ENDOVASCULAR INTERVENTION FOR ACUTE ISCHEMIC STROKE AT CAN THO UNIVERSITY OF MEDICINE AND PHARMACY HOSPITAL

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ABSTRACT

Introduction: *Acute cerebral ischemic stroke is a life-threatening emergency with high incidence of mortality and morbidity. Endovascular revascularization has been increasingly used as one of the treatment options. In this article, we report our outcomes of endovascular intervention for the treatment of ischemic stroke and highlight some technical experiences.* ***Materials and methods:*** *A cross-sectional descriptive study was conducted on all cerebral ischemic stroke patients who came to Can Tho University of Medicine and Pharmacy Hospital within 8 hours from the first symptom would be included. National Institute of health stroke (NIHSS) scale was used for stroke grading which should be 10 or above. The vascularization procedure would be performed with the thrombus aspiration systems or stent retrievers with or without angioplasty and stenting. Post-procedure care would be conducted for at least 2 weeks before discharge.* ***Results:*** *A total of 53 patients were recruited from 1st of January 2018 to 30th December 2020 (24 months). Male to female ratio was 1.54:1. Ages ranged from 38 to 90 (mean 64). NIHSS scores ranged from 12-25. Approximately 98% of patients had comorbidities with hypertension, diabetes, atrial fibrillation , mitral valve stenosis and valvular insufficiency, A-V block. Totally there were 44 patients experiencing thrombectomy with catheter-based distal aspiration (35), stent retrievers (03), aspiration and stent retriever combination (06). The total technical success rates for all procedures were 47/53 (88.6%)). The total death rate was 15/53 (28.3%) due to combining comorbiditiese. There were 31/53 patients (58.4%) who had significant recovered in muscle movement, language and cognition after 2 weeks.* ***Conclusion****: Endovascular intervention is a one of the good options*

for the management of acute ischemic stroke, which has a high revascularization rate (88.6%) and can save up to 58.4% of patients out of disability. Successful revascularization is the crucial first step to salvage the patients and obtain a better prognosis.

***Keywords**: acute ischemic stroke, IV rTPA, intra-arterial thrombolysis, catheter-based thrombectomy, intra and extracranial angioplasty and stenting.*

I. INTRODUCTION

Acute cerebral ischemic stroke is a severe emergency condition with high rate of mortality and morbidity. Treatment for ischemic stroke could be intravenous thrombolysis or catheter-based revascularization. In many institutes, intravenous thrombolysis was used regularly for the ischemic stroke sufferers within 4 hours since the onset. Currently, endovascular revascularization including mechanical thrombectomy with or without intra-arterial thrombolysis, angioplasty with or without stenting has been increasingly used as one of the treatments for cerebral thromboembolism. In this article, we are reporting our outcomes of endovascular intervention as a treatment for ischemic stroke with catheter-based thrombectomy with or without thrombolysis, angioplasty and stenting.

II. MATERIALS AND METHODS

This is a cross-sectional, descriptive study. All ischemic stroke patients with the National institute of Health Stroke (NIHSS) grading scale of 10 or above were included from 1st of January, 2018 until 31th of December, 2020 in Can Tho University of Medicine and Pharmacy (CTUMP) Hospital (24 months). The time of stroke was within 8 hours since the onset or since when the patients' symptoms have been identified until the admission to the hospital.

Exclusion criteria include cerebral infarction more than 8 hours from the onset or there was evidence of obvious hypodensity at the infarcted areas on plain CT images to indicate that brain parenchyma has been severely damaged. Other exclusion criteria were ischemic stroke with hemorrhage, severe comorbidities that might cause fatality, i.e.myocardial infarction, unstable vital signs which were not suitable for the procedures.

The diagnosis would be made by clinical assessment, plain computed tomography (CT) scan, CT angiography or magnetic resonance imaging (MRI). Initially the patients were clinically assessed. The NIHSS score was used to grade the stroke scale and the patient NIHSS score should be 10 or above to get included. Blood samples would be taken for renal function test, ALT, AST, blood glucose, coagulation and electrocardiography (ECG) would be conducted in the emergency room. Unless the patients had a well-established history of chronic renal failure, we did not wait for the renal function test and sent the patients for a CT scan straight away to exclude hemorrhagic stroke, to assess brain parenchyma and confirm the occlusion sites. MRI would be indicated for those who had a NIHSS score of less than 10 or for cooperative patients since it is quite sensitive to motion artifacts. MRI was also used for the patients with contraindication of iodinated contrast media. However, MRI also has some contraindication that should also be noticed and could make it a little bit more time-consuming for safety screening. Digital subtraction angiography (DSA) would be indicated when there was evidence of occlusion at carotid arteries, M1 portion of the middle cerebral artery, vertebral artery or basilar artery. Revascularization procedure would not be performed if there were evidence of obvious hypodense lesions at the infarcted areas because those lesions could be too late for recovery and could increase the risk of cerebral hemorrhage.

