DOI: 10.38103/jcmhch.17.8.8

Case report

PREOPERATIVE EMBOLIZATION FOR GIANT SPHENOIDRIDGE MENINGIOMA TUMORECTOMY: A CASE REPORT AND REVIEW LITERATURE

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ABSTRACT

Giant sphenoid ridge meningiomas pose significant surgical challenges due to their size, location, and vascularity. Preoperative embolization has been suggested as an effective strategy to reduce intraoperative bleeding and facilitate tumor resection. We report a case of a 50-year-old male presenting with progressive left hemiplegia, found to have a 6 cm tumor at the skull base. Preoperative embolization of the middle meningeal artery, accessory meningeal artery, and inferolateral trunk was performed, followed by successful tumor resection via a transsylvian approach. This case highlights the role of embolization in improving surgical outcomes for large sphenoid ridge meningiomas.

Keywords: *Embolization; Giant Sphenoidridge; Meningioma; middle meningeal artery; Transsylvian approach.*

I. INTRODUCTION

Sphenoid ridge meningiomas account for approximately 15 - 25% of all intracranial meningiomas [1] and often present with progressive neurological deficits due to compression of adjacent neurovascular structures [2]. These tumors can be classified into medial, middle, and lateral subtypes based on their location along the sphenoid ridge, each posing unique surgical challenges [3]. Giant sphenoid ridge meningiomas, typically defined as those exceeding 5 cm in diameter [4], are particularly difficult to manage due to their extensive vascular supply and close association with the optic nerve, cranial nerves, and internal carotid artery [5]. Surgical resection remains the primary treatment for symptomatic sphenoid ridge meningiomas. However, excessive intraoperative bleeding is a major concern due to the tumor's rich blood supply, primarily from branches of the external carotid artery, including the middle meningeal and accessory meningeal arteries. Preoperative embolization has emerged as a valuable adjunct to surgery, aiming to reduce blood loss, improve visualization, and facilitate complete resection [6]. Here, we present a case of a giant sphenoid ridge meningioma successfully managed with embolization followed by microsurgical resection.

II. CASE PRESENTATION

A 50-year-old male with a history of rhabdomyolysis at age 34, requiring left shunt construction, and mild intellectual disability presented with progressive left-sided hemiplegia. His activities of daily living (ADL) were partially dependent, particularly in tasks such as dressing. Two months prior to admission, the patient experienced worsening hemiplegia and gait disturbances. Brain MRI revealed a 6 cm mass at the skull base, highly suggestive of a sphenoid ridge meningioma or cavernous angioma (Figure 1, 2). Given the tumor's size and location, he was referred to our hospital for further evaluation and surgical management.

Received: 02/6/2025. **Revised:** 04/11/2025. **Accepted:** 15/11/2025.

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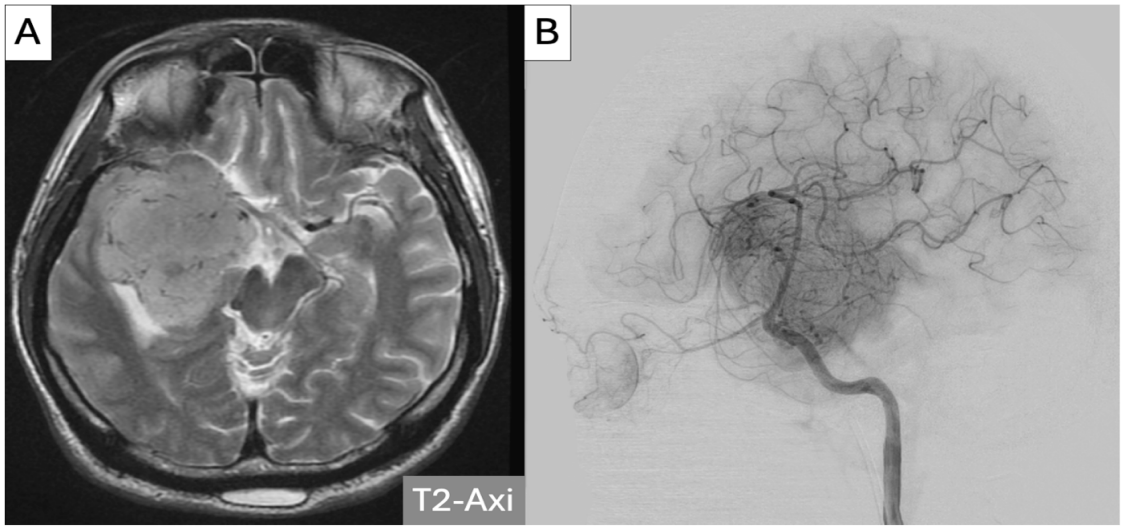

Figure 1: Preoperative brain MRI on the axial plane (A) detected a large tumor in the large sphenoid ridge with angiography vascular proliferation (B) compressing the nearby structure.

