

WHAT WOULD YOU DO?

Carotid Occlusion With Middle Cerebral Artery Thrombus

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CASE PRESENTATION

A 54-year-old woman with a history of hypertension presented with left upper extremity weakness and facial droop with a National Institutes of Health Stroke Scale (NIHSS) score of 12. She was last seen normal at 15:25 and presented to the hospital at 16:53. She had been found by her daughter on the floor at approximately 16:00 and was unable to communicate due to dysarthria and confusion. Results of CT of the head at the hospital were interpreted as normal, and the neurology team administered tissue plasminogen activator (tPA).



What is your next step?

- MRI/MRA
- CTA
- CT perfusion imaging
- Proceed directly to the angiographic/interventional suite
- Other

Dr. Rai: The next step would be a rapid and comprehensive imaging evaluation. At our institution, this has included vascular imaging with CTA and CT perfusion. The CTA is performed from the aortic arch to the cranial vertex. The extracranial imaging allows for evaluation of vascular access, especially tortuosity,

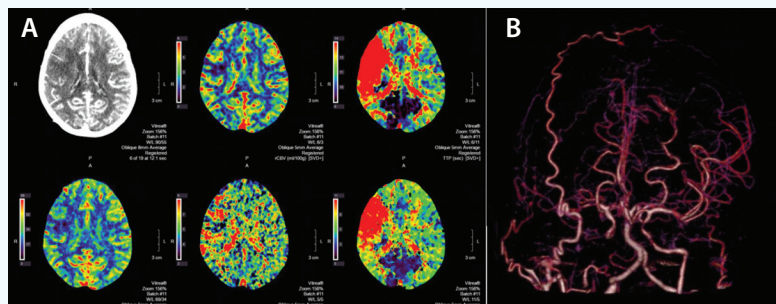


Figure 1. CT perfusion scan showing increased time to peak in the right MCA distribution with preserved volume and flow, suggestive of ischemic penumbra (A). Three-dimensional vessel reconstruction from this study (B).

stenosis, or occlusion. A whole brain CT perfusion is also included as part of the imaging evaluation. This helps determine salvageable versus irreversibly ischemic brain.

Dr. Turk: CTA is the next step. There is no need for perfusion imaging, as the patient presented within the 6-hour window. Our protocol has shifted to aggressively treating all strokes related to large vessel occlusion (LVO) within 6 hours irrespective of infarct burden. This move was driven by our inconsistency of Alberta Stroke Program Early CT Score (ASPECTS) scoring and the HERMES data showing that patients with large infarct burden (ASPECTS < 5) still potentially benefit from revascularization and are not injured from the procedure.

CASE CONTINUED

CTA and CT perfusion imaging are performed and demonstrate increased time to peak with mostly preserved cerebral blood volume and cerebral blood flow in the right middle cerebral artery (MCA), suggesting large viable penumbra with a small ischemic core and right internal carotid artery (ICA) and MCA occlusions (Figure 1). In addition, there is evidence of severe comparative reduction in time to peak in the posterior circulation, suggestive of bilateral carotid occlusion.

CTA confirms right ICA and left common carotid artery (CCA) occlusions with a tandem right M1 occlusion.



What do you do next?

Dr. Turk: The patient would go emergently to the angiography suite with plans to revascularize the symptomatic right ICA and right MCA. I would leave the left CCA alone, as this is likely chronic.

Dr. Rai: A three-dimensional reconstructed CTA image in an anteroposterior (AP) view shows an occluded cervical ICA on the right with retrograde filling of the intracranial ICA up to the distal petrous segment via the posterior communicating artery and possibly the anterior communicating artery. The right

