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Central Nervous System Tumors

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DEFINITION/EPIDEMIOLOGY

Central nervous system (CNS) tumors are of two types, primary or metastatic. Primary tumors arise from a variety of cell types within the parenchyma of the brain or spinal cord or the meninges adjacent to the brain or spinal cord. Metastatic tumors result from spread of systemic cancer to the brain, spinal cord, or meninges. This chapter considers both primary and metastatic brain tumors.

The incidence of primary malignant and nonmalignant brain tumors in the United States is 14.8/100,000. Approximately 20,500 individuals were diagnosed with primary malignant brain tumors in 2007 in the United States. High-grade gliomas and meningiomas are the most common types of adult primary brain tumors. The incidence of primary brain tumors is low in young adults but increases with advancing age and reaches a plateau between the ages of 65 and 79 years. There is a recent rise in the incidence of primary brain tumors among elderly patients, but part of this increase is due to improved detection methods. Meningiomas are the most common benign intracranial tumor and account for up to one third of benign brain tumors. The incidence of primary CNS lymphoma (PCNSL) is increasing in all age groups, accounted for only in part by CNS lymphoma associated with the acquired immunodeficiency syndrome (AIDS). Population-based studies suggest an incidence rate of 10/100,000 population with brain metastasis, but brain metastatic tumors are more common than primary CNS tumors. Because incidence rates are based on tumor registries and many patients with brain metastasis do not undergo surgery, they are underrepresented in these statistics.

Primary brain tumors are the second most common cancers in children. Medulloblastomas are the most common malignant pediatric brain tumor. In the United States, between 350 and 500 new cases of pediatric and adult medulloblastomas are diagnosed each year, and the majority of these are pediatric.

The cause of most CNS tumors is unknown. Aside from exposure to ionizing radiation, no environmental agents are known to be causative. Hereditary syndromes that are associated with an increased risk of CNS tumors include neurofibromatosis 1 and 2, tuberous sclerosis, von Hippel-Lindau disease, Li-Fraumeni syndrome, and Turcot's syndrome, but account for less than 1% of primary CNS tumors. Although the chromosomal abnormalities associated with many of these syndromes is known, the specific mechanisms leading to CNS neoplasia have not been defined.

PATHOLOGY

The World Health Organization classification defines brain tumors based on the cell of origin and includes a grading system, which is of use in predicting the biological behavior of the tumor. Most adult primary brain tumors are of neuroepithelial origin and result from neoplastic transformation of astrocytes, oligodendrocytes, or ependymocytes. Astrocytomas are the most common primary brain tumor in adults. Meningiomas derive from arachnoidal cap cells in the meningeal covering of the brain. Common locations of meningioma are the cerebral convexity, falx and parasagittal area, olfactory groove, sphenoid wing, and posterior fossa. They are comprised of heterogeneous histopathology patterns and careful neuropathological assessment is needed for accurate grading.

PCNSL is a rare form of non-Hodgkin lymphoma, typically of B cell origin. It presents within the white matter of the cerebral hemispheres, often in a periventricular location, and is often multiple, especially in AIDS patients. Brain metastasis develops when tumor cells gain access to the systemic circulation and embolize to the brain. Metastases occur most commonly from solid tumors arising in the breast, lung, colon, and skin (melanoma). Lung cancer, both non-small and small cell type, is the most common tumor overall to metastasize to the brain and constitutes up to 50% of cases of brain metastasis. In women, breast cancer is the most common source of brain metastasis. Malignant melanoma is a much less common systemic cancer but carries a high risk of brain metastasis; up to 50% of stage IV melanoma patients develop brain metastasis. Colon and renal cell carcinoma are also common underlying tumors. Other solid tumors are less frequent. Medulloblastomas are of primitive neuro-ectodermal origin and are highly cellular. Homer Wright rosettes can be found in up to 40% of cases. Medulloblastomas are grade IV tumors as they are invasive and rapidly growing, with a tendency to disseminate through the CSF.

CLINICAL PRESENTATION

Symptoms and signs caused by brain tumors typically result from compression or invasion of adjacent neural tissue by the tumor or from vasogenic edema resulting from disruption of the blood-brain barrier caused by vessel compression or invasion from tumor or from "leaky" blood vessels present within tumors. Neoangiogenesis associated with tumor growth typically results in embryonic vessels that lack a normal blood-brain barrier. Because of the uncompromising rigidity of the cranial vault, both histologically benign and malignant tumors may cause symptoms