Neurosurg Focus 32 (5):E16, 2012

Management of tandem occlusion stroke with endovascular therapy

***Haitham Dababneh, M.D.,[1] Waldo R. Guerrero, M.D.,[1] Anna Khanna, M.D.,[1] Brian L. Hoh, M.D.,[2] and J Mocco, M.D., M.S.[2]**

Departments of [1]Neurology and [2]Neurosurgery, University of Florida, Gainesville, Florida

Object. Approximately 25% of patients with middle cerebral artery (MCA) occlusion will have a concomitant internal carotid artery (ICA) occlusion, and 50% of patients with an ICA occlusion will have a proximal MCA occlusion. Cervical ICA occlusion with MCA embolic occlusion is associated with a low rate of recanalization and poor outcome after intravenous thrombolysis. The authors report their experience with acute ischemic stroke patients who suffered tandem ICA/MCA (TIM) occlusions and underwent intravenous thrombolysis followed by extracranial ICA angioplasty and intracranial MCA mechanical thrombectomy.

Methods. In a retrospective analysis of their stroke database (2008–2011), the authors identified 2 patients with TIM occlusion treated with intravenous thrombolysis followed by extracranial ICA angioplasty and intracranial mechanical thrombectomy. They examined early neurological improvement defined by a greater than 10-point reduction of National Institutes of Health Stroke Scale (NIHSS) score and an improved modified Rankin Scale (mRS) score at 60 days. Successful recanalization based on thrombolysis in cerebral infarction (TICI) score of 2 or 3 was also evaluated.

Results. In both patients a TICI score of 2b or 3 was achieved, signifying successful recanalization. In addition, both patients had a reduction in the NIHSS score by greater than 10 points and an mRS score of 0 at 60 days.

Conclusions. Tandem occlusions of the cervical ICA and MCA may be successfully treated using the multimodality approach of intravenous thrombolysis followed by extracranial ICA angioplasty and intracranial mechanical thrombectomy.

(http://thejns.org/doi/abs/10.3171/2012.1.FOCUS11350)

Key Words • middle cerebral artery • internal carotid artery • tandem occlusion • balloon angioplasty • endovascular therapy

Half of all patients presenting acutely with ICA occlusions will have comorbid MCA occlusions, and a quarter of patients with MCA occlusions will have concomitant ICA occlusions.[3,5] Morbidity and mortality are higher in these patients, while therapeutic approaches remain unclear.[3] Therapeutic strategies include combined intravenous and intraarterial thrombolysis by microcatheter navigation through the occluded ICA,[14] mechanical thrombectomy,[4,6] and angioplasty with or without stent placement of the occluded ICA.[2,7,11,13] However, there is concern that these multimodal approaches are time consuming and associated with high risk of complications. To our knowledge, there have been no reports describing the utilization of the combined approach of intravenous thrombolysis followed by ICA balloon angioplasty, as well MCA mechanical thrombectomy.

Abbreviations used in this paper: CCA = common carotid artery; ICA = internal carotid artery; MCA = middle cerebral artery; mRS = modified Rankin Scale; NIHSS = National Institutes of Health Stroke Scale; TICI = thrombolysis in cerebral infarction; TIM = tandem ICA/MCA; t-PA = tissue plasminogen factor; TTP = time to peak.

* Drs. Dababneh and Guerrero contributed equally to this work.

Methods

We screened the University of Florida and Shands stroke database for strokes occurring between January 2008 and September 2011. Two patients met the following inclusion criteria: 1) acute stroke presenting within 4.5 hours of symptom onset, 2) CT angiography demonstrating TIM occlusion with perfusion deficit, 3) received intravenous systemic thrombolysis, 4) underwent ICA balloon angioplasty, and 5) underwent subsequent MCA mechanical thrombectomy in which an aspiration retrieval device was used. Neither patient had evidence of hemorrhage on initial or postprocedure noncontrast head CT scan. The patients' demographics, pre– and post–endovascular intervention NIHSS score, and mRS score at 60 days are summarized in Table 1.

