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Single-Center Experience Using the STENT RETRIEVER for the Treatment of Acute Ischemic Stroke with Distal Arterial Occlusions (M2, M3, A2, and P2 segments)

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Abstract

Background and Purpose— Endovascular treatment is the standard of care for the treatment of proximal large arterial occlusion related ischemic strokes. Patients with acute ischemic stroke in the anterior circulation are at risk for either primary or, following mechanical thrombectomy, secondary occlusion of the distal arteries. The safety and efficacy of endovascular treatment in the treatment of distal intracranial occlusions has not been well studied.

Methods— From an institutional database we selected consecutive patients treated with stent retriever for distal arterial occlusions. Recanalization success was measured by applying the Thrombolysis in Cerebral Infarction (TICI) score. To assess safety, we recorded device-related procedural events and potentially device-related hemorrhages on follow-up imaging. Infarcts in the dependent territory served as a measure for efficacy. Distal arterial occlusions were defined as any segment beyond anterior communicating [ACOM] in anterior cerebral artery (ACA), beyond posterior communicating [PCOM] in posterior cerebral artery, or occlusion at or distal to the middle cerebral artery (MCA)-M2 segment.

Results— Of 330 patients included in this analysis, we identified 42 (12%) patients with distal arterial occlusions. The recanalization rate with use of a stent retriever was 81% in these 42 patients. Periprocedural complications included vasospasms (n = 3, 7.1%) and distal embolization (n = 2, 4.8%). Asymptomatic post-thrombectomy intracerebral hemorrhages were seen in 9.52% (4/42) of the patients. At 90 days, functional independence (defined by modified Rankin scale of 0-2) was achieved in 88.7% (36/42) of patients with distal arterial occlusions.

Conclusions— Endovascular treatment using stent retrievers results in high rates of recanalization and functional independence in ischemic stroke patients with distal arterial occlusions.

INTRODUCTION

Endovascular recanalization of large arterial occlusion with stent retrievers is one of the evidence-based treatments for acute ischemic stroke. Five randomized trials demonstrated that endovascular treatment in combination with standard medical measures was superior to medical treatment alone in reducing death or disability in ischemic stroke patients [1-5]. Embolic occlusion of vessels smaller than 2 mm is frequently encountered during mechanical thrombectomy and may reflect either extension of a thrombus from a larger vessel into a distal smaller branch or spread of thrombus material due to fragmentation during the procedure. Patient may present distal arterial occlusions which may result in disability if branches supplying eloquent brain tissue are affected. Although large studies have evaluated mechanical thrombectomy in proximal large arterial occlusions, [6-7] there are few reports of endovascular treatment for distal arterial occlusions. We review our single-center experience of thrombectomy distal arterial occlusions.

MATERIALS AND METHODS

Patient Selection

We used a prospectively collected patient cohort with acute ischemic stroke undergoing endovascular treatment in the anterior circulation at our institution between June 2015 and September 2019. We selected patients with distal arterial occlusions for this retrospective analysis. All eligible patients

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TABLE 1: Baseline characteristics of patients with distal arterial occlusions.

Characteristics	Patients (N = 42)
Age (yr), mean (SD)	62.8±12.4 years [Range 32–78 years]
Women	38.09% (16/42)
Hypertension	46.61% [20/42]
Diabetes mellitus	11.90% [05/42]
Atrial fibrillation	19.04% [08/42]
Coronary artery disease	11.90% [05/42]
Cigarette smoking	23.80%[10/42]
Hyper cholesterolemia	9.52% [04/42]
Initial NIHSS score [median]	15 [10-18]
ASPECT score	
CT brain	9-10
MRI brain	8-10
Intravenous tPA	90.42 (38/42)
Time from stroke onset to groin puncture (min), median (IQR)	210 [138-288]

TABLE 2: List of types, manufacturers, and number of devices used for mechanical thrombectomy.

Device	Size	Number
ERIC MicroVention	4 x 24	01
Revive Codman	4.5 x 22	34
Solitaire FR Covidien	4 x 20	05
Trevo ProVueStrykere	4 x 20	02

