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Association of Tumor Consistency with Functional Status of Facial Nerve Following Vestibular Schwannoma Surgery in Our Perspective

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Abstract **Original Research Article**

Background: Vestibular schwannomas are the most common cerebellopontine angle tumors, with variable intraoperative consistency that may influence facial nerve outcomes. This study aims to assess the association between tumor consistency and postoperative facial nerve function following vestibular schwannoma surgery. ***Aim of the study*:** The aim of the study was to evaluate the association between intraoperative tumor consistency and postoperative facial nerve functional status in patients undergoing vestibular schwannoma surgery. ***Methods:*** This experimental study at the Department of Neurosurgery, Bangabandhu Sheikh Mujib Medical University, and the National Institute of Neurosciences and Hospital, Dhaka (March 2018–September 2019), included 31 vestibular schwannoma patients. Data on demographics, preoperative T2 MRI intensity, intraoperative tumor consistency, extent of resection (postoperative CT), and facial nerve function (House-Brackmann grading) were collected. Tumor consistency was assessed by the chief surgeon. Data were analyzed with SPSS 23; $p < 0.05$ was significant. ***Results:*** Of the 31 patients, 58.1% had soft tumors and 41.9% had firm tumors. Gross total resection was significantly more common in soft tumors (83.3% vs. 23.1%, $p = 0.001$). Good facial nerve function improved from 77.4% on 3rd POD to 87.1% on 7th POD ($p = 0.375$), with no significant association between tumor consistency and facial outcome at either point ($p = 1.000$). ***Conclusion:*** Tumor consistency is significantly associated with the extent of tumor resection but not with immediate postoperative facial nerve function, and may serve as a useful preoperative indicator to guide surgical planning and patient counseling.

Keywords: Tumor Consistency, Facial Nerve Function, Vestibular Schwannoma.

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INTRODUCTION

Vestibular schwannoma (VS), also known as acoustic neuroma (AN), is the most common tumor of the cerebellopontine angle (CPA), originating from either the superior or inferior vestibular nerve within the internal auditory canal (IAC) and extending into the CPA [1]. Histologically benign and slow-growing, these tumors typically enlarge at a rate of 1 to 2.4 mm per year, though cystic and neurofibromatosis type 2 (NF2)-related variants can grow faster, up to 3.2 mm/year [1-3].

VS accounts for 85–92% of CPA tumors and 93.1% of intracranial nerve schwann cell tumors, representing 7.79–10.64% of all intracranial neoplasms [4]. It typically presents in patients aged 45–55 years, with a higher prevalence in females [1]. Clinically, these tumors present with progressive sensorineural hearing loss, tinnitus, imbalance, and in advanced cases, cranial nerve dysfunction and brainstem compression [1,5].

Radiologically, VSs appear isointense on T1-weighted MRI and hyperintense on T2-weighted sequences, with strong contrast enhancement. Tumors can be homogeneous, heterogeneous, or cystic, depending on histological composition [6]. Importantly, consistency correlates with MRI signal characteristics: soft schwannomas are often hyperintense on T2, while firm tumors tend to be hypointense [7]. However, radiology cannot fully replace intraoperative assessment, especially concerning the tumor's relation to the facial nerve [6].

Intraoperatively, VS consistency varies—ranging from soft/suctionable to firm/fibrous—and is thought to influence facial nerve preservation during

surgery. Firm tumors may be more easily dissected due to a clearer arachnoid plane and reduced adherence to the nerve, potentially facilitating better outcomes [8,9]. Conversely, others report firm, fibrous, adherent, and vascular tumors as risk factors for poor functional outcomes [5,10].

Preservation of facial nerve function is paramount, as injury can cause lasting cosmetic and functional deficits, reduce quality of life and increasing healthcare burden [11,12]. Although facial nerve weakness before surgery is rare—occurring in 3–5% of cases—it is more frequently observed in patients with firm tumors [10]. This underscores the potential predictive value of tumor consistency, both clinically and radiologically, in guiding surgical planning and prognosis [7].

