Endoscopic Pituitary Surgery: A 10-Year Experience

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Abstract

Background: Transsphenoidal surgery (TSS) is the primary treatment for pituitary tumors. Until 2016, microscopic sublabial TSS was performed for tumors of the pituitary gland. We took an X-ray at the time of operation to localize the sella floor and then used the microscope. Once we obtained the 3D endoscope, all surgeries are performed with the endoscope except for giant tumors requiring craniotomy.

Objective: To describe the clinical features, tumor characteristics, and surgical outcomes of 267 consecutive patients undergoing endoscopic transsphenoidal surgery over a 10-year period at a national neurosurgical referral centre, with reference to our prior microscopic institutional experience for contextual comparison.

Methods:We reviewed a total of 267 patients who underwent pituitary surgery between April 2016 and March 2026. Data were analyzed on age, sex, symptoms, tumor type, Knosp grading, and extent of resection. Before 2016, surgery was done with a microscope; after that, we used an endoscope.

Results: There were 120 males (45%) and 147 females (55%) with a mean age of 34 years. Headache was the most common (32%), followed by visual problems (24%) and amenorrhea/galactorrhea (22%). Acromegaly was present in 11%, and pituitary apoplexy in 6%. Non-functioning tumors (48%), prolactinomas 25%, and GH-secreting 22% were most common. Most tumors were invasive: Knosp 3A (39%), 3B (40%), and 4 (11%).

With an endoscope, complete removal was achieved in 88% of cases. Under the microscope (until 2016), it was 92%. The microscopic approach provides a slightly better visualization at the extent of the resection. Endoscopic surgery has shorter operative times, less blood loss, and better visualization during surgery.

Conclusion:Endoscopic pituitary surgery is safe and efficacious. Complete removal is a bit less efficient than the microscope, endoscope has clear advantages: (1) Less time, (2) less bleeding, (3) better intraoperative view. It is now our go-to method of treating most pituitary tumors.

Keywords:Endoscopic TSS; Microscopic TSS; Pituitary adenoma; Extent of resection; Knosp grading; Surgical outcomes

Introduction

Transsphenoidal surgery remains the standard surgical approach for pituitary adenomas and other sellar lesions. Historically, the microscopic transsphenoidal technique introduced by Hardy revolutionized pituitary surgery by providing a minimally invasive alternative to transcranial approaches[1]. Microscopic surgery utilizes an operating microscope to achieve magnified stereoscopic visualization through a sublabial or endonasal corridor. Although this method demonstrated favorable outcomes and low morbidity, visualization is restricted to a narrow linear field, limiting access to tumors with suprasellar or parasellar extension.

The introduction of endoscopic endonasal transsphenoidal surgery represented a major advancement in pituitary neurosurgery[2]. Unlike the microscope, the endoscope provides panoramic illumination and wide-angle visualization of the sellar region, allowing improved assessment of tumor margins and adjacent neurovascular structures[3]. Angled endoscopes further facilitate visualization around anatomical corners, making the endoscopic technique particularly useful for macroadenomas with suprasellar extension or cavernous sinus invasion[4].

Several comparative studies and meta-analyses have evaluated outcomes between endoscopic and microscopic approaches. Endoscopic surgery has been associated with higher rates of gross total tumor resection, improved visualization, shorter hospital stays, and better postoperative visual outcomes[4–5]. Additionally, the endoscopic approach avoids sublabial incisions and extensive nasal dissection, resulting in reduced postoperative discomfort and improved sinonasal

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recovery[6]. Tabaee et al. demonstrated that endoscopic pituitary surgery achieved effective tumor removal with low complication rates and favorable endocrine outcomes[7].

Despite these advantages, microscopic surgery continues to remain effective, especially in centers with substantial microscopic expertise. The microscope provides superior depth perception through binocular vision, which some surgeons consider advantageous during delicate dissection near critical neurovascular structures. Moreover, early experiences with endoscopic surgery reported increased rates of cerebrospinal fluid (CSF) leakage; however, advancements in skull base reconstruction techniques have significantly reduced this complication.

Current evidence suggests that both endoscopic and microscopic transsphenoidal surgeries are safe and effective procedures when performed by experienced surgeons. Nevertheless, the endoscopic approach has increasingly become the preferred technique because of its superior visualization, expanded surgical corridor, and minimally invasive nature[4–7]. The choice of surgical method ultimately depends on tumor characteristics, surgeon experience, and institutional preference.

