Lesson 275: PreAnesthetic Assessment of the Patient Undergoing Resection of a Carotid Body Tumor

LEARNING OBJECTIVES
At the end of this activity, the participant should be able to:
1. Review the classification of CBTs and its surgical implications.
2. Describe the role of carotid bodies in respiration.
3. Explain why patients who live 5,000 ft above sea level may be at risk for a CBT.
4. List the most common symptoms that develop in patients with CBTs.
5. Describe the importance of a systems-based approach for evaluating patients with CBTs and anticipating perioperative complications.
6. Identify the studies required to characterize and diagnose CBTs.
7. Discuss the role of preoperative embolization in preparation for the resection of CBTs.
8. Recognize the most common complication of CBT resection.
10. Cite the benefits and risks of regional and general anesthesia in patients undergoing resection of a CBT.

CASE HISTORY
A 42-year-old Asian man presented with a slow-growing mass on the right side of the neck; he had first noted it 6 months earlier while shaving. A review of his symptoms was significant for intermittent episodes of dizziness and headaches. He denied motor or sensory changes. His medical history included degenerative disk disease of the lumbar spine. During his medical assessment, an abnormal electrocardiogram was also noted that included left ventricular hypertrophy and non-specific ST-T–wave changes. He reported the ability to climb 3 flights of stairs without a problem. He had hypertension; his preoperative blood pressure was 150/97 mm Hg. His heart rate was 106 beats/min. His list of medications included quinapril hydrochloride and hydrochlorothiazide, but not a β-blocker. Physical examination findings were significant for a 4-cm prominence on the right side that was pulsatile.

CALL FOR WRITERS
If you would like to write a CME lesson for Anesthesiology News, please send an e-mail to Elizabeth A.M. Frost, MD, at ElizFrost@aoa.com.

PREANESTHETIC ASSESSMENT
Dr. Elizabeth A.M. Frost, who is the editor of this continuing medical education series, is clinical professor of anesthesiology at The Mount Sinai School of Medicine in New York City. She is the author of Clinical Anesthesia in Neurosurgery (Butterworth-Heinemann, Boston) and numerous articles. Dr. Frost is past president of the Anesthesia History Association and former editor of the journal of the New York State Society of Anesthesiologists, Sphere. She is also editor of the book series based on this CME program, Preanesthetic Assessment, Volumes 1 through 3 (Birkhäuser, Boston) and 4 through 6 (McMahon Publishing, New York City).

A COURSE OF STUDY FOR AMA/PRA CATEGORY 1 CREDIT
Read this article, reflect on the information presented, then go online and complete the lesson post-test and course evaluation before August 31, 2009. (CME credit is not valid past this date.) You must achieve a score of 80% or better to earn CME credit.

TIME TO COMPLETE ACTIVITY: 2 hours
RELEASE DATE: August 2008
TERMINATION DATE: August 31, 2009

ACCREDITATION STATEMENT
The Mount Sinai School of Medicine is accredited by the Accreditation Council for Continuing Medical Education (ACCME) to provide continuing medical education for physicians.

CREDIT DESIGNATION STATEMENT
The Mount Sinai School of Medicine designates this educational activity for a maximum of 2 AMA PRA Category 1 Credits.™ Physicians should only claim credit commensurate with the extent of their participation in the activity.

It is the policy of Mount Sinai School of Medicine to ensure objectivity, balance, independence, and scientific rigor in all CME-sponsored educational activities. All faculty participating in the planning or implementation of a sponsored activity are expected to disclose to the audience any relevant financial relationships and to assist in resolving any conflict of interest that may arise from the relationship. Presenters must also make a meaningful disclosure to the audience of their discussions of unlabeled or unapproved drugs or devices.

T he Swiss anatomist and physiologist Albrecht von Haller first characterized the carotid body in 1743.1 Carotid body tumors (CBTs), with an incidence of about 1 in 30,000, are the most common type of head and neck paragangliomas.2 The vast majority of these tumors are painless, benign, and slow-growing. The definitive treatment is surgical resection (Figure 1).3 The first published reports of the resection of CBTs appeared in the 1880s. Unfortunately, many of the early cases ended in death from intraoperative hemorrhage or neurologic compromise secondary to stroke. Data on the morbidity and mortality associated with the operation were not reassuring, which prompted Hayes Martin, MD, former chief of the head and neck service at Memorial Hospital in New York City (now part of the Memorial Sloan-Kettering Cancer Center) to recommend abandoning the resection of difficult (Shamblin group III) CBTs entirely.

