Image of the Month

Dr. Meng Law of the departments of radiology and neurosurgery at Mount Sinai Medical Center in New York and his colleagues have been investigating the use of dynamic susceptibility-weighted contrast-enhanced perfusion MRI to gather physiologic information about vascular endothelial proliferation, vascular density, and angiogenesis. In particular, they hypothesized that this technique can provide a means of characterizing tumor biology and predicting tumor progression. They retrospectively evaluated whether relative cerebral blood volume (CBV) measurements could be used to predict clinical outcomes in patients with malignant high-grade gliomas and low-grade gliomas. Specifically, they looked at whether patients who have gliomas with high initial relative CBV have more rapid progression than do those who have gliomas with low relative CBV.

Dynamic susceptibility-weighted contrast-enhanced perfusion MRI takes advantage of signal changes that take place with the passage of paramagnetic contrast agents—such as gadopentetate dimeglumine—through the cerebrovasculature. Dynamic susceptibility-weighted contrast-enhanced perfusion MRI results in a drop in signal intensity due to the susceptibility of the gadolinium that is proportional to the blood volume.

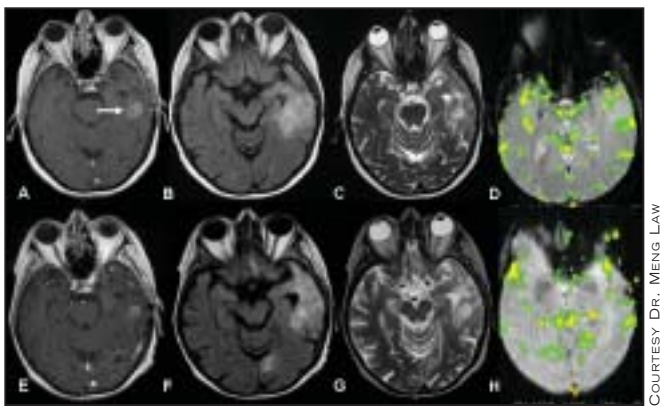
The technique "can be utilized and translated to the clinic pretty readily and that really provides us with a new way to predict tumor biology—one that is much needed, given the limitations that we have" with current classification systems, said Dr. Law.

The study included 189 patients (65% male, mean age 43) with pathologically proved gliomas, using the World Health Organization four-tier classification of gliomas (Radiology 2008;247:490-8). Patients were referred for preoperative assessment of intracranial tumors. They could not have any evidence of systemic malignancy or immune status compromise. In all, 28 patients had low-grade fibrillary astrocytomas (WHO II), 11 had low-grade oligoastrocytomas (WHO II), 14 had low-grade oligodendrogliomas (WHO II), 72 had anaplastic astrocytomas (WHO III), 12 had anaplastic oligoastrocytomas (WHO III), and 52 had glioblastoma multiforme (WHO IV).

Patients were followed up a median of 334 days and assessed clinically and with MRI—1.5 T conventional, single-dimension measurements of contrast-enhanced T1 enhancement and T2 signal hyperintensity (for tumor size), and serial relative CBV measurements.

Each patient was assigned to one of four response categories, based on clinical chart review and MR findings: complete response (4 patients), stable disease (41 patients), progressive disease (130 patients), and death (14 patients). Complete response was defined as no visible tumor on MRI and no new neurologic deficit. Stable disease was defined as no change in the patient's neurologic examination results and Karnofsky score, and less than 25% change in tumor size on MRI. Progressive disease was defined as a decline in neurologic status and Karnofsky score, or an increase in tumor size of more than 25% on MRI. Patients were assessed at 3-month intervals by their neuro-oncologist. MRIs were performed at the same time.

Dynamic susceptibility-weighted contrast-enhanced perfusion MRI does not give an absolute measure of CBV. Instead, CBV in the area of interest is expressed as a ratio relative to the CBV measured in standard tissue—typically normal contralateral white or gray matter. The researchers developed color overlay maps of relative CBV. Regions of interest were placed in regions of greatest perfusion on the color overlay maps for each patient. A constant radius of 3.6 mm was used for all regions of interest. Four separate CBV measurements were made in these regions of interest and the maximal value was recorded.



Courtesy Dr. Meng Law

Glioma seen on conventional MRI (arrow) did not progress with time, indicated by susceptibility-weighted contrast-enhanced perfusion MR images (color slices).

The researchers calculated means, standard deviations, and medians of relative CBV measurements in the regions of interest for all patients in a clinical response category. Mean relative CBV values were 1.41, 2.36, 4.84, and 3.82 for the complete response, stable disease, progressive disease, and death groups, respectively.

Patients were also classified in groups with low or high relative CBV, using a threshold of 1.75. Dr. Law and his colleagues previously identified this threshold value to provide optimal sensitivity and specificity for differentiating low-grade gliomas from high-grade gliomas in a study of 160 patients (Am. J. Neuroradiol. 2003;24:1989-98).

