Extended Endoscopic Endonasal Approach to the Skull Base

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.
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.**

![Table 1](min159/31.12.2008/macmillan)

<table>
<thead>
<tr>
<th>No.</th>
<th>Age/sex</th>
<th>Type of lesion</th>
<th>Symptoms and signs</th>
<th>Approach</th>
<th>Outcome</th>
<th>% Residual lesion</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>35/M</td>
<td>Non-functioning pituitary adenoma with extension to lateral compartment of the cavernous sinus</td>
<td>Headache and III n. deficit</td>
<td>EPSea</td>
<td>Relief of the symptoms</td>
<td>0%</td>
</tr>
<tr>
<td>2</td>
<td>36/F</td>
<td>GH-secreting adenoma with extension to lateral compartment of the cavernous sinus</td>
<td>Headache, acral growth and GH hormone elevated</td>
<td>EPSea</td>
<td>Relief of the symptoms and significative reduce of the GH</td>
<td>&lt;20%</td>
</tr>
<tr>
<td>3</td>
<td>28/M</td>
<td>GH-secreting adenoma with extension to lateral compartment of the cavernous sinus</td>
<td>Headache, acral growth and GH hormone elevated</td>
<td>EPSea</td>
<td>Relief of the some symptoms and reduce to a half of the preoperative GH</td>
<td>20%</td>
</tr>
<tr>
<td>4</td>
<td>34/F</td>
<td>GH-secreting adenoma with extension to lateral compartment of the cavernous sinus</td>
<td>Headache, acral growth and GH hormone elevated</td>
<td>EPSea</td>
<td>Relief of the symptoms and reduce to normal level of the GH</td>
<td>0%</td>
</tr>
<tr>
<td>5</td>
<td>37/M</td>
<td>Chordoma of the clivus</td>
<td>Headache and VI nerve deficit</td>
<td>TEel</td>
<td>Relief of the symptoms</td>
<td>&lt;20%</td>
</tr>
<tr>
<td>6</td>
<td>25/F</td>
<td>Chordoma of the clivus</td>
<td>Headache and VI nerve deficit</td>
<td>TEel</td>
<td>Relief of the symptoms</td>
<td>0%</td>
</tr>
<tr>
<td>7</td>
<td>50/M</td>
<td>Non-functioning pituitary adenoma with extension to tuberculum sellar</td>
<td>Headache and bitemporal hemianopsys</td>
<td>TEel</td>
<td>Relief of the headache and recovery of vision</td>
<td>0%</td>
</tr>
<tr>
<td>8</td>
<td>56/M</td>
<td>Non-functioning pituitary adenoma with extension to tuberculum sellar</td>
<td>Headache and bitemporal hemianopsys</td>
<td>TEel</td>
<td>Relief of the headache and recovery of vision</td>
<td>0%</td>
</tr>
<tr>
<td>9</td>
<td>45/F</td>
<td>Non-functioning pituitary adenoma with extension to tuberculum sellar</td>
<td>Headache and bitemporal hemianopsys</td>
<td>TEel</td>
<td>Relief of the headache and recovery of vision</td>
<td>0%</td>
</tr>
<tr>
<td>10</td>
<td>43/M</td>
<td>Non-functioning pituitary adenoma with extension to suprasellar space</td>
<td>Amaurosis of OD hemianopsys of Ol</td>
<td>TEel</td>
<td>Recovery of Ol vision</td>
<td>0%</td>
</tr>
<tr>
<td>11</td>
<td>60/M</td>
<td>Non-functioning pituitary adenoma with extension to suprasellar space</td>
<td>Headache and bitemporal hemianopsys</td>
<td>TEel</td>
<td>Relief of the headache and recovery of vision</td>
<td>0%</td>
</tr>
<tr>
<td>12</td>
<td>42/M</td>
<td>Hypothalamic astrocytoma</td>
<td>Headache</td>
<td>TEel</td>
<td>Died</td>
<td>&gt;50%</td>
</tr>
</tbody>
</table>

Abbreviations: EPSea = ethmoido-pterigo-sphenoidal endoscopic approach; TEel = trans-sphenoidal endoscopic extended to tuberculum sellar; TEEC = trans-sphenoidal endoscopic supra-diaphragmatic

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).

**Discussion**

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

**Table 3** Surgical results expressed by percent residual of lesions.

<table>
<thead>
<tr>
<th>% Residual</th>
<th>Adenomas</th>
<th>Chordomas</th>
<th>Craniopharyngiomas</th>
<th>Astrocytoma</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>radical, 0%</td>
<td>5</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td>subtotal, 20%</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>partial &lt;50%</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>insufficient &gt;50%</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

**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.
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 Preoperative pictures of a chordoma.

Fig. 4 Postoperative pictures of a chordoma.

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
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