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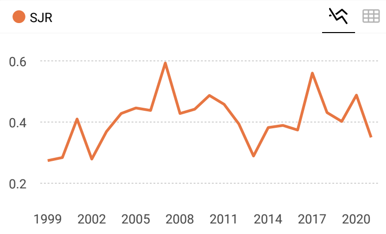

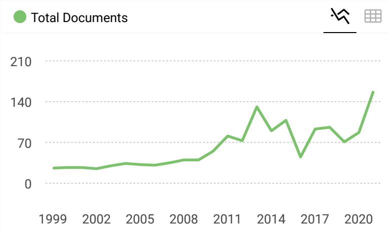

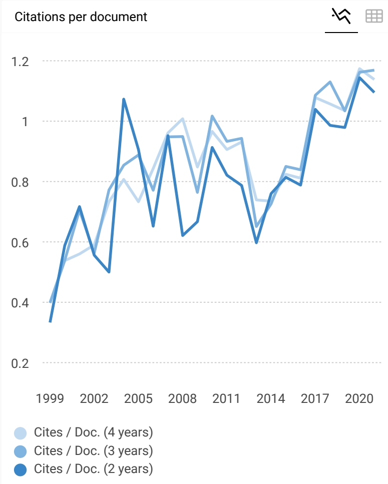

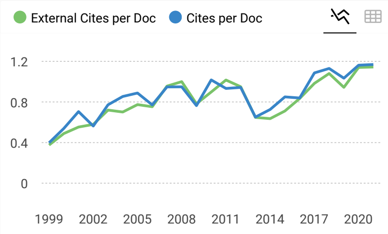

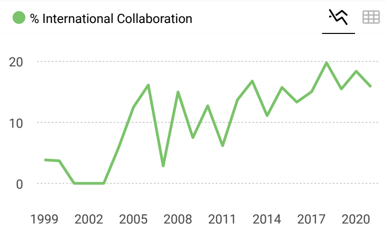

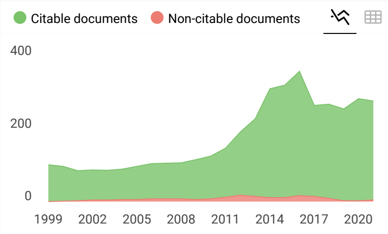

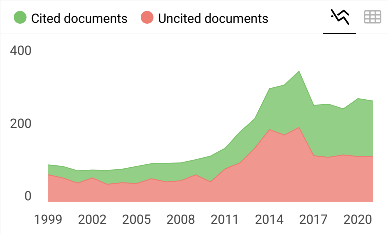

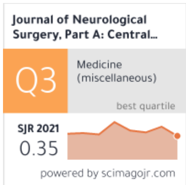

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Erratum

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JOURNAL OF NEUROLOGICAL SURGERY — PART A

Central European Neurosurgery

Zentralblatt für Neurochirurgie

Modified Transpetrosal–Transtentorial Approach for Resection of Large and Giant Petroclival Meningioma: Technical Nuance and Surgical Experiences

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Abstract

Background Meningiomas arising from the petroclival area remain a challenge for neurosurgeons. Various approaches have been proposed to achieve maximum resection with minimal morbidity and mortality. Also, some articles correlated preservation of adjacent veins with less neurologic deficits.

Objective To describe the experiences in using a new technique to achieve maximal resection of petroclival meningiomas and preserving the superior petrosal veins (SPVs) and the superior petrosal sinus (SPS).

Methods A retrospective analysis of 26 patients harboring a true petroclival meningioma with a diameter ≥25 mm and undergoing surgery with the modified transpetrosal–transtentorial approach (MTTA) was performed.

Results Fifty-four percent of 22 patients complained of severe headache at presentation. There[Q2] was also complaint of cranial nerve (CN) deficit, with CN VII deficit being the most common (present in 42% of patients). The average tumor size (measured as maximum diameter) was 45.2 mm, and most of the tumors compressed the brainstem. Total resection was achieved in 12 patients (46.2%), whereas the others were excised subtotally (54.8%). Most of the patients had WHO grade I (96.1%) meningioma; only one had a grade II (3.8%) meningioma. In addition, clinical improvement and persistence of symptoms were observed in 17 (65.4%) and 8 (30.7%) patients, respectively, and postoperative permanent CN injury was observed in 3 (11.5%) patients.

Conclusion Using the MTTA, maximal resection with preservation of the CNs and neurovascular SPV-SPS complex can be achieved. Therefore, further studies and improvements of the technique are required to increase the total resection rate without neglecting the complications that may develop postoperatively.

Keywords
- Petroclival meningioma
- superior petrosal vein
- superior petrosal sinus
- modified transpetrosal-transtentorial approach

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Introduction

Petroclival meningioma (PCM) accounts for only 2% of all meningiomas. PCMs are in close vicinity to the internal carotid and basilar artery, perforating arteries, brainstem, and cranial nerves (CNs). This vicinity makes PCM surgery one of the most challenging surgery of skull base lesions.[1–4] Al-Mefty et al defined true PCMs as those originating from upper two-thirds of the clivus with CN V as the most lateral border of the tumor.[1] Therefore, to achieve total resection while preserving vital structures, a wide corridor for visualization, dissection, and resection is pivotal in the choice of the surgical approach.[5] Hakuba et al first described the combined transpetrosal approach in 1988, and over the years, several approaches to the petroclival area has been described.[6,7]

In the transpetrosal approach, one of the most crucial factors is the preservation of the superior petrosal vein (SPV) and superior petrosal sinus (SPS).[8] Several authors recommended that surgeons feel free to sacrifice the SPV to better visualize the lesion and optimize safe decompression. These studies reported no difference in the rate of vascular complications or postoperative auditory function whether the SPV is sacrificed or preserved.[9–12] However, literature review and experiences from large series suggested that obliterating the SPV may be associated with complications. A recent systematic review showed that although the incidence of complications due to SPV obliteration are low, the sequelae might be worse than the natural history of the treated pathology.[13] Therefore, it was suggested to preserve SPV to optimize outcome.