Median time to progression for patients with relative CBV values less than 1.75 was 3,585 days. In comparison, median time to progression for patients with relative CBV values greater than 1.75 was 265 days, regardless of histopathologic tumor type. Use of the 1.75 threshold was significantly associated with time to progression among all patients, with or without adjustment for pathologic status. Age and relative CBV—but not gender—were significant predictors of disease progression and death, based on binary logistic regression. However, using the 1.75 CBV threshold was not significantly associated with survival.

The relative CBV measurement might provide an important imaging biomarker of glioma malignancy that could potentially affect therapeutic choices.

—Kerri Wachter

Resection Remains Best Treatment for Carotid Body Tumors

BY PATRICE WENDLING
Chicago Bureau

CHICAGO — Surgical resection remains the treatment of choice for carotid body tumors, as presented in a review of 88 patients at one center.

Radiation therapy and chemotherapy are unsuitable alternatives because these rare tumors are too slow growing, and radiation exposes the carotid arteries to radiation arteritis, accelerated atherosclerosis, and even necrosis, Dr. Thomas A. Whitehill said at a vascular surgery symposium sponsored by Northwestern University.

Preoperative percutaneous tumor embolization has been tried with mixed results, but can be an important adjunct when treating select patients with large tumors (greater than 6 cm). There has been one report of a successful use of covered stents to facilitate resection (J. Vasc. Surg. 2003;38:389-91).

The malignancy rate for carotid body tumors is hard to define because there are no reliable histologic markers, but is thought to range from 2% to 5%, he said. Even if benign on histologic exam, all tumors, once discovered, should be surgically removed because they will ultimately wrap around the internal and external carotid arteries, erode into the base of the skull, and entrap neighboring cranial nerves. Increasing size also can interfere with speech, swallowing, and respiration, said Dr. Whitehill of the vascular surgery division of University of Colorado Health Science Center, Denver.

From 1993 to 2007, Dr. Whitehill and colleagues surgically resected 88 Shamblin classification II or III carotid body tumors, with an average diameter of 10.4 cm (range 5-16 cm). The patients ranged in age from 30 to 40 years.

Surgery time ranged from 4 to 14 hours, with an average blood loss of 375 mL (range 50-1800 mL). An internal carotid artery (ICA) resection bypass was performed in three patients, and ICA ligation in none.

Complications were relatively low, Dr. Whitehill said, and included cranial nerve IX neuropraxia (4%) or injury (1%), cranial nerve XII neuropraxia (30%), and superior laryngeal nerve injury (10%). There were no strokes or deaths.

Surgical advances and the widespread use of CT and MRI have decreased the overall risk of postoperative stroke over the past 25 years from about 30% to less than 2%, although the incidence of cranial nerve injury remains high at 15%-35%, he said. ■

Skip Angiography, and Other Surgical Pearls

Dr. Thomas A. Whitehill offered tips for carotid body tumors.

► Skip the angiography suite when making the diagnosis, and focus on CT imaging, preferably axial cuts rather than reconstructions. MRI may be slightly better at evaluating distant, metastatic deposits at the skull base.

► A nerve stimulator may be useful for preoperative identification of the cranial nerve.

► Do preoperative vocal cord and speech evaluations.

► Consider serial embolization in patients who are too old or have too many comorbidities to tolerate surgery.

► On a side CT view, draw a line between the mastoid tip and the angle of the mandible to get an idea of how high an exposure is needed and to help with preoperative planning.

► Utilize nasotracheal intubation in most patients, as it provides greater mobility with the mandible when resecting large tumors.

► In high access cases, mobilize the parotid gland anteriorly, up to the level of the facial nerve.

► Gain vascular control, if possible, and mobilize the tumor circumferentially to assess the extent of disease.

► Resect the tumor from proximal to distal.

► Fine mosquito clamp dissection and 3-0 or 4-0 silk ligation can give the best hemostasis.

► Send all suspicious lymph nodes for frozen permanent sections.

► Rather than using maxillomandibular arch bar fixation to obtain mandibular subluxation, consider interdental cross-wiring between the maxilla and mandible using bicuspids in dentate patients and Steinmann pins in patients with no teeth.

► For very distal tumors, cutting the digastric muscle will get you within 2 cm of the skull base.

► For large tumors, ligating the external carotid artery near its takeoff provides greater mobility.

► Avoid ligation of the internal carotid artery.

► If a tumor is 6 cm or more in diameter, consider preoperative embolization.

► Pushing the tumor completely through the bifurcation or pulling it anteriorly through the bifurcation may improve exposure angles and ease dissection.

► Take your time after the tumor is cleared of the two carotid arteries. The posterior surface and medial side of the tumor still must be separated from the deeper parapharyngeal tissues. Haste at this stage can result in the superior or inferior laryngeal nerves being transected or medial pharyngeal injuries, causing substantial swelling and neck pain in patients.