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DIFFERENT SURGICAL MANIFESTATIONS OF MENINGIOMAS

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Abstract: Meningiomas are among the most common primary intracranial tumors arising from the meningothelial cells of the arachnoid layer. Though typically benign, their surgical manifestations vary significantly depending on their size, location, vascular supply, and relationship with adjacent neurovascular structures. Surgical management remains the mainstay of treatment, and understanding the diverse presentations of meningiomas is critical for neurosurgeons. Supratentorial meningiomas, such as those located at the convexity or parasagittal region, often present with seizures or focal neurological deficits, and can be accessed relatively easily via craniotomy. In contrast, skull base meningiomas—including sphenoidal wing, clinoid, and petroclival types—pose greater surgical challenges due to their proximity to cranial nerves and vital vasculature [1]. Spinal meningiomas, though less common, require a different surgical approach and frequently result in symptoms of cord compression. Moreover, certain meningiomas exhibit invasive behavior or recur after resection, necessitating complex surgical strategies, including staged operations or combination with adjuvant therapies. Technological advancements, such as neuronavigation, intraoperative imaging, and microsurgical techniques, have greatly improved surgical outcomes. A tailored approach considering tumor pathology, anatomical complexity, and patient-specific factors remains essential in achieving optimal resection and minimizing morbidity.

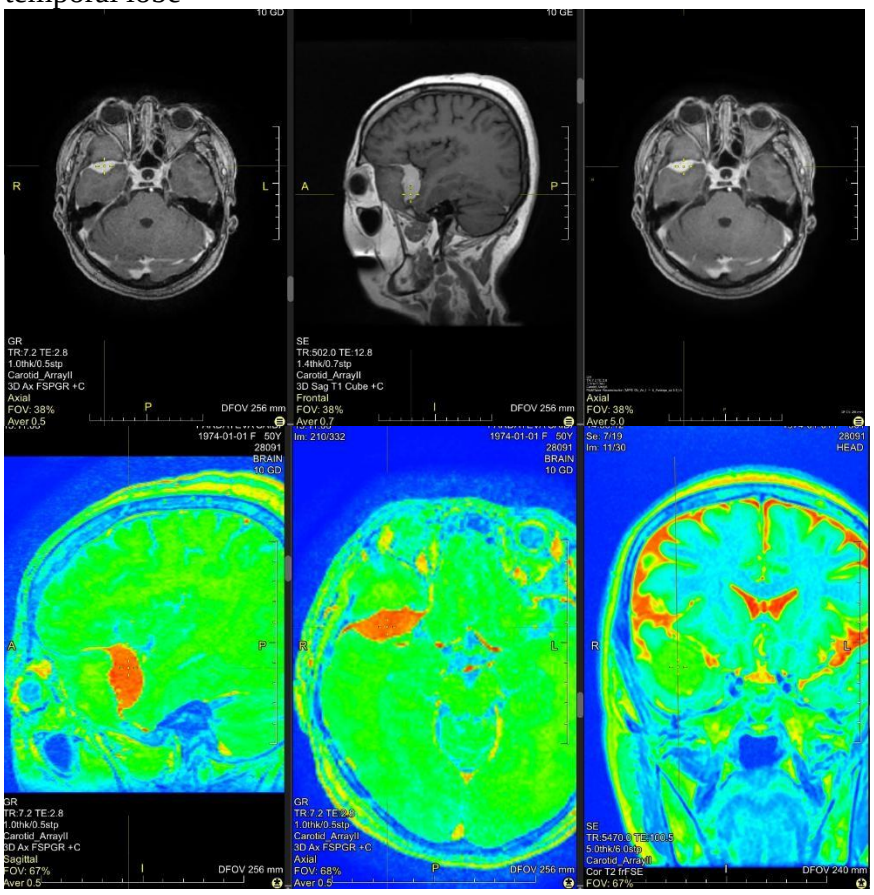
Keywords: meningiomas, brain tumors, neurosurgery, surgical approach, skull base tumors, spinal meningioma, tumor resection, microsurgery, neuronavigation, intracranial neoplasms, neurological surgery, surgical outcomes, tumor recurrence

Introduction

Meningiomas are extra-axial neoplasms originating from the meninges, accounting for approximately one-third of all primary brain tumors. While most meningiomas are histologically benign (WHO Grade I), a minority demonstrate atypical (Grade II) or malignant (Grade III) features, influencing their surgical and postoperative management. The surgical manifestations of meningiomas largely depend on their anatomical location, growth pattern, and extent of involvement of critical structures such as cranial nerves, venous sinuses, and the brainstem. Convexity meningiomas are generally the most accessible surgically due to their superficial location. They often present with headaches, seizures, or localized neurological deficits, and are typically approached via a standard craniotomy. These tumors usually allow for complete

resection, particularly if they do not invade the surrounding bone or dura extensively. Parasagittal and falcine meningiomas, depending on their relationship to the superior sagittal sinus, may require more delicate resection to avoid sinus injury and preserve venous outflow.

Pic 1. MRI of the brain. Determined petrosal meningioma of the right medio-basal part of the temporal lobe



Skull base meningiomas, which include tumors of the sphenoid wing, olfactory groove, tuberculum sellae, clivus, and petroclival region, present more complex surgical challenges. These tumors are often located deep within the cranial base, adjacent to vital neurovascular structures such as the internal carotid artery, optic nerves, and cranial nerves III to XII. Resection of these tumors requires meticulous planning, often using extended skull base approaches, such as the orbitozygomatic, transsphenoidal, or retrosigmoid routes. Complete removal may not always be feasible due to the risk of neurological deficits, and in such cases, subtotal resection followed by radiosurgery may be considered.

Some meningiomas are en plaque, spreading over large areas of dura and often associated with hyperostosis of the skull. These can be particularly challenging due to their diffuse nature and the difficulty of complete resection. In addition, certain meningiomas exhibit invasive behavior, infiltrating adjacent bone or brain tissue, which complicates surgical excision and increases the likelihood of recurrence.

The management of recurrent meningiomas or those with atypical/malignant features often involves multiple surgeries or combination with adjuvant therapies, including radiation. Surgical strategies must be revised based on the patient’s clinical condition, prior surgical history, and the biological behavior of the tumor.

Advancements in surgical techniques and technology have played a pivotal role in enhancing outcomes. Tools such as neuronavigation, intraoperative MRI, fluorescence-guided surgery, and endoscopic assistance enable more precise resections while preserving neurological function. Microsurgical techniques have become the gold standard in minimizing trauma to surrounding tissues, especially in skull base surgery.

Postoperative care is also crucial, with close monitoring for complications such as hemorrhage, cerebral edema, infection, or cerebrospinal fluid leaks. Rehabilitation and follow-up imaging are essential to track tumor recurrence, especially in cases where complete resection is not possible.

In conclusion, meningiomas present with a wide range of surgical manifestations that demand individualized assessment and planning. The surgical approach must be tailored based on tumor location, size, invasiveness, and the patient's overall health. With modern tools and techniques, the prognosis for most meningioma patients is favorable, but careful long-term monitoring remains vital to ensure early detection of recurrence and timely intervention.

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