Despite many factors influencing facial nerve outcomes—such as tumor size, location, adherence, and surgical approach—the prognostic role of intraoperative tumor consistency remains underexplored and controversial [7]. Some believe soft tumors pose more challenges due to higher vascularity and unclear dissection planes, while others favor their pliability [8].

Given this background, our study aims to assess the association between intraoperative tumor consistency and postoperative facial nerve functional status in vestibular schwannoma surgery. We also explore how tumor consistency correlates with the extent of resection, with implications for preoperative counseling and operative strategy.

OBJECTIVE

- To evaluate the association between intraoperative tumor consistency and postoperative facial nerve functional status in patients undergoing vestibular schwannoma surgery.

METHODOLOGY & MATERIALS

This experimental study was conducted at the Department of Neurosurgery, Bangabandhu Sheikh Mujib Medical University (BSMMU), and the National Institute of Neurosciences and Hospital, Dhaka, Bangladesh, between March 2018 and September 2019. A total of 31 patients diagnosed with vestibular schwannoma were consecutively enrolled based on specific inclusion and exclusion criteria to evaluate the association between tumor consistency and postoperative facial nerve functional status following vestibular schwannoma surgery.

Inclusion Criteria:

- Patients clinically and radiologically diagnosed with vestibular schwannoma.
- Patients who underwent surgical treatment for vestibular schwannoma.
- Patients with histopathological confirmation of vestibular schwannoma after surgery.
- Patients with clear operative notes describing tumor consistency and extent of tumor resection.

Exclusion Criteria:

- Recurrent or residual vestibular schwannoma cases.
- Cases lacking surgeon's description of tumor consistency.
- Patients with bilateral vestibular schwannoma on radiological imaging.
- Cases without available or consistent histopathological reports.
- Patients diagnosed with neurofibromatosis type 2.
- Patients who received prior radiation therapy or stereotactic radiosurgery.
- Patients with hearing deficits due to medical or surgical ENT causes other than vestibular schwannoma.
- Patients with complete preoperative facial nerve palsy.
- Patients with purely intracanalicular tumors.

The study variables included demographic factors (age and sex); imaging characteristics (preoperative T2-weighted MRI intensity categorized as hyperintense, isointense, or hypointense, and postoperative CT scans to assess extent of tumor removal); operative variables (intraoperative tumor consistency classified as soft/suctionable or firm/fibrous); and clinical variables (preoperative and postoperative facial nerve function evaluated using the House-Brackmann grading system on the 3rd and 7th postoperative days). Data were collected prospectively from eligible patients after obtaining written informed consent. Detailed histories and clinical examinations were conducted. Tumor consistency was subjectively assessed intraoperatively by the chief surgeon. Facial nerve status was graded preoperatively and postoperatively, while tumor resection extent was confirmed by contrast-enhanced postoperative CT scans. Tumor consistency classification was based on intraoperative findings, with soft tumors being suctionable and firm tumors requiring piecemeal removal with instruments. MRI intensity was compared to adjacent temporal lobe gray matter and independently evaluated by two neurosurgeons; only concordant cases were included. Tumor resection was categorized as gross total (>95%), near total (90–95%), or subtotal (<90%) removal. Ethical approval was obtained from the Department of Neurosurgery and the Central Ethical Committee, Bangabandhu Sheikh Mujib Medical University, and patient confidentiality was strictly maintained. Data analysis was performed using SPSS version 23, applying descriptive statistics and inferential tests (Chi-square, Fisher's exact, t-tests, or Z-tests), with significance set at $p < 0.05$.

RESULTS

Table 1: Demographic Characteristics of the Study Subjects (n = 31)

Variable		Frequency (n)	Percentage (%)
Age (years)	≤20	4	12.9
	21 – 30	7	22.6
	31 – 40	7	22.6
	41 - 50	8	25.8
	>50	5	16.1
	Mean ± SD	37.68 ± 16.45	
	Range	14 - 75	
Gender	Male	14	45.2
	Female	17	54.8

The majority of patients were aged 41–50 years (8 patients, 25.8%), followed by those aged 21–30 years and 31–40 years equally (7 patients each, 22.6%). Patients aged over 50 years comprised 16.1% (5 patients), and those aged 20 years or younger made up 12.9% (4 patients). The gender distribution showed a slight female predominance, with 17 females (54.8%) and 14 males (45.2%).

