Thalamic tumor

- Triple-target radiosurgery for intractable cancer pain of mixed origin: Two-centre experience in Central America
- Diffusion kurtosis imaging biomarkers associated with amelioration of neuroinflammation, gray matter microstructural abnormalities, and gut dysbiosis by central thalamic deep brain stimulation in autistic -like young rats
- Cholinergic neuronal activity promotes diffuse midline glioma growth through muscarinic signaling
- Minimally Invasive and Cost-Effective Access to Deep-Seated Intracranial Lesions Using 19F Peel-Away Sheath Introducer and "Dynamic" Retraction: Technical Note and a Case Series
- Comprehensive molecular characterization of adult H3K27M mutated thalamic glioma long-term survivors
- Amelioration of Chemotherapy Induced Neuropathic Pain using Novel Nicotinic Acid Derivatives with possible HCN channel binding ability
- Brain Abscess Mimicking Brain Tumors: A Systematic Review of Individual Patient's Data
- Thalamic pleomorphic xanthoastrocytoma central nervous system World Health Organization grade 3

Epidemiology

Thalamic tumors are **rare intracranial neoplasms**, accounting for **1–5% of all brain tumors**. They can occur at any age but are more frequently observed in **children and young adults**, particularly in cases of **diffuse midline gliomas (DMG, H3 K27-altered)**.

1. Incidence & Prevalence

- **Overall incidence:** Estimated at **0.1 to 0.5 per 100,000 persons per year**. - **Pediatric vs. adult population:**

1. More common in **children and adolescents**, particularly **DMG, H3 K27-altered**.
2. Less common in adults, where **glioblastomas, low-grade gliomas, and metastases** are more frequent.

- **Gender distribution:** No strong gender preference, though some studies suggest a slight male predominance.

2. Age-Specific Epidemiology

Age Group	Most Common Thalamic Tumors
Children & Adolescents	Diffuse Midline Glioma, H3 K27-altered (WHO Grade 4) \ Pilocytic Astrocytoma \ Embryonal Tumors (e.g., PNETs)
Young Adults (20–40 years)	Low-Grade Gliomas (Astrocytomas, Oligodendrogliomas) \ Gangliogliomas
Older Adults (>40 years)	High-Grade Gliomas (Glioblastoma) \ Metastases (Lung, Breast, Melanoma) \ Primary CNS Lymphoma

3. Geographic & Ethnic Variation

- **H3 K27-altered DMG** is predominantly reported in **pediatric populations worldwide**. - **Primary CNS Lymphoma** is **more common in immunocompromised individuals**, especially in areas with high **HIV/AIDS prevalence**. - **Metastases** to the thalamus are **more frequent in high-income countries**, where cancer survival rates allow for late-stage metastases.

Classification

1. Histopathological Classification

Thalamic tumors can be primary (originating from thalamic structures) or secondary (metastatic or extensions from adjacent structures). The most common histopathological types include:

A. Thalamic Gliomas (Most Common)

B. Embryonal Tumors (More Common in Pediatrics)

Atypical Teratoid/Rhabdoid Tumor (ATRT) – Highly malignant, often seen in young children.

Primitive Neuroectodermal Tumors (PNETs) – Rare but aggressive.

C. Ependymal Tumors

Ependymoma (WHO Grade II-III) – Can occur in the thalamus, usually well-defined with variable prognosis.

D. Neuronal and Mixed Glioneuronal Tumors

Ganglioglioma (WHO Grade I-II) – Slow-growing, often with seizures.

Dysembryoplastic Neuroepithelial Tumor (DNET, WHO Grade I) – Rare, associated with epilepsy.

E. Lymphomas and Histiocytic Tumors

Primary CNS Thalamic Lymphoma (PCNSL, WHO Grade IV) – Aggressive B-cell lymphoma, common in immunocompromised patients.

Langerhans Cell Histiocytosis (LCH) – Can involve the thalamus in systemic cases.

F. Metastatic Tumors

Lung, breast, melanoma, and renal cell carcinoma metastases can spread to the thalamus.

2. Radiological Classification Thalamic tumors can be categorized based on imaging characteristics (MRI & CT):

Enhancing vs. Non-Enhancing: High-grade gliomas and metastases enhance with contrast, whereas low-grade gliomas may not. Diffusely Infiltrative vs. Well-Circumscribed: Pilocytic astrocytomas tend to be well-circumscribed, while glioblastomas are highly infiltrative. Midline vs. Unilateral: Diffuse midline gliomas commonly involve both thalami.

