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Editor: Ekkehard Kasper, M.D., Harvard Medical School, Boston, MA, USA

Case Report

Endoscopic transnasal suprasellar approach for anterior clinoidal meningioma: A case report and review of the literature

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Received: 15 April 17 Accepted: 21 June 17 Published: 22 August 17

Abstract

Background: Anterior clinoidal meningiomas (ACM) are traditionally approached through transcranial routes. Due to their tendency to extend laterally and their proximity to vital neurovascular structures, the endoscopic transnasal suprasellar approach is still questionable. We present and describe an ACM case that underwent an endoscopic transnasal suprasellar approach, and provide a review of the literature and operative technique.

Case Description: A 56 year-old lady who presented with chronic left-sided decreased vision. Brain imaging revealed a lesion measuring 9 × 10 × 11 mm attached to the left anterior clinoid process (ACP) and extending to the left optic canal. Lesion was compressing the left optic nerve (ON) and abutting the supraclinoid part of the left internal carotid artery (ICA). Utilizing the endoscopic transnasal suprasellar approach, the meningioma was resected and the optic canal was decompressed. Reconstruction was achieved using fascia lata, vomer bone, and nasoseptal flap. A lumbar drain was inserted perioperatively. Patient had no perioperative morbidity and retained vision in the affected eye.

Conclusions: Resection of selected ACMs can be safely achieved utilizing the endoscopic transnasal suprasellar approach. Although the literature lacks long-term outcome comparison between the transnasal and the traditional transcranial approaches, specifically addressing ACMs, this technique is becoming more popular over the last decade. More efforts should be directed towards implementing and reporting the endoscopic transnasal suprasellar approach for meningiomas of the anterior clinoid process.

Key Words: Anterior clinoid process, endoscopic transnasal suprasellar, meningioma

Access this article online
Website: www.surgicalneurologyint.com
DOI: 10.4103/sni.sni_147_17
Quick Response Code:

INTRODUCTION

Anterior Clinoidal Meningiomas (ACMs) represent special entity of meningiomas that have been referred to as, or grouped with, suprasellar, parasellar, sphenoid wing, or frontal skull base meningiomas.[18] They often are mentioned in the same context as meningiomas

How to cite this article: Bardeesi AM, Alsaleh S, Ajlan AM. Endoscopic transnasal suprasellar approach for anterior clinoidal meningioma: A case report and review of the literature. Surg Neurol Int 2017;8:194.
http://surgicalneurologyint.com/Endoscopic-transnasal-suprasellar-approach-for-anterior-clinoidal-meningioma:-A-case-report-and-review-of-the-literature/

originating from tuberculum sellae, diaphragma sellae, planum sphenoidale, or optic canal meningiomas. ACMs, originating from the arachnoid layer covering the anterior clinoid process (ACP),[18] has an incidence of 34% to 43.9% of all sphenoidal meningiomas.[2] With its tendency to extend laterally, and its proximity to the optic nerve (ON), the internal carotid artery (ICA) and its branches, it constitutes a surgical challenge to neurosurgeons, in terms of subsequent morbidity and achievement of gross total resection.[18] Another challenge is the choice of surgical approach to these types of tumors. Whereas different transcranial approaches have been proposed in the literature, there is paucity of studies reporting the implementation and description of a purely endoscopic approach to resect ACMs. We present a case of ACM that was resected by a purely endoscopic transnasal suprasellar approach (Transtuberculm), with detailed description of the surgical technique.

CASE DESCRIPTION

A 56 year-old female who is a known case of hypertension, dyslipidemia, and glaucoma, presented with long-standing decreased vision in her left eye. She had no headaches, no seizures, and no focal motor or sensory symptoms. Her systemic evaluation was irrelevant. On examination, she was conscious, alert, and oriented. Her vitals were within normal ranges. Ophthalmological assessment revealed limited vision to hand motion perception, afferent pupillary defect, superior, inferior, and temporal pallor of the optic disc in the left eye, with fully intact vision and findings in the right eye. She was otherwise neurologically intact.

