

# TCAR Mastery: Five Technical Tips for Successful Outcomes

Practical guidance from a high-volume center on procedural planning, team coordination, carotid access, and technical execution of TCAR.

By Irina Kanzafarova, MD, and Michael Stoner, MD, FACS, DFSVS

The concept of cerebral flow reversal during carotid procedures for neuroprotection was first investigated in the late 1990s by Dr. Juan Parodi and his group, based on intraoperative observations of good tolerance of flow reversal on transcranial duplex ultrasound in an awake patient during shunt insertion for carotid endarterectomy (CEA).<sup>1</sup> It took more than a decade of trials and system refinement before, in 2015, the FDA approved transcarotid artery revascularization (TCAR) and its associated neuroprotection and stent system (Enroute transcarotid stent system, Boston Scientific Corporation) for patients at high surgical risk for traditional open surgery.<sup>2</sup> In 2022, the FDA expanded this approval to include patients with carotid disease at standard risk of complications.<sup>3</sup>

Our institution was among the first to include TCAR as a treatment option for patients with carotid stenosis. Now, with extensive experience as a high-volume center, our team can share several tips to enhance outcomes after TCAR.



## **A good preoperative plan is 50% of the success.**

Preparation for any surgical elective case should begin well before the surgical date, with a review of comorbidities and available scans. Reviewing preoperative CTA for TCAR inclusion based on anatomic instructions for use

(IFU) criteria is essential; however, we also consider surrounding structures and anatomic variations for surgical planning, such as overlying thyroid tissue, common carotid artery (CCA) depth > 4 cm, severe tortuosity of the CCA, and clavicular deformities. Focusing on the quality of the carotid plaque, along with the anatomy of the distal internal carotid artery (ICA) and the intracranial atherosclerotic burden, may assist in selecting appropriate cases. Reviewing the neck CTA may help choose a side for arterial line placement for precise intraoperative blood pressure (BP) monitoring to avoid BP tracing from a nearly occluded subclavian artery.



## **Optimal patient positioning and operating room (OR) ergonomics will reduce extra movements and save time during the case.**

In our practice, we aim to perform all TCAR cases in the hybrid OR with a standard image intensifier positioned at 45° to the left at the head of the table; this allows for smooth image intensifier movement during the case and optimal, ergonomic positioning for the surgeon and first assistant across from each other. We also recommend checking the positioning of electrocardiographic leads and other anesthesia monitoring device wires before draping the patient for surgery, as it can be time-consuming to determine which wire or cord is visible in

the surgical field on fluoroscopy after carotid exposure and then remove it from view during the procedure.

Although a shoulder roll is routinely used to optimize positioning during CEA, it is usually unnecessary for carotid exposure at the neck base in TCAR. Turning the patient's head to the opposite side of the surgical site typically provides sufficient exposure. Additionally, after positioning the patient on the table, ultrasound can be employed to locate the carotid artery, helping speed up the exposure process. This can be done in addition to marking standard anatomic landmarks such as the sternum, clavicle, and the heads of the sternocleidomastoid muscle.



### **Clear communication is crucial in high-stakes cases.**

This practical tip is vital for TCAR cases because it emphasizes the importance of ongoing, timely communication with the surgical team, your assistant, radiologic technologist, and anesthesia team. Regardless of your team's experience level, it's advisable to review BP parameters and key intraoperative medications such as atropine, heparin, and protamine with the anesthesia team; ensure activated clotting time (ACT) checks and goals are clear; and confirm the availability of necessary and backup equipment with the surgical team. Also, keep in mind that achieving a desirable systolic BP (approximately 160 mm Hg) prior to carotid clamping, as well as administering heparin and checking ACT, takes time. Make sure to give the anesthesia team appropriate advance notice. We usually try to administer heparin before encircling the CCA with umbilical tape to reduce the risk of microembolization during CCA manipulation. Our ACT goal is > 300 seconds prior to obtaining a carotid access.



