Preoperative Embolization in Managing Carotid Body Tumors

The advent of endovascular techniques and devices has led to this procedure becoming the standard of care for most patients prior to surgical resection.

BY ROBERT B. McLAFFERTY, MD

The carotid body is a chemoreceptor located in the adventitia of the posteriomedial aspect of the carotid artery bifurcation. Measuring 3 mm to 5 mm in size, the receptors are reddish-brown ellipsoid structures that are innervated though the glossopharyngeal nervous system. Hypoxia, hypercapnia, and acidosis stimulate the receptors, which in turn cause an increase in respiratory rate, tidal volume, blood pressure, and heart rate.

INCIDENCE

Tumors of the carotid body (Figure 1) are exceedingly rare, and their exact cause is unknown. Populations living in high altitudes and patients with chronic obstructive pulmonary disease have a higher incidence of carotid body tumors.[1,2] This observation has led to the hypothesis that chronic stimulation of the carotid body from hypoxia may predispose an individual to tumor formation. Metastasis seems to be the hallmark of malignancy, as histologic determination remains difficult. Present in up to approximately 5% of cases, the cervical lymph nodes are most commonly involved, with rarer instances of spread to the brain, lungs, and kidneys.[3-6]

Most tumors present as a painless mass in the anterior triangle of the neck. Nonspecific symptoms may include neck stiffness, tightness of the shirt collar, and tenderness. Cranial nerve palsies can occur and include dysphagia, hoarseness, and tinnitus. Rarely, a carotid body tumor may contain neurosecretory granules, which cause symptoms such as palpitations, headaches, diaphoresis, dizziness, and flushing. Other descriptors for this tumor include chemodectomas, endothelioma glomus caroticum, peritheliomas, chromaffinomas, and nonchromaffin paragangliomas.

RATIONALE FOR EMBOLIZATION

Generally, tumor size and other patient comorbidities determine whether embolization is necessary. For small tumors (<3 cm) in good surgical candidates, operation is the treatment of choice. For larger tumors in patients who are not surgical candidates, radiation—with or with-

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Figure 1. Computed tomography with intravenous contrast of the neck shows a left carotid body tumor (arrow), as evidenced by its location between the internal and external carotid arteries and its intense contrast-enhanced vascularity.

out embolization—is the treatment of choice. Most patients are surgical candidates, and for those with large tumors, preoperative embolization has increasingly become the standard of care to aid in safer resection. Embolization may also have a role in palliative therapy. For unresectable lesions with severe local symptoms, considerable symptom relief can be achieved and, in turn, quality of life is improved by decreasing vascularity and dimensions of the tumor. Occasionally, those tumors thought to be unresectable prior to embolization can shrink and may become resectable.

Although most carotid body tumors are benign, they behave indolently with extensive growth and will encase vital neurovascular structures in the neck. Surgical excision can be extremely challenging due to the hypervascularity of these structures, which average 200 mL/gm per minute of blood flow (Figure 1). For larger carotid body tumors, blood loss can be significant. Previous reports have documented a mean perioperative transfusion requirement of 2.1 units.[7-9] Another series noted a mean blood replacement of 2 L per patient. The necessity to minimize blood loss and maintain a dry operative field remains paramount to avoiding neurovascular injury, particularly with larger tumors.

The goal of embolization is to selectively obliterate the abnormal vascular structure while maintaining normal blood flow through the carotid artery arcade (Figure 2). Each arterial branch is carefully selected and imaged to assess for dominant filling into the carotid body tumor. Stable catheter access is necessary to avoid inadvertent embolization of the internal carotid artery and stroke. The primary benefit of preoperative embolization of a carotid body tumor is to reduce intraoperative blood loss and facilitate operative tumor resection (Figure 3). The utility of this adjunctive endovascular procedure in operative management of carotid body tumors has been highlighted by several studies. In a retrospective analysis of 35 patients by Murphy et al, 18 patients had preoperative embolization prior to surgery. Those patients had significantly lesser amounts of bleeding compared to nonembolized patients (mean, 1,122 mL vs 2,769 mL, respectively).[10] Others have observed that blood loss in patients with preoperative embolization was approximately one half of those without preoperative embolization.[11,12] Additional advantages have also included decreased operative time and shorter hospital stay.

