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Case Report

Combined simultaneous transcranial and endoscopic endonasal resection of sphenoorbital meningioma extending into the sphenoid sinus, pterygopalatine fossa, and infratemporal fossa

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Abstract

Background: Sphenoorbital meningiomas are surgically challenging because of their nature to extend to adjacent structures. Here, we describe a case of recurrent sphenoorbital meningioma extending into the sphenoid sinus, pterygopalatine fossa, and infratemporal fossa, which was resected using combined simultaneous transcranial and endoscopic endonasal approaches.

Case Description: A 62-year-old man who had 15 years earlier undergone partial resection of a left sphenoorbital meningioma presented with a 1-year history of progressive proptosis of the left eye. Magnetic resonance imaging (MRI) showed a Gd-enhancing tumor occupying the left sphenoid wing and orbital lateral wall and extending into extracranial structures such as the sphenoid sinus, pterygopalatine fossa, and infratemporal fossa as well as adjacent structures such as the cavernous sinus and superior orbital fissure (SOF). Based on the MRI findings of tumor extension into the sphenoid sinus with broad continuity, the risk of postoperative cerebrospinal fluid (CSF) leakage through the large defect in the sphenoid sinus was considered high. Subtotal resection using combined simultaneous transzygomatic and endoscopic endonasal approaches was performed, leaving residual tumor in the cavernous sinus and SOF. The large skull base defect between the middle fossa and sphenoid sinus was covered with a free graft of fascia lata from the transcranial side and with a vascularized nasoseptal flap from the endonasal side. No CSF rhinorrhea and no neurological deficits developed postoperatively.

Conclusion: Combined simultaneous transcranial and endoscopic endonasal approaches may become a safe and feasible alternative for sphenoorbital meningioma with a large skull base defect penetrating to the paranasal sinus.

Key Words: Cerebrospinal fluid leakage, combined transcranial and endoscopic endonasal, reconstruction, sphenoorbital meningioma

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INTRODUCTION

Sphenoorbital meningioma is a rare entity that accounts for 0.2–9.0% of all intracranial meningiomas.[16,19] Because of its nature of extending into adjacent structures such as the cavernous sinus, superior orbital fissure (SOF), anterior clinoid process, and middle fossa as well as the greater and lesser sphenoid wings and orbit, resection of these tumors has been historically difficult, resulting in a high rate of recurrence.[3,12] In particular, in cases with extracranial extension into the sphenoid sinus, pterygopalatine fossa, and infratemporal fossa, radical resection of the tumor becomes more challenging.[2,18,20] When the sphenoid sinus is penetrated by tumor extension from an intracranial lesion, the risk of postoperative cerebrospinal fluid (CSF) leak is markedly increased. Recently, a method for reconstructing skull base defects using a vascularized nasoseptal flap (NSF) was developed in the field of endoscopic endonasal surgery for cases at high risk of postoperative CSF leak.[5,6,9] Skull base reconstruction using an NSF is expected to prove useful to prevent postoperative CSF leak in cases of extensive sphenoorbital meningioma, but to date has rarely been used in real cases. We report a case of recurrent sphenoorbital meningioma extending into the sphenoid sinus, pterygopalatine fossa, and infratemporal fossa resected using combined simultaneous transcranial and endoscopic endonasal approaches. This technique was useful not only for aggressive resection of tumor infiltrating into the skull base and extending into the sphenoid sinus, but also to secure the skull base reconstruction to prevent postoperative CSF leakage.

CASE REPORT

A 62-year-old man who had 15 years earlier undergone partial resection for left sphenoorbital meningioma in another hospital presented with a 1-year history of progressive proptosis of the left eye. He was referred to our hospital because magnetic resonance imaging (MRI) and computed tomography (CT) revealed a hyperostotic tumor of the left sphenoid wing with orbital and middle fossa extension. On admission, ophthalmic examination showed slight proptosis of the left eye, but visual acuities, visual field areas, eye movements, and pupillary light reflexes remained normal. Neurological examination showed no neurological deficits. The results of laboratory examinations, including thyroid function, were essentially normal. CT performed in our hospital revealed hypertrophy of the left sphenoid wing, orbital lateral wall, and floor of the middle fossa [Figures 1a and b]. MRI showed a Gd-enhancing tumor occupying the left sphenoid wing and orbital lateral wall [Figure 2a]. Extension of the tumor into extracranial structures such as the sphenoid sinus, pterygopalatine fossa, and infratemporal fossa as well as adjacent structures such as the cavernous sinus and SOF was also revealed [Figure 2b and c]. Cerebral angiography demonstrated hypervascularity of the tumor supplied by the branches of the internal maxillary artery [Figure 3a]. Although detailed information about the previous operation was unavailable, including histopathological examinations and surgical procedures, the radiological findings were compatible with gross extension of recurrent sphenoorbital meningioma. Preoperative embolization using N-butyl cyanoacrylate was performed 1 day before the surgical resection [Figure 3b]. Based on MRI findings of tumor extension into the sphenoid sinus from the middle fossa with broad continuity, surgical resection through combined simultaneous transcranial and endoscopic endonasal approaches was planned for aggressive surgical resection with minimized risk of postoperative CSF leakage. Subtotal resection was performed, leaving residual tumor in the cavernous sinus and SOF. Postoperative CT showed extensively drilled skull base bone [Figure 1d–f]. Postoperative neurological examination revealed no neurological deficits, including ocular movement and facial sensation. A lumbar spinal drain was placed for 5 days postoperatively and no CSF rhinorrhea developed. Histopathological examination identified the tumor as meningothelial meningioma, World Health Organization grade I. Follow-up MRI at 3 months postoperatively demonstrated residual tumor only in the cavernous sinus and SOF [Figure 2d–f].

