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Endoscopic Endonasal Skull Base Surgery: Analysis of the Results in the Author's Initial 200 Cases

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Abstract

Background

Endoscopic endonasal approaches represent currently an important tool for approaching the skull base. The evolution of new techniques is based in the continuous acquisition of skills and abilities and it is paramount to determine the safety and effectiveness of new approaches. Based on that, the aim of this study is to analyze our results after the first 200 cases.

Material and methods

We performed a retrospective review of all cases operated on through an endoscopic endonasal approach in our Skull Base Unit, between January 2007 and May 2018. We analyze the results and all the per-operative complications associated.

Results

In this study we included 200 cases, comprising 105 female (52,2 %) and 95 male (47,5 %), with a mean age of 45,6 (range 21-85 years-old).

The most commonly reported pathology was the pituitary adenoma, comprising 121 cases (60,5 %), followed by 13 meningocele (6,5 %), 9 chordoma (4,5 %), 6 skull base meningioma (3 %) and 7 craniopharyngioma (3,5 %). 161 cases (81 %) represented first surgery.

The most frequently reported complication was diabetes insipidus in 17 % of all cases, followed by CSF leak, represented by 15 cases (7,5 %). 12 CSF leak cases were

successfully treated by external lumbar draining and 3 patients required second surgery to skull base repair. In the last 50 cases, only one CSF leak has been reported, representing an incidence of 2 %, successfully treated by endoscopic repair. This decrease in CSF leak represents the impact of the learning curve in skull base reconstruction. 5 % of patients suffered meningitis and 5 % presented permanent anosmia. In our serie we reported 1,6 % of transient neurologic deficit represented by oculomotor palsy and 1,6 % of permanent neurologic deficit due to infarction. 3 patients in this serie has died, two due to malignant ICA occlusion and 1 due to infection (overall mortality 1,5 %). The most commonly used approach was the transsphenoidal transsellar approach (58 %), followed by transplanum-transsphenoidal approach (8 %).

Gross total resection was achieved in 76 % of tumoral pathology, 71 % in cases of pituitary adenomas.

Conclusion

From this review we can conclude that, in our serie, endoscopic endonasal surgeries represent safe approaches to the skull base to a huge variety of pathologies. Progressive acquisition of skills and experience is paramount to improve the results, avoiding and reducing complications. Appropriate patient and pathology selection is also mandatory.

Keywords: Endoscopic Endonasal Approaches, Skull Base, Pituitary Adenoma, Minimally Invasive

Introduction

From the last years, there has been a growing interest in minimally invasive approaches in different fields of neurosurgery. Regarding skull base, this interest is focused in endoscopic endonasal surgery, with a broad spectrum of techniques and indications, in continuous evolution.

In every evolving procedure and technique is paramount to prove the safety, feasibility and efficacy, as well as progressive acquisition of skills and experience.

Currently, the classic transsellar approach has evolved towards more extended approaches, from anterior to posterior skull base, in the sagittal plane, as well as in the coronal plane.

Evolution and progressive extension of the approaches associate limitations and complications.

With this review our aim is to present our results after the first 200 cases operated on in our Skull Base Unit through an endoscopic endonasal approach, to analyze the results and the complications associated, as well as analyze the impact of the learning curve.

Material and Methods

We performed a retrospective review of prospectively collected data of all patients operated on through an endoscopic endonasal approach between January 2007 and May 2018 in our institution by the same group of surgeons.

This study collect the data from 200 cases, comprising 105 female (52,2 %) and 95 male (47,5 %), with a mean age of 45,6 (range 21-85 years-old). In all cases the patients underwent CT scan and MRI prior to surgery and after the procedure, endocrinological and ophthalmological examination (in case of clinical or radiological suspicion of optic nerve/optic chiasm compression).

We review all data regarding results, clinical outcomes (tumor resection, endocrine cure, vision results) and peri and postoperative complications in all cases, with the goal to identify minor and major complications, as well as mortality related to these approaches.

General surgical procedure

These approaches are performed by the same group of surgeons in our Skull Base Unit, composed by Neurosurgery and ENT.