(Courtesy of Peter H. Lin, MD, Houston, TX.)

Figure 2. Preoperative angiogram of a carotid body tumor revealed a highly vascularized mass displacing both internal and external carotid arteries (arrow) (A). After selective catheterization of the external carotid artery in which all feeding vessels of the carotid body tumor were embolized using coils, a completion angiogram revealed successful devascularization of the carotid body tumor (B).

TECHNIQUE OF EMBOLIZATION

Advanced endovascular skills are necessary to perform embolization of feeding arterial vessels to a carotid body tumor. To perform superselective guidewire and catheterization techniques, high-quality digital subtraction arteriography is necessary. Because patient cooperation is necessary to neurologically monitor patients, sedation should be avoided. Patients should be fully anticoagulated with heparin (activated clotting time >300 seconds) prior to aortic arch manipulation.

The procedure can be divided into three parts. First, the common carotid artery must be accessed with a sheath or guiding catheter such that placement is stable. Second, adequate diagnostic arteriography of the carotid bifurcation and stable wire/catheter access to the main feeding tumor artery is necessary. Third, deployment of embolic material must be performed in a controlled manner with continued assessment of blood flow.

After common femoral artery access, a 7-F Shuttle Sheath (Cook Incorporated, Bloomington, IN) is placed in the descending aorta. Using a Simmons 2 catheter (Cordis Corporation, a Johnson & Johnson company, Miami, FL), formed by the wire reflected antegrade from the aortic valve, the common carotid artery is catheterized. A stiff angled hydrophilic Glidewire (Terumo Medical Corporation, Somerset, NJ) or a Supracore wire (Guidant Corporation, Indianapolis, IN) is placed though the

Simmons 2 into the distal external or internal carotid artery. With this added stiffness and stability, the Shuttle sheath is then advanced slowly over the Simmons 2 catheter.

Occasionally, this maneuver will not succeed, and a more gradated tapered tip is required. In this case, the Simmons 2 is removed (while leaving the wire in place), and the introducer of the sheath is placed into the sheath and then slowly advanced over the wire. Depending on the ectasia of the aortic arch and great vessels, a curved guiding catheter may be necessary to provide for stable access, which generally leads to a slightly larger sheath at the femoral artery puncture site. After stable sheath or guiding catheter access to the distal aspect of the common carotid artery, digital subtraction arteriography should be performed with increased emphasis on defining the external carotid artery and dominant feeding arteries to the tumor. Multiple views with magnification are often needed, and small-to-moderate changes in patient position can be helpful. Often the lingual or ascending pharyngeal arteries may be the dominant feeding vessels to a carotid body tumor.

Deployment of microcoils is one method of embolizing carotid body tumors. Using a coaxial microcatheter access system such as the Tracker wire (Target Therapeutics, San Jose, CA) and the Terumo Microcatheter (Terumo Medical Corporation, Somerset, NJ) allows safe selectivity and "in-depth" access to the feeding artery. Helical platinum non-ferromagnetic microcoils (Target Therapeutics) placed as deeply as possible in the artery avoids risk of inadvertent embolization to the brain. To increase stability through which the microcatheter system can function, a 5-F Multipurpose (Boston Scientific Corporation) or Kumpe Catheter (Cook Incorporated) can be deployed to the orifice of the external carotid artery.

Because wire "purchase" is short, every precaution should be taken to avoid expulsion of the microcatheter during coil deployment. As the target vessel becomes filled distally with coils, the microcatheter is slowly backed out and more coils are deployed. Great care should be taken to not place coils completely to the orifice of the feeding artery or the external carotid artery. During manipulation of the tumor and artery, coils close to the orifice could be dislodged and embolize to the brain. Deployment ceases as the catheter gets closer to the feeding artery orifice.