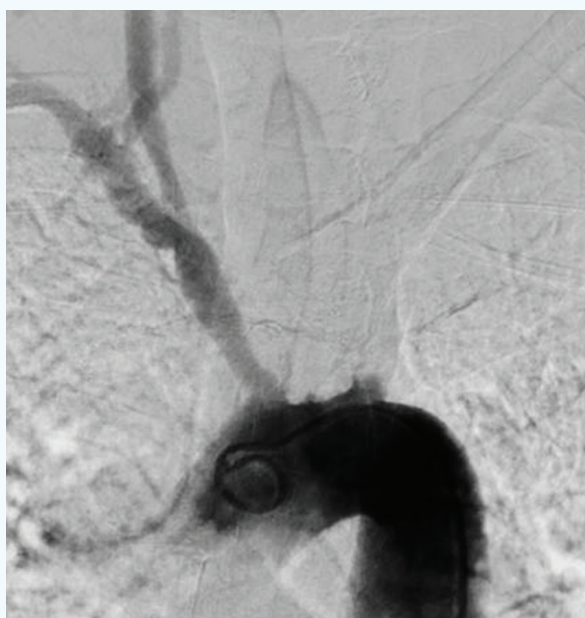


Figure 2. An aortic arch run showing a left CCA occlusion, as well as a left subclavian artery occlusion.

M1 segment is identified but the bifurcation branches are not well opacified. The accompanying perfusion images demonstrate some early ischemic changes on the source CTA images, with a corresponding increase in the mean transit time (MTT), mainly corresponding to the superior division of the MCA. The cerebral blood volume is mostly preserved, apart from a small area. An extracranial CTA would be helpful in assessing the level of occlusion of the right ICA, as well as access from the aortic arch. My assessment of the imaging is a tandem occlusion involving the right ICA and the right M2 superior division with favorable perfusion, indicating salvageable brain.

CASE CONTINUED

Given the concern for bilateral occlusions, an angiographic run of the aortic arch was performed using a 5-F pigtail catheter (Terumo Interventional Systems) to determine what approaches were available to the right MCA (Figure 2). It was our impression that the right ICA was the symptomatic vessel and recently occluded, potentially requiring acute carotid angioplasty and stenting.



How do you manage antiplatelet therapy and anticoagulation in the setting of acute administration of tPA and the need for acute cervical ICA stenting?

Dr. Rai: Our preferred approach to tandem occlusions is to revascularize the cervical occlusion with balloon angioplasty only and avoid acute stent placement. The rationale is to establish a route to the intracranial circulation to relieve the cerebral occlusion without acute stent placement, which can be a source of thrombotic complications. We have had a variable approach to antiplatelet therapy for tandem occlusions, and baseline imaging is critical in choosing an approach. If the CTA imaging, which includes the aortic arch and extra/intracranial vascular imaging, shows a tandem occlusion with viable brain, we prefer to hold the intravenous (IV) recombinant tPA and load the patient with 600 mg of clopidogrel and 650 mg of acetylsalicylic acid (ASA) via a nasogastric tube immediately. We will still aim for angioplasty of the extracranial occlusion but will be prepared if a stent is absolutely needed. In case the IV recombinant tPA is administered, we have used a weight-based dose of abciximab administered intravenously if a stent is placed and continued with antiplatelet therapy postoperatively after excluding major infarction on a noncontrast brain CT. If the deployed stent results in good resolution of the stenosis and is well

apposed without luminal irregularities, we have also used weight-based IV heparin and avoided administration of abciximab.

It is important to note that four of the seven recent trials for endovascular therapy allowed inclusion of tandem occlusions (MR CLEAN, ESCAPE, REVASCAT, and DEFUSE 3¹⁻⁴), although the definition of tandem was variable, ranging from stenosis to complete occlusion. The number of these cases was relatively small, but the trends clearly favored endovascular therapy for these cases, as shown by the HERMES study.⁵ However, despite showing efficacy for endovascular therapy, HERMES subgroup analysis highlighted the heterogeneity of treatment approaches without showing benefit of one approach over the other (ie, angioplasty alone vs stenting vs only recanalization of the intracranial occlusion if possible).⁵ Given the lack of clear evidence supporting one strategy over another, we have chosen to adopt the least “invasive” option (ie, angioplasty alone) and avoid acute large-dose antiplatelet administration.

