ORIGINAL ARTICLES
PHILIPPINE JOURNAL OF OTOLARYNGOLOGY-HEAD AND NECK SURGERY VOL. 41 NO. 1 JANUARY – JUNE 2026

Outcomes of Endoscopic Endonasal Transsphenoidal Surgery of Pituitary Adenomas at the Philippine General Hospital

Kenny S. Seng, MD[*1,2]
Arsenio Claro A. Cabungcal, MD[*3]
Oliver Ryan M. Malilay, MD[2]
Anna Pamela C. Dela Cruz, MD[3]
Ronnie E. Baticulon MD, MS[1]
*Co-first Authorship; these authors contributed equally to the work

[1]*Division of Neurosurgery, Department of Neurosciences College of Medicine and Philippine General Hospital University of the Philippines Manila*

[2]*Section of Neurosurgery, Department of Surgery Jose R. Reyes Memorial Medical Center, Manila*

[3]*Department of Otolaryngology-Head and Neck Surgery College of Medicine and Philippine General Hospital University of the Philippines Manila*

ABSTRACT

Objective: To review the surgical outcomes of patients who underwent endoscopic endonasal transsphenoidal surgery (EETS) for pituitary adenomas in our institution and compare them with the results of previous studies.

Methods:

Design: Retrospective Review of Records
Setting: Tertiary National University Hospital
Participants: Records of 56 adult pituitary tumor patients who underwent EETS at the Philippine General Hospital in Manila, Philippines from January 2020 to December 2023 were retrospectively reviewed. Their age, sex, tumor size, presenting symptoms, resection rates, surgery duration and length of stay and complications were recorded. Multivariate linear regression analysis identified factors influencing rates of gross total resection (GTR), surgical duration and hospital stay.

Results: GTR was achieved in 82% (n=46/56). The median surgery duration was 260 minutes (IQR 160-329 minutes), and the median hospital stay was 10 days (IQR 19.75-23.25 days). Complications arose in 35.7% (20/56), commonly diabetes insipidus (25%, 14/56) and meningitis (3.6%, 2/56)), but there were no mortalities (0%, 0/56 at 24 months follow-up). No factors were associated with GTR. Galactorrhea ((β = 1.769, 95% CI: 0.531-3.007, p=.010) and tumor size up to 6 cm (β = 0.572, 95% CI: 0.076-1.068, p=.032) were associated with more than 400 minutes operative time. Preoperative visual loss was associated with shorter admissions (-7.4 days, 95% CI: -11.994, -2.853, days, p=.004), while preoperative seizures (+19.4 days, , 95% CI: 6.447-32.327, p=.007), hypercortisolism (+10.9 days, 95% CI: 0.700-21.130, p=.040), and acromegaly (+7.1 days, 95% CI: 0.723-13.523, p=.037) were associated with longer stays. Each centimeter increase in tumor size predicted an increase in hospital stay by 1.1 days (95% CI: 0.071-2.169, p=.049).

Conclusion: EETS for pituitary adenomas in the Philippines led to high rates of GTR and manageable complication rates compared to previous studies. However, longer operative times and hospital stays were observed, which may reflect local practices, logistics, and demographics. Improved surgical infrastructure and experience may further optimize outcomes.

Keywords: *pituitary tumor; surgical outcomes; endoscopy, endonasal; transsphenoidal approach; Philippines*

Correspondence: Dr. Arsenio Claro A. Cabungcal
Department of Otolaryngology-Head and Neck Surgery
College of Medicine and Philippine General Hospital
University of the Philippines Manila
Taft Ave., Ermita, Manila 1000
Philippines
Phone: +63 2 8554 8467
Email: aacabungcal@up.edu.ph

The authors declared that this represents original material that is not being considered for publication or has not been published or accepted for publication elsewhere in full or in part, in print or electronic media; that the requirements for authorship have been met by all the authors, and that each author believes that the manuscript represents honest work.

Disclosures: The authors signed a disclosure that there are no financial or other (including personal) relationships, intellectual passion, political or religious beliefs, and institutional affiliations that might lead to a conflict of interest.

Data Sharing and Availability Statement: Datasets are not publicly available because participants did not give written consent for their data to be shared.

Philipp J Otolaryngol Head Neck Surg 2026; 41 (1): 12-19

Pituitary tumors are the third most common adult intracranial tumor, with an incidence of up to 4.8 cases per 100,000 patient-years.[1,2] Symptomatic patients, except for those with prolactinomas, are initially managed with surgery.[3] The first large series of surgery for pituitary tumors was published by Cushing, who successfully used the sublabial transsphenoidal approach for more than 200 patients in the 1910s. The transsphenoidal approach was subsequently improved by the use of the operating microscope by Hardy in the 1960s and by the introduction of the endoscope by Jho and Carrau in the 1990s.[4,5] Since then, EETS has been used to address a variety of pathologies in both adults and children, including functional and non-functional pituitary tumors, meningiomas, craniopharyngiomas, skull base metastasis, and cerebrospinal fluid (CSF) leaks secondary to skull base trauma.[6-12]

In recent years, surgery for tumors located at the sellar area and anterior skull base has seen a significant shift in surgical approaches, from open access external approaches to microscopic approaches and then eventually towards minimal access endonasal endoscopic approaches to the anterior skull base.[4] Endoscopes, high definition 4K endoscopic cameras and monitors, navigation systems, dopplers, powered drills and shavers have allowed this shift. These equipment and instruments have provided better visualization and dissection despite smaller access corridors through the natural orifices of the nose. Angled scopes and instruments have empowered surgeons to dissect beyond what is seen through a microscope. Areas at the sides of and around corners of the tumor can now be easily seen and dissected with the use of these endoscopes.[13] Currently, both the microscopic sublabial and the endoscopic endonasal techniques are used for excision of pituitary tumors,[14-17] and a meta-analysis of randomized controlled trials has shown them to have comparable rates of visual field improvement, and similarly low rates of overall complications, cerebrospinal fluid (CSF) leak, diabetes insipidus (DI), meningitis, visual impairment, syndrome of inappropriate antidiuretic hormone secretion (SIADH), new onset hypopituitarism, and hypothyroidism.[18] The same study showed a trend towards better rates of gross total resection (GTR) in EETS compared to microscopic sublabial transsphenoidal surgery (MSTS), but this did not reach statistical significance (77.5% vs 58.7%; RR 1.21, CI 0.96-1.53, p=.11). However, a different meta-analysis showed that EETS was superior to MSTS in terms of GTR rates (71.8% vs 58.0%; OR 1.86, CI 1.36-2.54, p=.0001).[16] The two approaches have also been shown to have similar outcomes in terms of nasal symptoms.[20] A large national database study of 30,488 patients also showed endoscopic and nonendoscopic surgery for pituitary tumors to have similar GTR rates (71.0% vs 72.2%; OR 0.944, CI 0.837–1.064, p=.34).[21] However, EETS has many proven advantages over traditional MSTS, including shorter hospital stays, faster operation times and lower healthcare costs.[16,20,21]