This current study describes step-by-step the modified transpetrosal–transtentorial approach (MTTA), a modification of the combined transpetrosal approach, with SPV and SPS preservation. In addition, the experience in true PCM management using MTTA was retrospectively analyzed.

Material and Methods

A[Q3] retrospective analysis of 26 patients whose tumors met the definition of true PCM with diameter ≥25 mm and underwent surgery using the MTTA was performed. Patient demographic data, symptoms, and radiologic findings were reviewed. Magnetic resonance imaging (MRI) evaluation includes inferior tumor extension, presence of hydrocephalus, and basilar artery and cavernous sinus involvement. The brainstem compression was also evaluated and categorized into three grades, namely, grade 1: <25% compression; grade 2: ≥25% but <50% compression; and grade 3: ≥50% compression. Based on tumor size, patients were categorized into two groups: (1) large tumor: 25 to 44 mm and (2) giant tumor: >45 mm.[14] Angiography was performed to evaluate the venous anatomy and the feeding arteries, extent of resection was evaluated using postoperative MRI. Neurologic outcome was assessed postoperatively and at 6 months of follow-up.

Operative Technique

Patient Positioning and Skin Incision

The patient was placed in the "park bench" position. The temporal region was kept in horizontal plane, and the head was elevated ~35°, resulting in a kyphotic curve in the upper thoracic and cervical spine. Intraoperative neuromonitoring (IOM) was prepared afterward. Skin incision started at the upper margin of the zygomatic arch, ~2 to 3 cm anterior to external auditory meatus, and ran upward until 1 cm below the superior temporal line, backward around the ear lobe, and then downward 2 to 3 cm behind the posterior margin of the mastoid process to the mastoid tip. Subsequently, the skin flap was turned inferolaterally and elevated off the temporalis muscle, pericranium, and suboccipital muscles. In addition, the temporalis muscle was elevated and retracted anteriorly and the suboccipital muscles caudally.

Craniotomy and Cosmetic Mastoidotomy

An occipitotemporal craniotomy involving the retrosigmoid and temporal regions was performed. Furthermore, the outer table of the mastoid process was split (cosmetic mastoidotomy; ►Fig. 1). The inner table was separated from the outer table using a high-speed drill until the posterior half of the sigmoid sinus was exposed. The mastoid air cells and antrum were drilled until the lateral semicircular canal

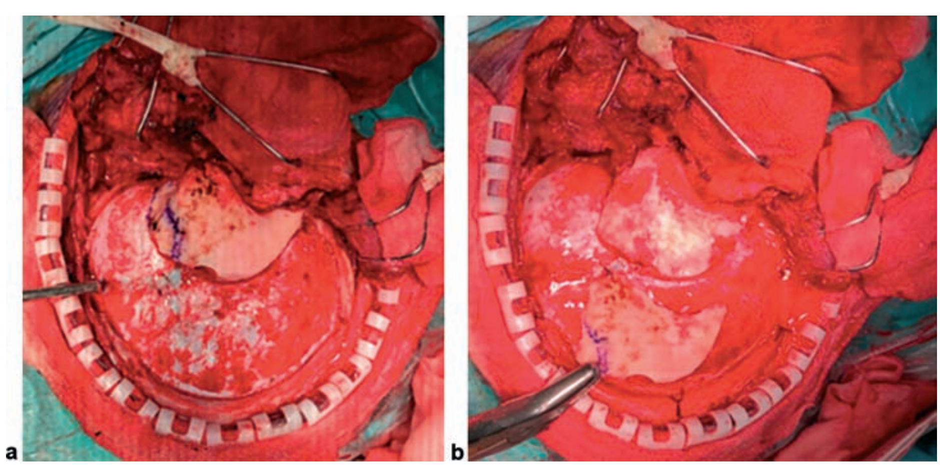

Fig. 1 (**a**) Dura and transverse sinus exposure after temporo-occipital bone flap. (**b**) Removal of the outer table of the mastoid process (cosmetic mastoidotomy).

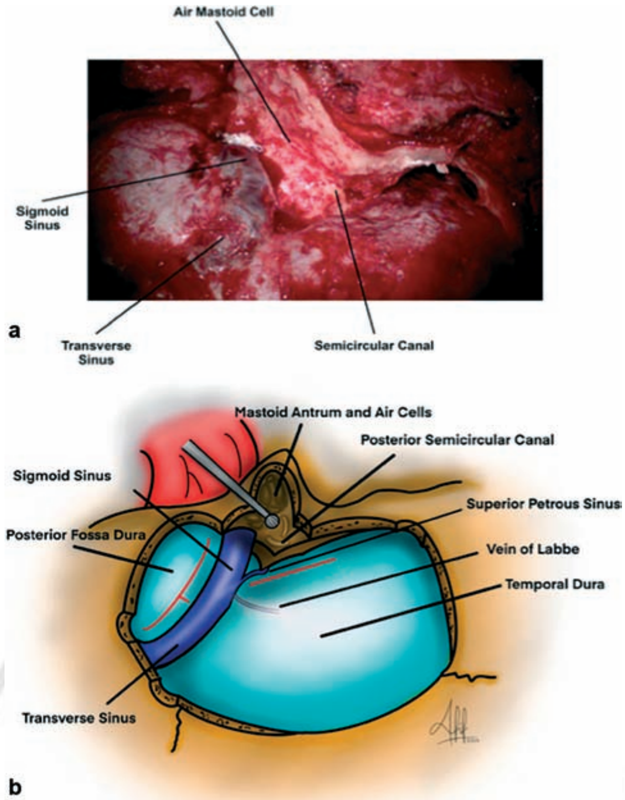

Fig. 2 (**a**) Exposure of the sigmoid sinus and the semicircular canal after the mastoid drilling. (**b**) schematic illustration of the final dural exposure. The dural incision is performed on the *red line* (retrosigmoid and temporal incision).