Dr. Turk: We always treat tandem occlusions with angioplasty and stenting of the proximal cervical ICA occlusion first.⁶ Then, we perform aspiration thrombectomy of any distal occlusions. Upon delivery of the stent, we administer a weight-based loading dose of abciximab (we do not place the patient on subsequent drip). At the end of procedure, we administer 600 mg of clopidogrel and 650 mg of ASA. With this approach, as the effect of abciximab wears off over 4 to 5 hours after administration, the clopidogrel then becomes therapeutic. We typically do not give heparin, or if we do, it is a low dose (2,000 units loading only). We have found that previous administration of tPA is not usually a problem due to the very short half-life. If the patient presents in the angiography suite with the tPA infusion still running, we typically stop it before we start the case. After the procedure, we carefully manage the patient’s blood pressure to avoid hypertension and minimize the risk of intracranial bleeding.

CASE CONTINUED

At our institution, because of the poor outcomes for patients with carotid occlusions who receive tPA (with nearly 0% of these lesions revascularized according to the literature), we tend to hold tPA and administer dual antiplatelet therapy. In addition, the investigators of the ARTIS trial demonstrated that tPA with antiplatelet therapy increases the risk of symptomatic intracranial hemorrhage. If tPA has already been given,

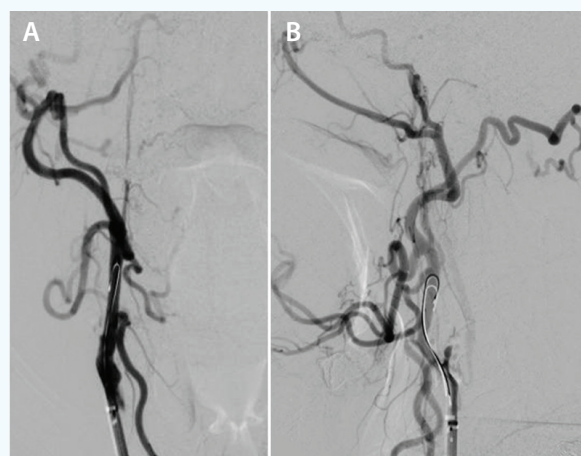


Figure 3. AP (A) and lateral (B) cervical right CCA runs demonstrating an ICA occlusion.

administering a loading dose of ASA and ticagrelor and checking P2Y₁₂ reaction units immediately after the procedure to titrate the antiplatelet therapy are crucial steps. We administered 180 mg of ticagrelor and 81 mg of ASA via a nasogastric tube and 3,000 units of heparin for this 60-kg patient. The activated coagulation time was measured at 257 seconds.



How do you approach the lesion, and what factors do you consider when selecting guide catheters (Figure 3)?

Dr. Turk: We would use a 6-F Neuron Max guide sheath (Penumbra, Inc.). This provides enough support and is large enough to accommodate any device needed for the carotid stent and thrombectomy portions of the case. I would advance this over a Vitek catheter (Cook Medical) insert and 0.038-inch Glidewire (Terumo Interventional Systems) to the ICA occlusion. Because there is no flow distal to the calcified plaque at the carotid bulb, I would first direct access with an 0.014-inch Synchro wire (Stryker Neurovascular) and 5- X 20-mm RX Apex balloon (Boston Scientific Corporation). If the carotid lesion was subocclusive, I would direct access with a microcatheter and exchange this for a Spider FX distal protection device (Medtronic). During balloon inflation, make sure to have atropine available and watch the heart rate in case the patient becomes bradycardic or asystolic. After angioplasty, I would then exchange for a Precise nitinol stent (Boston Scientific Corporation) that is 1 mm larger than the CCA diameter and deploy across the diseased segment from normal distal vessel to normal proximal vessel.

Dr. Rai: Our general access approach for endovascular stroke interventions involves a balloon guide catheter. However, for tandem occlusions with the need for angioplasty and possible stenting, I prefer the 6-F Shuttle sheath (Cook Medical), which serves as a more stable platform. Our initial attempt would be to perform balloon angioplasty for the cervical ICA occlusion. For balloon angioplasty, we use a 5- X 20-mm Viatrac balloon (Abbott Vascular). At times, we start with a 2-mm balloon and then dilate up to a higher caliber. If balloon angioplasty is unsuccessful, we will stent the occlusion. After balloon angioplasty and/or stent placement, we assess the intracranial circulation, and if there is a LVO, we will access it using an intermediate catheter and a stent retriever.

