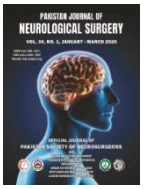

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Original Research

Extent of Resection and Complications in Transsphenoidal Surgery for Pituitary Adenoma and Its Outcome

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ABSTRACT

Objective: The aim of the research is to determine the level of resection and postoperative complications during transsphenoidal surgery in pituitary adenoma.

Materials & Methods: Seventy patients with radiologically confirmed pituitary adenomas who met the inclusion criteria were included in the final analysis. An expert neurosurgeon carried out all the procedures. The degree of tumor resection was evaluated based on comparing preoperative to the postoperative magnetic resonance imaging (MRI) scans at three months postop and ranged from gross total, near total, and subtotal resection. The postop complications were also evaluated, including CSF leak, hematoma, diabetes insipidus, and hyponatremia.

Results: The average age of the participants in the study was 48.01, and the standard deviation was 11.13, with most of the patients being males (65.7 percent). Gross total resection was attained in 57.1%, and near-total and subtotal resection were attained in 15.7% and 27.1% cases, respectively. In relation to the complications, CSF leak had a case of 10.0 percent, diabetes insipidus cases were 5.7 percent, and 8.6 percent cases had hyponatremia.

Conclusion: Transsphenoidal surgery for pituitary adenoma demonstrated grand total resection in 57.1% of cases, near total resection in 15.7%, and subtotal resection in 27.1% of cases. CSF leak was the most frequent post-op complication.

Keywords: Pituitary adenoma, endoscopic endonasal surgery, extent of resection, gross total resection, tumor morphology.

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INTRODUCTION

Pituitary adenomas (PAs) are neoplasms that originate from the anterior pituitary gland. The vast majority of PAs have slow growth and are

classified as benign. Classification depends on size as well as cellular origin. PAs can be divided into microadenomas, macroadenomas, and giant tumors based on their size.[1,2] Giant PAs exceed 40 mm in size. Functioning PAs are distinguished by cell types that lead to the greater release of one or more hormones from the anterior pituitary gland. Nonfunctioning adenomas fail to produce hormones; nevertheless, they may compress adjacent regions of the anterior pituitary, which leads to hormonal deficiencies.[3,4] Recent proteomic research on PAs has improved the understanding of varying hormonal levels exhibited by these malignancies. PAs are categorized as functional or non-functional, according to their ability to secrete hormones. Patients who have functional PAs exhibit hormone-associated clinical phenotypes. Different hyperpituitarism indicators have been linked with these phenotypes, based on the levels of hormone secretion influenced by PA. Patients with non-functional PAs do not secrete identifiable hormones; however, they remain clinically active and may present symptoms related to mass effect, such as vision loss and headaches.[5-7]

The endoscopic transsphenoidal approach (ETSA) provides access to the floor of the sella turcica by incising the dural sheath, which allows for exposure of the adenoma. The tumor is removed in a piecemeal fashion, and subsequent to its removal, the sellar floor is repaired.[8,9] Various studies have presented divergent outcomes concerning the complete resection of tumors resulting from endoscopic transsphenoidal resection of pituitary adenomas. It can also be employed for the excision of residual tumors.[10] The study outcomes indicated a 78% rate of success for gross tumor excision.[11] Another study reported that complete excision had been accomplished in 98% of tumors restricted to the sella turcica, while total excision was feasible in 96% of tumors that demonstrated extra-sellar growth.[12]

PAs are the most prevalent intracranial tumors, and transsphenoidal surgery is the most usual mode of treatment, especially in symptomatic lesions or hormonally active lesions. The amount of resection that is attained after the transsphenoidal surgery is a decisive factor in the short- and long-term outcome. The level of knowledge gap is the ability to define the direct relationship between the magnitude of resection and clinical outcomes in our local population. Thus, the assessment of the correlation between the level of resection during transsphenoidal surgery on PA and the outcome will be an important source of information to maximize the choice of the surgical procedure and improve the prognosis of the patient.

