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Research Article

A Study of Efficacy and Outcomes of Two Techniques of Mechanical Thrombectomy in Acute Ischemic Stroke

Tejesh Shavi[1] Paritosh Pandey[2] Ullas V Acharya[3]

[1] Department of Neurosurgery, Apollo Hospitals, Chennai, Tamil Nadu, India
[2] Department of Neurosurgery, Manipal Hospitals, Bangalore, Karnataka, India
[3] Department of Neuroradiology, Manipal Hospitals, Bangalore, Karnataka, India

Address for correspondence Tejesh Shavi, DrNB Neurosurgery, Department of Neurosurgery, Apollo Hospitals, Chennai, Tamil Nadu 600006, India (e-mail: tejesh.shavi13@gmail.com).

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Abstract

Background Endovascular mechanical thrombectomy (A Direct Aspiration First Pass Technique [ADAPT] and Solitaire stent retrieval techniques) as an emergency reperfusion therapy in acute ischemic stroke patients avoids secondary brain insult and thereby prevents permanent neurological deficits. As studies comparing the two thrombectomy procedures are scarce, we evaluated their efficacy.

Methods In this prospective observational study done at Manipal Hospitals Bangalore, 75 patients were separated into two groups based on the final reperfusion technique employed: ADAPT group with 39 patients who underwent contact aspiration technique and Solitaire group with 36 patients who underwent stent retrieval thrombectomy. The rate of successful reperfusion (modified treatment in cerebral infarction scores [mTICI]); functional outcomes (modified Rankin scale [mRS] and National Institutes of Health Stroke Scale [NIHSS]) at 24 hours, 1 month and 3 months postintervention; and the adverse events were compared between the two groups.

Results Successful reperfusion was significantly higher in the ADAPT group. Mean NIHSS and mRS scores reduced significantly postintervention for both groups, but was greater for the ADAPT group, while mortality and other adverse events were significantly greater in the solitaire group.

Conclusion Mechanical thrombectomy is an effective reperfusion therapy for acute ischemic stroke patients. Comparing the two techniques revealed better outcomes for ADAPT, than stent retrieval technique.

Keywords
- ischemic stroke
- aspiration thrombectomy
- mechanical thrombectomy
- stent retrieval thrombectomy
- reperfusion

Introduction

Stroke is the second-leading global cause of death that occurs in about 33 million people annually, and ischemic stroke accounts for approximately 2.8 million deaths.[1] The neurological deficit in stroke is because of the cerebral infarction that occurs subsequent to ischemia. However, there exists a window of time during which collateral circulation provides enough blood flow to sustain, and restoring the cerebral blood flow within this time reverses neurological deficits.[2]

Timely recanalization of the occluded vessel therefore remains the main focus of acute stroke therapy-achieved

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using intraarterial thrombolytics and modern mechanical thrombectomy techniques in the last two decades.[3,4] Several trials and a meta-analysis have reported better outcomes for mechanical thrombectomy over standard medical management alone.[3–6]

Stent retriever thrombectomy[7,8] and direct clot aspiration are the most commonly used mechanical thrombectomy techniques for reducing the time for revascularization,[5,6] while the former consists of closed-cell, self-expanding stents that are fully deployable and retrievable supplemented by balloon guide catheter inflation where necessary, the latter, called ADAPT- A Direct Aspiration, First Pass Technique, uses front-line aspiration alone to remove the thrombus through a highly trackable, atraumatic, large-bore aspiration catheter.

Controversies exist about the most relevant thrombectomy technique and additionally, studies that compared safety and effectiveness of the above two modalities are limited.[9,10] In view of the above, we aimed to compare the effectiveness of ADAPT and stent retriever techniques in acute stroke intervention.