CASE CONTINUED

Because there was terminal filling just beyond the plaque of the occlusive lesion at the carotid bifurca-

tion, the plan was to attempt to stent the carotid artery open, followed by an MCA thrombectomy. A 9-F Concentric balloon guide catheter (Stryker Neurovascular) was chosen to allow for proximal control and flow reversal during carotid stenting. In addition, we planned inflation of the balloon for flow reversal during the intracranial thrombectomy portion of the intervention. The 9-F guide catheter allows sufficient size for safe deployment of any carotid stent. A 0.038-inch exchange-length Glidewire, through a 5-F Vitek catheter, was used to deliver the 9-F Concentric balloon guide to the distal right CCA. An exchange-length Hi-Torque Spartacore wire (Abbott Vascular), 4- X 30-mm Aviator balloon (Cordis, a Cardinal Health company), and an 8- X 29-mm Wallstent (Boston Scientific Corporation) were selected for carotid angioplasty and stenting. The Hi-Torque Spartacore wire was chosen in this situation to cross the plaque and find the lumen of the vessel (Figure 4). The lesion was angioplastied under 9-F balloon guide inflation, followed by stent deployment. After aggressive aspiration from the inflated balloon guide catheter, we performed an intravascular ultrasound (Philips) study from the petrous ICA to the CCA, confirming no residual luminal thrombus. Thereafter, the bal-



Figure 4. AP (A) and lateral (B) cervical right CCA runs after carotid stent placement showing robust flow through the ICA.

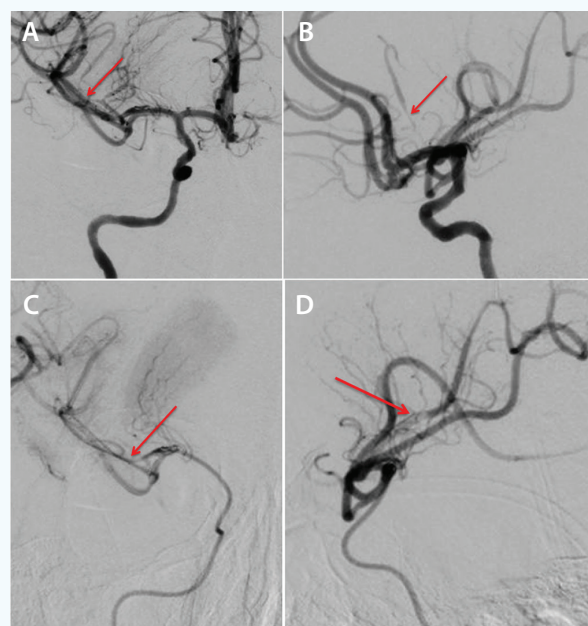


Figure 5. AP (A) and lateral (B) cranial runs showing sub-occlusive thrombus in the superior M2 branch. There is delayed filling of this vessel. AP (C) and lateral (D) magnified microcatheter runs demonstrating the same subocclusive thrombus in the superior M2 branch.

loon was deflated, and the balloon guide catheter was advanced through the stent into the distal cervical ICA (beyond the stent). Cranial runs were performed, showing thrombolysis in cerebral infarction (TICI) grade 2b revascularization of the M1 occlusion.



Given a TICI 2b revascularization with a concern for decreased flow in the superior M2 territory with evidence of collaterals flowing from the anterior cerebral artery into the affected area, it was difficult to discern if there was decreased flow through the superior M2 branch or whether there were multiple distal occlusions (Figure 5). Do you do anything further?

Dr. Rai: The intracranial angiogram after cervical revascularization with stent placement shows a partial frontal branch occlusion of the superior division. The MTT abnormality on the preoperative CT perfusion study is much larger than the localized branch occlusion, indicating interim recanalization of most of the main M2 occlusion. An M3 partial branch occlusion of the right superior division, especially with collateralization, is unlikely to result in major deficits and the risk/benefit may not favor aggressive intervention. Given the angiographic result after cervical ICA revascularization with patent M1 and M2 divisions, an M3 branch occlusion disproportionately smaller to the initial MTT abnormality, and IV recombinant tPA administration, I would not perform mechanical intervention. At most, I will administer 2 to 4 mg of local intra-arterial recombinant tPA and conclude the procedure.

