Journal of Comprehensive Surgery

Original Article

DOI: 10.51271/JOCS-0068

Predictors of length of hospital stay after endoscopic transnasal pituitary surgery: a 5-year single-center retrospective analysis

Yaşar Ünsal*[1], Mustafa Özkan[2], Ayça Yılmaz[1], Mehmet Özgür Özateş[3]

[1]Department of Neurosurgery, Ankara Bilkent City Hospital, Ankara, Turkiye
[2]Department of Neurosurgery, Deva Hospital, Gaziantep, Turkiye
[3]Department of Neurosurgery, Faculty of Medicine, Ankara Yıldırım Beyazıt University, Ankara, Turkiye

Cite this article as: Ünsal Y, Özkan M, Yılmaz A, Özateş MÖ. Predictors of length of hospital stay after endoscopic transnasal pituitary surgery: a 5-year single-center retrospective analysis. *J Compr Surg.* 2026;4(1):5-9.

Received: 23.12.2025 ◆ **Accepted**: 17.01.2026 ◆ **Published**: 24.02.2026

ABSTRACT

Aims: To identify clinical, radiological, surgical, and postoperative factors associated with prolonged hospitalization following endoscopic transnasal/transsphenoidal pituitary surgery in a single tertiary neurosurgical center.

Methods: This retrospective observational cohort study included 40 patients who underwent endoscopic transnasal/transsphenoidal pituitary surgery between January 2020 and December 2024. Demographic, clinical, radiological, surgical, and postoperative data were collected from electronic medical records. Length of hospital stay was analyzed as a continuous variable and dichotomized based on the cohort median to define prolonged hospitalization. Variables that were significant or near-significant in univariate analyses were included in multivariable logistic regression models to identify independent predictors of prolonged hospital stay.

Results: A total of 40 patients were analyzed. Length of hospital stay did not follow a normal distribution, with a median length of stay of 8 days. In univariate analyses, suprasellar extension, postoperative cerebrospinal fluid leakage, and postoperative meningitis were significantly associated with prolonged hospital stay. Due to the strong clinical association between cerebrospinal fluid leakage and meningitis, these variables were not included together in the same multivariable model. After adjustment for Knosp grade, suprasellar extension remained an independent predictor of prolonged hospital stay (odds ratio: 11.1; 95% confidence interval: 1.03-119.5; p=0.04).

Conclusion: Suprasellar extension is an independent determinant of prolonged hospital stay following endoscopic transnasal transsphenoidal pituitary surgery. Preoperative radiological assessment may assist in anticipating postoperative care requirements and optimizing perioperative management strategies.

Keywords: Pituitary adenoma, endoscopic transnasal surgery, transsphenoidal surgery, length of hospital stay, suprasellar extension

INTRODUCTION

Pituitary adenomas account for approximately 10-15% of all primary intracranial tumors and represent a common pathology of the central nervous system.[1] Although typically benign, these tumors may cause significant neurological and endocrine morbidity due to mass effect, hormonal hypersecretion, hypopituitarism, or, less commonly, pituitary apoplexy. Except for prolactinomas, surgical resection remains the primary treatment modality for most pituitary adenomas.

Transsphenoidal surgery has long been considered the standard surgical approach for pituitary adenomas. Over the past two decades, endoscopic transnasal transsphenoidal techniques have largely replaced microscopic approaches.[2,3] Endoscopic surgery provides a wider field of view, improved access to parasellar and suprasellar regions, and comparable or lower complication rates. Consequently, endoscopic transnasal transsphenoidal surgery is widely accepted as a safe and effective technique for the surgical management of pituitary adenomas.[4]

Despite advances in surgical technique and perioperative care, postoperative complications such as cerebrospinal fluid leakage, meningitis, electrolyte disturbances, and diabetes insipidus remain clinically relevant. LOS reflects not only the occurrence of postoperative complications but also overall quality of care, efficiency of perioperative management, and healthcare resource utilization.[5]

Previous studies have evaluated factors associated with prolonged hospitalization after endoscopic pituitary surgery; however, reported results regarding the relative impact of radiological tumor characteristics and postoperative complications remain heterogeneous.[6-8] In addition, data derived from single-center cohorts outside high-volume referral institutions are limited. Recent data from 2025 suggests

*Corresponding Author: Yaşar Ünsal , yaasar40@gmail.com

that the definition of "prolonged" stay itself can alter which risk factors appear significant.[9] Furthermore, understanding local predictors is essential for implementing "Enhanced Recovery After Surgery" (ERAS) protocols effectively.[10]

Therefore, this study aimed to identify factors associated with prolonged hospital stay in patients undergoing endoscopic transnasal transsphenoidal pituitary surgery.

