

Urgent Bypass Surgery Following Failed Endovascular Treatment in Acute Symptomatic Stroke Patient With MCA Occlusion

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Introduction: Although the benefits of extracranial-intracranial bypass surgery remain controversial, there is some surgical rationale for the augmentation of cerebral blood flow in cases of acute ischemic stroke with hemodynamic instability.

Case Report: We report a case of a 62-year-old woman who suddenly developed right hemiplegia and global aphasia. Initial magnetic resonance imaging and magnetic resonance angiography revealed a small acute ischemic lesion in left parietal lobe with occlusion at the left middle cerebral artery. We performed an endovascular thrombectomy, which failed. Her neurological deficits remained unchanged. On the basis of immediate postendovascular magnetic resonance perfusion, diffusion-weighted imaging (DWI), and neurological examination, an obvious clinical-DWI and a DWI-perfusion-weighted imaging mismatch were detected. We decided to perform emergency superficial temporal artery to middle cerebral artery bypass to prevent further progression of cerebral ischemia. On a 3-month follow-up, neurological deficits remained minimal motor aphasia and dysarthria.

Conclusions: Following failed endovascular treatment in patients with acute symptoms attributed to major cerebral artery occlusion, we recommend immediate multimodal neuroimaging. If there are clinical-DWI and DWI-perfusion-weighted imaging mismatch indications, surgical revascularization could be considered as the next salvageable strategy.

Key Words: middle cerebral artery, extracranial-intracranial arterial bypass, emergency bypass, endovascular treatment, superficial temporal artery to middle cerebral artery bypass

(*The Neurologist* 2017;22:14–17)

On the basis of a 2015 American Stroke Association guideline update, endovascular treatment is now the standard treatment for acute ischemic stroke within 6 hours of symptom onset attributed to major cerebral arterial occlusion.¹ Notably, the rate of successful recanalization has increased from 50% to 90% due to the use of stent retriever devices.² However, failed recanalization occurred in a considerable number of patients with acute ischemic stroke due to major cerebral arterial occlusion. This can lead to malignant cerebral infarction, which has a high risk of fatal brain edema and herniation.³

Although the benefits of extracranial-intracranial (EC-IC) bypass surgery remain controversial,^{4,5} there is some surgical rationale for the augmentation of cerebral blood flow in cases of acute ischemic stroke with hemodynamic instability.^{6,7} Some research has shown that delayed antegrade endovascular treatment improves clinical outcomes in highly selected patients using multimodal neuroimaging criteria, such as magnetic resonance (MR) or computed tomography perfusion imaging, to evaluate the brain for salvageable tissue.^{8,9} On the basis of these findings, when patients are confronted with an evolving stroke following the failure of endovascular treatment, physicians can consider urgent surgical revascularization as another treatment option to protect against the growth of an infarcted lesion.

There have been few studies to help physicians in making the decision about whether to perform an urgent surgical bypass following endovascular therapy failure for patients with acute stroke attributed to major cerebral arterial occlusion. This case report describes a patient with continued clinical-diffusion-weighted imaging (DWI) and DWI-perfusion-weighted imaging (PWI) mismatch in the middle cerebral artery (MCA) territory after failed recanalization therapy underwent successful management with an emergency superficial temporal artery to MCA bypass.

CASE REPORT

A 62-year-old woman with hypertension, diabetes mellitus, a previous ischemic stroke (internal borderzone infarction in the MCA territory), and colon cancer was admitted to our colorectal department for a laparoscopic left hemicolectomy. Eight days after surgery, she suddenly developed right hemiparesis and global aphasia. Her National Institutes of Health Stroke Scale (NIHSS) score was 23. MR image and angiography showed a small acute ischemic lesion in the left parietal lobe with occlusion at the left MCA in the distal M1 segment. The DWI Alberta Stroke Program Early Computed Tomography (DWI ASPECT) score was 8. MR perfusion revealed a marked peak perfusion delay of 8 seconds in the mean transit time (MTT) map, in a broad area of the MCA territory. (Fig. 1A) We performed an endovascular thrombectomy using the Solitaire retriever device and deployed the Solitaire stent after a failed mechanical thrombectomy. Following mechanical thrombectomy, partial recanalization of the occluded artery with limited distal branch filling and minimal reperfusion (thrombolysis in cerebral infarction grade 1) was achieved (Fig. 2). Collateral circulation was moderate throughout the anterior and posterior cerebral artery.