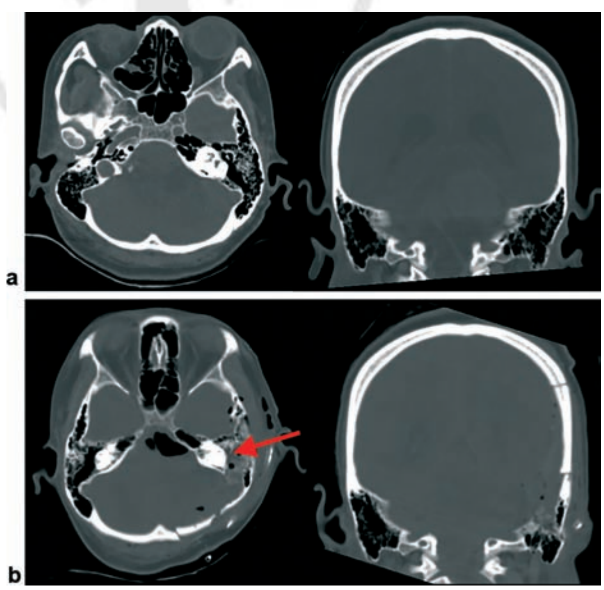

Fig. 3 Comparison between preoperative (**a**) and postoperative (**b**) computed tomography scan showed the extent of the mastoid drilling. Note that the semicircular canal was preserved (*red arrow*).

became exposed (►**Figs. 2** and **3**). Subsequently, the middle meningeal artery was coagulated and transected at the foramen spinosum. The partial petrosectomy and supratentorial bone removal allow the surgeon to better visualize tumor parts extending to the supratentorial compartment.

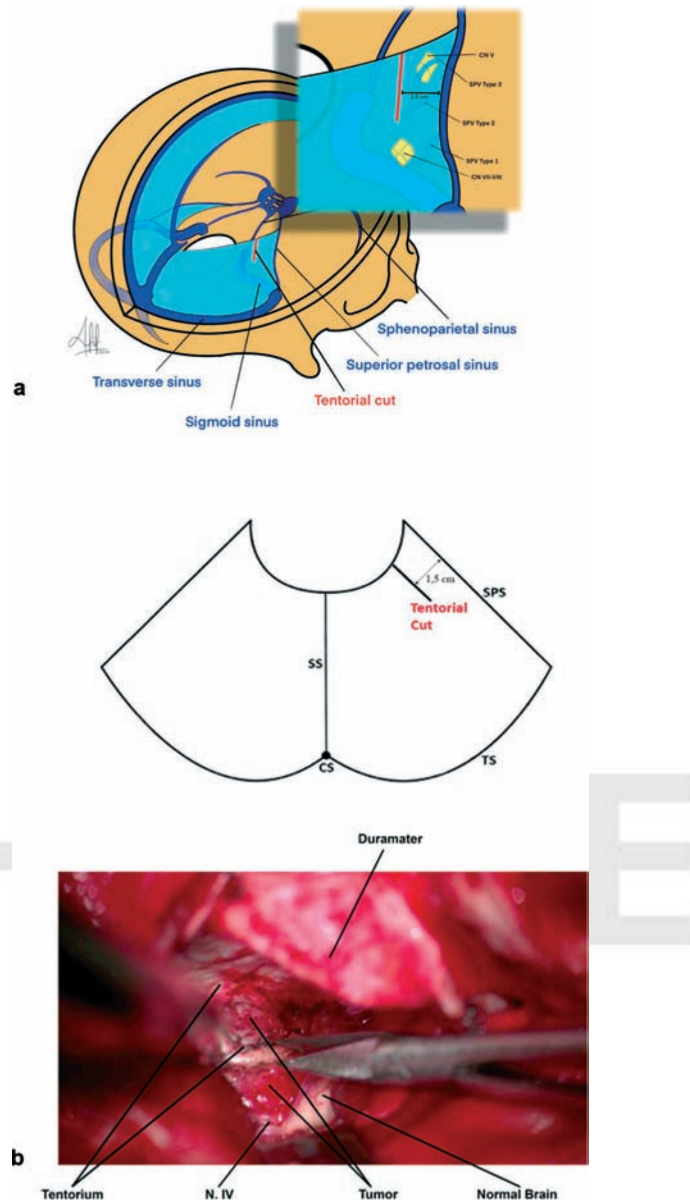

Fig. 4 (**a**) Schematic figure of the tentorium and location of the tentorial cut (CS[Q4], cavernous sinus; SPS, superior petrosal sinus; SS, sigmoid sinus; TS, transverse sinus). (**b**) Microscopic subtemporal view of the tentorial cutting. Identification of the trochlear nerve is mandatory before the tentorial cutting.

Dural Incision

Subtemporal and retrosigmoid durotomies were performed, and the subtemporal dura was opened in a linear shape along the inferior temporal lobe. Anteriorly, the incision was performed as far as needed. The posterior margin of the dural opening was the vein of Labbé without cutting the SPS. Also, the posterior fossa dura was opened, leaving 5 mm of dural fringe both along the posterior margin of the sigmoid sinus and along the inferior margin of the transverse sinus (►**Fig. 2b**).