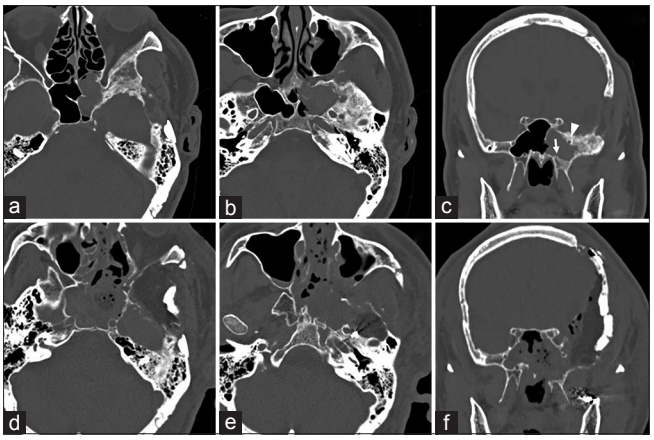

Figure 1: Pre- and postoperative computed tomography (CT). Preoperative CT in the bone window in the axial plane (a and b) demonstrating hypertrophy of the left sphenoid wing, orbital lateral wall, and floor of the middle fossa. Pre-operative CT in the bone window in the coronal plane (c) showing development of the lateral recess of the sphenoid sinus beyond the sphenoid body into the greater wing. Postoperative CT in the bone window (d–f) showing extensively drilled sphenoid wing, orbital lateral wall, floor of the middle fossa, ethmoid sinus, and sphenoid sinus. Arrow, vidian canal; arrowhead, foramen rotundum

Surgical procedure

Under general anesthesia, the patient was placed supine with the head fixed in a Mayfield clamp and rotated 30° to the right. To achieve both transcranial and endoscopic endonasal approaches, two surgical teams worked

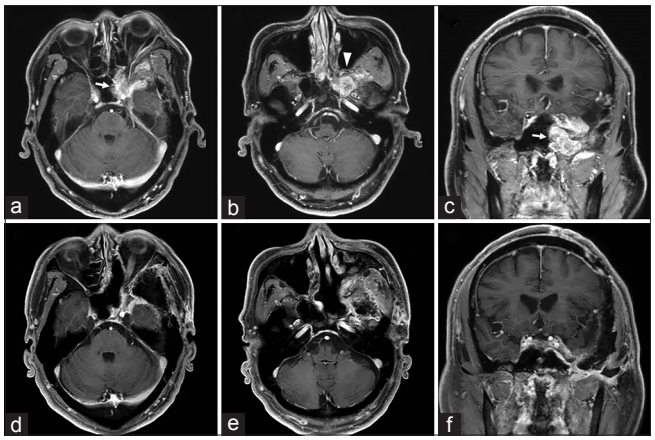

Figure 2: Pre- and postoperative magnetic resonance imaging. Pre-operative axial T1-weighted imaging with gadolinium contrast (a and b) and sagittal T1-weighted imaging with gadolinium contrast (c) demonstrating a homogeneously enhancing tumor extending into extracranial structures as well as adjacent structures. Postoperative axial T1-weighted imaging with gadolinium contrast (d and e) and sagittal T1-weighted imaging with gadolinium contrast (f) demonstrating residual tumor only in the cavernous sinus and superior orbital fissure. Arrows, tumor extending into the sphenoid sinus; arrowhead, tumor extending into the pterygopalatine fossa

simultaneously. The transcranial surgeon stood at the head end of the patient and the endonasal surgeon stood on the right side of the patient.