This technique was only relatively recently adopted in the Philippines[22] and to the best of our knowledge, based on a search of HERDIN Plus, the Western Pacific Region Index Medicus (WPRIM), the Directory of Open Access Journals (DOAJ), MEDLINE (PubMed and PubMed Central), and Google Scholar using the search terms "endoscopic endonasal," "transsphenoidal ," " pituitary tumors," and "Philippines ," the effectiveness and safety of EETS for pituitary tumors in the Philippines has not been previously reported.

In this paper, we retrospectively review the surgical outcomes of patients who underwent EETS for pituitary adenomas in our institution, particularly extent of resection, complication rates, surgery duration, and length of hospital stay, and compare them with the results of previous studies. We also describe the operative technique at our institution.

METHODS

With University of the Philippines Manila Research Ethics Board approval (UPMREB 2024-0397-01), we conducted this single-center retrospective review of all adult patients who underwent endoscopic endonasal transsphenoidal excision of pituitary tumors at our institution from January 1, 2020 to December 31, 2023. The following were excluded: those who had previously undergone any surgery or radiotherapy for their pituitary tumor, those with any previous endonasal surgery, those with recurrent pituitary tumors, and those whose surgeries were performed by surgeons not involved in the study. This retrospective cohort study adhered to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.[23] *(Figure 1)*

All surgeries were performed at the Philippine General Hospital, a tertiary teaching hospital in Manila, Philippines. All procedures were performed and/or supervised by a team of neurosurgeons and otorhinolaryngologists led by the primary investigators (KSS and ACAC) and assisted by residents.

Surgical Approach

The major intraoperative steps are shown in *Figure 2.* A brief description of the operative technique follows:

After anesthesia induction, nasal decongestion was performed using oxymetazoline HCl 0.05% (ClariClear® Bayer Philippines) or 1:1000 epinephrine-soaked gauze tiny strips, the nares and field were prepped with an iodine-based solution, and preoperative intravenous antibiotics (ampicillin sulbactam 1.5 g IV 30 mins prior to cutting) were given.

The otolaryngologist–head and neck surgeon (ORL-HNS) initiated the procedure using a 0-degree 4 mm nasal endoscope (Karl Storz, Tuttlingen, Germany) paired with a high-definition endocamera system

Table 1. Baseline Characteristics of Patients

Characteristic / Variables	Number (%), unless otherwise specified
Presenting symptom	
Visual disturbance (blurring of vision, diplopia or hemianopsia	38/56 (67.9)
Headache	17/56 (30.4)
Acromegaly	3/56 (5.4)
Amenorrhea	1/56 (1.8)
Galactorrhea	1/56 (1.8)
Cushingoid facies	1/56 (1.8)
Polycystic ovarian syndrome	1/56 (1.8)
Seizures	1/56 (1.8)
Apoplexy	1/56 (1.8)
Visual Acuity	
Both eyes better than 20/200	30/50 (60.0)
One eye 20/200 or worse	17/50 (34.0)
Both eyes 20/200 or worse	2/50 (4.0)
Endocrinologic status	
Normal	37/49 (75.5)
Hyperprolactinemia	12/49 (24.5)
Hypercortisolemia	2/49 (4.1)
Preoperative maximal tumor diameter (cm)	Median 3.0, (IQR 1.7)
Giant pituitary adenomas	12/44 (27.2)
Mortality	0 (0)
Complications	20/56 (35.7)
Postoperative CSF leak	1/56 (1.8)
Epistaxis	1/56 (1.8)
Meningitis	2/56 (3.6)
Hypocortisolism	6/56 (10.7)
Transient DI	10/56 (18)
Permanent DI	4/56 (7.2)
Extent of resection	
Gross total resection	46/56 (82)
Subtotal resection	10/56 (18)
Subjective Improvement in visual function	45/56 (80)
Duration of surgery	Median 260 minutes (IQR 160-329 minutes)
Hospital stay	Median 10 days (IQR 8-15.5 days)
Subgroup with meningitis	21.5 days (IQR 19.75-23.25 days)
Subgroup without meningitis	10 days (IQR 8-14.5 days)

(Karl Storz, Tuttlingen, Germany) for enhanced visualization. The middle and inferior turbinates were bluntly lateralized, or the middle turbinate was resected at times, and approximately 1-2 ml of a prepared mixture of 5 ml of 2% lidocaine HCl (generic, Euromed Laboratories), 0.1 ml epinephrine (generic, Global Pharmatrade) 1:100,000 and 5 ml of sterile water for injection was injected into the septal mucosa to achieve local vasoconstriction and hydrodissection. A nasoseptal flap was then developed. A horizontal incision just below the sphenoid ostium, extending anteriorly towards the nares along the superior septum was created using a long, bent, fine-tipped cautery (Million Surgical, Pakistan). This superior incision in the septal mucosa was approximately 1–1.5 cm below the skull base to avoid injury to the olfactory nerves.

Subsequently, an inferior horizontal incision of the flap was created just above the nasopharynx and was carried to the septal mucosa, following the direction of the septum along its inferior junction with the nasal floor. The superior and inferior incisions were connected anteriorly near the columella to form a nasoseptal flap, which was then elevated in the subperichondrial layer, remaining pedicled posteriorly at the site of the sphenopalatine artery. A rescue incision using the same cautery tip, was performed on the contralateral septum, initiated just below the contralateral sphenoid ostium and carried anteriorly at the superior aspect of the nasal septum, ending approximately at the level of the head of the middle turbinate.

