به نام خدا

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Neurology of Brain Tumor

Patients with systemic and neurological malignancies present with a variety of neurological symptoms that are related to the direct or indirect effects of the disease or to the treatments directed against such malignancies.

Headaches

Cognitive Dysfunction

Psychological, Behavioral,and Psychiatric Symptoms

Seizures

TABLE 120-1 Association between Tumor Type and Seizure Frequency

Tumor Type	Seizure Frequency (%)
Dysembryoblastic neuroepithelial tumor	100
Ganglioglioma	80-90
Low-grade astrocytoma	75
Meningioma	29-60
Glioblastoma multiforme	29-49
Metastasis	20-35
Leptomeningeal tumor	10-15
Primary central nervous system lymphoma	10

Focal Symptoms of Brain Tumors and Treatment Effects

Motor Dysfunction

Vision Changes

Hearing Impairment

Speech and Language Disturbances

Gait Disturbance

TABLE 120-2 Symptoms Based on Location

Location	Symptoms
Frontal lobe	Loss of initiative, apathy, impaired planning and executive functions, disinhibition, irritability, expressive aphasia, impaired attention, personality changes, impulsivity, hemiparesis, gait apraxia, anosmia
Temporal lobe	Complex partial seizures, superior quadrantanopsia, short-term memory impairment, receptive aphasia, anomia
Parietal lobe	Cortical sensory deficits, anosognosia, inferior quadrantanopsia or hemianopsia, alexia, agraphia, hemineglect, sensory ataxia
Occipital lobe	Contralateral hemianopsia or quadrantanopsia, seizures
Cerebellum	Ataxia, dysarthria, dysmetria, dysdiadochokinesia
Brainstem	Cranial neuropathies, hemiplegia, hemianesthesia, cerebellar symptoms (related to output and input pathways to cerebellum), hydrocephalus and increased intracranial pressure resulting in altered consciousness, papilledema
Cerebellopontine angle	Unilateral hearing loss, tinnitus, vertigo, facial palsy, possibly hemiparesis
Pituitary	Headache, bitemporal hemianopsia, unilateral optic atrophy, pituitary deficiency, pituitary apoplexy
Pineal	Hydrocephalus, headache, Parinaud's syndrome, precocious puberty

Brain Tumors:

lists more than 120 types of brain tumors. Classification of brain tumors is an evolving process, with obsolete entities being discarded and newly recognized tumors added with each successive revision. In the past, classification has relied heavily on recognition of morphologic patterns and immunohistochemical identification of differentiation antigens, but with the discovery a decade ago of the association between the translocation and subsequent deletion of chromosomal arms 1p and 19q2,3 and the responsiveness of anaplastic oligodendroglioma to treatment, a new era of molecular classification of brain tumors began.

- With advances in cross-sectional imaging modalities, including computed tomography (CT) and magnetic resonance imaging (MRI), radiologic evaluation has become an important step in initial diagnosis of brain tumors. The ability of imaging to noninvasively localize and characterize brain tumors can facilitate treatment planning. Imaging also plays important roles in determining extent of resection following surgery as well as monitoring treatment response after chemotherapy or radiation therapy.

- diagnoses of brain tumors should be based on both clinical and radiologic features to increase the accuracy in distinguishing among various tumor types as well as non tumor mimics.
- The decision for which imaging modalities are used during initial work-up of patients with suspected brain tumor largely depends on the clinical history (particularly acuity) and the availability of scanners. For example a patient presenting to the emergency department with active seizures would typically be subjected to CT evaluation in the acute setting, whereas a patient presenting to a medical clinic with headaches may instead be studied initially with MRI, CT performed only to address specific questions related to calcification or bony lesions.

- Exquisite soft tissue contrast and lack of ionizing radiation make MRI the imaging modality of choice for evaluation of central nervous system (CNS) tumors.

- Although non– contrast-enhanced MRI can often detect and characterize small brain lesions on the basis of intrinsic differences in magnetic relaxation properties of tissues as well as presence of associated edema, contrast-enhanced MRI allows detection of very small parenchymal or meningeal lesions—1 to 2 mm—that may significantly affect clinical decision making.

- the judicious use of advanced contrast-enhanced techniques, such as magnetic resonance perfusion (MRP) and magnetic resonance angiography (MRA), can provide functional data that help characterize the differences between pathologic and normal tissues. Finally, advanced MRI techniques such as blood oxygen level– dependent (BOLD) imaging and diffusion tensor imaging (DTI), the basis of brain activation and tractography studies, respectively, are widely used in presurgical planning.

The general imaging approach to patients with brain tumors consists of the following steps:

(1) identification of mass effect.

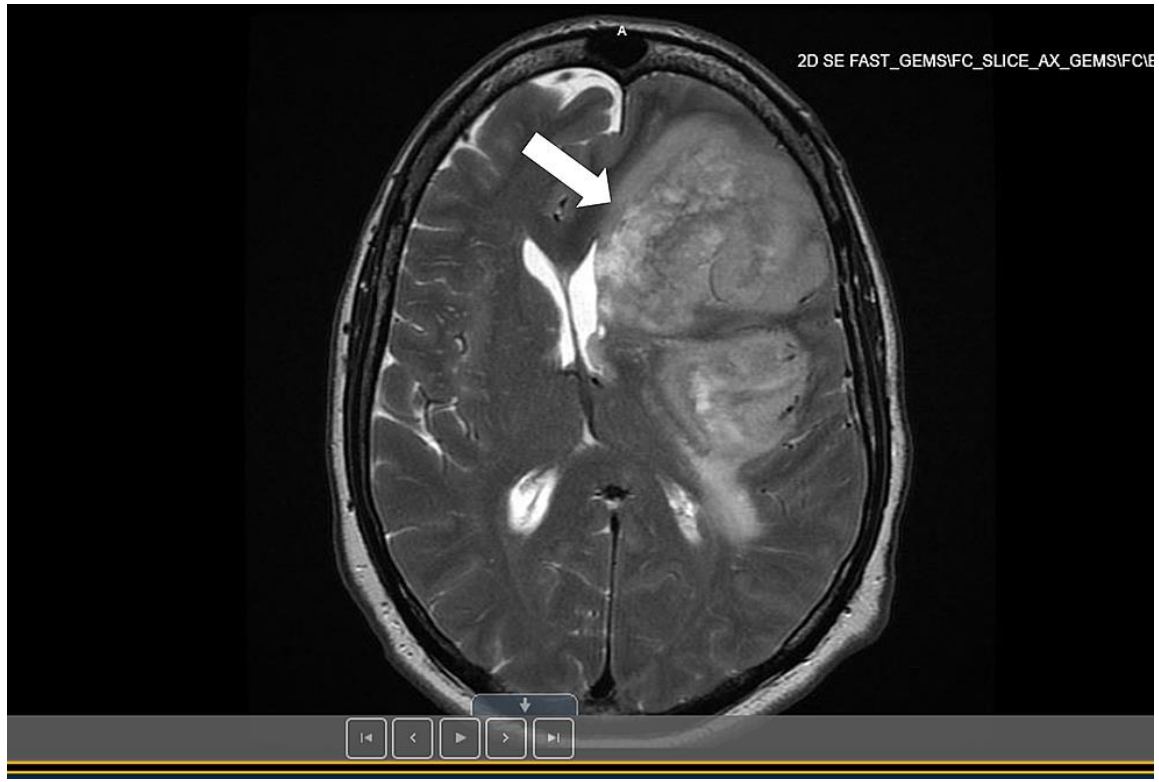
(2) localization of tumor within distinct anatomic regions of brain.

(3) analysis of imaging features within and around lesion(s).

Mass Effect

- Analysis of mass effect helps not only to distinguish tumors from other entities but also to provide guidance for management timeframe.

- Features of mass effect on imaging include direct expansion of brain, meninges, nerves, or cranium as well as indirect signs, including sulcal, ventricular, or cisternal effacement, displacement of vessels or cranial nerves, obstructive hydrocephalus, and herniation.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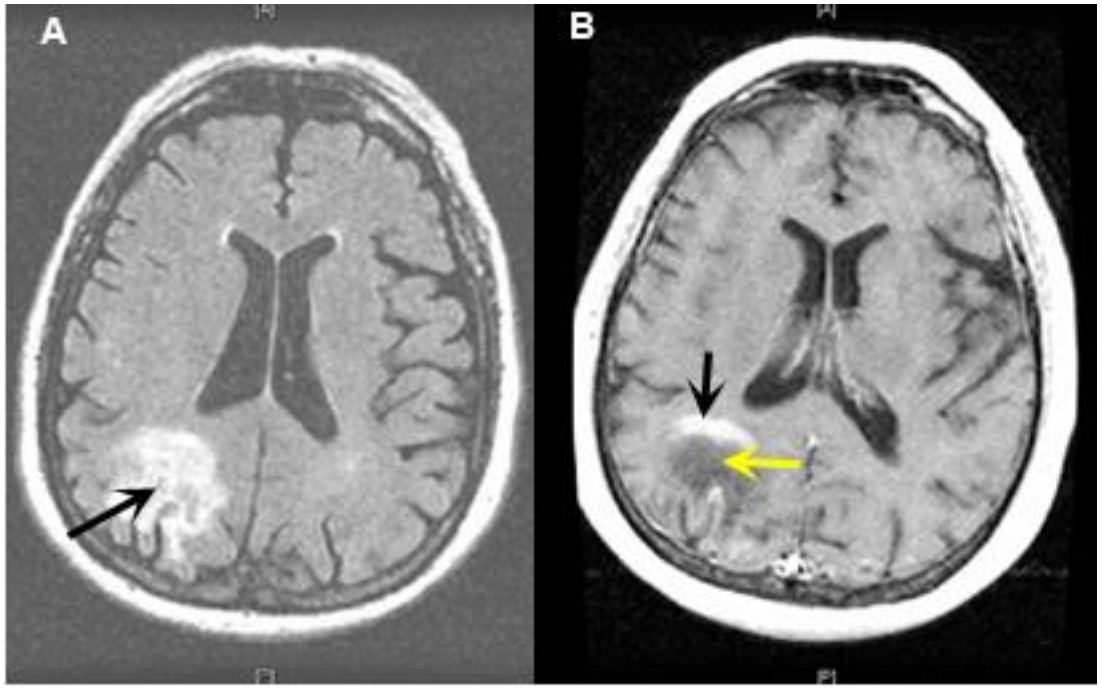
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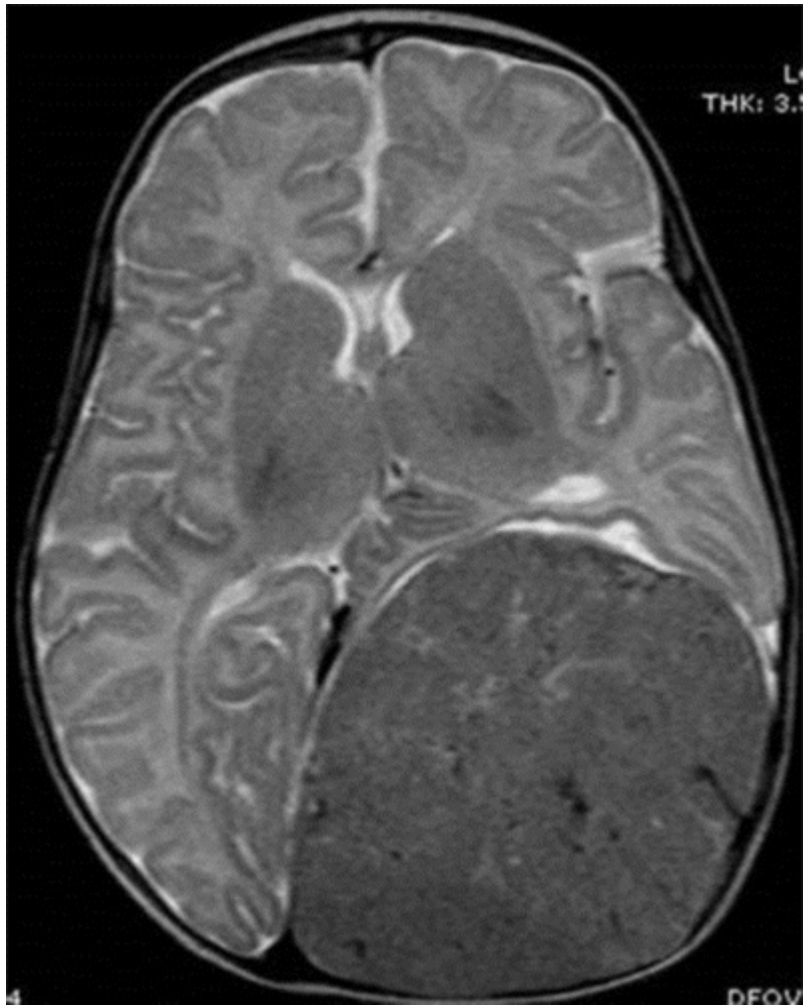
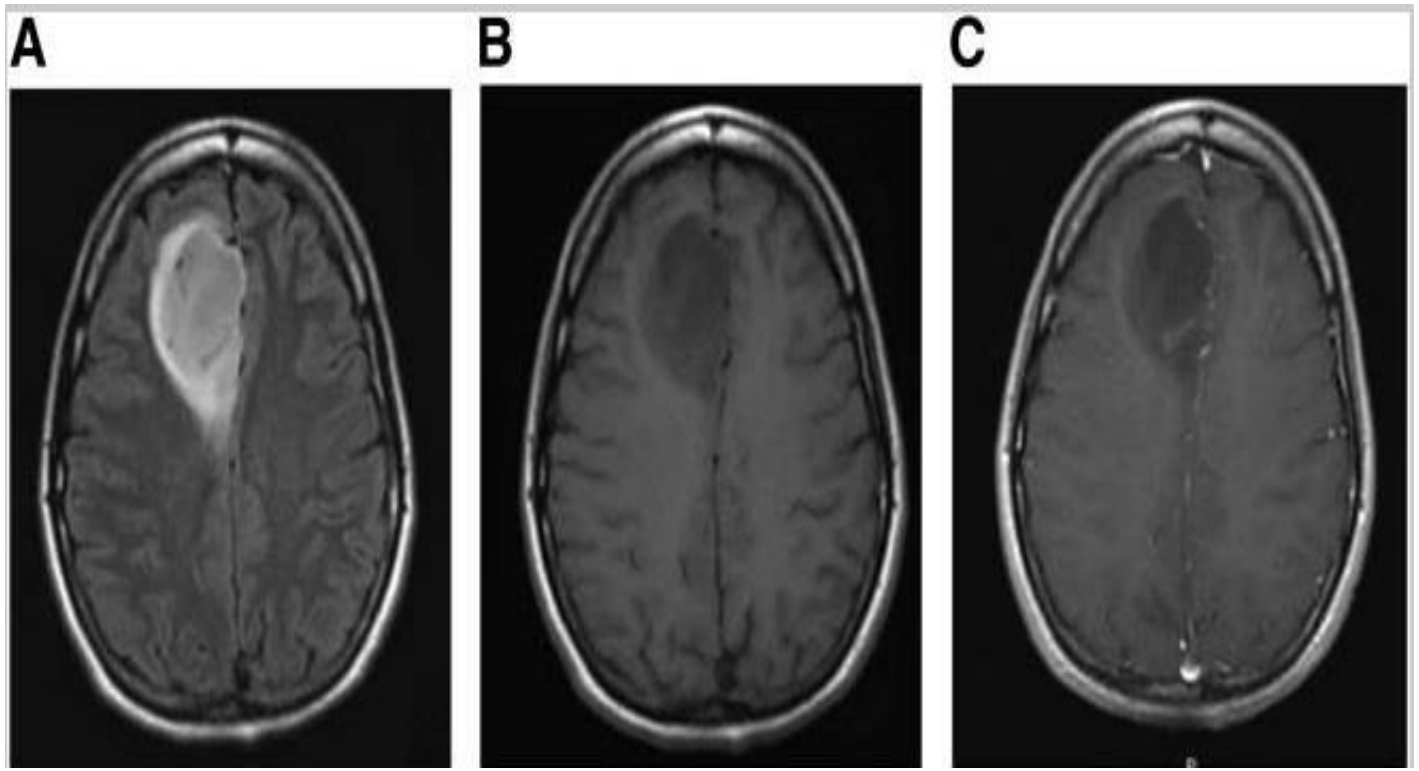
Tumor Locations: Intra-Axial versus Extra-AxialBrain Tumors

- Determining mass lesions as being in intra-axial (derived from brain) or extra-axial (outside of brain) locations can greatly facilitate imaging diagnosis as well as surgical planning.

- Although the majority (>80%) of extra-axial tumors in adults are benign, including meningiomas and schwannomas, the majority of intraaxial tumors are malignant, including metastases and high-grade gliomas that carry a poor prognosis.

- Although intra-axial and extra-axial tumors can be reliably differentiated in most cases, a small number of tumors may have features of both tumor locations, making determination difficult. Most notably, gliosarcoma as well as other sarcomatous tumorscan involve both intra-axial and extra-axial compartments.

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Extra-axial masses frequently exhibit the following characteristics:

- Displacement or compression of adjacent cortex
- Cerebrospinal fluid or cortical vessels between mass and brain
- Contrast enhancement and thickening of dura, leptomeninges,or cranial nerves
- Invasion of adjacent bone

Features supporting intra-axial location are as follows:

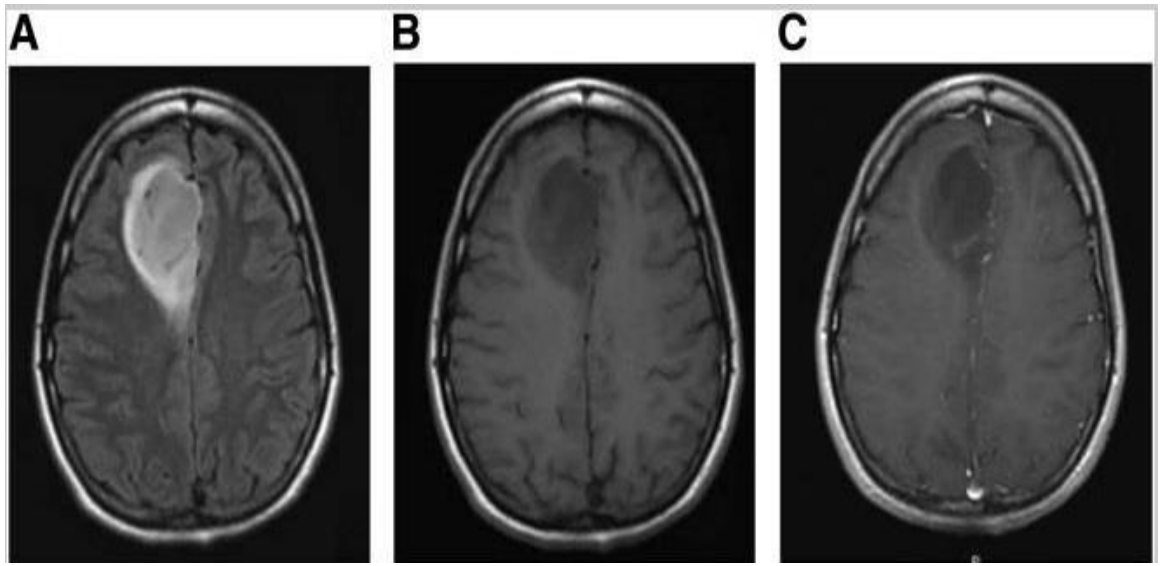
- Containment of all the margins of the lesions by brain parenchyma
- Expansion of the cortex

Lesional and Perilesional Imaging Features of Brain Tumors

Tumor Permeability

- Vascular permeability can be affected by the presence of tumor, due either to direct breakdown of the blood-brain barrier (BBB) or to indirect effect from tumor-related vasoactive secretions.
- These physiologic changes are responsible for the qualitative lesion enhancement observed on CT scans or T1-weighted MR images obtained after administration of a contrast agent, as a result of extravascular leakage of the contrast agent.

