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Technique for transcarotid artery revascularization of tandem lesions

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ABSTRACT

The repair of tandem carotid lesions has been described using myriad methods, often involving a hybrid approach of stenting with carotid endarterectomy. Because of the worrisome stroke rates associated with this method, we have reported an innovative technique of transcarotid artery revascularization (TCAR) for tandem lesions in a patient with high-grade stenosis of the right common and internal carotid arteries. Technical success was achieved with TCAR via retrograde and antegrade access using dynamic flow reversal for the treatment of both lesions. The patient experienced no postoperative complications, highlighting the successful repair of tandem carotid lesions using TCAR in a patient who is too high risk for carotid endarterectomy. (J Vasc Surg Cases and Innovative Techniques 2021;7:148-51.)

Keywords: Carotid artery stenting; Flow reversal; Tandem lesion; Tandem carotid stenosis; TCAR; Transcarotid artery revascularization

Carotid artery stenosis has been extensively studied to allow for improvements in stroke prevention. Carotid endarterectomy (CEA) has been recommended as first-line treatment of patients with symptomatic or high-grade asymptomatic extracranial carotid stenosis, with carotid artery stenting (CAS) advised for symptomatic patients who are too high risk to undergo CEA.[1] However, transcarotid artery revascularization (TCAR) has been emerging as an attractive alternative to CEA with procedural success. The postoperative stroke rate for high-risk patients was 0.6% for TCAR and 2.3% for CEA in two separate trials.[2,3] Tandem internal carotid artery (ICA) and common carotid artery (CCA) stenoses occur with an incidence of 2.1%[4] and can be associated with a greater rate of postoperative stroke after hybrid repair compared with that after isolated CEA (3.0% vs 1.4%).[5] We have described the technical aspects for successful treatment of high-grade tandem carotid stenoses with TCAR in a high-risk patient. The patient provided written informed consent for the report of his case details and images, and institutional review board approval was not required at our institution.

CASE REPORT

A 64-year-old man with asymptomatic high-grade stenoses of the right CCA and ICA was referred after a previous unsuccessful attempt at transfemoral CAS given his type III aortic arch. Preoperative computed tomography angiography, carotid duplex ultrasonography, and angiography demonstrated >80% stenosis of both the right CCA and the right ICA and 60% to 70% stenosis of the left ICA using the NASCET (North American Symptomatic Carotid Endarterectomy Trial) criteria. He was high risk for CEA because of his history of myocardial infarction with percutaneous coronary intervention and three-vessel stenting 10 months prior and an ejection fraction of 20%. He was living independently and had had New York Heart Association class I symptoms from ischemic cardiomyopathy. He was already taking dual antiplatelet therapy.

The patient was at high risk for CEA because of his congestive heart failure, cardiovascular disease, and contralateral carotid stenosis. Thus, we believed TCAR would be a good alternative to protect against embolization during retrograde stenting. A longitudinal neck incision of ∼4 cm was performed, instead of our usual 2-to 3-cm transverse incision, to expose a longer length of the CCA than typically required for routine antegrade TCAR. The operating room was arranged to accommodate both antegrade and retrograde access, with the surgeon and assistant positioned on opposite sides of the table (Fig 1). The patient received heparin for anticoagulation, and a purse-string suture was placed at the distalmost aspect of the exposed CCA to maximize the length of the CCA for retrograde sheath placement. The CCA was punctured retrogradely, a micropuncture sheath was advanced, and an angiogram was performed, which demonstrated >80% stenosis just distal to the origin of the right CCA (Fig 2, *A*). Very little length was available to place a stiff wire