After endovascular treatment (approximately 9 h from symptom onset), her neurological deficits and NIHSS score remained unchanged and immediate postendovascular DWI and MR perfusion showed a small amount of infarcted lesion growth (DWI ASPECT score of 7) with a large perfusion delay of 8 to 10 seconds on the MTT map, which indicated an obvious clinical-DWI and a DWI-PWI mismatch (Fig. 1B).

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The authors declare no conflict of interest.

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ISSN: 1074-7931/17/2201-0014

DOI: 10.1097/NRL.0000000000000086

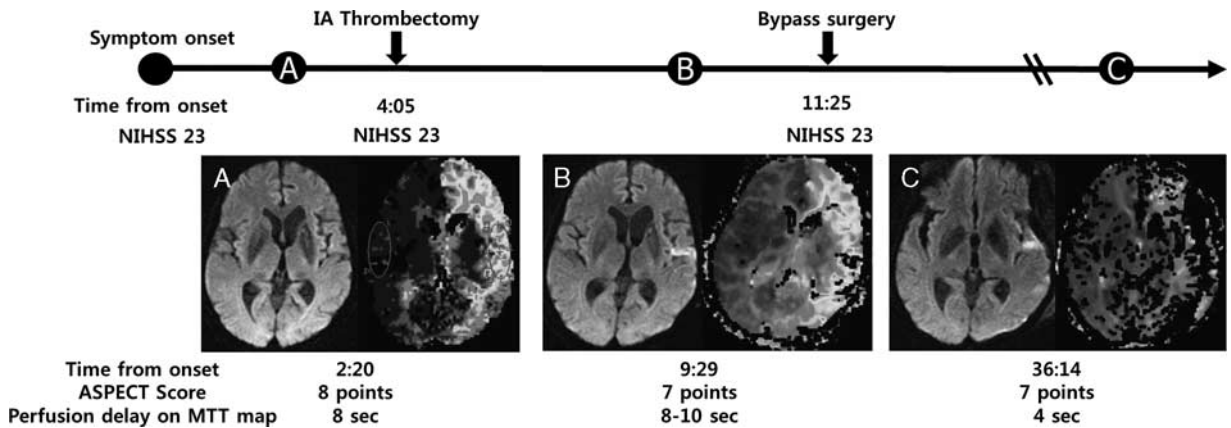


FIGURE 1. Clinical and time flow sheet with diffusion-weighted imaging (DWI) and perfusion-weighted imaging (PWI). Initial magnetic resonance imaging and magnetic resonance perfusion shows a mismatch between DWI and PWI (A). After IA thrombectomy, there is still a DWI-PWI mismatch (B). After superficial temporal artery to middle cerebral artery bypass surgery, a DWI-PWI mismatch was decreased (C). ASPECT indicates Alberta Stroke Program Early Computed Tomography; IA, intra-arterial; MTT, mean transit time; NIHSS, National Institutes of Health Stroke Scale.