Transcranial approach

The frontotemporal craniotomy made 15 years earlier was used and an additional zygomatic osteotomy was created to approach the tumor. The thickened hyperostotic sphenoid wing and lateral wall of the orbit were completely drilled out and removed. After cutting of the meningo-orbital band followed by peeling of the dura propria of the middle fossa from the lateral wall of the cavernous sinus, further drilling around the SOF and floor of the middle fossa was performed. Following identification of the maxillary and mandibular nerves, the floor of the middle fossa around the foramen rotundum and foramen ovale was drilled until the pterygopalatine fossa and infratemporal fossa were exposed. During these procedures, the tumor mass extending into the sphenoid sinus was exposed and the sphenoid sinus was then widely opened by resection of the tumor mass [Figure 4a]. All skull base bone infiltrated by the tumor was extensively drilled out and removed. Tumor-involved dura was resected and repaired with a free graft of fascia lata. Tumor extension into the cavernous sinus and SOF was left in place to avoid the risk of postoperative ocular nerve palsies. The large bone defect of the sphenoid sinus was covered with a free graft of fascia lata and then fixed with fibrin glue from the transcranial side [Figure 4b].

Endoscopic endonasal approach

A rigid high-definition endoscope (Karl Storz, Tuttlingen, Germany) was used in a standard endonasal approach

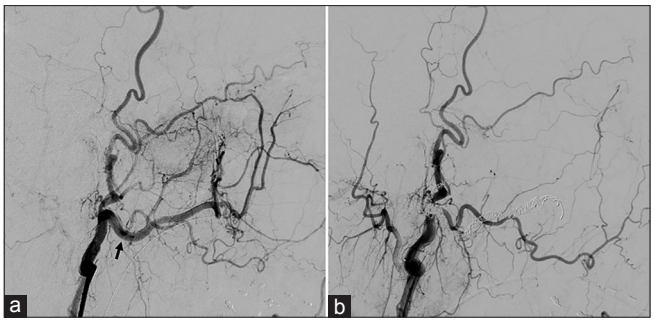

Figure 3: Pre- and postembolization angiogram. Pre-embolization angiogram (a) showing hypervascular tumor blush arising from the branches of the internal maxillary artery. Postembolization angiogram (b) demonstrating disappearance of the tumor blush. Arrow, internal maxillary artery

to expose the sphenoid sinus. A pedicled NSF was then prepared while maintaining the vascular supply from the posterior septal branch of the sphenopalatine artery.[6] Because the tumor had expanded laterally along with development of the lateral recess of sphenoid sinus beyond the sphenoid body into the greater wing [Figure 1c], the transmaxillary transpterygoid approach was employed to approach the tumor extending laterally over the vidian canal.[8] Uncinectomy, ethmoidectomy, and sphenoidotomy were performed in a stepwise manner. After the vidian nerve and artery were coagulated and sectioned, the contents of the pterygopalatine fossa were subperiosteally dissected and retracted laterally enough to expose the foramen rotundum. Tumor expanding laterally in the sphenoid sinus was then removed en bloc [Figure 4c]. After resection of the tumor from the transcranial approach, the large skull base defect between the middle fossa and sphenoid sinus was covered with a pedicled NSF and then fixed with fibrin glue [Figure 4d]. The NSF was secured with placed Surgicel®, then buttressed by gauze packing in the sphenoid sinus.

DISCUSSION

Infiltration to surrounding structures is one of the most striking features of sphenoorbital meningioma. Accordingly, radical resection of sphenoorbital meningioma is still challenging, with a significant risk of complications. The main structures limiting radical resection are the cavernous sinus and SOF, in which tumors directly infiltrate cranial nerves and extend along connective tissue planes in between these nerves.[19,20] Although extracranial extension of tumor into the sphenoid sinus, pterygopalatine fossa, and infratemporal fossa makes surgery more difficult in terms of approaching the tumor, the development of advanced skull base techniques has enabled adequate exposure of these deep-seated skull base lesions. Given the fact that even in cases with incomplete resection, the maximum

