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Factors predicting Post-Operative Facial Nerve Function following Retromastoid Vestibular Schwannoma Surgery

Prakash Chandra Adhikari, Rajendra Shrestha, Binod Rajbhandari, Sameer Aryal, Sushil Mohan Bhattarai, Namrata Khadka, Anjan Singh Karki, Niraj Giri, Somraj Lamichhane, Rajiv Jha

Author(s) affiliation

Department of Neurosurgery, National Neurosurgical Referral Centre, Bir Hospital, National Academy of Medical Sciences, Kathmandu, Nepal

Corresponding author

Prakash Chandra Adhikari, MBBS, MS
adhikari.prakashchandra@gmail.com

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ABSTRACT

Introduction
Facial nerve (FN) preservation is a critical outcome measure in vestibular schwannoma (VS) surgery. This study aimed to identify factors predicting postoperative FN function following retromastoid VS surgery.

Methods
A retrospective analytical study was conducted in 30 patients with unilateral VS undergone retromastoid surgery (RMS) at Department of Neurosurgery, Bir Hospital, Nepal. Patient's demographic data, clinical data, intraoperative tumor characteristics, and post-operative FN function status were obtained from hospital record.

Results
The study included 30 patients (mean age 40.7 years, 56.7% male) with unilateral VS undergone retromastoid resection. Most tumors were large (mean size 3.73 cm; 53.3% >4 cm, 70% Koos grade 4). Immediate poor FN function (House Brackmann (HB) III-VI) was observed in 76.7% of cases, improving significantly to 83.3% HB I-II by 6 months. Tumor consistency strongly influenced outcomes: firm/hard tumors had poorer immediate (p=0.001) and delayed (p <0.001) FN function compared to soft/cystic tumors. Intraoperative neuromonitoring (used in 20% of cases) improved immediate FN outcomes (p <0.001) but showed no long-term benefit (p =0.58). Age ≥30 years predicted worse immediate FN function (p =0.012). Preoperative FN dysfunction correlated with persistent poor outcomes (p <0.001). Tumor size, extent of resection, and hearing status did not significantly affect FN prognosis. One mortality (3.3%) occurred due to postoperative hematoma and hydrocephalus.

Conclusion
Tumor consistency was the strongest predictor, with firm tumors linked to worse outcomes. Intraoperative neuromonitoring aided early function but had limited impact on long-term recovery. Younger age and better preoperative FN status favored recovery.

Keywords
Facial nerve outcome; House-Brackmann scale; retromastoid surgery; vestibular schwannoma

INTRODUCTION

Vestibular schwannoma (VS) account for 75–85% of cerebellopontine angle tumors, 8% of all intracranial tumors.[1] Facial nerve (FN) preservation is a major goal of surgical success and facial dysfunction affecting 33–45% of patients.[2]

In a series Matthies and Samii[2] demonstrated that the rate of preservation of FN was 24% in cases of large tumors (> 3cm) and 57% in cases of small tumors (< 3cm).[2] In a series of Betka et al. poor function (HB III-VI) was noted in 45% immediately after surgery and in 33% on follow-up at 1 year period.[3] In a study of Brackmann et al. in translabrynthine approach for VS, HB grade 1/2 was attained in 81%, HB grade 3/4 in 15%, and HB grade 5/6 in 4% at 1 year.[4] In a series of Samii of VS sugery via retrosigmoid approach, excellent or good FN function had been achieved in 81% of the cases and on follow-up 1 year post surgery, no patients had total facial palsy.[5] Existing literature identifies tumor size, preoperative HB grade, extent of resection and surgical approach as key predictors.[6 7]

Data from low-resource settings like Nepal are scarce. A retrospective study done at Bir Hospital by Jha et al.[8] on 212 patients showed, Intra operative facial nerve monitoring (IONM) was strongest predictor of post-operative facial nerve outcome.[8]

Our study aims to identify demographic, clinical and perioperative factors that could predict the prognosis of FN after retromastoid surgery (RMS) of VS.

METHODS

This was a retrospective observational study done in Department of Neurosurgery, Bir Hospital, Kathmandu, Nepal in 30 patients who had undergone retromastoid surgery (RMS) microsurgical resection for unilateral VS between March 2024 to February 2025. Ethical approval was taken from Institutional Review Board, National Academy of Medical Sciences (Reference Number: 19/2082/83). The study utilized nonprobability (convenience) sampling. The data were obtained from the hospital records of the patients, excluding individuals under 18 years of age, who have received surgical or radiation therapy earlier.