In 1971, physicians and surgeons from Mayo Clinic in Rochester, MN, published the method currently used to classify CBTs—now commonly referred to as the 3 Shamblin groups4:
were first described by Wright and colleagues in 1979. The anesthetic concerns associated with CBT resection are significant and require a thoughtful perioperative plan. Thus, bradycardia and hypotension can be elicited by stimulation of the carotid sinus and aortic arch. This stimulation activates vagal efferents located within the carotid sinus and aortic arch. The carotid body functions primarily as a peripheral chemoreceptor. The major blood supply is from the external carotid arteries. The carotid body is formed from both the mesoderm of the third brachial arch and the neural crest cells of the ectoderm. Its normal size is 3 × 5 mm, and it is located deep to the bifurcation of the common carotid artery (Figure 2). The carotid body is a small, flattened, oval structure that lies near the capillary sinusoids; it has an abundance of nerve fibers supplied from both the glossopharyngeal and vagus nerves. The carotid body allows the human body to respond to a low PaO₂ and to changes in the PaCO₂ and pH. The detection of a low level of oxygen by carotid or aortic chemoreceptors results in activation of the respiratory and cardiovascular systems through the glossopharyngeal and vagus nerves. As a result, respiration is stimulated (increase in minute ventilation), and the heart rate and blood pressure are both increased. On the other hand, it is also important to describe the carotid sinus reflex. A high blood pressure or rapid heart rate can stimulate baroreceptors located within the carotid sinus and aortic arch. This stimulation activates vagal efferents, resulting in a lower blood pressure and slower heart rate. Thus, bradycardia and hypotension can be elicited by carotid sinus massage during an attempt to evaluate and palpate a neck mass, or by compression and manipulation of the carotid sinus intraoperatively by surgeons during CBT resection.

Epidemiology of Carotid Body Tumors

In 2007, Sajid and co-workers studied the largest series of patients with CBTs. Of the 95 patients, 63% were women, and the mean age was 55 years. Most of the tumors (58%) were located on the right side; 18% of them were bilateral and 4.2% malignant. In general, malignancy is reported when a tumor exhibits the potential for local invasion of vessels, nerves, the airway, and the base of the skull. Distant metastases can involve the lung, bone, breast, pancreas, thyroid, kidney, and liver. In rare cases of functional tumor, catecholamine is released from the carotid body, causing palpitations, tachycardia, and hypertension.

Sajid et al also reported a 35% chance of significant morbidity and a 1% mortality rate. These rates are markedly lower than those reported in the early 1900s because of improved surgical techniques—including the meticulous subadventitial dissection and excision technique developed by Gordon-Taylor—and possibly also because of the use of shunts as indicated.

However, when a CBT is larger than 5 cm, the mortality rate can increase to 3% in the postoperative period. It is important to note that the median growth rate of a CBT is 1 mm per year, with a median doubling time of 4.2 years. Significant end points in many of the studies of CBT resection include cranial nerve palsy, stroke, and death.

Forms of Carotid Body Tumors

The 3 forms of CBTs are sporadic, hyperplastic, and familial. Risk factors for the hyperplastic form, which may be caused by chronic hypoxia, include chronic obstructive pulmonary disease, congenital cyanotic heart disease, and living at more than 5,000 ft above sea level (eg, in New Mexico, Peru, or Colorado). CBTs of the familial form, which generally develop in younger patients, are not necessarily related to periods of hypoxia but have been associated with a relatively high incidence of malignancy. The inheritable form of CBTs has been attributed to 4 different chromosomal loci; studies have found a pattern of autosomal-dominant transmission with variable penetrance.

Symptoms of Carotid Body Tumors

The most common symptom in patients presenting with a CBT is a neck mass below the angle of the mandible. The differential diagnosis includes cervical lymphadenopathy, lipoma, brachial cyst, neurofibroma, and carotid artery aneurysm. Other symptoms reported by patients with a CBT include headache, voice change, vertigo, neck pain, hoarseness, stridor, dysphagia, odynophagia, cranial nerve (CN) palsy, jaw stiffness, and sore throat. CN involvement is generally associated with a CBT larger than 5 cm. Typically, during the physical examination, the practitioner can palpate a lateral neck mass and move it medially and laterally because of its adventitial attachment, but not superiorly or inferiorly.