During the procedure, thrombus aspiration would be performed using an aspiration system with a large bore of being up to 6F in diameter. The thrombi would be aspirated repeatedly in maximally 4-5 times until the occluded vessels were totally revascularized. If the thrombus cannot be aspirated and the flow is not regained, stent retrievers would be used for thrombus removal. Solitaire, Trevo or Catch View stent retrievers could be used with Rebar, Trevo or Vasco 18 microcatheters. After clots were removed from the occluded sites, if there were remained stenosis, angioplasty would be proceeded using balloon gateway 2.5-3mmx15 or 20mm. The balloon could be inflated and remain in 30 seconds to one minute before deflation.

In cases there were stenosis and tandem lesions, angioplasty and stenting would be performed before or after thrombectomy. If the stenosis was extracranial i.e. at ICA origin, balloon dilation would be done and followed by stent deployment using balloon Saphire or Gateway and Carotid Wallstent. If the stenosis was intracranially located at the thrombus sites, balloon dilation, stent deployment after thrombectomy would be performed using Gateway balloon and Wingspan stenting system.

After the procedure, if cerebral edema progressed with midline shift or herniation, decompressing craniotomy would be performed by neurosurgeons. After the patients were discharged, follow-up appointments would be allocated one week, three weeks, and two months afterward.

III. RESULTS

A total of 53 patients were recruited from 1st of January 2018 to 30th December 2020 (24 months). Male to female ratio was 1.54:1. Ages ranged from 38 to 90 (mean 64). NIHSS scores ranged from 12-25. Approximately 95% of patients came after 4 hours. 98% of patients had comorbidities with hypertension, diabetes, atrial fibrillation , mitral valve stenosis and insufficiency, A-V block type 1, dyslipidemia..

Forty four patients were experiencing thrombectomy (Table) with catheter-based aspiration, stent retrievers, aspiration and stent retriever combination (Figure 1).

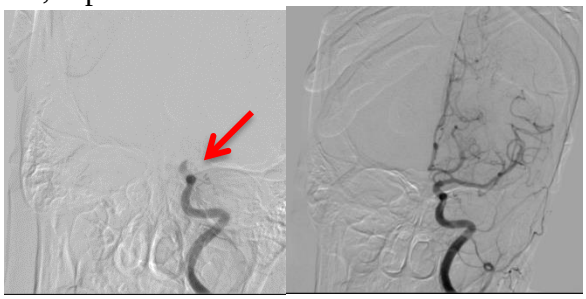

Figure 1a **Figure 1b**

Figure 1. Image of a patient with occluded left ICA (1a, arrow) and the left ICA after successful thrombectomy by catheter-based aspiration (1b).

Table 1. Outcomes

Procedure		**Number of patients**	**Technical results**	**Clinical recovery**
Thrombectomy	Catheter-based aspiration	32	30 successful	21 recovered well
				04 unchanged
				5 dead
			02 unsuccessful	01 death

Procedure		Number of patients	Technical results	Clinical recovery
				01 worsening cognition after 02 weeks and died after 2 ms
	Stent retriever	5	4 successful	03 recover well
				01 unchanged
			1 unsuccessful	01 death
	Aspiration and retriever	7	4 successful	3 recovered well
				01 unchanged
				01 death
			3 unsuccessful	3 deaths
Thrombectomy with angioplasty and stenting		9	9 successful	5 recovered well
				01 unchanged
				03 death (01 vertebral stent, 01 MCA stent, 01 ICA stent)

There were 04 patients having stenting after thrombectomy at MCA. 04 patients had ICA origin stenoses and tandem thrombus embolism at the MCA which were revascularized with thrombectomy at the MCA and stenting at the ICA stenoses (Figure2). 01 patients with basilar artery occlusion had stenting after thrombectomy.

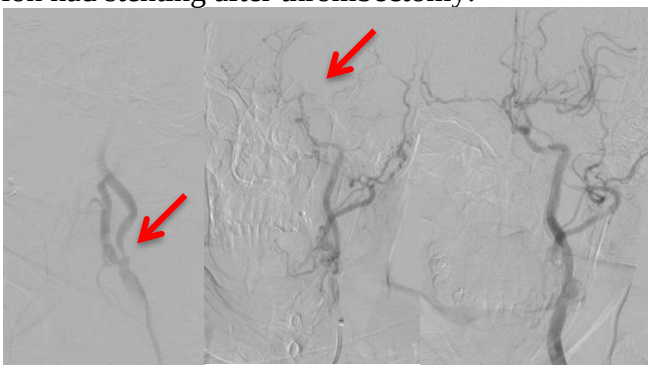

Figure 2a 2b 2c

Figure 2. DSA images showed ICA origin stenosis (2a, arrow). Left MCA occlusion (2b, arrow). The left ICA stenosis after stenting and thrombectomy (2c).