Brain Magnetic Resonance Imaging (MRI) revealed a small oval-shaped suprasellar extra-axial lesion measuring 9 × 10 × 11 mm attached to the left ACP and part of planum sphenoidale. It was compressing the extracanalicular left ON and extending to the optic canal. The lesion was abutting the supraclinoidal segment of the left ICA.

The patient underwent endoscopic transnasal resection of the extra-axial lesion. After intubation, a lumbar drain was inserted in lateral position. Then, the patient was kept in the supine position and the head was fixed with Mayfield pins (15° right side rotation to the surgeon side, 15° lateral tilt to the right side, minimal flexion). Neuronavigation using Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) with contrast was implemented. Endoscopic partial middle and superior turbinectomy, middle meatal antrostomy, and partial ethmoidectomy were done on the left with exposure of a large Onodi cell on the left. This provided ample exposure of the left ON and orbital apex. Vascularized nasoseptal flaps were raised on both sides. Posterior nasal septectomy and complete removal of the sphenoid sinus face was then done bilaterally. Sphenoid sinus mucosa and bony septae were all removed. The sellar floor, prechiasmatic sulcus and planum sphenoidale were drilled and opened with the aid of Kerrison bone punches and 3 mm burr drill. Dura was coagulated to decrease flow to the tumor. The tumor was identified after opening the dura, and central debulking was done. Resection of the tumor was started medially to laterally using the arachnoid plane. Small residual portion of tumor was left on the ON because of absence of clear separation between the tumor and the nerve. Then, the optic canal was opened using a 3 mm diamond drill to expose the intracanalicular nerve and tumor extension. The intracanalicular tumor was resected from proximal to distal. Defect reconstruction was done in a multilayer fashion with fascia lata, vomer bone, the bilateral nasoseptal flaps and a Merocel® nasal pack [Figure 1].

Lumbar drain was left in place and the patient had no intraoperative complications. Patient was extubated and transferred to High Dependency Unit, vitally stable within the normal ranges. She was started on Dexamethsone 4 mg intravenously every 6 hours, and Ceftriaxone 1 gram intravenously twice daily, with instructions given to keep the head elevated at 30° and the lumbar drain was set to drain 10 milliliters/hour. The lumbar drain was removed and the patient was discharged home later on the 4th day postoperatively. Histopathological evaluation revealed a meningioma, transitional variant, World Health Organization (WHO) grade 1.

Two weeks after surgery, the patient was re-admitted because of nasal discharge. The nasal discharge was minimal amount of clear fluid with no signs of central nervous system infection. She underwent endoscopic exploration for suspicion of cerebrospinal fluid (CSF) leak. Intraoperatively, no clear site of a leak was identified, but a small mucosal defect in the superior edge of the repair was identified. The edges were freshened and grafted with a free mucosal graft from the nasal floor. The patient was discharged 2 days after the second procedure. The patient was followed in the outpatient clinic for more than 12 months with no evidence of a CSF leak. Visual field and acuity assessment by ophthalmology service confirmed her vision status remained stable with no worsening or improvement in both eyes, with no new complaints or tumor recurrence on follow up brain MRI.

DISCUSSION

The first reported use of a transsphenoidal route for tumor resection was in 1907, and that was carried out by Herman Schloffer for a pituitary adenoma.[24] The transsphenoidal technique re-flourished again after the introduction of the surgical microscope, as it was implemented by Jules