Cisternostomy

The cerebellomedullary cistern was carefully opened and cerebrospinal fluid (CSF) was drained to achieve brain relaxation.

Table 1 Patient characteristics

Patient	Sex, age (yr)	Preoperative neurologic deficit	Widest diameter	Middle fossa extension	Cavernous involvement	Inferior extension	BA involvement	Brainstem compression	Resection	Postoperative neurologic deficit	Postoperative complications
1	F, 43	Unilateral CN III	4.9 cm	+	+	IAM	Displaced	3	Subtotal	Persist	–
2	F, 43	Headache, hemiparesis	4.8 cm	+	–	–	Nondisplaced	1	Subtotal	Persist	–
3	F, 46	Unilateral CN III, IV, VI	5 cm	+	+	IAM	Displaced	3	Subtotal	Persist	Temporary CN VII, VIII deficit
4	F, 37	Unilateral CN III	4.8 cm	+	+	IAM	Encased	2	Subtotal	Persist	Temporary CN VIII deficit
5	F, 45	Unilateral CN IV, V1, V2	5.1 cm	+	+	IAM	Displaced	3	Subtotal	Persist	–
6	F, 38	Headache	5.3 cm	+	–	IAM, JF	Displaced	3	Subtotal	Relieved	Permanent CN IV deficit
7	F, 47	Headache, hemiparesis	4.5 cm	+	–	IAM	Displaced	2	Total	Relieved	–
8	F, 65	Unilateral CN VII	3.5 cm	+	–	–	Displaced	1	Total	Worsen	Permanent CN VII deficit
9	M, 46	Unilateral CN VII	5.2 cm	+	–	IAM, JF	Displaced	3	Total	Relieved	–
10	F, 55	Unilateral CN V1, V2, V3	3 cm	+	–	–	Non displaced	1	Total	Relieved	CSF leakage
11	F, 42	Headache, hemiparesis	4.8 cm	+	–	IAM	Displaced	3	Total	Relieved	–
12	F, 46	Unilateral CN III, IV, VI	5.2 cm	+	+	IAM	Displaced	3	Subtotal	Persist	Temporary CN VIII deficit
13	F, 58	Headache, hemiparesis	5 cm	+	–	IAM	Displaced	3	Total	Relieved	–
14	F, 45	Headache	3.2 cm	+	–	IAM	Encased	2	Total	Relieved	–
15	M, 35	Headache, unilateral CN V1, V2, VII	4.6 cm	+	–	IAM	Displaced	2	Total	Relieved	–
16	F, 39	Headache, unilateral CN VII, VIII	3.7 cm	+	–	IAM	Displaced	2	Total	Relieved	–
17	F, 52	Headache, Unilateral CN VIII	4.9 cm	+	–	IAM, JF	Displaced	3	Subtotal	Persist	–
18	F, 36	Unilateral CN VII, tetraparesis	4.5 cm	+	+	IAM, JF	Displaced	3	Subtotal	Relieved	Temporary CN VIII deficit

Table 1 (*Continued*)

Patient	Sex, age (yr)	Preoperative neurologic deficit	Widest diameter	Middle fossa extension	Cavernous involvement	Inferior extension	BA involvement	Brainstem compression	Resection	Postoperative neurologic deficit	Postoperative complications
19	F, 39	Headache, hemiparesis	5.4 cm	+	+	IAM	Displaced	2	Subtotal	Persist	Temporary CN VII deficit
20	M, 54	Headache	4.2 cm	+	–	IAM	Displaced	3	Total	Relieved	–
21	M, 39	Headache	3.1 cm	+	–	–	Non displaced	1	Total	Relieved	Temporary CN VII, VIII deficit
22	F, 57	Headache	5.2 cm	+	+	IAM	Encased	1	Subtotal	Deceased	Infarct PCA (deceased)
23	F, 43	Unilateral CN IX, X, XI, XII, tetraparesis	5.6 cm	+	+	IAM, JF	Displaced	3	Subtotal	Relieved	Temporary CN IV, VIII deficit
24	F, 48	Hemiparesis	4.1 cm	+	–	IAM	Displaced	3	Total	Relieved	–
25	F, 29	Headache, hemiparesis	4 cm	+	–	IAM, JF	Encased	3	Subtotal	Relieved	Permanent CN VI deficit
26	F, 63	Headache	4.1 cm	+	–	IAM, JF	Displaced	2	Subtotal	Relieved	–

Abbreviations: BA, basilar artery; CN, cranial nerve; IAM, internal auditory meatus; JF, jugular foramen.

Tentorial Incision

The cerebellar tentorium was incised via the temporal dural opening, parallel and 1.5 cm away from the SPS, with extension to the hiatus. This proposed 1.5-cm distance from the SPS is a safe distance and avoids entering venous lacunas. Identification and preservation of CN IV before cutting the tentorium is mandatory (►**Fig. 4**). With tentorial incision and retraction of the temporal lobe, the supratentorial portion of the tumor can be debulked, and early brainstem decompression can be obtained.

Tumor Detachment and Resection

Detachment of the tumor from its matrix was performed to minimize blood loss during tumor resection. The petroclival region was widely exposed from the retrosigmoid dural opening. Identification of the CN VII/VIII complex is needed before tumor debulking. Furthermore, the tumor was debulked in piece-meal fashion starting in the tumor center portion. Then, dissection of the arachnoid plane of the tumor and separation from the surrounding normal structures was performed. CNs V and VI and SPV were found lateral to the tumor. All adjacent CNs and SPV were preserved by a meticulous blunt and sharp dissection.