Case 1

This 18-year-old female college student with no medical history presented to the Shands emergency department with sudden left hemiplegia that she had experienced while driving. She subsequently loss of control of her car and had a low-speed collision. On presentation,

TABLE 1: Summary of patient demographics*

Case No.	Age (yrs), Sex	Admission NIHSS Score	IV t-PA	Successful Mechanical Recanalization†	NIHSS After Angioplasty & Thrombectomy	60-Day mRS Score
1	18, F	15	yes	yes	1	0
2	62, F	19	yes	yes	1	0

* IV = intravenous.
† Flow represents a TICI Grade 3.

her NIHSS score was 15. Computed tomography angiography showed a complete occlusion of the right CCA, ICA, and MCA. Perfusion CT scanning demonstrated increased TTP in the entire right MCA territory (Fig. 1A). The patient was treated with intravenous thrombolysis within 3 hours of stroke ictus, but no significant clinical improvement occurred. She then was taken emergently to the angiography suite, where she underwent right femoral catheterization; angiography demonstrated stenosis of the right CCA (Fig. 2A) and occlusion of ICA. Using a 6 × 40–mm Aviator balloon, right CCA and ICA angioplasty was performed. Multiple passes with repeated inflations to 10 atm were required for restoration of flow in the right CCA (Fig. 2B), as well as right ICA. Intracranial cerebral angiography demonstrated persistent occlusion of the proximal right MCA (Fig. 3C). Serial angiograms were acquired as a 041 Penumbra microcatheter was introduced to debulk and remove the thrombus, and a thrombectomy was accomplished. The proximal M_1 segment had blood flow shown to have a TICI score of 3 (Fig. 2D) after thrombectomy. Postprocedure MR imaging revealed a small diffusion weighted–positive region in the right insular cortex (Fig. 1B).

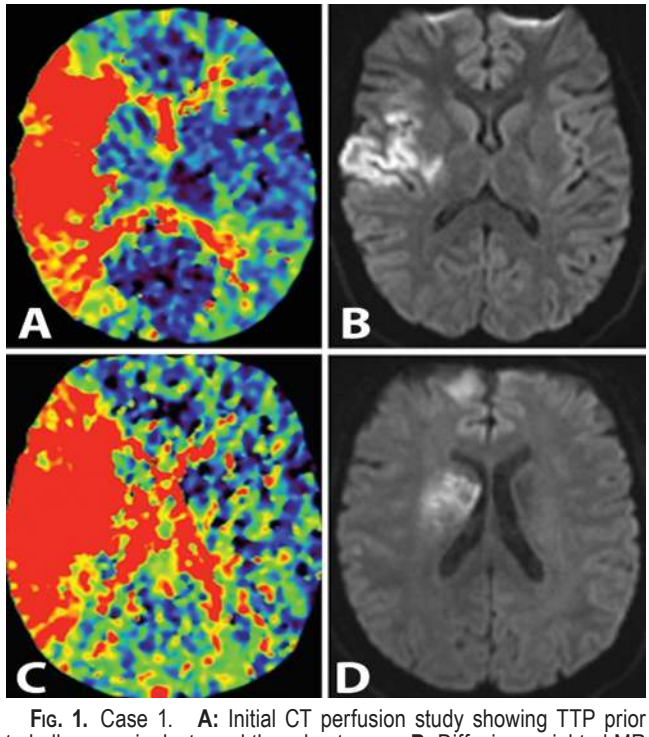

Fig. 1. Case 1. **A:** Initial CT perfusion study showing TTP prior to balloon angioplasty and thrombectomy. **B:** Diffusion-weighted MR image obtained after endovascular intervention. Preprocedure TTP (A) shows a large area of ischemia in the entire right MCA territory compared with smaller final infarct size (B) postprocedure. Case 2. **C:** Initial CT perfusion study showing TTP. **D:** Diffusion-weighted MR image acquired after the endovascular intervention. The TTP shows a larger area of ischemia in the right MCA territory preprocedure (C) compared with the final infarct size (D) postprocedure.

Case 2

This 62-year-old woman presented to the emergency department with sudden-onset left facial droop and hemiplegia. Her medical history was significant for coronary artery disease status after remote multiple cardiac bypasses, diabetes, and hypertension. On presentation, her NIHSS score was 19. Computed tomography angiography showed a complete occlusion of the right ICA and MCA. Perfusion CT scanning showed a large area in the right MCA territory of increased TTP (Fig. 1C). The patient was treated with intravenous thrombolysis, but no improvement occurred. She then underwent invasive catheterization, which revealed right ICA stenosis (Fig. 3A). Using an Aviator 4 × 15–mm balloon, balloon an-

