Meningiomas Overview

Meningiomas arise from the meninges, the connective tissue layers that surround and protect the brain and spinal cord. While meningiomas can arise anywhere along the neuraxis, almost 90 percent occur within the cranium. Approximately 10 percent arise in the spine and a very small percentage in the optic nerve sheath. The cause of most meningiomas is unknown, but potential risk factors for tumor development include ionizing radiation, including radiation therapy for prior malignancies, genetic factors, hormonal factors and a history of head trauma.

Although the vast majority of meningiomas are benign, they can cause neurological symptoms if they compress or infiltrate important areas of the brain or spinal cord. The symptoms caused by a meningioma are a function of the location, overall size and rate of growth of the mass. “Incidental tumors” are those that are asymptomatic and are discovered only incidentally on a neuroimaging study performed for other reasons, hence their name. Observational studies of patients with incidental tumors suggest that most such tumors grow very slowly over extended periods of time. In contrast, “symptomatic tumors” that grow in proximity to critical neural structures may be diagnosed while still relatively small due to the presence of symptoms.

Focal neurological deficits are characteristically caused by tumors in specific locations. Parasellar meningiomas can cause visual field deficits due to optic nerve compression (Figure 1) while optic nerve sheath meningiomas can cause progressive unilateral visual loss. Diplopia and facial numbness or pain can result from cavernous sinus meningiomas while cerebellopontine angle meningiomas can cause facial weakness, sensorineural hearing loss or ataxia (Figure 2). Extremity weakness can be due to direct pressure on the motor cortex along the convexity or adjacent to the falx.

Foramen magnum meningiomas can produce a characteristic sequence of ipsilateral arm then leg weakness followed by contralateral leg and arm weakness. Spinal meningiomas frequently cause both weakness and numbness of the legs. Mental status changes, including neglect, inattention and personality changes, can be due to left frontal tumors (Figure 3). Additional neurological manifestations of meningiomas include seizures and obstructive hydrocephalus.

While a definitive diagnosis of meningioma requires histologic evaluation of tumor tissue, imaging studies can be highly suggestive. Magnetic resonance imaging (MRI) is the preferred modality and tumors are typically isointense or hypointense on T1-weighted images and isointense or hyperintense on proton density and T2-weighted images to gray matter. Almost all meningiomas demonstrate strong homogeneous gadolinium enhancement. MRI can often delineate the dural origin and 3D location of the tumor as well as reveal the presence of large intratumoral vessels. Computed tomography (CT) can be complementary to MRI by better demonstrating intratumoral calcifications as well as boney invasion, erosion or hyperostosis if present. CT may also be useful for patients who cannot have MRIs. The radiographic differential diagnosis for a dural-based, contrast-enhancing lesion includes lymphoma, metastatic carcinoma, inflammatory lesions such as sarcoidosis and Wegener’s granulomatosis, and infections such as tuberculosis.

Treatment Options

The three treatment options for meningiomas are active surveillance, surgical resection and radiation therapy. Small, incidental meningiomas can be observed with serial MRI or CT scans until they enlarge significantly or become symptomatic. If an initial follow-up scan in three to six months shows no
growth, subsequent scans can be obtained annually as long as patients remain asymptomatic. The amount of interval growth that warrants surgical intervention is much smaller for younger patients than older ones, given the remaining life expectancy of the former. Surgical resection is generally indicated for symptomatic tumors and asymptomatic ones that are expanding, have significant associated edema, or appear to be infiltrating the brain or spinal cord (Figure 4). If possible, a gross total resection of the tumor and its dural attachment should be attempted as it can be curative. Advances in microsurgery, endoscopy and intraoperative image-guidance have increased the ability of neurosurgeons to safely remove tumors previously considered inoperable. A useful adjunct for skull-base tumors in particular is preoperative angiography and embolization to delineate and decrease their vascular supply, respectively. For tumors that have been partially resected or are truly inoperable, radiation therapy (RT) is the next best treatment option as chemotherapies have not been shown to be effective. RT can be in the form of external beam radiation or one of the newer conformal RT techniques such as stereotactic radiosurgery (SRS), fractionated stereotactic radiotherapy (SRT), intensity-modulated radiation therapy (IMRT) and proton radiotherapy. Following treatment with surgery and/or RT, surveillance imaging should be initiated or resumed.

Reference: