Intracranial metastases classification

- Development and validation of a preoperative magnetic resonance imaging-based and machine learning model for the noninvasive differentiation of intracranial glioblastoma, primary central nervous system lymphoma and brain metastases: a retrospective analysis
- High-Grade Glioma With Parotid Metastasis: A Case Report of Long-Term Treatment and Follow-Up
- Neurosurgical management of brain metastases in the elderly: a prospective study on adverse event prevalence and predictors
- Prolactin-secreting pituitary carcinomas with intra- and extracranial metastasis: case report and review
- Comparing the Rates of Further Resection After Intraoperative MRI Visualisation of Residual Tumour Between Brain Tumour Subtypes: A 17-Year Single-Centre Experience
- Influence of brain metastases on the classification, treatment, and outcome of patients with extracranial oligometastasis: a single-center cross-sectional analysis
- A retrospective multicenter study of WHO 2021 classification-diagnosed solitary fibrous tumor of the CNS in a population from Lombardy, Italy
- Central nervous system solitary fibrous tumors: Case series in accordance with the WHO 2021 reclassification. Framework for patient surveillance

1. By Anatomical Location

Supratentorial Brain Metastases: Located above the tentorium cerebelli, typically in the cerebral hemispheres. These are the most common and can involve the frontal, parietal, occipital, and temporal lobes.

Infratentorial Metastases: Found below the tentorium cerebelli, primarily in the cerebellum and brainstem. Less common but associated with more significant neurological impairment due to proximity to vital structures.

Leptomeningeal Metastases (Leptomeningeal Carcinomatosis): Cancer spreads to the leptomeninges (the thin layers of tissue covering the brain and spinal cord), leading to diffuse involvement of the central nervous system.

Skull or Dural Metastases: Affect the bones of the skull or the dura mater (outermost meningeal layer). These may present as bony metastases or direct involvement of the dura with secondary compression of the brain.

2. By Histopathological Type (Primary Cancer Source)

Intracranial metastases can arise from a variety of primary cancers, and the type of primary tumor significantly influences prognosis and treatment. Common sources include:

Lung Cancer: The most frequent source of brain metastases, particularly non-small cell lung cancer (NSCLC) and small-cell lung cancer (SCLC).

Breast Cancer: A common cause of brain metastases, particularly in HER2-positive and triple-negative

breast cancers.

Melanoma: Highly prone to metastasize to the brain, often hemorrhagic and with poor prognosis.

Renal Cell Carcinoma: Tends to produce large, hemorrhagic metastases.

Colorectal Cancer: Less common but possible, particularly in advanced disease stages.

Prostate Cancer: Rarely metastasizes to the brain but can involve the dura or skull.

3. By Number of Lesions

Solitary Metastasis: A single brain lesion. These cases are more likely to be surgically resected or treated with stereotactic radiosurgery (SRS).

Oligometastases.

Multiple Metastases: More than 4 lesions, commonly treated with whole-brain radiotherapy (WBRT) or systemic therapy depending on the primary cancer and overall condition of the patient.

4. By Imaging Characteristics

Intracranial metastases have distinct imaging features that can aid in their classification:

Ring-enhancing Lesions: Characterized by a ring of contrast enhancement surrounding a necrotic core, commonly seen in metastases. Hemorrhagic Metastases: Metastases from cancers like melanoma, renal cell carcinoma, and choriocarcinoma are prone to bleeding, creating mixed-density areas on imaging.

Edema and Mass Effect: Many metastases are associated with significant surrounding vasogenic edema (swelling) and mass effect, which may compress nearby brain structures.

Cystic Metastases: Some metastases develop cystic areas, as seen in cancers such as breast and gastrointestinal tumors.

5. By Molecular Markers and Genetic Profiles

Molecular profiling of primary tumors and brain metastases can influence treatment strategies:

HER2-positive breast cancer metastases often respond to targeted therapies like trastuzumab. EGFR-mutated NSCLC metastases or ALK-rearranged NSCLC metastases can be treated with tyrosine kinase inhibitors (TKIs).

BRAF mutations in melanoma allow the use of BRAF inhibitors. PD-L1 expression in lung cancer and melanoma influences the use of immunotherapy like checkpoint inhibitors.

6. By Response to Treatment

Radiosensitive Metastases: Tumors that typically respond well to radiation therapy (e.g., small-cell lung cancer). Radioresistant Metastases: Tumors less responsive to conventional radiation, such as melanoma or renal cell carcinoma, may require stereotactic radiosurgery (SRS) or surgical intervention. Systemic Therapy Sensitive Metastases: Some metastases respond to targeted systemic treatments or immunotherapies based on molecular markers (e.g., HER2, EGFR, ALK mutations).

7. By Clinical and Symptomatic Presentation

Asymptomatic Metastases: Often detected incidentally on imaging studies done for other reasons. Symptomatic Metastases: Present with neurological deficits such as headaches, seizures, motor or sensory deficits, and cognitive or behavioral changes depending on the location. Leptomeningeal Metastases: Present with diffuse neurological symptoms like cranial nerve deficits, altered mental status, and signs of meningeal irritation.

8. By Prognostic Classification

Graded Prognostic Assessment (GPA): A commonly used scoring system that incorporates factors like patient age, performance status (Karnofsky Performance Score), number of brain metastases, and the status of the primary cancer (controlled vs. uncontrolled). Higher GPA scores predict better outcomes. Recursive Partitioning Analysis (RPA): Another classification system that divides patients into different prognostic categories based on age, performance status, and control of the primary tumor

Number of Lesions

Solitary Metastasis: Refers to a single metastatic lesion in the brain.

Multiple Metastases: Refers to the presence of two or more metastatic lesions in the brain.

Location of Metastases

Supratentorial Metastases: Metastases located above the tentorium cerebelli, including the cerebral hemispheres.

Infratentorial Metastases: Metastases located below the tentorium cerebelli, including the cerebellum and brainstem.

Cortical, Subcortical, or Deep Brain Metastases: Depending on the depth within the brain where the metastases occur.

Leptomeningeal Metastases: Metastases involving the meninges, the membranes covering the brain and spinal cord.

Primary Site of Cancer

Breast Cancer Metastases: Metastases originating from breast cancer.

Lung Cancer Metastases: Metastases originating from lung cancer.

Renal Cell Carcinoma Metastases: Metastases originating from renal cell carcinoma.

Melanoma Metastases: Metastases originating from melanoma, which can have a predilection for the brain.

Radiological Features

Hemorrhagic Metastases: Metastases with evidence of bleeding.

Cystic Metastases: Metastases with cystic components.

Ring-Enhancing Metastases: Metastases with a ring of enhancement on contrast-enhanced imaging, often seen in abscesses and some metastases.

Histological Features

Adenocarcinoma Metastases: Metastases originating from glandular tissue.

Squamous Cell Carcinoma Metastases: Metastases originating from squamous epithelial cells.

Small Cell Carcinoma Metastases: Metastases originating from neuroendocrine cells, often seen in lung cancer.

Classification systems may vary depending on the context and specialty, such as oncology, neurology, or radiology. The classification helps in guiding treatment decisions and predicting prognosis for patients with intracranial metastases.

Brain metastases classification

Brain metastases classification.

Intraventricular metastases

Intraventricular metastases.

Cerebellar metastases

Cerebellar metastases.