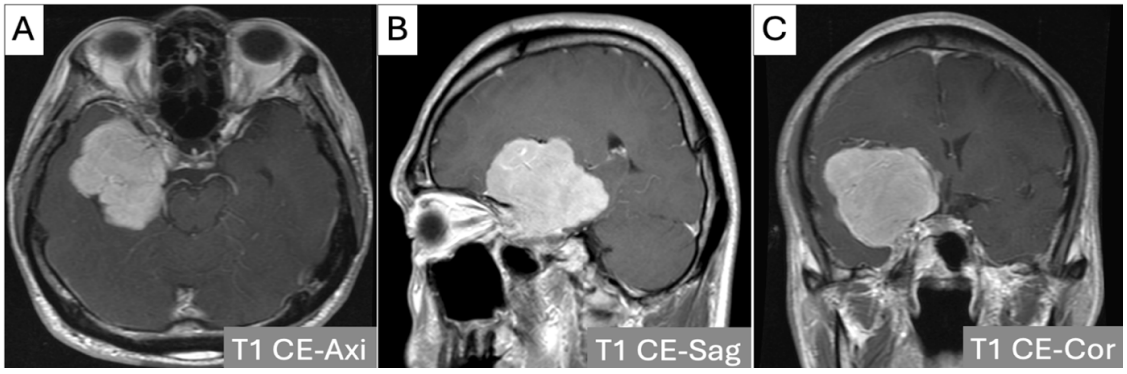

Figure 2: Brain MRI with contrast injection with T1W on the axial plane (Fig 1A.), sagittal plane (Fig 1B) and coronal plane (Fig 1C) reveals a 6x5.4cm tumor with most contrast-enhanced and well-defined with compression of the brainstem and lateral ventricles, third ventricle.

The patient was admitted for planned surgical resection. Preoperative embolization was performed one day before surgery, targeting the middle meningeal artery, accessory meningeal artery, and inferolateral trunk to reduce intratumoral blood flow (Figure 3). The procedure was successful, with no immediate complications.

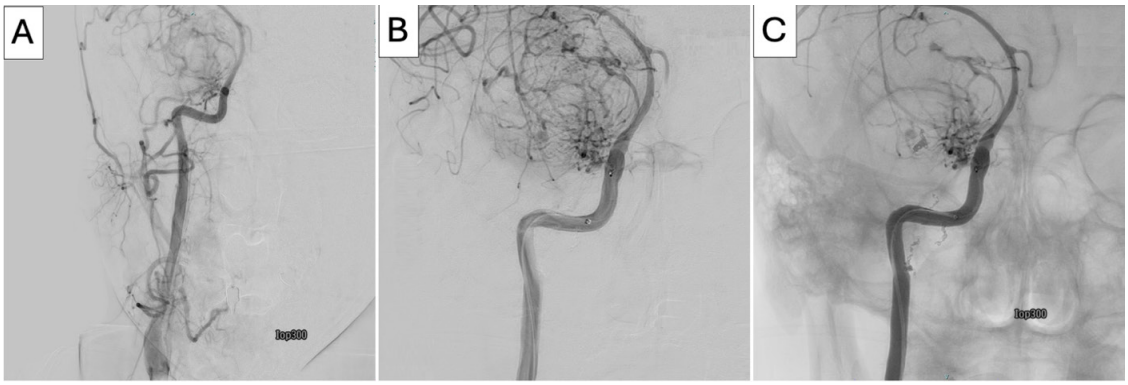

Figure 3: CT angiography before (A, B) and after embolism (C)

A frontotemporal craniotomy was performed under general anesthesia using a transsylvian approach. The patient was positioned supine with his head rotated to the left. A frontotemporal curved skin incision was made, followed by craniotomy and dural opening. The sylvian fissure was carefully dissected to expose the insular cortex, and a corticotomy was performed. Under microscopic visualization, the tumor was resected, and intraoperative biopsy confirmed the diagnosis of meningioma. The tumor exhibited strong adhesions to the right optic nerve, oculomotor nerve, and adjacent cerebral vasculature. Despite these challenges, gross total resection was achieved in the visible surgical field.

