

## Radiologic mimicry: CNS lymphoma mimicking meningioma on CT and MRI

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### Abstract

Meningiomas, which represent the majority of primary intracranial tumours, are characterized by typical imaging features such as a well-defined shape and homogeneous contrast enhancement. However, clinical practice necessitates the inclusion of rare neoplasms capable accurately mimicking them in the differential diagnosis. This study aims to present in detail the case of a 69-year-old male with a tumour in the cerebellar vermis, which on magnetic resonance imaging (MRI) demonstrated strong, homogeneous contrast enhancement, initially suggesting a meningioma. Crucial atypical imaging elements that challenged this diagnosis were the lesion's irregular shape, its poor demarcation from the surrounding brain tissue, and significant restricted diffusion on diffusion-weighted imaging (DWI) sequences. The decisive clinical evidence,

however, was the spectacular regression of the volume of the tumour following empirical corticosteroid therapy, which strongly suggests lymphoma of the central nervous system. Final confirmation of a disseminated lymphoproliferative process was obtained through the biopsy of a concomitant kidney lesion, with histopathological results consistent with diffuse large B-cell lymphoma. This case vividly illustrates radiologic mimicry in neuro-oncology and underscores the critical importance of analyzing subtle, atypical imaging features and the response to steroid therapy. The conclusion drawn from this report is the necessity of including SCNSL – secondary central nervous system lymphoma – in the differential diagnosis of every dural-based mass, which prevents diagnostic errors and an unnecessary, burdensome craniotomy in favour of implementing appropriate systemic treatment.

## Introduction

Meningiomas are the most common primary intracranial tumours in adults, accounting for nearly 38% of all primary brain tumours, with an incidence rate of 8.83 per 100,000 individuals according to the most recent data from the Central Brain Tumor Registry of the United States (Ostrom et al. 2022, 2023). They demonstrate a marked female predominance, with a female-to-male incidence ratio of 3:1, increasing up to 9:1 in cases of spinal localization (Louis et al. 2021). The peak incidence occurs around the age of 65 years, and the frequency of meningioma diagnosis continues to rise with advancing age as well as with the increasingly widespread availability of advanced neuroimaging modalities (Woehrer et al. 2014). Magnetic resonance imaging (MRI) remains the gold standard in the radiological evaluation of meningiomas. On MRI, a typical meningioma appears as a well-circumscribed extra-axial mass characterized by homogeneous and intense contrast enhancement. A classic, although non-pathognomonic, radiological feature is the so-called “dural tail sign”, defined as linear enhancement of the dura mater adjacent to the tumour (Go et al. 2006). On computed tomography (CT), meningiomas are frequently hyperdense relative to the cerebral cortex, and hyperostosis of the underlying bone may be present, manifesting as thickening and sclerosis of the skull with the characteristic “beaten brass appearance” (Go et al. 2006). Intratumoural calcifications are also commonly observed. Despite substantial advances in neuroimaging techniques, MRI alone remains insufficiently reliable for precise prediction of the histopathological grade of malignancy according to the World Health Organization (WHO) grading system. Advanced imaging modalities, including MR spectroscopy (demonstrating an alanine peak), diffusion-weighted imaging (DWI) (with decreased apparent diffusion coefficient [ADC] values), and positron emission tomography (PET) using somatostatin analogues ( $^{68}\text{Ga}$ -DOTATATE), represent promising tools for improved tumour characterization (Tang et al. 2011).

Systemic lymphoma with secondary involvement of the central nervous system (secondary central nervous system lymphoma, SCNSL) represents a subtype of non-Hodgkin lymphoma, most commonly of B-cell origin, characterized by dissemination to the central nervous system (CNS) in the setting of previously diagnosed or concomitantly occurring systemic lymphoma. CNS involvement

may affect the brain parenchyma, leptomeninges, cranial nerves, spinal cord and ocular structures. On MRI, lesions most frequently involve deep cerebral structures, including the periventricular white matter, basal ganglia, corpus callosum and frontal lobes; however, their radiological appearance is considerably more heterogeneous than that observed in primary CNS lymphoma (PCNSL). Typically, SCNSL lesions demonstrate intense, predominantly homogeneous contrast enhancement on T1-weighted post-contrast images and restricted diffusion attributable to their high cellularity. Nevertheless, a subset of cases may exhibit areas of necrosis, heterogeneous contrast enhancement or multifocal disease, thereby increasing diagnostic complexity and potentially leading to misdiagnosis as other intracranial neoplasms, particularly high-grade gliomas or meningiomas. In contrast to PCNSL, patients with SCNSL have either concurrent or previously documented systemic lymphoma outside the CNS, a distinction that is essential for establishing the correct diagnosis and guiding subsequent therapeutic management.