Puget et al. divided tumors of the thalamic region into unilateral, bilateral, and thalamopeduncular; a term that best describes the anatomical features of these tumors without designating a specific structure of origin, which is largely unknown. These tumors appear to arise in the cerebral peduncle at its junction with the inferior thalamus, and the majority of these tumors are confluent lesions with histological features consistent with pilocytic tumors. They are slow growing, displacing the corticospinal tracts (CSTs), which accounts for the clinical presentation of slowly progressive spastic hemiparesis [1].

Thalamic tumors (TTs) account for approximately 1% of all intracranial neoplasms. TTs are seen predominantly in children and young adults.

Most childhood neoplasms in this location are of glial lineage, a large proportion being low grade tumors.

Clinical features

The evolution of symptoms before diagnosis is characteristically shorter in children than in adults.

Clinical features of TTs reflect the pressure of the mass on the cerebrospinal fluid pathways, the pyramidal tracts, the thalamic nuclei and the optic radiations.

Clinical features of a thalamic tumor can vary depending on the specific location within the thalamus, the size of the tumor, and its impact on surrounding structures. Thalamic tumors can affect various functions due to the thalamus's role in relaying sensory and motor signals throughout the brain. Common clinical features may include:

Neurological Symptoms:

Motor Dysfunction: Weakness, clumsiness, or problems with coordination. Sensory Changes: Altered sensation, such as numbness or tingling. Balance Issues: Difficulties with coordination and maintaining balance. Cognitive and Behavioral Changes:

Memory Impairment: Difficulty with memory recall and formation. Personality Changes: Behavioral alterations, mood swings, or emotional disturbances. Cognitive Decline: Problems with thinking, reasoning, and decision-making. Visual Disturbances:

Visual Field Deficits: Changes in the field of vision, such as blurred or double vision. Eye Movement Abnormalities: Difficulty moving the eyes or controlling eye movements. Speech and Language Issues:

Dysarthria: Difficulty articulating words due to impaired muscle control. Language Impairment: Problems with understanding or expressing language. Seizures:

Epileptic Seizures: Thalamic tumors can trigger seizures. Headaches:

Increased Intracranial Pressure: Tumors may lead to headaches, especially if they cause a buildup of

pressure within the brain. Endocrine Abnormalities:

Hormonal Changes: Depending on the location, thalamic tumors may affect hormone regulation. Sleep Disturbances:

Insomnia or Hypersomnia: Changes in sleep patterns may occur. It's important to note that the clinical presentation can be diverse, and not all individuals with thalamic tumors will experience the same symptoms. Additionally, the rate of progression and severity of symptoms can vary. Diagnostic procedures, such as imaging studies (MRI or CT scans), are essential for identifying the presence, location, and characteristics of the tumor. Treatment options may include surgery, radiation therapy, chemotherapy, or a combination, depending on the type of tumor and its specific features. Early diagnosis and intervention can significantly impact the prognosis and quality of life for individuals with thalamic tumors.

Diagnosis

Magnetic Resonance Imaging (MRI) of Thalamic Tumors

Thalamic tumors are rare and may include **diffuse midline gliomas (DMG, H3 K27-altered), low-grade gliomas, high-grade gliomas, and metastases**. MRI plays a crucial role in diagnosis and treatment planning.

1. Key MRI Sequences & Findings

MRI Sequence	Findings in Thalamic Tumors
T1-weighted (T1W)	Hypointense to isointense lesion
T2-weighted (T2W)	Hyperintense, with peritumoral edema
Fluid-Attenuated Inversion Recovery (FLAIR)	Hyperintensity suggesting tumor infiltration
T1 with Contrast (Gadolinium-enhanced)	Variable enhancement: Low-grade (minimal) vs. High-grade (strong, irregular)
Diffusion-Weighted Imaging (DWI)	Restricted diffusion in high-grade tumors
Apparent Diffusion Coefficient (ADC)	Low ADC in aggressive tumors
Susceptibility-Weighted Imaging (SWI)	Possible hemorrhage or microvascular proliferation
Magnetic Resonance Spectroscopy (MRS)	Increased choline (Cho), decreased NAA, lipid/lactate peaks in necrotic areas
Perfusion MRI (DSC-PWI or DCE-PWI)	Elevated rCBV in high-grade tumors