The tumor size[9], the tumor Koos grading system of VS[10], preoperative FN status recorded on House-Brackmann grade (HB Grade)[11], and preoperative hearing status on Gardner-Robertson Scale[12] were recorded. The perioperative variables, consistency of the tumor categorized as soft (debulked with the suction), firm (debulking require emulsification with CUSA (Cavitron Ultrasonic Surgical Aspiration)), and fibrous (needs sharp dissection with microscissiors)[13]; extent of tumor resection as gross-total resection or subtotal resection were recorded.

The immediate postoperative FN functional status on HB scale assessed on the 7th postoperative day and subsequently at six months after the surgery were recorded.

All data were analyzed using IBM SPSS (version 20.0). The results were expressed as the mean±SD/median(range) for the descriptive data. The categorical data were compared using $\chi 2$ test or Fisher's exact test where p-value < 0.05 was taken as statistically significant.

RESULTS

A total of 30 patients were studied.

Demographics, clinical and intraoperative characteristics

The average age of the patient was 40.7±13.3 years with majority of patients in the age group 45-59 years and 15-29. Male were 56.7%. Majority (93.3%) of the tumor were 3 cm or larger and 70% had the Koos Grade 4 tumor. Majority (90%) had preoperative good FN function (HB I-II). Majority (76.7%) had preoperative non-serviceable hearing loss. Majority (60%) had firm to hard tumor consistency. Average tumor dissection time was 3.75 (+/- 1.37) hours and in 70% of the cases gross total resection was achieved. Intra-operative FN monitoring was used in only 20% of the cases (Table: 4).

Post-operative FN outcome

Majority of the patients had poor FN outcome (HB III-VI) in the immediate postoperative period and good FN outcome (HB I=II) at 6 months follow-up. One patient (3.3%) had mortality due to hematoma in the tumor bed with hydrocephalus. The post-operative FN status of 29 patients was analyzed. (Table: 5).

Comparison of demographics and clinical characteristics between patients with Good (HB I-II) and Poor (HB III-VI) immediate FN outcome and FN outcome at 6 months

Significant difference in the mean age of the patient was noticed among the immediate good and poor FN outcome (p=0.03) while it was lacking at 6-month (p =0.45). The outcome was not associated with gender. Surprisingly, the tumor size had no association with the outcome of FN in the immediate (p =0.44) and even on 6 months follow-up (p =0.83). The FN outcome status of patients with firm and hard tumor were poorer compared to those with cystic or soft tumor consistency in the immediate (p =0.001) and at 6 months (p <0.001). Significant recovery to good functional status was noted in all groups except in those with hard tumor (Table: 6 and Table: 7).

Patients presenting with preoperative FN

Table 1. Demographics, Clinical and intraoperative characteristics (N=30)

Characteristics		Frequency (n=30, %)
Mean ± SD Age (Years)		40.7±13.3
Age Category (Years)	15-29	10(33.3)
	30-44	5(16.7)
	45-59	11(36.7)
	60-75	4(13.3)
Gender	Male	17(56.7)
	Female	13(43.3)
Tumor Size (cm)	<3	2(6.7)
	3-4	12(40)
	>4	16(53.3)
Koos Grade	3	9(30)
	4	21(70)
Preoperative FN status	HB I	24(80)
	HB II	3(10)
	HB III	2(6.7)
	HB IV	1(3.3)
	HB V	0
	HB VI	0
Preoperative Hearing Status	Serviceable	7(23.3)
	Non-Serviceable	23(76.7)
Consistency of the Tumor	Soft	7(23.3)
	Firm	10(33.3)
	Hard	8(26.7)
	Cystic	5(16.7)
Extent of Resection	Total (GTR)	21(70)
	Subtotal (STR)	9(30)
Intraoperative FN Monitoring	Used	6(20)
	Not Used	24(80)

dysfunction had poor FN outcome after surgery at 6 months (p <0.001) (Table: 4) but no significant association on the immediate postoperative FN outcome (p = 0.58) (Table: 3). Preoperative hearing status of serviceable and non-serviceable condition had no association with the FN outcome immediate (p =0.55) or at 6 months (p =0.31) after surgery.

Extent of total and subtotal resection of the tumor has no association in prognostication of the FN status in the immediate (p =0.63) or postoperative assessment at 6 months (p =0.64).

The use of intraoperative FN neuromonitoring has impact on the good prognosis of the FN outcome in immediate postoperative period (p <0.001) however, the outcome at 6 months has no relation with the use or no use of FN neuromonitoring (p =0.58).

