

Extended Endoscopic Endonasal Approach to the Skull Base

Authors

O. L. Arbolay¹, J. G. González¹, R. H. González², Y. H. Gálvez³

Affiliations

¹Department of Neurosurgery, "Hermanos Ameijeiras" Hospital, La Habana City, Cuba

²Department of Anesthesiology, "Hermanos Ameijeiras" Hospital, La Habana City, Cuba

³Department of Maxillo-Facial Surgery, "Hermanos Ameijeiras" Hospital, La Habana City, Cuba

Key words

- skull base
- extended endoscopic endonasal approach
- tumor

Abstract

Objective: Different approaches to the skull base have been developed through the sphenoidal sinus. Traditional boundaries of the trans-sphenoidal approach can be extended in antero-posterior and lateral planes. We review our experience with the extended endoscopic endonasal approach in the first 12 cases.

Methods: We used the extended endoscopic endonasal approach in 12 patients with different lesions of the skull base. This study specifically focuses on the type of lesions, surgical approach, outcome and surgical complications.

Results: The extended endoscopic endonasal approach was used in 12 patients with the following lesions: 4 invasive adenomas to the

cavernous sinus, 2 clival chordomas, 2 craniopharyngiomas, 1 hypothalamic astrocytoma and 3 pituitary adenomas extended upon the tuberculum. Gross total resection was achieved in 8 cases (66.7%) subtotal resection in 3 and just a biopsy could be accomplished in the case with astrocytoma. This last patient developed meningo-encephalitis and died two weeks later.

Conclusions: The extended endoscopic endonasal approach is a promising minimally invasive alternative for selected cases with sellar, parasellar or clivus lesions. As techniques and technology advance, this approach may become the procedure of choice for most lesions and should be considered an option in the management of the patients with these complex pathologies by skull base surgeons.

Introduction

Approaches to different regions of the skull base have been developed in the last century. All of them have a high risk of mortality and morbidity. After introduction of modern CT and MRI techniques, surgeons have the possibility to plan and perform more precise surgery [1]. The trans-sphenoidal approach represents more than 95% of the operations whose target is the sellar region [2]. The microscopic trans-septal transsphenoidal approach is mostly used and it is safe and efficient, but the range of action offered by it is limited because in most cases lesions with extension to the clival, supra- and parasellar spaces cannot be treated directly. However, the endoscopic approach offers a wide angled view and brings the light directly to the target [3,4] and traditional boundaries of the trans-sphenoidal approach can be extended to other regions of the skull base including regions from the cribriform plate to the lower clivus and cavernous sinus [5–9]. Trans-sphenoidal trans-tuberculum, supra-

diaphragmatic and trans-clival approaches are used for lesions located in the skull base in an antero-posterior plane [10]. Other techniques such as the ethmoido-pterigo-sphenoidal approach, are employed for lesions situated laterally [11,12]. With these procedures the surgeon can safely reach and remove any lesion of the skull base but the preservation of neurological functions and a good quality of life should always be the goal. Achievement of complete tumor removal should not be attempted whenever severe a neurological deficit would be a consequence [1]. We reviewed our recent surgical results with the extended endoscopic endonasal approach in the first 12 cases.

Patients and Method

We used the extended endoscopic endonasal approach in 12 patients with lesions of the skull base at the "Hermanos Ameijeiras" Hospital between 2006 and 2007.

Bibliography

DOI 10.1055/s-0028-1119414
 Minim Invas Neurosurg 2009;
 52: 1–5
 © Georg Thieme Verlag KG
 Stuttgart · New York
 ISSN 0946-7211

Correspondence

O. L. Arbolay, MD, PhD

Department of Neurosurgery
 "Hermanos Ameijeiras"
 Hospital
 San Lazaro 701
 La Habana City
 Cuba
 Tel.: ■ ■ ■ ■
 Fax: ■ ■ ■ ■
 arbolay@infomed.sld.cu

Table 1 General data, symptoms, place of invasion, approach and outcome.