Result

Clinical Characteristics

Twenty-six cases of PCM were reviewed. The mean patient age was 45.6 years (range: 27–65 years), and the female-to-male ratio was 4.5:1 (22 females and 4 males). Fifty-four percent of 22 patients complained of severe headache on presentation. There was also complaint of CN deficit, with CN VII deficit being the most common (present in 42% of patients), followed by deficits of CNs III and V (present in 15.4%).

Radiographic and Pathologic Characteristics

The average tumor size (measured as maximum diameter) was 45.2 mm. Furthermore, inferior tumor extension was noted in 22 cases (15 cases reaching the internal auditory meatus [IAM] only and 7 cases reaching the jugular foramen). The basilar artery was displaced by tumor in 19 patients (73%) and circumferentially encased by tumor in 4 patients (15.4%). Most of the tumors compressed the brainstem: grade I: 5 patients (19.2%); grade II: 7 patients (26.9%); and grade 3: 14 patients (53.8%). Histopathology report showed 25 (96.1%) patients had WHO grade I meningioma and 1 patient (3.8%) had grade II meningioma.

Tumor Resection and SPV preservation

Total resection was achieved in 12 patients (46.2%). In the remaining patients, the tumor was resected subtotally (54.8%). Among these were nine patients with tumor extension into the cavernous sinus (34.7%). Other reasons for subtotal removal were tumor attachment to brainstem, nerves or vessels and IOM warning. The SPV was preserved in all patients, as judged by the senior neurosurgeon, who operated on all cases.

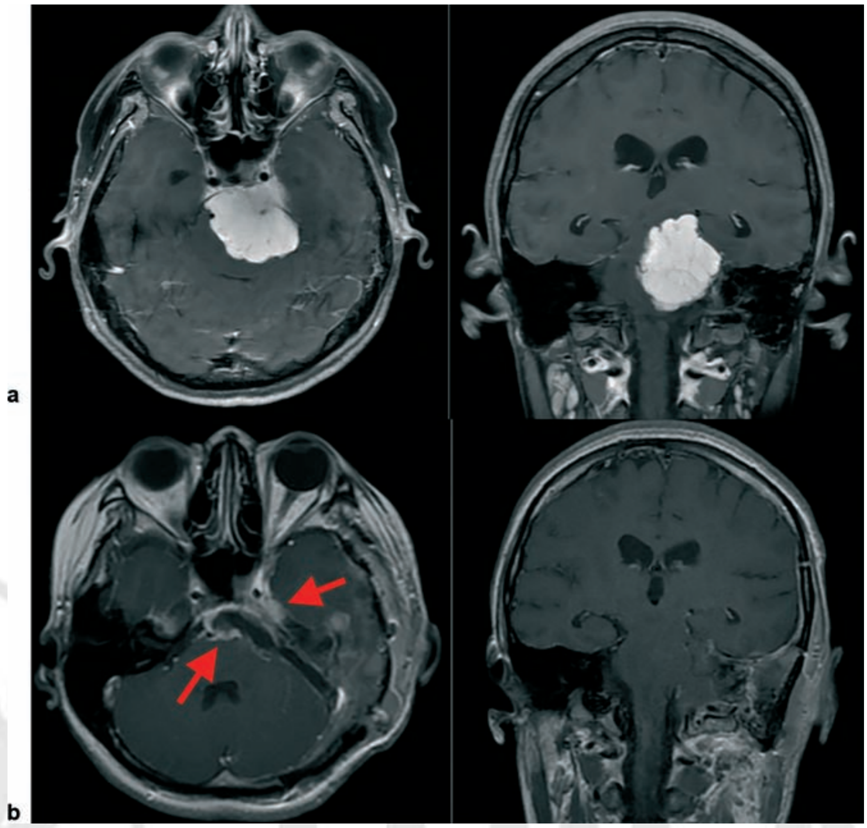

Fig. 5 (**a**) Preoperative magnetic resonance imaging (MRI). Within the left petroclival region, there is a homogenous contrast-enhanced extra-axial mass with dural tail. A supratentorial extension of the mass was found in this case. The mass extends to the inferior clivus inferiorly and causes grade 3 brainstem compression. (**b**) Postoperative MRI showed residual tumor in the cavernous sinus and at the brainstem surface (*red arrows*).

Outcomes

Postoperative clinical improvement and persistency of the symptoms were observed in 16 (61.5%) and 8 (30.7%) patients, respectively. There was one postoperative death (perioperative mortality rate of 3.8%), which occurred during postoperative intensive care due to posterior cerebral artery (PCA) infarction. A CSF leak (otorrhea) occurred in one patient (3.8%) and was treated by a lumbar drain. The otorrhea stopped 3 days. Permanent postoperative CN deficit was observed in three patients (11.5%), with deficits of CNs IV, VI, and VII. Transient postoperative CN deficits were observed in seven patients (26.92%), affecting the CNs IV, VII, and VIII. All findings are summarized in ►**Table 1**.

Illustrative Case

Case 1 (Patient 25)

A 29-year-old woman presented with a paroxysmal headache a month before admission. The patient also complained of a slight weakness of the right extremity. Preoperative MRI revealed a left PCM (►**Fig. 5**). As seen on angiography, the tumor was supplied by the left meningohypophyseal trunk, and ascending pharyngeal artery. Angiography further depicted the location of the SPV and the SPS (►**Fig. 6**). Embolization of the ascending pharyngeal artery was performed before surgery. Postoperative MRI showed the subtotal removal of the tumor. Subsequently, clinical condition of the patient significantly improved.

