Research Square

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Endoscopic Endonasal Approach in the Diagnosis and Treatment of Clival Metastatic Tumors

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Abstract

Introduction: Clival tumors are rare lesions of the central skull base. Chordomas are the most common primary tumors arising from the clivus. Among other clival lesions, metastases represent an important diagnostic consideration. Their deep location poses significant surgical challenges. For clival metastases, conventional open approaches often result in limited access, suboptimal tumor visualization, and increased morbidity, leaving an unmet need for safer and more effective treatment strategies. The aim of this study was to evaluate surgical outcomes in patients with clival metastatic tumors treated using the endoscopic endonasal approach (EEA). Material and Methods: This retrospective study included 34 patients (9 women and 25 men) who underwent endoscopic transsphenoidal surgery for clival metastatic tumors between 2011 and 2025. The mean age was 61.3 years (range, 32–90 years), and the mean follow-up period was 1.9 years (range, 0–7 years). Results: Carcinoma was the most frequent histopathological diagnosis (n = 31; 91.2%), and adenocarcinoma was the most common subtype (n = 10; 29.4%). Partial tumor resection was performed in 28 patients (82.4%), including biopsy in 19 cases (67.9% of partial resections). The median overall survival (OS) was 23 months. Postoperative complications included one case of transient diabetes insipidus and one episode of epistaxis. No perioperative mortality was observed. Conclusions: EEA enables safe tissue diagnosis and selected tumor resection in patients with clival metastases. The complication rate was low in this series. Based on these findings, EEA should be considered the first-line surgical option in patients with radiologic ambiguity and cranial nerve deficits, where both diagnostic confirmation and symptom relief are critical.

Introduction

The clivus is a sloping bony structure formed by the occipital and sphenoid bones at the central skull base [1]. It descends from the dorsum sellae to the anterior border of the foramen magnum [1]. Clival tumors are a rare and heterogeneous group of neoplasms, accounting for approximately 0.1% of all intracranial tumors [2]. Chordoma is the most common primary tumor of the clivus, with an incidence of approximately 0.02 per 100,000 individuals [3; 4]. Other lesions involving the clivus include chondrosarcomas, metastases, lymphomas, meningiomas, and fibrous dysplasia [2]. Metastatic clival tumors comprise approximately 0.02% of all intracranial neoplasms [5].

The optimal surgical approach for clival metastases has not been clearly established. Traditional open approaches are technically demanding and may not adequately expose the entire clivus. While the endoscopic endonasal approach (EEA) has emerged as a viable alternative to overcome these limitations [6; 7], data on EEA for clival metastases remain scarce and fragmented. This knowledge gap highlights the need for further study. The aim of this study was to evaluate surgical outcomes in a series of patients with clival metastatic tumors treated using EEA.

Material and Methods

Study population

The study is a retrospective analysis of a series of 34 patients (9 women and 25 men) who underwent endoscopic endonasal surgery for clival metastatic tumors between 2011 and 2025 at the Maria Skłodowska-Curie National Research Institute of Oncology in Warsaw, Poland.

The mean age of the patients was 61.3 years (32–90 years), and the mean follow-up was 1.9 years (range 0–7 years) (Table 1).

Surgical Indications and Treatment Strategy

All cases were reviewed by a multidisciplinary tumor board, including neurosurgeons, neuroradiologists, radiation oncologists, medical oncologists, and specialists in palliative care, to ensure a comprehensive approach to patient management. Surgical intervention was considered for patients with radiological evidence of a clival lesion combined with one or more decision criteria: diagnostic uncertainty, progressive cranial nerve deficits, severe headache refractory to medical therapy, or a clival lesion representing the initial manifestation of systemic malignancy requiring histopathological confirmation. This multidisciplinary evaluation enabled individualized treatment planning, integrating specialized input for both surgical and nonsurgical aspects of care.

The primary surgical objective was personalized to each patient. For most cases, the aim was diagnostic confirmation and decompression rather than radical tumor excision. When the lesion invaded the cavernous sinus, the paraclival internal carotid artery, the basilar artery, or demonstrated infiltrative growth toward the subarachnoid cisterns and the brainstem, resection was intentionally limited to reduce morbidity. Gross total resection (GTR) or near-total resection (NTR) was pursued only when the lesion was well circumscribed and did not involve critical neurovascular structures on preoperative imaging and intraoperative inspection.

Surgery was not performed when the clival mass was accompanied by other metastatic lesions that were more accessible for biopsy, or when imaging findings were considered sufficiently characteristic and did not raise diagnostic uncertainty or cause significant symptoms.