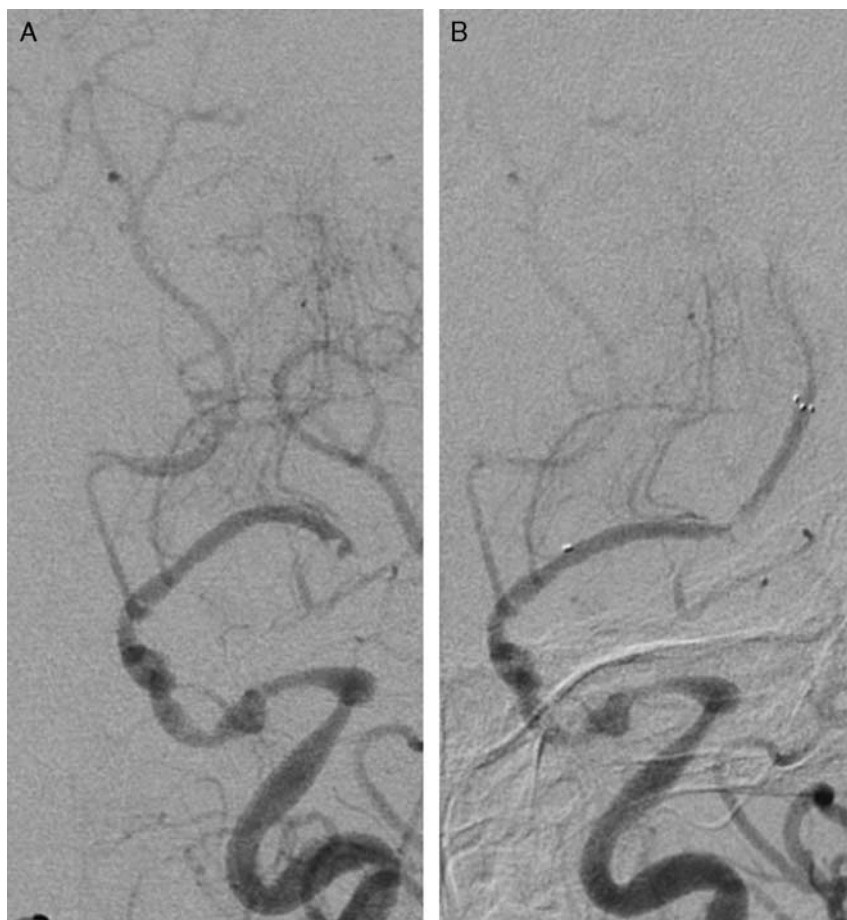


FIGURE 2. Conventional angiography during endovascular treatment. Initial conventional angiography shows the occlusion at the left middle cerebral artery, distal M1 (A). Endovascular thrombectomy using the Solitaire retriever device with deployment was carried out. Partial recanalization of the occluded artery with limited distal branch filling and little reperfusion as thrombolysis in cerebral infarction grade 1 was achieved (B).

Finally, we decided to perform an emergency EC-IC bypass to prevent further progression of cerebral ischemia. Over 9 hours, the left parietal branch of her superficial temporal artery was anastomosed to the left distal MCA (M3 segment) by end-to-end anastomosis.

On postoperative day 1 (the first day of symptom onset was defined as day 0), clinical symptoms improved and postoperative MR perfusion showed a delay of 4 seconds on the MMT map. Follow-up MR image showed only minimal lesion growth at the site of acute ischemia on DWI and no hemorrhagic complications on the gradient-echo T2*-weighted image. (Fig. 1C) She showed no recurrence or progression of neurological symptoms during admission. At the 3-month follow-up examination, her neurological deficits included minimal motor aphasia and dysarthria. At the 1-year follow-up, only subjective dysarthria was present.

DISCUSSION

As seen in this case study, revascularization by emergency bypass after failure of endovascular thrombectomy in a patient with acute ischemic stroke attributed to MCA occlusion, could improve clinical outcomes. Our patient was highly selected by immediate MR perfusion and DWI after failure of the endovascular treatment, which showed a clinical-DWI and a DWI-PWI mismatch. Following the bypass, the patient had a good functional outcome without any complications, such as hemorrhagic transformation.

