Minimally invasive endoscopic unilateral transsphenoidal surgery for pituitary adenomas

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Abstract. Minimally invasive endoscopic unilateral transsphenoidal surgery for pituitary adenomas.

Objective: The aim of this study was to analyse the results of minimally invasive endoscopic unilateral transsphenoidal surgery for pituitary adenomas.

Methods: A series of 83 patients presenting with a pituitary lesion was reviewed retrospectively. Surgical procedures were performed between February 2007 and December 2010. The extent of resection was evaluated on post-operative contrast-enhanced MRI. We also reviewed our complications and compared them with the literature.

Results: Our series included 10 micro- and 73 macro-adenomas, with cavernous sinus invasion in 60.3%. Fifty-three per cent were non-secreting. Complete resection of the macro-adenomas was achieved in 22.5% of the cases. Complications were as follows: 2 deaths (2.5%), 2 sinusitis (2.5%), 5 CSF leaks (6.2%), 1 meningitis (1.2%), 16 post-operative anterior lobe insufficiency (19.8%) and 4 persistent diabetes insipidus (4.9%). Thirty-seven patients (44.6%) presented with a compression of optical pathways with an improvement of visual acuity in 94.3%.

Conclusions: Purely endoscopic unilateral endonasal transsphenoidal adenoma resection is minimally invasive surgery leading to a good rate of gross total tumour resection and it is associated with a low complication rate.

Introduction

Pituitary adenomas are benign tumours representing 15% of all intracranial tumours and inducing either endocrine disorders (secret- ing adenomas), or a mass effect (non-secreting adenomas). Medical treatment represents the first choice for prolactinomas. Surgery is the gold standard for all other secre- ting and non-secreting adenomas.

Harvey Cushing was the first to suggest that a tumour could be associated with both pituitary hypo- and hypersecretion. In the early 20th century, the preferred approach for the resection of pituitary lesions was transcranial in the majority of cases. In 1907, Hermann Schloffer was the first to remove a pituitary tumour using a transsphenoidal approach. In the years that followed, Hirsch developed an endonasal trans- sphenoidal approach and Cushing a sublabial transsphenoidal approach. During the latter half of the 20th century, this technique was standardised by Dott, Guiot and Hardy. Guiot introduced fluoroscopy and, later, the use of the microscope.

In 1992, Jankowski introduced the endoscope for the resection of pituitary adenomas via a purely endonasal route. This procedure was standardised by Carrau, Jho and Cappabianca. In addition to its minimally invasive nature, this technique greatly reduced the duration of hospitalisation, as well as the possible damage caused to the nasal mucosa which was frequently encountered in previous techniques.

Furthermore, for about ten years now, intra-operative imaging has been performed to optimise the complete resection of these tumours.

In this retrospective study, we reviewed our minimally invasive interventions using a unilateral endoscopic endonasal approach and the special closure of the posterior wall of the sphenoid sinus in pituitary surgery. We analysed our results and compared them with the literature.
multidisciplinary team: an ENT surgeon and a neurosurgeon.

Surgery was considered when neuro-ophtalmological disorders were present (mass effect) or when the health of the patient could be compromised by the excessive secretion of pituitary hormones.

Endocrinological evaluation

An endocrinological assessment was made before each surgical procedure. It included a clinical evaluation involving the measurement of various hormones using a morning blood test: cortisol, adrenocorticotrophichormone (ACTH), dehydroepiandrosterone (DHEA), testosterone, oestradiol, prolactin (PRL), thyroid-stimulating hormone (TSH), free thyroxine, follicle stimulating hormone (FSH), and luteinising hormone (LH), insulin-like growth factor-1 (IGF-1), and 24-hour urinary free cortisol excretion.

Dynamic hormonal tests were performed in cases of Cushing syndrome, acromegalia or in cases of pituitary incapacity affecting at least one axis.

Ophthalmo logical and neurologi cal evaluations

A visual field examination (Goldman testing) was performed for each patient before and after surgery. The patients also underwent a complete neurological examination.

Pre-operative imaging

A pre-operative MRI was performed for every patient. This examination allowed us to classify the adenomas according to size and extent. We used a modified Hardy’s classification. Grade I corresponds to a microadenoma <10 mm, grade II is a non-invasive adenoma >10 mm, grade III relates to a local invasion (cavernous sinus) and grade IV to a diffuse invasion (cavernous sinus + other extrasellar location). Adenoma size was determined using the largest axis.

The choice of the nasal fossa to be used during surgery was based on patient anatomy and the location of the adenoma (pre-operative sinus CT scan).

Surgical technique

All the patients underwent the same surgical technique with support from neuronavigation and intra-operative MRI.

The patient was placed in the supine position on the operating table with the back elevated and the head tilted back. The patient’s head was then placed in a three-point head holder (Mayfield) and an intra-operative MRI (PoleStar® N20 Surgical MRI system. Medtronic™/StealthStation®) was performed with Gadolinium being injected, followed by the implementation of the neurosurgical navigation (Medtronic™/StealthStation®).