Adjuvant therapy, including chemotherapy and radiotherapy, was administered based on histopathological findings, systemic staging, and the overall oncological treatment plan.

Data collection

We collected information from patients' medical records, including age, gender, clinical presentation, length of postoperative hospitalization, and duration of follow-up. We also collected information about the endoscopic surgical procedure: the extent of resection (gross total resection (GTR) and near total resection (NTR) ≥ 95%, subtotal resection (STR) ≥ 80%, and partial resection (PR) < 80%). Other variables

recorded were the modality of skull base reconstruction, intraoperative cerebrospinal fluid leaks, postoperative complications, reoperations, and hospital readmissions. Follow-up data were collected from outpatient clinic records and, when necessary, via telephone surveys. Postoperative surveillance typically included clinical evaluation and endoscopic assessment of nasal healing at 1 month after surgery and cranial MRI at 3–4 weeks after surgery, then every 3 months, or more frequently when clinically indicated. Additional imaging or laboratory tests were performed as required based on oncological assessment.

Tumor specimens were fixed in 10% buffered formalin, embedded in paraffin and stained with hematoxylin and eosin (H/E). The final histopathological diagnosis was based on both (H/E) and a set of immunohistochemical reactions dedicated to specific malignancies.

Surgical Approach

All procedures were performed using an extended endoscopic endonasal transsphenoidal transclival approach. Surgery was conducted by one of two neurosurgeons with extensive experience in endoscopic skull base procedures. We used “one and a half” or mononostril four-hand technique was used in all cases to limit the invasiveness of the approach. Reconstruction of the skull base defect was performed selectively, depending on intraoperative findings.

Data analysis

Descriptive statistics were calculated and included mean, median, standard deviation, minimal and maximal values. Categorical variables were compared using Fisher’s exact test or the chi-square test using Social Science Statistics software. Statistical significance was defined as $p < 0.05$.

Results

The majority of our patients were men (n = 25; 73.5%). The most common initial symptom was headache (n = 18; 52.9%), followed by unilateral abducens nerve palsy or paresis (n = 14; 41.2%). Other symptoms included cranial nerves III, IV, VII, IX, XI, XII palsies or pareses, visual disturbances, and hearing problems among others (Table 2). Most patients underwent a partial tumor resection (n = 28; 82.4%) including a biopsy in 19 patients (n = 19/28, 67.9%) to obtain a thorough histopathological diagnosis. All patients had extended transclival EEA. One patient needed reconstruction of the meningeal defect with an abdominal fat graft (2.9%) – see Table 3. The only complications were one case of transient diabetes insipidus and one case of epistaxis (Table 4).

The most frequent tumor type diagnosed in the patients was carcinoma (n = 31; 91.2%), and among carcinomas the most common was adenocarcinoma (n = 10; 29.4%). Apart from carcinomas, there were single cases of neuroendocrine tumors, sarcomas, melanoma, and schwannoma (Table 5).

The median overall survival (OS) was 23 months (Fig. 1). By the time of analysis 3 patients were alive (8.8%). In most patients (76.5%), the clival lesion was the first known site of metastasis. About 35% of the patients underwent an additional postoperative chemotherapy to treat the neoplasm and 44% had radiotherapy (Table 1).

Illustrative Cases

Case 1

70-year-old man was admitted to the clinic due to headaches, diplopia, and strabismus (right abducens nerve palsy) for 3 months. He had no relevant past medical history. On MRI a clival tumor was seen.

He underwent a subtotal endoscopic transsphenoidal resection and was diagnosed with lung adenocarcinoma. Subsequent investigations confirmed a primary tumor in the left lung. He died 7 months after the diagnosis.

Case 2

50-year-old man was admitted to the clinic due to diplopia (left abducens nerve palsy) for 2 months. He had no relevant past medical history. On MRI a clival tumor was seen.

He underwent a partial endoscopic transsphenoidal resection and was diagnosed with adenocarcinoma of unknown origin. After resection he had radiotherapy and pharmacotherapy. He died 14 months after the diagnosis.

Case 3

72-year-old man was admitted to the clinic due to headache and diplopia (bilateral abducens nerve palsy). He had no relevant past medical history. On MRI a clival tumor was seen.

He underwent an endoscopic transsphenoidal biopsy and was diagnosed with non-small cell carcinoma of unknown origin. He died 19 months after the diagnosis.

Case 4

56-year-old man was admitted to the clinic due to ptosis and ophthalmoplegia of the right eye (right oculomotor and abducens nerve palsy) for 4 months. He had no relevant past medical history. On MRI a clival tumor was seen.

