Zygomatic pretemporal skull base approach for resection of a radiation-induced sphenoid wing meningioma: surgical technique

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Abstract: In this video, we present the surgical technique and operative nuances of the zygomatic pretemporal skull base approach for resection of a large left sphenoid wing and middle cranial fossa radiation-induced meningioma (RIM) with invasion and encasement of the middle cerebral artery (MCA). RIMs represent a distinct and surgically challenging entity due to aggressive biological behavior, altered tissue planes, and frequent vascular involvement. In the present case, prior childhood cranial irradiation resulted in dense tumor adherence to the MCA within radiation-altered tissue, necessitating meticulous microsurgical technique. The zygomatic pretemporal approach effectively converts a deep skull base lesion into a convexity-like lesion, providing a wide basal surgical corridor, reducing working distance, and minimizing frontal and temporal lobe retraction. After zygomatic osteotomy and extradural skull base drilling, early devascularization was achieved through removal of the sphenoid ridge and division of the meningo-orbital band. Intradural microsurgical dissection focused on internal tumor debulking followed by sharp arachnoid dissection to circumferentially separate the tumor from the MCA and its branches. In areas of dense adherence, vessel-preserving strategy was prioritized. A Simpson Grade I resection was achieved without vascular injury. Zygomatic reconstruction using low-profile "dog-bone" plates allowed anatomical realignment of the osteotomized segment, preservation of temporalis muscle function, and excellent cosmetic outcome. Postoperative imaging confirmed gross total resection (GTR) and stable reconstruction. The patient recovered without new neurological deficits and demonstrated complete resolution of preoperative hemiparesis at follow-up. This case highlights the value of the zygomatic pretemporal skull base approach in achieving radical resection of complex sphenoid wing RIMs while facilitating safe dissection of critical neurovascular structures.

Keywords: Zygomatic pretemporal approach; sphenoid wing meningioma; radiation-induced meningioma (RIM); middle cerebral artery (MCA); skull base surgery

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Introduction

Meningiomas of the sphenoid wing and middle fossa often present significant surgical challenges due to their proximity to the middle cerebral artery (MCA), cavernous sinus, and optic apparatus. Traditional approaches—including pterional or frontotemporal craniotomies—may offer limited exposure, particularly when tumors extend deeply into the skull base or encase critical neurovascular structures (1-5).

The zygomatic skull base approach provides a multidirectional surgical corridor with improved basal

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exposure, minimizing brain retraction and effectively "turning a skull base lesion into a convexity lesion" (2,6,7). This approach allows meticulous dissection of tumor from the MCA and adjacent cranial nerves while preserving function.

Radiation-induced meningiomas (RIMs) represent a distinct clinical entity, often characterized by earlier onset, higher recurrence rates, and more aggressive biological behavior compared to sporadic meningiomas (8). The present case demonstrates the value of the zygomatic approach in achieving gross total resection (GTR) of a large sphenoid wing RIM in a patient who underwent cranial irradiation during childhood.

The objective of this surgical technique report is to demonstrate the technical nuances of the zygomatic pretemporal skull base approach for resection of a radiation-induced sphenoid wing meningioma, with particular emphasis on extradural skull base work, microsurgical dissection of an MCA encased by tumor within radiation-altered tissue, and zygomatic reconstruction strategies that preserve temporalis muscle function and cosmetic outcome. We present this article in accordance with the SUPER reporting checklist (available at https://jovs.amegroups.com/article/view/10.21037/jovs-25-38/rc).

Preoperative preparations and requirements

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee(s) and with the Declaration of Helsinki and its subsequent amendments. Written informed consent was obtained from the patient for the publication of this study, accompanying images, and the video. A copy of the written consent is available for review by the editorial office of this journal. The senior author (K.I.A.) performed the surgery.

Highlight box

Surgical highlights

- Large sphenoid wing/middle fossa meningioma resected via zygomatic skull base approach with gross total removal.
- Meticulous dissection from middle cerebral artery achieved without morbidity; zygomatic reconstruction performed with dog bone plates.