Table 2: Distribution of Study Subjects According to Per Operative Tumor Consistency (n = 31)

Tumor Consistency	Frequency (n)	Percentage (%)
Soft	18	58.1
Firm	13	41.9
Total	**31**	**100.0**

Among the 31 patients, the majority of tumors were soft in consistency, accounting for 18 cases (58.1%), while firm tumors were observed in 13 cases (41.9%).

Table 3: Association of Per Operative Extent of Tumor Resection with Tumor Consistency (n = 31)

Extent of Tumor Resection (EOR)	Per operative consistency		Total n (%)	p-value
	Soft n (%)	Firm n (%)		
Gross Total Resection (GTR)	15 (83.3%)	3 (23.1%)	18 (58.1%)	0.001
Near Total Resection (NTR)	3 (16.7%)	5 (38.5%)	8 (25.8%)	
Subtotal Resection (STR)	0 (0.0%)	5 (38.5%)	5 (16.1%)	
Total	18 (100.0%)	13 (100.0%)	31 (100.0%)	

The extent of tumor resection was significantly associated with tumor consistency (p = 0.001). Gross total resection was achieved in 15 (83.3%) of soft tumors compared to only 3 (23.1%) of firm tumors. Near total and subtotal resections were more common among firm tumors, indicating greater surgical difficulty with firmer lesions.

Table 4: Association of Facial Nerve Status on 3rd Postoperative Day with Tumor Consistency (n = 31)

Facial Nerve Status (3rd POD)	Per operative consistency		Total n (%)	p-value
	Soft n (%)	Firm n (%)		
Good (H&B Grade I–III)	14 (77.8)	10 (76.9)	24 (77.4)	1.000
Worse (H&B Grade IV–VI)	4 (22.2)	3 (23.1)	7 (22.6)	
Total	18 (100.0)	13 (100.0)	31 (100.0)	

On the 3rd postoperative day, good facial nerve function (House–Brackmann Grade I–III) was observed in the majority of both soft (77.8%) and firm (76.9%) tumor groups. Poorer outcomes (Grade IV–VI) were similarly distributed. No statistically significant association was found between tumor consistency and early postoperative facial nerve status (p = 1.000).

Table 5: Association of Facial Nerve Status on 7th Postoperative Day with Tumor Consistency (n = 31)

Facial Nerve Status (7th POD)	Per operative consistency		Total n (%)	p-value
	Soft n (%)	Firm n (%)		
Good (H&B Grade I–III)	16 (88.9%)	11 (84.6%)	27 (87.1%)	1.000
Worse (H&B Grade IV–VI)	2 (11.1%)	2 (15.4%)	4 (12.9%)	
Total	18 (100.0%)	13 (100.0%)	31 (100.0%)	

By the 7th postoperative day, good facial nerve function (House–Brackmann Grade I–III) improved further in both soft (88.9%) and firm (84.6%) tumor consistency groups. Poor function remained low and nearly equal across both groups. There was no statistically significant association between tumor consistency and facial nerve outcome at this time point (p = 1.000).

Table 6: Comparison of Facial Nerve Status Between 3rd and 7th Postoperative Days (n = 31)

Facial Nerve Status	3rd PODn (%)	7th PODn (%)	p-value
Good (H&B Grade I–III)	24 (77.4%)	27 (87.1%)	0.375
Poor (H&B Grade IV–VI)	7 (22.6%)	4 (12.9%)	
Total	31 (100.0%)	31 (100.0%)	

Table 6 shows that 24 patients (77.4%) had a good facial nerve outcome (House-Brackmann Grade I–III) on the 3rd postoperative day (POD), which increased to 27 patients (87.1%) by the 7th POD. Conversely, 7 patients (22.6%) exhibited poor outcomes (Grade IV–VI) on the 3rd POD, decreasing to 4 patients (12.9%) on the 7th POD.