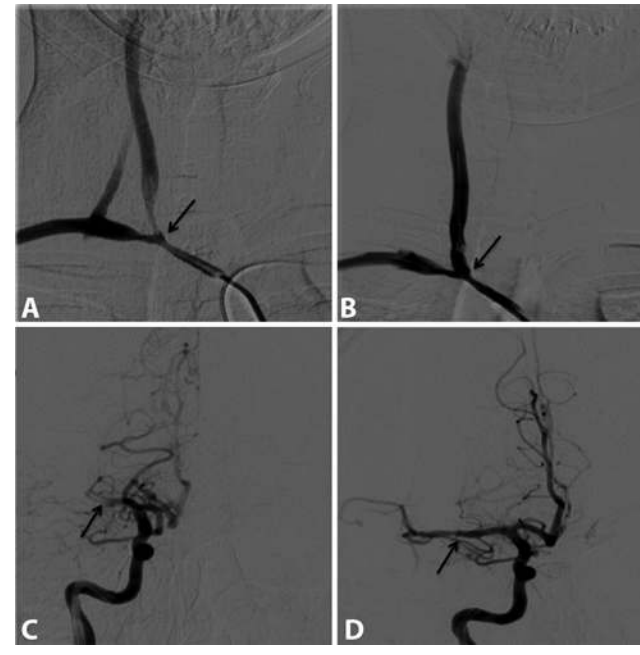

Fig. 2. **A:** Pretreatment selective right CCA angiogram (anteroposterior view) showing a stenosis at the origin *(arrow)*. **B:** Angiogram acquired after balloon angioplasty demonstrating complete recanalization of the right CCA *(arrow)*. **C:** Despite ICA flow restoration, the right M_1 segment remains occluded *(arrow)*. **D:** Angiogram revealing successful recanalization of the right MCA after thrombectomy *(arrow)*.

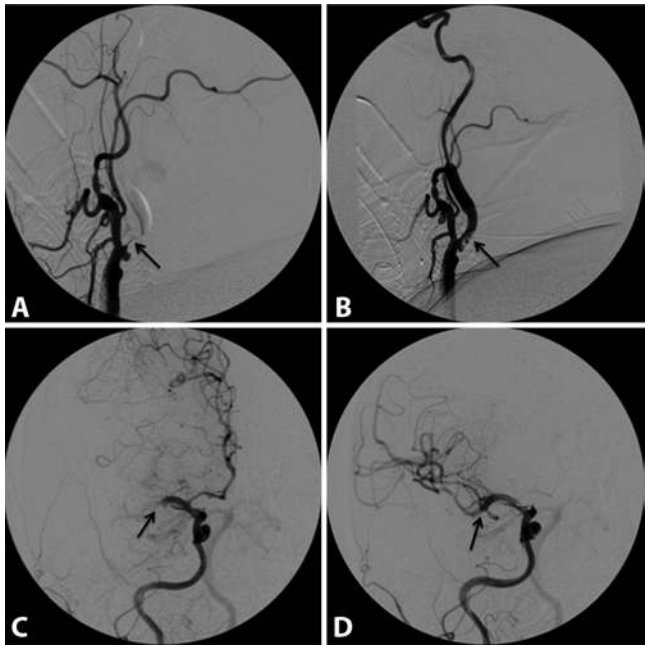

Fig. 3. **A:** Pretreatment selective angiogram of the right ICA showing a stenosis at the bifurcation of the right CCA *(arrow)*. **B:** Angiogram obtained after balloon angioplasty, demonstrating complete recanalization of the right ICA *(arrow)*. **C:** The right MCA M_1 segment remains occluded *(arrow)*. **D:** Successful recanalization of the right MCA after thrombectomy *(arrow)*.

gioplasty of the right ICA was performed with multiple passes, and repeated inflations were required for restoration of flow (Fig. 3B). Cerebral angiography showed a persistent thrombus in the right MCA. A 041 Penumbra microcatheter was then introduced to debulk and remove the M_1 segment thrombus (Fig. 3C). A TICI score of 3 was also achieved in the proximal M_1 segment (Fig. 3D). Postprocedure MR imaging demonstrated a right subcortical infarct (Fig. 3D).

Results

Both patients were female. Both patients presented with conventional angiography–documented tandem ICA and proximal MCA occlusions. Intravenous recombinant t-PA was given to both patients within 3 hours of ictus and each underwent balloon angioplasty of the ICA followed by MCA thrombectomy. Successful recanalization with restoration of TICI Grade III flow was achieved in each case. There were no peri- or postprocedural complications. Postprocedural noncontrast head CT revealed no hemorrhage. Prior to discharge, each patient had a 1-week NIHSS score of 1, with minor lower face weakness. Furthermore, both patients had a mRS score of 0 at 60 days.