Pat. No.	Age/Sex	Type of lesion	Symptoms and signs	Approach	Outcome	% Residual lesion
1	35/M	Non-functioning pituitary adenoma with extension to lateral compartment of the cavernous sinus	Headache and III n. deficit	EPSEa	Relief of the symptoms	0%
2	36/F	GH-secreting adenoma with extension to lateral compartment of the cavernous sinus	Headache, acral grow and GH hormone elevated	EPSEa	Relief of the symptoms and significative reduce of the GH	<20%
3	28/M	GH-secreting adenoma with extension to lateral compartment of the cavernous sinus	Headache, acral grow and GH hormone elevated	EPSEa	Relief of the some symptoms and reduce to a half of the preoperative GH	20%
4	34/F	GH-secreting adenoma with extension to lateral compartment of the cavernous sinus	Headache, acral grow and GH hormone elevated	EPSEa	Relief of the symptoms and reduce to normal level of the GH	0%
5	37/M	Chordoma of the clivus	Headache and VI nerve deficit	TEEC	Relief of the symptoms	<20%
6	25/F	Chordoma of the clivus	Headache and VI nerve deficit	TEEC	Relief of the symptoms	0%
7	50/M	Non-functioning pituitary adenoma with extension to tuberculum sellar	Headache and bitemporal hemianopsia	TEETs	Relief of the headache and recovery of vision	0%
8	56/M	Non-functioning pituitary adenoma with extension to tuberculum sellar	Headache and bitemporal hemianopsia	TEETs	Relief of the headache and recovery of vision	0%
9	45/F	Non-functioning pituitary adenoma with extension to tuberculum sellar	Headache and bitemporal hemianopsia	TEETs	Relief of the headache and recovery of vision	0%
10	43/M	Non-functioning pituitary adenoma with extension to suprasellar space	Amaurosis of OD hemianopsia of OI	TESd	Recovery of OI vision	0%
11	60/M	Non-functioning pituitary adenoma with extension to suprasellar space	Headache and bitemporal hemianopsia	TESd	Relief of the headache and recovery of vision	0%
12	42/M	Hypothalamic astrocytoma	Headache	TESd	Died	>50%

Abbreviations: EPSEa = ethmoido-pterygo-sphenoidal endoscopic approach; TEETs = trans-sphenoidal endoscopic extended to tuberculum sellar; TEEC = trans-sphenoidal endoscopic extended to clivus; TESd = trans-sphenoidal endoscopic supra-diaphragmatic

The series included 3 pituitary adenomas invasive to the cavernous sinus (4 GH secreting with invasion of the antero-inferior and lateral compartments), 2 chordomas, 2 craniopharyngiomas, 1 hypothalamic astrocytoma and 3 non secreting pituitary adenomas with extension upon the tuberculum sellare. The study was focused on surgical approach and outcome. Everyone patient was informed about the method, objective of the surgery and gave informed consent.

Follow-up was done at three and six months after surgery with clinical and imaging assessments according to the disease. Surgical results were evaluated by magnetic resonance images (MRI) and CT scans in all the patients and classified according to the percent of residual tumor [12].

All the procedures were performed with two rigid 4-mm diameter and 18-cm length endoscopes, one of them with 0 degree and the other with 30 degree optics.

Results

General data, symptoms, place of invasion, approach and outcome are presented in [Table 1](#).

An ethmoido-pterygo-sphenoidal approach (EPSa) was used in 4 pituitary adenomas with invasion of the antero-inferior and lateral compartments of the cavernous sinus. Two chordomas were removed by approaches extended to the clivus whereas in 2 craniopharyngiomas and 1 hypothalamic astrocytoma, a supra-diaphragmatic approach was used. In 3 non-secreting pituitary adenomas with tuberculum extension, an extended approach to tuberculum of the sella was used ([Table 2](#)).

Table 2 Kind of lesions and surgical approach.