Recently, endovascular thrombectomy for major cerebral artery occlusion has frequently been performed based on clinical evidence.¹ Successful recanalization is closely related to good functional outcomes.¹⁰ Despite the negative results of some EC-IC bypass studies,^{4,5} some neurosurgeons have continued to perform this procedure on carefully selected patients with ischemic atherosclerotic disease. Many studies have reported that patients with hemodynamic insufficiency are at a significantly increased risk of having an ischemic stroke if the insufficiency is managed medically or left untreated, and that these patients might benefit from the EC-IC bypass surgery.^{11–14}

However, these case studies must be interpreted within the context of their differences and whether or not patient selection was suboptimal due to the lack of sophisticated brain imaging after failure of endovascular treatment. Aggressive recanalization therapy without consideration of infarcted lesions and penumbra volume may increase the risk of hemorrhagic transformation and high-flow reperfusion injury.^{15–17}

If successful revascularization is not achieved in patients undergoing endovascular treatment for acute occlusion of a major cerebral artery, immediate multimodal imaging of the brain, such as MR perfusion with DWI, should be considered as soon as possible to evaluate ischemic lesion volume and the current perfusion status. This may help in deciding whether or not additional surgical revascularization will be safe and effective.

Postendovascular MR perfusion and DWI in this case still showed a small-volume diffusion lesion and inadequate perfusion of the left MCA territory. At that time, the patient's neurological deficits were unchanged and severe, with an NIHSS score of 23. On the basis of clinical-DWI and DWI-PWI mismatch, urgent bypass surgery to prevent progressive neurological deterioration and infarction growth was carried out. A clinical-DWI mismatch, defined by an NIHSS score ≥ 8 and a DWI volume of ≤ 25 mL, indicates a high probability of infarct growth and early neurological deterioration.^{18,19}

Janjua and colleagues conducted a small population study evaluating the effect of late endovascular revascularization. They reported that endovascular treatment in patients with ischemic

stroke beyond 8 hours and a clinical-DWI mismatch can prevent infarct growth and early neurological deterioration.²⁰

Although cutoff values in perfusion delay remained controversial,²¹ delay on MR perfusion is accepted as an additional imaging marker for an increased chance of infarct growth and early neurological deterioration.^{22,23} Parsons et al²⁴ suggested using an MTT > 6 seconds as a cutoff time to progress infarct lesion finally. In the present case, initial and postendovascular MR perfusion revealed a perfusion delay of 8 seconds and 8 to 10 seconds on the MTT map, respectively. Postbypass MR perfusion shows a delay of only 4 seconds.

According to previous studies of emergency bypass surgery, most patients have a different indication than observed in our case; primary bypass for dissection and not severe neurological deficits.^{11–14} Hwang et al¹¹ reported only 2 patients who underwent immediate surgical bypass after failure of endovascular recanalization. However, the EC-IC bypass surgery was done without evaluating postendovascular MR perfusion or DWI, and the patients did not have severe neurological deficits.

In the present case, infarcted lesion growth on post-endovascular DWI was minimal, despite over 9 hours having passed since the onset of symptoms. One possible reason for this was moderate collateral circulation. Of 5 positive endovascular trials, The Endovascular Treatment for Small Core and Anterior Circulation Proximal Occlusion with Emphasis on Minimizing Computed Tomography to Recanalization Times (ESCAPE) enrolled patients with a small infarct core (ASPECTS 6 to 10) and moderate to good collateral circulation up to 12 hours after symptom onset.²⁵ Our case had a DWI ASPECT of 7. Another explanation seems to be the use of the Solitaire device, which works on the concept of using a temporary endovascular bypass to restore transient antegrade flow by creating a channel inside the thrombus.²⁶

CONCLUSIONS

Following failed endovascular treatment in patients with acute symptoms attributed to major cerebral artery occlusion, we recommend immediate multimodal neuroimaging, such as MR perfusion and DWI. If there are clinical-DWI and DWI-PWI mismatch indications, surgical revascularization could be considered as the next salvageable strategy.

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