Methods

Following a prospective observational study design, our objectives were to compare the clinical and functional outcomes using the National Institutes of Health Stroke Scale (NIHSS)[11] and the mRS (modified Rankin scale),[12] respectively, and reperfusion rates using modified treatment in cerebral infarction (mTICI) score.[13] We recruited 75 acute ischemic stroke patients undergoing mechanical thrombectomy, in our institution from May 1, 2018 to May 31, 2021 and follow-up visits were scheduled at 1 and 3 months in addition to 24 hours postintervention. The sample size was calculated, considering 95% confidence intervals, a power of 80%, and the proportion of successful recanalization after ADAPT and Solitaire stent retrieval procedure from a previous similar study.[9] Patients above 18 years of age with confirmed acute ischemic stroke on neuroimaging; those with middle cerebral artery occlusion/ intracranial internal carotid artery occlusion/ posterior circulation vessel involvement; and those treatable by mechanical thrombectomy within 24 hours of stroke onset, with bridging therapy (previous IV recombinant tissue plasminogen activator) or standalone thrombectomy were included. Whereas, those referred for acute ischemic stroke after 24hrs of stroke onset time; with mild stroke symptoms-defined by a presentation NIHSS score less than 6 without aphasia; functional dependence prior to stroke onset-defined as a pre-stroke mRS score of more than 3; and any intracranial hemorrhage were excluded. Biochemical and electrocardiographic results were recorded for patients with suspected acute ischemic stroke; NIHSS and mRS scores at presentation, magnetic resonance imaging brain and magnetic resonance angiography of the cerebral vessels, were also done. Eligibility for endovascular reperfusion therapy was determined based on the clinical profile and after ruling out known contraindications. The time of symptom onset, time of onset to femoral puncture (ictus to start of thrombectomy), and time from femoral puncture to reperfusion (start of thrombectomy to reperfusion on cerebral angiogram) were also recorded. For patients eligible for mechanical thrombectomy, an informed consent was obtained and one of the two techniques—Contact Aspiration technique (ADAPT) and Stent Retriever technique (Solitaire)—was done. Procedures were done by two operators, working together, to achieve successful reperfusion of occluded vessel at quickest possible rate and minimal complications. At least two attempts at revascularization were performed using the primary endovascular technique before switching to the other procedure (noted as rescue therapy) if needed. Antiplatelet therapy, statins, and other supportive measures were administered to all the patients irrespective of the intervention group.

The angiographic (rate of successful recanalization defined as mTICI 2c–3); clinical (degree of disability assessed by overall distribution of the mRS score at 3 months, functional independence as defined by a 3 months mRS score of 2 or lower, change in NIHSS) score at 24 hours, death due to any cause at 3 months); and adverse events (infarct in a new vascular territory, presence of intracerebral edema leading to parenchymal mass effect, intracranial hemorrhage on imaging at 24 hours, and symptomatic patients requiring decompressive craniectomy as a life-saving measure) were evaluated. For patients who were lost to follow-up (due to death) at 1 or 3 months, the condition on the last day of examination was regarded as the final follow-up. IBM SPSS version 21 was used for statistical analysis of data-unpaired t test for comparison of age, and chi-squared analysis for all the other categorical variables were done. A p-value less than 0.05 was considered significant.

Results

Demographic, angiographic, and clinical profile were obtained for 75 patients who underwent emergency endovascular mechanical thrombectomy for acute ischemic stroke. These patients were followed up at 24 hours, 1, and 3 months postintervention, for evaluating their functional outcome. Solitaire device and ADAPT technique were used in 36 (48%) and 39 (52%) patients, respectively. Basic details of the patients in the two groups are as illustrated in ►**Table 1** and as noted, the presentation findings were not significantly different between the two groups.

The mean NIHSS score preintervention and at 24 hours postintervention were significantly greater in the solitaire group. The reduction in mean score of NIHSS was significantly higher in ADAPT group (−4.72 [−6.90–−2.54) as compared to –1.61 [–4.97–1.75] in solitaire group; $p = 0.026$). The mRS scores were significantly greater for the solitaire group at all time points of measurement postintervention (►**Table 2**). A significantly greater number of patients in ADAPT group (66.7%) achieved functional independence (mRS scores ≤ 2) after 3 months, compared to solitaire group (38.4%) (odds ratio [OR] = 0.333; 95% confidence interval [CI] = 0.12–0.94; $p = 0.039$).

Table 1 Comparison of demographics and other findings between the two groups, analyzed using unpaired t-test for age and chi-squared analysis for the other categorical variables