Case 2 (Patient 18)

A 43-year-old woman presented with weakness of all the extremities for 1 year before admission. The patient also complained of headache and right facial weakness. Preoperative MRI showed a PCM extending to the thalamic region (►**Fig. 7**). Furthermore, the mass significantly compressed the brainstem and displaced the basilar artery to the contralateral side. The patient underwent embolization of the ascending pharyngeal artery before tumor resection. During the surgery, no clear interface between the tumor and the brainstem was seen. Surgery was stopped due to an IOM warning. Postoperative MRI showed the subtotally resected tumor. The patient's weakness and headache subsided 2 months after surgery. Hearing loss was observed postoperatively, which relieved after 4 months.

Discussion

Options for surgical approaches for PCM range from orbitozygomatic to posterior fossa, with or without petrosectomy depending on the tumor size, extension to the middle and posterior fossae, and CN deficits. The anterior transpetrosal approach (subtemporal) is best suited for PCM located medially to the IAM with minimal extension to the posterior fossa.[15] The retrosigmoid approach offers a wider operative field around the clivus and brainstem,[16] whereas the posterior transtentorial approach is appropriate for lesions in the upper and middle clivus.[7,17–19] In this study, PCM was

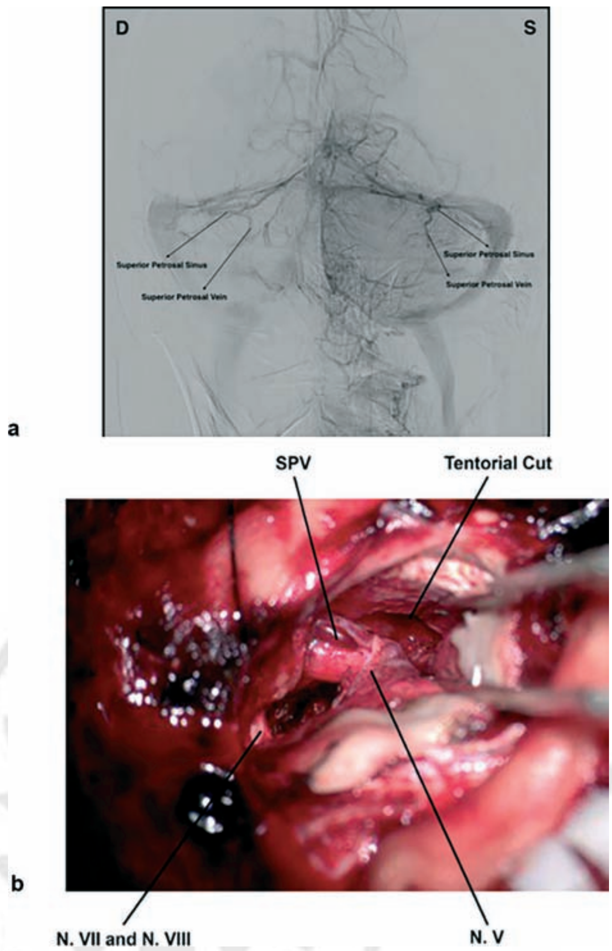

Fig. 6 [Q5] (**a**) Anteroposterior view of the preoperative angiography showed the superior petrosal vein (SPV) and superior petrosal sinus (SPS). (**b**) Microscopic retrosigmoid view after tumor resection. Note that the SPV was preserved and drained to the SPS on the lateral side of the trigeminal nerve.

managed from a different approach allowing to preserve the SPV and SPS complex.

The technique was originally performed by Kenji Ohata, and reported by Kunihiro et al in 2014. They considered the technique as a modification of Hakuba's approaches by limiting the petrous drilling and proposed it for retrochiasmatic craniopharyngioma removal.[20] Furthermore, they emphasized that this approach offers wider exposure of retrochiasmatic lesions and unique posterior-to-anterior and inferior-to-superior visualization of the inferior and posterior surfaces of the chiasm, the floor of the third ventricle, and the tuber cinereum area. This technique was developed based on an attempt to preserve the facial and cochlear nerve functions. Disadvantages are the occasional occurrence of transient CN III palsy and increased risk of CSF leakage due to wide opening. Haq et al, used Ohata technique in removing PCM and proposed an additional modification of the subtemporal dural incision for preserving the SPV. Tentorial incision was made by opening the presigmoid dura (Trautmann's triangle) along the sigmoid sinus toward the edge of the SPS with taking the SPV position into account.[8] This allows the surgeon to have a better corridor for reaching the superior extension of a PCM.

In the MTTA, another modification, namely the temporal and retrosigmoid dural incision, was used for preserving the SPS. Preoperative MR venography (MRV) or angiographyare helpful for planning of the approach The MTTA has several advantages including better visualization, minimal brain retraction, easy tumor detachment, early brainstem decompression, adequate supratentorial exposure with preservation of the SPV-SPS complex, and, possibly, shorter surgery duration. Without drilling the petrous apex, there will be low risk of CSF leakage and injury to the inner ear. On the other hand, the dural and tentorial incision have a higher risk of injuring the vein of Labbé and the trochlear nerve. This approach will leave the tumor extension in the Meckel's cave and the cavernous sinus. The advantages and limitations of published approaches and their modification are described below (►**Table 2**).

