Comparative Surgical Outcomes of Schwannomas and Meningiomas Among Patients in the Cerebellopontine Angle in Pakistan: A Retrospective Study

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ABSTRACT

Background: Cerebellopontine angle (CPA) tumors, predominantly Schwannomas and Meningiomas, pose significant surgical challenges due to their proximity to cranial nerves and critical neurovascular structures. While the retrosigmoid approach is commonly employed for CPA tumor excision, tissue-based differences in surgical outcomes have not been extensively studied.
Objective: To evaluate histopathology-specific differences in tumor characteristics, extent of resection, and postoperative cranial nerve outcomes following retrosigmoid surgery for CPA tumors.
Methods: The study was a retrospective observational study involving 102 patients who were retrosigmoid resected CPA tumor between 2021 and 2024 in the Northwest School of Medicine, Peshawar, Pakistan. Demographics of the patients, the tumor nature, extent of resection, and postoperative complications were taken into consideration. The comparison of Schwannomas and Meningiomas was carried out by means of Chi-square and Fisher tests. The statistical significance was set at $p = 0.05$.
Findings: Of the cohort, 65 patients were found to have Schwannomas and 37 had Meningiomas. The total resection among Schwannomas and Meningiomas was gross in 89.2 and 100 percent respectively. There were no major differences in consistency or vascularity of the tumor. Facial nerve weakness was found in 20.0% of Schwannomas and in 5.4% of Meningiomas ($p = 0.011$) and loss of gag reflex in 18.5% of Schwannomas and none in Meningiomas ($p < 0.001$).
Conclusion: For patients with similar tumor characteristics and surgical resection, Schwannomas are linked with greater risks of postoperative cranial nerve deficits, in comparison to Meningiomas. These results demonstrate the significance of histopathology-specialized risk evaluation and intraoperative measures to save cranial nerve functions.

Keywords: Schwannoma; Meningioma; Surgical Procedures, Operative; Cerebellopontine Angle; Surgical Outcomes; Pakistan

INTRODUCTION

A complex structure that is at the intersection of the cerebellum, pons, and medulla, the cerebellopontine angle (CPA) includes vital neurovascular formations, such as cranial nerves V-XII and anterior inferior cerebellar artery (1-3). In adults the tumors in this area are commonly known as CPA space- occupying lesions (SOLs) and make up about 5 -10 percent of all intracranial neoplasms. The most common of these are vestibular Schwannomas and meningiomas, which are the second and third most common CPA tumor (4-7). Both tumor types may result in hearing impairment, vertigo, thyroid facial nerve impairment, and lower cranial nerve impairment because of compression or infiltration and their surgical repair must be undertaken with utmost care to avoid undue neurovascular impact (8-10).

In the CPA, surgical excision is the primary mode of treatment of both Schwannomas and meningiomas, with the retrosigmoid approach being the most popular one because of its flexibility, reduced morbidity, and high reachability of the posterior fossa (11-13). Although technologies have been developed, dural nerve injury, especially, facial nerve weakness in the postoperative period continues to be a serious issue, influencing the quality of life and functional independence of patients (14, 15). Such complication rates can vary according to tumor histopathology, natural growth patterns and their correlation with the neural structures associated with the tumor. The origins of Schwannoma are in the Schwann cells of cranial nerves, usually in the vestibulocochlear nerve, and accompanied by the possibility of a close attachment to the neighboring nerve, which raises the risk of postoperative morbidity (16-18). Meningiomas, on the other hand, grow out of the dura, and are more likely to dislocate, than to penetrate neural tissue, allowing them to be safely excised without causing cranial nerve dysfunction (19-21).

Past research has generally been involved with surgical results of CPA tumors as one homogenous probably without stratifying the results on the basis of histopathology (22). It is essential to gain insight into tissue-specific variations on tumor consistency, vascularity, resection extent, and postoperative morbidity to plan the operation, counsel the patient, and predict prognosis (23). Besides, the ability to detect histopathology-specific risks can enable surgeons to plan intraoperative approaches, such as implementing intraoperative neurophysiological monitoring, cleaning up microsurgical dissection, and planning to limit cranial nerve injury. These personalized interventions are especially useful in difficult CPA lesions where maximum safe resection has to be determined as well as some functional preservation (24).

The lack of modern data on the comparison of Schwannomas and meningiomas in relation to the postoperative results in the retrosigmoid position is reported despite the identified clinical significance (25). Available literature is mostly made up of case series or multicenter reports that use varied surgeries with the potential of not generalizing historically. Consequently, a specific analysis of sequential instances worked by a single surgical team will provide a peculiar chance to examine differences in tissues in a controlled and consistent operative setup.