Postoperatively, the patient remained hemodynamically stable. Immediately after surgery, his Glasgow Coma Scale (GCS) score was E3 V5 M6, with motor strength graded 5/5 in the right upper limb, 4/5 in the left upper limb, and 5/5 in both lower limbs, MRI shows tumor angiography is completely removed (Figure 4). Pupillary light reflexes were intact, and no diplopia was observed. The postoperative period of the patient is stable, no complications are recorded.

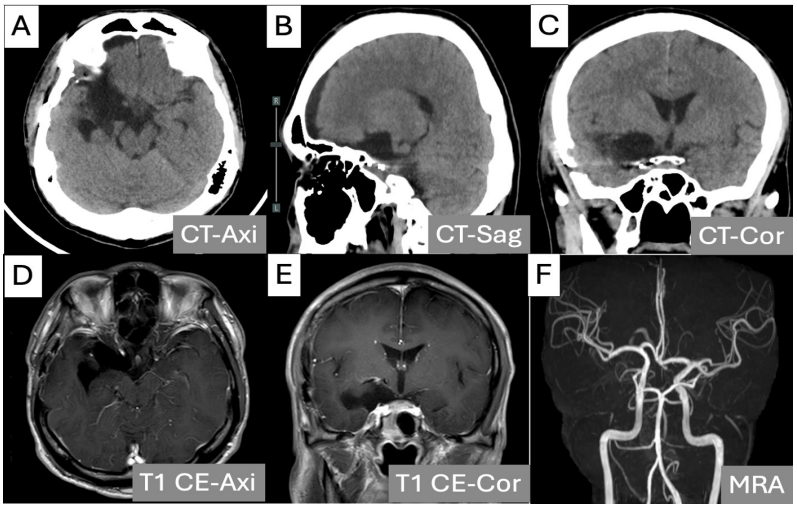

Figure 4: Postoperative CT scan on axial plane (A), sagittal plane (B), coronal plane (C) The tumor has been completely removed. Postoperative MRI with T1 with contrast injection on the axial plane (A), coronal plane (B) and tumor angiography is completely removed.

III. DISCUSSION

Meningiomas are the most common primary intracranial tumors, accounting for approximately 50% of all benign brain tumors [7]. Among them, sphenoid ridge meningiomas represent 15 - 20% of cases and are frequently diagnosed in middle-aged adults, with a higher incidence in females, likely due to hormonal influences [8]. Giant sphenoid ridge meningiomas, defined as those exceeding 5 cm in diameter, are less common but pose significant surgical challenges because of their size, mass effect, and proximity to critical neurovascular structures [4]. Clinical presentation varies depending on tumor size and location, with common symptoms including headaches, visual disturbances, cranial nerve deficits, and, in some cases, motor impairment such as hemiparesis, as observed in our patient.

4.1. Diagnosis and imaging characteristics

The diagnosis of sphenoid ridge meningiomas is based on clinical presentation and imaging findings. On non-contrast CT, these tumors typically appear isodense to gray matter, while MRI usually shows isointense to slightly hyperintense signals relative to gray matter, with avid contrast enhancement. Calcifications are seen in 20 - 30% of cases [9]. A characteristic imaging feature of meningiomas is the dural tail sign, which represents reactive thickening and perilesional meningeal enhancement, present in approximately 60 - 72% of cases [10]. High-grade meningiomas may exhibit lytic and destructive features, which necessitate differentiation from other pathologies such as solitary fibrous tumors or metastases. Although MR spectroscopy is not routinely used, it can be helpful in equivocal cases

by detecting specific metabolic peaks such as alanine peak at 1.3 - 1.5 ppm and increased glutamine and glutamate level [11]. Digital subtraction angiography (DSA) is often employed to evaluate tumor vascularity and to guide preoperative embolization if indicated. In our case, MRI revealed a 6 cm skull base mass, and DSA identified the primary arterial feeders from the middle meningeal artery, accessory meningeal artery, and inferolateral trunk, prompting embolization to reduce intraoperative bleeding.