In the differential diagnosis, which primarily includes glioblastoma multiforme (GBM) and tumefactive demyelinating lesions, advanced MRI techniques play a crucial role. On DWI, PCNSL demonstrates markedly restricted diffusion and lower ADC values compared with GBM, owing to its higher cellular density (Suh et al. 2019). Magnetic resonance spectroscopy (MRS) in patients with SCNSL demonstrates a metabolic profile broadly comparable to that observed in PCNSL. The characteristic spectroscopic pattern includes a prominent lipid peak (approximately 1.3 ppm), frequently accompanied by elevated choline levels and reduced N-acetylaspartate (NAA) concentrations, reflecting high cellular proliferative activity, increased membrane turnover and the infiltrative nature of the neoplasm. Notably, the presence of a marked lipid peak, even in the absence of extensive necrosis, results from lipid release by lymphoma cells and may serve as an important diagnostic hallmark. On dynamic susceptibility contrast magnetic resonance imaging (DSC-MRI), relative cerebral blood volume (rCBV) values are typically low or only moderately elevated, distinguishing SCNSL from high-grade gliomas, which are characterized by pronounced neoangiogenesis and substantially higher rCBV values. The integrated interpretation of MRS and DSC-MRI findings may substantially improve the differential diagnosis of CNS lymphoma from other intracranial neoplasms and facilitate appropriate diagnostic work-up as well as subsequent therapeutic planning (Kickingeder *et al.* 2014).

Metabolic imaging using  $^{18}\text{F}$ -FDGPET (fluorine-18 fluorodeoxyglucose positron emission tomography) constitutes an important component of the diagnostic workup. These tumours demonstrate highly intense and homogeneous glucose uptake, with SUVmax values ranging from 14 to 22, approximately 2.5-fold higher than those observed in normal grey matter (Albano et al. 2018). Elevated FDG uptake is particularly useful in differentiating SCNSL from GBM and metastatic lesions, which often exhibit a more heterogeneous metabolic pattern (Raguž et al. 2018).

## Case description

The aim of this study is to present a rare case of SNCNSL that mimicked the typical radiological features of a meningioma on MRI, thereby highlighting significant diagnostic challenges and emphasizing the necessity of including lymphoma in the differential diagnosis of intracranial tumours, even in the presence of an apparently classic and characteristic radiological appearance suggestive of an alternative diagnosis.

A 69-year-old male patient was admitted to the Department of Neurosurgery due to a tumour located in the region of the cerebellar vermis, which resulted in secondary ventricular enlargement. According to the medical documentation, the patient's subjective complaints at the time of admission were not described in detail; however, the clinical presentation indicated the need for urgent diagnostic evaluation and treatment.

On physical examination, the patient was in good general condition, ambulatory and afebrile. Neurological examination revealed no significant deficits. Despite the presence of cerebellar lesions, the absence of focal neurological symptoms and the stable clinical condition suggested a relatively slow progression of the pathological process.

The initial contrast-enhanced CT scan of the head (06.06.2024) demonstrated a focal lesion located in the superior portion of the cerebellar vermis, measuring  $24 \times 23 \times 13$  mm. The tumour exhibited homogeneous, intense contrast enhancement and was adjacent to the tentorium cerebelli. Compared with the previous CT examination performed on 20.05.2024, a marked reduction in lesion size was observed (from  $33 \times 33 \times 20$  mm), representing an atypical finding that could suggest a specific histopathological nature of the tumour. The ventricular system remained non-dilated on CT imaging.

Contrast-enhanced MRI of the brain (10.06.2024) revealed an irregular, poorly demarcated proliferative lesion within cerebellar segments IV–V, measuring approximately 2.5 cm, demonstrating intense contrast enhancement, diffusion restriction and a small amount of surrounding peritumoural oedema (Images 1, 2). In the radiological report, SCNSL was suggested as the leading diagnosis, followed by metastatic disease. Additionally, several small hyperintense foci within the white matter of both cerebral hemispheres were identified on T2-weighted and FLAIR sequences, corresponding to chronic ischemic vascular-related changes.

