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Cerebrovasc Dis 2007;23:69–71
DOI: 10.1159/000097031

Mechanical Thrombectomy in Acute Proximal Middle Cerebral Artery Thrombosis with the Alligator Retrieval Device

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A 56-year-old right-handed Chinese man presented to us with sudden right-sided hemiparesis (Medical Research Council grade 1 in the right upper limb and grade 4 in the right lower limb) and expressive dysphasia. He arrived at the emergency room nearly 3 h after symptom onset. The National Institute of Health Stroke Scale (NIHSS) score was 22. He was a smoker and social drinker with a history of type 2 diabetes mellitus and hypertension. There was no previous transient ischemic attack.

Computed tomography (CT) of the brain was performed using a Light Speed multislice CT scanner (General Electric Medical Systems, Milwaukee, Wisc., USA) which revealed hypodense left basal ganglia with no dense middle cerebral artery sign. There was no intracerebral hemorrhage. A dynamic CT perfusion study was performed with the following protocol: 80 kV (peak), 190 mA, 512 × 512 matrix size, and four 5 mm thick slices parallel to the orbitomeatal plane with the most caudal one at the basal ganglia level; dynamic scanning was done at a rate of 1 scan/s for 60 s with a 5-second delay from the beginning of intravenous bolus injection of Iopamiro 370 (40 ml at 4 ml/s; Bracco, Milan, Italy). Quantitative maps of cerebral blood flow (CBF), cerebral blood volume (CBV), and mean transit time were generated by deconvolution of the tissue enhancement curves. Severe hypoperfusion at the left middle cerebral artery territory with elevation of the mean transit time and reduction of the CBF was noted. The left anterior cerebral artery territory was spared. Areas of signal misregistration were seen in the left basal ganglia, manifested as areas with no

color registry on the perfusion maps. The rest of the left middle cerebral artery territory showed slightly elevated CBV. Diffusion-weighted imaging was performed with a 1.5-tesla magnetic resonance system (Signa; General Electric Medical Systems). Restricted diffusion was seen in the left basal ganglia which conformed closely to the region of signal misregistration on the perfusion CBV map. The CBF at the left basal ganglia measured 4 ml/100 g/min with a CBF ratio of 0.066. The corresponding CBV was 0.289 ml/100 g with a CBV ratio of 0.11. These values were well below a CBF ratio of 0.32, a CBV ratio of 0.68, a CBF threshold of 12.7 ml/100 g/min, and a CBV threshold of 2.2 ml/100 g for tissue infarction [1]. Huge perfusion-diffusion mismatch was confirmed. Time-of-flight magnetic resonance angiography of the circle of Willis showed abrupt truncation at the proximal middle cerebral artery (M1). Emergency digital subtraction angiography (Neurostar; Siemens, Munich, Germany) was performed under general anesthesia. Occlusion at the proximal left middle cerebral artery (M1) was confirmed.

Mechanical thrombectomy was performed. A 7-Fr guiding catheter was placed at the vertical portion of the left petrous internal carotid artery. Navigation of the proximal left middle cerebral artery with a Renegade microcatheter (Boston Scientific, Natick, Mass., USA) and a Transcend floppy microguidewire (Boston Scientific) was performed. Penetration of the thrombus with microguidewire and microcatheter was achieved. Patency of the distal left middle cerebral artery was confirmed. Retrieval of the thrombus with a 2.5-mm Alligator Retrieval Device (ARD; Chestnut Medical Technologies, Menlo Park, Calif., USA) back into the guiding catheter was performed. A 3 mm long clot was retrieved 5 h after symptom onset. A control angiogram showed reconstitution of the distal left middle cerebral artery flow. A short segment of moderate stenosis (>50%) just before the left middle cerebral artery bifurcation was noted which was believed to be the underlying cause of the stroke (fig. 1). Oral aspirin 300 mg daily was started after the operation. The patient had full limb power recovery, and his NIHSS score dropped to 2.

Postoperative CT of the brain showed no cortical infarct or hemorrhage. The CT perfusion study was repeated, showing significant improvement in the left middle cerebral artery territory flow, with some residual hypoperfusion at the watershed areas, likely to be related to the underlying middle cerebral artery stenosis.