Lesions	No	Localization	Approaches
Adenomas	4	Cavernous sinus, lateral compartment	Ethmoido-pterygo-sphenoidal endoscopic approach
	3	Tuberculum sellar	Trans-sphenoidal endoscopic extended to tuberculum sellar
Chordomas	2	Clivus	Trans-sphenoidal endoscopic extended to clivus
Craniopharyngiomas	2	Suprasellar	Trans-sphenoidal endoscopic supra-diaphragmatic
Astrocytoma	1	Suprasellar (hypothalamic)	Trans-sphenoidal endoscopic supra-diaphragmatic
Total	12	–	–

Gross total resection was achieved in 8 cases (66.7%), and subtotal resection in 3 (25%). In the case with hypothalamic astrocytoma only a biopsy was performed (8.3%) ([Table 3](#)).

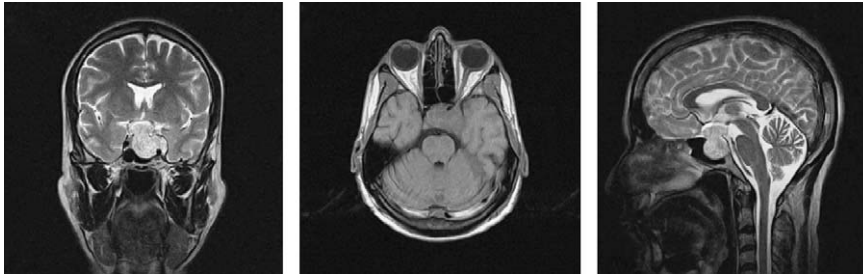
Intra-operative complications were not observed. Only one patient had a postoperative complication. This was meningitis in the patient with the astrocytoma who died 2 weeks later.

Discussion

Up to the 1970s, the cranial base has been approached by conventional techniques with prohibitive morbidity and mortality. Since them, several procedures were developed using the skull base itself as a route. This fact has improved both morbidity and

Table 3 Surgical results expressed by percent residual of lesions.

% Residual	Adenomas	Chordomas	Craniopharyngiomas	Astrocytoma	Total
radical, 0%	5	1	2	0	8
subtotal, 20%	2	1	0	0	3
partial <50%	0	0	0	0	0
insufficient >50%	0	0	0	1	1

**Fig. 1** Preoperative pictures of a pituitary adenoma with invasion of the cavernous sinus.**Fig. 2** Postoperative pictures of an pituitary adenoma with invasion of the cavernous sinus.

mortality, but introduced its own and still important kind of morbidity. With the development of minimally invasive cranial base approaches, endoscopic techniques have generated significant interest in the neurosurgical community [13]. More recently, the standard endonasal approach has been expanded to provide access to other parasellar lesions. With the addition of the endoscope, this expansion carries significant potential for the resection of skull base lesions. The natural extension may be to the anterior cranial base, the suprasellar cistern, as well as parasellar and clival regions [14]. The transtuberculum, supra-diaphragmatic and trans-clival trans-sphenoidal approaches as well as ethmoido-pterigo-sphenoidal approach have been described [12, 14–16]. In all of these approaches the modern MRI and CT scans are essential for planning and performing more precise surgery [1]. As the first step on the extended endoscopic approach and different from the endoscopic standard approach, we as well as other authors [10, 14, 17–19], enlarge the surgical corridor with resection of the middle turbinate, laterally of the contralateral middle turbinate and resection of the posterior portion of the nasal septum. This offers better visualization and facilitates the instrumentation while providing the possibility for a binasal approach [14]. We optimized the available space and place the endoscope superiorly at 12 o'clock, the suction tube at 6 o'clock in the right naris and the dissecting instruments between them via the other naris if this should be necessary as has been described by Kassam [14]. We continue with identification of the sphenoidal ostium and enlarge it in order to make the bilateral sphenoidotomies as wide as possible. We remove the sphenoidal rostrum commonly until the medial edge of pterygoid process. The bilateral sphenoidotomies are then the starting point of all subsequent expanded endoscopic approaches.