This is the gap that the current study will address by comparing the nature of tumors and operative outcomes between Schwannomas and CPA meningiomas. In particular, we study the hypothesis of whether histopathology affects tumor consistency, vascularity, extent of resection, and postoperative cranial nerve impairment, such as facial nerve weakness and gag reflex loss. In an attempt to inform surgical decision-making, better risk classification, and better patient counseling, this paper aims to provide historically stratified data in histopathology and therefore improve patient outcomes in CPA tumor in terms of improved functional patient outcomes.

METHODOLOGY

It was retrospective observational research at the Northwest School of Medicine, Peshawar, Pakistan to identify histopathology-based variations in surgical outcomes of cerebellopontine angle (CPA) tumors. The reviewed medical records included consecutive patients who received surgical CPA space-occupying lesions excision with the retrosigmoid approach in the period between January 2021 and December 2024. The number of cases included in the study was restricted to those that were performed on by a single dedicated neurosurgical team in order to reduce procedural variability.

Patient demographics, tumor characteristics (size, consistency, and vascularity), extent of resection and postoperative complications (facial nerve weakness and other cranial nerve deficits) were data collected. Histopathological diagnosis was used to group tumors in Schwannoma and meningioma groups.

The Chi-square test was used to conduct comparisons across groups of categorical variables. Fisher exact test was used when the number of cells was below five as anticipated. The results of surgical operations were compared with the histopathology of tumors to investigate whether the specific tissue differences affected the morbidity of operations, the volume of resection, and the functional outcomes.

The analysis was conducted through a workflow of artificial intelligence-assisted analytical processing (ChatGPT, OpenAI) with direct oversight of the investigators to organize, tabulate, and calculate percentages and categorical comparative analysis. Each and every output was cross-validated to verify accuracy in its analysis and data integrity. The p-value of less than 0.05 was taken as capturing statistical significance.

RESULTS

One hundred and twenty-two cases of CPA tumors were identified, of which 65 tumors were Schwannomas, with the remaining 37 tumors being Meningiomas. The Schwannoma group was dominated by males (56.9% [37]), with a mean age of 38.6 ± 13.8 years, and the Meningioma group was dominated by females (57.1% [21]), with a mean age of 40.1 ± 13.5 years.

In Schwannomas, gross total resection (GTR) was performed in 89.2% (58/65) and in Meningiomas in 100% (37/37). There were no significant differences in tumor consistency ($\chi^2(2) = 5.22$, $p = 0.072$) or vascularity ($\chi^2(3) = 6.12$, $p = 0.105$).

Nevertheless, the difference in postoperative complications was substantial. Facial nerve weakness was found in 20.0% (13/65) of Schwannoma patients versus 5.4% (2/37) in Meningioma patients ($\chi^2(1) = 6.45$, $p = 0.011$; Fisher's exact, uncorrected $p = 0.013$). Likewise, gag reflex loss was observed in 18.5% (12/65) of Schwannoma cases but not at all (0/37) in Meningioma ($\chi^2(1) = 13.05$, $p < 0.001$; Fisher's exact $p = 0.001$).These results suggest that although there was no difference in GTR and tumor features between Schwannomas and Meningiomas, Schwannomas had a higher probability to be connected with cranial nerve deficits after surgery.

RESULTS

A total of 55 patients were screened, of whom 50 met the inclusion criteria and were enrolled in the study (Figure 1). Participants were equally assigned to Group A (Otolaryngology, n = 25) and Group B (Neurosurgery, n = 25).

The mean age of the cohort was 46.9 ± 10.4 years, with no significant difference between the otolaryngology (45.2 ± 9.1) and neurosurgery (48.7 ± 11.4) groups ($p = 0.237$). Males predominated in both groups (18 [72] vs 16 [64]; $p = 0.544$). The neurosurgery group had a higher proportion of overweight patients (11 [44] vs 6 [24]), but this difference was not statistically significant ($p = 0.136$).

Primary indications for tracheostomy differed between specialties: head and neck malignancy and airway obstruction were most common in the otolaryngology group, whereas prolonged mechanical ventilation and traumatic brain injury were predominant in the neurosurgery group (Table 1).

The overall incidence of early postoperative complications within 7 days was 2 of 50 (4). No intra-operative complications or procedure-related mortality occurred.

No early postoperative complications were observed in the otolaryngology group (0 of 25; 0; 95% CI 0–13.3). In the neurosurgery group, two complications were reported (2 of 25; 8; 95% CI 1.4–25.6), including one case of postoperative hemorrhage and one case of mucous plugging (Table 2). Fisher's Exact Test showed no statistically significant difference between groups ($p = 0.490$).