M2 occlusions are reasonable targets for endovascular therapy. It is important to note that the classification of MCA segments is based on cadaveric studies for surgical anatomy. However, from an ischemic stroke point of view, the functional footprint of an M2 branch is more important than the anatomic categorization. For example, a dominant M2 can have a very large perfusion abnormality affecting more than two-thirds of the MCA distribution and thus presents with significant neurologic deficits and results in poor outcomes. On the other hand, a nondominant M2 can be neurologically benign without significant deficits. Thus, selection of patients with an M2 occlusion should not just be based on anatomy but should include the functional significance as shown by the extent of perfusion abnormality and the deficits on presentation. Recent population analysis of M2 occlusions from our center shows significantly poor outcomes for patients with M2 occlusions presenting with an NIHSS ≥ 9 versus

those < 9 .⁷ Thus, distal occlusions with higher deficits can functionally behave as LVOs and could be considered for treatment, increasing the scope of endovascular stroke therapy.⁷

Dr. Turk: Yes, because we are talking about M2 to M3 level occlusions, I would use the largest-size catheter that would fit the occluded vessel. Often, a 4MAX or 5MAX aspiration catheter (Penumbra, Inc.) will access this location. I would advance into the proximal MCA, where I would do more superselective runs. Often, a right anterior with Waters (caudal) oblique projection on the frontal projection works well to discern the level of occlusion(s).

CASE CONTINUED

A 0.025-inch Velocity microcatheter (Penumbra, Inc.) over a 0.014-inch Synchro 2 microwire was brought up to the distal M1 segment. Intra-arterial tPA (4 mg) was injected into the superior M2 branch. No significant changes in the filling of this vessel were noted.

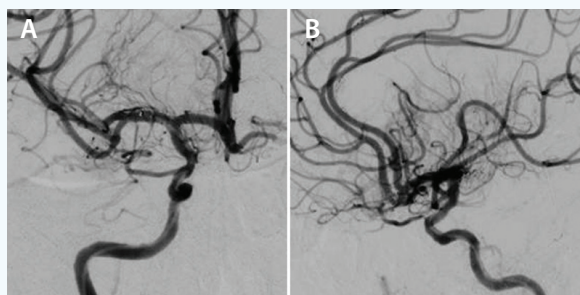


Figure 6. AP (A) and lateral (B) right ICA cranial runs showing a TICI grade 3 recanalization after ADAPT of the subocclusive thrombus from the superior M2 branch.



Figure 7. Thrombus retrieved from the ADAPT pass in the superior M2 branch displayed on a piece of gauze.



Would you do anything further?

Dr. Turk: I would advance the largest aspiration catheter to the level of occlusion and perform a direct aspiration first pass technique (ADAPT) or direct aspiration of the clot. This approach works as well in the distal small vessels as it does in proximal larger vessels.

Dr. Rai: No, as previously discussed, I would stop at this point because the benefit of recanalizing a right M3 partial branch occlusion, much smaller than the initial perfusion abnormality and with collateral support, is doubtful. Placing a distal catheter and/or stent retriever runs the risk of causing a complication.

CASE CONCLUSION

Additional views suggested partially occlusive thrombus in a proximal superior trunk M3 branch. A 4MAX aspiration catheter was then advanced over the Velocity microcatheter and Synchro microwire into the superior M3 branch until it was wedged to allow for ADAPT

for the subocclusive thrombus (Figures 6 and 7). TIC1 3 revascularization was obtained. An on-table cone-beam CT was obtained, which demonstrated no hemorrhage. Catheters were withdrawn, and the groin access site was closed with an 8-F Angio-Seal device (Terumo Interventional Systems).

The patient was seen in the neurointensive care unit on postprocedure day 1, and her NIHSS score was 0. She was maintained on dual antiplatelet therapy and discharged to home. ■

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