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The important role of manual aspiration through the guiding catheter during repeated Solitaire mechanical thrombectomy in acute ischemic stroke

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Abstract. – OBJECTIVE: Acute ischemic stroke (AIS) is an important global health problem. Intravenous (IV) thrombolysis with recombinant tissue plasminogen activator (rt-PA) is the standard treatment. However, only a small number of patients benefit from it because of strict application restrictions. Increasing evidence has demonstrated that mechanical thrombectomy is an effective and safe therapy for AIS.

PATIENTS AND METHODS: We present 14 cases of successful recanalization with Solitaire devices for AIS patients after stroke onset. During stent retrieval, continuous manual aspiration was applied through the guiding catheter, and several large pieces of thrombus were aspirated into the catheter along with the clot, which was adhered to the stent. Clinical outcomes were assessed by the NIHSS at discharge and the mRS on follow-up at 90 days.

RESULTS: All 14 patients with AIS occlusions were treated with Solitaire stents during the study period. The successful recanalization rate was 100%. On discharge, all patients (100%) had improved (NIHSS of ≥ 10 points). At 90 days, 12 patients (86%) had a good functional outcome with mRS of ≤ 2.

CONCLUSIONS: We recommend the use of manual aspiration through a guiding catheter as an alternative technique when a specialized aspiration device is not available, to facilitate a fast, complete, and safe thrombus retrieval by the Solitaire system.

Key Words

Acute ischemic stroke, Mechanical thrombectomy, Solitaire AB/FR device, Thrombus aspiration.

Introduction

Proximal intracranial artery occlusion is one of the most common causes of acute ischemic stroke (AIS) and can cause long-term disability and mortality. The recanalization of large occluded vessels has been proven to be an important factor for the favorable outcome of AIS[1,2].

Since intravenous recombinant tissue plasminogen activator (rt-PA) emerged as the first United States Federal Food and Drug Administration approved treatment for AIS in 1996, treatment for AIS has evolved to include intravenous thrombolysis up to 4.5 h after onset. However, there are limitations to intravenous (IV) thrombolysis, such as the narrow therapeutic window and low reperfusion rate in the proximal segment of the large intracerebral artery. To overcome these limitations, endovascular treatment for AIS, including intra-arterial (IA) chemical thrombolysis and mechanical thrombectomy were introduced, and have been developed over the last decades, resulting in an expanded window of 6-8 h[3-8].

The management of ischemic stroke from large vessel occlusion has changed because of the publication of five positive randomized trials, which predominantly used stent retrievers. These trials have led to the highest level of guideline recommendations in the United States, Europe, and Canada, supporting the use of mechanical stent thrombectomy within 6 h of ischemic stroke onset for patients with large vessel stroke from internal carotid and middle cerebral artery occlusions[9-13].

Stroke is the second leading cause of death and a leading cause of disability worldwide. Cerebral infarction, because of thrombotic occlusion of a brain artery, is the most common type of stroke, accounting for 65-85% of all cases. The only specific therapy with a demonstrated benefit for AIS is IV fibrinolysis with rt-PA, given 4-5 h after onset. However, patients with occlusions of large, proximal, intracranial arteries are often not responsive to recombinant time-plasminogen activator (IV rt-PA). Lytic

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therapy achieves early reperfusion in only 13-50% of patients with occlusions of the carotid terminus and the M1 segment of the middle cerebral artery (MCA)[14-21] .

The Solitaire™ Flow Restoration (FR) device is a self-expanding stent retriever that restores blood flow in patients experiencing ischemic stroke because of large intracranial vessel occlusions. In multicenter registries and large clinical trials, the Solitaire stent retriever has yielded high rates of reperfusion and favorable clinical outcomes. In a randomized, head-to-head device trial, compared with first-generation coil retriever devices, the use of the Solitaire FR was associated with superior recanalization rates, faster achievement of reperfusion, reduced intracranial hemorrhage, and improved disability outcome[22-29].

We present 14 cases of successful recanalization with the Solitaire device for acute ischemic stroke. During stent retrieval, continuous manual aspiration was applied through the guiding catheter, and several large pieces of thrombus were aspirated into the catheter along with the clot adhered to the stent. Angiography confirmed complete blood flow restoration to the vessels, and patients achieved a favorable functional outcome three months after the procedure. We, thus, emphasize the use of manual aspiration through the guiding catheter as an alternative technique when a specialized aspiration device is not available, to facilitate a fast, complete, and safe thrombus retrieval by the Solitaire system. Here, we referred mainly about two of the all cases treated.