Preoperative Diagnosis

Opinions differ as to the best initial study for diagnosis. One study claims that the duplex scan is the single best investigatory tool, whereas another states that angiography is the main method of diagnosis (Figure 3). Duplex scans are noninvasive and can delineate the extent of growth at the carotid bifurcation. In a study of more than 40 patients at 2 centers in New York City, the preferred regimen included bilateral carotid angiography to characterize the tumors, preoperative embolization of the tumor nidus to reduce intraoperative blood loss, and cerebral angiography to evaluate the status of the circle of Willis.

Cardiovascular Concerns

The 2 major concerns of the anesthesiologist in pre-anesthetic assessments of these patients are hypersensitivity and hemorrhage.
Hypersensitivity: Patients may have carotid sinus hypersensitivity, in which palpation of the carotid body during physical examination preoperatively or manipulation of a CBT by the surgeon intraoperatively can lead to bradycardia, hypotension, and cardiac ischemia. If a CBT is detected preoperatively, a head-up tilt test is strongly recommended. The test involves tilting the patient in the head-up position at different angles while measuring the blood pressure and heart rate, and concurrently monitoring the patient for symptoms such as dizziness, light-headedness, nausea, palpitations, blurred vision, and fainting spells. Significant bradycardia is a known phenomenon during resection of a CBT. Boyd has described the administration of lidocaine into the operative field to minimize decreases in heart rate. In case of a bradycardic event intraoperatively, an anticholinergic such as atropine or glycopyrrolate should be immediately administered to increase the heart rate. Cardiac pacing may be necessary in patients who have significant carotid sinus hypersensitivity.

Hemorrhage: Massive hemorrhage has been a major cause of morbidity and mortality, both preoperatively and intraoperatively. Preoperatively, needle biopsies and open biopsies are not recommended because of the risk for life-threatening hemorrhage due to the highly vascularized nature of CBTs. Before surgery, preoperative embolization should be strongly considered for patients with a Shamblin group III CBT to decrease vascularity. In a study of 53 patients who underwent CBT resection within 48 hours of embolization, the reason for the timing of the operation was to prevent recruitment of collateral blood flow to the tumor and minimize the effects of post-embolization inflammation. Ideally, an angiogram after embolization should show patency of the external carotid system and an absence of tumor “blush.” However, not all CBTs need to be embolized before resection; rather, the technique should be reserved for patients in whom a marked decrease in intraoperative bleeding with embolization can be anticipated. The major risks associated with embolization include CN palsy, vascular spasm, transient hemiparesis, and migration of glue into the intracranial vasculature resulting in stroke.

Intraoperatively, the anesthesiologist must closely monitor the progress of the surgery because if the internal carotid artery is severed, it can retract into the base of the skull and result in significant bleeding. The anesthesiologist should ensure that replacement blood is available for all patients. In cases in which significant blood loss is expected, autotransfusion may be considered. In their seminal article in 1979, Wright and colleagues reported administering 2,000 mL of blood, on average. In a later study (2006), the mean blood loss in 25 patients was 480 mL. These data may be attributable to a difference in severity of disease in the 2 groups; however, it is imperative to closely monitor blood loss during the operation. Furthermore, given the possibility of hemodynamic instability, early placement of an arterial cannula is indicated.

Respiratory Concerns

The carotid body serves as the primary chemoreceptor for detecting low levels of oxygen in the blood. Neuronal discharge from the carotid body increases as PaO2 drops below 75 mm Hg and is quite significant when the PaO2 drops below 55 mm Hg. Patients who undergo CBT resection may be unable to respond effectively to hypoxia, especially if bilateral CBT resection is completed. In fact, the subsequent excision of a contralateral CBT has been associated with a greater incidence of refractory hypertension, stroke, and hypoxia. Although blunting of the sympathetic stimulation of the operation may be achieved by the intraoperative administration of narcotics, the anesthesiologist should anticipate the common side effects of opioids in the immediate postoperative period. In an effort to preserve the ability of the patient to respond to hypoxia, the anesthesiologist may try to minimize exposure of the patient to respiratory depressants, like opioids. A combination of an opioid with a nonsteroidal anti-inflammatory drug (eg, ketorolac tromethamine) and possibly infiltration of the operative site with a local anesthetic by the surgeon should be considered.