Methods & Materials

This is a prospective study of endoscopic pituitary adenoma surgery and its degree of resection at the National Neurosurgical Referral Center (NNRC), National Academy of Medical Sciences (NAMS) Bir Hospital. The hospital obtained institutional review board (IRB) approval. Consent was obtained from patients who were able to communicate and from next of kin when they could not. This study included all histopathologically proven pituitary adenomas in this department. The study period was January 2016 to January 2026 (10 Years). Age, sex, clinical presentations, and neurological manifestations were documented. Outcome was evaluated by the extent of tumor excision at 3 months.

Definition of complete resection: Gross total resection (GTR) was defined as no residual tumor detectable on postoperative contrast-enhanced MRI, assessed by a neuroradiologist blinded to intraoperative findings. Subtotal resection (STR) was defined as any detectable residual tumor on postoperative imaging, irrespective of volume.

Timing of imaging: All patients underwent dedicated postoperative gadolinium-enhanced MRI of the sella and parasellar region at 3 months following surgery, in accordance with our institutional protocol. Early postoperative MRI (within 72 hours) was performed in selected cases where intraoperative findings suggested uncertain residual.

Imaging protocol: 3T MRI with dedicated pituitary sequences including thin-slice coronal and sagittal T1-weighted post-gadolinium images with a minimum slice thickness of 2mm was used throughout the study period.

Radiological confirmation: All EOR classifications were based on radiological reporting and were not derived from intraoperative surgeon assessment alone.

Knosp grading correlation: We have added a dedicated paragraph in the results section describing EOR stratified by Knosp grade, which demonstrates the expected inverse correlation between cavernous sinus invasion and complete resection rates.

Results

Some 267 patients underwent pituitary surgery between January 2016 and January 2026. (Figure 1) Of these, 120 men (45%), 147 women (55%); mean age of 34 years. (Figure 2).

Headache was the most common presenting symptom: 32% of patients reported it, followed by visual deficits at 24%, and amenorrhea/galactorrhea in 22%. Clinical acromegaly was present in 11% of cases, and pituitary apoplexy was reported at 6%. 5% of patients present with other presenting symptoms (Figure 3).

For tumor subtype, non-functioning pituitary adenomas were the most frequent lesions, contributing 48% of cases. Prolactinomas accounted for 25%, growth hormone–secreting adenomas 22%, and other-secreting adenomas 5% (Figure 4).

Most tumors were invasive at preoperative MRI according to Knosp grading. 39 percent of patients had Grade 3A tumors, and 40 percent had Grade 3B tumors, but only 11% had Grade 4 tumors. Ten percent of instances had lower-grade tumors (Grades 1 and 2) (Table 1)

Gross total resection in 88% of patients who underwent endoscopic transsphenoidal surgery, and subtotal resection in 12% (Table 2). Until 2016, pituitary surgeries were accomplished via the microscopic sublabial transsphenoidal approach, with intraoperative skull X-ray localization of the sellar floor. In this period, total resection was performed in 92% of patients.[8]

The microscopic approach demonstrated somewhat more extensive tumor removal, but the endoscopic approach showed shorter operative time (90 minutes vs 120 minutes), less intraoperative blood loss (50 ml vs 70 ml), and superior intraoperative visualization that contributed to better identification of tumor margins and surrounding structures.

The annual rates for pituitary surgeries increased annually over the study period and approached the highest values in 2026 (Figure 1)