DISCUSSION

Numerous predictors of facial nerve function following vestibular schwannoma (VS) surgery have been proposed [7]. While much clinical research has addressed diagnostic methods, tumor incidence, surgical approaches, and hearing preservation [13], only limited studies have explored the relationship between per-operative tumor consistency and postoperative facial nerve function. This study aimed to evaluate that association in a local context, seeking insights to aid in surgical planning and outcome prediction.

The mean age of the study population was 37.68 ± 16.45 years, with most patients (45.2%) in the 21–40-year age group. This is younger than findings by Sharma *et al.,*[14], who reported a mean age of 54.5 years, and Samii *et al.,*[15], who found a mean of 42.1 years. This discrepancy may reflect demographic differences or regional life expectancy.

The gender distribution showed a slight female predominance (male-to-female ratio 1:1.21), which aligns with findings by Sharma *et al.,*[14] and Samii *et al.,*[16], who also observed higher prevalence in females. Copeland *et al.,*[7], however, reported an equal gender distribution.

In this study, 58.1% of tumors were soft, while 41.9% were firm in consistency. A statistically significant association was found between tumor consistency and the extent of tumor resection (p = 0.001). Gross total resection (GTR) was achieved more often in soft tumors (83.3%) compared to firm tumors (23.1%), consistent with the understanding that firmer tumors are more challenging to remove completely.

Regarding facial nerve function, no statistically significant association was found between tumor consistency and facial nerve outcomes on either the 3rd or 7th postoperative day (p = 1.000 for both). On the 3rd POD, 77.4% of all patients had good facial nerve outcomes, which increased to 87.1% by the 7th POD. This overall improvement is likely due to subsiding postoperative edema, reduced surgical trauma, and recovery from ischemic changes. However, while both soft and firm tumor groups showed improvement, no statistical difference was observed between them, suggesting that tumor consistency may not independently predict short-term facial nerve outcomes.

Our findings align partially with those of Copeland *et al.,*[7], who reported that firm tumors tended to result in poorer facial nerve function due to increased manipulation, although their results did not reach statistical significance (p = 0.09). Zaouche *et al.,*[17] similarly noted that increased tumor manipulation and consistency may affect outcomes, though they emphasized multifactorial causes, including tumor vascularity.

Although preoperative imaging, particularly T2-weighted MRI, has been suggested to help predict tumor consistency [7], this study did not assess radiologic–pathologic correlation, which limits comparative analysis on that front.

Several studies have emphasized that tumor consistency, while important, is one of many factors affecting postoperative facial nerve function. Surgical expertise, approach, tumor size, and extent of adhesion also play critical roles [10,12].

In summary, this study confirms a significant association between tumor consistency and extent of resection, but no significant correlation with early postoperative facial nerve function. These findings highlight the complexity of surgical outcomes in vestibular schwannoma and the need for further research with larger cohorts and long-term follow-up.

LIMITATIONS OF THE STUDY

This study had some limitations:

- The study was conducted on a small sample size; a larger sample would provide more robust and generalizable results.
- Different MRI machines were used to measure tumor intensity, which may have introduced variability in imaging data.
- Tumor consistency was described by different surgeons; consistency assessments would be more reliable if performed by the same surgeon.
- The study lacked the use of facial nerve monitoring during surgery.
- Time constraints limited the scope and duration of the study.

CONCLUSION

From this study, it was observed that there was no significant association between per-operative tumor consistency and postoperative facial nerve functional status in the immediate follow-up period after vestibular schwannoma surgery. However, a significant association was found between per-operative tumor consistency and the extent of tumor resection. Although the association with facial nerve outcome was not statistically significant, tumor consistency may still serve as a useful preoperative indicator—particularly when assessed through T2-weighted MRI—to predict postoperative facial nerve function. This information could assist neurosurgeons in planning surgical strategies and providing patients with more accurate preoperative counseling regarding the potential extent of tumor removal and expected surgical outcomes.

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