Discussion

The 2 patients who presented with tandem occlusion within 3 hours of symptom onset were eligible and did receive intravenous thrombolysis. However, at the time of endovascular procedure neither patient had noticeable improvement in their clinical status, suggesting persistent MCA occlusions despite intravenous t-PA therapy. This is not surprising given previous reports stating that in the presence of tandem occlusions, an ICA occlusion likely reduces the delivery of systemic recombinant t-PA to the MCA thrombus.[15] Tandem occlusions have lower predicted rates of recanalization and worse outcomes than solitary MCA occlusions when using intravenous thrombolytics.[16] Moreover, a tandem occlusion is an independent predictor of early reocclusion after t-PA–induced recanalization.[15]

Given the lowered incidence of revascularization with intravenous t-PA in this clinical setting, we used an endovascular approach combining balloon angioplasty of the extracranial carotid arteries followed by revascularization of the MCA in which a penumbra retrieval device was used. Recently, various studies have reported successful navigation through an occluded ICA to dissolve a distal MCA clot.[9,14,17] Lavallée et al.[10] compared endovascular stent-assisted thrombolysis (6 patients) and intravenous recombinant t-PA (4 patients). The NIHSS score was comparable in both groups before treatment, but the 3-month outcome was poorer in the intravenous thrombolysis group than the endovascular group. Four patients in the endovascular group had an mRS score of 0 at 3 months and 3 patients in the t-PA group had an mRS score exceeding 3. Furthermore, Baumgartner et al.[1] reported a series of patients with ICA dissection causing tandem occlusion. Four patients underwent carotid artery stenting followed by intraarterial thrombolysis, and 14 were treated with intravenous thrombolysis according to the NINDS (National Institute of Neurological Disorders and Stroke) criteria. The 3-month outcome was similar in the 2 groups.

The benefits of ICA recanalization with balloon angioplasty prior to MCA revascularization include creating direct access for thrombolytics to an MCA thrombus. Successful recanalization with flow determined to be a TICI score of 2b or 3 was achieved in both patients. Additionally, both patients had good early neurological improvement as defined by a reduction in their NIHSS score by greater than 10 points. In 1 case immediate neurological improvement was observed in the angiography suite. Although limited by numbers, this is in contrast to a report by Kim et al.,[8] in which 25% early neurological improvement was achieved at 24 hours when using intravenous thrombolysis in tandem occlusions. A randomized trial comparing intravenous thrombolysis and a combined approach of intravenous thrombolysis and endovascular treatment in patients with tandem occlusions would provide definitive evidence.

The theoretical risks of endovascular recanalization include blind probing with a microguidewire and manipulation of a microcatheter, which can potentially lead to vessel dissection or perforation, entrance of a false lumen of an ICA dissection, or dislodgment of a thrombus while crossing the ICA occlusion. There is also the risk of hyperperfusion syndrome increasing the likelihood of intracerebral hemorrhage.[12] However, we did not encounter such complications during extracranial ICA balloon angioplasty and MCA thrombectomy with the Penumbra retrieval device. Post-recanalization blood pressures were

normalized in each instance in an effort to decrease the likelihood of hemorrhagic conversion. Clinical deterioration during the hospitalization of our patients was not observed, and within 1 week both patients were discharged to home.

Conclusions

There are no current guidelines for treatment of TIM occlusions. The present cases illustrate the potential utility and effectiveness of a multimodal approach of systemic intravenous thrombolysis followed by ICA angioplasty and MCA thrombectomy using Penumbra retrieval device for reperfusion of TIM occlusions.

Disclosure

Dr. Mocco is a consultant for Concentric and Lazarus Effect and receives honoraria from Edge Therapeutics.

Author contributions to the study and manuscript preparation include the following. Conception and design: Dababneh, Guerrero. Acquisition of data: Dababneh, Guerrero. Analysis and interpretation of data: Dababneh, Guerrero. Drafting the article: Dababneh, Guerrero. Critically revising the article: all authors. Reviewed submitted version of manuscript: all authors. Approved the final version of the manuscript on behalf of all authors: Dababneh. Statistical analysis: Dababneh, Guerrero. Administrative/technical/material support: Dababneh, Guerrero. Study supervision: Dababneh, Guerrero.

