Recanalization of Acute Intracranial Artery Occlusion Using Temporary Endovascular Bypass Technique

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Authors: S. H. Suh; Seoul/KR
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Purpose

Intracranial stenting has been applied in acute ischemic stroke as a rescue regimen although a significant rate of symptomatic intracranial hemorrhage due to antiplatelet therapy. Recently there are some case reports about ‘temporary endovascular bypass technique (TEB)’ using a self-expandable stent for therapy of acute ischemic stroke, which recanalized an occluded intracranial artery without stenting. The purpose of this study is to evaluate feasibility, efficacy and safety of temporary endovascular bypass technique for treatment of acute ischemic stroke using a self-expandable stent.

Methods and Materials

Patients

Institutional review board approval was waived and written informed consent was obtained from the next of kin. From January 2009 until March 2010, all patients treated by TEB or intracranial stenting for acute stroke were retrospectively analyzed. Clinical data were collected from our stroke database. Inclusion criteria for intracranial stenting were (1) contraindication to perform intravenous thrombolysis or IAT, such as previous cerebral infarction or major surgery; (2) failed IAT or TEB; (3) suspicious of stenoocclusive lesion by cerebral angiography; (4) a large amount of thrombus burden, such as CTO. Inclusion criteria for IAT were as follows; 1) clinical diagnosis of acute stroke by neurologist, 2) baseline NIHSS score # 4, except for isololated aphasia, hemianopia, 3) exclusion of ICH by CT or MRI, 4) confirmation of vessel occlusion by angiography, correlating to neurologic deficit, 5) no clinical or laboratory contraindication for IAT, 6) initiation of treatement within 6 hours of symptom onset for hemispheric stroke and within 9 hours for cerebrobasilar stroke, 7) informed consent by patients’ relatives, 8) exclusion of patients with stroke # 80 years. Baseline study consisted of a neurological and physical examination, assessment of stroke severity by the NIHSS, routine blood analysis and ECG.

Endovascular Technique

The patient was moved into the angiographic suite and diagnostic angiography was performed to evaluate occlusion segment of the intracranial arteries and collateral flows. Under local anesthesia, a 6 Fr Envoy guiding catheter (Codman Neurovascular, Miami Lakes, FL) was advanced to the petrous internal carotid artery, via right femoral artery. A Prowler select plus microcatheter (Codman Neurovascular) was manipulated over an Agility 0.010 microwire (Codman Neurovascular) to the occlusion segment,
confirming proximal and distal ends of the occlusion segment of IA. 100,000 units of intraarterial urokinase (UK) were infused directly into the thrombus via this microcatheter and simultaneously mechanical thrombolysis was performed, with repeated penetration of the microcatheter and microwire across the thrombus. After these procedures were verified to be unsuccessful in accomplishing recanalization for 10-20 minutes, the second microcatheter (Prowler 14 microcatheter; Codman Neurovascular or SL-10 microcatheter; Boston Scientific) was advanced into the proximal end of the occluded IA. Intracranial self-expandable stent (Enterprise vascular reconstruction device; Codman Neurovascular) with double the length of occlusion segment was delivered across the occlusion segment via the first microcatheter. As almost two-thirds the length of the stent was partially deployed across the occluded segment, control angiography was performed to confirm immediate recanalization across the occluded segment of the IA. Additional 100,000 units of UK or tirofiban 1 mg was infused intraarterially through the second microcatheter in order to dissolve the residual thrombus or acute in-stent thrombus. Delayed angiography after 20 minutes was performed to prove to maintain recanalization of the temporary stented IA and the stent was resheathed and retrieved carefully. Post-retrieval angiography was also done for validation of recanalization. If reocclusion of the stented IA was confirmed on the angiography, careful retrieval of this stent was performed for removal of the thrombus within the stent and the stent was redeployed partially in the reoccluded IA. The same procedure as mentioned above was repeated 2-3 times until the golden time of 6 hours. Intracranial stent was deployed on the occluded IA in case of CTO, failure of TEB and prolonged time to recanalization (> 6 hours).

Clinical Outcome

Feasibility of TEB was evaluated by angiographic result of recanalization. Initial and postprocedural angiographies were compared by the same two neuroradiologist (T.-S.Chung, D.I.Kim). The status of vessel recanalization was classified according to the TIMI scale (grade 0, no perfusion; grade 1, penetration but not perfusion; grade 2a, partial perfusion with incomplete distal filling of <50% of the expected territories; grade 2b, partial perfusion with incomplete distal filling of 50 - 99% of the expected territories; grade 2c, near complete perfusion but with delay in contrast runoff; grade 3, full perfusion with normal filling of distal branches in a normal hemodynamic fashion)1. Recanalization was defined as TIMI grades 2b, 2c or 3. Safety of this procedure was evaluated by hemorrhagic event, either symptomatic (defined as worsening more than 4 points of NIHSS score) or asymptomatic, or neurologic deterioration. Clinical outcome was evaluated with NIHSS score at discharge and 3-month mRS score, which was estimated by a neurologist (K.-Y. Lee). Brain MR angiography was performed 7 days after thrombolysis to confirm preservation of the vessel recanalization.