METHODS

The study was conducted with the permission of the Ankara Bilkent City Hospital Medical Research Scientific Researches Ethics Committee (Date: 12/24/2025, Decision No: TABED2/1774/2025). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.[11]

This study was designed as a single-center retrospective observational cohort study. Adult patients who underwent endoscopic transnasal transsphenoidal surgery for pituitary adenoma between January 2020 and December 2024 were retrospectively reviewed.

Patients aged 18 years or older with histopathologically confirmed pituitary adenoma who underwent endoscopic transnasal transsphenoidal surgery were included. Patients with incomplete medical records, pediatric patients, those who underwent transcranial or combined approaches, and revision surgeries following primary procedures performed at other institutions were excluded.

Demographic data, clinical presentation, radiological tumor characteristics, surgical details, and postoperative complications were obtained from electronic medical records and radiological databases. Radiological evaluation included tumor size, presence of suprasellar extension (defined as tumor extension above the diaphragma sellae), and cavernous sinus invasion assessed according to the Knosp classification. Knosp grades were dichotomized as low grade (0-2) and high grade (3-4) for analysis.

Postoperative diabetes insipidus was defined according to established clinical criteria, including polyuria with associated laboratory abnormalities and the need for desmopressin or fluid replacement therapy.[12] Hyponatremia was defined as a serum sodium concentration below 135 mEq/L.[13] Postoperative cerebrospinal fluid leakage was identified based on clinical rhinorrhea with or without biochemical confirmation. Postoperative meningitis was diagnosed based on clinical findings and laboratory evaluation.

The primary outcome measure was LOS, defined as the number of days from the day of surgery to discharge, inclusive. Length of stay was analyzed as a continuous variable and dichotomized according to the cohort median (>8 days) due to non-normal distribution.

Statistical analyses were performed using IBM SPSS Statistics software. Normality of continuous variables was assessed using the Shapiro-Wilk test. Continuous variables were presented as mean±standard deviation or median with range, as appropriate. Categorical variables were expressed as counts and percentages. Group comparisons were performed using Student's t test, Mann–Whitney U test, chi-square test, or Fisher's exact test, as appropriate. Variables with a p value less than 0.10 in univariate analyses were entered into multivariable logistic regression models. To avoid model instability and collinearity, postoperative cerebrospinal fluid leakage and meningitis were not included together in the same multivariable model. Results were reported as odds ratios (OR) with 95% confidence intervals (CI). A p value less than 0.05 was considered statistically significant.

RESULTS

A total of 40 patients were included in the analysis. The mean age was 54.4±13.5 years, and 60% of patients were male. The mean tumor diameter was 20.9±7.1 mm. Suprasellar extension was present in 77.5% of patients. According to the Knosp classification, 62.5% of patients had low-grade and 37.5% had high-grade cavernous sinus invasion.

LOS ranged from 3 to 23 days, with a median of 8 days. In univariate analyses, suprasellar extension, postoperative cerebrospinal fluid leakage, and postoperative meningitis were significantly associated with prolonged hospital stay (**Table 1**, **Table 2**). In multivariable logistic regression analysis, after adjustment for Knosp grade, suprasellar extension remained an independent predictor of prolonged hospital stay (OR: 11.1; 95% CI: 1.03-119.5; p=0.04) (**Table 3**).

Table 1. Demographic, clinical, and surgical characteristics of the study cohort (n=40)

Characteristic	Value
Age (years)	
Mean±SD	54.4±13.6
Range (minimum-maximum)	24-82
Gender, n (%)	
Male	24 (60.0%)
Female	16 (40.0%)
Comorbidities, n (%)	
Present	20 (50.0%)
Absent	20 (50.0%)
Tumor characteristics	
Maximum diameter (mm), mean±SD	20.9±7.1
Tumor functionality, n (%)	
Functional	20 (50.0%)
Non-functional	20 (50.0%)
Suprasellar extension, n (%)	
Present	31 (77.5%)
Absent	9 (22.5%)
Knosp grade, n (%)	
Low grade (0-2)	25 (62.5%)
High grade (3-4)	15 (37.5%)
Surgical data, n (%)	
Intraoperative CSF leak	4 (10.0%)
Reconstruction technique	
Nasoseptal flap	28 (70.0%)
Graft/none	12 (30.0%)
Length of stay (days)	
Median (range)	8.0 (3-23)