This approach effectively exposed the bilateral sphenoid ostia after a posterior septectomy. The sphenoid ostia were subsequently enlarged using 2 mm upbiting and downbiting Kerrison Rongeurs (Storz® USA) to facilitate the removal of the anterior walls of the sphenoid sinuses on both sides, including the resection of the rostrum and posterior septum, using a 3 or 4 mm diamond bur drill (NSK Primado, Nakanishi Inc, Tochigi, Japan), thus, creating a unified working space in the sphenoid sinus via bilateral nasal corridors. The extent of the required size of the nasal corridors dictated the resection of the superior and middle turbinates, as well as the posterior ethmoids as needed. Finally, mucosa and any bony septations within the sphenoid sinuses were excised.

At this point, the neurosurgeon assumed the primary role, while the otolaryngologist–head and neck surgeon (ORL-HNS) managed the endoscope, 0 and 30 degree endoscopes were used as needed. The sellar floor was opened using a 3 or 4 mm diamond bur drill (NSK Primado, Nakanishi Inc, Tochigi, Japan) along with Kerrison rongeurs, extending from the right to left carotid prominences, which was confirmed with the use of an ultrasound Doppler (Hadeco Bi-directional Doppler, Hadeco, Inc., Kawasaki Japan) and from the tuberculum sella to the clival recess. When available, navigational equipment (Brainlab Curve® Navigation, Brainlab SE, Munich, Germany) was utilized to confirm anatomical landmarks. The dura mater was incised sharply, allowing access for tumor removal through a combination of double suction and sharp dissection techniques. Extracapsular dissection was performed when feasible. Following tumor excision and descent of the diaphragma sella, a fascia lata with fat graft was applied only in the presence of cerebrospinal fluid (CSF) leaks. Gelfoam® (Pharmacia and Upjohn, Pfizer, NY, USA) was placed above the sella, subsequently covered by a nasoseptal flap. The flap was then covered all around with Surgicel™ absorbable hemostat (Ethicon, Johnson & Johnson, TX, USA). NETCELL® Epistaxis PVA nasal packing (Network Medical Products Ltd., UK) was utilized as needed.

Table 2. Multivariate analysis of preoperative factors on gross total resection, surgery duration and hospital stay

Variable	Gross total resection				Surgery duration				Surgery duration			
	Est	SE	T	P	Est	SE	T	P	Est	SE	T	P
Intercept	0.706	0.307	2.301	.028	0.141	0.323	0.437	.665	15.333	4.852	3.160	.005
Age	-0.002	0.005	-0.488	.629	-0.001	0.005	-0.223	.825	-0.059	0.052	-1.134	.269
Sex: Male	-0.100	0.145	-0.693	.494	0.249	0.152	1.633	.114	2.712	1.607	1.688	.106
Tumor Size: Up to 4cm	-0.205	0.378	-0.543	.591	-0.172	0.190	-0.905	.374				
Tumor Size: Up to 6cm	0.181	0.175	1.036	.308	0.572	0.253	2.264	.032				
Tumor Size: Greater than 6cm	0.253	0.237	1.067	.294	-0.237	0.370	-0.641	.527				
Symptom: Vision	0.173	0.173	0.998	.326	-0.129	0.205	-0.629	.535	-7.424	2.281	-3.254	.004
Symptom: Headache	-0.015	0.161	-0.091	.928	0.185	0.176	1.055	.301	-2.133	1.858	-1.148	.264
Symptom: Amenorrhea	0.181	0.485	0.373	.712	-0.264	0.468	-0.564	.577	-7.712	4.900	-1.574	.130
Symptom: Apoplexy	0.357	0.470	0.759	.454	-0.111	0.461	-0.241	.812	3.724	4.788	0.778	.445
Symptom: Acromegaly	0.287	0.340	0.844	.405	0.323	0.339	0.955	.349	7.123	3.195	2.229	.037
Symptom: Galactorrhea	0.091	0.653	0.139	.890	1.769	0.632	2.800	.010	-5.160	6.300	-0.819	.422
Symptom: PCOS	0.147	0.496	0.297	.769	-0.281	0.480	-0.584	.564	-3.612	5.009	-0.721	.479
Symptom: Seizures	-0.074	0.523	-0.141	.889	-0.774	0.498	-1.555	.132	19.387	6.456	3.003	.007
Hyperprolactinemia (> 19.4 ng/mL)	0.198	0.189	1.047	.303	0.164	0.182	0.905	.374	-0.395	2.063	-0.192	.850
Hypercortisolemia (>497 nmol/L)	0.115	0.580	0.198	.845	-1.084	0.566	-1.914	.067	10.915	5.212	2.094	.049
Visual acuity < 20/200	-0.171	0.158	-1.082	.287	0.192	0.158	1.222	.233	2.722	1.732	1.571	.131
Presence of any visual field cut	-0.623	0.486	-1.282	.210	-0.139	0.502	-0.277	.784	-6.680	5.253	-1.272	.217
Tumor Size, per additional cm									1.120	0.535	2.093	.049
Resection Type: Subtotal									-0.590	3.843	-0.153	.879
Resection Type: Gross total									-0.943	3.370	-0.280	.782
Surgery Duration									0.000	0.003	-0.071	.944
R^2	0.336				0.492				0.785			
Adjusted R^2	-0.050				0.140				0.590			
F Test	0.870			.614	1.396			.214	4.025			.001

Est = estimate, or β; SE = standard error, T = T-statistic, p = p-value. Tumor measurements are greatest diameter in cm.