Table 2. Post-operative FN Outcome (N=29)

Characteristics		Frequency (n=30, %)
Immediate Post Op FN Status	Good (HB I-II)	6(20)
	Poor (HB III-VI)	23(76.7)
FN Status at 6 months	Good (HB I-II)	25(83.3)
	Poor (HB III-VI)	4(13.3)
Mortality		1(3.3)

Other preoperative factors like gender; preoperative hearing status and intraoperative factors like intraoperative tumor dissection time, extent of tumor resection showed no relation with the prognosis of the FN in immediate or at 6 months period.

DISCUSSION

The present study evaluated FN (FN) outcomes following retromastoid surgery for VS in 30 patients, focusing on preoperative, intraoperative, and postoperative factors influencing FN function. Our findings align with existing literature while providing nuanced insights into the association of these factors with the immediate and long-term FN recovery. A striking observation was the high rate of immediate postoperative FN dysfunction (76.7% HB III-VI), contrasting with significant recovery at 6 months (83.3% HB I-II) owing this finding with the use of postoperative facial physiotherapy.

The findings of our study align with and expand upon the retrospective analysis by Jha et al.[8] from the same institution, which evaluated FN outcome in 212 VS (VS) patients over seven years. Comparing our study with the study done by Jha et al.[8] both studies demonstrate significant FN recovery over time. Our cohort exhibited higher rates of immediate postoperative dysfunction (76.7% HB III-VI vs. 27% in Jha et al.[8]), likely attributable to differences in tumor characteristics - specifically, our study consisting of only seven (36.8%) patients with soft-consistency tumor compared to the previous study's majority of soft-consistency tumors (61%). Both studies converge on the critical observation that most FN palsy is transient, with our data showing 83.3% achieving HB I-II by 6 months compared to 90-93% recovery at 3 months in the Jha et al.[8].

This mirrors prior studies of Matthies and Samii[2] reporting transient FN paresis due to intraoperative

Table 3. Comparison of demographics and clinical characteristics between patients with Good (HB I-II) and Poor (HB III-VI) immediate FN outcome (N=29)

Characteristics		Immediate FN Outcome		p -value
		Good (HB I-II)	Poor (HB III-VI)	
Age Category (Years)	15-29	5	4	0.01#
	30-44	0	5	
	45-59	0	11	
	60-75	1	3	
Gender	Male	4	12	0.44#
	Female	2	11	
Tumor Size (cm)	<3	0	2	0.62#
	3-4	2	10	
	>4	4	11	
Koos Grade	3	1	8	0.38*
	4	5	15	
Consistency of the Tumor	Soft	2	5	0.001#
	Firm	0	10	
	Hard	0	7	
	Cystic	4	1	
Preoperative FN status	HB I	6	17	0.58#
	HB II	0	3	
	HB III	0	2	
	HB IV	0	1	
Preoperative Hearing Status	Serviceable	1	6	0.55*
	Non-Serviceable	5	17	
Intraoperative FN Monitoring	Used	5	1	<0.001*
	Not Used	1	23	

#Chi-square Test, * Fisher's Exact Test

nerve manipulation, with gradual recovery over months. The discrepancy underscores the importance of distinguishing between temporary neuropraxia and permanent injury in prognostication.

Tumor size and FN outcome had a paradoxical finding. Contrary to established literatures of Matthies and Samii[2], Samii et al. and Fatima et al.[2,5,6] , our study found no significant association between tumor size and FN outcomes in either immediate (p =0.62) or long-term assessments (p =0.82). This contrasts with seminal studies by Matthies and Samii, where larger tumors (>3 cm) had lower FN preservation rates (24% vs. 57% for smaller tumors)[2]. Several factors may explain this discrepancy. Our center's standardized retromastoid approach, refined through high-volume experience, may mitigate size-related risks. Meticulous dissection techniques (e.g., arachnoid plane preservation) could offset challenges posed by larger tumors. The dominant influence of tumor consistency (soft/cystic vs. firm/hard) may overshadow size effects, for example, even small but firm fibrous and hard tumors had poorer outcomes, while some large soft and cystic tumors recovered well (p =0.002). Our cohort predominantly comprised large tumors (93.3% >3 cm), limiting statistical power to detect size effects. The absence of very small tumors (<2 cm) precludes direct comparison with prior studies. While larger tumors often cause immediate postoperative dysfunction (76.7% HB III-VI), long-term recovery (83.3% HB I-II) suggests size may affect recovery pace rather than ultimate outcome. A 2021 meta-analysis by Fatima et al.[6] similarly noted that size alone poorly predicts FN function when adjusted for consistency and surgical approach. Comparing our study with the findings of Jha et al.[8] tumor consistency emerged as a stronger predictor than size in our study, with firm/hard tumors showing poorer outcomes (p =0.002), suggesting this factor