He underwent a gross total endoscopic transsphenoidal resection complicated by epistaxis. Histopathological analysis revealed non-small cell lung carcinoma. Subsequent investigations confirmed a primary tumor in the right lung. He died 5 months after the diagnosis.

Discussion

Clival metastatic tumors are rare, and the literature regarding them, particularly in surgically treated patients, is limited (Table 6). Clinical presentation is variable, but cranial nerve palsies are common. Cranial nerve involvement has been described as a negative prognostic factor [8]. Reported OS for patients with clival metastases is approximately 10 months [8], while cranial nerve palsy has been associated with shorter survival, with an average OS of about 5 months [9]. Therefore, a detailed cranial nerve examination is warranted in patients with disseminated cancer who may develop clival metastases [10].

Abducens nerve palsy is considered as the most frequent cranial nerve deficit in clival metastases [5; 8]. This nerve is particularly vulnerable to compression or invasion by clival tumors due to its close topographical relationship to mid-upper clivus [11]. In our case series abducens nerve palsy was the most common cranial nerve deficit, however, headache was the most frequent presenting symptom, present in over 50% of the patients.

According to the literature, the most common primary malignancies with clival metastases include prostate cancer, breast cancer, lung cancer, hepatocellular carcinoma, and thyroid follicular carcinoma [8; 12]. However, in our case series the most frequent diagnosis was squamous cell carcinoma of an unknown origin. These cases may reflect occult head and neck cancers not yet evident on imaging or continuous invasion from nasopharyngeal or skull base malignancies. This overrepresentation may reflect selection bias, as patients with clival metastases may not undergo surgical treatment or histopathological verification. Consequently, surgery in our cohort was likely performed mainly in cases with diagnostic uncertainty or atypical presentation.

All patients in this series were treated using EEA, which has been described as a safe option for management of clival metastases [8]. This technique provides direct midline access to the clivus, including deep lesions, and offers optimal visualization with angled endoscopes [13]. The risk of complications and mortality is reported to be low [14]. EEA also enables histopathological diagnosis, which remains important because imaging alone may be insufficient for definitive differentiation of clival lesions [14]. Compared with open approaches, EEA is generally associated with lower neurological morbidity, although complete resection rates may be lower [15].

The median OS for patients with bone metastases is approximately 9 months; it is 8 months for patients with an unknown primary tumor at diagnosis and 14 months for those with a known primary tumor [16]. The median overall survival depends on tumor type for example, for prostate cancer – 24 months, for breast cancer – 14 months, and for lung cancer 6 months [16]. Metastases to the calvaria are more common than metastases to skull base [17; 18].

Metastatic lesions may also involve the pituitary gland and sellar region and can be considered part of upper clival involvement [19–23]. They are rare and account for < 1% of intracranial secondary tumors [19].

On imaging, clival metastases show features different from those of other frequently observed tumors in this area – chordomas and chondrosarcomas [24]. Chordomas and chondrosarcomas are typically hyperintense on T2-weighted magnetic resonance imaging (MRI) and hypo- or isointense on T1-weighted MRI [25; 26]. Additionally, chordomas may show honeycomb pattern after contrast, and chondrosarcomas – ring-and-arc pattern [27]. Chondrosarcomas may also exhibit calcifications (popcorn-like pattern) and have higher apparent diffusion coefficient (ADC) values [27]. In contrast, metastases are hypointense on T1-weighted MRI, show variable signal intensity on T2-weighted MRI, and enhance following contrast administration [28].

Our study has several limitations. Its retrospective character carries an inherent risk of selection bias. Only patients who needed surgical intervention were included; therefore, the cohort does not represent the entire population of patients with clival metastases. This selection bias is partially reflected in the histopathological spectrum of the cohort, which may not fully reflect the true epidemiological distribution of metastases to this part of the skull base. The relatively small sample size and heterogeneity of primary tumor types limit the ability to perform meaningful subgroup analyses. Survival outcomes must be interpreted cautiously, as systemic disease burden and oncological treatment strategies varied considerably among patients. Additionally, follow-up duration was limited in some cases.

Despite these limitations, the present series represents one of the largest surgically treated cohorts of clival metastases reported to date.

Conclusions

EEA is a safe option for diagnosing patients with clival lesions. In addition to enabling thorough histopathological evaluation, it may allow complete tumor removal in selected cases. EEA should be considered in patients with metastatic neoplasms presenting with neurological symptoms and radiological evidence of skull base involvement.

Declarations

Competing Interests

The authors have no relevant financial or non-financial interests to disclose.

Ethics approval

This is an observational study. The Institutional Ethics Committee of Maria Sklodowska-Curie Institute—Oncology Center in Warsaw, Poland has confirmed that no ethical approval is required.