Table 3. Comparison of results of our study with other studies done in our region

Study	Current Study	Keandongchun *et al* (2021)	Skulsampaopol, *et al* (2019)	Wongsirisuwan, *et al* (2014)	Saad, *et al* (2011)	Hong and Ho (1990)
Country	Philippines	Thailand	Thailand	Thailand	Malaysia	Singapore
Number of patients	56	126	100	38	25	40
Approach	EETS	EETS	EETS	EETS	Mixed*	MSTS
GTR	44 (83)	101 (80.2%)	43 (43%)	27 (73.7%)	12 (48%)	37 (93%)
Death	0	3 (2.4%)	0	1	0	0
CSF leak	1 (1.8%)	No data	3 (3%)	4 (10.6%)	1 (4%)	1
Meningitis	2 (3.6%)	7 (5.6%)	3 (3%)	0	No data	No data
Transient DI	10 (18%)	61 (48.4%)	No data	5 (13.2)	8 (32%) (unspecified if transient or permanent)	6
Permanent DI	4 (7.2%)	12 (9.5%)	No data	0		3
Duration of surgery	Median 260 minutes	Average 134 minutes	No data	Average 118 minutes	No data	No data
Length of hospital stay	Median 10 days	Average 13 days	No data	Average 7 days	No data	No data

GTR = gross total resection; tDI = transient diabetes insipidus; pDI = permanent diabetes insipidus, SD = surgery duration, HS = length of hospital stay
*18 of the patients underwent transcolumellar transsphenoidal hypophysectomy and 7 patients underwent transnasal transsphenoidal hypophysectomy

Data Collection

The electronic medical records database of the Philippine General Hospital was searched, and all records of patients who met the inclusion criteria during the study period were obtained. Only patients with histologically confirmed pituitary adenomas were included. The following information were collected from these records: age, sex, clinical symptoms (blurring of vision, visual field cuts, headache, amenorrhea, apoplexy, acromegaly, galactorrhea, PCOS, or seizures), radiologic preoperative and postoperative tumor size on magnetic resonance imaging (MRI) as measured by radiologists, location of the pituitary tumor, preoperative and postoperative endocrinologic status when available, preoperative and postoperative visual acuity as measured on a Snellen chart when available, duration of the surgery (from first incision to placement of the nasal pack), length of

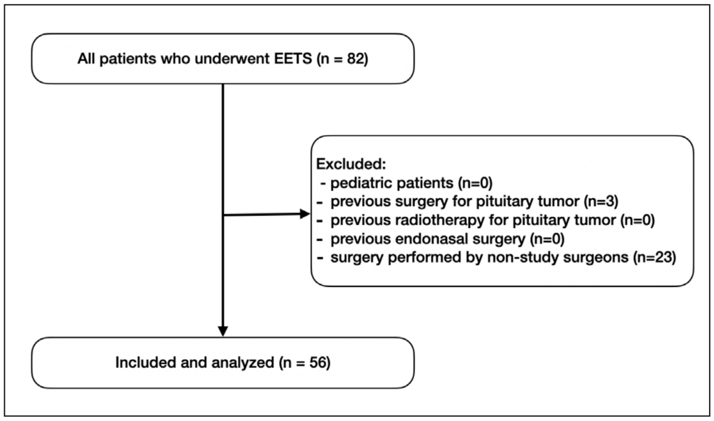

Figure 1. Flow chart summarizing patient selection

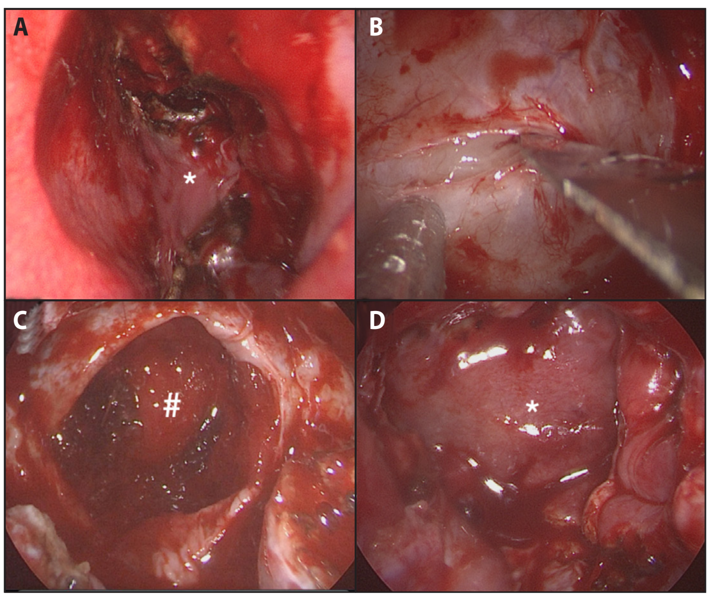

Figure 2. Intraoperative photos of the major steps in the procedure; all images were taken using a 0-degree 4mm scope; top of each image is patient's anterior, and left of each image is patient's left: **A.** After the middle and inferior turbinates were bluntly lateralized, horizontal incisions were made just below the sphenoid ostium and just above the nasopharynx, which were then connected anteriorly near the columella and elevated to form a nasoseptal flap (asterisk); **B.** The sphenoid ostia were exposed and enlarged to facilitate removal of the anterior sphenoid sinuses, followed by opening of the sellar floor from the right to left carotid prominences and from the tuberculum sella to the clival recess. The dura mater was incised sharply as seen in the photograph, and the tumor removed; **C.** The diaphragma sella (hash #) is visible following tumor excision; and **D.** Gelfoam was placed above the sella, which was subsequently covered by a nasoseptal flap (asterisk). The flap was then covered all around with Surgicel absorbable hemostat.

hospital stay, reconstruction with a nasoseptal flap, and post-operative complications (diabetes insipidus, cerebrospinal fluid leakage, meningitis, epistaxis, hypopituitarism).

The following definitions were used for this study. Resection rates were based on the postoperative MRI of the sella and pituitary gland at 3 months after surgery, with gross total resection defined as no enhancing tumor, whereas subtotal resection was defined as the presence of any enhancing residual tumor. A pituitary protocol was

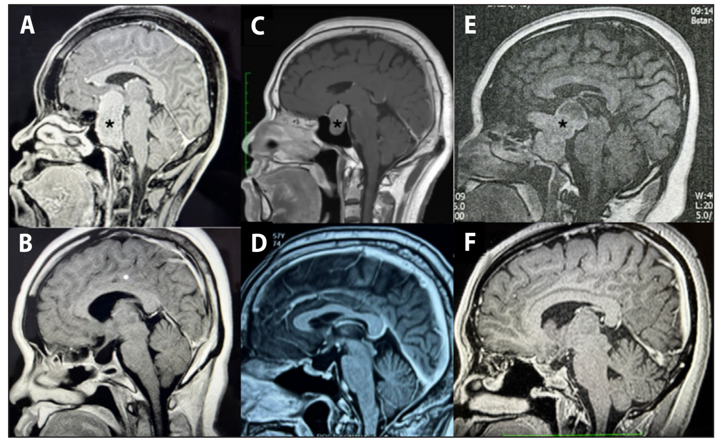

Figure 3. Representative cases, all tumors are marked with an asterisk **A.** preoperative MRI of a 39F with severe vision loss (light perception only) showing a 6cm pituitary tumor; **B.** her postoperative MRI showing gross total resection. Her visual acuity recovered to 20/100, but her hemianopsia did not improve; **C.** preoperative MRI of a 57M with vision loss (20/100 bilaterally) showing a 2.5cm pituitary tumor; **D.** his postoperative MRI showing gross total resection; his vision recovered completely; **E.** preoperative MRI of a 40F with severe vision loss (no light perception in the right eye, counting fingers in the left) showing a 5cm lobulated pituitary tumor; and **F.** her postoperative MRI showing gross total resection. Unfortunately, there was no improvement in vision after surgery.