Case 1

Case 1 was of basilar artery (BA) occlusion. A 72-year-old man presented with acute onset of aphasia and paralysis of all voluntary muscles except for those performing eye movements (NIHSS score 23; mRS score 5). Computed tomography (CT) scan performed at a local hospital 1 h after stroke onset failed to reveal visible brain lesions. A diagnosis of AIS was considered, and the patient received IV infusion of 1,300,000 U of urokinase without effects. The patient was transferred to our hospital. Magnetic resonance imaging and magnetic resonance angiography were performed 6 h after onset of symptoms,

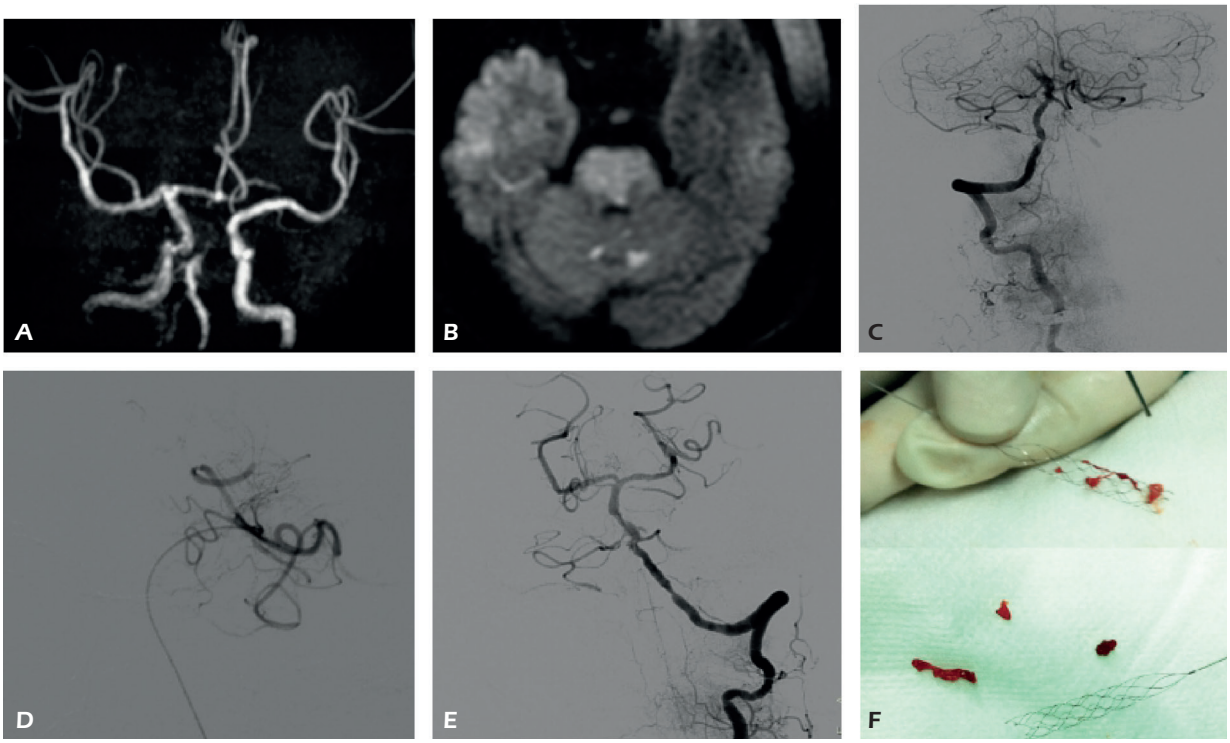


Figure 1. Radiographical images for Case 1. **A**, Magnetic resonance angiography 6 h after symptom onset; **B**, Magnetic resonance imaging scan 6 h after symptom onset; **C**, Angiogram demonstrated a partial filling defect in the V5 segment of the left vertebral artery (LVA) and complete occlusion of the basilar artery (BA); **D**, Angiogram was performed to confirm the microcatheter position; **E**, Angiogram was performed to confirm complete BA recanalization and reperfusion of the posterior cerebral artery and superior cerebellar artery; **F**, Aspirated thrombus material.