- Among intra-axial tumors, most aggressive tumors, including metastases, higher-grade astrocytomas, primitive neuroectodermal tumors (PNETs), and lymphomas, enhance. On the other hand, nonenhancing tumors tend to be observed among lowgrade tumors such as low-grade astrocytoma and subependymoma. Also, a number of nonaggressive tumors can enhance, including many extra-axial tumors, such as meningiomas and schwannomas, and intra-axial tumors, including pilocytic astrocytoma, glioneuronal tumors, and a small subset of low-grade gliomas.5 Contrast enhancement is not specific to brain tumors; other pathologic processes, including infarct, inflammation, and infection can also affect the integrity of the BBB and thus cause leakage of contrast material to interstitial space.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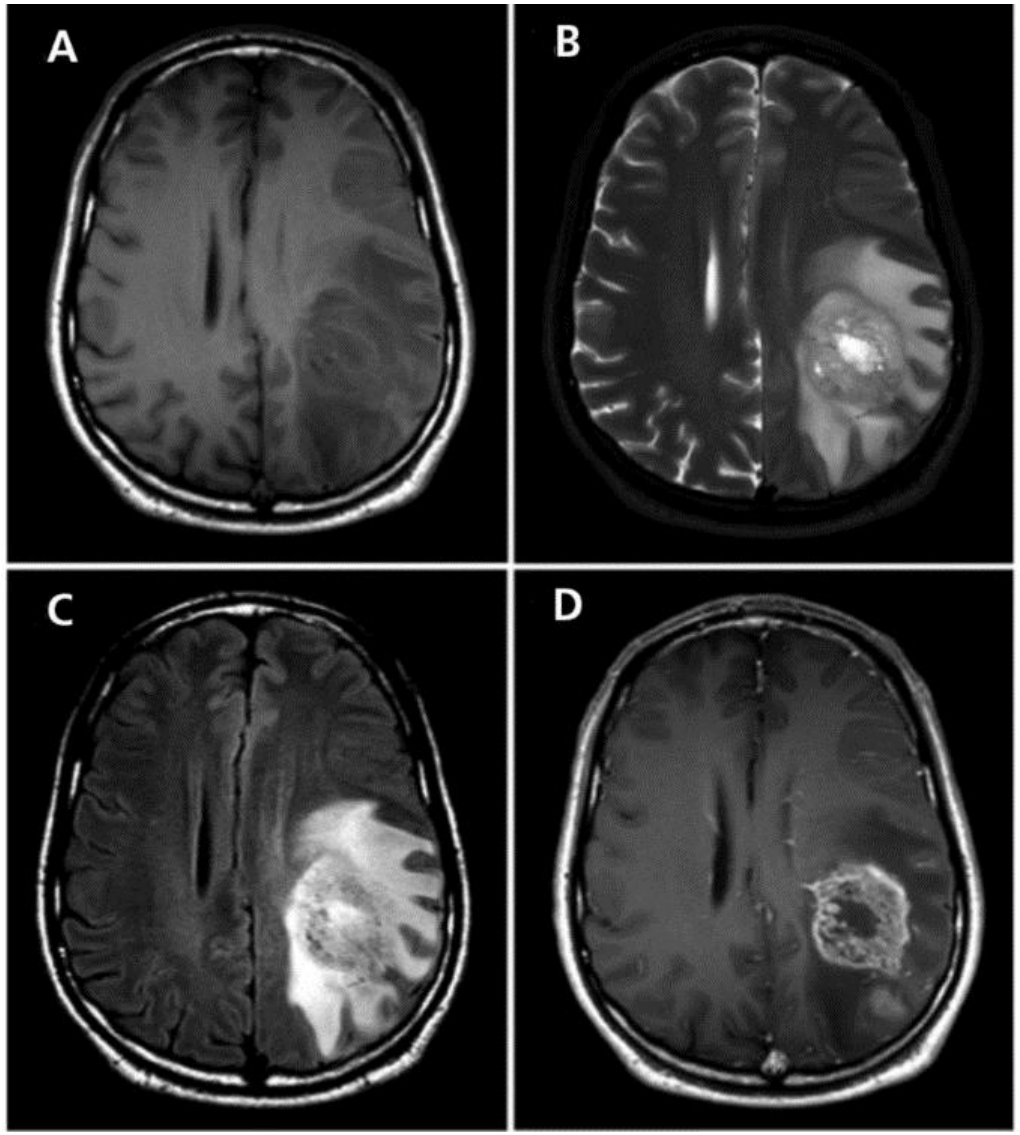
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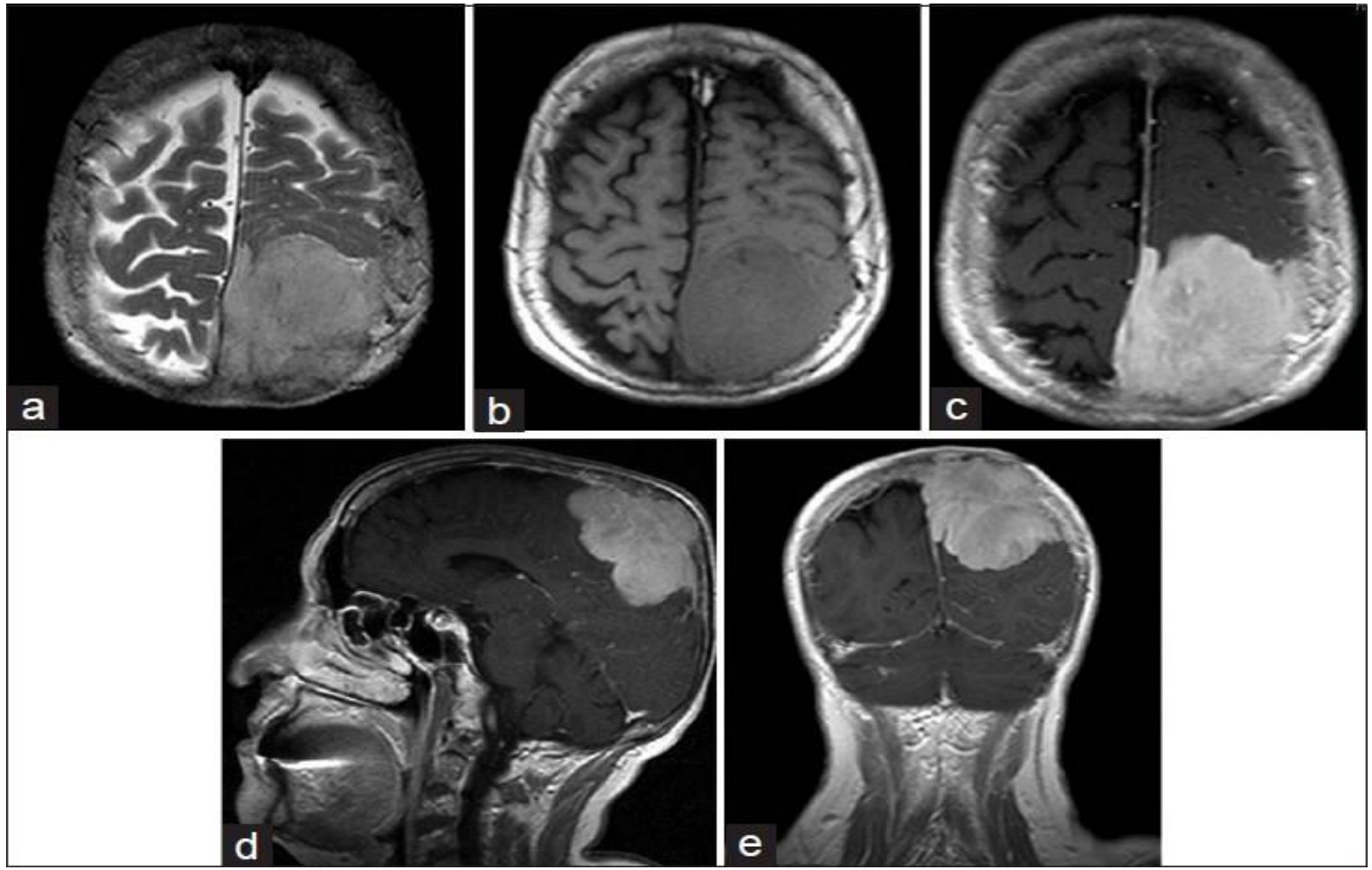
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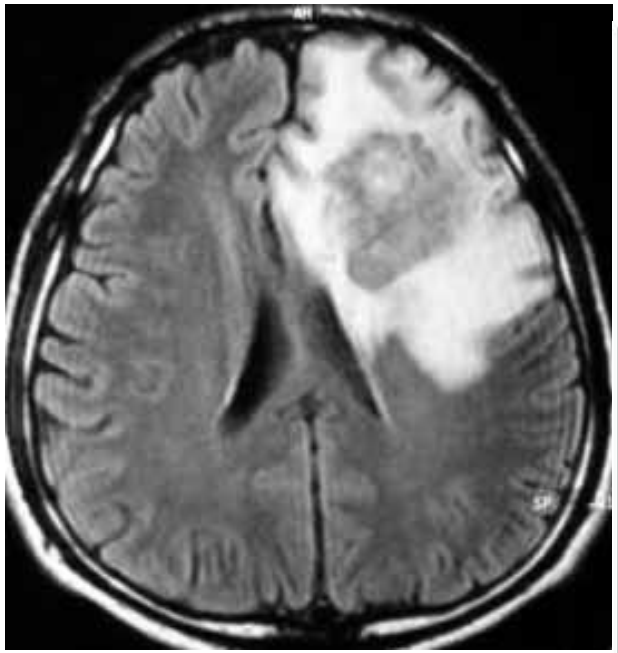
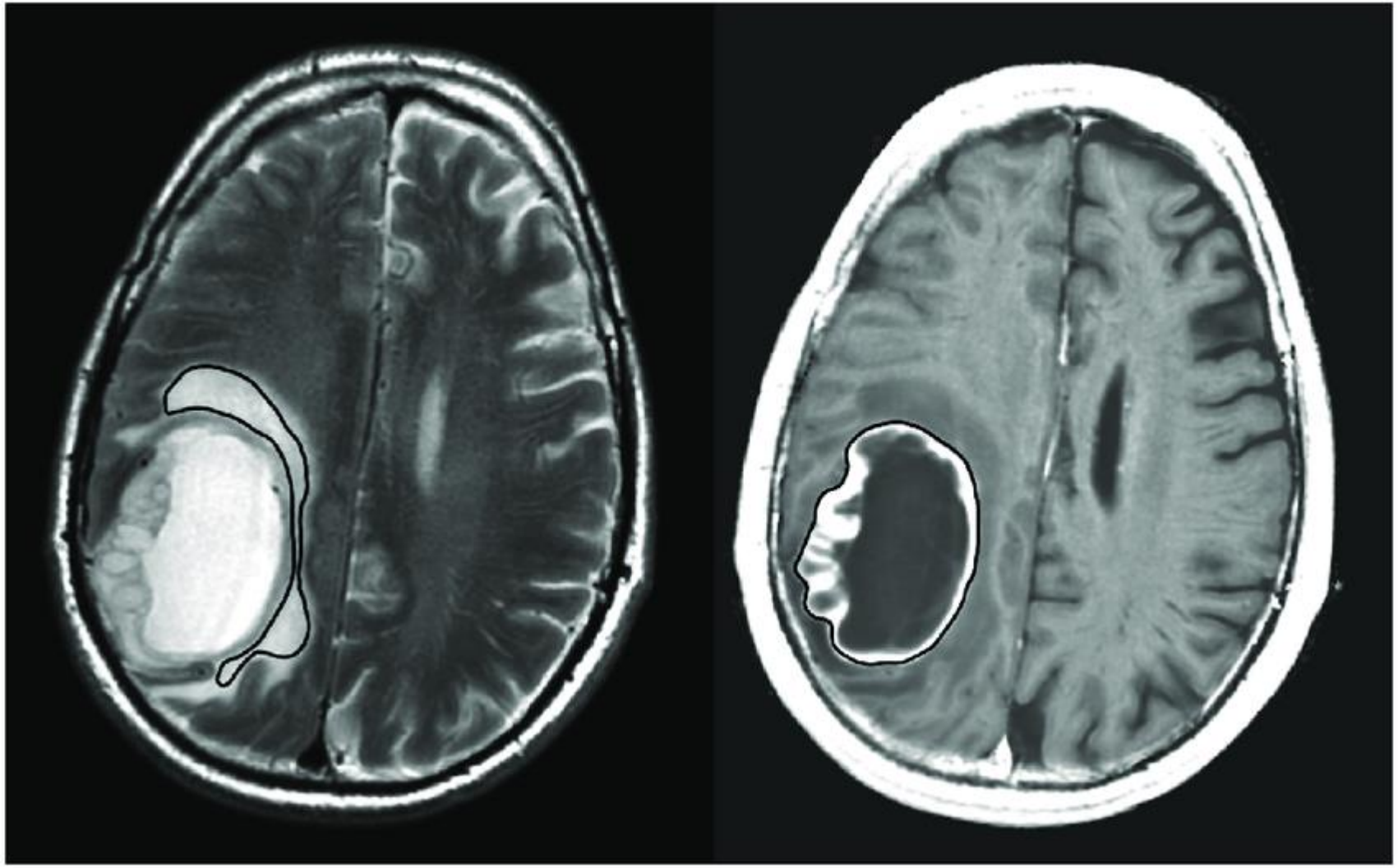
Perilesional Edema