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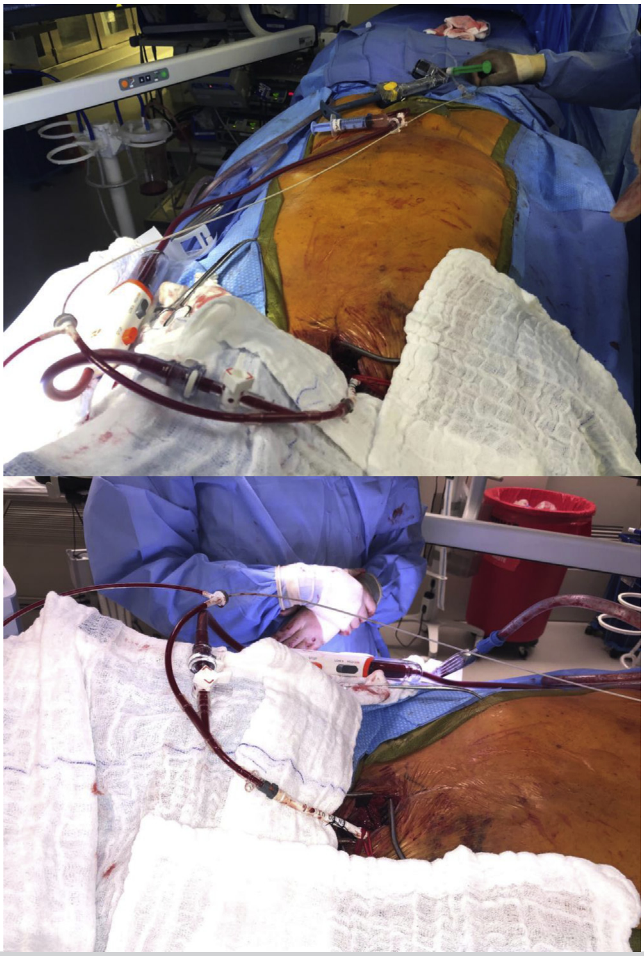

Fig 1. Photographs showing operating room setup for retrograde carotid access.