used to identify early enhancement of the pituitary gland compared to tumor, but the amount of residual tumor was not quantified. Diabetes insipidus (DI) was defined as urine output of more than 2.5 mL/kg/hr, transient DI was defined as DI lasting for two weeks or less, whereas permanent DI was defined as DI lasting for two weeks or more. We attributed polyuria to DI, ruling out other polyuria-polydipsia states because none of the patients had polyuria-polydipsia preoperatively, and diabetes insipidus is the main cause of polyuria following pituitary surgery. Meningitis was defined as postoperative changes in sensorium with persistent fever and CSF pleocytosis, or a positive CSF culture study. Hypocortisolism was defined as serum cortisol levels less than 172 nmol/L.

Data Analysis

Each medical record was assigned a unique reference number at the start of the study to ensure anonymity. Data was collated and encoded using Microsoft Excel® for Mac version 16.99.2 (Microsoft Corp. Redmond, CA, USA). Descriptive statistics were calculated, including medians for surgery duration and length of hospital stay; multivariate linear regression was used to determine factors associated with gross total resection rates, length of hospital stay, and duration of surgery. Models for GTR, surgery duration and hospital stay were created using a stepwise regression process. Model building began with a model containing no regressors. Variables were then added one by one, with the selection guided by their relevance in existing literature and their contextual importance to the surgical setting of the study. This was chosen because, in total, there were 24 potential explanatory variables (including dummy variables) to be chosen from, with a limited sample size. This deliberate methodology ensures that not all predictors are entered into the model at once, resulting in more parsimonious and clinically meaningful final models while reducing the risk of spurious associations. We performed the Breusch-Pagan test (BPT) and calculated the variance inflation factors (VIF) for the models to determine if multicollinearity and heteroscedasticity were present. Race for Your Life R version 4.4.1 (R Foundation, Vienna, Austria) was used for statistical computations. Selection bias was addressed by including all patients who underwent surgery during the included dates. Given the retrospective nature of the study, the sample size was determined based on the number of eligible cases that met the inclusion criteria during the study period. Missing data were handled using pairwise deletion (based on available case analysis).

RESULTS

There were 82 patients who underwent EETS for pituitary adenoma during the study period. Twenty three (23) patients were excluded because their surgeries were done by surgeons not involved in the study, and three (3) were excluded because they had recurrent pituitary tumors. A total of 56 patients were included in the study. Of these, 31 (55.4%) were female, and 25 (44.6%) were male. Their ages ranged from 23 to 81 years of age, with a median of 45.5 (IQR 34-58.5). All patients had macroadenomas, defined as tumors larger than 1 cm.[3] The most common presenting symptom was visual disturbance (blurring of vision, diplopia or hemianopsia), which was reported by 67.9% of patients (38/56). Among those with preoperative visual examinations, vision loss was severe in one or both eyes in 38% of patients (19/50). Among those with preoperative endocrinologic examinations, the most common endocrinological dysfunction was hyperprolactinemia (12/49 or 24.5%). The median preoperative maximal tumor diameter was 3.0cm (IQR 2.3-4.0cm). Giant pituitary adenomas, defined as greater than 4 cm in any diameter, were present in 27% of patients (12/44). Characteristics are summarized in *Table 1;* representative cases are presented in *Figure 3*.

Surgical 0utcomes

The median operative duration was 260 minutes or 4 hours and 20 minutes (IQR 160-329 minutes). There were no mortalities among our patients at 24 months of follow-up. Meningitis occurred in 3.6% (2/56), hypocortisolism in 10.7% (6/56), rhinorrhea in 1.8% (1/56), epistaxis in 1.8% (1/56). Postoperative diabetes insipidus developed in 25.25% (14/56) of which 71% was transient (10/14). Most patients (80%, 45/56) experienced subjective improvement in their visual acuity. Gross Tumor Resection was achieved in 82% (46/56) of patients while the remaining 18% had a subtotal excision. The patients with meningitis were successfully managed with antibiotic treatment. The patient with CSF leak underwent reoperation, wherein the nasoseptal flap was taken down and returned after a multilayered repair was done using fascia lata graft and subcutaneous fat graft from the thigh. The median hospital stay overall was 10 days (IQR 8-15.5 days); for the subgroup with postoperative meningitis (n=3/56) the median hospital stay was 21.5 days (IQR 19.75-23.25 days) while for the subgroup without postoperative meningitis (n=53/56) the median hospital stay was 10 days (IQR 8-14.5 days).

On linear multivariate analysis, none of the patient factors were determined to be independently associated with GTR. Meanwhile, galactorrhea (β = 1.769, 95% CI: 0.531-3.007, p=.010) and tumor size up to 6cm (β = 0.572, 95% CI: 0.076-1.068, p = .032) were found to be associated with surgery longer than 400 minutes. Tumor size was associated with length of hospital stay, with each centimeter increase in tumor size predicting an increase in hospital stay by 1.1 days (95% CI: 0.071-2.169, p=.049). Finally, the presence of preoperative visual disturbance symptoms was associated with shorter hospital stays (-7.4, 95% CI: -11.994, -2.853, days, p=.004), while preoperative seizures (+19.4 days, CI: 6.447-32.327, 95% CI: p=.007), hypercortisolism (+10.9 days, 95% CI: 0.700-21.130, p=.040), and acromegaly (+7.1 days, 95% CI: 0.723-13.523, p=.037) were noted to be associated with longer hospital admissions. The models for GTR (R^2 = 0.336, adjusted R^2 = -0.050, fit test = 0.870, p = .614) and surgery duration (R^2 = 0.492, adjusted R^2 = 0.140, fit test = 1.396, p = . 214) were not significantly able to explain the variances in their respective variables, but the regression model for hospital length of stay was statistically significant and had a strong fit (R^2 = 0.785, adjusted R^2 = 0.590, fit test = 4.025, p = .001). *(Table 2)* For the GTR model, BPT statistic was 2.7352 (p=.4343), and all VIF <5; for the surgery duration model BPT statistic was 1.0691 (p=.9568), all VIF <5; finally, for the hospital stay model BPT statistic 29.314 (p = .0612), all VIF <5 except for visual acuity < 20/200 and visual field cuts with a VIF of 5.52).