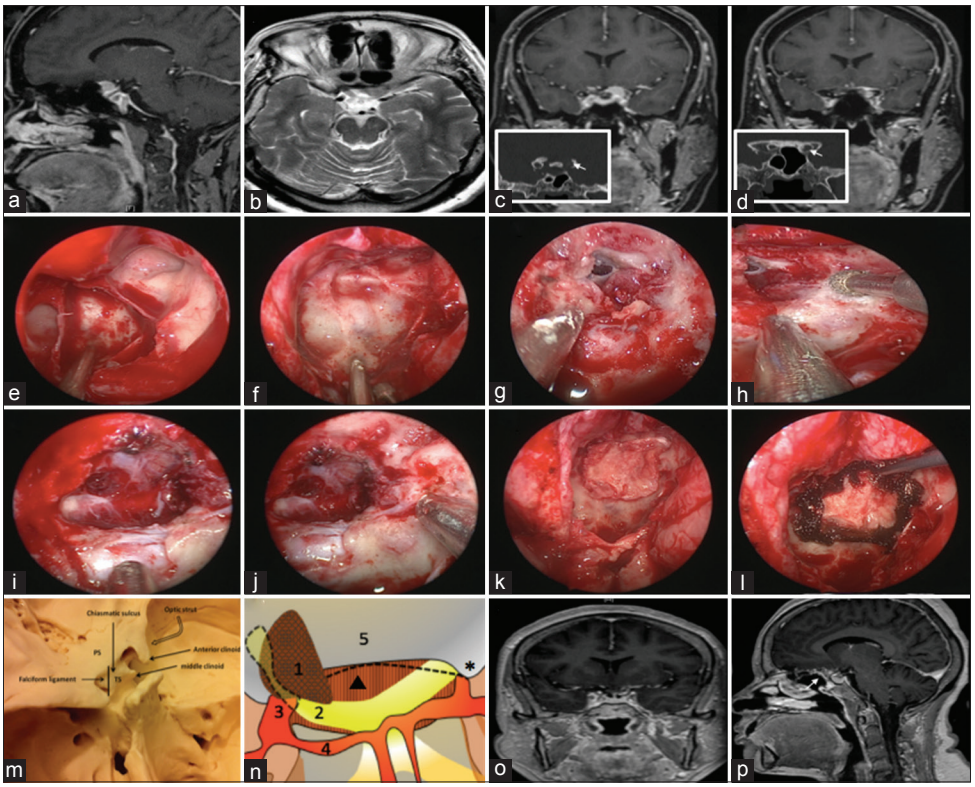

Figure 1: Imaging and approach of ACMs. (a) Preoperative sagittal and (b) axial brain MRI showing the lesion. (c and d) Coronal preoperative MRI with contrast demonstrating the extension of the lesion into the left optic canal. (White arrows) show the enlargement of the left optic canal on coronal CT scan. Intraoperative endoscopic images showing; (e) post drilling of the sphenoid sinus, (f) the sellar floor, (g) dura was opened with partial resection of the tumor and dura over the pituitary gland was kept intact, (h) drilling of the optic canal, (i) tumor resection with residual tumor on the left side covering the optic nerve, (j) Resection of tumor in the optic canal on the lift side. Optic chiasm, right optic nerve and anterior communicating artery complex are observed. (k) Fascia lata, Mepore (gasket seal technique was used) and (l) Surgicel were applied. (m) Superior view of the anterior clinoid and its relation to sellar structures. (n) A superior diagrammatic illustration of the clinoidal lesion compressing the left optic nerve demonstrating; (1) the lesion, (2) the left optic nerve, (3) internal carotid artery, (4) A1 segment, (5) planum sphenoidale, (Dotted line) the falciform ligament, (Triangle) diaphragma sellae and (Star) Right anterior clinoid. (o) Coronal and (p) sagittal MRI with contrast post resection of the lesion with a small part left attached to the left optic nerve. (White arrow) demonstrates the nasoseptal flap in place

Hardy in 1965.[13] After the transphenoidal microsurgical technique revealed some deficiencies in terms of visualizing the lesions, the endoscope was implemented in the transphenoidal approach with its panoramic view and more adequate illumination. Hence, the first ever purely endoscopic transnasal approach is attributed to Casiano *et al.* for resection of esthesioneuroblastomas.[6] Later, it was Jho *et al.*[14] who reported the first use of a purely endoscopic transnasal approach for resection of a suprasellar meningioma compressing the ON. The next extensive description of the endoscopic transnasal approach to suprasellar lesions with a larger number of cases was the work of Laufer *et al.*[17] and included 5 cases of suprasellar meningiomas. ACMs were reported for the first time in the literature by Cushing and Eisenhardt in 1938.[10] Since then, this entity of tumors is being reported in the literature either solely or grouped with other suprasellar meningiomas, where they were approached transcranially. Although few studies addressing the purely endoscopic transnasal approach for suprasellar meningiomas had included some cases of ACMs, there are yet no reports specifically and independently addressing this approach to them.