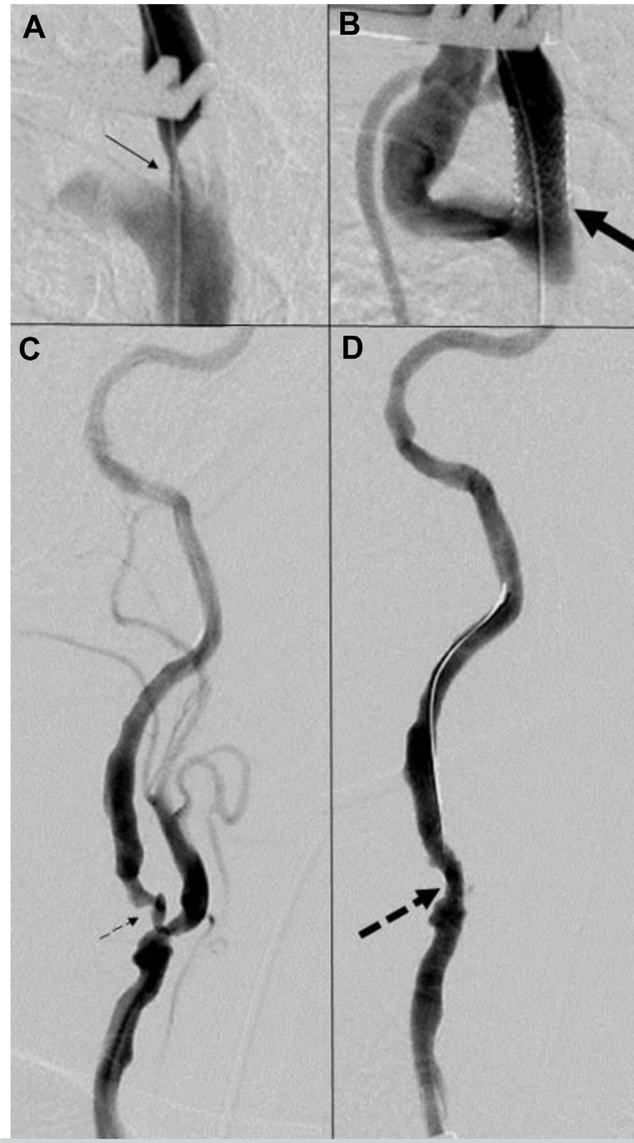

Fig 2. Angiographic images of right common carotid artery (CCA) and right internal carotid artery (ICA) before (**Left**) and after (**Right**) transcarotid artery revascularization (TCAR) demonstrating pretreatment >80% stenosis of right CCA (*thin solid arrow*) **(A)**, no residual stenosis of right CCA after stenting (*thick solid arrow*) **(B)**, pretreatment >80% stenosis of right ICA with significant tortuosity (*thin dotted arrow*) **(C)**, and right ICA after stenting with 20% residual stenosis and occlusion of right external carotid artery (ECA; *thick dotted arrow*) **(D)**.

distal to the lesion to advance the ENROUTE sheath (Silk Road Medical, Sunnyvale, Calif). Therefore, a 0.014-in. wire was used to carefully cross the stenosis, and the micropuncture sheath was then advanced into the innominate artery with the distal CCA clamped. A 180-cm Rosen wire (Cook Medical, Bloomington, Ind) was then placed into the innominate artery, over which the ENROUTE sheath (Silk Road Medical) was placed retrogradely into the CCA and secured to the skin. The Rosen wire (Cook Medical) was selected because of its curved atraumatic tip, which can limit wire-induced injury, and for mechanical support to enable ENROUTE sheath (Silk Road Medical) placement and subsequent iCast stent (Atrium Medical, Merrimack, NH) placement without the need for another wire exchange. Advancing the wire retrogradely from the patient's left side without causing bowing of the wire requires two skilled participants to allow the sheath to be secured simultaneously. The left common femoral vein was accessed, and active flow protection was begun. The CCA lesion was predilated with a 4- × 60-mm balloon and stented with a 7- × 22-mm iCast stent (Atrium Medical) just past the origin of the CCA. Initially, after deployment, the distal aspect of the stent was not completely opposed against the luminal wall of the CCA. Therefore, it was post-dilated with a 9- × 40-mm balloon. The completion angiogram demonstrated no residual stenosis (Fig 2, *B*). After 2 minutes of active flow protection, the sheath was removed, and the arteriotomy was flushed and closed.

Another purse-string suture was placed around the exposed CCA, and the same ENROUTE sheath (Silk Road Medical) was placed antegradely in standard fashion in a location proximal to the previous puncture site. This maneuver was required owing to the relatively short distance between the right CCA

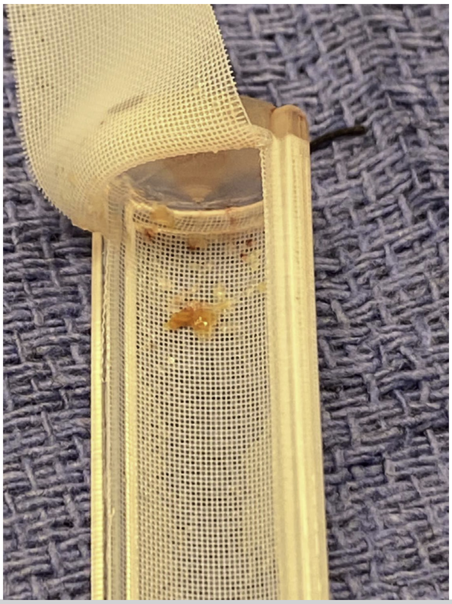

Fig 3. Photograph showing plaque and debris captured by filter during flow reversal.