Supplementary CT of the chest, abdomen, and pelvis (06.06.2024) revealed a right renal mass measuring 40 mm, small residual lesions in the left kidney (up to 10 mm), as well as a pulmonary nodule in the left lung measuring  $12 \times 8$  mm, requiring follow-up imaging studies. No enlarged mediastinal or hilar lymph nodes were identified. This radiological presentation raised suspicion of a systemic pathological process involving both the CNS and the kidneys. The patient received corticosteroid therapy (dexamethasone), which resulted in

a significant regression of the cerebellar tumour and reduction of hydrocephalus. Such a dynamic therapeutic response, rarely observed in primary cerebellar tumours such as meningiomas, is more characteristic of lymphomas or certain metastatic lesions.

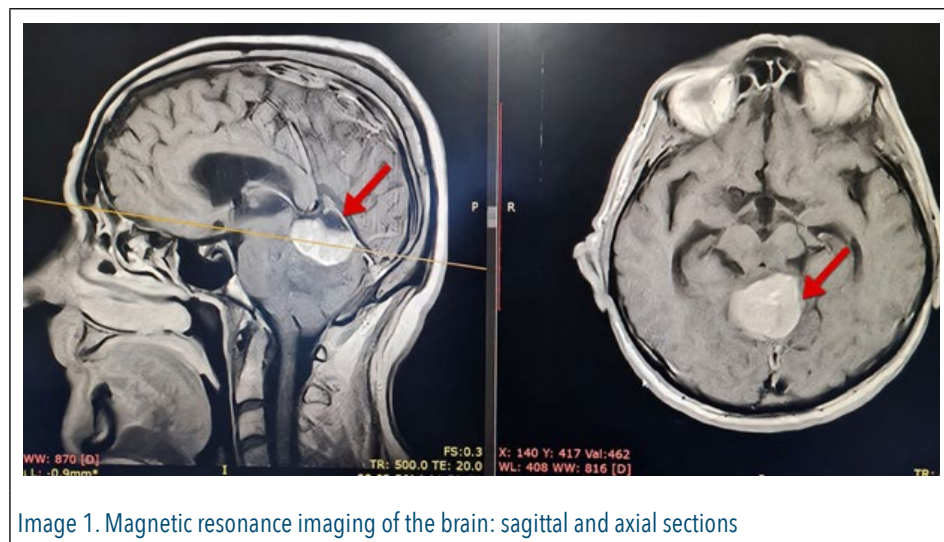


Image 1. Magnetic resonance imaging of the brain: sagittal and axial sections

Source: retrieved from the patient's medical records.

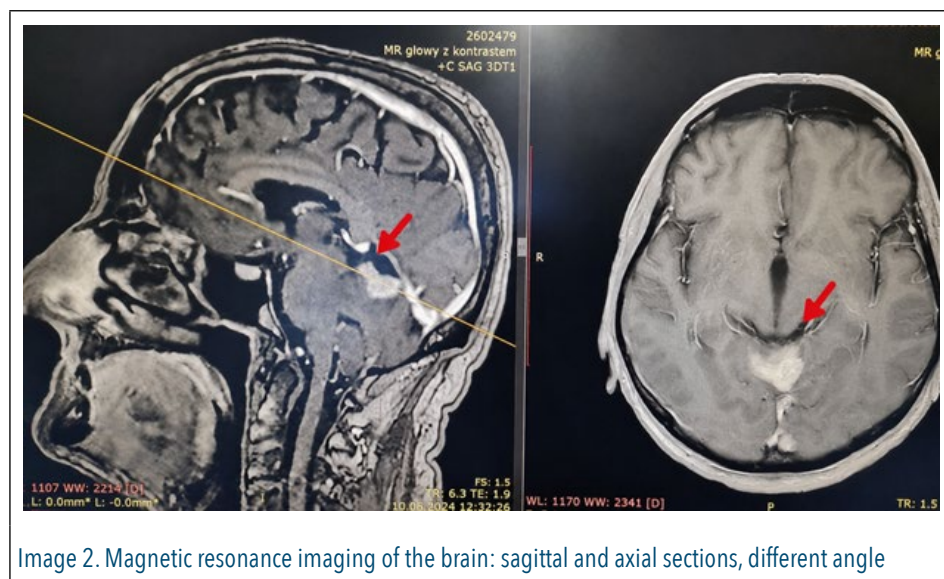


Image 2. Magnetic resonance imaging of the brain: sagittal and axial sections, different angle

Source: retrieved from the patient's medical records.

Due to the presence of secondary hydrocephalus, the patient was qualified for ventriculoperitoneal shunt implantation. The procedure was performed using a standard surgical technique: the ventricular catheter was inserted into the frontal horn of the right lateral ventricle, while the distal catheter was introduced into the peritoneal cavity. The surgery was uneventful, and the principal objective of the intervention was to protect the patient from further complications associated with hydrocephalus. The tumour was not resected because of the substantial regression of the lesion following pharmacological treatment.