Consent to participate

Informed consent was obtained from all patients included in this study.

Consent to publish

The authors affirm that human research participants provided informed consent for publication of the images in Illustrative Cases section.

Clinical trial number

not applicable.

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Author Contribution

Concept & Design: JK, BB; Literature Search: JK, BB; Data Extraction: BB, JK, WG; Statistical Analysis: BB; Interpretation of Data: JK, BB; Drafting of Manuscript: BB, JK; Critical Revision: JK, WG; Supervision: JK.

Data Availability

All data supporting the findings of this study are presented within the article. A complete Excel dataset containing all patient records can be made available by the corresponding author upon request.

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Tables

Table 1
General characteristics of the patients

Variables	Value/number of patients	Percentage of patients
Age	**-**	**-**
mean age [years]	61.3	-
median age [years]	63.5	-
range [years]	32–90	-
Gender	-	-
male	25	73.5%
female	9	26.5%
Observation time	-	-
mean [years]	1.9	-
median [years]	1.0	-
range [years]	0–7	-
Number of days spent at the hospital after the surgery	-	-
mean	4.0	-
median	4.0	-
range	3–8	-
Was the clival metastasis the first manifestation of the neoplasm?	-	-
yes	26	76.5%
no	8	23.5%
Does the patient have disseminated cancer?	-	-
yes	2	5.9%
no	32	94.1%
Did the patient receive postoperative systemic chemotherapy?	-	-
yes	13	38.2%
no	21	61.8%
Did the patient have a postoperative radiotherapy?	-	-

Variables	Value/number of patients	Percentage of patients
Age	**-**	**-**
yes	15	44.1%
no	19	55.9%

Table 2
Symptoms

Symptoms	Number of patients	Percentage of patients
Headache	18	52.9%
Unilateral cranial nerve palsy/paresis		
CN III	7	20.6%
CN IV	1	2.9%
CN V	1	2.9%
CN VI	14	41.2%
CN VII	3	8.8%
CN IX	1	2.9%
CN X	1	2.9%
CNXI	1	2.9%
CNXII	1	2.9%
Bilateral cranial nerve palsy/paresis		
CN III	3	8.8%
CN V	1	2.9%
CN VI	7	20.6%
CN IX	3	8.8%
CN X	3	8.8%
CN XII	1	2.9%
Unilateral visual disturbances	4	11.8%
CN V hyperesthesia (trigeminal neuropathy)	4	11.8%
Unilateral hearing problems	4	11.8%
Vertigo	2	5.9%
Tinnitus	1	2.9%

Table 3
Surgical characteristics

Variables	Number of patients	Percentage of patients
Resection	-	-
GTR	2	5.9%
STR	4	11.8%
PR	28	82.4%
Biopsy	19/28	67.9%
Reconstruction of skull base with a fat tissue graft	1	2.9%
Intraoperative CSF leak	0	0.0%
Reoperation	-	-
None	33	97.1%
Early reoperation due to complications	0	0.0%
Due to tumor regrowth	1	2.9%

Table 4
Complications

Complication	Number of patients	Percentage of patients
Transient diabetes insipidus	1	2.9%
Epistaxis	1	2.9%

Table 5
Histopathological diagnoses

Diagnosis	Number of patients	Percentage of patients
Carcinoma		
Squamous cell carcinoma of the nasopharynx	7	20.6%
Adenocarcinoma	10	29.4%
Lung adenocarcinoma	4	11.8%
Prostatic adenocarcinoma	3	8.8%
Breast adenocarcinoma	1	2.9%
Unknown origin	2	5.9%
Non-small cell lung carcinoma	7	20.6%
Adenoid cystic carcinoma	3	8.8%
Acinic cell carcinoma	1	2.9%
Lobular carcinoma with signet-ring cell differentiation	1	2.9%
Small cell lung cancer	2	5.9%
Neuroendocrine tumor of the lung	1	2.9%
Sarcoma		
Monophasic synovial sarcoma	1	2.9%
Melanoma	1	2.9%

Table 6
Case series with patients with clival metastases

Study	Number of patients with clival metastases	Histopathology	Management
Kingdom et al. (2003) [29]	3	Adenocarcinoma (n = 1), liposarcoma (n = 1), renal cell carcinoma (n = 1)	Transsphenoidal biopsy
McDermott et al. (2004) [30]	4	Prostate carcinoma (n = 4)	Radiotherapy
Pallini et al. (2009) [31]	7	Lung adenocarcinoma (n = 2), lung squamous cell carcinoma (n = 1), prostate carcinoma (n = 2), skin melanoma (n = 1), hepatocellular carcinoma (n = 1)	Transsphenoidal biopsy +/- radiotherapy or chemotherapy
Sturgis et al. (2021) [10]	44	Breast cancer (n = 19), prostate cancer (n = 18), multiple myeloma (n = 6)	Radiotherapy
Carretta et al. (2024) [8]	4	Lung carcinoma (n = 2), gastric signet ring cell carcinoma (n = 1), gastroenteropancreatic neuroendocrine tumor (n = 1)	Transsphenoidal biopsy or partial resection +/- radiotherapy or chemotherapy