### **Tension on the CCA should be maintained by the most experienced hand in the room throughout the case.**

TCAR steps are now highly standardized after > 10 years of procedural refinement. It involves a CCA exposure at the base of the neck via a vertical or transverse incision. In our practice, we favor a 3- to 4-cm transverse incision placed 1 cm above the clavicle because it aligns with Langer lines and yields better

cosmetic results. Very frequently, we need to transect the omohyoid muscle with cautery to access the carotid sheath at the base of the neck. The jugular vein is retracted medially, and care is taken not to damage the vagus nerve, which is usually located laterally and posteriorly to the CCA. Approximately 2 cm of the CCA is exposed—just enough to obtain circumferential control with umbilical tape. We prefer a triangular adventitial purse-string stitch with a 5-0 polypropylene suture on an RB-2 needle at the planned site of arterial cannulation, rather than a U-stitch. If possible, ultrasound-guided venous access is obtained in the contralateral vein, followed by insertion of a venous return sheath to position the Enroute neuroprotection flow reversal device across the patient's body, thereby increasing system stability.

After systemic heparinization, carotid access is obtained with a micropuncture needle through the previously placed adventitial purse-string suture. Maintaining steady back-tension on the umbilical tape is essential to ensure accurate micropuncture and minimize the risk of back-wall puncture. Additionally, the lead surgeon should apply gentle back-tension on the umbilical tape during micropuncture sheath insertion and Enroute arterial sheath placement. Excessive or insufficient tension on the carotid artery may cause dissection, complicating the procedure.



### **Pay close attention to the small steps.**

There are proponents of the "stop short" technique, in which a 0.035-inch exchange J-wire stops before the carotid bifurcation or proximal extent of the lesion, and alternately, the external carotid artery can be cannulated if lesion morphology allows. In both scenarios, we recommend performing sheath exchanges and wire manipulations under direct fluoroscopic visualization to exclude the possibility of the wire crossing the ICA lesion before initiating flow reversal. We prefer to suture the arterial access sheath with a slight forward tension on the skin at the edge of the incision and on the drape to decrease the risk of sheath migration during the case. The sheath is carefully aspirated and flushed with heparinized saline using syringes prefilled to reduce the risk of micro-air embolism. Then, the Enroute reverse-flow cerebral protection device flow controller is connected to the arterial access sheath. After allowing it to passively fill with arterial blood, it is connected to the venous return sheath. The TCAR pause is performed to ensure

necessary supplies are ready, ACT is therapeutic, and BP is in the desired range, and an appropriate stent is selected. The CCA is clamped, and passive flow reversal is confirmed. Cerebral angiography is performed with a gentle, slow dye injection, using a meticulous back-bleeding and aspiration technique prior to injection to prevent air embolism, and flow reversal is paused during angiography. We advocate for nominal 1:1 balloon sizing based on the maximal target ICA adventitial diameter. Routine postdilation is avoided to prevent plaque prolapse, where stent struts push through the plaque. It is only used if there is > 30% residual stenosis after stenting. A 2-minute washout period is adhered to, followed by posttreatment angiography. The wire is removed under flow reversal, and the carotid artery is unclamped. A preplaced purse-string stitch is then tied after removing the arterial sheath, following a brief back-bleeding (“burp”) of blood to clear any potential perisheath thrombus. Heparin is reversed with protamine, and after achieving meticulous hemostasis, the incision is closed in multiple layers.

## SUMMARY

The TCAR procedure has become a vital tool in the interventionalist’s arsenal for treating carotid disease. It is most effective when performed on carefully selected patients, with strict adherence to all procedural steps, attentive communication, and thorough knowledge of each phase. ■

1. Parodi J, Bates MC, Ohki T, Schönholz C. The history of proximal carotid protection and flow reversal to prevent stent angioplasty embolization. *Semin Vasc Surg*. 2018;31:9-14. doi: 10.1053/j.semvasc.2018.03.002
2. US Food and Drug Administration. Premarket approval (PMA): Enroute transcrotid stent system. May 18, 2015. Accessed August 20, 2026. <https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfpma/pma.cfm?id=P140026>
3. US Food and Drug Administration. Enroute transcrotid stent system—P140026/S016. April 28, 2022. Accessed August 20, 2026. <https://www.fda.gov/medical-devices/recently-approved-devices/enroute-transcrotid-stent-system-p140026s016>

## Irina Kanzafarova, MD

University of Rochester  
Rochester, New York  
*Disclosures: None.*

## Michael Stoner, MD, FACS, DFSVS

Professor and Chief  
Division of Vascular Surgery  
University of Rochester  
Rochester, New York  
[michael\\_stoner@urmc.rochester.edu](mailto:michael_stoner@urmc.rochester.edu)  
*Disclosures: Consultant to Boston Scientific Corporation.*