What is conventional and what is novel/modified?

- Pterional/frontotemporal approaches for sphenoid wing meningiomas.
- Zygomatic skull base approach "turns" skull base tumors into convexity lesions, improving surgical access and vascular dissection safety.

What is the implication and what should change now?

- Surgeons should consider the zygomatic skull base approach as a standard option for large, complex sphenoid wing meningiomas, particularly in radiation-induced cases where gross total resection is required.

Imaging

Standard preoperative evaluation of skull base meningiomas includes contrast-enhanced magnetic resonance imaging (MRI) to assess tumor extent, neurovascular relationships, and soft tissue planes. In this patient, MRI was contraindicated due to the presence of an MRI-unsafe intracranial clip implanted during childhood posterior fossa surgery for malignant ependymoma. Consequently, high-resolution computed tomography (CT) and computed tomography angiography (CTA) were used for surgical planning. CTA demonstrated the relationship between the tumor and the MCA, including cranial displacement and encasement. Although digital subtraction angiography (DSA) was considered to further assess tumor vascularity and embolization feasibility, it was deferred given the extensive MCA involvement, anticipated limited embolization benefit, and sufficient vascular information obtained from CTA. CT angiography demonstrated preserved patency of the MCA and its major branches, with an intact Circle of Willis and no evidence of hemodynamically relevant collateral compromise. The limitations of CT-only planning—particularly reduced visualization of arachnoid planes and soft tissue interfaces around the MCA—were recognized and addressed intraoperatively through meticulous microsurgical dissection (*Figures 1*,*2*).

Functional assessment

Neurological examination was done with particular attention to cranial nerve deficits; baseline ophthalmological assessment if optic nerve compression was suspected.

Surgery planning

3D cranial CT was used for bony anatomy and reconstruction strategy. Patient informed consent on the risks of vascular dissection was obtained, including bleeding and stroke. Patient counseling on reconstruction of zygoma for improved cosmetic outcome was also provided.

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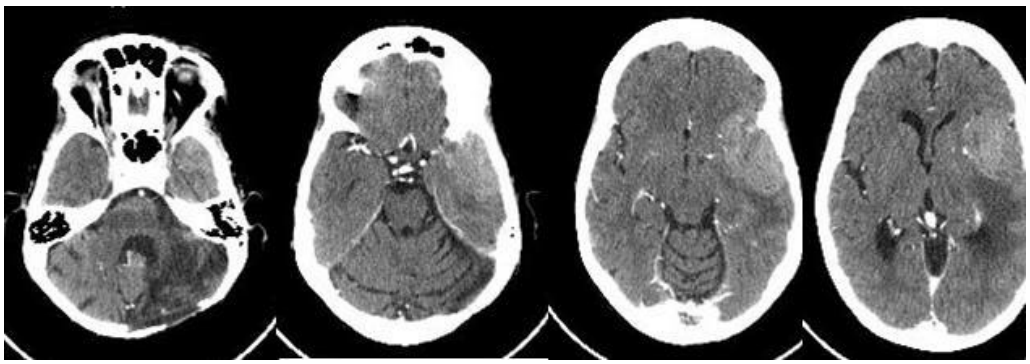


Figure 1 Preoperative axial CT scan of the head demonstrating postoperative changes from prior left posterior fossa tumor resection and a large left frontotemporal sphenoid wing meningioma with encasement of the middle cerebral artery. CT, computed tomography.