MATERIALS & METHODS

Study Design and Setting

This was a single-center descriptive case series conducted in the Department of Neurosurgery, Hayatabad Medical Complex, Peshawar, within a period of six months, January 2025 to July 2025. The research was conducted to determine the degree of tumor resection and postoperative complications after an endoscopic transsphenoidal surgery of the pituitary adenomas. Patient enrollment was done after seeking ethical approval at the Institutional Review Board of Hayatabad Medical Complex. (**Approval No: 2529**).

Population and Sampling

First of all, 150 patients were screened. Upon the elimination of those patients whose clinical records were not complete, lacking adequate radiological follow-up, or those who were lost to follow-ups, 70 patients were incorporated into the final analysis. Patients who had incomplete clinical records, poor radiological follow-up, or who had been lost to follow-up were excluded to appropriately measure the outcomes.

Surgical Technique

A consultant neurosurgeon who had over five years of experience in endoscopic skull base surgery post-fellowship conducted all the procedures. General anesthesia was used in conducting surgeries where the patient would be lying on his back. Endoscopic navigation in the attainment of proper sphenoidotomy and excellent exposure of the sellar floor was used. The removal of tumors was performed directly under endoscopic observation in a sterile setting with the help of microsurgical instruments, the goal of which was to provide maximum safe resection of tumors without damaging the surrounding neurovascular structures, such as the optic apparatus and internal carotid arteries.

Outcome Measures

The main result of the research was the degree of resection of the tumor, which comprised gross total resection (removal of 100 percent of the tumor), near-total resection (between 90 percent and 100 percent), and subtotal resection (between 70 percent and 90 percent), according to postoperative radiological examinations. All MRI scans were independently reviewed by the operating neurosurgeon to maintain consistency in assessment. The assessment of postoperative complications, such as cerebrospinal fluid leak, hematoma, diabetes insipidus, and hyponatremia, was the secondary outcome. Measurement of formal postoperative endocrinological remission or hormonal outcome was not covered under this study.

Data Collection Procedure

All patients had their demographic variables, such as age and gender, recorded. Magnetic resonance imaging was utilized to determine tumor-related variables, including size and morphology, before the operation. The MRI scan three months after the surgery was taken and compared with the preoperative scans systematically to find the extent of the resection. To measure any postoperative complications in the hospital stay and early follow-up, clinical records were reviewed to record the same.

Data Analysis

Statistical Package of Social Sciences (SPSS version 26) was used to enter and analyze the data. Continuous variables, such as age, will be expressed as the mean standard deviation. Frequencies and percentages were used to display categorical variables that included gender, tumor size, tumor morphology, extent of resection, and postoperative complications. The stratification was done to determine the relationship between tumor factors (size and morphology) and the extent of resection. Where necessary, the chi-square test was used to test the statistical significance. The p-value was deemed to be statistically significant at a value of 0.05 or below.

RESULTS

Demographic Characteristics

This research involved 70 patients who met the inclusion criteria. The average age of the patients was 48.01 years, and the standard deviation was 11.13 years. The participants were predominantly males, with 46 (65.7%) males and 24 (34.3%) females.

Tumor Characteristics

The size of the tumors was analysed, and it was found that 35 (50.0%) patients had tumours whose size was less than 1 cm, 22 (31.4%) patients had tumours between 1 cm and 3.9 cm, and 10 (14.3%) patients had tumours bigger than 3.9 cm. In terms of tumor morphology, round tumours were most common with 43 (61.4%) patients, dumbbell tumours were found in 17 (24.3%).

Secondary Outcome Findings

Besides the tumor size and morphology, the scope of the resection seemed to affect the postoperative morbidity. Patients who had gross

total resection had a reduced total burden of complications compared to the near-total or subtotal repositioned patients. Leakage of cerebrospinal fluid (CSF) was more common in patients who had bigger tumors and complicated morphology, especially multilobular and dumbbell adenomas.

Though there were no significant results of formal statistical tests, the trend of higher endocrine disturbances with diabetes insipidus and hyponatremia was observed in patients who had subtotal resection. These results indicate that partial ablation of the tumor can potentially predispose patients to temporary pituitary dysfunction in the early postoperative stage.

Extent of Resection

Radiological evaluation at the time of postoperative showed that in 40 (57.1%) patients, gross total resection was obtained. Complete resection was seen in 11 (15.7%) patients, and subtotal resection was seen in 19 (27.1%) patients (Table 2).

