Initial Results of a Direct Aspiration First-Pass Technique to Treat Acute Ischemic Stroke Patients in Nepal

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AJNS 2023;18:75–79.

Abstract

Objective Endovascular therapy has become the mainstay of treatment of acute ischemic stroke (AIS) due to large vessel occlusion. A direct aspiration first-pass technique (ADAPT) using large bore aspiration catheters has been introduced as a rapid, simple method for achieving good revascularization and good clinical outcomes. The aim of this study was to assess the safety and efficacy of ADAPT in the treatment of AIS due to large-vessel occlusion in the Nepali patient population.

Materials and Methods Retrospective data were collected for all consecutive patients treated for AIS with ADAPT from March 2019 through January 2021 at two hospitals. Outcomes were successful revascularization (modified thrombolysis in cerebral infarction score of 2b-3), time to revascularization, procedural complications, and good clinical outcome (modified Rankin Scale score of 0 to 2) and mortality at 90 days.

Statistical Analysis Retrospective data were collected and descriptive statistics were calculated.

Results Sixty-eight patients treated for AIS with ADAPT were included. The median National Institutes of Health Stroke Scale score at presentation was 13 (IQR 10–13.25). The median time from arterial puncture to revascularization was 40 minutes (IQR 30–45). Successful revascularization was achieved in 54 patients (79.4%). No cases of symptomatic intracranial hemorrhage occurred. At 90-day follow-up, good clinical outcome was achieved in 57 patients (83.8%), and 4 patients died (5.9%).

Conclusion A direct aspiration first pass technique appears to be a fast, simple, safe, and effective method for the management of AIS in the Nepali patient population.

Keywords
- ADAPT
- endovascular procedure
- ischemic stroke
- LMIC
- stroke
- thrombectomy

article published online
March 27, 2023

DOI https://doi.org/10.1055/s-0043-1761233.
ISSN 2248-9614.

Thieme Medical and Scientific Publishers Pvt. Ltd., A-12, 2nd Floor, Sector 2, Noida-201301 UP, India

Key Messages

- Mechanical thrombectomy has only recently become regularly available in Nepal. We report our initial experience with a direct aspiration first-pass technique (ADAPT) in the treatment of acute ischemic stroke.
- The rate of successful revascularization after all treatments was 79.4%, and the rate of good clinical outcome at 90-day follow-up was 83.8%.
- A direct aspiration first pass technique (ADAPT) appears to be a fast, simple, safe, and effective method for the management of acute ischemic stroke in the Nepali patient population.

Introduction

Stroke is a leading cause of death and disability in high-income countries and low- and middle-income countries (LMICs). Stroke causes nearly 5.5 million deaths every year and 116.4 million global disability-adjusted life-years.[1] During the past several decades, the burden of stroke in the world has shifted from high-income countries to LMICs.[1] Nepal is an LMIC struggling to reduce its extreme social inequality, which is reflected in the shortage of healthcare infrastructure, especially for low-income people who depend exclusively on the public health system. According to a report published in 2012, stroke is a major cause of death and is one of the top five diseases in Nepal based on disability-adjusted life years.[2]

In the past few years, the treatment of acute ischemic stroke (AIS) has been revolutionized after the near-simultaneous publication of several randomized trials that demonstrated the efficacy of mechanical thrombectomy in AIS patients with emergent large vessel occlusion.[3–8] Mechanical thrombectomy was not regularly offered at any center in Nepal until 2018 because of the absence of trained personnel. Since March 2019, a dedicated interventional neuroradiologist (S.P.) has performed endovascular stroke management at two of the largest tertiary care hospitals in Kathmandu, Nepal. The aim of this study was to report our initial experience in Nepal with a direct aspiration first-pass technique (ADAPT) using large-bore aspiration catheters in the treatment of AIS due to large-vessel occlusion.

Materials and Methods

Ethical approval for this study was obtained from the Institutional Review Boards at Grande International Hospital and Upendra Devkota Memorial National Institute of Neurological and Allied Sciences. Retrospective data were collected for all consecutive patients treated with ADAPT for AIS due to large vessel occlusion from March 2019 through January 2021 at these hospitals.