- Increase in interstitial water content is one consequence of greater vascular permeability and can manifest as either decreased attenuation on CT or hyperintense signal on T2-weighted MRI secondary to prolonged T2 relaxation times in the affected tissues. Evaluation of the edema pattern surrounding brain lesions can also be very helpful in making a diagnosis.
- Extra-axial tumors, primarily meningiomas and schwannomas, are not associated with edema in adjacent brain parenchyma, although edema can occur in some of these tumors, presumably from impedance of venous drainage by mass effect as well as from a direct effect on capillary permeability. Intratumor hemorrhage can also cause rapid expansion of tumor volume and thereby cause secondary edema from compressive effect. Among intra-axial primary brain tumors, edema is typically present in glioblastomas but absent with low-grade astrocytomas, oligodendrogliomas, gangliogliomas, ependymomas, and hemangioblastomas. Although lowgrade gliomas typically lack surrounding edema, these tumor tissues can be difficult to distinguish from edema on conventional MRI sequences because of their similarities in T2 relaxation times.





Tumor Cellularity

- Tumor cellularity, or the density of tumor cells per unit volume they occupy, is a prognostic histologic marker. For example, in the setting of gliomas, higher grade tumors typically demonstrate hypercellularity and carry a worse prognosis.

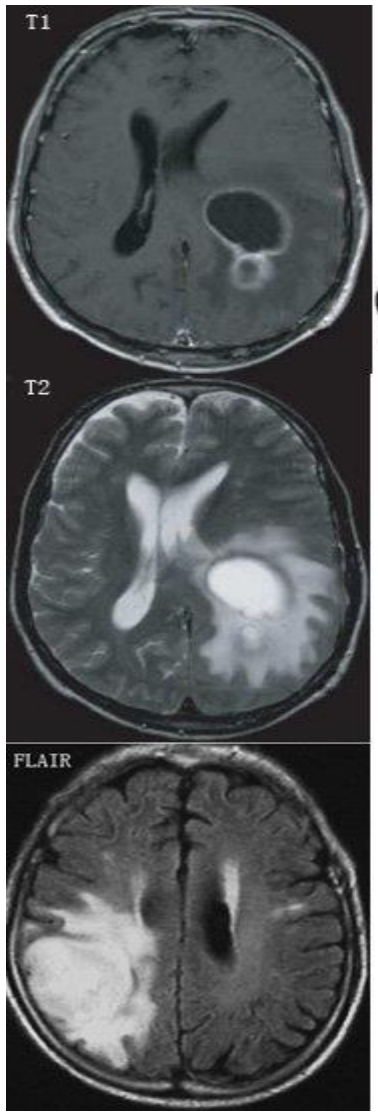
- The tumor cell density has been shown to directly correlate with CT attenuation values, with regions of hypercellularity demonstrating hyperdensity. On MRI, apparent diffusion coefficient (ADC) values derived from diffusion-weighted imaging (DWI) have also been correlated with cell density.16 Hypercellularity typically manifests as reduced diffusivity on the ADC map.

Tumor Necrosis

- Necrosis is a common imaging feature in high-grade gliomas,
- Metastasis also frequently demonstrates necrosis and appears similar to glioma when manifesting as a solitary mass.

- Necrosis is uncommon in lymphomas among immunocompetent patients; in the immunocompromised population, tumor necrosis is much more common and can mimic other brain lesions, such as toxoplasmosis.

- Following chemotherapy or radiation therapy, necrosis can commonly occur within and around tumor tissues.


T1
T2
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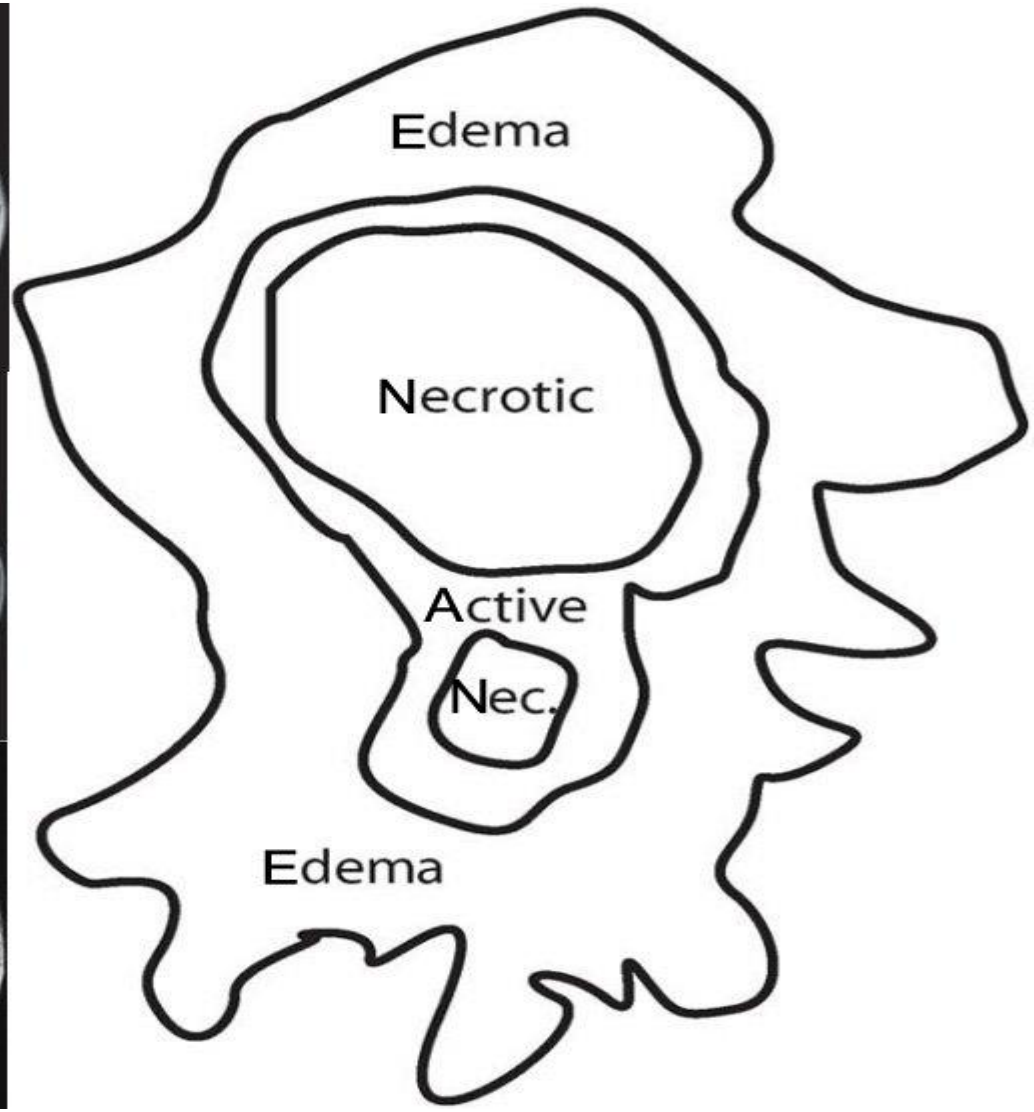
Edema
Necrotic
Active
Nec.
Edema