Discussion

To the best of our knowledge, this is the first case of clot retrieval using the ARD. This is an off-label use of the device that is meant for the removal of foreign bodies such as coils in the peripheral and neurovasculature. It is a retriever with grasping jaws attached to the tip of a flexible wire. Grasping jaws and distal tip of the device are made of radiopaque material, and the device is designed to be used with a microcatheter having an inner diameter of 0.21 in or 0.51 mm. Once the microcatheter is in the correct position, the microguidewire is removed, and the ARD is introduced just like a microwire into the microcatheter. When the tip of the ARD has reached the tip of the microcatheter, the latter is withdrawn slowly, while the ARD position is fixed. The grasping jaws will open. Advancement of the microcatheter again will close the grasping jaws of the ARD.

The Food and Drug Administration has given clearance to the Concentric Retriever Device (Concentric Medical, Mountain

Fig. 1. **a** Left internal carotid digital subtraction angiogram showing truncation at left M1. **b** Control digital subtraction angiogram after deployment of the ARD confirmed grasping of a thrombus shown as filling defect (arrowheads) with satisfactory flow to distal left middle cerebral artery. There was a short segment of significant narrowing at distal left M1 (arrow). **c** The 3-mm clot that was removed was attached to the grasping jaws of the retrieval device.

View, Calif., USA) in August last year based on the MERCI trial [2]. Forty-six percent of the patients had vascular recanalization [TIMI (thrombolysis in myocardial infarction) grades 2 and 3] which was significantly ($p < 0.0001$) higher than in the control arm (18%) of the Prolyse in Acute Cerebral Thromboembolism (PROACT II) study [3]. There was a significant improvement in favorable outcomes in terms of modified Rankin score (≤ 2) and NIHSS score (a drop of ≥ 10 points) in the recanalized group as compared with the group of patients without vascular recanalization. The therapeutic window had also been extended to 8 h from the onset of stroke symptoms [2] as compared with the narrow 3-hour window of intravenous thrombolysis [4], where half of the patients were actually treated within 90 min of symptom onset.

Despite the narrow therapeutic window, intravenous thrombolysis only showed 13% sustained recanalization for proximal middle cerebral artery occlusion [5]. The recanalization rate is much higher in the MERCI trial [2] (46% TIMI grades 2 and 3) and in the PROACT II trial [3] (66% TIMI grades 2 and 3). In one case series of mechanical thrombectomy using the Concentric or the Neuronet thrombectomy device (Guidant, Indianapolis, Ind., USA) [6], 80% TIMI grade 3 recanalizations could be achieved.

The operators (R.L. and W.M.L.) do not have experience in using the Concentric Retriever Device, as this is still not available on the Southeast Asian market. The key point in the use of the ARD is the control of opening and closure of the grasping jaws by means of the advancement or retrieval of the microcatheter. There

is no direct advancement of the grasping jaws, making the whole procedure a lot safer in the operators' opinion. Thirteen percent (19/141) procedural complications occurred in the MERCI trial [2]. Ten cases (7.1%) of them were classified as significant, including 3 cases of vascular perforation and 3 cases of subarachnoid hemorrhage without vascular perforation.

Intracranial stenosis was found to be the underlying pathology in our patient. There was no significant extracranial carotid stenosis. This is consistent with the previously reported findings [7] that intracranial atherosclerosis is more prevalent in the Chinese population. Intracranial stenting with the self-expandable WingSpan Stent System (Smart Therapeutics/Boston Scientific) or drug-eluted stents such as Cypher (Cordis, Hialeah, Fla., USA) or Taxus (Boston Scientific) is coming to place [8, 9]. They are the treatment of choice in patients with symptomatic intracranial stenoses refractory to medical therapy [10]. Encouraging preliminary reports point to the combination of thrombolytic drugs and mechanical devices in patients with acute ischemic stroke [11]. Early experience also showed that hypothermia might offer a new approach to the treatment of acute cerebral ischemia [12].

Further study and clinical trials on the efficacy of the ARD in clot retrieval in stroke patients would be necessary.

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