Pre-Procedure Clinical and Radiological Assessment

The stroke severity was assessed and documented by the National Institutes of Health Stroke Scale score (NIHSS) once the patient arrived at the hospital. A non-contrast computed tomography (NCCT) brain scan or magnetic resonance imaging (DWI and FLAIR) was promptly performed to evaluate the extent of brain parenchymal injury and assign a baseline Alberta Stroke Program Early CT Score (ASPECTS).[9] To assign ASPECTS, we preferred MRI over CT as MRI-DWI is easily readable by less-experienced medical personnel. Vascular imaging (CT angiography or MR angiography) was then performed to assess the presence and site of artery occlusion and collaterals. Computerized tomography perfusion or MR perfusion was not performed owing to the lack of RAPID software in our hospitals and because for most cases, our current imaging protocol provided sufficient information for us to decide on the treatment.

According to institutional protocol, all patients whose stroke onset to admission time was within 4.5 hours received bridging therapy with intravenous recombinant tissue plasminogen activator (IV tPA) if they were eligible. For patients with wake-up stroke, posterior circulation stroke, or a stroke onset to admission time of six to 24 hours, mechanical thrombectomy was performed for those patients who had a presumed large penumbra, defined as clinical/diffusion mismatch and MR-ASPECTS greater than five.

Neurointerventional Procedure

All mechanical thrombectomy procedures were performed by the neurointerventional team, which provides 24/7 coverage for emergency care. The type of anesthesia (local anesthesia with or without intravenous conscious sedation) for each case was determined according to the patient's clinical condition and was agreed upon by the anesthesiologist and interventional neuroradiologist.

All procedures were performed through an 8-F short femoral sheath with an 8-F guide catheter (Neuron MAX, Penumbra, Inc., Alameda, CA, USA), which was continuously perfused with a solution of 10 ml of nimodipine and 1,000 IU of heparin diluted in 1,000 mL of 0.9% saline solution. Mechanical thrombectomy was performed using ADAPT with an ACE 68 or JET 7 reperfusion catheter (Penumbra, Inc.). Our standard clinical practice is to perform only ADAPT in the internal carotid artery (ICA), tandem ICA/middle cerebral artery (MCA), proximal M1 MCA, proximal M2 MCA, and basal artery; ADAPT plus a stent retriever in the distal M1 MCA (as, in our experience, the clot tends to migrate distally if only aspiration thrombectomy is performed in that location); and only a stent retriever in the posterior cerebral artery. Successful revascularization was defined as modified thrombolysis in cerebral infarction score (mTICI) of 2b-3 as seen in digital subtraction angiography (DSA). If two aspiration passes were not sufficient to achieve successful revascularization, rescue therapy with a stent retriever (Solitaire, Medtronic, Inc., Irvine, CA, 107 USA) was performed (i.e., Solumbra technique) or, in patients who could not afford to buy a stent retriever or for whom a stent retriever was not available, a third aspiration pass with the same aspiration catheter was performed.

Post-Procedure Clinical and Radiological Assessment

An NCCT brain scan was performed in all patients immediately after the thrombectomy and 24 to 48 hours after the treatment. Clinical outcome was assessed by the modified

Rankin Scale score (mRS) at discharge and 90-day follow-up; an mRS of zero to two was considered a good clinical outcome.

Statistical Analysis

Stroke severity was categorized by the baseline NIHSS as mild (6–10), moderate (11–15), or severe (> 15). Median and IQR were calculated for numeric variables as appropriate. Percentage and count were reported for categorical variables. All statistical analyses were performed by using Excel (Microsoft Corp., Redmond, WA, USA).

Results

Sixty-eight AIS patients treated with ADAPT were included—43 (63.2%) from Grande International Hospital and 25 (36.8%) from Upendra Devkota Memorial National Institute of Neurological and Allied Sciences (►**Table 1**). The median patient age was 56 years (IQR 47.5–70) and 46 patients (67.6%) were male. The median stroke onset to admission time was 4.5 hours (IQR 3–6.25). Thirty-three patients (48.5%) presented within 4.5 hours of stroke onset and received bridging therapy with IV tPA. The median baseline NIHSS was 13 (IQR 10–13). Stroke severity, based on baseline NIHSS, was mild in 18 patients (26.5%), moderate in 44 patients (64.7%), and severe in 6 patients (8.8%). For all patients, the median baseline ASPECTS was seven (IQR 6–7.25); for the 63 patients with anterior circulation occlusion, the median baseline ASPECTS was also seven (IQR 6.0–7.5). Most patients (63; 92.6%) had an ASPECTS of at least six; the remaining five patients (7.4%) had an ASPECTS of five. Among patients with anterior circulation stroke, 33 patients had right-sided occlusion and 30 patients had left-sided occlusion.