Variable	Solitaire group ($n = 36$)	ADAPT group ($n = 39$)	*p*-Value
Age	56.4 ± 15.9	55.9 ± 17.4	0.897
Gender			
Male	15 (41.7%)	17 (43.6%)	0.867
Female	21 (58.3%)	22 (56.4%)	
Presenting complaint			
Headache	18 (50%)	8 (20.5%)	0.007[a]
Vomiting	10 (27.8%)	4 (10.3%)	0.051
Convulsions	2 (5.6%)	2 (5.1%)	0.665
Altered sensorium	31 (86.1%)	22 (56.4%)	0.005[a]
Dysarthria	33 (91.7%)	29 (74.4%)	0.048
Comorbidities			
Diabetes mellitus	19 (52.8%)	19 (48.7%)	0.726
Hypertension	22 (61.1%)	26 (66.7%)	0.616
Ischemic heart disease	6 (16.7%)	11 (28.2%)	0.233
Previous H/O stroke	2 (5.6%)	1 (2.6%)	0.944
Previous H/O venous thrombosis	0 (0%)	2 (5.1%)	0.510
Use of antithrombotic medications	6 (16.7%)	12 (30.8%)	0.153
Personal history			
Smoking	14 (38.9%)	15 (38.5%)	0.975
Alcoholism	12 (33.3%)	11 (28.2%)	0.630
Neurological examination			
Glasgow Coma Scale (GCS) score			
3 to 7	0 (0%)	0 (0%)	0.1
8 to 12	13 (36.1%)	10 (25.6%)	
13 to 15	23(63.9%)	29 (74.4%)	
Speech			
Normal	2 (5.6%)	7 (18%)	0.166
Aphasia	26 (72.2%)	8 (20.5%)	
Dysphasia	8 (22.2%)	24 (61.5%)	
Cranial nerve palsies			
III nerve	0 (0%)	1 (2.6%)	0.964
VII nerve	31 (86.1%)	39 (100%)	0.052
IX nerve	5 (13.9%)	0 (0%)	0.052
X nerve	6 (16.7%)	0 (0%)	0.260
Mean power			
Left UL	3.92 ± 1.11	3.31 ± 1.40	0.412
Left LL	4.22 ± 0.87	3.95 ± 0.83	0.173
Right UL	3.11 ± 1.14	4.38 ± 1.23	0.131
Right LL	3.75 ± 0.77	4.59 ± 0.68	0.200
Facial asymmetry	29 (80.6%)	39 (100%)	0.013[a]

(*Continued*)

Table 1 (*Continued*)

Variable	Solitaire group ($n = 36$)	ADAPT group ($n = 39$)	*p*-Value
Lab investigation findings			
Hb%			
<7 gm%	2 (5.6%)	4 (10.3%)	0.921
7–10 gm%	12 (33.3%)	14 (35.9%)	
>10 gm%	22 (61.1%)	21 (53.8%)	
Total counts			
<4,000	2 (5.6%)	6 (15.4%)	0.623
4,000–11000	23 (63.9%)	23 (59%)	
>11,000	11 (30.5%)	10 (25.6%)	
Platelet count			
<1.5 lakh	1 (2.8%)	2 (5.1%)	0.990
1.5–4 lakhs	33 (91.7%)	34 (87.2%)	
>4 lakh	2 (5.5%)	3 (7.7%)	
Prothrombin time			
<10 s	6 (16.7%)	0 (0%)	0.280
10–14 s	26 (72.2%)	27 (69.2%)	
>14 s	4 (11.1%)	12 (30.8%)	
Activated partial thromboplastin time			
<30 s	14 (38.9%)	21 (53.9%)	0.341
30–50 sec	22 (31.1%)	16 (41%)	
>50 sec	0 (0%)	2 (5.1%)	
International normalized ratio (INR)			
<0.8	2 (5.5%)	2 (5.1%)	0.430
0.8–1.1	29 (80.6%)	26 (66.7%)	
>1.1	5 (13.9%)	11 (28.2%)	
Random blood sugar			
≤200 mg/dL	15 (41.7%)	21 (53.8%)	0.291
>200 mg/dL	21 (58.3%)	18 (46.2%)	
Serum creatinine			
<0.6 mg/dL	3 (8.3%)	5 (12.8%)	0.958
0.6–1.3 mg/dL	27 (75%)	29 (74.4%)	
>1.3 mg/dL	6 (16.7%)	5 (12.8%)	
Serum sodium			
<135 mEq/L	2 (5.6%)	3 (7.7%)	0.931
135–145 mEq/L	32 (88.8%)	32 (82.1%)	
>145 mEq/L	2 (5.6%)	4 (10.2%)	
Serum potassium			
<3.5 mEq/L	2 (5.6%)	1 (2.6%)	0.454
3.5–4.5 mEq/L	32 (88.8%)	31 (79.5%)	
>4.5 mEq/L	2 (5.6%)	7 (17.9%)	
ASPECTS score	6 (7-6)	7 (8-6)	0.3

Table 1 (*Continued*)

Variable	Solitaire group ($n = 36$)	ADAPT group ($n = 39$)	*p*-Value
Site of occlusion			
Right middle cerebral artery	23 (64%)	6 (15.4%)	0.009[a]
Left middle cerebral artery	11 (30.5%)	8 (20.5%)	
Right internal cerebral artery	0 (0%)	5 (12.8%)	
Left internal cerebral artery	1 (2.8%)	13 (33.3%)	
Left vertebral artery	0 (0%)	1 (2.6%)	
Basilar artery	1 (2.8%)	6 (15.4%)	
Time from onset to puncture			
<3 hours	13 (36.1%)	19 (48.7%)	0.1
3–6 hours	18 (50%)	14 (35.9%)	
>6 hours	5 (13.9%)	6 (15.4%)	
Time from puncture to reperfusion			
<45 minutes	9 (25%)	27 (69.2%)	<0.001[a]
45–90 minutes	18 (50%)	11 (28.2%)	
>90 minutes	9 (25%)	1 (2.6%)	

Abbreviations: Hb, hemoglobin; LL, Lower Limb; UL, Upper Limb.
[a]Significant at $p < 0.05$.