The ACP is a bony projection, located medially at the posterior aspect of the lesser sphenoidal wing. From a superior view, it appears as a triangular prominence that directs posteromedially, with anterior and posterior roots attaching its base to the sphenoid bone.[1] The anterior root represents the roof of the optic canal, whereas the posterior root, known as the optic strut, forms the inferolateral wall of the optic canal, separating it from the superior orbital fissure. From the ACP, a bony connection is occasionally found to the middle clinoid process, forming the caroticoclinoid foramen. The falciform ligament crosses medially from the ACP to the posterior part of planum sphenoidale, under which runs the ON. Other vital neural structures are related to ACP from its inferior surface, the oculomotor, trochlear, and ophthalmic nerves. The ICA passes forward by the side of the body of the sphenoid bone, and then curves upward on the medial side of the ACP.[1]

From an endoscopic view, the sellar floor appears centrally with a clival indentation inferiorly, planum sphenoidale superiorly, two lateral bony projections of the ICAs with two more ON projections superior to them. In between the carotid and optic protuberances on both sides, and depending on the degree of pneumatization of the sphenoid sinus, the lateral opticocarotid recess (OCR) can be identified.[16] It appears as a bony depression corresponding to the anterior part of the optic strut. Another bony indentation found on the medial aspect of the carotid protuberance is the lateral tubercular recess (LTR).[16] Medial to the lateral OCR bilaterally, lies another important teardrop-like structure which is the medial OCR, and that is a depression formed at the junction of the optic canal and the paraclinoidal carotid canal. It is an important landmark in endoscopic transnasal surgeries, as it offers identification and protection of paraclinoidal segment of the ICA, in addition to giving a safe entry point.[16] After exposure and bone drilling takes place, the dura will be exposed. The dura lining the medial OCR is in continuation with the distal dural ring, tubercular dura, and periosteal dura lining the medial edge of the paraclinoid carotid sulcus. The dura at the mediolinferior aspect of the medial OCR, represents the medial attachment of the distal dural ring. It is formed by the confluence of the dura lining the upper surface of the ACP that extends medially and the dura extending posteriorly from the superior surface of the optic strut, then the medial part of the distal ring, which is in continuation with the diaphragma sellae, extends posteroinferiorly to encircle the ICA.[16] The distal ring is a complete and competent ring that adherently fuses with the adventitia of the artery and hence serves as a barrier between the intra and extradural spaces.[16] The proximal dural ring forms as the confluence of the dura lining the inferior surface of the optic strut and the dura covering the inferior surface of the ACP. It extends medially to the carotid sulcus and it is often incomplete because it does not encircle the ICA completely on its medial side.[16]

Comparison of surgical techniques and outcomes

ACMs were classified by Al-Mefty into three groups based on their anatomical relation to the ICA.[2,18] Tumors that originate proximal to the end of the carotid cistern and encase the ICA with direct attachment to its adventitia, and are not separated by an arachnoid plane, constitute group I. This subtype usually extends laterally and inferior to the ACP, which makes the endoscopic resection unfeasible and risky. Group II constitute tumors originating from the superior surface of the ACP encasing the ICA, but have clear arachnoid plane separating them,[2] which was like in our case. We think this subtype can be resected transnasally. The transnasal endoscopic resection can be limited by the lateral extension of the tumor beyond the ACP lateral border. Group III constitute tumors that originated from the optic foramen, located between the ON and the ICA.[2] The endoscopic approach role will be limited to optic canal decompression in this subtype. The tumor resection will be limited because of the ON location medially interfering with direct visualization [Figure 2].