We used a rigid 30° angled endoscope 4 mm in diameter and 18 cm in length (Olympus True View Direct wide angle). The optic was directly connected to the head of the camera (Olympus True View OTH–S7H–VA). A Xenon light source (Olympus Visera CLV-S40) was also connected to a control unit (Olympus CV – 180).

The surgeon introduced neurosurgical cottonoids previously soaked with a solution of cocaine (400 mg in 4 ml of 0.1% adrena line) to relieve congestion in the selected nasal fossa. The space between the middle turbinate and the nasal septum was then gently widened to allow good visualisation of the superior turbinate and the sphenoidal meatus. The surgeon penetrated into the sphenoid sinus and resected the anterior wall unilaterally without crossing the midline using a 45° Kerrison rongeur.

After this wide unilateral sphenoidotomy, the anterior wall of the sellar region was opened, the dura was incised, and the adenoma was removed with specific curettes. Resection control was performed with the endoscope and then with intra-operative MRI. The dura was closed with a piece of bone (obtained during surgery) and Duraseal® only.

If no major bleeding was observed, no nasal packing was placed.

Post-operative follow-up

Endocrinological and ophthalmological follow-up was performed in the post-operative period. The success of the tumour removal was assessed using MRI findings with contrast obtained 3 months and then 1 year after surgery. The tumour was considered to be totally removed when MRI found no residual tumour.

Statistical analysis

All data are stated as mean ± standard deviation (SD). The statistical software used was SPSS 19.0 (SPSS Inc., Chicago, IL). The Fisher test and Student’s T-test were used, with P<0.05 being considered statistically significant.

Results

The study sample comprised 83 patients who underwent minimally invasive unilateral transsphenoidal surgery for a pituitary pathology.
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There were 44 men (53%) and 39 women (47%), and age varied from 23 to 85 years (50.07 ± 13.81 years). The mean size of the lesion was 22.81 ± 10.94 mm. Our series included 73 macro-adenomas (88%) with a majority of grade III and IV, in other words with invasion of at least one cavernous sinus (60.3%) (Table 1).

Fifty-three per cent of the patients presented with a non-functioning adenoma. On immunohistochemical analysis, 17 patients (20.5%) presented with multiple hormonal expression and 7 (8.4%) were uninterpretable. Those patients were reclassified according to clinical presentation (data in brackets) (Table 2).

There were 83 (100% total) resections at three months showed 24 complete resections (29.6%) and 57 partial resections (70.4%) with 50 patients presenting with at least one cavernous sinus invasion. A statistically significant correlation was found between Hardy grade and complete or partial resection (Table 3). This correlation was also found between size and resection. Indeed, the mean size for patients with complete resections was 16.02 mm, whereas in incomplete resections was 25.76 mm (P < 0.001; IC: 95%) (Table 4).

Clinical results

Ophthalmological

Thirty-seven patients (44.6%) presented with a compression of optical pathways, and there was an improvement of visual acuity in 94.3%. One patient had a temporary decrease of visual acuity with a complete recovery in connection with a spontaneous resolution of an intrasellar haematoma. Two patients (2.5%) with pre-operative visual disorders did not demonstrate post-operative improvement.

Hormonal secretion

The majority of adenomas were non-secreting. Sixteen patients had a panhypopituitarism before surgery. After surgery, ten patients had persistent panhypopituitarism.

Surgical complications (Table 5)

Intra-operative complications

Surgery on five patients was interrupted due to bleeding. Two patients died: one due to haemorrhaging from an ACA aneurysm, and another from the dissection of a...
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PCA. This case was the third surgery for a grade IV adenoma and there was probably a fibrosis between the artery and the adenoma. In two patients, surgery could not be completed because of their specific anatomy.

Post-operative complications

Endocrinological outcome: persistent diabetes insipidus was observed in four patients (4.9%). Sixteen patients presented with reduced activity in one or more axes (19.8%) with medical substitution treatment.

Infections: two patients (2.5%) developed a sphenoid sinusitis and one patient (1.2%) developed bacterial meningitis that was treated with antibiotics.

CSF leaks: we observed five CSF leaks (6.2%), two of which (2.5%) required a new endoscopic procedure to close the skull base.

Discussion

Purely endoscopic transsphe- noidal surgery has become the gold standard for pituitary lesions. It has a lot of advantages compared with the operating microscope: panoramic vision of the sphenoid sinus with a 30° endoscope that allows better visualisation of the various anatomical structures, particularly in corners; the elimination of the need for a speculum, considerably reducing nasal mucosa trauma and avoiding post-operative nasal packing.6,12-13

Endoscopic surgery seems to reduce the rate of post-operative complications and therefore the duration and cost of hospitalisation.7,10 On the other hand, in the beginning, 2D vision can be unsettling for the neurosurgeon, one hand is used to hold the endoscope leaving just one hand free, there is often clouding of the lens by blood, requiring frequent cleaning, and haemostasis is difficult.12