During the physical examination, a thorough airway examination is essential to anticipate the possibility of a difficult airway. Likewise, a compromised airway is an extremely important consideration perioperatively. Extrinsic pressure from the tumor in addition to hematoma formation can compromise airway patency. Morbidity and mortality may result if effective oxygenation and ventilation are not maintained. Thus, early identification of respiratory problems, a clear plan for and familiarity with rescue maneuvers to establish an airway, and emergency evacuation of significant hematomas are essential.

Neurologic Concerns

The most common complications after surgical resection of a CBT are stroke and CN injury. The combined rate of transient ischemic attacks and strokes ranges from 0% to 8% globally. The incidence of CN injuries is 11% to 49%, but the majority of these injuries are temporary. Nevertheless, the anesthesiologist must be prepared to improve cerebral perfusion and oxygenation by increasing the mean arterial pressure, minimizing hypocapnea, and possibly transfusing blood products in a patient who is anemic. The incidence of permanent nerve damage is 1%. Given these statistics, it is important to conduct a thorough neurologic examination preoperatively.

Postoperatively, the mental and neurologic status of the patient should be assessed, with particular emphasis on CN function. The endangered nerves include the following: the glossopharyngeal nerve, which is CN IX; the vagus nerve, which is CN X; the superior laryngeal nerve, which is a branch of CN X, and the marginal mandibular branch of the facial nerve, which is CN VII. The selective intraoperative monitoring of CNs can be achieved with the use of an electromyographic endotracheal tube. After successful intubation and confirmation of proper placement, the endotracheal tube must be connected to the appropriate nerve-monitoring apparatus. For example, one model of a special endotracheal tube is reinforced with 4 stainless steel wires to function as a nerve stimulator, which allows the surgeon and anesthesiologist to continuously monitor the recurrent laryngeal nerves intraoperatively by stimulating the vocal cords.

Preoperatively, electroencephalography (EEG) is useful to detect any abnormal activity before and during occlusion testing of the carotid vessels. Unfortunately, manipulation of the carotid vessels in a patient with underlying atherosclerotic disease can place the patient at risk for thromboembolic events. Tumors of the carotid body are not considered an atherosclerotic occlusive disease; therefore, embolic strokes are unlikely to occur intraoperatively. Although the effects of strokes and cerebral perfusion abnormalities can be detected by EEG monitors, processed EEG analysis, and transcranial Doppler technology, to name a few, none of these modalities used intraoperatively have been shown to improve outcomes in patients undergoing CBT resection. It may be prudent to evaluate the status of the circle of Willis preoperatively in anticipation of possible vascular compromise later. Ligation of the internal or external carotid arteries requires adequate collateral circulation through anastomosis of the descending branch of the occipital artery with the vertebral and deep cerebral arteries. Thus, preoperative cerebral angiography may provide important data regarding brain perfusion.

Anesthetic Techniques

For CBT resection, 2 different methods of anesthesia have been described—general and regional. General anesthesia is preferred because of the advantages it affords both the patient (cerebral protection by decreasing the cerebral metabolic rate of oxygen consumption, comfort) and the anesthesiologist (control of the airway, the ability to adjust ventilator settings). Alternatively, a regional technique can be considered. With the performance of superficial and deep cervical plexus blocks, the intraoperative assessment of cerebral functioning in an awake patient is possible. The drawbacks include an unprotected airway, potential inability of the patient to tolerate the entire procedure while awake, risk for intravascular injection, risk for high spinal anesthesia, and difficulty intubating the patient in the middle of a prolonged operation.