In the operating room, after orotracheal intubation, the patient is positioned supine with Mayfield head-holder in case of optic neuronavigation is used. At the present time we normally use electromagnetic navigation. The head is slightly extended and rotated to improve the access to the surgeons. We normally prepare suprapubic area to get the fat graft if required at the end of the procedure and, in case of extended approach, we also prepare the left leg, so we can get fascia lata for skull base reconstruction if a high-flow intraoperative CSF leak is encountered.

The approach is started by the rhinologist (ENT), creating a binasal corridor, normally with medial right turbinectomy to improve the exposure, then they harvest the "rescue" Hadad nasoseptal flap, which is stored and protected in the nasopharynx until the end of the procedure. The exposure is completed through a posterior septectomy and bilateral esphenoidectomies and the sellar floor is reached. From this point the surgery varies depending on the approach and the pathology.

Pathology

In our series 81 % of cases represented first surgery.

The most commonly reported surgery has been pituitary adenoma with 60,5 % of cases (121), followed by meningocele with 7 % (13 cases), chordoma 5 % (9 cases) and non-traumatic CSF leak 4 % (8 cases). In Table 1 we can see represented the most commonly pathologies.

Table 1: Pathology

Pituitary adenoma	121 (60,5 %)
Meningocele	13 (6,5 %)
Chordoma	9 (4,5 %)
Non-traumatic CSF leak	8 (4 %)
Meningioma	6 (3 %)

Cranioyopharingioma	7 (3,5 %)
Inverted papilloma	6 (3 %)
Traumatic CSF leak	5 (2,5 %)
Postoperative CSF leak	4 (2 %)
Other (adenocarcinoma, orbit hemangioma, cavernous sinus hemangioma...)	10,5 %

Regarding pituitary adenoma in our serie 121 cases has been operated. The most common adenoma was non-functioning adenoma in 44 % of cases, followed by GH-secreting adenoma (24 %) and ACTH-secreting adenoma (20 %).

Regarding location, 45 % of cases showed suprasellar extension, 26 % were exclusively sellar adenoma and 25 % presented parasellar extension.

With respect to Knosp classification, the most commonly reported grade was grade 0 in 30 % of cases. 24 % represented invasive adenoma, grade 3 and 4 of Knosp classification.

8 cases presented with pituitary apoplexy.

Approaches and skull base repair

Regarding approaches, we divided between extended and non-extended approaches.

With respect to non-extended approaches, the most commonly used approach was the transsellar in 58 % of all cases, being the most frequent approach in general.

Extended approaches are represented in our serie by transplanum-transtuberculum, in 8 % of total cases, followed by transclival in 6 % of cases.

In the coronal plane, the most commonly used approach was the transptergoid in 7% of cases.

Regarding skull base reconstruction and closure, as mentioned before, at the first steps of the procedure we harvest the "rescue" Hadad nasoseptal flap and store it at the nasopharynx. We only complete the resection in case of need at the end of the procedure.

In most cases of a standard transsellar approach and in case of intact diaphragm and no evidence of CSF leak during the surgery, we only use hemostatic agents during closure.

In case of low-flow CSF leak observed during surgery, we complete the harvest of the Hadad nasoseptal flap and we also use a free fat graft for skull base reconstruction, in addition to hemostatic agents (after the fat graft).

In case of high-flow CSF leak observed during surgery or if we observe a big diaphragm defect, we implement a multilayer skull base reconstruction, since we use all the before mentioned in addition to two layers of fascia lata: one inlay and one onlay. In that case, fat graft is placed inside the defect and no hemostatic agents are placed between layers. We finish the reconstruction with the application of the nasoseptal flap with hemostatic agents to keep the layers in place.

Additionally, in these cases sometimes we put an external lumbar drain for two or three postoperative days and we remove it in case no CSF leak is observed during admission.

In all cases we apply Merocel at final steps of the surgery and we remove them after two or three postoperative days.

Results

In our serie we achieved gross total resection in 76 % of tumoral pathology, subtotal resection (greater than 80 %) in 16 % of cases, partial removal in 7 % and biopsy in 1 %.

Total extent of resection has been achieved in 71 % of pituitary adenomas, 85 % of meningiomas and

craniopharyngiomas, 67 % in case of chordomas (Table 2). Regarding extent of resection related to Knosp classification in case of pituitary adenomas, we found statistically significant difference between low Knosp grades and greater extent of resection, as expected.