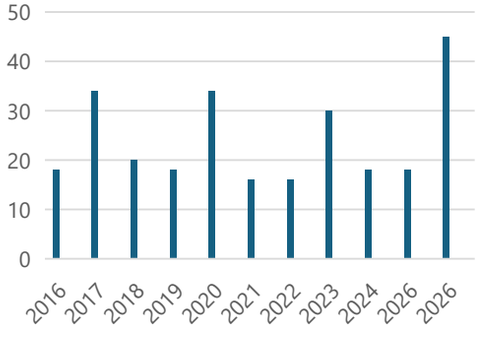

Figure 1. Year wise distribution

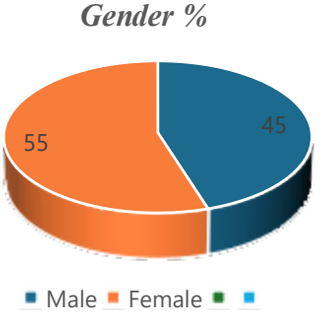

Figure 2. Gender

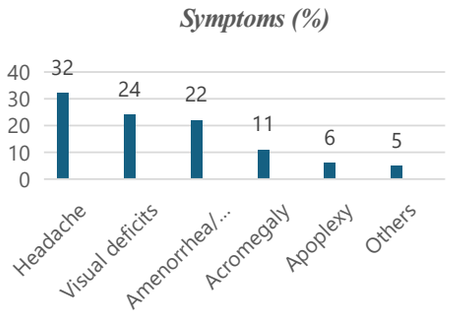

Figure 3.Symptoms

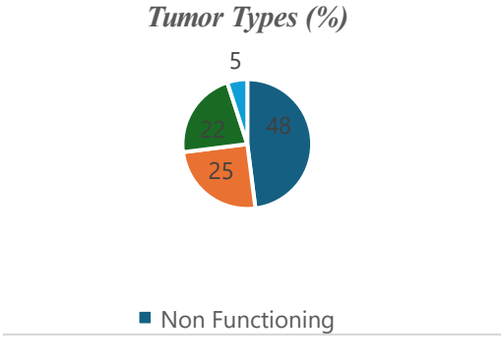

Figure 4.Tumor Types

Table 1.Knosp Classification

Grade	Description	No in %
1	Adenoma extends the medial line, but doesn't reach the median line	2
2	Tumor extends to the lateral aspects of ICAs.	8
3A	Tumor extends beyond lateral aspects of ICAs and into the superior cavernous sinus compartment.	39
3B	Tumor extends beyond lateral aspects of ICAs and into the inferior cavernous sinus compartment.	40
4	Tumor totally wraps around the intracavernous carotid artery.	11

Table 2.Extent of resection

Extent of Resection	Microscope	Endoscope
Complete	92%	88%
Incomplete	8%	12%

Comparison: Microscope (till 2016) vs Endoscopic (2016 onwards)			
Parameter	Microscopic Sublabial TSS (till 2016)	Endoscopic Endonasal TSS (2016 onwards)	Remarks
Extent of resection (complete Excision)	92%	88%	Microscope has little extra benefit in seeing extent of resection
Operative time	Longer (120 minutes)	Shorter (90 minutes)	Endoscopic approach takes less time
Intraoperative blood loss	More(70ml)		Blood loss is less in endoscopic
Intraoperative visualization	Limited (Straight line)	Wide angle, Panoramic (3D endoscope)	Better visualization and tumor identification with endoscope
Approach used	Microscopic sublabial TSS with intraoperative X-ray localization of sellar floor	Endoscopic Endonasal TSS (3 D / 2 D endoscope)	All surgeries after 2016 done with endoscope except giant adenomas

Discussion

Intracranial lesions arising from the pituitary region are relatively common, with pituitary adenomas (PAs) representing the most frequent benign tumors of the sellar region. Originating from adenohypophyseal cells, these lesions often exhibit significant suprasellar extension, which can complicate management[9-10]. The incidental detection rate of PAs in MRI and autopsy studies ranges from 14.4% to 22.5%, reflecting their notable prevalence[11].

Pituitary adenomas can exert mass effects on adjacent structures, including the sella turcica, dura mater, vascular components, cranial nerves, and surrounding brain tissue, resulting in diverse clinical manifestations. Large macroadenomas with suprasellar extension commonly produce visual field defects, particularly bitemporal hemianopia, due to compression of the optic chiasm and its crossing fibers. Management strategies are guided by both the hormonal activity and anatomical characteristics of the tumor, with primary goals including preservation or restoration of pituitary function, decompression of neural structures, and prevention of recurrence[12].

Over the past century, the treatment landscape for pituitary adenomas has evolved significantly. Advances in pharmacotherapy, hormone replacement strategies, surgical techniques, and radiotherapy have collectively improved clinical outcomes[13]. In particular, the advent of endoscopic endonasal transsphenoidal surgery has revolutionized pituitary surgery by providing a minimally invasive approach with superior visualization and surgical precision[14]. This technique has largely replaced traditional microscopic and open approaches, especially

in the management of large macroadenomas (>4 cm) requiring optic apparatus decompression. The extended endoscopic transsphenoidal approach allows for more extensive tumor resection while minimizing injury to surrounding structures[15]. Despite these advancements, achieving complete tumor resection while preserving critical neurovascular structures remains challenging, particularly in cases involving cavernous sinus invasion. The Knosp grading system is widely utilized to assess the likelihood of cavernous sinus involvement and to predict the extent of surgical resection. Understanding the relationship between Knosp grade and postoperative outcomes is essential for surgical planning and prognostication. Visual impairment is a common presenting feature in patients with pituitary macroadenomas; however, postoperative visual recovery is variable. Evaluating visual outcomes in relation to tumor invasion and resection extent may help predict postoperative improvement.

This study aims to evaluate the extent of tumor resection using the Knosp grading system following endoscopic transsphenoidal surgery for pituitary macroadenomas.