Figures

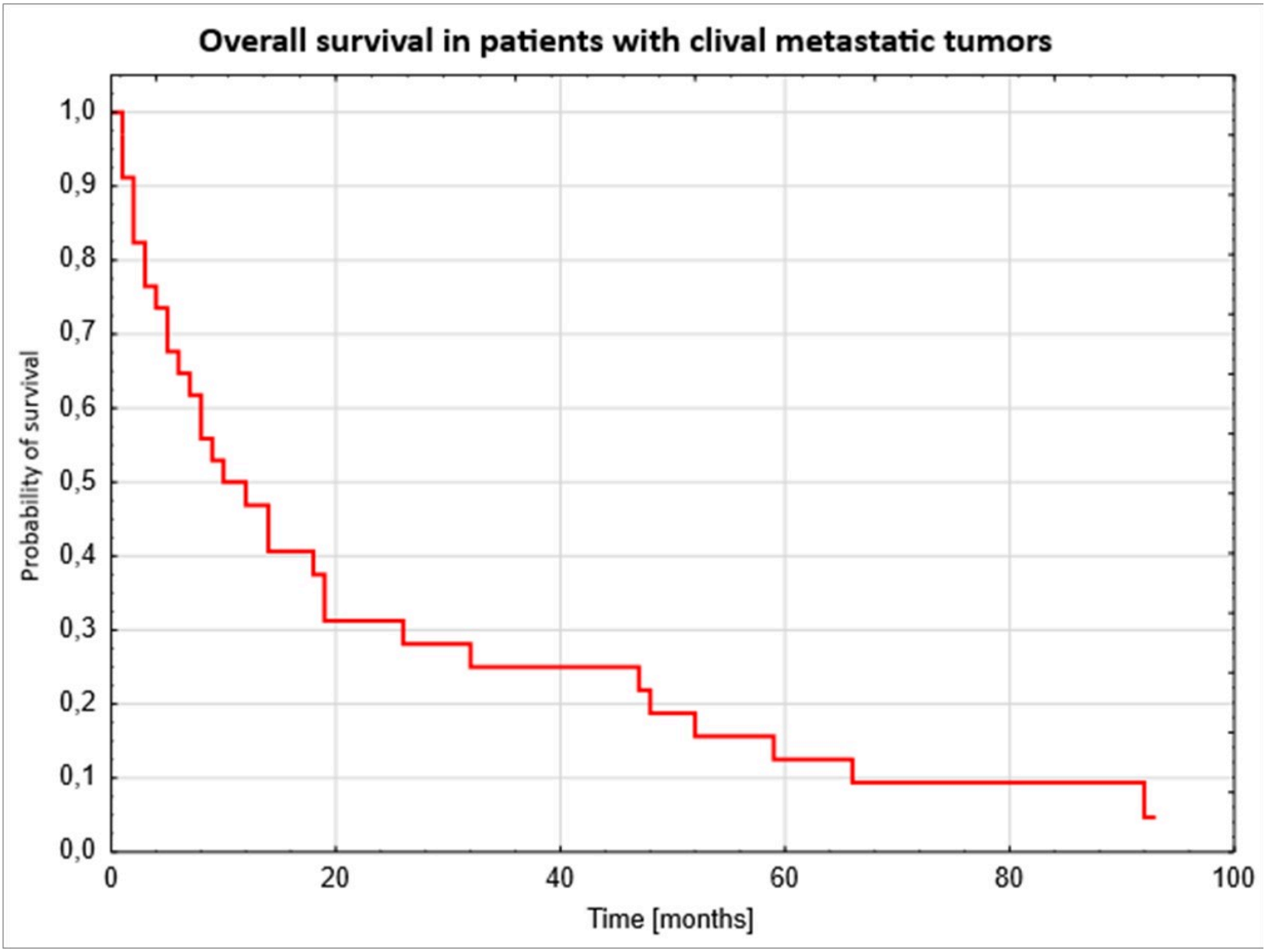

Figure 1

Overall survival in patients with clival metastatic tumors

