus stentriever.

approaches reported in the literature. While other operators have used multiple ADAPT passes,^{8,17} we typically attempt a single pass with the aspiration catheter, and, if adequate recanalization is not achieved using this, we deploy a stentriever through the aspiration system in order to use CASPER as our “rescue” on the next attempt. Our rationale is that we plan to use a stentriever only in the context of the CASPER technique, and therefore an initial aspiration attempt necessitates no additional equipment and, if successful, obviates the need for stentriever altogether. More than a single ADAPT pass is rarely used. In these situations, the initial ADAPT aspiration has successfully debulked the clot, and additional aspiration for proximal clot is attempted to extract the remnant (Fig. 1). If the initial thrombectomy is unsuccessful or smaller and more distal fragments remain, then a stentriever is used as

the rescue therapy (Fig. 2). The high success rate of both techniques and the rescue alternative is similar to recent trial data and illustrates the efficacy of the next-generation thrombectomy devices.

In a recent publication by Delgado Almandoz et al., the patients in their ADAPT group had a significantly higher rate of good clinical outcome at 90 days than the patients in their CASPER group (55.6% vs 30.9%; $p = 0.015$). The use of the ADAPT technique (OR 6, 95% CI 1.0–31.2; $p = 0.049$) was an independent predictor of a good clinical outcome at 90 days.⁸ Similarly, Romano et al. reported on the experiences of 9 Italian stroke centers and demonstrated an association between the revascularization of ELVO with ADAPT and an mRS score of 0–2 score at the 90-day follow-up, underscoring the importance of successful reperfusion in a timely manner.²¹ In our cohort, in

TABLE 3. Outcome data

Variable	ADAPT			Stentriever	p Value*	p Value†	p Value‡
	ADAPT Success	ADAPT Failure/Stentriever Rescue	Total				
No. of patients	27	20	47	70			
Any intracranial hemorrhage	6 (22.2)	11 (55)	17 (36.2)	22 (31.4)	>0.99	0.46	0.07
slCH	1 (3.7)	5 (25)	6 (12.8)	7 (10)	0.77	0.44	0.13
Disposition							
Home	4 (14.8)	1 (5)	5 (10.6)	14 (20)	0.09	0.09	0.07
Rehabilitation	22 (81.5)	14 (70)	36 (76.6)	47 (67.1)			
Mean 7-day NIHSS score	6.4	9.3	7.6	7.3	0.81	0.55	0.24
Mean 90-day mRS score	2.2	3.3	2.7	3.0	0.83	0.23	0.53
90-day mRS Score 0–2	14 (51.9)	9 (45)	23 (48.9)	29 (41.4)	0.45	0.37	0.80
Death	1 (3.7)	5 (25)	6 (12.8)	13 (18.6)	0.45	0.06	0.54

All values are presented as the number of patients (%) unless indicated otherwise.

* ADAPT versus stentriever.

† ADAPT success versus stentriever.

‡ ADAPT failure/stentriever rescue versus stentriever.

TABLE 4. Independent predictors of a good functional outcome (mRS Score 0–2) at 90 days

Parameter	Odds ratio	Coefficient	p Value
Endovascular thrombectomy technique	NA	NA	0.47
Age	0.95	−0.05	<0.01
Previous stroke	0.11	−2.22	<0.01
NIHSS score	0.85	−0.16	0.01
TICI 2b/3 recanalization	23.37	3.15	<0.01
Time to groin puncture, mins	0.1	−0.005	0.03

contrast, equivalent outcomes were seen with both techniques, supporting the concept that reperfusion produces better clinical outcomes with device choice as a secondary factor. The effect of timely reperfusion is well established for stroke. A pathophysiological basis for a difference between ADAPT and CASPER exists given the rapid treatment times with ADAPT and the possibility of more complete recanalization.²³ We did not find this relationship in our cohort, which may be a reflection of the sample size. Complementing this finding, a recently published long-term experience with the ADAPT technique by Vargas et al. failed to detect differences in outcome between cases

treated with primary ADAPT and ADAPT followed by CASPER rescue. Seventy-nine (57.7%) patients who underwent direct aspiration achieved an mRS score of 0–2 at 90 days compared with only 19 (43.2%) patients who underwent adjunct therapies ($p = 0.12$). However, this analysis did not include a cohort treated with stentriever alone.²⁶ It remains difficult, therefore, to distinguish between the 2 techniques on the basis of patient outcomes alone.

In the United States, there is increasingly a migration toward value-based care.^{3,12} Value in health care is a relationship between cost and clinical outcomes. These economic changes will meaningfully impact the neuroen-

FIG. 1. A 46-year-old male patient presented with an NIHSS score of 12 and right MCA syndrome. CTA showed a right ICA terminus occlusion. **A:** MRI demonstrated acute infarction of the right anterior temporal lobe, insula, and basal ganglia as assessed by DWI. **B:** Initial diagnostic cerebral angiography confirmed the right ICA terminus occlusion. **C:** A single ADAPT attempt resulted in recanalization of the right ICA terminus, but persistent partial occlusion of the distal right M₁ MCA (arrow). **D:** A second ADAPT attempt resulted in TICI 3 recanalization of the right anterior circulation. Figure is available in color online only.