We observed 88% of macro-adenomas (grade II-IV) compared to 48.3 to 86% in the literature.1,10,14,15 We also found that 60.3% of the tumours invaded the cavernous sinus (grade III and IV) according to the criteria of Knosp et al.16 A complete resection of an adenoma invading the cavernous sinus is considered to be difficult. Our high number of grade III and IV tumours explains our low percentage for complete resection. In two recent publications, Nakao and Theodosopoulos found rates of 9.3% and 7.4% respectively for cavernous sinus invasion.17,18 They also managed to completely remove 51.3% and 72% of the grade II lesions respectively. In our series, this rate was 60.9%. In our series, 22.5% of macro-adenomas (Grades II to IV) were completely removed, compared to 47% and 66.7% in the two studies referred to. However, we were able to completely remove two grade III adenomas, which probably corresponds to a compression rather than an invasion of the cavernous sinus. Differential diagnosis between compression and invasion was difficult based on imaging.

Our results demonstrated that, in grade II adenomas, complete resection was not achieved as often as in the literature. In our series, the mean size of grade II adenomas was relatively high (20.22 ± 5.85 mm) compared with grade III (24.14 ± 7.42 mm). Adenoma size was not stated in the majority of

<table>
<thead>
<tr>
<th>Table 4</th>
<th>Resection depending on size</th>
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<tbody>
<tr>
<td>Complete resection at 3 months</td>
<td>Number</td>
</tr>
<tr>
<td>Yes</td>
<td>24 (29.6%)</td>
</tr>
<tr>
<td>No</td>
<td>57 (70.4%)</td>
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<tr>
<td>Total</td>
<td>81</td>
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P<0.001.

<table>
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<tr>
<th>Table 5</th>
<th>Surgical complications</th>
</tr>
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<tbody>
<tr>
<td>Complications</td>
<td>Number</td>
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<tr>
<td>Per-operative bleeding</td>
<td>5</td>
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<tr>
<td>Post-operative endocrinological</td>
<td>20</td>
</tr>
<tr>
<td>Persistent diabetes insipidus</td>
<td>4 (4.9)</td>
</tr>
<tr>
<td>One dysfunctioning axis</td>
<td>6 (7.4)</td>
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<tr>
<td>&gt;1 dysfunctioning axis</td>
<td>10 (12.4)</td>
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<tr>
<td>Post-operative oronasofacial</td>
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<tr>
<td>Sphenoid sinusitis</td>
<td>2 (2.5)</td>
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<tr>
<td>Post-operative CSF leaks</td>
<td>5</td>
</tr>
<tr>
<td>Secondary surgical revision</td>
<td>2 (2.5)</td>
</tr>
<tr>
<td>Meningitis</td>
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<tr>
<td>Death</td>
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Table 6
Post-operative complications

<table>
<thead>
<tr>
<th>Authors</th>
<th>meningitis</th>
<th>sinusitis</th>
<th>carotid injury</th>
<th>CSF leak</th>
<th>death</th>
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<tr>
<td>Gondim et al.(^1) 2010</td>
<td>2</td>
<td>5</td>
<td>3</td>
<td>8</td>
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<tr>
<td>Dehdashti et al.(^2) 2008</td>
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<td>Leach et al.(^3) 2010</td>
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<td>3</td>
<td>1</td>
<td>3</td>
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<tr>
<td>Present study 2011 (n = 83)</td>
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<td>0</td>
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</table>

n.a.: not available.

the series and so comparison is not easy.\(^7\) Our results confirmed the conclusions of Jain et al.,\(^9\) who specify that factors affecting the complete resection of the adenomas were: cavernous sinus invasion, size, and the consistency and location of the lesion.

Visual disorders were due to optic chiasm compression and were observed in 44.6% of all our cases and 50.7% of macro-adenomas. Improvement after surgery was observed in 94.3% of the patients. Xiang Zhang et al.\(^1\) and Theodosopoulos et al.\(^2\) state a post-operative visual improvement of 96.4% and 86.4% respectively.

Our results with this approach seemed to be similar to larger series (Table 6).\(^1,10,12,20,21\) Endocrinological complications were close to those generally published: we found 19.6% of permanent pituitary dysfunction as compared to the rates in the literature, which varies from 3% to 29.6%.\(^1,10,12,13,17,18,20\) Our rate of permanent diabetes insipidus (4.9%) was higher than in the literature (which ranges from 0% to 1.85%) but this could be explained by the hospitalisation of our patients in the endocrinological unit, who are under very close scrutiny.\(^1,10,15,17,21\)

Conclusions

The purely endoscopic transsphenoidal approach is currently the gold standard for pituitary adenomas. Our results are close to larger series in the literature. A single-nostril approach is feasible without complication and with excellent outcome. We believe that the results are better if a large bone window of the sella is established, allowing for wider and deeper visualisation. The learning curve, which is longer for neurosurgeons working alone, is considerably reduced in a multidisciplinary team (with ENT surgeons and neurosurgeons).

References


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