DISCUSSION

In this study, we were able to achieve a GTR in 82% of patients, which compares favorably with the results of the previous studies mentioned earlier (71.8% and 77.5%) and supports the current opinion that EETS is superior to MSTS in terms of resection rates.[16,18] We were also able to achieve low rates of CSF leaks (2% vs 9.6%) but higher rates of overall complications (35.7% vs 17.1%) and diabetes insipidus (25% vs 4.8%) when compared to the same meta-analysis.[18] The low rates of CSF leak may be attributable to the routine use of a nasoseptal flap, whereas the higher rates of DI and overall complications may result from more aggressive pituitary manipulation and tumor excision because of the increased visualization afforded by the endoscope. On multiple linear regression, 78.5% of the variance in hospital stay (or 59.0% when correcting for complexity) can be explained by the model, and this is about 4.025 times greater than the unexplained variance. The models for GTR and surgery duration were not significant predictive. One possible explanation is that the EETS approach made successful surgery achievable despite differences in tumor size or characteristics.

A few studies have also investigated the effectiveness of EETS in patients in Southeast Asia, where the Philippines is located, and presented in *Table 3*.[24-28] Relative to these studies, we were able to achieve similar rates of GTR and complications, but we had longer operative times and lengths of hospital stays. Several factors may have contributed to the longer operative times observed in our institution. First, we routinely used nasoseptal flaps for all patients – this was done to decrease the risk of CSF leaks but entailed additional time for harvesting and placing the flap. Second, there was a learning curve involved in learning the new technique, and one study found that a mean of 103 ± 139.43 (range, 9-500) cases was required for mastery.[29] We had a similar experience, where outcomes were better in the latter cases, and we found that the learning curve was steep in the first 20 cases. Third, our patients often have their surgery delayed due to limited finances, leading to larger tumors on presentation. Fourth, Filipinos may have smaller nostrils leading to narrower surgical corridors, although to the best of our knowledge, no studies have documented this yet. Finally, the limited availability of hemostatic agents, sealants, and absorbable intranasal packing materials required more meticulous and time-consuming methods of hemostasis and closure, although we could not find studies that directly compared operative times for endoscopic endonasal surgeries with and without flowable hemostatic agents and sealants and intranasal packing materials. In our experience, other factors that influence operative time include the consistency of the tumor, with more fibrous tumors taking longer to remove; the presence of an intraoperative CSF leak; and entering the cavernous sinus during surgery.

Our data identified galactorrhea and increased tumor size as independent factors for longer surgeries, this likely reflects increased technical difficulty in these cases. Larger tumor sizes necessitate larger sellar openings, and more tumor debulking and dissection away from surrounding structures, which greatly increases the length of the surgery. The median tumor size among our patients was 3.0 mm (IQR 1.3-4.7), which is comparable to other studies where tumors had mean diameter of 26.76 mm (range 3-78 mm)[30] and median diameter of 3.0 cm (IQR 3.0-4.3 cm).[31] On the other hand, patients with galactorrhea have usually undergone medical treatment with dopamine agonists, which may cause tumor fibrosis and lead to longer surgeries.[32] Meanwhile, reasons for the prolonged hospital stay include problems with preoperative clearance (at our institution, patients are usually seen and cleared by the internal medicine service only after the patient has been admitted), or difficulty in obtaining operating room schedules for our patients, as evidenced by an average postoperative stay for our patients of only 5 days, with preoperative days contributing more to the prolonged hospital stay. Intuitively, patients with straightforward vision problems as the presenting symptom will have shorter hospital stays than those with more complex presentations such as seizures, hypercortisolism and acromegaly and large tumors that may require more time for neurologic and endocrinologic monitoring and stabilization, as well as additional medical treatment aside from the surgery itself.

Based on our experience, the main advantage of the EETS is the ability to bring into sharp focus the critical structures in sellar and suprasellar areas which allowed us to inspect for completeness of tumor resection, identification of the origin of any CSF leaks, and protection of vascular and neural structures from iatrogenic injury. The main difficulty we encountered was related to hemostasis in the suprasellar space since the cost of flowable hemostatic agents (one 10mL vial of FloSeal® (Baxter, Illinois, USA) costs US $ 770, twice the average monthly salary in the Philippines equivalent to US $ 312) limits its routine use in our setting. This is also the reason why we could not be aggressive in cases with significant cavernous sinus invasion (Knosp 3 and above). We also did not have access to fibrin glues and sealants, hence a nasoseptal flap to seal the defect was used in all patients. In our practice, cavernous sinus invasion and tumor extension behind the dorsum sella were factors that often limited our extent of resection, while increasing tumor size and suprasellar extension were characteristics that led to prolonged operations.

Our study was limited by its retrospective nature and nonrandomized design. Some important data were missing, there was no comparison group, and the reporting of surgical outcomes was not standardized. Additionally, because of certain peculiarities in the local practice of EETS as discussed above (routine use of nasoseptal flap, learning curve, delayed presentation, smaller nostrils, limited hemostatic agents, problems with preoperative clearance, and difficulty in obtaining operating room schedules), the results of our study may not be generalizable to other settings, particularly when it comes to operative times and lengths of stay. Because Knosp grades could have been a better explanation for our outcomes, a prospective study design including the Knosp grading of patients, with longer follow-up and standardized monitoring of radiologic, visual, and endocrinologic outcomes is recommended. Because selection bias may not have been completely eliminated by considering for inclusion all patients who underwent the procedure at our institution during the study period, future studies may also consider adding a control group as well as including multiple centers. Moreover, while functional and patient-centered outcomes such as quality of life were not included, these could be considered areas for future research.

