TUMOR

Endoscopic Endonasal Resection of Suprasellar Meningiomas: The Importance of Case Selection and Experience in Determining Extent of Resection, Visual Improvement, and Complications

Malte Ottenhausen[1], Matei A. Banu[1], Dimitris G. Placantonakis[5], A. John Tsiouris[4], Osaama H. Khan[6], Vijay K. Anand[2], Theodore H. Schwartz[1-3]

Key words
- Endonasal
- Endoscopic
- Suprasellar meningioma
- Transsphenoidal

Abbreviations and Acronyms
CSF: Cerebrospinal fluid
GTR: Gross total resection
MRI: Magnetic resonance imaging

From the Departments of [1]Neurological Surgery, [2]Otolaryngology, [3]Neurology and Neurosciences, Brain and Mind Institute, and [4]Radiology, Weill Medical College of Cornell University, New York-Presbyterian Hospital, New York, New York, USA; [5]Department of Neurosurgery, New York University, New York, New York, USA; and [6]Division of Neurosurgery, University of Toronto, Toronto, Ontario, Canada

To whom correspondence should be addressed: Theodore H. Schwartz, M.D.
[E-mail: schwarh@med.cornell.edu]

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■ OBJECTIVE: **Suprasellar meningiomas have been resected via various open cranial approaches. During the past 2 decades, the endoscopic endonasal approach has been shown to be an option in selected patients. We wished to examine the learning curve for parameters such as extent of resection, visual outcome, and complications.**

■ METHODS: **We retrospectively reviewed a consecutive series of patients in whom suprasellar meningiomas were resected via an endonasal endoscopic approach between 2005 and 2013 at our institution. After June 2008, our surgical technique matured. Using this time point, we divided our case series into 2 chronological groups, group 1 (n = 8) and group 2 (n = 12). This cut-off also was used to examine rates of gross total resection (GTR) and visual improvement. Case selection criteria in successful and unsuccessful cases were examined to determine important principals for case selection.**

■ RESULTS: **Mean patient age at surgery was 57.05 years (range, 31—81 years). Mean tumor volume was 11.98 cm^3 (range, 0.43—28.93 cm^3). Overall, GTR was achieved in 80%, and vision improved or normalized in 14 patients (82.4%) with no occurrence of postoperative visual deterioration. Rates of GTR increased from 62.5% (group 1) to 91.7% (group 2). Visual improvement increased from 75% (group 1) to 88.9% (group 2). Rates of cerebrospinal fluid leak were 25% in group 1 and 0% in group 2. Average follow-up was 51.5 month (range, 3—96 months).**

■ CONCLUSION: **Once the learning curve is overcome, surgeons performing endonasal endoscopic resection of suprasellar meningiomas can achieve high rates of GTR with low complication rates in well-selected cases.**

INTRODUCTION

Originating from limbus sphenoidale, tuberculum sellae, chiasmatic sulcus, and diaphragma sellae, suprasellar meningiomas represent approximately 10% of all intracranial meningiomas (1). Because they are benign, slow-growing tumors, the goals of treatment generally are complete resection with preservation or improvement of neurologic function. The traditional transcranial approaches such as the bifrontal, the unifrontal, the pterional, or the frontolateral approach (11, 19, 22) recently have been augmented by more-sophisticated transsphenoidal approaches that use either microscope (4, 7)- or endoscope (3-5, 9, 12, 14, 17)-based techniques.

With constant improvement in technique, instruments, and surgical experience, endoscopic endonasal approaches have proven to be safe and effective in carefully selected cases (6), offering the advantage of reduced brain retraction and minimal manipulation of neurovascular structures (10). Formerly reported high rates of cerebrospinal fluid (CSF) leaks have decreased dramatically (18).

In this report, we present our experience in a consecutive series of 20 patients with suprasellar meningiomas treated with resection through an endoscopic endonasal extended transsphenoidal, transplanum, transtuberculum approach (14, 21). Emphasis is placed on the learning curve and the increase in extent of resection, increase in visual improvement, and decrease in complication rates comparing the early to the later part of the series. The evolution of a variety of technical nuances is presented. Likewise, principals of case selection are discussed, specifically criteria that have been considered contraindications, such as optic canal invasion and a "cortical cuff" are examined to determine if they play a role in resection and complication rates. Some of these cases have been presented in previous publications (2, 14).

METHODS

Patients

Twenty consecutive patients with histologically confirmed suprasellar meningiomas were selected from a prospective database of a consecutive series of endonasal, endoscopic surgeries performed by the senior authors, an otolaryngologist, and a neurosurgeon from March 2005 to April 2013. Institutional review board approval was obtained from Weill Cornell Medical College for this study. Patients were divided into two groups. Starting in June 2008, we began closing the skull base by using a combination of the gasket seal and a nasoseptal flap and faded out the use of intracranial fat. Those operated on before this time period (n = 8) were labeled group 1. Those operated upon after this period (n = 12) were labeled group 2. Comparisons between the 2 groups were performed with the Fisher exact and Student *t* tests.