The technical success rate for all procedures was 47/53 (88.6%) with TICI (thrombolysis in cerebral infarction) perfusion scale rates from grade 2B (14%) to grade 3 (86%).

The unsuccessfully (TICI from 2a to below) procedure were 6 cases due to being unable to aspirate or retrieve the thrombi. These thrombi were hard and large and could not shape into the catheters or stent retrievers. All of these patients were dead due to progressive symptoms.

The total death rate was 15/53 of patients (28.3%) including those with unsuccessful procedures (6/53) and even with successful revascularization (9/53). The causes of death were related to multiple comorbidities including progressive cerebral edema, cerebral hemorrhagic transformation, pneumonia, unstable blood pressure with hypertension, diabetes with uncontrollable serum glucose, progressive renal failure..There were 31/53 patients (58.4%) with successful revascularization who had significantly recovered in muscle movement, language and cognition after 2 weeks.

IV. DISCUSSION

The requirement for the diagnosis of acute ischemic stroke is accurate and quick to reduce tim-consuming which might lead to brain cell death. General biological assessment of renal function, serum electrolytes, total blood count, PT, APTT, INR and ECG should be performed before the revascularization procedure to obtain the patient's general condition necessary for patient prognosis. A plain CT scan is an initial study that could provide information on the early stage of the cerebral ischemia. The finding includes dense MCA sign (Figure 3), effacement of sulci of the insula (aka insular ribbon sign), effacement of the cerebral hemisphere sulci, loss of corticomedullary differentiation. Additionally, a plain CT scan can rule out hemorrhagic stroke. If there is no lesion seen on the CT images which is a discrepancy to the patient clinical symptoms indicating that the stroke time happens acutely still in the early stages. If there were lesions that are hypodensities seen on the brain parenchyma, it indicates that the patient has come at the late stages likely more than 3 hours and the chance for recovery is diminishing. However, the early Ct scan changes alone were not proven to be associated with increased risk of adverse outcomes after rTPA treatment [1]. The CT angiography would be indicated to identify the occluded sites of the cerebral arteries. However, CT angiography does need some amount of intravenous iodinated contrast injection which is more disadvantageous and carries adverse reaction risks if the patient could proceed to revascularization procedure, which needs more contrast media. Hence, some of the institutes now choose MRI as a prioritized diagnostic tool in the stroke protocols.

Figure 3. Dense MCA sign on CT scan image (arrow)

Magnetic resonance imaging is very sensitive for the detection of acute cerebral ischemia by using the diffusion sequences. The restricted areas (Figure 4) indicating infarction could be observed about 10 minutes after the onset of the stroke event. MRI could provide information about the brain parenchyma and vascular lesions without a need for gadolinium-based contrast media administration. In cases the patients were contraindicated for CT scan or iodinated contrast media, MRI could be the modality of choice to assess brain parenchyma, especially for detection of infarction at the brain stem or hemispheric white matter which might cause hemiparesis without any big vessel occlusion. Moreover, by matching the FLAIR and diffusion-weighted imaging sequences, MRI could tell us

whether the lesions are still in an early state or too late for intervention. All the acute infarcted areas would be bright on DWI, if it was also bright or hyperintense in FLAIR meaning that the lesions already were already later than 4 hours. MRI is also a superior study compared to CT scan for identification of acute MCA thromboembolism based on 3D susceptibility-based perfusion MR images [2]. To thoroughly depict the patient status, certain MRI protocols with advanced sequences could be conducted for additional information, however, it takes prolonged acquisition time. Moreover, MRI is too sensitive to motion artifact that requires the patients to stay still during image acquiring which is hardly obtained in uncooperative stroke patients.