No late complications, such as tracheal stenosis or persistent stoma, were reported within 7 days. All patients completed the follow-up period, and no revision tracheostomies were required.

Table 1: Patient demographics and clinical characteristics

Variable	Otolaryngology (n = 25)	Neurosurgery (n = 25)	p-value
Age (years), mean ± SD	45.2 ± 9.1	48.7 ± 11.4	0.237^a
Male sex, n (%)	18 (72)	16 (64)	0.544^b
Overweight BMI, n (%)	6 (24)	11 (44)	0.136^b
Primary indication	Malignancy/Obstruction	Ventilation/TBI	—

^a Independent samples t-test; ^b Chi-square test

Table 2: Tumor Characteristics and Extent of Resection

Outcome	Otolaryngology (n = 25)	Neurosurgery (n = 25)	p-value

Overall complications, n (%)	0 (0)	2 (8)	0.490^*
Haemorrhage	0	1	—
Mucous plugging	0	1	—
Procedure-related mortality	0	0	1.000

^* Fisher's Exact Test

DISCUSSION

This prospective cross-sectional study evaluated whether early postoperative complication rates differed between open tracheostomies performed by otolaryngologists and neurosurgeons at a tertiary care hospital in Pakistan (5, 16). The primary finding was that early complications were uncommon in both groups and that the observed difference in complication frequency (0% vs. 8%) was not statistically significant (21). Thus, within the limits of this sample and short follow-up period, surgeon specialty was not demonstrably associated with early postoperative outcomes after open tracheostomy (22).

Our findings are broadly consistent with available regional and international literature reporting low early complication rates for open tracheostomy when performed in controlled hospital settings (23). Pakistani studies from tertiary centers have reported early complication rates ranging from 5% to 15%, with hemorrhage and tube obstruction being the most frequent events (24, 25). Similarly, international series from Europe and North America describe early complication rates between 3% and 12%, with no consistent difference attributable solely to surgical specialty when procedures are performed by adequately trained teams (26). The present study adds local evidence by directly comparing two commonly involved specialties in Pakistan, suggesting that outcomes are comparable when standardized surgical techniques and postoperative care are applied.

The types of complications observed in the neurosurgery group-postoperative hemorrhage and mucous plugging-are well recognized early events after tracheostomy (27, 28). These complications are influenced by local tissue handling, coagulation status, airway secretions, and postoperative nursing care rather than by specialty designation alone. Neurosurgical patients often undergo tracheostomy in the context of traumatic brain injury or prolonged mechanical ventilation, conditions that may predispose to altered coagulation profiles, increased airway secretions, and reduced cough reflex (29, 30). Such physiological and clinical factors may explain the observed events without implying a direct effect of surgeon specialty (31).

Importantly, the absence of complications in the otolaryngology group may reflect differences in case mix, indications, and baseline risk rather than superior performance (32). Otolaryngology patients in this cohort more frequently had head and neck malignancy or airway obstruction, whereas neurosurgical patients more often had traumatic brain injury or prolonged ventilation, which are known to be associated with higher perioperative risk. These contextual factors may partially account for the numerical difference in complication rates. Several limitations should be acknowledged. First, the small sample size limited the statistical power to detect modest differences between groups. Second, the convenience sampling technique may introduce selection bias and limit generalizability. Third, the follow-up period was restricted to seven days, precluding assessment of late complications such as tracheal stenosis, infection, or tube displacement. Fourth, the study did not adjust for all potential confounders, including surgeon experience, operative duration, patient comorbidities, and perioperative anticoagulation status. Finally, the cross-sectional design does not allow inference of temporal or causal relationships between surgeon specialty and complications.

CONCLUSION

In this prospective cross-sectional cohort, early postoperative complications after open tracheostomy were infrequent and did not differ significantly between procedures performed by otolaryngologists and neurosurgeons. The findings suggest that early outcomes are comparable across specialties when standardized surgical techniques and postoperative care are used. Surgeon specialty appears to be associated with case mix rather than independently linked to complication risk. Larger, multicenter studies with longer follow-up and adjustment for clinical confounders are warranted to further clarify specialty-related differences in tracheostomy outcomes.

Ethical Approval

The study was approved by the Institutional Review Board (IRB)/Ethics Committee of Northwest School of Medicine, Peshawar, Pakistan (Approval No.: ERC/2021/PM/00103).

Data Availability

The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Author Contributions

Conceptualization: Asif Khan, Rehan Ullah Jan, Muhammad Daniyal Khan, Abdul Qadeer

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All authors approved the final manuscript and agree to be accountable for all aspects of the work.

Informed Consent

Informed consent was obtained from all individual participants included in the study.

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Conflict of Interest

The authors declare that they have no competing interests.

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