Clinical and Radiologic Evaluation

Medical records were retrospectively reviewed for medical history, physical examination, neurologic signs, visual function, operative reports, surgical technique, operative results, visual outcomes, and follow-up. Visual fields performed by a neuro-opthalmologist were compared preoperatively and postoperatively. Complete endocrinologic assessment of all pituitary axes were performed preoperatively and postoperatively. The diagnosis was made by magnetic resonance imaging (MRI) and histology. After surgery, all patients had an MRI scan with contrast, including a spoiled grass 1-mm coronal scan at 2 days and 3 months. The extent of resection was determined by a neuroradiologist, who performed volumetric calculations comparing preoperative spoiled grass images acquired for neuronavigation with postoperative images and classified as gross total resection (GTR), near-total resection (≥95%), or subtotal resection (≤95%).

Operative Approach and Closure

The details of the surgical approach are provided elsewhere (15, 23). However, the key technical achievements we adopted over time include the following.

1. More aggressive removal of the posterior ethmoids and selective resection of the superior turbinate and middle turbinate on the left side if the nasal corridor was limiting to adequate dissection with those structures present.
2. Removal of the rostrum of the sphenoid sinus to enlarge the working space.
3. Larger bone opening in the skull base, including the medial opticocarotid recess, the medial optic canal, and the planum sphenoidale up to the most anterior extent of the tumor.
4. The use of the radiofrequency monopolar ball electrode (Elliquence, Baldwin, New York, USA) to internally debulk and devascularize the tumor.
5. The use of bayoneted microsurgical instruments rather than pistol-grip instruments, which we believe is critically important to increasing fine control of the tips of the instruments. These instruments must be specially designed, such as the Sepehrnia (Karl Storz, Tuttlingen, Germany), the Evans "Rotatable" Endoscopic and Cranial Instruments Set (Mizuho America, Beverly, Massachusetts, USA), and The Stamm Skull Base Instrument Set (Medtronic, Washington, DC, USA).
6. More liberal use of a 30-degree scope during extracapsular resection of the superior and lateral components of the tumor.
7. The order of tumor resection—we begin with internal decompression, followed by finding the anterior margin of the tumor over the planum, where there is least chance of encountering a cortical blood vessel; extracapsular resection over the top of the tumor with a 30-degree scope back to the chiasm; using the superior margin to achieve extracapsular dissection of the lateral margin of the tumor off the optic nerve into the canal using a 30-degree scope; identification and preservation of the superior hypophyseal artery, which must be sharply dissected off the capsule of the tumor; and removal of the inferior and posterior midline aspect of the tumor off the stalk and away from the mammillary bodies using a 0-degree scope with resection of the diaphragma sellae.

Our closure techniques have also evolved over time, resulting in dramatically lesser rates of CSF leak. Earlier cases were closed by the use of buttressed fat grafts and tissue sealants. Starting in 2008, we began using a "gasket-seal" closure and then added a nasoseptal flap followed by tissue sealant and limited lumbar drainage for 24 hours. The evolution of this closure technique is also documented elsewhere in the literature (8, 16, 18, 20).

RESULTS

Clinical Presentation and Radiologic Findings

There were 20 patients in this cohort. Mean age at surgery was 56.5 years (range, 31–81 years). There were 6 men (30%) and 14 women (80%). Two patients had previous transcranial surgery, and 1 had previous transsphenoidal surgery with previous subtotal tumor resection. No patients had any previous radiation treatment. Preoperative symptoms included visual impairment only (50%), visual impairment and headaches (30%), visual impairment and panhypopituitarism (5%), headaches only (5%), and endocrine abnormalities only (5%). Table 1 provides an overview of the clinical symptoms.

MRI studies were performed preoperatively in every patient and evaluated by a radiologist who also determined the tumor volume. The mean tumor volume was 11.98 cm^3 (range, 0.43–28.93 cm^3). Mean tumor volume in group 1 was 11.92 cm^3 and in group 2 was 12.02 cm^3 (not significant). Seven (35%) of 20 meningiomas showed peritumoral edema. Nine (45%) meningiomas originated from the tuberculum sellae, 7 (35%) from the planum sphenoidale, 3 (15%) from both the tuberculum sellae and the planum sphenoidale, and 1 that was within the third ventricle (5%). The tumor was juxtaposed to the optic apparatus in all 20 patients. In no patients was a cortical cuff, defined as brain tissue separating the tumor capsule from vessels,

Table 1. Clinical Presentation

Symptoms	Number of Patients
Visual impairment and headaches	6 (30%)
Visual impairment and endocrine abnormalities	1 (5%)
Visual impairment only	10 (50%)
Headaches only	1 (5%)
None (tumor growth)	1 (5%)
Endocrine abnormalities only	1 (5%)