Table 2 Intergroup comparison of clinical outcome—preintervention, 24 hours postictus, 1 month and 3 months, analyzed using unpaired t-test

Clinical outcome	Time of assessment	Solitaire group	ADAPT group	*p*-Value
NIHSS score	Preintervention	16.4 ± 4.98	12.3 ± 4.66	0.001[a]
	24 hours	14.8 ± 8.80	7.59 ± 5.01	<0.001[a]
	1 month	6.20 ± 3.93	4.54 ± 4.71	0.148
	3 months	4.96 ± 3.58	3.87 ± 4.45	0.308
mRS	Preintervention	$2.33 \pm .80$	$2.25 \pm .77$	0.736
	24 hours	4.08 ± 1.23	2.80 ± 1.24	<0.001[a]
	1 month	2.84 ± 1.43	1.77 ± 1.72	0.012[a]
	3 months	2.48 ± 1.48	1.46 ± 1.59	0.013[a]

Abbreviations: mRS, modified Rankin scale; NIHSS, National Institutes of Health Stroke Scale.
[a]Significant at $p < 0.05$.

A significantly higher number of patients in the ADAPT group achieved a mTICI score of 2C and 3—both at the end of all procedures, and at the end of first-line strategy alone (►**Table 3**). All-cause mortality at 3 months was significantly greater in the solitaire group (27.8 vs. 0%; $p = 0.015$), but the computed tomography scan findings were not (►**Table 4**). Further, decompressive craniotomy was done in 30.6 and 20.5% of the patients in the solitaire and ADAPT groups, respectively ($p = 0.318$).

Discussion

Recanalization and reperfusion strategies form the mainstay of treatment for acute ischemic stroke, as they reverse the neurological deficits by reopening of the occluded vessel. As a majority of the reperfusion therapy trials used stent retriever techniques, questions regarding the safety and efficacy of aspiration thrombectomy techniques as a first-line therapy remained unaddressed, owing to the limited literature. Therefore, we compared the two techniques for patients with acute ischemic stroke and large vessel occlusion.

Angiographic Outcome

As per previous literature that reported an mTICI score of 2c or 3 as successful revascularization,[14,15] we compared it between the two groups for angiographic outcome. Overall, as 65 patients from both groups showed successful revascularization, mechanical thrombectomy can be

Table 3 Intergroup comparison of rate of successful recanalization, analyzed using chi-squared analysis

Outcome	Solitaire	ADAPT	Risk difference, % (95% CI)	Odds ratio (95% CI)	*p*-Value
Successful recanalization at the end of all procedures					
mTICI score of 3 ($n = 10$)	1 (2.8%)	9 (23.1%)	−20.3 (−34.6 to −6.0)	0.095 (0.011–0.796)	0.03[a]
mTICI score 2C & 3 ($n = 65$)	26 (72.2%)	39 (100%)	−27.8 (−42.4 to −13.2)	0.032 (0.002–0.569)	0.019[a]
Successful recanalization at the end of first-line strategy alone					
mTICI score of 3 ($n = 6$)	1 (2.8%)	5 (12.8%)	−10 (−21.8 to 1.8)	0.194 (0.022–1.751)	0.144
mTICI score 2C & 3 ($n = 41$)	11 (30.6%)	30 (76.9%)	−46.3 (−66.3 to −26.3)	0.132 (0.047–0.369)	<0.001[a]
Use of rescue treatment ($n = 34$)	25 (69.4%)	9 (23.1%)	46.3 (26.2–66.4)	7.58 (2.71–21.19)	<0.001[a]

Abbreviations: CI, confidence interval; mTICI, modified treatment in cerebral infarction
[a]Significant at $p < 0.05$.

