

Critical Decision Making in Carotid Embolic Protection

Carotid stenting in a patient with stenosis of the left external and internal carotid arteries.

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In September 2010, a 72-year-old man was admitted to the neurological department of his nearest hospital due to a transient ischemic attack with sudden weakness of the right arm and leg that continued for approximately 10 minutes. Cranial magnetic resonance imaging ruled out cerebral lesions. His risk factors included hypertension (adequately treated), hyperlipidemia, and peripheral arterial occlusive disease. Initial examinations included a duplex scan of the supra-aortic arteries, a transcranial Doppler examination, transthoracic and transesophageal echocardiography, and a 24-hour electrocardiogram. Diagnostics revealed a high-grade eccentric stenosis of the left internal carotid artery (ICA) and the left external carotid artery (ECA).

After informing the patient about different treatment modalities, clopidogrel and statins were added to his medication, and he was referred to our center for carotid stenting of the symptomatic left ICA. Angiography demonstrated a short, eccentric, high-grade stenosis of the left ICA, an ostial subtotal occlusion of the left ECA with slow flow, and a comparably large-lumen superior thyroid artery. As measured by angiography, the common carotid artery (CCA) measured 7 mm in diameter, and the ICA was 5 mm in diameter. The intracranial runs revealed adequate flow in both the anterior and middle cerebral artery.

DECISION POINT 1

Considering the patient suffered a transient ischemic attack 1 week before, would a proximal embolic protection device or a distal filter device be best in this situation?

Because the procedure was performed shortly after a cerebrovascular event, embolic complications were more likely to occur due to vulnerable plaques.¹⁻³ By providing complete

“In general, correct selection of embolic protection based on clinical aspects as well as on radiological features of the lesion is essential . . .”

protection through retrograde flow before lesion manipulation, the chance of microembolization of very small particles (< 80 µm in diameter) can theoretically be reduced by using a proximal occlusion device. These systems consist of a long introducer sheath with a balloon that is inflated in the CCA. A second balloon inflated in the ECA ensures the total blockade of the antegrade blood flow in the ICA. The proximal protection systems facilitate the cerebral vascular connections of the circle of Willis. After the occlusion of the CCA and ECA, the collateral flow through the circle of Willis creates so-called back pressure, which prevents antegrade flow in the ICA.

Although large, randomized studies comparing the clinical benefit of the different approaches are pending, it is conceivable that a proximal occlusion device could be beneficial in vulnerable lesions with fresh thrombus compared to a device that is placed distally and therefore requires unprotected crossing of the lesion. With the Mo.Ma system (Medtronic Invatec, Frauenfeld, Switzerland), the occlusion balloons of the ECA and CCA are mounted on the guiding catheter in a fixed distance. Therefore, in patients with significant stenosis of the ECA, positioning of the distal balloon is either cumbersome or, in some cases, not possible.⁴⁻⁵ In the situation of a total occlusion of the ECA, the sole occlusion of the CCA balloon may not establish complete blockage of