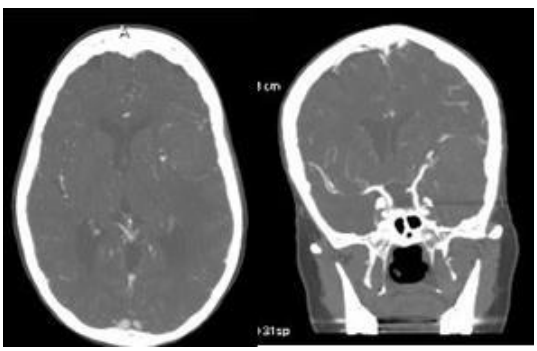
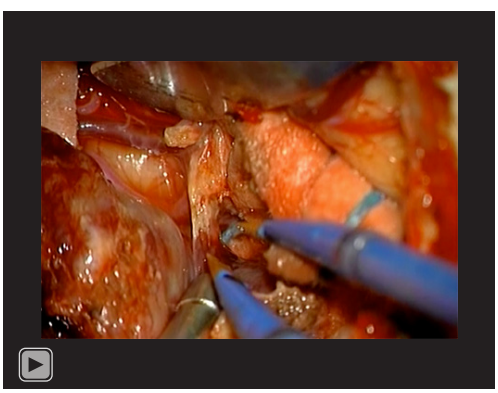


Figure 2 Preoperative axial and coronal CT angiography demonstrating the spatial relationship between the sphenoid wing meningioma and the middle cerebral artery, highlighting arterial encasement relevant for surgical planning. CT, computed tomography.



Video 1 Demonstration of the zygomatic pretemporal skull base approach for resection of a radiation-induced sphenoid wing meningioma. The video illustrates patient positioning, zygomatic osteotomy, extradural skull base drilling, circumferential devascularization, microsurgical dissection of the middle cerebral artery, and anatomical reconstruction of the zygomatic arch.

Positioning and setup

The patient was positioned supine with the head fixed in a Mayfield clamp, rotated approximately 45° contralaterally and slightly extended to optimize basal exposure. A multidisciplinary team approach was employed, involving close coordination between the neurosurgeon, neuroanesthesiologist, and neurophysiology team. Continuous intraoperative neuromonitoring included somatosensory evoked potentials and facial nerve monitoring, with predefined response protocols for any changes suggestive of vascular compromise. Anesthetic management emphasized stable hemodynamics and brain relaxation to facilitate prolonged microsurgical dissection around critical neurovascular structures.

Patient presentation and preoperative assessment

Our case was a 49-year-old patient who underwent surgery in childhood for malignant ependymoma in the posterior fossa and received radiation afterwards. She presented with sudden onset of severe headaches, speech disturbances, seizure and right hemiparesis. As we were unable to perform MRI due to an MRI-unsafe clip implanted in the first surgery, CT head with and without contrast including CTA was performed and showed a giant left-sided sphenoid wing/middle cranial fossa meningioma with peri-focal edema with invasion and cranial dislodgment of the left MCA in the Sylvian fissure, wrapping around the tumor.

Step-by-step description (*Video 1*)

In this video we show the resection of a giant left sphenoid wing/middle cranial fossa meningioma using zygomatic pre-

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temporal skull base approach.

The patient was positioned supine, ipsilateral shoulder elevated and the head fixed in Mayfield clamp and turned approximately 45 degrees to the right. A preauricular skin incision was made, anterior to the tragus, and extended to the hemi-pupillary contralateral line in the frontal region, behind the hairline.

The interfascial dissection of the temporal muscle was performed. For the details of the zygomatic approach please refer to our reference list at the end of this video. After the fascia was reflected anteriorly, the zygomatic bone with its frontal and temporal process was well exposed subperiosteally to preserve facial nerve branches. The superior orbital rim and the supraorbital foramen and nerve were identified.

The zygomatic osteotomy was performed. After the lower dislocation of the zygomatic arch, it was possible to inferiorly move the temporal muscle facilitating optimal exposure of the floor of the middle fossa. The zygomatic osteotomy was performed in a stepwise fashion. After subperiosteal exposure, osteotomy cuts were placed at the zygomaticofrontal suture anteriorly and the zygomatic arch posteriorly, using an oscillating saw while carefully protecting the frontal and temporal branches of the facial nerve. The zygomatic arch was then mobilized inferiorly as a single bone segment, allowing inferior displacement of the temporalis muscle and significantly increasing the inferior-to-superior surgical working angle toward the middle cranial fossa floor.