To enhance the effect of occlusion by microcoils, particle embolization can be added to the procedure. This should not be performed when deployment of coils is completed for fear of embolization to the brain. Injection of particles, such as polyvinyl alcohol beads (Contour Emboli, Interventional Therapeutic Company, San Francisco, CA), acrylic polymer microspheres (Embosphere Microspheres, Biosphere, Rockland, NY), or Gel foam (Pfizer, New York, NY), is performed prior to or just after the initial most distal coils are deployed. Contrast is added to particles ranging from 300 µm to 1,000 µm in size to help image the pathway of flow upon gentle administration through the catheter. Figure 2 shows an angiogram of a carotid body tumor before and after embolization with microcoils.

Several other techniques of carotid body tumor embolization have been reported. Tripp et al described preoperative vascular exclusion for carotid body tumors.[13] Multiple feeding arteries to the tumor were excluded by percutaneous placement of two covered stents in the external carotid artery. Horowitz et al reported the use of ethanol injection with simultaneous balloon occlusion.[14] With nondetachable balloons placed in the proximal internal and external carotid arteries, a microcathether was placed into the feeding vessel, and ethanol was infused over 15 minutes. The follow-up arteriogram demonstrated complete tumor devascularization with continued normal carotid artery branches. Embolization has also been applied by a direct percutaneous approach after failure of endovascular particle embolization.[15] Using duplex ultrasound guidance, N-butyl cyano-

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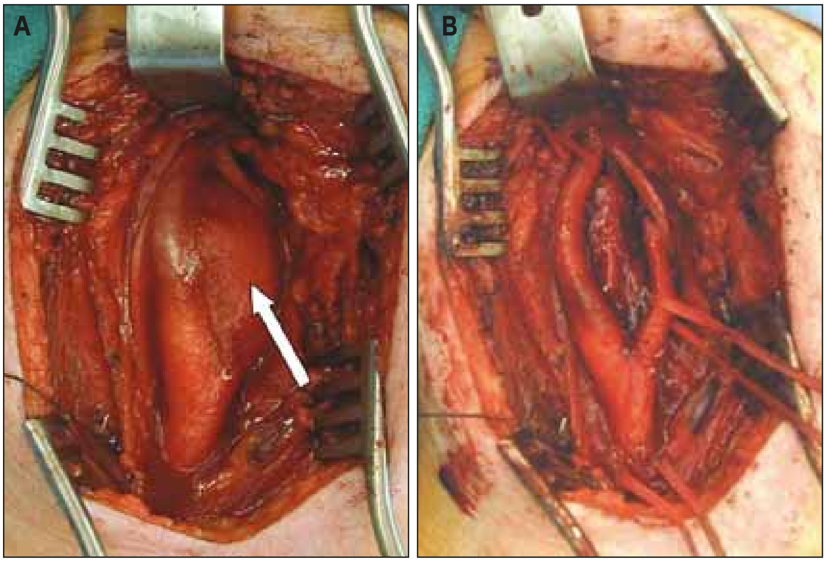

Figure 3. Intraoperative image of a carotid body tumor (arrow) before surgical resection (A). Intraoperative image of the carotid bifurcation after resection of the carotid body tumor (B).

acrylate was directly injected into the tumor. Simultaneous catheter access assisted in imaging and demonstrated complete embolization.

SUMMARY

The advent of advanced endovascular devices and treatments has led to preoperative embolization of carotid body tumors becoming the standard of care in the large majority of patients prior to surgical resection. Many options are available as to the optimal method of embolization, and physicians and allied health professionals involved in such procedures should be well versed in the details of the procedure and potential complications. Significant decreases in blood loss and operative time are observed in most patients undergoing preoperative embolization, thereby reducing the already increased risk of iatrogenic cranial nerve injury. In the right hands, embolization of moderate-to-large carotid body tumors can be performed safely to facilitate a better outcome. ■

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