One of the main problems affecting the extent of resection and complication rate is tumor adherence to the brainstem, the vessels, and the CNs. These structures have to be meticulously dissected to prevent further damage and intraoperative rupture of vessels. Tumor adherence could be seen as destruction of the arachnoidal plane on T1-weighted magnetic resonance images.[21] Brainstem compression and edema formation contribute to surgery difficulty. Resection of tumor adhering to the brainstem is not advisable as it may harm the perforating branches from the vertebrobasilar artery to the brainstem. Anatomical knowledge supported by IOM is essential during the surgery in this area. PCMs may affect CNs V, VII, VIII, IX, X, and XI posteriorly, CN VI medially, and the brainstem medially and posteriorly, and extend to the cavernous sinus, IAM, and jugular foramen. Sometimes, PCMs may also displace CN V laterally and superiorly, CN VI laterally and posteriorly, CNs VII/VIII, IX/X/XI posteriorly, CN XII posterior and inferiorly, and the brainstem posteriorly.[1,22] We were unable to expose the Meckel cave due to preservation of the petrous apex. The other limitation is that tumor extending into the cavernous sinus cannot be exposed and resected as shown in ►**Fig. 8**.

Despite being an important anatomical landmark, the SPV limits the range of cerebellar retraction and visualization of the superior corridor.[23] Narayan et al summarized the reported cases and studies of complications following SPV sacrifice showing a complication rate of 0.3 to 31% resulting in an overall morbidity of up to 7%.[13] Cheng reported that complications following SPV obliteration were underreported, but could be significant.[24] Another interesting study was conducted by Zhao et al who performed brainstem monitoring after an occlusion test during microvascular decompression for trigeminal neuralgia. Of the five patients who had pathologic brainstem monitoring results, three developed significant complications after sacrificing the SPV.[25]

The SPS is one of the dural venous sinuses that drain the cavernous sinus. To prevent subsequent postoperative complications, avoidance of SPS sacrifice is needed. Furthermore, it is important to avoid temporal lobe mobilization (by separating it from the underlying dura or tentorium).[8,26–29] The MTTA can spare the SPS-SPV complex by cutting the dura

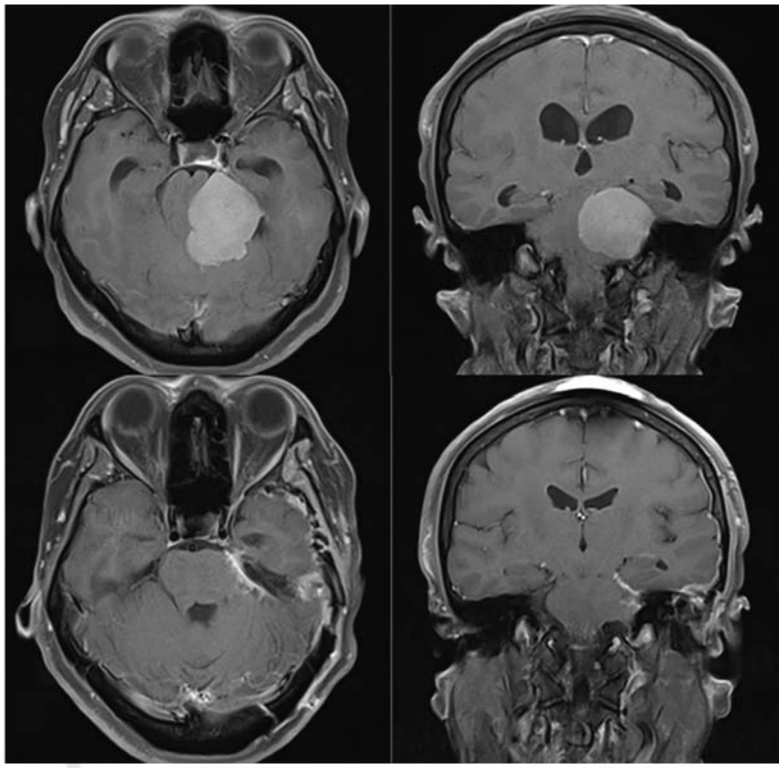

Fig. 7 Preoperative magnetic resonance imaging (MRI) showed homogenous contrast-enhanced mass at the left petroclival region. Two-month postoperative MRI: Tumor infiltration of brainstem arachnoid made total resection without high risk of brainstem infarction impossible.

Table 2 Summary of previously published surgical approaches for petroclival meningioma

Study[Q6]	Approach	No. of patients	Percentage of total resection	Advantage	Disadvantage
Kunihiro et al[20]	Minimum anterior and posterior combined trans-petrosal approach	16	93.8 (15)	• Wide posterior-to-anterior and inferior-to-superior exposure of the surfaces of the chiasm, the floor of third ventricle, and the tuber cinereum area	• Time-consuming and difficult procedure • Cranial nerve (CN) damage (transient oculomotor nerve palsy)
Haq et al[8]	Petrosal approach with SPV preservation (dural incision technique)	45	NA	• Possibly lower risk of postoperative venous complications such as venous infarction or hemorrhage	• Preservation of the SPV is not always possible during the petrosal approach • Tumors involving the petrous apex may encase the SPV
Zhao et al[31]	Retrosigmoid transtentorial approach	64	71.9% (46)	• Less traumatic, simpler approach, less time consuming • Avoidance of traction injury of the vein of Labbé • More exposure without more traction of cerebellum and venous sinus Earlier exposure and handling of brain–tumor boundary and tumor matrix without necessarily extensive resection of the petrous bone, drilling of the suprameatal bone, and exposing the internal structures of petrosal bone	• For the petroclivosphenoidal type of PCMs[Q7], the rate of GTR was only 52.2% (12 cases in 23 patients), the rate of new postoperative CN deficits was up to 47.8%, higher rate of progress and death during follow-up • This route appears to have limitations for the lesions reaching the middle cranial fossa through Meckel's cave and/or extending above the tentorium through the tentorium cerebelli hiatus or infiltrating the tentorium itself • The resection of tumor was mainly achieved through neurovascular windows, increasing, the risk of iatrogenic injury of neurovascular structures

Table 2 (*Continued*)

Study[Q6]	Approach	No. of patients	Percentage of total resection	Advantage	Disadvantage
Spiess-berger et al[32]	Combined anterior transpetrosal and subtemporal/ transcavernous approach	2 cadaveric specimen	NA	• Provides a wide anterolateral exposure of the brainstem, cerebral peduncles, and adjacent neurovascular structures from the level of the internal auditory canal caudally to the level of the anterior clinoid process cranially, useful for large tumor lesions	• Temporal lobe retraction that carries the risk of brain contusion • Risk of CN deficits (especially CNs III and IV) • Risk of a vein of Labbé infarction

Abbreviations: GTR, gross total resection; PCMs, petroclival meningiomas; RTTA, retrosigmoid-transtentorial approach; SPV, superior petrosal vein.