Management of the Case Presented

Preoperative Evaluation and Treatment

The results of recent cardiac stress testing of our patient were negative for myocardial ischemia and infarction. The patient also underwent selective carotid angiography and a balloon occlusion study with concurrent EEG monitoring.
This study tests the adequacy of cerebral cross-circulation by assessing an awake patient for changes in mental and motor functions. It also evaluates the patient for outcomes in case of carotid artery sacrifice. In our patient, baseline EEG was compared with EEG during the 45-minute balloon inflation. Throughout the procedure, the patient was evaluated for changes in visual fields, facial strength (smile), handgrip strength, and sensitivity to light touching of the face and arms. No abnormalities were reported, and the study revealed adequate collateral circulation of the circle of Willis. In addition, no complications were reported. An handgrip strength, and sensitivity to light touching of the EEG was compared with EEG during the 45-minute balloon CBT was found to be splaying the external and internal sure ranged from 90 to 150 mm Hg; the pulse rate varied from 70 to 106 beats/min.

Brain function monitoring was performed on arterial blood gases and follow trends in blood pressure central cannula enabled the anesthesiologist to obtain data oxygen (1:1 L/min), and 2.0% to 2.5% sevoflurane. mechanical ventilation was applied in conjunction with air, endotracheal tube was placed without trauma. Continuous sedation and esmolol for better control of the heart rate induced in the patient with 50 mg of 1% lidocaine, 200 mg in anticipation of direct laryngoscopy. Anesthesia was

Postoperatively, the patient’s course was unremarkable. The cardiovasular agent propranolol was added to his antihypertensive regimen of an angiotensin-converting enzyme inhibitor and a diuretic. The patient’s hematocrit remained stable, and he did not require a blood transfusion. A neurologic examination determined that the CNs were grossly intact with a midline tongue and uvula, normal shoulder shrug, and normal speech. Neither hoarseness nor nerve weakness was reported. The patient was discharged on postoperative day 2 on oral pain and antibiotic medications. He was instructed not to perform strenuous activities for a limited time. Pathology results revealed that the tumor was a paraganglioma.

Summary

CBTs are rare and generally benign. Because surgical resection is the accepted treatment, the anesthesiologist must be prepared to address cardiovascular instability, respiratory problems, and potential neurologic complications in the perioperative period. Some complications may require consultation with other medical specialties, but the anesthesiologist should be equipped to anticipate, diagnose, and treat hemorrhage, neurologic changes, myocardial ischemia, and respiratory distress. The most common complications are transient neurologic deficits, mostly involving the CNs.

References


Visit www.mssm.procampus.net today for instant online processing of your CME post-test and evaluation form.

For inquiries about course content only, send an e-mail to Customer.Support@ProCEO.com.

Post-test

1. The most common type of paraganglioma is a:
   a. jugular paraganglioma
   b. carotid body tumor (CBT)
   c. tympanic paraganglioma
   d. glomus tumor

2. Which of the following is the definitive treatment for CBTs?
   a. Observation (for all classes of CBTs)
   b. Radiation only
   c. Physical examination and aggressive palpation of the CBT
   d. Positron emission tomography

3. The most common symptom of CBTs is:
   a. cardiac ischemia
   b. diabetes insipidus
   c. amaurosis fugax
   d. neck mass

4. The most common complication of CBT resection is:
   a. neurologic symptoms related to cranial nerve(s)
   b. myocaridal ischemia or infarction
   c. inabillty to taste
   d. syndrome of inappropriate antidiuretic hormone secretion

5. The nerves that supply the carotid body include the:
   a. oculomotor and vagus nerves
   b. glossopharyngeal nerve
   c. hypoglossal and glossopharyngeal nerves
   d. auricular and recurrent laryngeal nerves

6. Which is not generally a type of CBT?
   a. sporadic
   b. hyperplastic
   c. familial
   d. hormonal

7. The patency of the circle of Willis is most accurately assessed by:
   a. cerebral angiography
   b. positron emission tomography
   c. physical examination and aggressive palpation of the CBT
   d. duplex ultrasonography

8. The pathognomonic image of a CBT on carotid angiography is a:
   a. thumbprint sign
   b. steeple sign
   c. lyre-like image
   d. apple core sign

9. Which of the following is not associated with carotid body hypersensitivity?
   a. Bradycardia
   b. Diplopia
   c. Hypertension
   d. Cardiac ischemia

10. The preferred modality for anesthesia in CBT resections is usually:
   a. general
   b. high spinal
   c. epidural
   d. monitored anesthesia care

This lesson is available online at www.mssm.procampus.net

AnesthesiologyNews.com AUGUST 2008