Frank and [12] stated that the aim of the extended endoscopic approach to the cavernous sinus is to confirm cavernous sinus invasion, to reach a histological diagnosis and to remove the tumor as radically as possible; in our series we achieve these objectives. We made 4 ethmoido-pterigo-sphenoidal approaches in patients with the tumor involving the antero-inferior and lateral compartments. We had 2 patients with GH-secreting adenomas in whom we achieved subtotal removal. In one of them, the tumor was not soft and the dissection was difficult. Postoperative studies showed residual tumor and elevated hormone levels. Another case showed a small residual tumor and a slightly elevated hormone level in the postoperative study. This patient received treatment with octreotide. In the other cases total removal was achieved. The extended endoscopic approach has increased the visualization, avoided blind curettage and allows safe and effective management of tumors in this region [10, 12, 14–19]. **Fig. 1 and 2** show preoperative and postoperative pictures of a pituitary adenoma with cavernous sinus invasion.

The trans-tuberculum approach was practiced on patients with non-secreting macroadenomas with significant supra-sellar extension in the tuberculum sellar. As has been described previously [10, 14], rostral exposure in our cases was carried out from the sella to sphenoidale planum. This allowed subsequent access to the supra-sellar portion of the tumor in the prechiasmatic cisterns. Total removal was achieved in all these cases.

The supra-diaphragmatic approach was done in patients with lesions with parasellar extension (2 craniopharyngiomas and 1 suprasellar tumor in which the anatomopathological study demonstrated hypothalamic astrocytoma). In these cases we began with debulking of the tumor, after which the endoscopic view facilitated extracapsular sharp dissection of arachnoid bands between the tumor capsule and the chiasm. This modus operandi has been cited by other authors [14, 20].

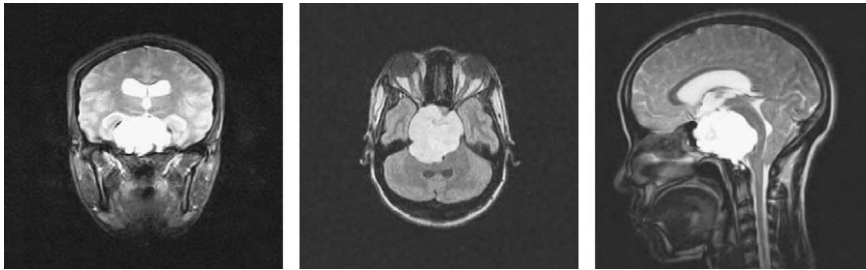


Fig. 3 Preoperative pictures of a chordoma.



Fig. 4 Postoperative pictures of a chordoma.

Especially in the case with the astrocytoma, vascular structures like the bilateral A1 segment, the communicating anterior artery and the bilateral A2 proximal segment, were identified along the interhemispheric fissure. In our opinion, the supradiaphragmatic approach is a useful technique and it is indicated in strictly median and supradiaphragmatic lesions, in patients with normally pneumatized sphenoidal sinuses.

The same as the other classical anterolateral, and posterolateral skull base approaches which are usually described for accessing extra-axial lesions ventral to the brainstem [21–29], the endonasal approach to the clival area has been used to remove clival chordomas [30–33]. Our two cases had boney destruction of the clivus related to the chordoma and this creates the surgical pathway making the trans-sphenoidal approach less difficult. Like others [15,34] we think that with this approach not only the upper two thirds of the clivus can be exposed, but also the entire lower skull base, down to the foramen magnum and even the odontoid process of C2. • **Fig. 3, 4** show preoperative and postoperative pictures of a clival chordoma.