Regarding endocrine response in case of functioning pituitary adenomas we achieved a complete secretion remission in 75 % of cases (hormone cure). Persistent hormone secretion has been identified in 23 % of cases and recurrence was observed in 2 % during follow-up.

With respect to visual outcome, 23 % of patients presented chiasm compromise in preoperative MRI. 60 % out of these patients showed visual field defects in preoperative campimetry.

4 % of patients who underwent surgery showed visual function worsening after the procedure. All these patients presented bilateral suprasellar tumor extension.

Complications

In our serie, the most commonly reported complication has been hormone dysfunction, in 23 % of cases. 17 % of total complications is represented by transient diabetes insipidus and 3 % by hypopituitarism. 5 % of patients suffered from permanent diabetes insipidus. We can see hormone complications represented in Table 2.

Table 2: Hormonal dysfunction

Transient Diabetes Insipidus	17 %
Hypopituitarism	3 %
Hypo + DI	2,5 %
Definitive DI	0,5 %

Table 3: Postoperative complications

Hormonal dysfunction	23 %
Post-operative CSF leak	7,5 %
Meningitis	5 %
Hemorrhage	4 %
Anosmia	5 %
Hydrocephalus	1,6 %
Oculomotor deficit	1,6 %
Infarction	1,6 %
Mortality	1,5 %

CSF leak has been reported in 7,5 % of cases in our serie (15 cases). Other reported complications are meningitis (5 %), anosmia (5 %) and hemorrhage (4 %). We reported hydrocephalus, focal motor deficit and infarction ni 1,6 % respectively (Table 3).

Overall mortality has been reported in 1,5 % in this serie (3 cases). Two cases due to ICA occlusion and malignant infarction. One due to ventricular hemorrhage plus meningitis and fulminant ventriculitis.

Regarding CSF leak, in our serie we reported 7,5 % of cases (15 patients), as showed in previous literature. 12 cases has been successfully treated through external lumbar drain and 3 cases required surgical repair.

8 cases of CSF leak presented bilateral suprasellar extension. The most commonly related to CSF leak approach has been the transtuberulum/transplanum in this serie.

On the other hand, most commonly related to CSF pathology has been pituitary adenoma, as expected, because this is the most frequently operated pathology.

Learning curve

In this study we tried to analyze the impact of the learning curve over the years [6], with the progressive acquisition of skills and experiences. With that in mind we divided the patients in two periods: first 5 years and last 5 years.

CSF leak incidence has decreased significantly, from 9,5 % to 7 %. Gross total resection in adenomas has also improved over the years, from 66 % in the first 5 years to 77 % in the last 5 years. Hormonal cure has been achieved in 83 % of all cases in the last 5 years, compared with 67 % during the first period (result statistically significant).

CSF leak in the last 50 cases of this serie has decreased dramatically, with only one case reported, requiring surgical repair.

Discussion

Endoscopic endonasal approaches to the skull base has experienced a great evolution in last decade, due to an increased interest in minimally invasive approaches. In any new and emerging field it is paramount not only the progressive experience, but also the review and report of results and complications associated, with the aim to check the efficacy and safety of new techniques.

Over the years, approaches centered in the sellar area have given way to more extended approaches in coronal and in sagittal planes. At the present time there are lots of pathologies we can approach through endoscopic endonasal surgery.

All of this carries some limitations and complications, so it is important to report and analyze these complications and compare with previous traditional approaches.

In this study we tried to expose our results and all perioperative complications associated with these approaches, taking into account the heterogeneity of pathologies and approaches. Given this heterogeneity, adenomas have been reviewed and reported separately.

CSF leak

CSF leak incidence after endoscopic transsphenoidal surgeries varies in the literature, ranging from 2 % to 13 %.

Over the years there has been an evolution towards better results regarding CSF leak. Feiz-Erfan *et al.* [2] reported in 2005 CSF leak rates after open approaches to the anterior skull base of 29%. Sekhar *et al.* [3], reported a postoperative CSF leak in 20.3% of patients

And Kassam *et al.* [1] reported in their first 800 cases a postoperative CSF leak rate of 15.9%.

In our serie, CSF leak was reported in 7,5 % of cases, with slight difference between the first 5 years (9,5 %) and the last 5 years (7 %).