Tumor-Associated Cysts

- Although tumor-associated cysts can appear similar to necrosis, the latter is often irregular in shape, with irregular, thick borders, and exhibits a greater degree of surrounding edema.
- When cystic lesions are encountered, it is important to consider infectious etiologies such as brain abscesses, particularly when the content of cysts shows low diffusivity (hyperintensity) on DWI.
- Unlike post-chemotherapy or post-irradiation necrosis, which typically indicates treatment response, growth of cysts is often a sign of tumor growth and treatment resistance.

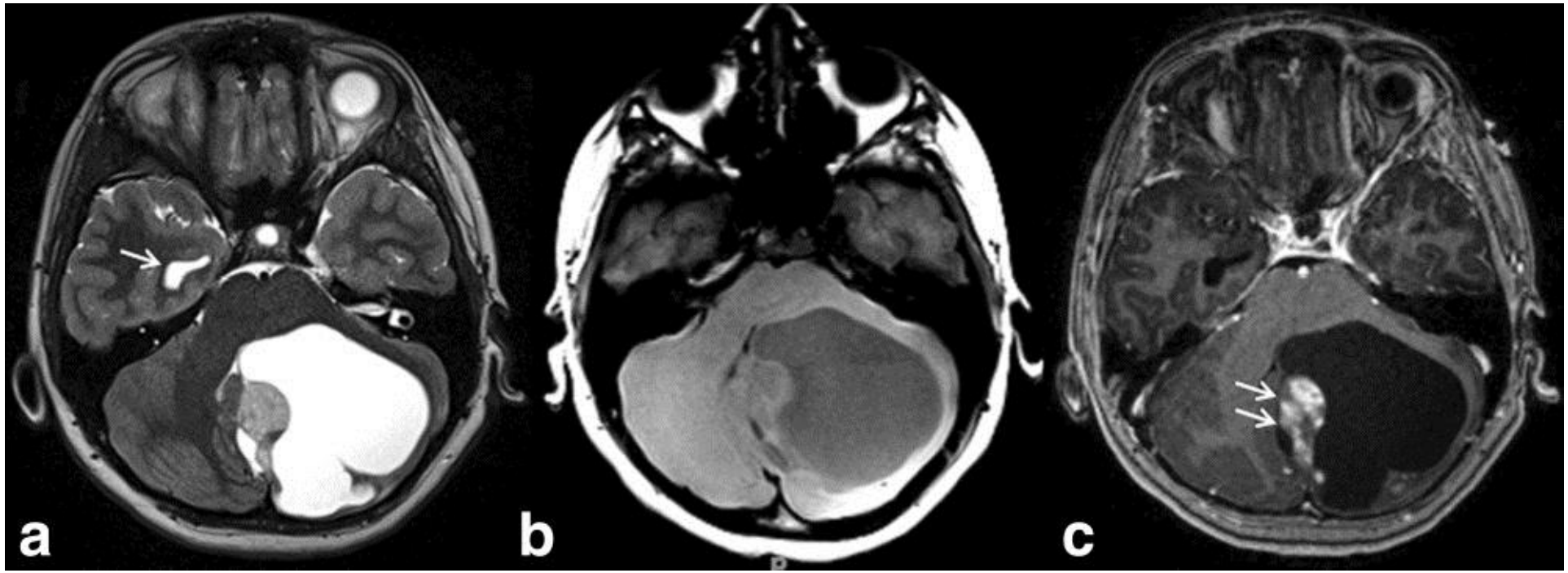
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TABLE 121-1 Differential Diagnoses for Imaging Features of Central Nervous System Tumors according to Location

	Location	
Imaging Feature(s)	**Intra-Axial**	**Extra-Axial**
Calcification	Oligodendroglioma, central neurocytoma, metastases (genitourinary or gastrointestinal origins, osteosarcomas, and chondrosarcomas)	Meningioma, craniopharyngioma
Cysts	Metastasis, hemangioblastoma, pilocytic astrocytoma, desmoplastic infantile ganglioglioma, dysembryoplastic neuroectodermal tumor, ganglioglioma	Craniopharyngioma, schwannoma, meningioma, arachnoid cyst, epidermoid/dermoid
Necrosis	Glioblastoma, metastasis	Metastasis, meningioma
High cellularity	Lymphoma, glioblastoma, primitive neuroectodermal tumors, metastasis	Meningioma, lymphoma, metastasis
High vascularity	Glioblastoma, hemangioblastoma, metastasis (renal cell carcinoma, choriocarcinoma, and thyroid carcinoma)	Meningioma

Metabolic Imaging of Tumor by Magnetic Resonance Spectroscopy

- Magnetic resonance spectroscopy (MRS) can noninvasively measure concentrations of tissue metabolites and has shown promising applications in evaluating brain tumors, including their diagnosis, grading, pretherapy planning, and posttherapy assessment.
- *N*-acetyl aspartate (NAA), NAA is a neuronal marker that decreases in concentration in most known brain pathologic conditions that damage neurons, including tumor, inflammation , and infection.