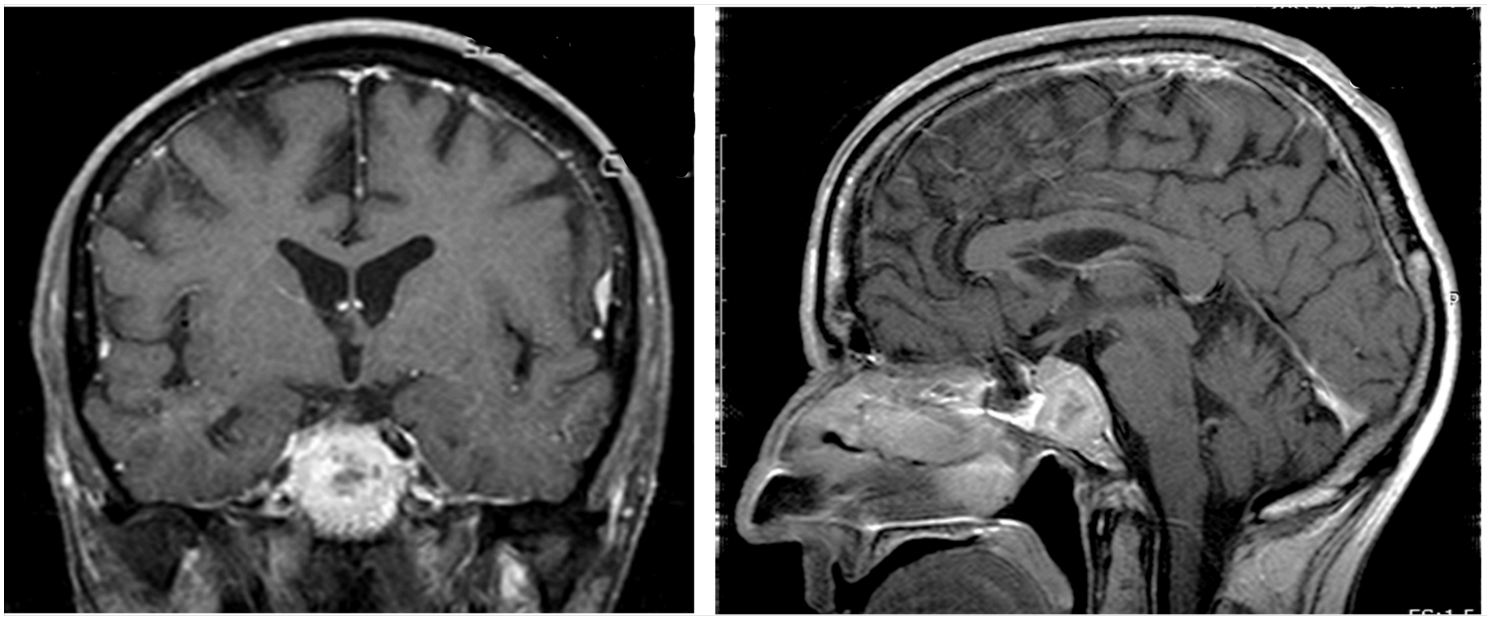

Figure 2

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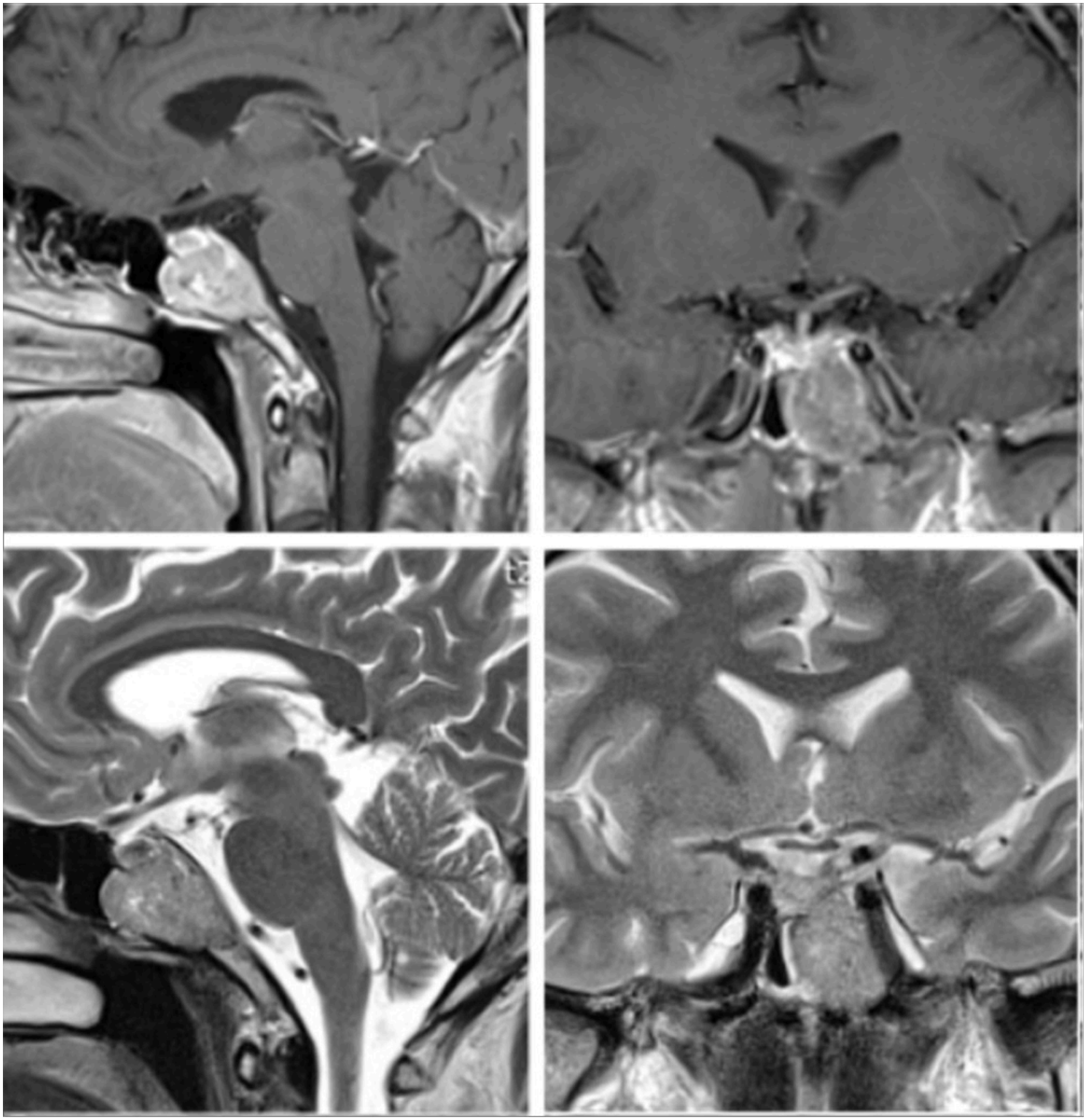