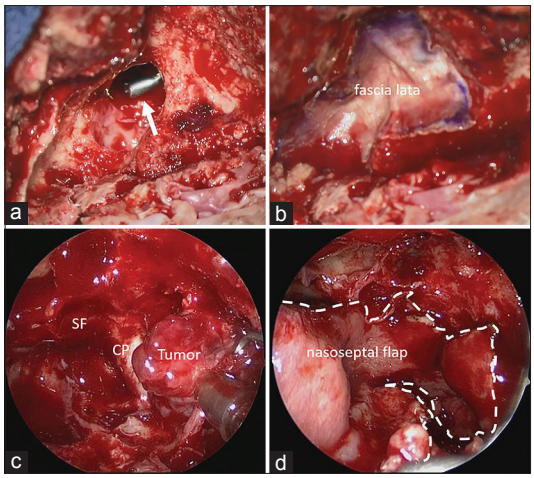

Figure 4: Intraoperative photographs. (a) Intraoperative photograph from the transcranial side showing the large bone defect of the sphenoid sinus after tumor resection. Arrow indicates suction from the endonasal side. (b) Intraoperative photograph demonstrating repair of the defect with a free graft of fascia lata. (c) Intraoperative photograph from the endonasal side showing tumor extending into the sphenoid sinus. SF, sellar floor; CP, carotid prominence. (d) Intraoperative photograph demonstrating repair of the defect with a pedicled nasoseptal flap. Dotted line indicates the margin of the nasoseptal flap

extent of reduction of residual tumor volume improves the planning and efficacy of adjuvant radiotherapy, radical resection including any extracranial extension, but excluding extension into the cavernous sinus and SOF, is considered helpful to achieve long-term tumor control.[1,19,20] Particularly in elderly patients with minor symptoms, however, a decision whether to perform complex skull base surgeries is not always easy because of a relatively high risk of potential complications. In the present case, we decided surgical indication because the patient developed progressive proptosis within relatively short term, suggesting a rapid tumor growth. Indication for the complex skull base surgeries should be carefully considered when discussing the benefits and risks for individual patients, especially in elderly patients with minor symptoms.

CSF leakage is one of the most frequent and potentially threatening complication after resection of skull base tumors. To avoid CSF leaks, use of vascularized flaps such as temporoparietal fascial flap, pericranial flap, or galeopericranial flap is highly recommended to reconstruct the defect, particularly in cases with a large skull base defect penetrating to the paranasal sinus.[13] In the present case, however, due to the influence of the previous surgery, sufficiently vascularized flaps were not available from the transcranial route. Through the development of extended endoscopic endonasal surgery for ventral skull base lesions, vascularized NSF has contributed to a decreased incidence of postoperative CSF leaks. Since Hirsch first described the use of a NSF for endonasal repair of a CSF leak in 1952, several modifications have been reported.[5,7,21] Among these, a neurovascular pedicled flap of nasal septal mucoperiosteum and mucoperichondrium based on the nasoseptal artery (Hadad-Bassagasteguy flap) is most widely used, offering good outcomes for skull base repair during endoscopic endonasal surgery.[5,6,9] To minimize the risk of postoperative CSF leak in the present case with a large skull base defect penetrating to the sphenoid sinus, we decided to harvest a vascularized NSF through the application of combined simultaneous transcranial and endoscopic endonasal approaches.

The combination of simultaneous transcranial and transsphenoidal approaches was first described by Loyo *et al*. in 1984 for the resection of extremely large pituitary tumors.[11] Various combined approaches have since been proposed. The main advantages of a supra-infrasellar approach, including the transcranial approach and microscopic transsphenoidal approach and the transcranial approach and endoscopic transsphenoidal approach for giant pituitary adenoma, are avoidance of critical postoperative bleeding from the residual tumor as well as compensation for blind areas and protection of critical intradural structures.[4,10,14] The main advantages of combined endoscopic transsphenoidal and transventricular approaches for giant pituitary adenoma with third ventricular extension are mobilization and delivery of the tumor from the intraventricular location into the sphenoid sinus, and direct verification of resection of both the intraventricular and sellar components.[15,17] Most reports of combined approaches have described adaptions to pathologies located in the anterior skull base, and few cases involving lateral skull base lesions treated with simultaneous combined above-and-below approaches have been reported. Our technique, combining transzygomatic and endoscopic endonasal approaches for a lateral skull base lesion, took advantage of prevention of postoperative CSF leakage with a vascularized NSF and a shortened operation time through the simultaneous resection of tumor via two operative windows. Attia *et al*. reported simultaneous transcranial orbitozygomatic and endonasal endoscopic approaches for two cases of sphenoorbital meningioma with extracranial extension.[1] They also mentioned the value of the vascularized NSF for skull base closure with respect to minimizing the risk of postoperative CSF leakage, along with the strengths of applying complementary approaches.

CONCLUSION

Combined simultaneous transcranial and endoscopic endonasal approaches may offer a safe and feasible alternative for resecting sphenoorbital meningiomas with extracranial extension. In particular, when a tumor penetrates and extends into the sphenoid sinus with

broad continuity, this technique contributes to not only facilitating aggressive resection of tumor infiltration into the skull base bone and extension into the paranasal sinus, but also preventing postoperative CSF leakage using a vascularized NSF. It should be emphasized, however, that application of combined approaches requires careful patient selection and tailored modification depending on the experience of the surgical teams.

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Conflicts of interest
There are no conflicts of interest.

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