FIG. 2. A 59-year-old female patient presented with an NIHSS score of 20 and left MCA syndrome. CTA showed a proximal left M₁ MCA occlusion. **A:** MRI demonstrated acute infarction of the left insula as assessed by DWI. **B:** Initial diagnostic cerebral angiography confirmed the proximal left M₁ MCA occlusion. **C and D:** A single ADAPT attempt resulted in recanalization of the left M₁ MCA but persistent occlusion of the left M₂ MCA superior division (arrow). **E and F:** A 4 mm × 20-mm Solitaire FR stentriever was then employed for mechanical thrombectomy, resulting in TICI 2b recanalization of the left anterior circulation. Figure is available in color online only.

dovascular community.¹³ New trials bring new questions about the most cost-effective means of achieving good outcomes in patients with ELVO.⁶ Our data suggest that these questions extend to thrombectomy choices. Thrombectomy devices are expensive, and the ability to achieve recanalization without the additional price of a stentriever is an important consideration in our treatment paradigm. We show that, for 57% of our acute stroke cases, an aspiration catheter is all that we used to achieve reperfusion with a single pass. In our practice environment, this decreases the equipment cost of a mechanical thrombectomy procedure by approximately \$6,000–\$7,000 USD. Performing additional ADAPT attempts appears to decrease the need for stentriever rescue to less than 30%⁸ and may be a consideration in our future protocols, further diminishing stentriever needs in order to save costs. Nascent literature exists that points toward the cost effectiveness of ADAPT in treating stroke,²⁵ but analysis of ADAPT, CASPER, stentriever use alone, and the use of a balloon guide catheter without an intermediate aspiration system remains to be systematically performed.

The focused update to the American Heart Association/American Stroke Association stroke guidelines²⁰ recommend that thrombectomy for stroke be performed using stentriever on the basis that these were the predominant devices used in the recent thrombectomy trials. However, the rapid pace of technological change argues against a device-specific mandate,¹⁰ and the current comparisons between ADAPT and stentriever represent an example of this. As other options become available for mechanical thrombectomy, it will be imperative that we evaluate more nuanced aspects of device effect, including first-pass effect, speed of thrombectomy, complications such as emboli to new territory, and the impact on value of care.²⁷ This will allow refined comparisons across different device and technique platforms.

While the data in this analysis were prospectively acquired, our study suffers from the limitations inherent to a single-center, retrospective work; however, the single-center nature does ensure consistent approaches to our periprocedural management of patients with ELVO given the highly protocolized nature of our stroke management and reflects a real clinical practice, rather than a trial environment. Moreover, while the overall impact on the study results is unclear, patients in the ADAPT and stentriever cohorts differed with respect to age and history of atrial fibrillation. In addition, the use of a stentriever or aspiration system is determined by the attending physician's preference, and may add selection bias to our findings. The rapid evolution of devices with evolving operator experience may have an additional effect on our results. Finally, we do not use a balloon guide catheter in stroke cases, and this may arguably decrease the efficacy of primary stentriever use¹⁸ and therefore affect our comparison of techniques.

Conclusions

A single pass of ADAPT as the first-line treatment for acute anterior circulation stroke was successful in achieving recanalization in 57% of our patients and can be considered in any treatment scenario where CASPER (a stentriever used in combination with distal aspiration)

is planned. In cases without successful primary aspiration, the use of a stentriever as a rescue did not add additional time to stentriever thrombectomy alone. All 3 techniques proved to be efficacious for achieving recanalization. Future studies evaluating these varied approaches should not be limited to recanalization and functional outcome. Rather, they should include detailed economic analyses and evaluate granular, milestone-based procedural timing.

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Disclosures

Dr. Hirsch is a consultant for Medtronic and CareFusion and a member of the data and safety monitoring board of Codman NV. Dr. Patel is consultant for Medtronic-Covidien and Penumbra. Dr. Yoo is a consultant for Neuravi and receives non–study-related clinical or research support from Penumbra.

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Conception and design: Patel, Stapleton, Leslie-Mazwi. Acquisition of data: Stapleton, Leslie-Mazwi, Torok, Hakimelahi. Analysis and interpretation of data: Stapleton, Leslie-Mazwi, Hakimelahi. Drafting the article: Patel, Stapleton, Leslie-Mazwi. Critically revising the article: all authors. Reviewed submitted version of manuscript: all authors. Approved the final version of the manuscript on behalf of all authors: Patel. Statistical analysis: Stapleton, Hakimelahi. Administrative/technical/material support: Patel, Leslie-Mazwi. Study supervision: Patel, Leslie-Mazwi.

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