Multiple studies in the literature reported surgical resection of anterior clinoidal meningiomas using traditional transcranial (pterional, extended pterional, frontotemporal, frontoorbital, and frontoorbitozygomatic) approaches, with the pterional approach being mostly implemented.[3,4,9,11,21-23,26] The outcomes of interest in these studies were the degree of resection, visual outcome, postoperative complications, mortality rate, and rate of recurrence. The reviewed studies [Table 1][3,4,9,11,21-23,26] revealed diversity of rates of gross total resection (Simpson's I and II) ranging between 30.4% to 90.7%. The rest of the operated meningiomas in these studies had either subtotal or partial resection, and reasons for that can be attributed to cavernous sinus infiltration, or tight attachment to the ON or adjacent vessels.[3]

Secondary to the close proximity of ACM to the ON, patients tend to present clinically with unilateral visual deterioration,[4] and potential mechanisms explaining the damage are the effect of direct compression, ischemic insult or demyelination.[9] Visual outcomes in patients who underwent tumor resection by various transcranial approaches, were reported in the literature at various rates. Visual improvement reported in rates between 28%[23] to 84%,[21] and visual worsening between 0[9] to 13.5%.[4]

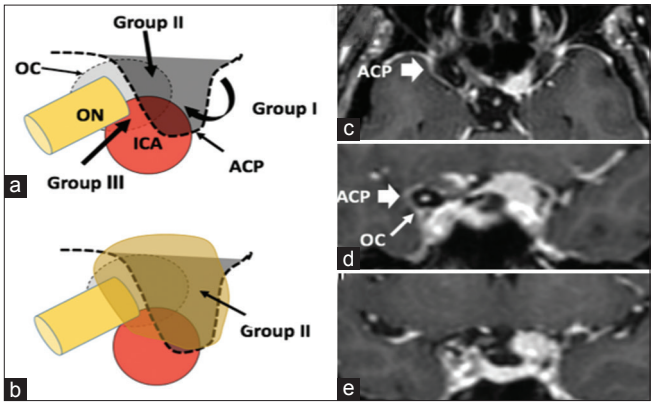

Figure 2: Subgroups of ACMs. (a and b), Schematic drawings illustrating the relation of the three possible groups of ACMs to the surrounding important anatomical structures, where group I are medial to the ACP, the most common group II (Orange shape) arising superiolaterally to the ACP and Group III arising from and extending to the optic canal region. (c) Axial and (d and e) coronal pre-operative brain MRI with contrast showing the right ACP (Thick white arrow), and right optic canal (Thin white arrow) comparing them to the left side with the comparative anatomy invaded by the tumor, in keeping with group II ACM. ACM: Anterior clinoidal meningiomas ACP: Anterior clinoid process, ICA: Internal carotid artery, OC: Optic canal, ON: Optic nerve

Table 1: Series of anterior clinoidal meningiomas approached transcranially in the literature

Author and Year	Cases	GTR	Complications				Recurrence†
			Visual outcome*		Mortality	CSF leak	
			Improved	Worsened			
Puzilli *et al.*,[22] 1999	33	18 (54.5%)	N/A		5 (15%)	0	5/19 (26%)
Cui *et al.*,[9] 2007	26	16 (61.5%)	16 (61.5%)	0	0	0	0
Pamir *et al.*,[21] 2008	43	39 (90.7%)	36 (84%)	N/A	0	0	4/43 (9.3%)
Bassiouni *et al.*,[4] 2009	106	62 (59%)	21/52 (40.4%)	7/52 (13.5%)	2 (1.9%)	4 (3.8%)	10/95 (10%)
Yang *et al.*,[26] 2010	53	38 (72%)	N/A		0	N/A	0
Romani *et al.*,[23] 2011	73	57 (78%)	11/39 (28%)	4/39 (10%)	3 (4%)	3 (4%)	3 (4%)
Attia *et al.*,[3] 2012	22	7 (30.4%)	12/18 (66.7%)	2 (11.1%)	0	8 (36.3%)	3 (13.6%)
Czernicki *et al.*,[11] 2015	30	19 (63%)	6/9 (66.7%)	1/9 (11.1%)	2 (6.7%)	0	2 (11.8%)

*In patients with preoperatively existing visual impairment; † Of followed up patients

Postoperative CSF leak rates ranged between 0[9,11,21,22] to 36.3%,[3] while case of mortality were reported from 0[3,9,21,26] to 15%.[22] Recurrence rates in followed up patients with variable follow up periods, ranged from 0[9,26] to 26%.[22]