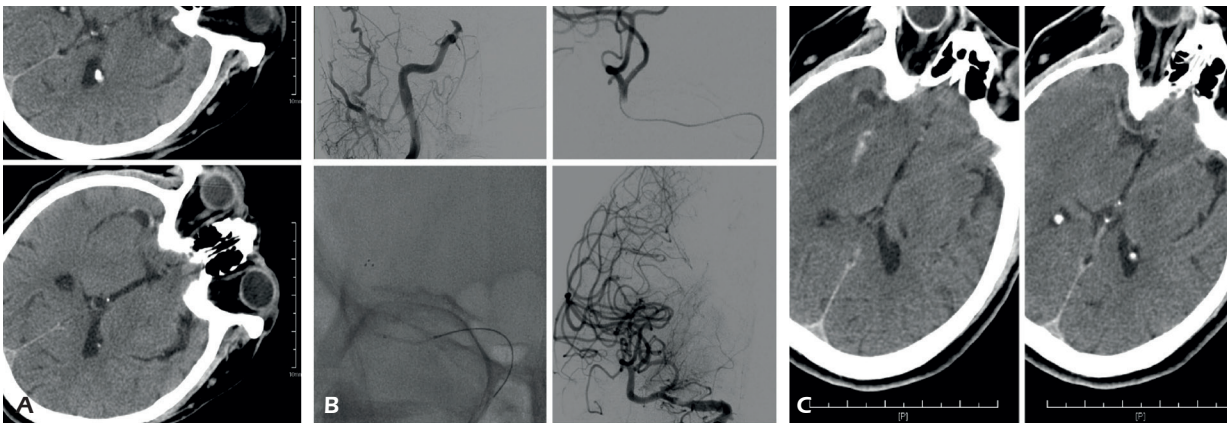
which showed occlusion of the proximal BA and extensive ischemic lesions in the pons (Figure 1A, 1B).

Informed consent was obtained from the patient's relative, and 7 h after stroke onset, mechanical thrombectomy with a Solitaire FR device was performed via a femoral artery approach under general anesthesia. A 6F balloon-guiding catheter was inserted into the right vertebral artery (RVA), and an angiogram demonstrated a partial filling defect in the V5 segment of the left vertebral artery (LVA) and complete occlusion of the BA (Figure 1C). The RVA was tortuous and the guiding catheter could not be further advanced. Therefore, the catheter was changed to the LVA. A 0.021-inch microcatheter (Rebar 18 ev3) was navigated distal to the point of BA occlusion over a 0.014-inch microwire (Silverspeed ev3). Subsequent distal angiogram was performed to confirm the microcatheter position distal to the thrombus and was localized in the P1 segment of the left posterior cerebral artery (PCA) (Figure 1D). A Solitaire FR stent (4 mm in diameter, 20 mm in length) was advanced through the microcatheter and placed at the occlusion site under fluoroscopic monitoring. The fully deployed stent was maintained in place for a few minutes and was gently pulled back together with the delivery microcatheter. It was then recovered through the guiding catheter. Before stent retrieval, the balloon guide catheter was inflated to suspend anterograde flow. Continuous manual aspiration with a 50 ml syringe was performed through the hemostatic valve during the retrieval in order to reverse the flow and to aspirate clot debris. Repeat angiogram showed partial recanalization, and the procedure was repeated once more. A final angiogram was performed, which confirmed complete BA recanalization and reperfusion of the PCA and superior cerebellar artery (Figure 1E). Based on the angiogram, a thrombolysis of cerebral infarction score of 3 was reached.

Thrombus material was found in the stent and more clots of increased size were found in the aspiration syringe (Figure 1F). Pathological examination showed a fibrin thrombus with focal calcification. The patient recovered well after the procedure, without complications (i.e. intracranial hemorrhage) identified on follow-up imaging studies. National Institute of Health Stroke Scale (NIHSS) assessed after two months was 12 and mRS was 3.

Case 2

Case 2 was of MCA occlusion. A 50-year-old man presented acute onset of aphasia and paralysis of left voluntary muscles except for those responsible for eye movements (NIHSS score 21; mRS score 6). CT scan performed at a local hospital 1.5 h after stroke (Figure 2A) onset failed to reveal visible brain lesions. A diagnosis of AIS was considered, and the patient received IV infusion of 1,300,000 U of urokinase without effects. The patient was treated by mechanical thrombectomy as described above (Figure 2B). The patient recovered well after the procedure. CT scan after surgery is shown in Figure 2C.