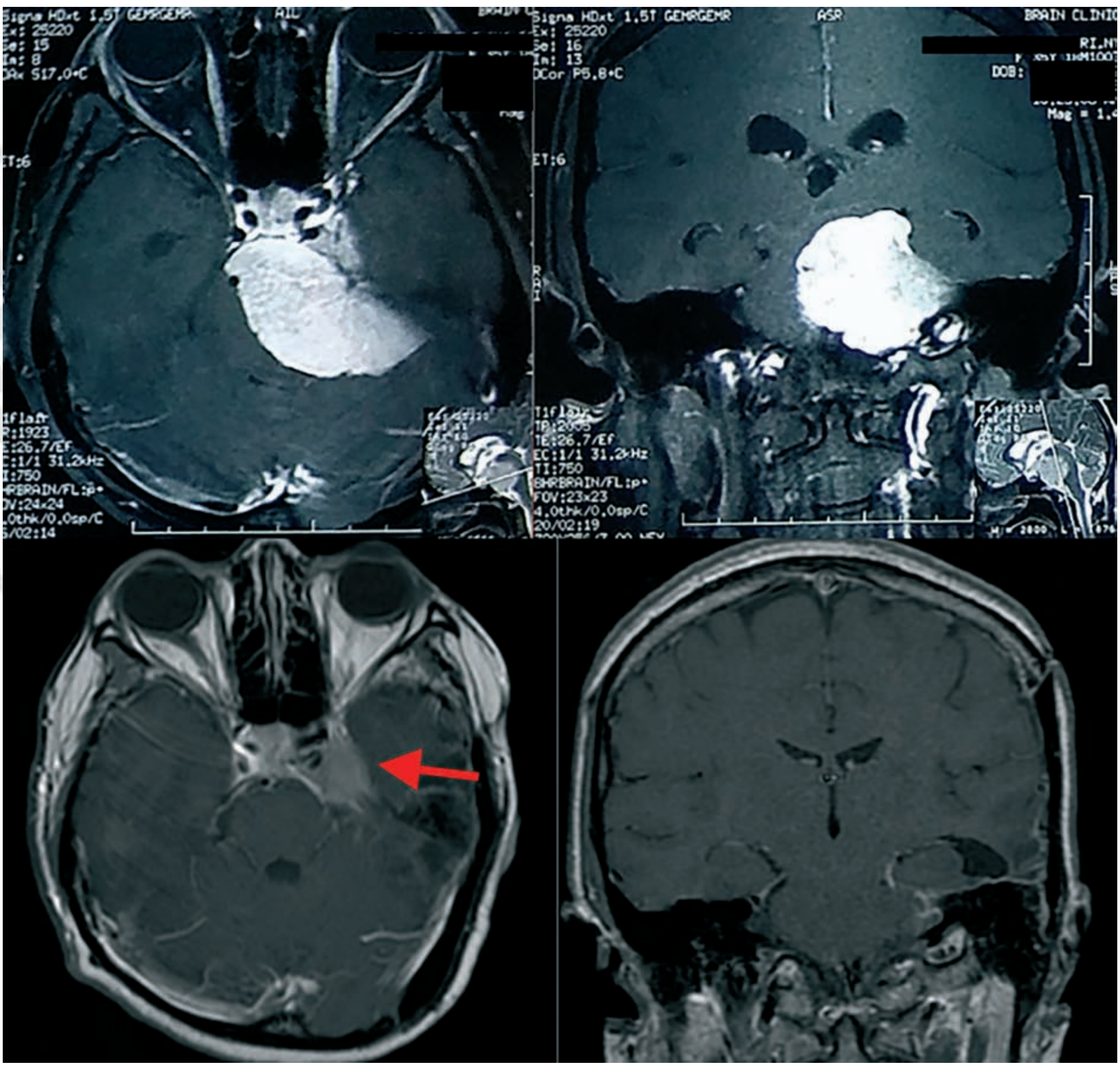

Fig. 8 [Q8] Pre- and postoperative magnetic resonance imaging (MRI) showing tumor extension into the cavernous sinus. Removal of the cavernous part of the tumor is limited if using the modified transpetrosal–transtentorial approach. (red arrow)

in distance to that vein complex. Postsurgical MRI in some patients showed patent SPV-SPS complex, but they are difficult to visualize, probably due to obliteration after prolonged compression. We believe that MTTA not only increases the chance of complete removal but also lessens the risk of morbidity, including CN deficits. By considering all preoperative factors, better surgical results with less post-operative deficits can be achieved.[30]

Conclusion

PCMs[Q9] remain a challenge for skull base surgeons. Total resection with preservation of CNs and important neurovascular structure is mandatory to minimize the recurrence rate, morbidity, and mortality while achieving better functional outcome. MTTA offers adequate visualization to help achieve maximal resection in PCMs. Preservation of the SPS-SPV complex should be attempted whenever possible to minimize the rate of complications.

Statement of Ethics
Consent was obtained directly from the patients.

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Conflict of Interest
None declared.

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