Ischemic stroke

Direct thrombus aspiration using the Penumbra system for the treatment of pediatric intracranial dissection

Motoaki Fujimoto,¹ Satoshi Tateshima,¹ Latisha Ali,² Radoslav Raychev,¹ Fernando Vinuela¹¹Department of Radiological Sciences, Division of Interventional Neuroradiology, David Geffen School of Medicine at UCLA, Los Angeles, California, USA²Department of Neurology, David Geffen School of Medicine at UCLA, Los Angeles, California, USA**Correspondence to** Dr M Fujimoto, Department of Radiological Sciences, Division of Interventional Neuroradiology, David Geffen School of Medicine at UCLA, 757 Westwood Plaza, Suite 2129, Los Angeles, California 90095, USA; mfujimoto@mednet.ucla.edu**Summary**

We describe a case of a 15-year-old girl who developed a spontaneous intracranial arterial dissection with distal middle cerebral artery (MCA) occlusions. From the digital subtraction angiography provided, the dissection flap appeared to originate at the internal carotid artery terminus with extension into the right M1 segment and occluding the right anterior cerebral artery, A1 segment. CT perfusion study showed salvageable tissue in the posterior MCA territory, including the motor cortex. In order to avoid further injury to the dissection, clot retrieval systems were not a treatment option. We therefore performed selective thrombus aspiration with the Penumbra system for the occluded central and precentral arteries distal to the non-occlusive dissecting lesion. Sufficient recanalization was achieved and the patient made a marked recovery. Although mechanical thrombectomy with the use of retrieval intracranial stent systems has demonstrated satisfactory recanalization rates, the aspiration methodology remains useful for patients with an accompanying proximal vascular lesion.

BACKGROUND

Pediatric stroke has been increasingly recognized with the development of neuroimaging techniques. The death rate is high (10–20%), while two-thirds of children with stroke are burdened with lifelong neurological deficits.¹ Among the various etiologies, cervicocephalic arterial dissection (CCAD) accounts for 10% of childhood stroke, and is associated with a poor outcome.² CCAD is more commonly associated with embolic than hemodynamic strokes. In general, anticoagulation therapy is recommended for CCAD to prevent additional thromboembolic events. However, the therapeutic strategy for intracranial dissecting lesions is not well established.³ Herein we describe a pediatric case of thromboembolic middle cerebral artery (MCA), M2 occlusion associated with intracranial internal carotid artery (ICA) dissection treated by selective direct aspiration, using the Penumbra mechanical thrombectomy system (Penumbra, California, USA).

CASE PRESENTATION

The patient was a 15-year-old, right-handed female, with no significant past medical history, who presented with sudden onset of slurred speech and left-sided weakness at 21:10. She was taken to a primary stroke center where CT and CT angiography demonstrated an intimal flap in the M1 segment of the right MCA, suggestive of an intracranial arterial dissection. Given her age and the intracranial dissection, a decision was made to avoid intravenous administration of tissue plasminogen activator (t-PA). The patient was transferred to our comprehensive stroke center. Her National Institutes of Health Stroke Scale (NIHSS) score at the time of arrival to our hospital (02:30) was 20. Repeated brain CT showed effacement of the right basal ganglia and loss of gray–white differentiation in the right

insula and the right frontal lobe. Brain CT perfusion study showed a perfusion abnormality in the entire right MCA territory, but potentially salvageable tissue in the posterior part of the MCA territory, which included the motor cortex (figure 1). The patient was taken to the neurointerventional suite.

Pretreatment angiograms demonstrated irregular caliber in the right M1 segment and the right distal ICA. A contrast filling defect along the superior and medial wall of the distal ICA and the M1 segment, with a resultant occlusion of the right A1 segment of the anterior cerebral artery, was also noted. These findings were consistent with the known diagnosis of intracranial dissection. There were multiple thrombi in the M2 segments. The posterior parietal and angular artery branches were patent; the rest of the distal vessels were occluded (figure 2). The right anterior cerebral artery was supplied from the contralateral A1 via the anterior communicating artery (figure 2F). In order to avoid further injury to the dissection centered in the right carotid terminus region, a decision was made to use the Penumbra aspiration system rather than a clot retrieval device, such as a Merci retriever.

TREATMENT

Under local anesthesia, a 6 French Penumbra Neuron catheter in 7 French shuttle sheath was positioned at the petrous segment of the right ICA via the right femoral approach. A 032 Penumbra System was gently advanced beyond the dissection segment over a combination of Echelon 10 microcatheter and Xpedion 10 microwire (Covidien Neurovascular, Irvine, California, USA), including the central and precentral arteries that were feeding the salvageable posterior MCA territory. After three aspiration sessions in each occluded M2 branch, partial recanalization

Figure 1 Initial CT shows effacement of the right basal ganglia and loss of gray–white differentiation in the right insula and the right frontal lobe (A). CT perfusion demonstrates decreased cerebral blood volume in the anterior right middle cerebral artery (MCA) territory (B), with diminished cerebral blood flow (C) and prolonged mean transit time (D) through right MCA territory.

was achieved (Thrombolysis in Cerebral Infarction Scale score of 2a). Intravenous heparin or antiplatelet agents during the procedure was not administered because of the risk of intracranial hemorrhage.