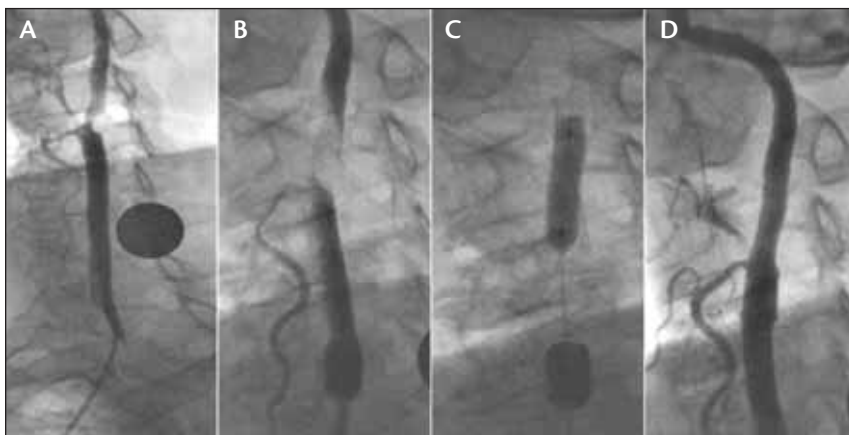


Figure 1. Angiography revealed an eccentric, high-grade stenosis of the left ICA and a subtotal occlusion of the left ECA. The superior thyroid artery originated from the CCA below the carotid bifurcation (A). After inflation of the proximal balloon in the CCA, a column of contrast remained in the CCA, and the contrast located in the ICA was washed out slowly. Forward flow to the intracranial arteries was still maintained via the superior thyroid artery and partially contributed to by the subtotally occluded ECA (B). Postdilation of the carotid stent while a distal filter and proximal protection device are in place (C). Final angiogram showed adequate flow in the ICA and no residual stenosis (D).

antegrade flow. The total occlusion may lie distal to the ostium of the most proximal branches of the ECA—the superior thyroid artery and lingual artery.

In our patient, the ECA was subtotally occluded at its ostium, with only slow flow through the external carotid lesion shown in angiographic imaging. In addition, the patient had an anatomical variation—the superior thyroid artery originated from the CCA below the carotid bifurcation and not as a side branch of the ECA distal to the subtotal lesion (Figure 1A). In this quite specific anatomy, the use of the Mo.Ma system was limited due to the previously mentioned specifications of the device. Unlike with the Mo.Ma device, the proximal and distal balloons of the Gore Flow Reversal system (Gore & Associates, Flagstaff, AZ) are mounted on two separate components. The distal balloon is mounted on the balloon wire, and the proximal balloon is located at the distal end of the introducer sheath. On the basis of these small advantages, the Gore Flow Reversal system was a viable alternative in our patient's anatomy because it allowed the operator to position the proximal occlusion balloon at any distance to the bifurcation. However, after positioning the proximal protection device and occluding the balloon in the CCA, a column of contrast remained in the CCA, and the contrast located in the ICA was washed out slowly. In this situation, forward flow to the intracranial arteries was still maintained via the superior thyroid artery, partially contributed to by the subtotally occluded ECA. Thus, ade-

quate cerebral protection was not achieved (Figure 1B).

DECISION POINT 2

What should you do when antegrade flow cannot be adequately blocked by proximal occlusion?

Some options are available to prevent antegrade flow in this situation. One basic concept is to increase the amount of back pressure applied to the cerebral circulation. By opening the proximal stopcock of the arterial sheath and letting it bleed back, or alternatively, by attaching the external filter of the device and connecting the system to a sheath placed in a femoral vein (producing an arteriovenous shunt), retrograde flow can be enhanced. Due to the patient's specific anatomical situation with the superior thyroid artery originating from the CCA below the carotid

bifurcation, blockage of the superior thyroid artery with a balloon would prevent antegrade flow via this route, yet would not eliminate the chance of distal embolization via the ECA. Performing manual aspirations with a syringe between the steps of the procedure would additionally prevent distal embolization but would not sufficiently eliminate antegrade flow in between aspirations.

A further option would be to place a filter embolic protection device in the distal ICA and therefore achieve additional distal protection by filtering the remaining antegrade blood flow. In this particular patient, as complete retrograde flow could not be established even after connecting the system to the femoral vein, the operator decided to place a Gore Embolic Filter device (Gore & Associates) adjunctive to the proximal protection device (Figure 2). A feature of the Gore Embolic Filter is its comparably long circumferential frame at the proximal end of the filter, which provides improved alignment of the filter basket to the vessel wall. As a result of filter placement, embolic protection was additionally given through the filtration of blood that continued to flow distally despite proximal protection.