In conclusion, in this cohort of adult patients who underwent endoscopic endonasal transsphenoidal excision of pituitary adenomas at a tertiary hospital in the Philippines, the rate of gross tumor removal was excellent and comparable to regional standards. The risk of complications, particularly diabetes insipidus, was higher than in previous studies, and this could be attributed to inexperience with the new technique. Galactorrhea and tumor size 4 to 6 cm were associated with longer operative times, and preoperative seizures, acromegaly, hypercortisolism and incremental increases in tumor size were associated with longer lengths of hospital stay. Preoperative visual symptoms were associated with shorter admissions. Local practices, logistics, and demographics may have also contributed to longer surgery durations and hospital admissions. Improved surgical infrastructure and experience may further optimize outcomes.

ACKNOWLEDGEMENTS

The authors would like to thank Mr. Dominic Dayta, Assistant Professor of the University of the Philippines Diliman School of Statistics, for his statistical support.

REFERENCES

1. Chen C, Hu Y, Lyu L, Yin S, Yu Y, Jiang S, et al. Incidence, demographics, and survival of patients with primary pituitary tumors: a SEER database study in 2004–2016. *Sci Rep*. 2021 Jul 26;11(1):15155. DOI:10.1038/s41598-021-94658-8; PubMed PMID: 34312470; PubMed Central PMCID: PMC8313564.
2. Araujo-Castro M, Berrocal VR, Pascual-Corrales E. Pituitary tumors: epidemiology and clinical presentation spectrum. *Hormones (Athens)*. 2020 Jun;19(2):145-155. DOI:10.1007/s42000-019-00168-8; PubMed PMID: 31933100.
3. Jaursch-Hancke C, Deutschbein T, Knappe UJ, Saeger W, Flitsch J, Fassnacht M. The interdisciplinary management of newly diagnosed pituitary tumors. *Dtsch Ärztebl Int.* 2021 Apr 9;118(14):237-243. DOI:10.3238/arztebl.m2021.0015; PubMed PMID: 34114552; PubMed Central PMCID: PMC8283682.
4. Deopujari C, Shaikh S. Evolution of pituitary surgery. *Neurol India*. 2020 May-Jan;68(7):33-38. DOI:10.4103/0028-3886.287673; PubMed PMID: 32611890.
5. Jho HD, Carrau RL. Endoscopic endonasal transsphenoidal surgery: experience with 50 patients. *J Neurosurg*. 1997 Jul;87(1) :44-51. DOI: 10.3171/jns.1997.87.1.0044; PubMed PMID: 9292264.
6. Van Gerven L, Qian Z, Starovoyt A, Jorissen M, Meulemans J, van Loon J, et al. Endoscopic, endonasal transsphenoidal surgery for tumors of the sellar and suprasellar region: a monocentric historical cohort study of 369 patients. *Front Oncol*. 2021 May 7;11:643550. DOI: 10.3389/fonc.2021.643550; PubMed PMID: 34026618; PubMed Central PMCID: PMC8138557.
7. Ottenhausen M, Banu MA, Placantonakis DG, Tsiouris AJ, Khan OH, Anand VK, et al. Endoscopic endonasal resection of suprasellar meningiomas: the importance of case selection and experience in determining extent of resection, visual improvement, and complications. *World Neurosurg*. 2014 Sep-Oct;82(3-4):442-9. DOI: 10.1016/j.wneu.2014.03.032; PubMed PMID: 24657254.
8. Tang C, Wang P, Liu J, Jiang H, Zhang G, Wu N. Endoscopic endonasal transsphenoidal approach for symptomatic Rathke cleft cyst: A case series. *Exp Ther Med.* 2022 Oct 6;24(6):713. DOI: 10.3892/etm.2022.11649; PubMed PMID: 36382096; PubMed Central PMCID: PMC9634343.
9. Zacharia BE, Romero FR, Rapoport SK, Raza SM, Anand VK, Schwartz TH. Endoscopic endonasal management of metastatic lesions of the anterior skull base: case series and literature review. *World Neurosurg*. 2015 Nov;84(5):1267-77. DOI: 10.1016/j.wneu.2015.05.061; PubMed PMID: 26079759.
10. Sheth MK, Strickland BA, Chung LK, Briggs RG, Weiss M, Wrobel B, et al. Endoscopic endonasal approaches for reconstruction of traumatic anterior skull base fractures and associated cerebrospinal fistulas: patient series. *J Neurosurg Case Lessons*. 2022 Jun 20;3(25):CASE2214. DOI: 10.3171/CASE2214; PubMed PMID: 35733841; PubMed Central PMCID: PMC9210271.
11. Schelini JC, Cavalheiro S, Dastoli PA, Hirai ÉR, Atallah C, Costa M, et al. Endoscopic endonasal transsphenoidal approach for pediatric craniopharyngiomas: A case series. *Int J Pediatr Otorhinolaryngol*. 2020 Mar;130:109786. DOI: 10.1016/j.ijporl.2019.109786; PubMed PMID: 31812002.
12. Storr HL, Drake WM, Evanson J, Matson M, Berney DM, Grossman AB, et al. Endonasal endoscopic transsphenoidal pituitary surgery: early experience and outcome in paediatric Cushing's disease. *Clin Endocrinol (Oxf)*. 2014 Feb;80(2):270-6. DOI: 10.1111/cen.12275; PubMed PMID: 23800132.
13. Yadav Y, Sachdev S, Parihar V, Namdev H, Bhatele P. Endoscopic endonasal trans-sphenoid surgery of pituitary adenoma. *J Neurosci Rural Pract*. 2012 Sep;3(3):328-37. DOI: 10.4103/0976-3147.102615; PubMed PMID: 23188987; PubMed Central PMCID: PMC3505326.
14. Dai W, Zhuang Z, Ling H, Yang Y, Hang C. Systematic review and network meta-analysis assess the comparative efficacy and safety of transsphenoidal surgery for pituitary tumor. *Neurosurg Rev.* 2021 Feb;44(1):515-527. DOI: 10.1007/s10143-020-01240-3; PubMed PMID: 32036504.