2. Specific MRI Features by Tumor Type

A. Diffuse Midline Glioma (DMG), H3 K27-Altered

- **T1W:** Hypointense
- **T2/FLAIR:** Hyperintense, diffuse infiltration
- **Contrast Enhancement:** Variable, may be mild
- **DWI/ADC:** High-grade cases show restricted diffusion
- **MRS:** High choline, low NAA, lactate peaks

B. Low-Grade Gliomas (Pilocytic Astrocytoma, Oligodendroglioma, Ganglioglioma)

- **T1W:** Iso/hypointense
- **T2/FLAIR:** Hyperintense, well-defined margins
- **Contrast Enhancement:** Minimal or cystic
- **MRS:** Moderate choline increase, preserved NAA

C. High-Grade Gliomas (Glioblastoma, Anaplastic Astrocytoma)

- **T1W:** Hypointense
- **T2/FLAIR:** Hyperintense, necrosis and edema
- **Contrast Enhancement:** Irregular ring enhancement
- **DWI:** Restricted diffusion
- **MRS:** High choline, lipid/lactate peaks, low NAA

D. Metastatic Lesions

- **T1W:** Hypointense or mixed signal
- **T2W:** Hyperintense, peritumoral edema
- **Contrast Enhancement:** Strong, well-defined ring enhancement
- **DWI/ADC:** Central necrosis with peripheral restriction

Neuroendoscopic biopsy represents the procedure of choice for pure intraventricular lesions. Instead, in case of deep-seated paraventricular tumors, with intact ependyma, the advantage of neuroendoscopy over stereotactic biopsy is not so evident, because the lesion is not under direct vision; the tissue sample may be limited to more superficial ependymal layer, and bleeding may obscurate vision. Also, stereotactic biopsy may reserve additional problems for these lesions: inaccuracy caused by leak of cerebrospinal fluid and increased risk of severe hemorrhage due to damage of the ependymal vessels.

Case reports: We report two cases of young children affected by thalamic tumors that were biopsied using a modification of a recently proposed technique: endoscopic visual control, neuronavigated needle biopsy.

Conclusion: This technique may combine the accuracy of a stereotactic needle biopsy with the advantage of visual control on site of ependymal puncture and possibility of immediate bleeding control [2)].

Differential Diagnosis

Thalamic tumors are relatively rare and can have a wide range of differential diagnoses. They can be classified based on their primary origin (glial, neuronal, embryonal, etc.) or secondary involvement (metastases, inflammatory, infectious, or vascular causes).

1. Primary Neoplastic Lesions A. Glial Tumors (Most Common) Diffuse Midline Glioma, H3 K27-Altered (WHO Grade 4)

Common in children and young adults. Aggressive, infiltrative, poor prognosis. MRI: T2/FLAIR hyperintense, minimal enhancement, H3 K27M mutation confirmation. Low-Grade Glioma (Astrocytoma, Oligodendroglioma)

Slower-growing tumors. MRI: T2 hyperintense, no or minimal contrast enhancement. Glioblastoma (WHO Grade 4)

High-grade astrocytoma with necrosis and hemorrhage. MRI: Irregular contrast enhancement, necrotic core, peritumoral edema. Pilocytic Astrocytoma (WHO Grade 1)

More common in children. MRI: Well-defined, cystic lesion with mural nodule, strong contrast enhancement. B. Neuronal and Mixed Neuronal-Glial Tumors Ganglioglioma

Slow-growing, mixed neuronal-glial tumor. MRI: Well-circumscribed, calcifications, solid-cystic pattern. Dysembryoplastic Neuroepithelial Tumor (DNET)

Rare in the thalamus, often associated with epilepsy. MRI: Well-defined, no significant enhancement. C. Embryonal Tumors Primitive Neuroectodermal Tumor (PNET) Aggressive, highly cellular. MRI: Large, poorly defined, heterogeneous enhancement. 2. Secondary Neoplastic Lesions (Metastases) Lung Cancer Metastasis (Most Common) Breast Cancer Metastasis Melanoma Metastasis Renal Cell Carcinoma Metastasis MRI Features: Well-defined, strong contrast enhancement, surrounding edema. 3. Inflammatory and Infectious Lesions Neurosarcoidosis

MRI: Non-specific, enhancing nodular lesions, can mimic gliomas. Tuberculoma

Seen in endemic areas. MRI: Ring-enhancing lesion, can have central caseating necrosis. Neurocysticercosis