received intravenous tPA (tissue-type plasminogen activator) according to the standard guidelines. Patients were selected based on clinical examination and a standard imaging protocol including NCCT/CTA and MRI/MRA. Treatment decisions were made by the neuroendovascular and stroke teams based on the clinical symptoms and neuroimaging data about the viability and eloquence of the involved vascular territories. In general, patients with persistent disabling deficits despite intravenous tPA and evidence of proximal or distal occlusion accounting for their symptoms were taken to angiographic suite. We did not delay treatment for intravenous tPA treatment response. All cases were done within 6 hrs of stroke onset. No age limit was used as an inclusion or exclusion criterion for eligibility for endovascular treatment, and the decision to perform endovascular treatment was made on the basis of the patient's comorbidities, pre stroke mRS, and choice of the patient and/or family. Intra procedural use of mechanical and/or pharmacologic treatments remained at the discretion of the treating interventionist. Micro catheters and stent retrievers used for endovascular treatment in this patient cohort were subject to change due to technical development during the observation period. Procedures were performed with the patient under conscious sedation. Follow-up imaging (either NCCT or MR imaging) was routinely performed at 1–24 hours after treatment. Post interventional NIHSS and mRS scores were assessed by detailed physical examinations performed by stroke neurologist at discharge. Follow-up data after 3 months were obtained by an in-patient visit or a telephone call by a neurologist. Distal arterial occlusions were defined as any segment of the anterior cerebral artery (ACA) beyond ACOM, any segment of posterior cerebral artery (PCA) beyond PCOM, or occlusion at or distal to the middle cerebral artery (MCA)-M2 segment.[8] We further divided the distal arterial occlusions into primary occlusions, where the distal vessel was the original target of the endovascular treatment, and secondary occlusions, where after endovascular treatment for a proximal large vessels occlusion a distal occlusion was visualized in the previously involved territory or in an uninvolved territory that was then treated with endovascular treatment.[9] We have only included primary distal arterial occlusions in our analysis.

Data Collection

Data collection included baseline demographics (age and sex) and medical history (eg, hypertension, coronary artery disease, congestive heart failure, atrial fibrillation, diabetes mellitus, hypercholesterolemia, cigarette smoking, and previous stroke) and time interval between symptom onset and treatment and stroke severity as measured by the NIHSS score. The time of initiation of stroke imaging and the time of start of mechanical thrombectomy were captured automatically by the CT scanner and angiographic unit. The stroke onset was considered as occlusion onset time and time of recanalization were evaluated according to the time stamp of the relevant angiographic images.

Devices and medication used during the interventional procedures, number of thrombectomy maneuvers, and intra procedural complications were evaluated according to the treatment protocols. Angiographic recanalization was graded by Thrombolysis in Cerebral Infarction (TICI) score and complications (eg, vessel perforation or dissection) were assessed by a neuro interventionist. Occurrence of cerebral infarction or parenchymal hemorrhage (by criteria of the second European-Australasian Acute Stroke Study [ECASS] [10] or subarachnoid hemorrhage were assessed after review of routinely performed follow-up neuroimaging.

Data analysis/statistics

Descriptive statistics included the number of observations, mean and SD, and median and IQR for continuous variables, and counts and percentages for discrete variables.

Results

Between June 2015 and April 2019, 350 patients underwent endovascular treatment for acute ischemic stroke at our institution. Among the 350 patients, we identified 42 (12%) with primary distal arterial occlusions. The mean age of these patients was 62.8±12.4 years (range 32–78 years); 38.09% (16/42) of the cohort were women. The median NIHSS score was 15 (IQR 10–18) and median ASPECT score was 9 (IQR 8–10). Intravenous tPA was administered in 90.42% (38/42) of all patients before mechanical thrombectomy. Four patients did not receive IV rtPA because of contraindications. The baseline characteristics of all patients with distal occlusions are shown in Table -1.

Distal arterial occlusions were seen in middle cerebral artery, anterior cerebral artery, and posterior cerebral artery in 42% (30/42), 9.52% (04/42), and 19.04% (08/42) of patients, respectively. A total of 9.52% (4/42) had an isolated M3 occlusion, 52.38% (22/42) had isolated M2 occlusions, 9.52% (04/42) had M2 and M3 occlusions, 9.52% had A2-A3 and 19.04% had P2-P3 occlusions. Most of the distal arterial occlusions were on left side of the brain. A total of 66.66% (28/42) of distal arterial occlusions were treated within one pass; 23.8% (10/42) required two passes; and 9.52% (04/42) needed a third pass.

Mechanical thrombectomy with a stent retriever was the aim for all patients (see Figures 1 and 2), but a stent retriever could not be deployed in 3/42 patients (9.52%), because of tortuous ICA in two patients. Placement of a micro catheter behind the thrombus was not possible in one patient and we were not able to place wire in target artery in one patient. Deployment of a stent retriever and mechanical thrombectomy was performed in 38/42 (90.5%) patients (for type and manufacturer of the devices used as well as the number of maneuvers performed, see Table 2).