All procedures were performed under local anesthesia, with conscious sedation in most patients (53, 77.9%; ►**Table 2**). The aspiration catheter was ACE 68 for 47 patients (69.1%) and JET 7 for 21 patients (30.9%). The median procedure time (puncture to revascularization) was 40 minutes (IQR 30–45). Successful revascularization was achieved after first-pass aspiration in 18 patients (26.5%) and after second-pass aspiration in an additional 32 patients (47.1%), for a total of 50 patients (73.5%). Of the remaining 18 patients, rescue therapy with a stent retriever was performed in 8 patients (11.8%) and a third aspiration pass was performed in the other 10 patients (14.7%).

After all treatments, successful revascularization was achieved in 54 patients (79.4%); 9 patients (13.2%) had mTICI 2a and 5 patients (7.4%) had mTICI 1. Near-complete revascularization (mTICI 2c-3) was achieved in 47 patients (69.1%). Two patients (5.9%) had a small subarachnoid hemorrhage observed on follow-up CT; however, no cases of symptomatic intracranial hemorrhage occurred.

Fifty-seven patients (83.8%) had good clinical outcomes (mRS of 0–2) at 90-day follow-up. Seven patients (10.3%) had an mRS of 3 to 5. Four patients (5.9%) had died (mRS of 6) at 90-day follow-up. Three of those patients had posterior circulation strokes. In two of the patients with posterior circulation stroke, adequate recanalization was not achieved despite rescue therapy (post-procedure TICI 1 in both patients). The third patient with posterior circulation stroke presented to the hospital late (10 hours after the onset) and developed a rapidly increasing mass effect due to cerebellar infarct. One patient with anterior circulation stroke died; this patient had borderline ASPECTS (5), a high-moderate baseline NIHSS (14), and a late presentation to the hospital (7 hours after onset).

Table 1 Baseline data for patients treated with a direct aspiration first-pass technique (ADAPT) for acute ischemic stroke due to large vessel occlusion

ADAPT ($N = 68$)	
Hospital	
Grande International Hospital	63.2% (43/68)
UDMNINAS	36.8% (25/68)
Age, y (median [IQR])	56.0 (47.5–70.0)
Sex, M	67.6% (46/68)
Stroke onset to admission time, hours (median [IQR])	4.50 (3.00–6.25)
≤ 4.5*	48.5% (33/68)
> 4.5 to 6	26.5% (18/68)
> 6	25.0% (17/68)
NIHSS at presentation	13.00 (10.00–13.25)
6–10 (mild AIS)	26.5% (18/68)
11–15 (moderate AIS)	64.7% (44/68)
> 15 (severe AIS)	8.8% (6/68)
ASPECTS at presentation	7.00 (6.00–7.25)†
5	7.4% (5/68)
6–10	92.6% (63/68)
Occlusion site	
Tandem	7.3% (5/68)
ICA occlusion	19.1% (13/68)
M1 MCA only	63.2% (43/68)
M2 MCA only	2.9% (2/68)
Posterior circulation	7.4% (5/68)
Anterior circulation stroke side	63
Right-sided	52.4% (33/63)
Left-sided	47.6% (30/63)

Abbreviations: AIS, acute ischemic stroke; ASPECTS, Alberta Stroke Program Early CT Score; ICA, internal carotid artery; MCA, middle cerebral artery; NIHSS, National Institutes of Health Stroke Scale score; UDMNINAS, Upendra Devkota Memorial National Institute of Neurological and Allied Sciences.
Note: Values are presented as median [IQR] or percentage (n/N)
*Patients within this time window received bridging intravenous recombinant tissue plasminogen activator.
†For all patients; 7.0 (6.0–7.5) for the 63 patients with anterior circulation occlusion.

Table 2 Procedural data and outcomes for patients treated with a direct aspiration first pass technique (ADAPT) for acute ischemic stroke due to large vessel occlusion

ADAPT ($N = 68$)	
Conscious sedation	77.9% (53/68)
Aspiration catheter	
ACE 68	69.1% (47/68)
JET 7	30.9% (21/68)
Puncture to revascularization time, min (median [IQR])	40 (30–45) (range, 20–55)
mTICI 2b-3 after first pass aspiration	26.5% (18/68)
mTICI 2b-3 after first or second pass aspiration	73.5% (50/68)
Rescue therapy (stent retriever)	11.8% (8/68)
mTICI after all treatments	
3	54.4% (37/68)
2c	14.7% (10/68)
2b	10.3% (7/68)
2a	13.2% (9/68)
1	7.4% (5/68)
2c-3	69.1% (47/68)
2b-3	79.4% (54/68)
Complications	
Subarachnoid hemorrhage	5.9% (4/68)
Symptomatic intracranial hemorrhage	0.0% (0/68)
mRS at 90-day follow-up	
0–2	83.8% (57/68)
3–5	10.3% (7/68)
6	5.9% (4/68)