Results
10 patients (7 men and 3 women, mean age 72 years, range 50 to 75), treated by TEB for acute ischemic stroke, were enrolled in this study from January 2009 to March 2010. Indication for stent implantation was failed TEB (n=2), prolonged recanalization time, previous surgery and CTO lesion (n=1). Mean NIHSS score at admission was 13.6 ±4.2 (median 13). Mean time from onset to vessel recanalization was 368 ±49 minutes (median, 360 minutes; range 300 to 450 minutes). All the patients presented with TIMI 0 and the occluded vessel was middle cerebral artery (n=5), basilar artery (n=1), and carotid "T" occlusion (n=4). Brain MRI (n=6) or brain CTA (n=10) was performed before procedure. Intravenous tPA (the dose 0.6-0.9 mg/kg) was infused in 4 patients and mechanical thrombolysis with intraarterial urokinase was performed in 7 patients. Intraarterial tirofiban (less than 1.5 mg) were administered in all patients. In 3 of the patients treated by TEB, stent was implanted for recanalization. One patient with MCA occlusion had concomitant carotid artery stenosis and stent placement was performed in the proximal carotid artery before the thrombolytic procedure. Recanalization was achieved in 8 patients (80%); 7 (70 %) had TIMI 2b or 3 (p<0.00001 vs initial TIMI scores) and 3 had TIMI 1or 2a. In patients without stent implantation, 4 (40%) had TIMI 2b or 3 and 3 had TIMI 2a or 1. 6 patients (60%) improved after procedure by more than 4 NIHSS points during hospitalization. No patients had symptomatic ICH or worsened neurologic examination; but 3 patients showed no improvement in NIHSS of # 4 points. Two patients (20%) had asymptomatic ICH. Brain MRI revealed to keep the vessel recanalization 7 days after thrombolysis in 8 patients (80%). NIHSS score at discharge was 6.3 ±4 (median, 6; range 0 to 13; p <0.003 vs initial NIHSS scores). On 3-month follow-up, mRS of # 3 was obtained in 7 patients (70%) and mRS of # 1 in 4 patients (40%). No ischemic event or progression of neurological deficit occurred during follow-up period. No symptom associated with stent implantation was demonstrated. The mortality rate was 10% (1 patient).
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**Fig. 1:** Table. Patients’ characteristics and clinical outcome
Fig. 2: Figure 1. A 69-year-old man with the right middle cerebral artery occlusion A. The right CCA angiography shows total occlusion of MCA, which corresponds to TIMI 0
**Fig. 3:** Figure 1. A 69-year-old man with the right middle cerebral artery occlusion
B. Enterprise stent was delivered into the occluded MCA via Prowler select plus microcatheter.
Fig. 4: Figure 1. A 69-year-old man with the right middle cerebral artery occlusion C. The right MCA is recanalized with temporary stenting of Enterprise stent.

Fig. 5: Figure 1. A 69-year-old man with the right middle cerebral artery occlusion D. Follow-up brain CT shows focal infarction of the right basal ganglia without ICH.
**Fig. 6:** Figure 2. A 50-year-old man with the left middle cerebral artery occlusion A. The left CCA angiography shows total occlusion of MCA, which corresponds to TIMI 0.
**Fig. 7:** Figure 2. A 50-year-old man with the left middle cerebral artery occlusion B. Enterprise stent was half-deployed on the occluded MCA with restoration of antegrade flow.
**Fig. 8:** Figure 2. A 50-year-old man with the left middle cerebral artery occlusion C. After retrieval of Enterprise stent, the left MCA has antegrade flow of TIMI 2b.

**Fig. 9:** Figure 2. A 50-year-old man with the left middle cerebral artery occlusion D. Follow-up brain MRA shows reocclusion of the left MCA with no improvement of NIHSS score (< 4)
**Fig. 10:** Figure 2. A 50-year-old man with the left middle cerebral artery occlusion E. The photograph shows a lot of thrombus of the stent strut, which is captured by the retrieved Enterprise stent.
Conclusion

Temporary endovascular bypass technique may be effective and feasible in recanalization of acute cerebral artery occlusion.

References


Personal Information