DECISION POINT 3

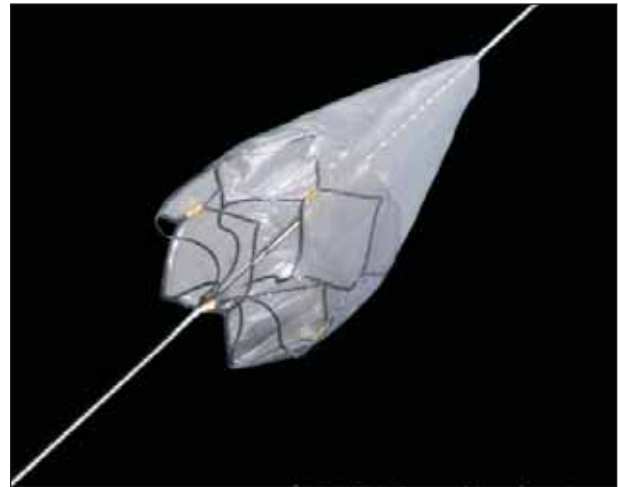
Which stent design is preferred in symptomatic carotid lesions?

The clinical impact of open-cell design versus closed-cell design, or perhaps more importantly the impact of cell size and pore size, is still unclear. Insufficient wall coverage of a

stent may lead to protruding atherosclerotic debris through the stent struts. Therefore, in lesions with high emboligenic potential, as presumed in this patient, closed-cell stents may provide better scaffolding.⁶⁻⁸ Additionally, choosing a carotid stent that is slightly larger than the vessel diameter itself (oversizing), creates an artificially smaller pore size between the stent struts. In this case, an 8-mm X 3-cm Xact stent (Abbott Vascular, Santa Clara, CA) was implanted and postdilated with a 5-mm balloon. Angiographic results were satisfactory (Figure 1C and 1D). Throughout the procedure and during the postprocedural period, the patient showed no neurological symptoms or hemodynamic complications. He was discharged 2 days after the procedure.

CONCLUSION

When using the Gore Flow Reversal system, it is mandatory to verify complete blockage of antegrade flow in the vessel and the achievement of blood flow reversal in the ICA before continuing with the next step of the intervention. If blood flow in the ICA merely stagnates, cerebral protection is not sufficient. In this situation, a short interruption of back pressure during the procedure could allow debris accrued in this area to flow cranially and possibly cause a



(Courtesy of Gore & Associates)

Figure 2. The Gore Embolic Filter has a long circumferential frame at the proximal end of the filter, providing improved alignment of the filter basket to the vessel wall.

severe stroke. In the case of the Mo.Ma device, the operator needs to verify that there is no flow in the ICA after inflation of the clamping balloons in the ECA and CCA. Furthermore,

What's Now.

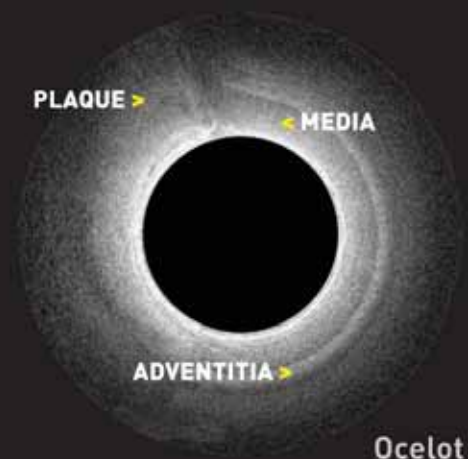


W400 WildCat



W500 KittyCat

What's Next.



Ocelot

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The Wildcat Guidewire Support Catheter is intended to be used to support steerable guidewires in accessing discrete regions of the peripheral vasculature. It may be used to facilitate placement and exchange of guidewires and other interventional devices. It may also be used to deliver saline or contrast. The Wildcat is not cleared by the FDA for use in crossing chronic total occlusions. Avinger is conducting the CONNECT study to secure FDA clearance for an indication specific to crossing chronic total occlusions.

performing the intervention stepwise and aspirating in between the procedural steps may provide additional safety. In general, correct selection of embolic protection based on clinical aspects as well as on radiological features of the lesion is essential and greatly influences the outcome of carotid stenting. Particularly in challenging anatomical situations, such as in the case presented here, specific knowledge of device-related advantages and potential drawbacks of different concepts of embolic protection is required to provide patients with the optimal treatment modality. ■

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