Some complications have been associated with the extended endoscopic endonasal approach to the skull base [34]. Some of them such as surgical bleeding from vascular structures were not observed in our cases. The bleeding from the circular sinus of venous plexures on the dura mater was not significant and was resolved with bipolar cauterization. Postoperative CSF leakages, the most common complication related with these approaches, ranging from 1.5 to 6.4 [34], were not observed in our patient. We used an autologous fat graft and bone from the middle turbinated in order to make watertight seal; however 1 patient presented with meningitis and died some weeks later.

We think that avoiding brain retraction and reducing operative time are significant advantages of these approaches that reduce morbidity, however, the risk of cerebrospinal fluid fistula with subsequent meningitis remains as a major challenge.

We conclude that the extended endoscopic endonasal approach is a promising minimally invasive alternative for selective cases with lesions on sellar, parasellar or clival regions. As techniques and technology continues to develop these approaches could become the procedure of choice for the majority of these lesions and should be considered by

skull base surgeon as an option in the management of the patients with these complex pathologies.

References

- 1 Sami M. Common sense in skull base surgery. *Skull base an interdisciplinary approach 2007*; 17 (Supp. 1): 1
- 2 Jane JA, Laws ER. The surgical management of pituitary adenomas in a series of 3093 cases. *J Am Coll Surg* 2001; 193: 651–659
- 3 Mokry M, Stammberger H, Braun H. Endoscopic endonasal versus microscopic trans-septal trans-sphenoidal surgery of sellar neoplasms: experiences with the first 150 cases. *Skull Base An Interdisciplinary Approach 2007*; 17 (Supp. 1): 1
- 4 Knosp E, Wolfsberger S, Marhold F. Endoscopic trans-sphenoidal surgery in the sellar and parasellar region skull base an interdisciplinary approach. Supplement 1 2007; 17: 16
- 5 Amir R D, Ahmed G, Ian W. Expanded Endoscopic Endonasal Approach to Nonpituitary Skull Base Lesions: One-Year Surgical Experience in 22 consecutive Cases. *Skull Base An Interdisciplinary Approach 2007*; 17 (Supp. 1): 2
- 6 Divittis E, Cappabianca P, Cavallo LM. Endoscopic transsphenoidal approach: adaptability of the procedure to different sellar lesions. *Neurosurgery* 2002; 51: 699–705
- 7 Couldwell WT, Weiss MH, Rabb C et al. Variations on the standard transsphenoidal approach to the sellar region, with emphasis on the extended approaches and parasellar approaches: surgical experience in 105 cases. *Neurosurgery* 2003; 55: 539–547
- 8 Dusick JR, Exposito F, Kelly DF et al. The extended direct endonasal transsphenoidal approach for non adomatous suprasellar tumors. *J Neurosurg* 2005; 102: 832–841
- 9 Jho HD. Endoscopic endonasal skull base surgery for midline lesions from olfactory groove to distal clivus. In: 67th Annual Meeting of the American Association of Neurological Surgeons. New Orleans, Louisiana; 1999
- 10 Cappabianca P, Exposito F, Cavallo LM et al. Abordajes transnasales a la base de craneo. In: *Técnicas actuales en neurocirugía endoscópica*. Ediciones Guadalupe 2007; 1: 269–288
- 11 Frank G, Pasquini E. Endoscopic endonasal cavernous sinus surgery with special reference to pituitary adenomas. *Front Horm Res* 2006; 34: 64–82
- 12 Frank G, Pasquini E, Calbucci F. Endoscopic approach to the cavernous sinus via an ethmoido-pterigo-sphenoidal route. Paper presented at: 5th European Skull Base Society Congress; June 15–17, Copenhagen 2001
- 13 Pillai P, Ammirati M. Endoscopic craniobase neuroanatomy as observed through endonasal trans-sphenoidal approach using image guidance. *Skull Base An Interdisciplinary Approach 2007*; 17 (Supp. 1): 1
- 14 Kassam A, Snyderman CH, Mintz A et al. Expanded endonasal approach: The rostrocaudal axis. Part I. Crista galli to sella turcica. *Neurosurg Focus* 2005; 19 (1)