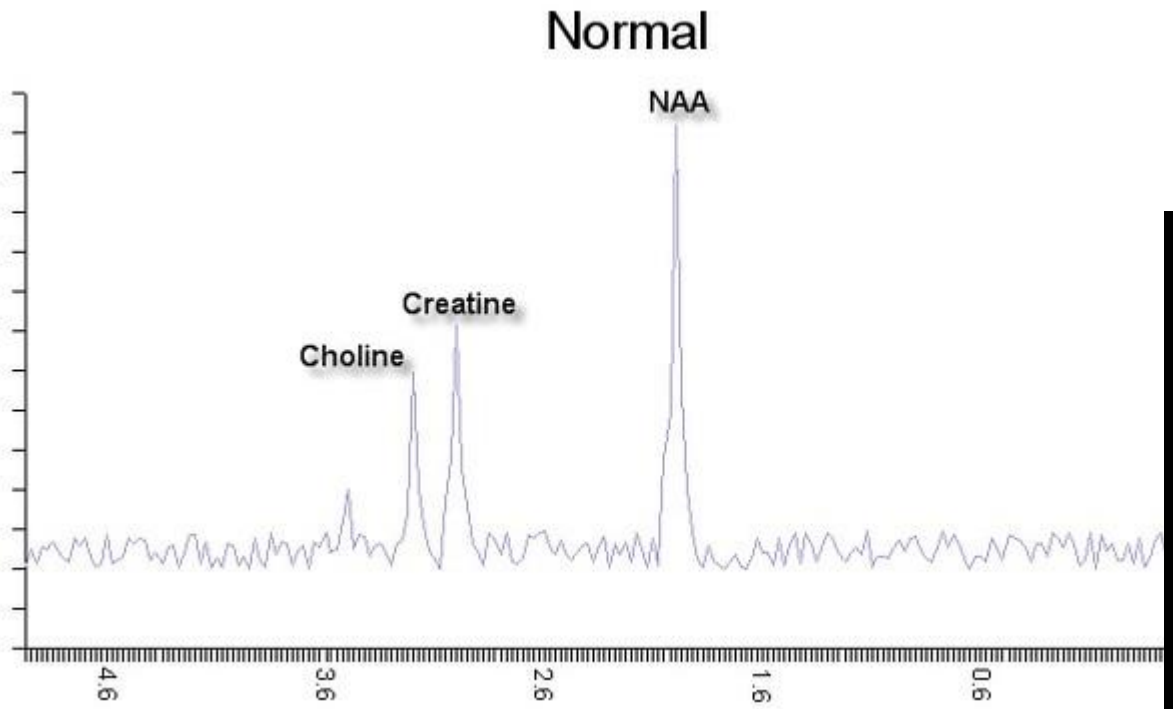
- Choline is a marker of cellular turnover and is typically elevated in neoplastic processes because of increased cellular proliferation. In certain tumor types, particularly glioblastomas, choline levels can be many times higher than in normal brain.

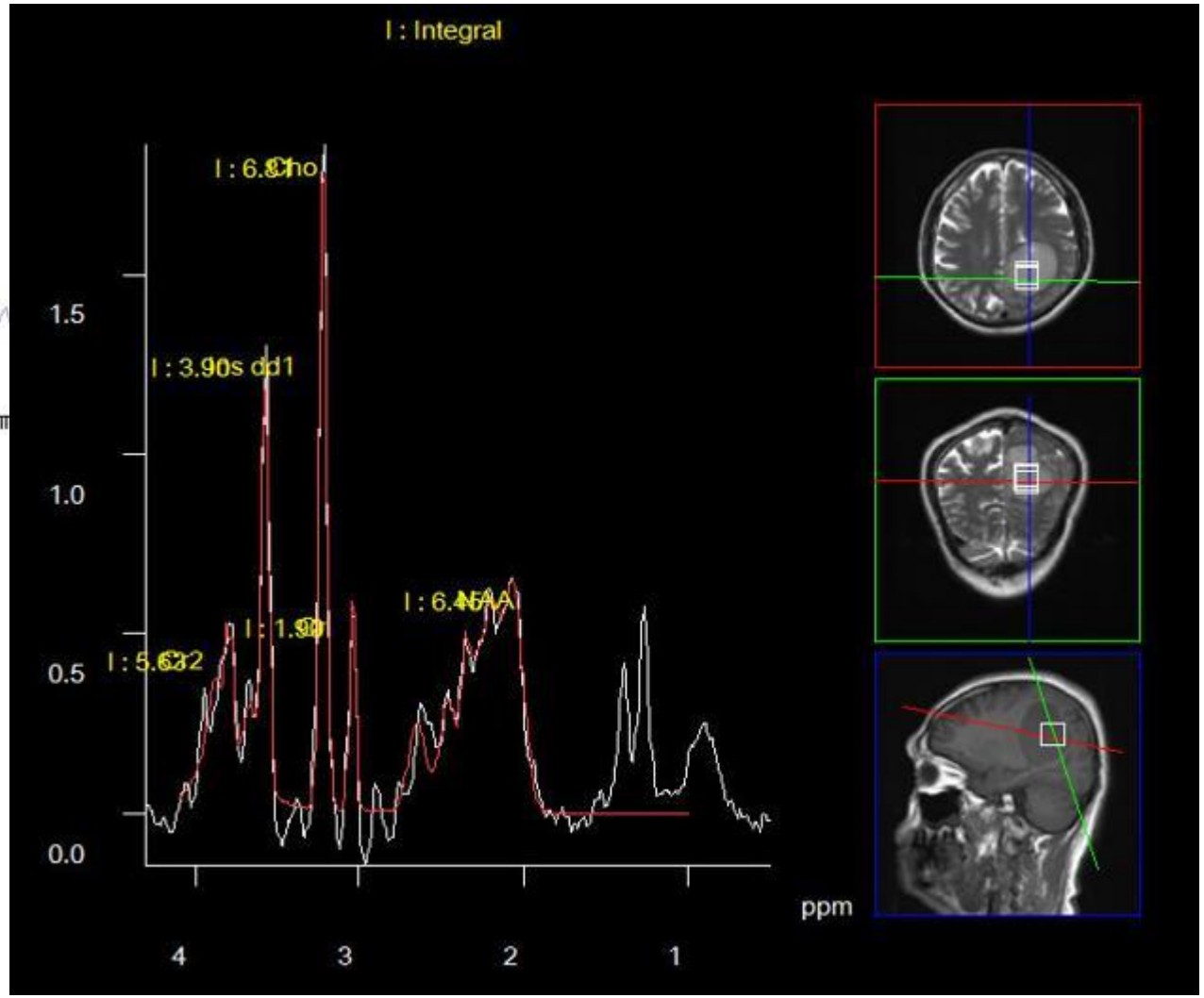
- Elevation of the Ch : NAA ratio in the peritumoral region can be a sign of tumor infiltration rather than edema induced by tumor, and this finding may allow differentiation of high-grade gliomas from brain metastases.

- A high myoinositol (mI) concentration has been observed in low-grade astrocytomas.

- MRS can reliably differentiate low- from high-grade tumors, as well as metastasis from highgrade glioma.

- Other metabolites observed in brain neoplasms include taurine in PNET, alanine in meningiomas and glycine in high-grade pediatric tumors. Nonneoplastic lesions such as abscesses and tuberculomas often demonstrate elevations in amino acids and lipids.


Normal
NAA
Creatine
Choline
4.6
3.6
2.6
1.6
0.6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I : 6.8 Cho
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I : 6.4 NAA
I : 1.9
I : 5.6 2
1.5
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4
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