Correlation between Tumor Characteristics and Resection

Stratification analysis showed that the less common tumors (<1 cm) were more likely to be related to gross total resection, which included 62.5% of the gross total resection group. The proportion reduced to 45.5 percent in the near-total resection group and 26.3 percent in the subtotal resection group. Conversely, the bigger tumors (>3.9 cm) were less often connected with gross total resection (12.5%) and were rather observed within the subtotal resection group (31.6%). These associations, however, were not statistically significant (P > 0.05).

On the same note, Tumors of round shape were widespread in all resection categories as they comprised 67.5 percent of gross total resections. Multilobular tumours were also more often correlated with near-total (27.3%), as well as subtotal (26.3%), resection in comparison to gross total resections (5.0%), but again this association was not statistically significant (P > 0.05) (Table 3).

Table 1: *Clinical Presentation.*

Clinical Presentation		n	%
Tumor size (cm)	< 1	35	50.0%
	1 to 3.9	22	31.4%
	> 3.9	13	18.6%
Tumor shape	Round shape	43	61.4%
	Dumbbell shape	17	24.3%
	Multilobular shape	10	14.3%

Table 2: *Extent of resection.*

Extent of Resection	n	%
Grand total resection (100%)	40	57.1%
Near total resection (90 to 100%)	11	15.7%
Subtotal resection (70 to 90%)	19	27.1%

Table 3: *Stratification of the extent of resection with clinical presentation.*

Clinical Presentation		Extent of Resection Grand Total Resection (100%) %	Near Total Resection (90 to 100%) %	Subtotal Resection (70 to 90%) %	P value
Tumor size (cm)	< 1	62.5%	45.5%	26.3%	P > 0.05
	1 to 3.9	25.0%	36.4%	42.1%	
	> 3.9	12.5%	18.2%	31.6%	
Tumor shape	Round shape	67.5%	54.5%	52.6%	P > 0.05
	Dumbbell shape	27.5%	18.2%	21.1%	
	Multilobular shape	5.0%	27.3%	26.3%	

Postoperative Complications

The number of patients who showed postoperative complications was minimal. The most common complication was cerebrospinal fluid leak, which was witnessed in 7 (10.0%) patients. Four (5.7%) patients had diabetes insipidus, 2 (2.9%) had hematoma, and 6 (8.6%) had hyponatremia.

The most significant point is that the majority of complications were short-lasting and successfully treated more conservatively, and no case of long-term neurological impairment or death was reported in the course of the follow-up.

DISCUSSION

Our cohort in terms of age (48.01 years old on average) and gender distribution (male-dominated 65.7 percent) is representative of the average population of patients found in many surgery series. Yasin et al also indicated a similar mean age of 50.02 years with 71.7% males in the study.[13] Little et al, also indicated that the diagnosis of the pituitary adenomas that need surgical management is more often diagnosed among middle-aged men (61%).[14] This uniform demographic trend supports the fact that the prevalence of the diagnosis is more often seen in middle-aged men.

Our primary study result was that there was a gross total resection (GTR) rate of 57.1. This figure is very informative when put into the context of other studies of the same nature. It lies in the wide range of literature. Our GTR rate is inferior to the 93.3% mentioned by Yasin et al, but similar to those reported in cohorts of more difficult-to-treat pathologies, e.g., in the case of recurrent pituitary adenomas, Do et al, achieved a GTR of 51.7%.15 In larger and giant adenomas, Gondim et al, and Izz-Alarab et al, obtained a GTR of 38% and 45.2, respectively.[16,17] The heterogeneous composition of the close correlation between the size of the tumor and the opportunity to have a complete resection is rather prominent in our analysis. The trend was quite evident as the small tumors (<1 cm) were 62.5 percent of the GTR group and 26.3 percent of the subtotal resection (STR) group. The GTR category had a low representation of larger tumours (>3.9 cm) (12.5%), whereas it formed 31.6% of the STR cases. This trend is a significant observation during pituitary surgery. In their research, Little et al, affirmed that tumor volume is a very critical outcome determinant, and Izz-Alarab et al, presented strong support, showing statistically significant tumor volume reduction between large adenomas (3-3.9 cm) (88.9% radical resection) and giant adenomas (4 cm) (46.7% radical resection).[14,17] Our data did not reach statistical significance in this result, but this is likely because of our sample size.