Figure 3

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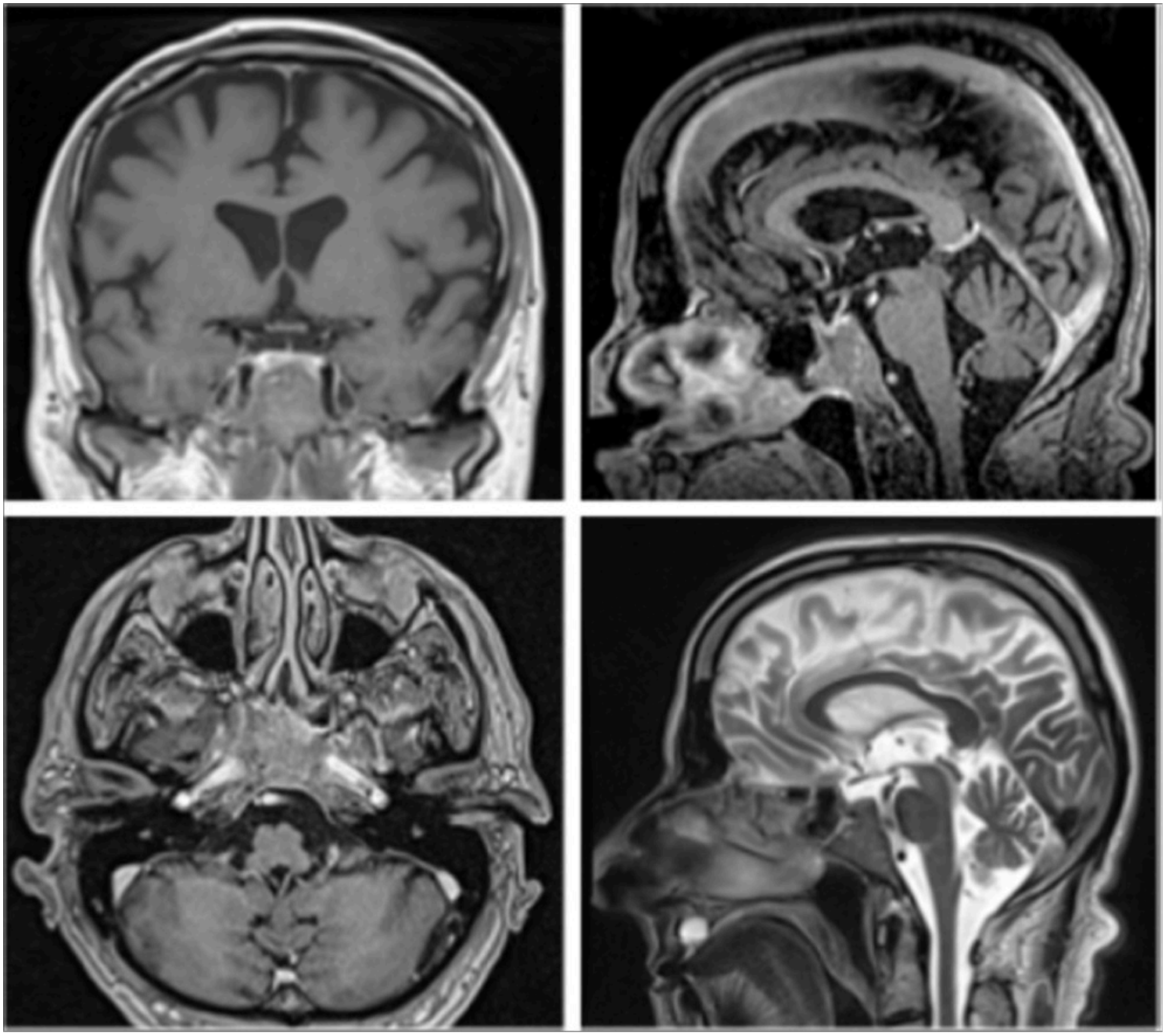