We can see that the incidence of postoperative CSF leak decreased significantly with the adoption of different reconstruction techniques (vascularized tissue, multilayer reconstruction and others) and, in the last 50 cases, only one CSF leak has been reported (2 % of cases).

Some considerations must be taken into account. 8 of 15 cases of CSF leak were related to bilateral suprasellar extension (53 %) and 3 related to unilateral suprasellar extension. CSF leak incidence was also higher in case of extended approaches compared with pure transsellar approaches (8 cases versus 6 cases). The most commonly related approach was the transplanum/transtuberulum (8 of

16 cases, 50 %).

The most commonly related pathology was adenoma, but that can be explained because of adenoma is the predominant pathology in our serie (10 of 121, 8 % of adenomas).

12 of 15 cases were successfully treated with an external lumbar drain and 3 patients required endoscopic endonasal repair of the postoperative CSF leak.

As we mentioned before, the use of pedicled vascularized nasoseptal flap have decreased the incidence of postoperative CSF leak. At the present time at our institution we perform a multilayer reconstruction, depending on the extent of the approach and the flow of the CSF.

Kassam *et al* reported a significant decrease of CSF leak in case of craniopharyngiomas before an after the use of the nasoseptal flap, with a rate of 58% prior to the adoption of the nasoseptal flap vs a 5,56 % rate after that [1, 4].

Incidence of CSF leak is specially important regarding this kind of approach, playing an important role in length of stay and secondary complications as infections.

Infections

Postoperative meningitis may be a secondary complication of CSF leak. The incidence of meningitis after endoscopic skull base surgery ranges from 0,3 % to 5,5 % in the literature.

Kassam *et al* reported 1,8 % incidence of intracranial infections, more commonly associated with intradural procedures (6,7 %) [1, 5].

In our serie we reported 5 % of the cases. One of this patients suffered from a fulminant meningitis/ventriculitis and died. We didn't observe long-term sequelae related to infections.

Vascular complications

Vascular injuries are major complications regarding endoscopic endonasal skull base approach, with high morbidity and mortality related [9, 10, 11].

Kassam *et al.* [1] did not report vascular complications in cases of pure pituitary surgery (level II of complexity). They reported one case of P1 perforator avulsion during the dissection of a retroinfundibular craniopharyngioma through a transplanum approach. After that, they started the pituitary transposition technique to access dorsum sellae lesions behind the membrane of Liliequist.

Romero *et al.* reported in a retrospective review of 800 cases, 4 arterial injuries (0.5%). They also performed literature review with identification of 7336 patients, of which there were 25 arterial injuries, of which 19 were of the ICA, with total rate of arterial injury of 0.34% and rate of ICA injury of 0.26%. They conclude arterial sacrifice was the only reliable method for managing arterial injury.

Skull base approaches for excising chordomas and chondrosarcomas are associated with an incidence of vascular complications of 12% and 14%, respectively in the literature.

It is of utmost importance the preoperative planning regarding possible vascular concerns during the surgery and a multidisciplinary team approach, if needed (consider balloon test occlusion of the ICA, external CA control etc).

Not only major vessels injury is important, but also minor vessels injury may have greater consequences in patients.

In our serie, three patients presented major vascular complications. Two patients presented ICA occlusion with

malignant infarction and died. This two cases were operated during the first five years. No ICA injury was observed during the last 5 years of this serie. We highlight the need for ability to effectively and endoscopically manage injuries to major vessels in this approaches.

One patient suffered from artery of Percheron infarction after extended endoscopic endonasal approach for a pituitary macroadenoma, with subsequent rostral midbrain and paramedian thalami ischemia [7, 8]. This complication may be associated with extended endoscopic approaches when treating lesions with retrosellar extension. Every effort should be made to preserve the small perforating arteries. Intraoperative neurophysiological monitoring of the motor and sensory pathways may not detect damage to these small arteries.

Morbidity and mortality

Mortality related to endoscopic endonasal approaches is caused by vascular events or infectious complications, particularly meningitis.

Our data is comparable with data found in the literature, Kassam *et al* reported a mortality rate of 0,9 % [1].

In our serie we reported 1% (2 patients).

Regarding morbidity, we report permanent deficits in 3,2 % of patients, related to oculomotor palsy (1,6 %) and infarction (1,6 %).

5 % of patients presented permanent anosmia after surgery.

