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Letter to the Editor

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The Psychiatric Effective Lesion in Meningioma: An Anatomical Framework Beyond Tumor Location

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Abstract

Meningiomas provide a distinctive model for investigating the anatomical substrates of psychiatric symptoms because their effects on the brain extend beyond the visible tumor mass. We propose the concept of the "psychiatric effective lesion," defined as the functional anatomical territory affected by cortical compression and displacement, peritumoral edema, deformation of white-matter pathways, and secondary network disruption. This framework predicts that integrated measures of these spatial effects may explain psychiatric phenotypes better than tumor volume or conventional anatomical location alone. Prospective studies combining detailed psychiatric phenotyping with structural and functional mapping could directly test this hypothesis.

Keywords: Meningioma; Neuroanatomy; Psychiatric symptoms; Peritumoral edema; Brain networks; Tumor-brain interface.

Dear Editor

Meningiomas offer a distinctive model for investigating the anatomical substrates of psychiatric symptoms. Unlike infiltrative intra-axial tumors, most meningiomas arise extra-axially and affect the brain primarily through compression, displacement, peritumoral edema, and secondary alterations of neural connectivity. Nevertheless, depression, anxiety, apathy, personality change, and other behavioral disturbances are well documented, particularly in tumors involving the anterior cranial fossa and frontotemporal regions [1,2]. Recent studies further indicate that at least some of these disturbances can improve after surgical decompression [3,4].

These observations raise an anatomical problem. The conventional radiological tumor boundary may not correspond to the neural territory responsible for the psychiatric phenotype. Tumor location and volume describe the mass itself, but they incompletely capture the spatial consequences of an extra-axial lesion on adjacent brain tissue. We therefore propose the concept of the psychiatric effective lesion: the functional anatomical territory affected by the combined effects of the tumor on adjacent cortex, subcortical connections, and distributed neural networks.

In meningioma, this territory could extend well beyond the dural attachment and enhancing tumor margin. Its anatomical components may include cortical compression and displacement, deformation of underlying white-matter pathways, peritumoral brain edema, local mass effect, and secondary disruption of functionally connected regions. Peritumoral edema is particularly relevant because it alters brain tissue outside the tumor itself and may substantially enlarge the volume of functionally compromised

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parenchyma. Its development reflects multiple processes at the tumor-brain interface, including vascular permeability changes, inflammatory signaling, extracellular-matrix alterations, and blood-brain barrier dysfunction [5].

Functional imaging provides evidence that these anatomical effects cannot be reduced to tumor volume alone. In patients with meningioma, whole-brain resting-state dysconnectivity has been associated with perifocal edema volume but not with tumor volume, while greater dysconnectivity has also been related to poorer neurocognitive performance [6]. More recently, patients with olfactory groove meningiomas were shown to have altered connectivity involving the default mode, salience, and frontoparietal networks. Some of these abnormalities were associated with perilesional edema, supporting the possibility that focal compression of the frontal lobes can produce spatially distributed functional consequences [7].

The same distinction may be relevant to psychiatric manifestations. A 2026 study of frontotemporal meningiomas found significant postoperative improvement in psychiatric as well as cognitive measures. Frontal-base origin was associated with less psychiatric recovery, although psychiatric manifestations were analyzed as a composite encompassing depression, anxiety, apathy, irritability, and other behavioral symptoms [3]. A prospective 2026 study of olfactory groove meningiomas similarly demonstrated a postoperative reduction in overall psychopathological symptoms, while depression and apathy showed improving but nonsignificant trajectories [4]. Together with recent systematic evidence showing considerable heterogeneity in cognitive, affective, and behavioral presentations, these findings suggest that conventional anatomical descriptors may be insufficient to explain individual psychiatric phenotypes [1].

A more anatomically resolved approach could therefore separate several spatial components rather than representing the meningioma as a single lesion mask. Future studies could quantify the tumor footprint, cortical displacement, edema volume and distribution, deformation of major white-matter pathways, and the structural or functional networks intersected by these alterations. These measures could then be related to specific psychiatric domains rather than to a single global psychiatric score. Depression, apathy, disinhibition, anxiety, and altered social behavior may not share the same anatomical substrate, even when they occur in patients with tumors classified within the same gross anatomical region.

This model generates testable predictions. A composite measure of the psychiatric effective lesion should explain psychiatric phenotype or symptom severity better than tumor volume or lobar location alone. Longitudinally, psychiatric recovery after surgery should correspond more closely to reduction of mass effect, resolution of edema, restoration of anatomical relationships, or normalization of network organization than to tumor removal considered in isolation. Conversely, if these expanded anatomical measures do not improve prediction beyond conventional location and volume, the proposed framework would be weakened.

The concept does not imply that psychiatric symptoms in patients with meningioma are exclusively neuroanatomical. Psychological responses to diagnosis, treatment, medications, seizures, and premorbid vulnerability remain potential contributors. Rather, it provides a way to isolate and test the anatomical component of psychiatric morbidity.

For an extra-axial tumor, therefore, the clinically relevant lesion may not be confined to the tumor itself. The psychiatric anatomy of meningioma may be better defined by the brain that is displaced, edematous, disconnected, and functionally perturbed than by the visible mass alone.

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