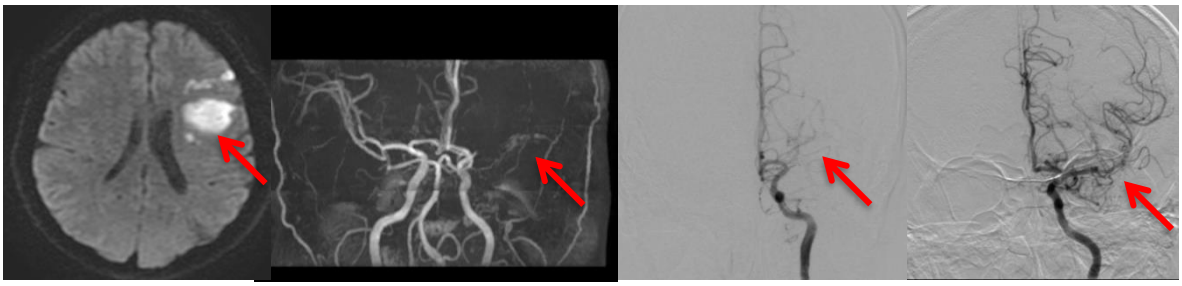

Figure 4a **4b** **4c** **4d**

Figure 4. MRI and DSA images of the patient with ischemic stroke. DWI sequence (4a, arrow) showed restricted areas at the left frontal region. TOF sequence (4b, arrow) showed occlusion of the left MCA. DSA image showed occluded left MCA (4c, arrowhead). DSA image after revascularization (4d, arrow) showed good flow to the left MCA.

It has been stated that IV thrombolysis has been shown to be ineffective in large vessel occlusion and related to cerebral hemorrhage. A study of 624 ischemic stroke patients treated with 0.9mg/kg IV thrombolysis and the patient came within 3 hours from the onset showed that, 31-50% of them obtained partial to total recovery after 3 months. Intracranial bleed was 6.4%. Death rates were 17% and 24% after 3 months and 1-year respectively [3]. One of the important issues for IV thrombolysis is that the time from the onset to the admission time, if it is beyond 4 hours or the later it is, the greater the risk of hemorrhage and death rate.

In our study, the success rates were dependent on the thrombus features whether they were rigid or soft, big or small. The technical success also depended on the vessel status i.e. tortuosity, underlying atherosclerosis, small calibers of the affected arteries; thus, the occluded sites might be hardly approached. Catheter exchange, stabilization of the guiding catheter could be useful to facilitate the vessel cannulation. In some situations, balloon dilatation of the stenotic arteries could make the caliber bigger and ease the canulation of aspirating catheter. When the above solutions seem to be ineffective for catheter advancing, direct puncture to the carotid artery could be considered to skip all the angulated proximal portions from the puncture site to the aortic arch and the carotid artery. However, direct carotid puncture should be considered as the last option because of possible complications

including severe hematoma causing compression to the airways. The incidence of significant hematoma causing compression may happen in up to 7%. Injury of the carotid artery and also infarction caused by direct cannulation of the carotid arteries were recorded at 8.7% of the stroke subjects [4,5]. We also had a case of a direct carotid puncture and the thrombectomy procedure was done successfully. The patient was doing well after the procedure. Her movement was unchanged in the first two weeks but improved after four weeks. Her cognition was reserved.

In the study SARIS (Stent Assisted Recanalization in Acute Ischemic Stroke), there were 20 patients who experienced emergency angioplasty and stenting after ineffective thrombolysis or catheter thrombectomy. All the patients achieved total or partial recanalarization. Functional recovery was 60% after 6 months and hemorrhage complication was 5%. The author stated that angioplasty and stenting could be a benefit for the acute ischemic patients [6]. In our study, we had 04 patients with severe stenosis of the carotid artery origin with tandem MCA occlusion, 04 patients having MCA thrombus occlusion over stenoses, 01 patient with thrombus over stenosis at basilar artery. They had experienced urgent thrombectomy and stenting at stenotic sites. Our urgent angioplasty and stenting were performed with significant stenosis (>70%) of the affected arteries. We did angioplasty first and waited for up to 15 minutes. If the stenoses recoiled then we put the stent in. Thrombolysis would be injected if there present the thrombus formation after stents were deployed after we do the angio-CT on spot to rule out hemorrhage. It was encouraging that all of the cases had obtained good flows. Six of them were recovered well and two deaths due to combination morbidities.

During catheter cannulation, if the interventionist cannot thread the guidewire through the occlusion site, the occlusion was likely chronic due to atherosclerosis and to salvage the patient, some authors could consider alteplase administered via microcatheter. Thrombolysis would be injected if the stroke time was still within 6 hours from the onset [7]. Besides the unsuccessful procedures, post revascularization cerebral edema was also happening in successful revascularization cases. One treatment option for cerebral edema was decompressive craniotomy but the patient might add up more injuries and carries a poor prognosis. The currently available treatment is hyperosmotic fluid, yet its effectiveness has been still under controversy and depending on the practices of different institutes.

V. CONCLUSIONS

Endovascular intervention is considered one of the effective treatment options for ischemic stroke, under which, the blood flow could be revascularized in 88.6% of cases technically. There were more than half of the patients achieved significant clinical improvement. Successful revascularization is the crucial first step to salvage the patients and obtain a better prognosis.

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