0,5 % of patients presented permanent diabetes insipidus.

After this analysis we report, in summary, 7,5 % cases of CSF leak, 5 % cases of meningitis, 1,6 % infarction, 1,6 % oculomotor palsy, 0,5 % permanent diabetes insipidus, 1 % of mortality rate. When compared with other serie we found that our results are favorable and comparable with traditional approaches in terms of efficacy and safety.

We reflect on this report the results during a 10 years time, highlighting the role of progressive acquisition of abilities and experience in our results, but we know we should always be cautious and take into account that complications may increase with the management of more complex cases.

Conclusions

After analyze all results obtained in our serie, we can conclude that endoscopic endonasal skull base approaches are effective and give good surgical results in experienced hands without significant incremented morbidity and mortality.

Learning curve has represented significant impact in our results during that period. Best resection, more hormone-rate remission and less complications were achieved with more experience by the surgeons.

References

1. Amin B Kassam, Daniel Prevedello M, Ricardo L Carrau, Carl H Snyderman, Ajith Thomas, Paul Gardner, Adam Zanation, Bulent Duz, S Tonya Stefko, Karin Byers, Michael B. Horowitz: Endoscopic endonasal skull base surgery: analysis of complications in the authors' initial 800 patients. 2011; 114(6):1544-1568. Doi: 10.3171/2010.10.JNS09406. Epub 2010 Dec 17.
2. Feiz-Erfan I, Han PP, Spetzler RF, Horn EM, Klopfenstein JD, Porter RW, *et al.* The radical transbasal approach for resection of anterior and midline skull base lesions. J Neurosurg. 2005; 103:485-

- 490.
3. Sekhar LN, Pranatartiharan R, Chanda A, Wright DC. Chordomas and chondrosarcomas of the skull base: results and complications of surgical management. *Neurosurg Focus*. 2001; 10(3):E2.
 4. Kassam AB, Thomas A, Carrau RL, Snyderman CH, Vescan A, Prevedello D, *et al*. Endoscopic reconstruction of the cranial base using a pedicled nasoseptal flap. *Neurosurgery*. 2008; 63(1Suppl 1):ONS44-ONS53,
 5. Hadad G, Bassagasteguy L, Carrau RL, Mataza JC, Kassam A, Snyderman CH, *et al*. A novel reconstructive technique after endoscopic expanded endonasal approaches: Vascular pedicle nasoseptal flap. *Laryngoscope*. 2006; 116:1882-1886.
 6. Varun R Kshetr, Hyunwoo Do, Khaled Elshazly, Christopher J Farrell, Gurston Nyquist, Marc Rosen, *et al*. The learning curve in endoscopic endonasal resection of craniopharyngiomas. *Neurosurg Focus*. 2016; 41(6):E9. Doi: 10.3171/2016.9.FOCUS16292
 7. Pereira MR, Hernández FM, Cortés CA. Artery of Percheron and Endoscopic Endonasal Surgery: Case Report and Review of the Literature. *Asian J Neurosurg*. 2020; 15(3):777-780. Doi: 10.4103/ajns.AJNS_370_19. PMID: 33145254; PMCID: PMC7591203.
 8. Aryan S, Sumit Thakar, Hegde AS. Artery of Percheron infarction after endoscopic pituitary surgery. *Acta Neurochir*, 2016. Doi: 10.1007/s00701-016-2925
 9. Oliver Chin Y, Ritam Ghosh, Christina Fang H, Soly Baredes, James Liu K. Jean Anderson Eloy. Internal Carotid Artery Injury in Endoscopic Endonasal Surgery: A Systematic Review. *Laryngoscope*. 2016; 126(3):582-590. Doi: 10.1002/lary.25748
 10. Becerra Romero A, Gangadharan J, Bander E, Gobin YP, Anand V, Schwartz TH. Managing Arterial Injury in Endoscopic Skull Base Surgery: Case Series and Review of the Literature. *Operative Neurosurgery*. 2017; 13(1).
 11. Rowan NR, Turner MT, Valappil B, Fernandez-Miranda, Wang EW, Gardner PA, *et al*. Injury of the Carotid Artery during Endoscopic Endonasal Surgery: Surveys of Skull Base Surgeons. *J Neurol Surg B Skull Base*. 2018; 79(3):302-308.