References

1. Baumgartner RW, Georgiadis D, Nedeltchev K, Schroth G, Sarikaya H, Arnold M: Stent-assisted endovascular thrombolysis versus intravenous thrombolysis in internal carotid artery dissection with tandem internal carotid and middle cerebral artery occlusion. **Stroke 39:**e27–e28, 2008 (Letter)
2. Chesebro JH, Knatterud G, Roberts R, Borer J, Cohen LS, Dalen J, et al: Thrombolysis in Myocardial Infarction (TIMI) Trial, Phase I: a comparison between intravenous tissue plasminogen activator and intravenous streptokinase. Clinical findings through hospital discharge. **Circulation 76:**142–154, 1987
3. Christou I, Felberg RA, Demchuk AM, Burgin WS, Malkoff M, Grotta JC, et al: Intravenous tissue plasminogen activator and flow improvement in acute ischemic stroke patients with internal carotid artery occlusion. **J Neuroimaging 12:**119–123, 2002
4. Dabitz R, Triebe S, Leppmeier U, Ochs G, Vorwerk D: Percutaneous recanalization of acute internal carotid artery occlusions in patients with severe stroke. **Cardiovasc Intervent Radiol 30:**34–41, 2007
5. El-Mitwalli A, Saad M, Christou I, Malkoff M, Alexandrov AV: Clinical and sonographic patterns of tandem internal carotid artery/middle cerebral artery occlusion in tissue plasminogen activator-treated patients. **Stroke 33:**99–102, 2002
6. Flint AC, Duckwiler GR, Budzik RF, Liebeskind DS, Smith WS: Mechanical thrombectomy of intracranial internal carotid occlusion: pooled results of the MERCI and Multi MERCI Part I trials. **Stroke 38:**1274–1280, 2007
7. Jovin TG, Gupta R, Uchino K, Jungreis CA, Wechsler LR, Hammer MD, et al: Emergent stenting of extracranial internal carotid artery occlusion in acute stroke has a high revascularization rate. **Stroke 36:**2426–2430, 2005
8. Kim YS, Garami Z, Mikulik R, Molina CA, Alexandrov AV: Early recanalization rates and clinical outcomes in patients with tandem internal carotid artery/middle cerebral artery occlusion and isolated middle cerebral artery occlusion. **Stroke 36:**869–871, 2005
9. Komiyama M, Nishio A, Nishijima Y: Endovascular treatment of acute thrombotic occlusion of the cervical internal carotid artery associated with embolic occlusion of the middle cerebral artery: case report. **Neurosurgery 34:**359–364, 1994
10. Lavallée PC, Mazighi M, Saint-Maurice JP, Meseguer E, Abboud H, Klein IF, et al: Stent-assisted endovascular thrombolysis versus intravenous thrombolysis in internal carotid artery dissection with tandem internal carotid and middle cerebral artery occlusion. **Stroke 38:**2270–2274, 2007
11. Lum C, Stys PK, Hogan MJ, Nguyen TB, Srinivasan A, Goyal M: Acute anterior circulation stroke: recanalization using clot angioplasty. **Can J Neurol Sci 33:**217–222, 2006
12. Meyers PM, Higashida RT, Phatouros CC, Malek AM, Lempert TE, Dowd CF, et al: Cerebral hyperperfusion syndrome after percutaneous transluminal stenting of the craniocervical arteries. **Neurosurgery 47:**335–345, 2000
13. Mori T, Kazita K, Mima T, Mori K: Balloon angioplasty for embolic total occlusion of the middle cerebral artery and ipsilateral carotid stenting in an acute stroke stage. **AJNR Am J Neuroradiol 20:**1462–1464, 1999
14. Nesbit GM, Clark WM, O'Neill OR, Barnwell SL: Intracranial intraarterial thrombolysis facilitated by microcatheter navigation through an occluded cervical internal carotid artery. **J Neurosurg 84:**387–392, 1996
15. Rubiera M, Alvarez-Sabín J, Ribo M, Montaner J, Santamarina E, Arenillas JF, et al: Predictors of early arterial reocclusion after tissue plasminogen activator-induced recanalization in acute ischemic stroke. **Stroke 36:**1452–1456, 2005
16. Rubiera M, Ribo M, Delgado-Mederos R, Santamarina E, Delgado P, Montaner J, et al: Tandem internal carotid artery/middle cerebral artery occlusion: an independent predictor of poor outcome after systemic thrombolysis. **Stroke 37:**2301–2305, 2006
17. Wang H, Lanzino G, Fraser K, Tracy P, Wang D: Urgent endovascular treatment of acute symptomatic occlusion of the cervical internal carotid artery. **J Neurosurg 99:**972–977, 2003

Manuscript submitted December 6, 2011.
Accepted January 12, 2012.

Current affiliation for Dr. Mocco: Department of Neurological Surgery, Vanderbilt University Medical Center, Nashville, Tennessee.

Please include this information when citing this paper: DOI: 10.3171/2012.1.FOCUS11350.

Address correspondence to: Haitham Dababneh, M.D., Department of Neurology, University of Florida, College of Medicine, HSC Box 100236, Gainesville, Florida 32610-0236. email: haitham.dababneh@neurology.ufl.edu.