- 15 *Kassam A, Snyderman CH, Mintz A et al.* Expanded endonasal approach: The rostrocaudal axis. Part II. Posterior clinoids to foramen magnum. *Neurosurg Focus* 2005; 19 (1)
- 16 *Frank G, Pasquini E, Mazzatenta D.* Extended transsphenoidal approach. *J Neurosurg* 2001; 95: 917–918
- 17 *Cappabianca P, Cavallo LM, Divitiis E de.* Endoscopic endonasal transsphenoidal surgery. *Neurosurgery* 2004; 55: 933–940
- 18 *Cappabianca P, Divitiis E de.* Endoscopic and transsphenoidal surgery. *Neurosurgery* 2004; 54: 1043–1048
- 19 *Divitiis E de, Cappabianca P, Cavallo LM.* Endoscopic endonasal transsphenoidal approach to sellar region. In: de Divitiis E, Cappabianca P, eds. *Endoscopic endonasal transsphenoidal surgery*. Springer, Wien, New York; 2003; 91–130
- 20 *Frank G, Pasquini E, Doglietto F et al.* The endoscopic extended transsphenoidal approach for craniopharyngiomas. *Neurosurgery* 2006; 59 (Suppl. 1): ONS75-ONS83 16888556
- 21 *al Mefty O, Ayoubi S, Smith RR.* The petrosal approach: indications, technique, and results. *Acta Neurochir Suppl* 1991; 53: 166–170
- 22 *Chanda A, Nanda A.* Partial labyrinthectomy petrous apicectomy approach to the petroclival region: an anatomic and technical study. *Neurosurgery* 2002; 51: 147–160
- 23 *Cho CW, al Mefty O.* Combined petrosal approach to petroclival meningiomas. *Neurosurgery* 2002; 51: 708–718
- 24 *Kawase T, Shiobara R, Toya S.* Anterior transpetrosaltranstentorial approach for sphenopetroclival meningiomas: surgical method and results in 10 patients. *Neurosurgery* 1991; 28: 869–876
- 25 *Lakhdar A, Sami A, Naja A et al.* Kyste épidermoïde de l'angle pontocérébelleux. *Neurochirurgie* 2003; 49: 13–24
- 26 *Nakamura M, Samii M.* Surgical management of a meningioma in the retrosellar region. *Acta Neurochir* 2003; 145: 215–220
- 27 *Reisch R, Bettag M, Perneczky A.* Transoral transclival removal of anteriorly placed cavernous malformations of the brainstem. *Surg Neurol* 2001; 56: 106–116
- 28 *Sepehrnia A, Knopp U.* The combined subtemporalsuboccipital approach: a modified surgical access to the clivus and petrous apex. *Minim Invasive Neurosurg* 2002; 45: 102–104
- 29 *Seifert V, Raabe A, Zimmermann M.* Conservative (labyrinth-preserving) transpetrosal approach to the clivus and petroclival region – indications, complications, results and lessons learned. *Acta Neurochir* 2003; 145: 631–642
- 30 *Divitiis E de, Cappabianca P, Cavallo LM.* Endoscopic transsphenoidal approach: adaptability of the procedure to different sellar lesions. *Neurosurgery* 2002; 51: 699–707
- 31 *Kobayashi S, Takemae T, Sugita K.* Combined transsphenoidal and transoral approach for clivus chordoma. *No Shinkei Geka* 1984; 12: 1339–1346 [in Japanese]
- 32 *Laws ER.* Clivus chordomas. In: Sekhar LN, Janecka IP, eds. *Surgery of Cranial Base Tumors*. New York: Raven Press; 1993; 679–685
- 33 *Laws Jr ER.* Transsphenoidal surgery for tumors of the clivus. *Otolaryngol Head Neck Surg* 1984; 92: 100–101
- 34 *Cavallo L, Messina A, Cappabianca P et al.* Endoscopic endonasal surgery of the midline skull base: anatomical study and clinical considerations. *Neurosurg Focus* 2005; 19 (1)