Another essential factor that affected the level of resection was the morphology of the tumor. We discovered that round-shaped tumors were sensitive to GTR (67.5% of GTR cases), whereas multilobular and dumbbell-shaped tumors were associated more with near-total resections or subtotal resections. This finding is consistent with the study conducted by Izz-Alarab et al, who have noted that the radical resection rate of a rounded tumor was 100% as opposed to 41.7% in multilobular tumor cases.[17] The reason behind this is the anatomy of surgery; tumors that are round in shape are likely to push the neurovascular structures aside, whereas multilobular or dumbbell-shaped tumors are likely to grow and entangle the important structures within the brain, including the optic nerves, which control vision, and removal without morbidity is extremely difficult.[18] This points to the fact that the preoperative assessment of tumor shape in MRI by the surgeon is as important as determining its size.

Consequently, as per these findings, like Kunicki et al, (2025), current literature has seen the trend of focusing on the importance of tumor size, morphology, and invasiveness as predictors of surgical success in endoscopic transsphenoidal surgery of pituitary adenomas. Modern multicenter and systematic reviews have shown that bigger tumors and those with complex

morphology, like multilobular or dumbbell-shaped adenomas, have lower rates of gross total resection and a higher chance of postoperative morbidity.[19] In addition, recent clinical practice updates point to the fact that although maximal safe resection is the main goal of surgical treatment, subtotal resection is a justified and safer option in those cases where tumor structure or location limits radical excision. The results of Chen et al, (2022) coincide with our findings and emphasize the need for careful preoperative radiological examination and surgical planning on a case-by-case basis to achieve the best possible outcomes and reduce the number of complications.[20]

The complexity of our study, as indicated by the complication profile, indicated that postoperative cerebral spinal fluid (CSF) leak was experienced by 10.0% of patients. Diabetes insipidus was present in 5.7% of patients, hematoma in 2.9%, and hyponatremia in 8.6% of patients. We had a lower rate of CSF leak and diabetes insipidus as compared to 26.2% and 11.9 of Izz-Alarab et al.[17]

Though statistically insignificant because of the reduced sample size, our findings confirm that the tumor size and morphology are the major determinants of surgical outcome in the surgery of pituitary adenoma. Our resection rates and complication rates are in line with the available research.

In the absence of statistically significant associations, the trends identified are relevant in clinical practice and in line with the available literature. The research was not powered to pick up on small effects, and thus these results can be viewed descriptively.

LIMITATIONS

This research has a number of drawbacks. First, it is a case series, a single-center descriptive case series, and lacks generalizability. Second, the follow-up was rather brief and was directed at the early postoperative radiological and clinical outcome. Third, no endocrinological and functional outcomes were being assessed in detail, which are also needed variables in determining the long-term surgical success in the context of the pituitary adenoma surgery. Also, the sample size did not allow for establishing statistically significant relationships between the characteristics of tumors and the extent of resection.

CONCLUSION

We conclude that transsphenoidal surgery for pituitary adenoma exhibited grand total resection in 57.1% of cases, near total resection in 15.7%, and subtotal resection in 27.1% of cases. We observed fewer postoperative complications in our study; CSF leak was the most frequent postoperative complication.

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Additional Information

Disclosure: The authors report no conflict of interest.
Ethical Review Board Approval: This study was approved by the Institutional Review Board, Hayatabad Medical Complex, Peshawar, **Approval No: 2529.**
Human Subjects: Informed consent was obtained from all participants included in the study.
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AUTHORS CONTRIBUTIONS

Sr.#	Author's full name	Intellectual Contribution to Paper in Terms of:
1.	***Muhammad Ali Noman***	Study concept, methodology design, literature review, and referencing.
2.	***Imran Khan***	Data collection, statistical analysis, and result interpretation.
3.	***Muhammad Danial***	Final review and referencing support, Manuscript writing, editing, and quality assurance.