OUTCOME AND FOLLOW-UP

MRI on the following day demonstrated a restricted infarct in the right basal ganglia, insular cortex, and frontal operculum (figure 3). Smaller foci of infarction in

Figure 2 Cerebral angiography demonstrates the irregular caliber and double shadow (arrowheads) from a right distal internal carotid artery (ICA) to M1 segment of the middle cerebral artery (MCA) with M2 occlusion (A–C). (A) and (C) are different arterial phases. Occluded MCA branches, including the central and precentral arteries, were partially recanalized after endovascular therapy (D, E). Left ICA angiography shows the leptomeningeal collateral supply from the right anterior cerebral artery territory to the right MCA territory (F).

Figure 3 Fluid attenuated inversion recovery MRI on the following day showed a restricted infarction involving the right basal ganglia, insular cortex, and frontal operculum.

the mesial and superior temporal lobe were detected. The patient has been subsequently maintained on aspirin (81 mg) without recurrent stroke or hemorrhagic complications. Her NIHSS scores were 11 and 1 at 24 h and 3 months, respectively, after her stroke. The length of stay in our hospital was 8 days until transfer to a rehabilitation center. She has made a remarkable recovery and returned to school (modified Ranking Scale score of 1).

DISCUSSION

The choice of therapeutic strategy is critical for successful treatment of stroke. We provided selective thrombus aspiration without t-PA for the treatment of pediatric MCA occlusion with intracranial ICA dissection involving A1 and M1, which had salvageable tissue in the posterior part of the MCA territory, including the motor cortex.

A recent meta-analysis reported that t-PA is safe and efficacious for use in adults with cervical arterial dissection.⁴ However, its effects are limited due to the narrow time window and inadequate recanalization rate for large arterial occlusion. In children, the safety profile of t-PA and the appropriate dosage are unclear. Our patient already exhibited early ischemic change involving the basal ganglia and deep white matter infarction, which was likely too late for effective t-PA. Proximal MCA occlusion was also shown to correlate with higher rates of symptomatic intracerebral hemorrhage after intravenous t-PA.⁵ Further, the extended indication of t-PA for intracranial arterial dissection remains highly controversial due to the expansion of intramural hematoma or bleeding complications.^{3 6} Thrombolytic therapy was not performed in our patient.

Endovascular therapies with intra-arterial thrombolysis or mechanical thrombectomy devices have also been advocated for the treatment of pediatric stroke, especially for patients who are ineligible for intravenous t-PA or those in which intravenous t-PA has failed.⁷ For pediatric intracranial dissection, the use of intra-arterial thrombolysis and/or stent deployment for flow limiting dissection has been reported.^{8 9} In our case, the use of thrombolysis or double antiplatelet therapy necessary for stenting was regarded as a risk for subsequent cerebral hemorrhage. Further, the dissection was not severe enough to limit cerebral blood flow. We chose a mechanical thrombectomy approach only to revascularize the salvageable territory.

Various types of devices have been developed for optimal stroke treatment, although a comparative study

of these devices has not been performed. Recently, retrieval intracranial stents were reported to exhibit faster and more efficient recanalization and more favorable outcomes.¹⁰ These retrieval stent systems are designed to be advanced within a thrombus and then pulled back with retention to the proximal catheter. However, during retrieval, there is a risk of vessel injury, leading to vasospasm, intimal disruption, or dissection.¹¹ By contrast, the Penumbra System applied in the present case is a proximal device used to debulk and aspirate a thrombus from the proximal surface by separator and microcatheter. This approach avoids multiple passages and minimizes the potential for injuring the proximal arterial wall. Further, we were able to successfully maneuver the Penumbra aspiration catheter to the distal branches, including M2. We suggest that the Penumbra Suction System is a useful tool for patients with an accompanying proximal vascular lesions associated with compromised endothelial integrity.

The patient had a remarkable recovery without recurrent stroke. In addition to early recanalization by endovascular therapy, there is a possible role of pial collateral flow in this patient's recovery (figure 2F). Although the subsequent treatment has not been established, anticoagulation or antiplatelet therapy for pediatric intracranial dissection is recommended to reduce the risk of further clots.³ Aspirin in doses of 2–3 mg/kg body weight can be accepted.¹

Learning points

- ▶ In our case, the use of thrombolysis or double antiplatelet therapy necessary for stenting was regarded as a risk for subsequent cerebral hemorrhage. Further, the dissection was not severe enough to limit cerebral blood flow. Thus we chose a mechanical thrombectomy approach only to revascularize the salvageable territory.
- ▶ We were able to successfully maneuver the Penumbra aspiration catheter to the distal branches, including M2. Thus we suggest that the Penumbra Suction System is a useful tool for patients with an accompanying proximal vascular lesions associated with compromised endothelial integrity.

Contributors MF designed the article, collected the data, and drafted and revised the paper. ST designed the article and revised the paper. LA, RR, and FV revised the draft paper.

Competing interests ST is a consultant for Penumbra Inc, the makers of the Penumbra System.

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