SD: Standard deviation, CSF: Cerebrospinal fluid

Table 2. Univariable analysis of factors associated with length of stay

Variable	n	Median LOS (days)	p-value
Gender			0.17
Male	24	8.0	
Female	16	8.5	
Comorbidities			0.31
Present	20	8.5	
Absent	20	8.0	
Tumor functionality			0.18
Functional	20	8.0	
Non-functional	20	9.0	
Suprasellar extension			0.02*
Present	31	9.0	
Absent	9	5.0	
Knosp grade			0.98
Low grade (0-2)	25	8.0	
High grade (3-4)	15	8.0	
Intraoperative CSF leak			0.24
Present	4	10.5	
Absent	36	8.0	
Reconstruction technique			0.12
Nasoseptal flap	28	8.5	
Graft/none	12	7.0	
Postoperative diabetes insipidus			0.37
Present	3	10.0	
Absent	37	8.0	
Postoperative hyponatremia			0.32
Present	3	11.0	
Absent	37	8.0	
Postoperative CSF leak			0.01*
Present	4	14.5	
Absent	36	8.0	
Postoperative meningitis			0.02*
Present	3	16.0	
Absent	37	8.0	

*LOS: Length of stay, CSF: Cerebrospinal fluid. Statistical significance tested using Mann-Whitney U test. p<0.05 indicates statistical significance

Table 3. Multivariable logistic regression analysis for predictors of prolonged hospital stay

Variable	OR	95% CI	p-value
Suprasellar extension	11.1	1.03-119.5	0.04*
Knosp grade	3.57	0.78-16.6	0.10

*Dependent variable: Prolonged length of stay (>median of 8 days). The Odds Ratio (OR) indicates the likelihood of prolonged stay compared to the reference group. p<0.05 indicates statistical significance, OR: Odds ratio, CI: Confidence interval

DISCUSSION

The primary objective of this 5-year retrospective analysis was to identify the determinants of hospital LOS following endoscopic transnasal pituitary surgery in a tertiary referral center. Our most significant finding is that suprasellar extension serves as the strongest independent predictor of prolonged hospitalization. The association between suprasellar extension and prolonged hospital stay may be attributed to increased surgical complexity and the need for more cautious postoperative monitoring, even in the absence of overt complications. Tumors with suprasellar extension often require extensive arachnoid dissection and diaphragmatic manipulation, prompting closer observation for potential delayed cerebrospinal fluid leakage, visual changes, or hypothalamic dysfunction. This contrasts with a substantial body of literature that prioritizes postoperative endocrine dysfunction as the main driver of delayed discharge.[6,7] Our results suggest that in developing centers with standardized endocrine protocols, the "anatomical burden" of the tumor dictates the recovery trajectory more than physiological variables.

The association between suprasellar extension and prolonged LOS (OR: 11.1) can be explained by several surgical and perioperative factors. Tumors extending into the suprasellar cistern often necessitate wider arachnoid dissection and manipulation of the diaphragma sellae to achieve gross total resection.[14] Even in the absence of an overt intraoperative cerebrospinal fluid (CSF) leak, surgeons tend to adopt a more cautious postoperative observation strategy for these patients due to the theoretical risk of delayed occult leaks or tension pneumocephalus.[4] Furthermore, patients with significant suprasellar extension require more intensive visual field monitoring and are at higher risk for transient hypothalamic dysfunction, which may subtlely influence discharge decision-making even if not capturing strictly defined complication criteria.[9] Guerra et al.[15] recently demonstrated that tumor characteristics, particularly those affecting surgical complexity such as suprasellar extension, were significantly associated with early versus late discharge patterns in pituitary adenoma patients undergoing endoscopic endonasal surgery, supporting our findings regarding the primacy of anatomical factors in determining length of stay.

Interestingly, neither diabetes insipidus (DI) nor hyponatremia emerged as significant predictors of LOS in our cohort. This finding diverges from the results of Vimawala et al.[6] and Bohl et al.,[7] who identified these complications as major contributors to delayed discharge. This finding may be explained by the presence of a well-coordinated perioperative endocrine management strategy at our institution, supported by close collaboration between neurosurgery and endocrinology teams in both the preoperative and postoperative periods. Early recognition and prompt ward-based management of fluid-electrolyte disturbances may mitigate their impact on discharge timing, even when such complications occur. More recently, Devarajan et al.[16] in a large single-center cohort of 310 patients similarly found that postoperative DI (p<0.01) was a significant predictor of prolonged length of stay, with a median stay of 54.9 hours in their series. We attribute this discrepancy to our institution's aggressive, ward-based management protocol for fluid-electrolyte disturbances. By enabling the administration of oral desmopressin and hypertonic saline in a non-ICU setting, we prevent the administrative delays often associated with endocrine monitoring. This supports the hypothesis by Gurses et al.[17] that optimized outpatient-focused care pathways can mitigate the impact of clinical complications on discharge timing.