A total of 81% (34/42) of patients underwent successful revascularization in the M2-M3, A2-A3 and P2-P3 territory; mTICI grade 3 was observed in 71.5% (30/42) of patients. Time from stroke onset to groin puncture was 210 [210-288] (min), median (IQR) and median time from groin puncture to revascularization was 41.5 min (IQR 20–55), At discharge, the median final NIHSS score was significantly reduced to 4 (IQR 3–5). At 90 days, functional independence was achieved in 88.7% (36/42) of patients with distal arterial occlusions.

There were 7.1% (3/42) cases of vasospasms in the distal arteries following a retrieval maneuver in the superior/inferior division M3 segment (n = 2) and the PCA P3 artery (n = 1). The vasospasms resolved completely after intra-arterial administration of nimodipine into the affected segment via a microcatheter. Vessel perforations or dissections were not observed but distal embolization was seen in 4.8% (2/42) of the patients. Asymptomatic post-thrombectomy intracerebral hemorrhages were seen in 9.52% (4/42) of the patients.

DISCUSSION

We report a series of patients who underwent thrombectomy with the stent Retriever for the treatment of distal arterial occlusions. Despite using the stent retriever in medium diameter vessels, we observed good recanalization rates and no significant intraprocedural complications. Similar results were observed in a retrospective stud with IV tPA and endovascular treatment in M2 occlusion.[11,12] The risk of peri-procedural complications demonstrated in our series with mechanical thrombectomy in distal arterial occlusions does not seems to be higher than that reported with large arterial occlusion in MCA-M1.[13] Our analysis has several limitations. First, the study was designed as a retrospective study. Second, this was single center case series of mechanical thrombectomy procedures performed with undefined biases in patient selection. Thus, our data may not be generalizable to other practices. Thirdly, because occlusions were treated with different revascularization devices, a recommendation of a specific device for treatment of distal arterial occlusions is not possible. We used stent retriever as the primary treatment modality but thrombectomy may be feasible even with a direct-aspiration first-pass technique. [14] The smaller diameter and pronounced kinking of a distal arteries should be taken into account when choosing catheters and devices to minimize distortion of the vessel wall. A prospective study with comparison of intravenous tPA only and thrombolysis with mechanical thrombectomy for distal arterial occlusions is required to prove the relative superiority of mechanical thrombectomy in distal arterial occlusions.