The transition from microscopic to endoscopic transsphenoidal surgery has significantly altered the surgical management of pituitary tumors over the last two decades. In this study, we analyzed our institutional experience with endoscopic pituitary surgery over a 10-year period and compared the outcomes with our previous microscopic approach. The findings demonstrate that endoscopic surgery provides effective tumor resection with additional operative advantages such as improved illumination, reduced operative morbidity, and shorter surgical duration.

The demographic distribution in our study revealed a predominance of young adults with a slight female majority. Similar demographic trends have been reported in large epidemiological studies of pituitary adenomas, particularly due to the high incidence of prolactin-secreting tumors among women of reproductive age[16]. The majority of patients in our series presented with headache and visual symptoms, which reflects the late presentation of macroadenomas producing compression of the optic apparatus and surrounding sellar structures[17]. Visual disturbance remains one of the most important indications for surgical decompression because prolonged optic chiasm compression may lead to irreversible deficits.

Our study demonstrated that non-functioning adenomas represented the largest tumor subgroup. These tumors are often diagnosed at a later stage because they lack early endocrine manifestations and usually become symptomatic only after significant tumor enlargement.[18] Growth hormone–secreting adenomas and prolactinomas were also frequently encountered, similar to patterns described in previous surgical series.

Most tumors in our cohort were invasive, with Knosp grade 3A and 3B lesions accounting for the majority of cases. Cavernous sinus invasion remains a major challenge in pituitary surgery because it limits the possibility of complete tumor excision while increasing the risk of injury to critical neurovascular structures[19] .Previous studies have shown that higher Knosp grades are associated with lower gross total resection rates and higher recurrence rates[20] .Therefore, the high prevalence of invasive adenomas in our study may explain the slightly lower complete resection rate observed in the endoscopic group.

Although microscopic surgery demonstrated a marginally higher complete excision rate in our earlier experience, endoscopic surgery offered superior intraoperative visualization. The panoramic endoscopic view and angled optics permit better visualization of hidden anatomical regions, especially suprasellar and parasellar extensions[21]. This expanded visualization enhances surgical confidence and may improve identification of residual tumor tissue during surgery. Furthermore, the endoscopic technique allows a more direct surgical trajectory with minimal nasal trauma.

Another important finding in this study was the reduction in operative time and intraoperative blood loss with endoscopic surgery. Similar benefits have been reported in comparative studies evaluating minimally invasive skull base approaches[22]. Reduced tissue handling and improved visualization contribute to more efficient tumor dissection and hemostasis. In addition, endoscopic surgery avoids sublabial incisions and extensive septal dissection, thereby improving postoperative recovery and patient comfort[23].

Despite these advantages, endoscopic surgery is technically demanding and requires specialized training. Loss of binocular depth perception and the need for two-dimensional orientation may initially increase surgical difficulty during the learning phase[24]. However, improvements in endoscopic instrumentation, neuronavigation systems, and skull base reconstruction techniques have substantially enhanced safety and reduced complication rates. The introduction of vascularized nasoseptal flap reconstruction has particularly reduced postoperative cerebrospinal fluid leakage, which was previously considered a major limitation of the endoscopic approach[25].

Our findings support the current trend toward endoscopic transsphenoidal surgery as the preferred approach for pituitary adenomas. While microscopic surgery remains an effective and reliable technique, the endoscopic method offers several practical and anatomical advantages that make it particularly suitable for invasive and anatomically complex tumors. Continued refinement of surgical techniques and long-term follow-up studies are necessary to further evaluate endocrine outcomes, recurrence rates, and quality of life following endoscopic pituitary surgery.

Complete tumor resection is not always achievable, and many patients require a multimodal treatment approach. This may include adjunctive medical therapy and adjuvant radiotherapy, such as fractionated stereotactic radiotherapy (SRT) or stereotactic radiosurgery (SRS), to ensure long-term disease control.

Conclusion

Overall comparison provides clear perioperative benefits of endoscopic endonasal transsphenoidal surgery versus the microscopic approach, including decreased operative time, a significant loss of blood, and a wider angle 3D visualization, giving better tumor identification. Despite having similar resection results (92% vs 88%), endoscopic techniques often result in greater efficiency and better safety for this type of tumor.

Our historical institutional comparison suggests a modest difference in complete resection rates between eras (92% vs 88%), which may reflect differences in case complexity, Knosp grade distribution, and surgeon learning curve rather than an inherent superiority of the microscopic technique.

This series contributes to the growing body of institutional evidence supporting the safe adoption and expansion of endoscopic transsphenoidal surgery in South Asian neurosurgical practice, and provides a foundation for future prospective comparative research.

Hence, endoscopic surgery is now the commonly used method for pituitary lesions, and microscopic studies are now generally performed in extremely small or massive tumors for which specific anatomical or technical considerations might be present.

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