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Discussion

For AIS from large artery occlusion, mechanical thrombectomy after standard care was associated with improved functional outcomes compared with standard care alone, and was found to be relatively safe, with no excess of intracranial hemorrhage. There was a trend toward reduction in all-cause mortality with mechanical thrombectomy. Ganesalingam et al[30] reported that mechanical thrombectomy was more expensive than intravenous t-PA, but it improved quality-adjusted life expectancy. The incremental cost per quality-adjusted life year gained from mechanical thrombectomy over a 20-year period was $11,651. The probabilistic sensitivity analysis demonstrated that thrombectomy had a 100% probability of being cost-effective at the minimum willingness to pay for a quality-adjusted life year commonly used in the United Kingdom.

Acute occlusion of the vertebrobasilar artery can cause several high mortality conditions including the "locked-in syndrome". Previous evidence[31] showed that mechanical thrombectomy in the anterior circulation was frequently less successful in patients with large vessel angles. Therefore, vessel curvature significantly influences the results of mechanical thrombectomy with stent retrievers for treatment of AIS. Further work is needed to understand the underlying causality. Earliest possible recanalization is associated with lower mortality and improved clinical outcome. Recent studies[32-34] have demonstrated that compared with intra-arterial treatment, mechanical thrombectomy had a much higher rate of recanalization and better functional outcome. The Solitaire AB/FR system is a new generation thrombectomy device, approved for clinical use to restore blood flow in AIS patients. The device combines the advantages of prompt flow restoration and mechanical thrombectomy, and the application has a high technical success rate. Furthermore, it can be re-repositioned and redeployed if necessary. Because the stent can be removed, there are no concerns for early rethrombosis and late in-stent stenosis. Also, there is no need for aggressive antiplatelet therapy, and no severe device-related adverse events occur.

Several studies have demonstrated the safety and efficacy of the Solitaire device for the treatment of acute BA occlusion. Papanagiotou et al[27] reported 22 patients with acute intracerebral artery occlusions treated with the Solitaire AB/FR, in which eight patients had BA occlusion. The results showed an overall recanalization rate of 90.9% and 87.5% for the BA occlusion patients, and 59% of patients had good clinical outcome. Machi et al[29] performed mechanical recanalization on 56 patients, and the vessel recanalization rate was 89%. Good clinical outcome was observed in 46% of cases. However, for the 15 patients with BA occlusions, only five (33.3%) had a good clinical outcome at discharge. Previous studies[35-38] have also shown that the clinical outcome was closely related to the timing of vessel recanalization, and treatment beyond 8 h was less effective. In our case, the vessel occlusion was so extensive that several stenoses involving the whole BA and V5 segment of the LVA occurred. We successfully performed mechanical recanalization using the Solitaire FR device, 7 h after stroke onset, and the patients achieved favorable functional outcome 2 months after the procedure (NIHSS 12, mRS 3).

Thromboembolic complications resulting in occlusion of unaffected distal arteries are a major concern during the procedure. To prevent these complications, two critical steps should be carefully performed while withdrawing the embolectomy device – inflation of the guiding catheter balloon to block anterograde blood flow and continuous proximal aspiration to reverse flow. Continuous manual aspiration is important for complete retrieval of the clot, particularly of thrombus materials not attached to the stent. We found that the major parts of the clot were removed through the aspiration syringe. Consistent with our observation, a previous study[39] described successful treatment of two cases of BA occlusion by direct aspiration of the clots using a 4F catheter.

Conclusions

In the current clinical practice of mechanical thrombectomy, the Solitaire system was found to be frequently used in combination with an aspiration catheter, mostly the Penumbra device, and this multimodal endovascular therapy was shown to be a safe and highly effective strategy for revascularization of large vessel occlusion in AIS. Here, we recommend the use of an alternative aspiration technique when a specialized aspiration device is not available, i.e., using a 50 ml syringe to manually apply constant aspiration to the guiding catheter, which greatly facilitates fast, complete, and safe thrombus retrieval[40].

Conflict of Interest

The Authors declare that they have no conflict of interests.

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