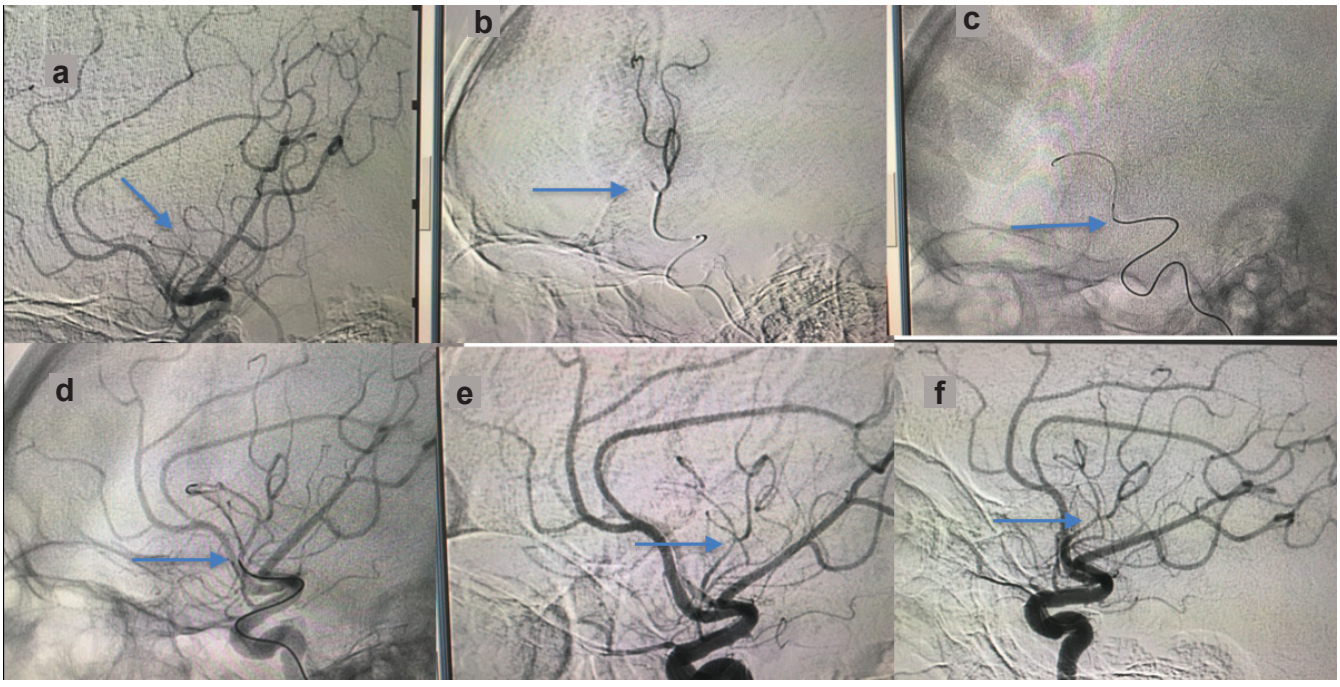

FIGURE 1: [a] Lateral projection shows pre-central and central artery occlusion, [b] micro-catheter angio shows M3 occlusion, [c, d] micro-catheter and stent retriever deployment in the M3 segment and proximal landing zone in M2, [e] complete recanalization of superior division MCA branch M3 with vasospasm and [f] vasospasm improved after nimodipine intra-arterial injection.

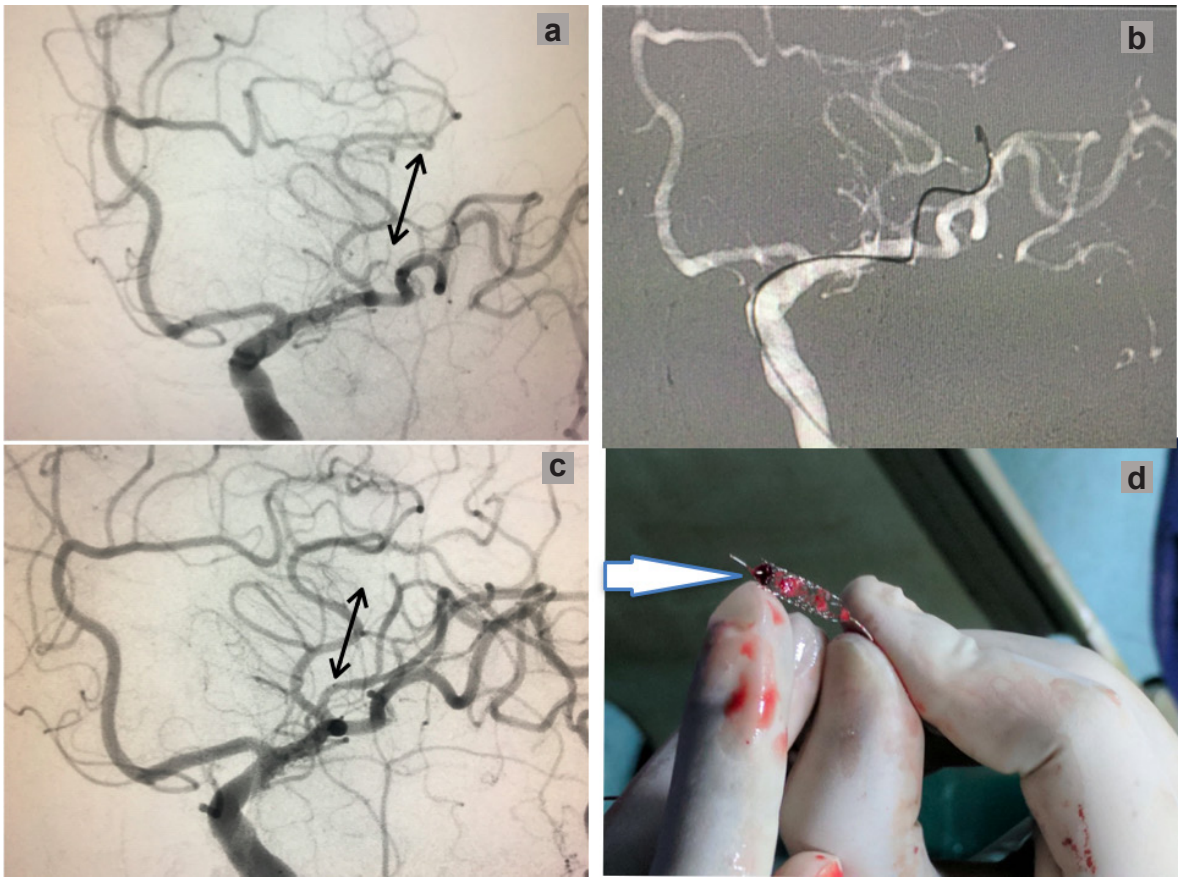

FIGURE 2: The patient was refered for the treatment of a left M1 occlusion after failure of intravenous thrombolysis. On DSA there was an embolic occlusion of tha angular artery [a]. A Revive 4.5 x 4 was deployed starting in the M3 segment with the proximal landing zone in M2 [b]. A TICI 3 result was achieved after thrombectomy [c]. Soft red clot with stent retriever [d].

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