Table 4. Comparison of demographics and clinical characteristics between patients with Good (HB I-II) and Poor (HB III-VI) FN outcome at 6 months

Characteristics		Immediate FN Outcome		p -value
		Good (HB I-II)	Poor (HB III-VI)	
Age Category (Years)	15-29	8	1	0.84#
	30-44	4	1	
	45-59	10	1	
	60-75	3	1	
Gender	Male	13	3	0.38*
	Female	12	1	
Tumor Size (cm)	<3	2	0	0.82#
	3-4	10	2	
	>4	13	2	
Koos Grade	3	6	3	0.08*
	4	19	1	
Consistency of the Tumor	Soft	7	0	<0.001#
	Firm	10	0	
	Hard	3	4	
	Cystic	5	0	
Preoperative FN status	HB I	23	0	<0.001#
	HB II	1	2	
	HB III	1	1	
	HB IV	0	1	
Preoperative Hearing Status	Serviceable	7	0	0.31*
	Non-Serviceable	18	4	
Intraoperative FN Monitoring	Used	6	0	0.58*
	Not Used	20	4	

#Chi-square Test, * Fisher's Exact Test

may explain some variations between cohorts. These results collectively highlight the importance of surgical technique and tumor biology over simple size-based prognostication. Our findings align with emerging views that tumor-nerve interface characteristics (e.g., adhesion, fibrosis) may be more critical than absolute dimensions[14,15].

Our study demonstrated good initial FN outcome, HB I-II: 83% with IONM vs. 4% without ($p < 0.001$), though this benefit did not persist at the 6-month follow-up ($p = 0.58$). This finding aligns with Matthies & Samii[2] finding of 71% HB I-II at discharge with IONM- likely reflecting our population's larger tumor burden (93% >3cm). This consistency suggests IONM provides proportional benefits regardless of baseline risk. This supports current guidelines advocating routine neuromonitoring to minimize iatrogenic injury.[8,16] The low IONM utilization rate (20%) in our cohort highlights a potential area for practice improvement.

Our finding that younger patients (15–29 years) had superior immediate postoperative FN function ($p = 0.01$) aligns with Macielak et al., who attributed this to greater axonal regenerative capacity in younger nerves.[17] However, age did not affect long-term outcomes, suggesting that recovery mechanisms compensate over time. This novel observation warrants further study into youth-specific regenerative factors.

Contrary to Bloch et al.[7], we found no gender-based differences, possibly due to uniform surgical technique. Our study found that extent of resection, gross total resection (GTR) vs subtotal resection (STR) did not significantly influence immediate FN outcome ($p = 0.63$) or delayed postoperative assessment ($p = 0.64$), contradicting some prior studies. While Fatima et al. associated STR with better FN outcomes in giant tumors, our cohort's

predominance of large tumors may explain the discrepancy.

While preoperative HB grade did not affect immediate outcomes, it strongly predicted 6-month function (p =0.001), emphasizing its role in long-term prognostication.[18] This finding aligns with statement of Samii et al.[5] Preoperative FN function is the most reliable predictor of postoperative function. Surprisingly, preoperative hearing status of serviceable and non-serviceable condition had no relation with the FN outcome immediate (p =0.55) after surgery or at 6 months (p =0.31). The absence of hearing- preoperative FN outcome correlation diverges from Tadokoro et al.[19], possibly reflecting our cohort's high rate of pre-existing hearing loss (76.7% non-serviceable), which may mask subtle associations seen in mixed-hearing populations.

Limitations include the small sample size, short follow-up, and limited use of neuromonitoring, and involvement of multiple surgeons with different level of expertise. These findings support individualized surgical planning and highlight the need for larger, multicenter studies with longer follow-up to refine FN preservation strategies in VS surgery.

CONCLUSION

Tumor consistency was the strongest predictor, with firm tumors linked to worse outcomes. Intraoperative neuromonitoring aided early function but had limited impact on long-term recovery. Younger age and better preoperative FN status favored recovery, while tumor size and resection extent were not significant predictors. Despite a high rate of immediate postoperative FN dysfunction, most patients recovered good function by six months, emphasizing the importance of distinguishing temporary from permanent deficits.

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CONFLICT OF INTEREST

The author(s) declare that they do not have any conflicts of interest with respect to the research, authorship, and/or publication of this article.

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