During hospitalization, a percutaneous biopsy of the right renal lesion was performed (07.06.2024). Histopathological analysis (final report dated 22.07.2024) demonstrated abundant interstitial infiltrates composed of small- and medium-sized lymphoid cells. These cells were immunohistochemically positive for CD45 and negative for pan-cytokeratin, thereby excluding an epithelial malignancy, such as renal cell carcinoma.

The biopsy specimen underwent partial damage due to liquefaction artifacts, which limited the possibility of performing a complete immunohistochemical panel and precise lymphoma subtyping. Nevertheless, the morphological findings, together with the radiological and clinical response to corticosteroid therapy, were highly suggestive of diffuse large B-cell lymphoma. The medical documentation did not mention intraoperative frozen section analysis; however, even if such an examination had been performed, in cases of this type it frequently does not allow for unequivocal differential diagnosis. Further diagnostic evaluation was not pursued because the patient died before additional investigations could be completed.

## Discussion

This case constitutes a rare yet clinically significant diagnostic example, illustrating the challenges associated with differentiating an apparently typical meningioma from other, less common neoplastic processes. The key feature of this case is the dramatic and rapid regression of the lesion following corticosteroid therapy, a behaviour that is considered almost pathognomonic for PCNSL and entirely atypical of meningiomas, which usually respond to steroids only with a modest reduction of peritumoural oedema, without any substantial decrease in tumour size itself. This remarkable therapeutic response represented the first decisive finding arguing against the diagnosis of meningioma.

Although isolated cases of PCNSL mimicking meningiomas have been described in the literature subtle differences on MRI are usually present and may guide clinicians towards the correct diagnosis. A typical meningioma is an extra-axial, sharply demarcated tumour with homogeneous contrast enhancement and a broad dural attachment. In this case, however, the MRI report described

the lesion as “poorly demarcated” and “irregular”, features that are more characteristic of the infiltrative nature of lymphoma than of a benign meningioma. Furthermore, the presence of marked diffusion restriction (decreased ADC values) is exceedingly uncommon in typical WHO grade I meningiomas and strongly suggests a highly cellular neoplasm such as lymphoma or medulloblastoma.

Had advanced imaging techniques been incorporated into the diagnostic workup, lymphoma might have been suspected at an earlier stage. MR perfusion imaging (DSC-MRI) would likely have demonstrated low to moderately elevated rCBV, with values lower than those typically observed in high-grade gliomas due to the dense capillary network within the tumour, which is characteristic of lymphoma, whereas rCBV values in meningiomas are considerably more variable. MRS would have probably revealed a prominent choline peak, reflecting high cellular turnover, together with a characteristic lipid peak around 1.3 ppm associated with necrosis and apoptosis, while simultaneously lacking the alanine peak considered a relatively specific marker of meningiomas.

<sup>18</sup>F-FDG PET would have demonstrated intense and homogeneous glucose uptake, substantially exceeding that observed in normal cerebral cortex, which is typical of aggressive lymphomas (Frances et al. 2024).

Ultimately, histopathological examination of the renal biopsy specimen provided conclusive evidence of a disseminated lymphoproliferative process, which, in conjunction with the CNS response to corticosteroid therapy, allowed the final diagnosis to be established. This case clearly demonstrates that in diagnostically equivocal situations, particularly when tumour localization and radiological appearance are not entirely characteristic, minimally invasive stereotactic biopsy should be considered prior to undertaking radical and potentially burdensome craniotomy. The therapeutic strategies for lymphoma and meningioma differ fundamentally, as treatment selection between surgical intervention and chemotherapy combined with radiotherapy are diametrically opposed. Consequently, an incorrect diagnosis may significantly delay the initiation of appropriate and effective treatment.

## Summary

This case of a 69-year-old male patient with a cerebellar tumour serves as an important warning against the diagnostic pitfall of overinterpreting a seemingly “typical” radiological appearance. It underscores the critical importance of diagnostic caution and the necessity of histopathological confirmation prior to planning definitive, and often invasive, treatment. In this case, the rapid tumour regression following corticosteroid therapy represented the most valuable clinical indicator, allowing an unnecessary craniotomy to be avoided and the patient to be redirected towards the appropriate therapeutic pathway, namely systemic

oncological treatment. This case reinforces the principle that the initial diagnostic impression, based primarily on disease prevalence and apparent radiological typicality, must always be verified through critical analysis of all available clinical, imaging, and histopathological data.

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### Declaration of Generative AI Use

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The authors declare no conflict of interest.