The pretemporal craniotomy was performed after burr holes were created, which are marked with asterisks.

Drilling and removing of the lesser wing of the sphenoid bone, along with part of the orbital lateral wall was performed to achieve the basal access with minimal brain retraction. The first step was drilling out the sphenoid ridge, until the superior orbital fissure was exposed, followed by opening of the lateral wall of the cavernous sinus.

Coagulation and transection of the middle meningeal artery was performed.

Extradural skull base work was performed prior to dural opening. This included drilling of the sphenoid ridge, exposure of the superior orbital fissure, and division of the meningo-orbital band, followed by extradural drilling of the lateral orbital wall and anterior middle fossa floor. These steps allowed early devascularization of the tumor and expanded basal exposure. Only after completion of extradural work was the dura opened in a circumferential fashion around the tumor attachment.

Dura was incised circumferentially around the attachment of meningioma, further devascularizing the tumor. The base of the dural flap corresponded with the previous location of the sphenoid ridge, and when folded back, it did not obstruct the microsurgical field.

The next step was the division of the meningo-orbital artery.

Opening of the Sylvian fissure and release of the cerebrospinal fluid reduced the intracranial pressure and facilitated the resection with minimal brain retraction.

The borders of the tumor were being carefully dissected from the surrounding brain tissue and padded with cotton paddies. Meningioma was resected piece by piece using intra-tumoral coagulation and resection with micro scissors.

MCA was invaded by the tumor, so the meticulous dissection and separation of the meningioma from the vessel was done using microsurgical technique. The MCA was partially encased by tumor and surrounded by radiation-altered tissue with poorly defined planes. Microsurgical dissection was performed under high magnification, prioritizing sharp arachnoid dissection rather than blunt traction. The arterial adventitia was identified early and protected throughout the dissection. Tumor was internally debulked to reduce tension on the vessel before circumferential dissection. Adherent tumor portions were separated using fine micro-scissors and low-current bipolar coagulation, avoiding traction on perforators. In areas of dense adhesion, a thin tumor remnant was intentionally left on the vessel wall to prevent arterial injury. This stepwise technique allowed safe preservation of MCA patency without ischemic complications.

Finally, after most of the tumor was resected, small tumor rests attached to the brain surface were carefully coagulated and dissected.

“Dog-bone” plates were used reconstruction of the zygomatic arch enabling preservation of the function of the temporal muscle and an adequate cosmetic outcome. Burr-hole covers were used for fixation of the craniotomy flap. Reconstruction of the zygomatic arch was performed using low-profile “dog-bone” plates oriented parallel to the natural curvature of the zygoma, allowing anatomical realignment of the osteotomized segment. This configuration provided stable fixation while minimizing bulk beneath the temporalis muscle, thereby preserving muscle excursion, reducing postoperative atrophy, and achieving a favorable cosmetic outcome.

The immediate postoperative and follow-up CT scan of head 6 months following surgery with and without contrast confirmed the total resection of the tumor. Postoperative

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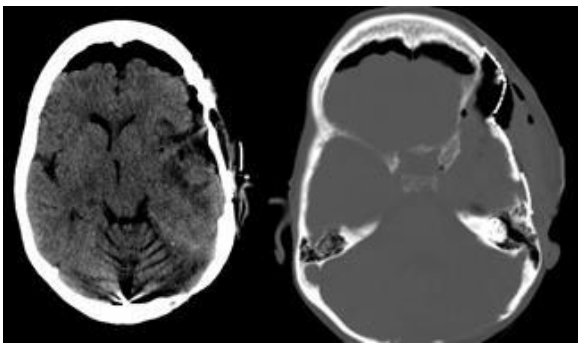


Figure 3 Postoperative axial CT scans in parenchymal and bone windows demonstrating complete tumor resection and anatomical reconstruction of the zygomatic arch using a dog-bone plate. CT, computed tomography.

imaging confirmed a Simpson Grade I resection, with complete removal of the tumor and involved dura while preserving critical neurovascular structures (*Figure 3*). Patient recovered her preoperative hemiparesis completely and was otherwise neurologically intact.