Abbreviations: mRS, Modified Rankin Scale score; mTICI, modified thrombolysis in cerebral infarction scale.
Note: Values are presented as median (IQR) or percentage (n/N)

Discussion

In our initial experience of using ADAPT in the treatment of 68 patients with AIS due to large vessel occlusion, we found that ADAPT was a safe and effective method with a short procedure time, a high revascularization rate, a low procedural complication rate, and a high functional outcome rate. Our median puncture to revascularization time of 40 minutes was equivalent to those reported in previous studies (28–72 min).[10] Our high rate of successful revascularization (79.4%) was also consistent with revascularization rates reported previously (82–85%).[10,11] Our rate of good clinical outcome (mRS of 0–2) at 90 days (83.8%) was higher than those rates published previously (45–53%).[5,10,11] Our successful revascularization rate was also comparable to results from recent studies performed in other LMICs (72–81%), and our rate of good clinical outcome at 90 days was higher than the results from those other studies (50–56%).[12,13]

Our median stroke onset to admission time (4.5 hours) was on the high side of those times reported previously (1 to 5 hours).[14,15] Our long stroke onset to admission time is attributable to low public and physician awareness of AIS, the absence of proper infrastructure for patient transport, and delayed interdepartmental communication that results in delays in initial stroke assessment.

We opted for ADAPT over primary stent retriever thrombectomy because recent clinical studies demonstrated that aspiration thrombectomy had significantly lower costs[16,17] while maintaining equivalent or better outcomes than primary stent retriever thrombectomy.[11,16,17] In particular, a randomized, blinded outcome study comparing aspiration thrombectomy and stent retriever thrombectomy as the first-line treatment reported that aspiration thrombectomy was non-inferior to stent retriever thrombectomy for good functional outcome and that aspiration thrombectomy cost substantially less than stent retriever thrombectomy.[16] Cost-effective treatments are especially of interest in Nepal, as most of the population is low- or middle-income and much of that population depends on the public health system. Aspiration thrombectomy rather than stent-retriever thrombectomy may reduce healthcare costs and allow greater health care access for patients without private insurance. Moreover, ADAPT is less technically complex than stent retriever thrombectomy and has no wait time for device integration into the thrombus, which may reduce procedure time,[10] thus leading to increased salvage of ischemic area and reduced neurological damage.[18]

The strengths of this study are that all consecutive patients were included and that all the procedures were performed by a single operator. Limitations of this study are that it was a dual-center retrospective study and that it lacked a blinded assessment of angiographic and clinical outcomes.

To provide widespread endovascular therapies for AIS in Nepal, our short-term plan is to increase awareness of stroke among the public and physicians. Increasing public awareness of AIS is of utmost importance to decrease the time between symptom onset and presentation to a hospital with the facilities to treat stroke and thus improve outcomes.[19] A heterogeneous group of hospital-based physicians from emergency, ICU, neurology, and radiology departments must be trained to promptly diagnose AIS and quickly initiate a response. Accordingly, we must also alleviate the deficiency in the number of personnel trained in AIS treatment.

Our long-term plan is to develop primary and comprehensive stroke centers to provide adequate coverage to the Nepali population. A primary stroke center must have a 24/7 on-call neurologist, emergency physician, and functional radiology department (for cross-sectional and vascular imaging); adequate facilities to administer IV tPA in eligible

patients; and proper protocol and infrastructure to quickly transfer a patient to a comprehensive stroke center that offers mechanical thrombectomy.[20,21] A comprehensive stroke center, in addition to having the facilities of a primary stroke center, must also have 24/7 coverage by an interventional neuroradiologist, a neuro-capable ICU, a dedicated stroke neurology team, and competent neurosurgical backup to provide complete care to AIS patients. Each comprehensive stroke center must have its catchment primary stroke centers clearly delineated.[20,21]

In conclusion, in our initial experience of treating 68 patients with AIS due to large-vessel occlusion, we found that ADAPT appeared to be fast, simple, safe, and effective in the Nepali patient population, with findings that were comparable with those from previous studies.

Ethical Approval

The manuscript conforms to the Declaration of Helsinki.

Funding

Penumbra, Inc. (Alameda, CA, USA) funded medical writing, editorial, and data analysis and preparation support.

Conflict of Interest

None declared.

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