Approaching suprasellar lesions through a purely endoscopic transnasal transphenoidal route is becoming an acceptable approach by many of the experts in the field, especially meningiomas. Upon reviewing the literature, we found that majority of studies addressing suprasellar meningiomas, are reporting tuberculum sellae and planum sphenoidale meningiomas specifically, where they were grouped with other anterior skull base lesions. A review article by Ditzel Filho *et al.*[12] found 29 studies where the endoscopic transnasal approach to tuberculum sellae meningiomas were reported, with a total of 203 patients operated. The rates of gross total resection ranged from 54% to 100%, with 19% rate of postoperative CSF leak reported as the most common surgical complication. The rates of visual deterioration postoperatively were reported at lower rates, 1.9% for transient deterioration and 1.3% for lifelong deficits.

Of the reviewed studies approaching anterior skull base meningiomas purely endoscopically, we were able to identify only two studies in which clinoidal meningiomas were included in the series of reported cases. Padhye *et al.*[20] included one case of ACM with their 15 reported meningioma cases, which was a revision case after a previous treatment with a craniotomy. It was measuring 1.5 × 1.2 × 0.7 cm, underwent a complete resection without postoperative complications or improvement in the preexisting visual impairment, and showed no recurrence upon follow up. In a later larger series of 37 cases conducted at the same institutes, 3 of them were clinoidal meningiomas.[5] No individualized details were provided concerning the characteristics of the cases or the postoperative results. One of the included ACMs in the series, which was large and had undergone a previous open approach, was complicated by mortality despite successful debulking and initial symptomatic relief.[5]

No reported series addressing the pure endoscopic transnasal suprasellar approach for ACMs exclusively, were found in literature. That might be explained mainly by the absence of consensus on the safety of approaching ACMs or suprasellar meningiomas that extend laterally to the ACP. Ottenhausen *et al.*[19] stated that meningiomas with lateral extension to the anterior clinoid may still be approached by an endoscopic transnasal technique, and such an anatomic location does not represent an absolute contraindication although a complete resection might not be possible. Koutourousiou *et al.*[15] suggested that meningiomas arising from the ACP should not be approached endoscopically, and that a transcranial approach would be suitable for such tumors extending lateral in relation to the ON. In our reported case, the lateral extension of tumor was not a limitation for gross total resection. This was facilitated by the utilization of the angled scope and dedicated endoscopic instrumentation.

A systematic review was carried out by Clark *et al.*[8] to compare the endoscopic transnasal approach to the transcranial approach for 49 and 412 tuberculum sellae meningioma patients, respectively. There was no significant difference in the rates of gross total resection between the two groups. The endoscopic transnasal approach cases, compared to the transcranial cases showed significantly higher rates of postoperative CSF leak, but higher rates of visual improvement on the other hand.[8]

When addressing the advantages of using the endoscopic approach, the visualization it provides with a panoramic view and a light source as close as

possible to the lesion, is superior to that provided by the microscope.[7] The endoscope allows for both early debulking and devascularization of the lesion with early ON decompression, without needing to retract the brain.[24] Postoperative CSF leak is a disadvantage of this approach, but the reported rates are improving and special emphasis is being directed towards skull base defects reconstruction.[24]

In the last 15 years, endoscopic skull base surgery has raised a growing interest in the neurosurgical community and nowadays is considered a sound alternative to "traditional" skull base surgery in several deep seated lesions, as a rule located in the central skull base. It is not unlikely that increasing experience and refinement of technology will help pure endoscopy to take over most of the space presently still taken by open skull base surgical approaches. However critical be the location, where lesion dissection would require delicate thus dangerous handling of critical neurovascular structure, should be still considered as a rule out of the competence of pure endoscopical procedures. Anterior clinoidectomy, which opens the view to cavernous sinus, medial ICA and optic nerve,[25] is a clear example of this. In any case, the authors honestly state that endoscopic removal is a quite exceptional evenience for clinoidal meningiomas.

CONCLUSION

Selected cases of ACMs, despite not being true midline lesions, can still be resected safely through a purely endoscopic transnasal suprasellar approach. Larger series addressing purely endoscopic approach for these types of meningiomas exclusively, separating them from the rest of anterior skull base meninigiomas, is mandated. Proper case selection should also be implied, to achieve the best possible outcomes.

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

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