Figure 4

Unnumbered image in the Results section.

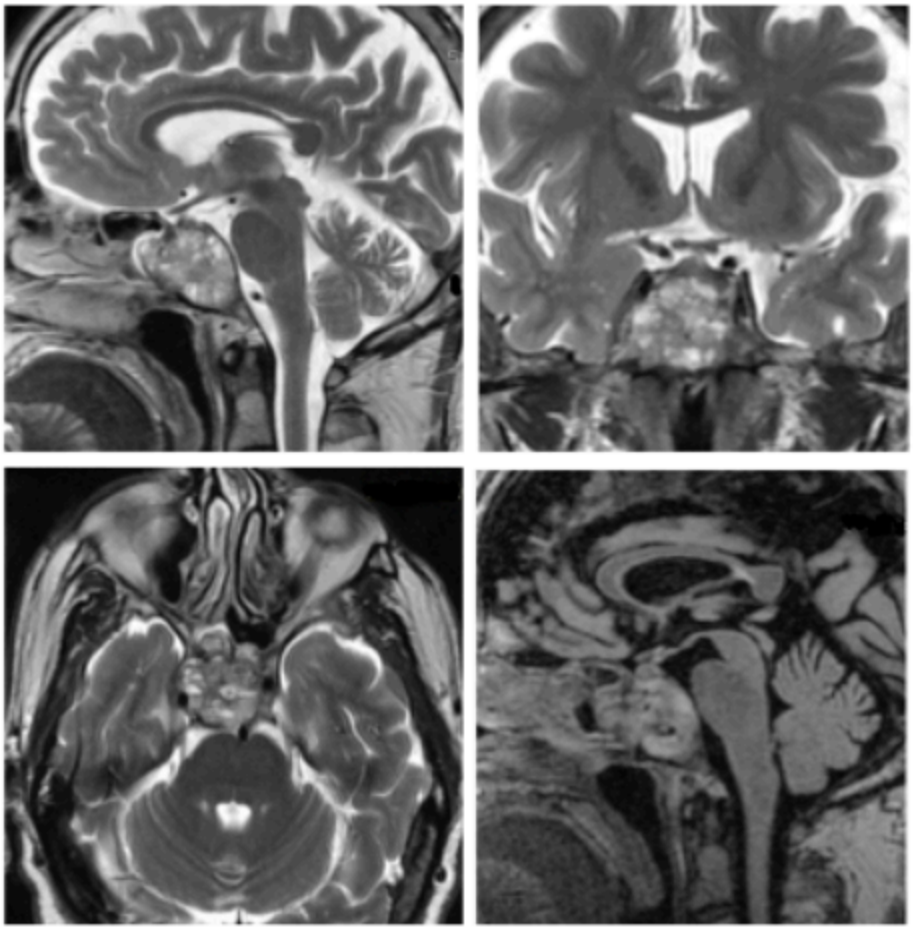

Figure 5

Unnumbered image in the Results section.