Consistent with Shimanskaya et al.,[18] we found that postoperative CSF leak and meningitis were associated with the longest hospital stays (median 14.5 and 16.0 days, respectively). These complications invariably trigger a cascade of resource-intensive interventions, including lumbar drainage, prolonged bed rest, and intravenous antibiotic courses. Although the incidence of these complications

was low in our series, their profound impact on LOS underscores the critical importance of meticulous skull base reconstruction. The use of vascularized nasoseptal flaps in high-risk patients (suprasellar extension) is a key strategy to minimize these outlier events.

The concept of ERAS is gaining traction in skull base surgery. Recent data from Arnaout et al.[10] demonstrated that structured ERAS protocols could reduce the mean LOS to 2.7 days. Our median LOS of 8.0 days indicates a potential for improvement. While our discharge timing reflects the cautious approach of a developing center, the lack of significance for endocrine factors suggests that we are clinically ready to adopt more aggressive ERAS pathways. Future protocols targeting "early mobilization" specifically for patients with suprasellar extension could help bridge the gap between our current practice and high-volume centers.

Limitations

This study is limited by its retrospective design and the sample size of 40 patients, which resulted in wide CI for the odds ratios. Additionally, we did not account for the "learning curve" effect, which Kabil et al.[3] suggest can influence complication rates over time. Furthermore, our definition of prolonged LOS (>8 days) differs from some contemporary studies using >4 days (e.g., Vimawala et al.[6]) or varying thresholds as noted by Shah et al.,[9] which may limit direct comparisons. Nevertheless, our data provides a valuable "real-world" perspective on the factors influencing discharge in a non-high-volume setting.

CONCLUSION

Suprasellar extension is a robust and independent predictor of prolonged hospital stay following endoscopic transnasal pituitary surgery in our practice, overshadowing the impact of endocrine complications. While surgical complications such as CSF leak naturally extend hospitalization, they are less frequent than the routine delays caused by the observation of anatomically complex tumors. Our findings suggest that preoperative identification of suprasellar extension should trigger "pre-emptive" discharge planning.[19] Furthermore, the successful ward-based management of endocrine issues in our cohort supports the feasibility of implementing future ERAS protocols to safely reduce length of stay even in complex cases.

Further large-scale, multi-center prospective studies are warranted to validate these findings and to establish standardized discharge criteria for anatomically complex pituitary adenomas.

ETHICAL DECLARATIONS

Ethics Committee Approval

The study was conducted with the permission of the Ankara Bilkent City Hospital Medical Research Scientific Researches Ethics Committee (Date: 12/24/2025, Decision No: TABED2/1774/2025).

Informed Consent

As this was a retrospective study, formal written informed consent was not required and was therefore not obtained.

Peer Review Process

This manuscript was subject to external peer review.

Conflict of Interest

The authors declare no conflicts of interest related to this study.

Financial Disclosure

The authors received no financial support for the conduct or publication of this research.

Author Contributions

Concept: Y.Ü.; Design: Y.Ü.; Control: M.Ö.Ö. Y.Ü.; Data collection and/or processing: A.Y. Y.Ü.;; Analysis an/or interpretation: M.Ö. Y.Ü.; Literature review: M.Ö. Y.Ü.; Article writing: M.Ö. Y.Ü.; Critical review: M.Ö.Ö. Y.Ü.;