Postoperative considerations and tasks

- Neuroimaging: immediate postoperative CT should be obtained to rule out hemorrhage and confirm reconstruction stability; contrast-enhanced CT should be obtained within 72 hours to evaluate extent of resection.
- Medical management: standard postoperative care with steroids should be administered including seizure prophylaxis in patients at risk.
- Functional assessment: early neurological reassessment should be completed.
- Follow-up: surveillance imaging should be obtained at 6 months and yearly thereafter, this is particularly critical in RIMs due to increased risk of recurrence.
- Reconstruction: continue monitoring of zygomatic fixation (dog bone plates) and cosmetic outcome.

Complications

Potential complications of the zygomatic pretemporal approach include facial nerve injury, temporalis muscle atrophy, cosmetic asymmetry, cerebrospinal fluid leakage, and vascular injury related to MCA dissection. Early postoperative imaging was used to assess for hemorrhage and vascular patency. Facial nerve function and mastication were monitored clinically. Meticulous extradural technique, low-profile reconstruction, and careful microsurgical vascular dissection are critical for minimizing these risks.

Tips and pearls

Zygomatic pretemporal approach reduces the working distance and enhances surgical angles, providing a wide basal exposure.

Early extradural removal of sphenoid wing bone facilitates devascularization and minimizes tumor bleeding.

Through zygomatic removal skull base lesion is turned into a convexity lesion, which enables safer dissection around the MCA and optic apparatus.

Use of microsurgical technique and arachnoid dissection around the MCA is critical.

Dog bone plates allow stable and anatomical zygomatic reconstruction with good cosmetic outcome.

Discussion

Value of the zygomatic approach

The zygomatic skull base approach represents a refinement over the standard pterional or frontotemporal craniotomy, particularly for deep sphenoid wing and middle fossa meningiomas. By lowering the surgical trajectory, it reduces brain retraction and increases exposure of the anterior and middle cranial fossae, enabling safer vascular and cranial nerve dissection. This approach has been reported to improve rates of GTR, reduce surgical morbidity, and facilitate early devascularization of the tumor (7,9,10). In the present case, it was crucial for achieving GTR while preserving MCA integrity.

RIMs

RIMs are a recognized late complication of cranial irradiation, with increased incidence in childhood survivors of leukemia and other pediatric brain tumors. Compared with sporadic meningiomas, RIMs tend to present earlier, are more frequently multiple, and display higher recurrence rates. Their surgical management can be challenging due to prior irradiation effects on tissues and vascularity. Radical resection remains the primary treatment, as adjuvant radiotherapy is usually contraindicated (8,11). This case emphasizes that skull base techniques such as the zygomatic approach, can be successfully applied even in the context

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of RIMs, with excellent postoperative recovery and no recurrence at early follow-up.

RIMs often demonstrate distinct intraoperative characteristics compared with sporadic lesions, including increased dural adherence, altered tumor consistency, and fibrosis of arachnoid planes surrounding neurovascular structures. In the present case, prior irradiation contributed to dense adhesions between the tumor and the MCA, necessitating sharp dissection and a vessel-preserving strategy. Awareness of these radiation-related changes is essential when planning surgical corridors and determining the extent of safe resection.

Conclusions

The zygomatic skull base approach is a powerful technique for resection of sphenoid wing and middle fossa meningiomas, offering wide exposure and facilitating safe dissection of neurovascular structures. In RIMs, where radical resection is critical due to their aggressive nature and limited adjuvant options, this approach may maximize the chances of durable tumor control with good functional outcomes.

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Footnote

Reporting Checklist: The authors have completed the SUPER reporting checklist. Available at https://jovs.amegroups.com/article/view/10.21037/jovs-25-38/rc

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Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee(s) and with the Declaration of Helsinki and its subsequent amendments. Written informed consent was obtained from the patient for the publication of this study, accompanying images and the video. A copy of the written consent is available for review by the editorial office of this journal.

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