4.2. Surgical management and role of preoperative embolization

Surgical resection is the primary treatment for sphenoid ridge meningiomas, with the objective of achieving maximal tumor removal while preserving neurological function. However, the deep skull base location, proximity to vital neurovascular structures, and high vascularity of giant sphenoid ridge meningiomas present substantial challenges [12]. Excessive intraoperative bleeding can complicate resection and prolong surgical duration. Preoperative embolization has been introduced as an adjunctive technique to minimize these complications by reducing tumor vascularity, thereby enhancing surgical safety and efficacy [13].

Preoperative embolization primarily targets tumor feeders arising from branches of the external carotid artery (ECA). Studies suggest that embolization significantly reduces intraoperative blood loss, providing a cleaner surgical field and facilitating precise tumor dissection [14].

However, while some studies report benefits such as decreased intraoperative blood loss [15, 16], tumor softening [17], and reduced operative time [15]. others indicate potential risks, including higher rates of neurological complications and increased morbidity and mortality [18]. A recent meta-analysis yielded inconclusive results regarding the effectiveness of embolization in reducing surgical time and estimated blood loss [19].

The degree of devascularization achieved through embolization may influence surgical outcomes. Bendszus et al. [20] found that only complete embolization significantly reduced intraoperative blood loss. Similarly, Borg et al.[21] reported that patients with partially devascularized tumors had a threefold higher likelihood of requiring transfusion compared to those with complete embolization. In cases where tumors receive dual arterial supply from both the internal carotid artery (ICA) and ECA, embolizing only the ECA feeders was effective in reducing tumor blush in just 26.5% of cases [22]. In our case, embolization of the middle meningeal artery, accessory meningeal artery, and inferolateral trunk successfully decreased vascularity, allowing for a more controlled tumor resection via the transsylvian approach.

4.3. Timing of embolization and surgical resection

The timing of embolization relative to surgery is crucial. Performing resection too soon (< 24 hours) after embolization may limit its effectiveness, as insufficient time for tumor necrosis can lead to increased intraoperative bleeding [23]. Histological studies have shown that thrombus formation and multinucleated giant cell reaction occur within seven days of embolization, after which recanalization and partial revascularization may develop in 30% of embolized vessels [24]. Tumor softening and improved resectability appear to peak 7 - 9 days post-embolization [17]. Therefore, current recommendations suggest performing surgery within 1 - 8 days after embolization to maximize its benefits. For large tumors or those at risk of post-embolization edema, steroid administration is advised, particularly if surgery is delayed. In cases where embolization leads to significant tumor infarction and swelling, immediate surgical resection should be considered [25]. Most guidelines recommend scheduling embolization 24 - 72 hours before surgery to optimize thrombosis while preventing recanalization or collateral vessel formation [26]. In our case, tumor resection was performed 48 hours post-embolization, optimizing surgical conditions.

4.4. Surgical outcomes and prognosis

Successful resection of giant sphenoid ridge meningiomas requires a multidisciplinary approach involving preoperative planning, embolization, and microsurgical techniques. In our case, preoperative embolization significantly reduced intraoperative bleeding, improved visualization, and shortened surgical duration. The postoperative course was favorable, with improved neurological function and no major complications. Long-term follow-up

is essential to monitor for recurrence, particularly when subtotal resection is performed due to critical neurovascular involvement. In cases of residual tumor, adjuvant radiotherapy may be considered to reduce recurrence risk [27]

4.5. Future directions and emerging trends

Advances in embolization techniques, such as the use of liquid embolic agents (e.g., Onyx, n-butyl cyanoacrylate [NBCA]) and microcatheter technology, have enhanced the safety and efficacy of preoperative embolization [28]. Additionally, intraoperative fluorescence imaging and neuronavigation have improved surgical precision for skull base meningiomas [29]. Ongoing research is exploring adjuvant therapies, including stereotactic radiosurgery and molecular-targeted treatments, for residual or recurrent tumors. While preoperative embolization remains a valuable tool, its use should be tailored to tumor vascularity, location, and individual patient factors to achieve the best outcomes.

IV. CONCLUSION

This case highlights the role of preoperative embolization in improving surgical outcomes for giant sphenoid ridge meningiomas. By reducing tumor vascularity, embolization facilitated gross total resection with minimal intraoperative blood loss. However, careful patient selection and meticulous angiographic assessment are essential to minimize potential complications. As surgical and interventional techniques continue to evolve, the integration of embolization, microsurgical techniques, and adjuvant therapies will likely refine the management of these complex tumors.

Conflicts of interest: None declared

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