and the right ICA stenoses. Because the left CCA will typically be longer than the right, this might be less of an issue on the left side. The angiogram demonstrated >80% stenosis of the right ICA, which was very tortuous (Fig 2, *C*). After beginning active flow reversal with the proximal CCA clamped, the lesion was crossed with the 0.014-in. wire and predilated with a 4- × 20-mm balloon. Next, a 7-m × 40-mm ENROUTE stent (Silk Road Medical) was deployed. Completion angiogram demonstrated ∼20% residual stenosis with occlusion of the external carotid artery (ECA; Fig 2, *D*). After 2 minutes of flow reversal, the sheath was removed, the arteriotomy was closed, and the heparin was reversed with protamine. Inspection of the filter after treatment of both lesions revealed the capture of significant atheromatous debris that could have embolized to the brain in the absence of flow protection (Fig 3). The patient recovered well with no neurologic changes or cardiovascular complications and was discharged the next day.

DISCUSSION

A meta-analysis of CEA with retrograde CAS reported a 1.5% combined 30-day mortality and stroke rate.[6] However, a subsequent multicenter study of tandem carotid stenoses treated with a hybrid technique found an early stroke and death rate of 11.3%, giving pause to many providers faced with tandem carotid lesions.[7] The increased risk assumed when treating this demographic was noted by Beach et al,[8] with a 9% combined 30-day stroke and death rate after 22 hybrid repairs for tandem carotid lesions compared with the 0.8% composite 30-day stroke and death rate reported by the ROADSTER 2 study (post-approval study of transcarotid artery revascularization in patients with significant carotid artery disease).[2] Transfemoral stenting of tandem carotid lesions is technically challenging and carries a high risk owing to the requirement of crossing a tight ostial lesion without support, exchanging wires in the CCA without cerebral protection and the treatment of multiple lesions that could have independent risks of embolization. A modified TCAR technique such as we have described could be a viable alternative to improve the perioperative stroke rates when treating tandem carotid lesions. Balceniuk et al[9] reported on the use of TCAR for retrograde lesions in a limited case series. However, more data are needed to assess the outcomes. Our intention was to describe a detailed technique for replication in appropriate cases.

TCAR will often be selected for patients with significant cardiac comorbidities, which has surprisingly not negatively affected the incidence of perioperative cardiovascular complications. A recent analysis of the Vascular Quality Initiative TCAR Surveillance Project demonstrated a lower incidence of postoperative myocardial infarction after TCAR compared with that after CEA,[10] highlighting the safety of the technique, regardless of the potentially confounding covariates.

We have typically used covered stents to treat CCA lesions because of some data showing that patency might be better with decreased reintervention rates.[11] Additionally, some potential risk of plaque protrusion through the cells of an uncovered balloon expandable stent exists, which has been associated with an increased risk of ischemic stroke.[12]

The choice of anesthesia type for carotid intervention has been widely studied across different approaches to mitigate risk for patients with poor cardiac health. TCAR performed with the patient under local or general anesthesia yielded comparable rates of myocardial infarction in a retrospective review of Vascular Quality Initiative data.[13] This finding supports our decision to perform the present case with the patient under general anesthesia, which did not negatively affect our patient's recovery.

Our patient's ipsilateral ECA was occluded but without clinical significance. This is a known phenomenon, and the rate of ECA occlusion after CAS has been significantly greater than that after CEA (3.8% vs 0.4%; $P = .04$).[14] ECA occlusion after TCAR has been poorly studied butpresumably would be similar to the incidence after CAS.

CONCLUSION

TCAR is a viable treatment of tandem carotid stenoses in high-risk patients and has the potential to improve the perioperative stroke rates. The specific nuances to this technique include a generous longitudinal skin incision of ≥4 cm to accommodate CCA exposure for two separate access sites and the use of a trained assistant for managing the curvature of the wire during retrograde CCA stenting. Careful crossing of the proximal lesion may be necessary before instituting flow protection, which poses the possibility of distal embolization, especially to the contralateral carotid artery. To mitigate against the risk of ipsilateral embolization, we recommend clamping the CCA just distal to the access site during this maneuver, which is usually well tolerated, and flushing the carotid arteriotomy antegradely and retrogradely after removing the sheath.

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