Table 4 Intergroup comparison of CT scan findings at 24 hours postintervention and mortality at 3 months, analyzed using chi-squared analysis

CT scan findings	Solitaire group ($n = 36$)	ADAPT group ($n = 39$)	*p*-Value
Normal	16 (44.4%)	28 (71.8%)	0.249
Bleed	5 (13.9%)	4 (10.3%)	
Mass effect	10 (27.8%)	5 (12.8%)	
Infarct (new)	5 (13.9%)	2 (5.1%)	
All-cause mortality at 3 months	10 (27.8%)	0 (0%)	0.015[a]

Abbreviation: CT, computed tomography.
[a]Significant at $p < 0.05$.

considered an effective reperfusion strategy. In addition, the greater revascularization within the ADAPT group is similar to that demonstrated in a study by Lapergue et al[9] that showed a 16.5% greater success rate within the ADAPT group (82.3 vs. 68.9%; $p = 0.022$). On the contrary, ASTER trial[10] found no significant difference between contact aspiration and stent retriever groups. However, higher rate of successful revascularization for ADAPT in our study could be attributed to the following reasons: most of the patients in the ADAPT group (48.7%) presented earlier than 3 hours as compared to Solitaire group (36.1%) leading to the assumption of formation of organized clot and difficult clot retrieval in the Solitaire group (however statistically this was not proven to be significant as highlighted in ►**Table 5**); second, as stent retriever requires passing it through the clot, it might result in a higher rate of distal emboli, leading to incomplete revascularization. Third, repeated use of old stent devices in patients could also lead to inefficient clot retrieval and revascularization

Table 5 Distribution by time gap from onset to reperfusion

Time gap from onset to reperfusion		Technique of mechanical thrombectomy		Total ($n = 75$)	*p*-Value
		Solitaire group ($n = 36$)	ADAPT group ($n = 39$)		
Time from onset to femoral puncture	<3 hours	13 (36.1%)	19 (48.7%)	24 (32%)	0.1; NS
	3 to 6 hours	18 (50%)	14 (35.9%)	27 (36%)	
	>6 hours	5 (13.9%)	6 (15.4%)	24 (32%)	
Time from femoral puncture to reperfusion	<45 minutes	9 (25%)	27 (69.2%)	36 (48%)	<0.001; S
	45 to 90 minutes	18 (50%)	11 (28.2%)	29 (38.7%)	
	>90 minutes	9 (25%)	1 (2.6%)	10 (13.3%)	

Abbreviations: NS, not specified; S, specified.

Clinical Outcome

Almost half of the patients in our study (36/75) attained functional independence at 3 months matching the results of endovascular treatment for Small Core and Anterior circulation Proximal occlusion with Emphasis on minimizing CT to recanalization times (ESCAPE) trial (53%).[16] Unlike our study, Contact Aspiration Versus Stent Retriever for Successful Revascularization (ASTER) trial[10] could not depict a significant difference in the NIHSS score at 24 hours between the two techniques of thrombectomy.

The degree of disability in the present study was also lesser for patients within the ADAPT group reflected through lesser mRS scores and a favorable shift at 3 months (OR = 1.502).

According to the reperfusion hypothesis, reversal of penumbra is possible with restoration of blood flow, hence thrombectomy when done within this viable time window, is capable of reversing the mRS scores as well. Further, the revised 2018 American Heart Association/American Stroke Association guidelines recommend- stent retriever thrombectomy, even when done for patients presenting after 24 hours assures good clinical outcomes.[17] This justifies the better postintervention outcomes depicted in the patients within both groups of our study.

Mortality

The overall mortality rate of 13% at 3 months in our study is almost similar to that in the EXTEND 1A (9%)[3] and ESCAPE (10.4%)[16] trials. It was significantly greater in the solitaire group.

Adverse Events

More number of patients within the solitaire group in our study had adverse events, namely, development of intracranial bleed, new ischemic strokes, and development of mass effect secondary to cerebral edema—in line with previous studies by Kowoll et al,[18] Turk et al,[19] and Blanc et al[20] that found greater proportion of symptomatic hemorrhages, and lower rates of embolization and symptomatic intracranial hemorrhages, respectively, for contact aspiration. The number of patients who underwent decompressive craniectomy in our study (25%) was greater than that in another study (12%).[10] Some limitations of our study include smaller sample size; not being a blinded trial; significantly higher baseline NIHSS score in the Solitaire group, which may have affected the outcome; and a short follow-up period that prevents drawing concrete conclusions.

Conclusion

Within the above limitations, the overall clinical outcome was good irrespective of the mechanical thrombectomy technique employed, but better results in terms of functional and angiographic outcomes were obtained in favor of ADAPT. Future studies with larger sample size, longer follow-up period, and those that determine the effectiveness of the intervention at various sites of vessel occlusion through a subgroup analysis are recommended.

Conflict of Interest
None declared.

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