REFERENCES

1. Ezzat S, Asa SL, Couldwell WT, et al. The prevalence of pituitary adenomas: a systematic review. *Cancer*. 2004;101(3):613-619. doi:10.1002/cncr.20412
2. Gao Y, Zhong C, Wang Y, et al. Endoscopic versus microscopic transsphenoidal pituitary adenoma surgery: a meta-analysis. *World J Surg Oncol*. 2014;12:94. doi:10.1186/1477-7819-12-94
3. Cappabianca P, Cavallo LM, de Divitiis E. Endoscopic endonasal transsphenoidal surgery. *Neurosurgery*. 2004;55(4):933-941. doi:10.1227/01.neu.0000137330.02549.0d
4. Juraschka K, Khan OH, Godoy BL, et al. Endoscopic endonasal transsphenoidal approach to large and giant pituitary adenomas: institutional experience and predictors of extent of resection. *J Neurosurg*. 2014;121(1):75-83. doi:10.3171/2014.3.JNS131679
5. Cote DJ, Dasenbrock HH, Muskens IS, et al. Readmission and other adverse events after transsphenoidal surgery: prevalence, timing, and predictive factors. *J Am Coll Surg*. 2017;224(5):971-979. doi:10.1016/j.jamcollsurg.2017.02.015
6. Vimawala S, Chitguppi C, Reilly E, et al. Predicting prolonged length of stay after endoscopic transsphenoidal surgery. *Int Forum Allergy Rhinol*. 2020;10(6):785-790. doi:10.1002/alr.22540
7. Bohl MA, Ahmad S, Jahnke H, et al. Delayed hyponatremia is the most common cause of 30-day unplanned readmission after transsphenoidal surgery for pituitary tumors. *Neurosurgery*. 2016;78(1):84-90. doi:10.1227/NEU.0000000000001003
8. Webb KL, Reilly CE 3rd, Hinkle ML, Shinya Y, Van Gompel JJ, Meyer FB. Incidence and risk factors of hyponatremia after transsphenoidal surgery: a systematic meta-analysis. *Neurosurg Rev*. 2025;48(1):630. doi:10.1007/s10143-025-03784-8
9. Shah KH, Susic N, DiStefano NV, et al. Correlates of prolonged length of stay after endoscopic transsphenoidal surgery for pituitary adenomas: varying definitions and non-clinical factors. *Pituitary*. 2025;28(1):21. doi:10.1007/s11102-024-01483-z
10. Arnaout MM, Makia MA, Bessar AA, Elnashar I, ElSheikh MO. Road map to enhanced recovery protocol for endonasal endoscopic approach to pituitary adenomas: surgical short-term outcome and experience of a single ENT/neurosurgery collaboration. *Surg Neurol Int*. 2025;16:192. doi:10.25259/SNI_726_2024
11. World Medical Association. WMA Declaration of Helsinki–ethical principles for medical research involving human subjects. 2013.
12. de Vries F, Lobatto DJ, Bakker LEH, et al. Postoperative diabetes insipidus: how to define and grade this complication? *Pituitary*. 2021;24(4):604-611. doi:10.1007/s11102-020-01083-7
13. Cote DJ, Alzarea A, Acosta MA, et al. Predictors and rates of delayed symptomatic hyponatremia after transsphenoidal surgery: a systematic review [corrected]. *World Neurosurg*. 2016;88:1-6. doi:10.1016/j.wneu.2016.01.022
14. Hofstetter CP, Shin B, Mabray MC, et al. Endoscopic endonasal transsphenoidal surgery for functional pituitary adenomas. *J Neurosurg*. 2012;116(1):93-100. doi:10.3171/2011.1.FOCUS10317
15. Guerra GA, Prasad A, Shah I, et al. Associations between tumor characteristics, postoperative complications, and early versus late discharge after endoscopic endonasal pituitary adenoma resection. *Oper Neurosurg*. 2026;30(2):193-200. doi:10.1227/ons.0000000000001667

16. Devarajan A, Vasan V, Dullea JT, et al. Clinical and operative risk factors associated with prolonged length of stay after endoscopic pituitary adenoma resection. *Neurosurgery*. 2024;95(2):392-399. doi:10.1227/neu.0000000000002890
17. Gurses ME, Khalafallah AM, Gecici NN, et al. Optimizing outpatient neurosurgery: evaluating ambulatory surgery and same-day discharge following intracranial tumor surgery. *J Neurosurg*. 2024:1-9. doi:10.3171/2024.4.JNS24504
18. Shimanskaya VE, Wagenmakers M, Bartels R, et al. Toward shorter hospitalization after endoscopic transsphenoidal pituitary surgery: day-by-day analysis of early postoperative complications and interventions. *World Neurosurg*. 2018;111:e871-e879. doi:10.1016/j.wneu.2017.12.174
19. Agam MS, Zada G. Complications associated with transsphenoidal pituitary surgery: review of the literature. *Neurosurgery*. 2018;65(CN_suppl_1):69-73. doi:10.1093/neuros/nyy160.