Parasitic infection. MRI: Cystic lesions with eccentric scolex (pathognomonic). Progressive Multifocal Leukoencephalopathy (PML)

JC virus infection in immunocompromised patients. MRI: White matter lesions without enhancement or mass effect. Multiple Sclerosis (Tumefactive MS)

MRI: Large demyelinating plaques, open-ring enhancement. 4. Vascular Lesions Cavernous Malformation (Cavernoma)

MRI: “Popcorn” appearance with hemosiderin ring (SWI hypointensity). Arteriovenous Malformation (AVM)

MRI/MRA: Flow voids, dilated draining veins. Ischemic Stroke (Subacute/Chronic)

Can mimic tumors in delayed stages. MRI DWI: Restricted diffusion in the acute phase. 5.

Miscellaneous Lymphoma (Primary CNS Lymphoma)

Common in immunocompromised patients. MRI: Strong homogeneous enhancement, diffusion restriction (DWI hyperintensity). Hemangioblastoma

Rare in the thalamus. MRI: Well-defined, cystic lesion with an enhancing mural nodule. Thalamic Hamartoma

Congenital, non-neoplastic. MRI: T1/T2 isointense, no enhancement. Conclusion Younger patients: Consider H3 K27-altered DMG, low-grade gliomas, pilocytic astrocytoma. Older patients: Consider high-grade gliomas, metastases, lymphoma. Immunocompromised patients: Consider lymphoma, tuberculosis, PML. MRI with spectroscopy, perfusion imaging, and biopsy is essential for an accurate diagnosis.

Treatment

see Thalamic glioma treatment.

Thalamic tumor surgery

Prognosis

H3 K27-altered DMG (Pediatric & Young Adults): Very poor prognosis, median survival ~12 months.

Low-Grade Gliomas: Better prognosis, median survival >10 years if managed appropriately.

Glioblastoma (WHO Grade 4): Poor prognosis, median survival ~12–18 months.

Metastases & Lymphoma: Prognosis depends on systemic disease and treatment response.

Surgical treatment of adult thalamic tumors must be individualized according to tumor location. Low-grade tumors and total/subtotal resection seem to be predictors of better surgical outcomes. Nevertheless, the outcome of adult patients was still worse than pediatric patients [3].

Case series

Thalamic tumor case series.

Case reports from the HGUA

Patient Information

Age: 59 years

Medical History

Type 2 Diabetes Mellitus

Current Medication

Cadryl 40mg (1-0-0)

Ebymec

Trulicity

A 59-year-old male patient was referred from Primary Care with a suspected stroke due to a two-month history of left-sided hemihypoesthesia. An urgent brain MRI was requested, and radiology contacted the neuro-oncology team due to significant findings.

The patient reports numbness in the left hemibody for the past 2-3 months, describing a persistent tingling sensation and internal coldness. He has also noticed mild weakness on the same side. No associated tremors or stereotyped movements have been observed, but he describes an intermittent “tremor-like” sensation in the left costal region. He denies any pain.

Physical Examination

Neurological Findings:

Left-sided tactile hemihypoesthesia

No other abnormalities detected

Additional Investigations

Brain MRI with Contrast

Right thalamic lesion compatible with a low-grade astrocytoma

Less probable differential diagnoses: lymphoma or inflammatory/infectious pathology (in an immunocompromised patient)

Clinical Assessment

Right Thalamic Space-Occupying Lesion (SOL) under investigation

Probable diagnosis: Low-grade astrocytoma

Planned Intervention

Neuronavigated Brain Biopsy

1)
Puget S, Crimmins DW, Garnett MR, Grill J, Oliveira R, Boddaert N, et al. Thalamic tumors in children: a reappraisal. J Neurosurg. 2007;106 (5 Suppl):354–362.
2)
Spennato P, Ruggiero C, Mirone G, Imperato A, Parlato RS, Cinalli G. Endoscopic needle biopsy of

thalamic tumors: technical note. Childs Nerv Syst. 2020 Nov;36(11):2835-2840. doi: 10.1007/s00381-020-04676-6. Epub 2020 May 19. PMID: 32430674.

3) Cao L, Li C, Zhang Y, Gui S. Surgical resection of unilateral thalamic tumors in adults: approaches and outcomes. BMC Neurol. 2015 Nov 7;15:229. doi: 10.1186/s12883-015-0487-x. PMID: 26545867; PMCID: PMC4636900.