15. Li A, Liu W, Cao P, Zheng Y, Bu Z, Zhou T. Endoscopic versus microscopic transsphenoidal surgery in the treatment of pituitary adenoma: a systematic review and meta-analysis. *World Neurosurg*. 2017 May;101:236-246. DOI: 10.1016/j.wneu.2017.01.022; PubMed PMID: 28104521.
16. Gao Y, Zhong C, Wang Y, Xu S, Guo Y, Dai C, et al. Endoscopic versus microscopic transsphenoidal pituitary adenoma surgery: a meta-analysis. *World J Surg Oncol*. 2014 Apr 11;12:94. DOI: 10.1186/1477-7819-12-94; PubMed PMID: 24721812; PubMed Central PMCID: PMC3991865.
17. Guo S, Wang Z, Kang X, Xin W, Li X. A meta-analysis of endoscopic vs. microscopic transsphenoidal surgery for non-functioning and functioning pituitary adenomas: comparisons of efficacy and safety. *Front Neurol*. 2021 Mar 23;12:614382. DOI: 10.3389/fneur.2021.614382; PubMed PMID: 33833725; PubMed Central PMCID: PMC8021708.
18. Li K, Zhang J, Wang X-S, Ye X, Zhao Y-L. A systematic review of effects and complications after transsphenoidal pituitary surgery: endoscopic versus microscopic approach. *Minim Invasive Ther Allied Technol*. 2020 Dec;29(6):317-325. DOI: 10.1080/13645706.2019.1660369; PubMed PMID: 31495241.
19. Osborne C, Lewis D, Dixon B, Caputo C, Magee A, Gnanalingham K, et al. Equivalent outcomes in nasal symptoms following microscopic or endoscopic transsphenoidal surgery: results from multi-centre, prospective study. *Acta Neurochir (Wien)*. 2022 Jun;164(6):1589-1597. DOI: 10.1007/s00701-022-05138-5; PubMed PMID: 35133481; PubMed Central PMCID: PMC9160117.
20. Eseonu CI, ReFaey K, Garcia O, Salvatori R, Quinones-Hinojosa A. Comparative cost analysis of endoscopic versus microscopic endonasal transsphenoidal surgery for pituitary adenomas. *J Neurol Surg B Skull Base*. 2018 Apr;79(2):131-138. DOI: 10.1055/s-0037-1604484; PubMed PMID: 29868317; PubMed Central PMCID: PMC5978862.
21. Goshtasbi K, Lehrich BM, Abouzari M, Abiri A, Birkenbeuel J, Lan MY, et al. Endoscopic versus nonendoscopic surgery for resection of pituitary adenomas: a national database study. *J Neurosurg*. 2020 Mar 13;134(3):816-824. DOI: 10.3171/2020.1.JNS193062; PubMed PMID: 32168478; PubMed Central PMCID: PMC8080843.
22. Formalejo JP, Amable JP. Cerebro-apinal fluid leak in skull base reconstruction using Hadad - Bassagasteguy flap after endoscopic endonasal transsphenoidal surgery: A case series . *Philipp J Otolaryngol Head Neck Surg*. 2021 Nov. 11;36(2):22. DOI: 10.32412/pjohns.v36i2.1797.
23. von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP; STROBE Initiative. The strengthening the reporting of observational studies in epidemiology (STROBE) statement: guidelines for reporting observational studies. *PLoS Med*. 2007 Oct 16;4(10):e296. DOI: 10.1371/journal.pmed.0040296; PubMed PMID: 17941714; PubMed Central PMCID: PMC2020495.
24. Wongsirisuwan M, Karnchanapandh K. Comparative outcomes of keyhole supraorbital approach (KSA) and endonasal endoscopic transsphenoidal approach (EETA) in pituitary surgery. *J Med Assoc Thai*. 2014 Apr;97(4):386-92. PubMed PMID: 24964680.
25. Skulsampaopol J, Hansasuta A. Outcomes of the endoscopic transsphenoidal surgery for resection of pituitary adenomas utilizing extracapsular dissection technique with a cotton swab. *Asian J Neurosurg*. 2019 Nov 25;14(4):1089-1094. DOI: 10.4103/ajns.AJNS_169_19; PubMed PMID: 31903345; PubMed Central PMCID: PMC6896643.
26. Keandoungchun P, Tirakotai W, Phinthusophon A, Wattanasen Y, Masayaanon P, Takathaweephon S. Pituitary hormonal status after endoscopic endonasal transphenoidal removal of nonfunctioning pituitary adenoma: 5 years' experience in a single center. *Asian J Neurosurg*. 2021 Mar 20;16(1):62-66. DOI: 10.4103/ajns.AJNS_386_20; PubMed PMID: 34211868; PubMed Central PMCID: PMC8202392.
27. Sand MSM, Gendeh BS, Husain S. Endonasal endoscopic transsphenoidal pituitary surgery for pituitary adenoma: a retrospective analysis of surgical outcome. *Med J Malaysia*. 2011 Dec;66(5):443-6. PubMed PMID: 22390098.
28. Hong A, Ho KH. Pituitary surgery--a report of 46 cases. *Ann Acad Med Singap*. 1990 Jul;19(4):429-34. PubMed PMID: 2171413.
29. Ahn Y, Lee S, Shin DW. Learning Curve for Endoscopic Transsphenoidal Surgery: A Systematic Review and Meta-Analysis. *World Neurosurg*. 2024 Jan;181:116-124. DOI: 10.1016/j.wneu.2023.10.029; PubMed PMID: 37838158.
30. Hernandez MAL, Lopez DJ, Narag J, Seng K, Khu KJ. Post-operative Outcomes of Pituitary Macroadenoma Patients in a Tertiary Hospital in the Philippines. *J ASEAN Fed Endocr Soc.* 2025 Nov;40(2):114-125. DOI: 10.15605/jafes.040.02.14; PubMed PMID: 41357058; PubMed Central PMCID: PMC12680866.
31. Shamim MS, Bari ME, Khursheed F, Jooma R, Enam SA. Pituitary adenomas: presentations and outcomes in a South Asian country. *Can J Neurol Sci*. 2008 May;35(2):198-203. DOI: 10.1017/s0317167100008635; PubMed PMID: 18574934.
32. Ryba A, Gonzalez Lopez D, Rotermund R, Flitsch J. Preoperative treatment with dopamine agonist therapy influences surgical outcome in prolactinoma: a retrospective single-center on 159 patients. *Acta Neurochir (Wien)*. 2024 Aug 1;166(1):316. DOI: 10.1007/s00701-024-06198-5; PubMed PMID: 39085706; PubMed Central PMCID: PMC11291524.