Factors affecting facial nerve outcome in vestibular Schwannoma surgery

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Abstract

Introduction: Preservation of facial nerve injury is a key important factor in vestibular schwannoma surgery as facial paralysis has devastating functional and psychological consequences for patients. Our objective was to correlate different factors resulting in facial nerve preservation in vestibular schwannoma surgery by retro mastoid retro sigmoid approach.

Material and Methods: This is a retrospective analysis of facial nerve status of 212 cases of vestibular schwannoma microsurgery through Retrosigmoid Retromastoid (RSRM) approach. This study was carried out in National Neurosurgical Referral Center(NNRC), National Academy Of Medical Sciences (NAMS), Bir hospital between January 2016 to December 2022.Preoperative and post operative details of facial nerve function status compared according to House and Brackmann (H and B) grading system, and factors influencing outcome in facial nerve preservation were analyzed. Recurrent and residual tumors were excluded.

Results: A total of 212 cases of vestibular schwannoma were operated during the study period. The average age of presentation was 47 years. Most common affected age group was 51-60 years. Female to male ratio was 3:2.5. The most common clinical symptoms for vestibular schwannoma were sensorineural hearing loss followed by headache and difficulty in limb coordination. Tumor size and consistency was most important indicator of facial nerve function outcome.

Conclusion: The incidence of post operative facial palsy is found to be correlated to tumor size and consistency. Improvement of the facial nerve outcome is detected in patients undergone simultaneous intraoperative monitoring (IONM).

Keywords: Vestibular Schwannoma Facial Nerve Intra operative Nerve Monitoring (IONM)

Introduction

Vestibular schwannoma (VS) is a benign tumor which constitutes about 8-10% of all intracranial tumors. Vestibular schwannoma (VS) arise from the Schwann cells investing the vestibular nerve arising from both superior and inferior vestibular branches. The origin is from the junctional zone where the central and peripheral myelin meets which is just medial to or inside the internal acoustic meatus (IAM). The incidence of bilateral VS is about 5%.The internal auditory meatus(IAM) has a width of 9-10mm and a height of 3-6mm and the internal auditory canal has a height of 307mm and length of 6-7mm. The VII and VIII cranial nerves exit through the IAC by a constant relationship at its lateral end. The facial and vestibulocochlear nerves arise near the flocculus at the lateral end of pontomedullary sulcus and abducens nerve arises at the medial end of the sulcus. Identification of the VII and VIII cranial nerves at their origin from the brainstem is facilitated by tracing upward the line of junction of the rootlets of IX<X and XI cranial nerves through pontomedullary junction [1]. The facial nerve origin is about 2-3 mm above these rootlets just anterosuperior to the choroid plexus in foramen of Luschka and floccules of cerebellum.

The percentage of patients whose facial nerve function is preserved after surgical removal of vestibular schwannoma has increased during last decades. The main technical points underlying these improvements are use of operating microscopes [2], introduction of intraoperative nerve monitoring (IONM)[3], improved imaging techniques and enhanced surgical skills. But despite these technical advances, the percentage of patients with facial nerve paresis (grade 3 to 6 according to House- Brackmann scale[4] after surgical removal of vestibular schwannoma still ranges between 7-41% in recent large series [5,6,7,8].Beside technical issues, the major factor shown to influence post operative outcome of facial nerve function is size of the vestibular schwannoma[9]

The purpose of our study was to evaluate the demographics, clinical presentation, extent of surgery, and facial nerve outcome after vestibular schwannoma surgery through retrosigmoid and retromastoid approach over the past 7 years at our institution.

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Methods and Materials

This is a retrospective study of vestibular schwannoma surgery , carried out at National Neurosurgical Referral Center (NNRC), National Academy of Medical Sciences (NAMS) Bir hospital. Institutional review board (IRB) approval was taken from the hospital for the study. Consent was taken from the patients if they were able to communicate and from the next of kin if they were not able to give consent. Recurrent schwannoma, NF type 2, post radiotherapy were excluded in this study. The duration of the study was from January 2016 to December 2022 (7 years). Age, sex, clinical presentations, neurological manifestations, and extent of surgery also noted. Vestibular schwannoma size calculated on preoperative magnetic resonance imaging of the brain with gadolinium contrast. Koos classification system (Table 1) was used to categorized to grade the tumor. According to Koos grading, Grade I, small intracanalicular tumor, Grade II, small tumor with protrusion into the cerebellopontine cistern (CPA), no contact with the brain stem, Grade III, tumor occupying the cerebellopontine cistern with no brainstem displacement and Grade IV, large tumor with brainstem and cranial nerves displacement. Retrosigmoid and Retromastoid (RSRM) (Figure 1) approach was used in all cases. . All procedures were performed in Park Bench position(Figure 2). Facial nerve function was assessed according to the house – Brackmann (HB) facial grading system (Table 2) according to which Grade I, normal, Grade III, mild dysfunction, Grade III, moderate dysfunction, Grade IV, moderately severe dysfunction, Grade V, severe dysfunction and Grade VI, total paralysis. Facial nerve function was assessed preoperatively in the immediate post operative period (1 week) and in 3 months after surgery. Intra operative Nerve Monitoring (IONM) for facial nerve function was used in 28 cases.

Results

Total number of vestibular schwannoma operated was 212. The average age of presentation was 47 years. Most common affected age group was between 51-60 years (Table 3) . Female had slight preponderance over male. The most common clinical symptoms and sign was sensorineural hearing loss followed by headache with pappiloedema and difficulty in balance (Table 4). Out of 212 patients, based on the Koos grading system for the size of vestibular schwannoma, there were no Grade I tumor, there were about 4% Grade II tumor, 58% Grade III tumor and Grade IV consisted about 34% (Table 1).Tumor was found on right side in 58%. Vestibular Schwannoma size calculated on preoperative magnetic resonance imaging of the brain with gadolinium contrast (Figure 3). Retrosigmoid Retromastoid (RSRM) approach was used in all surgeries. In 130 (61%) cases, tumor had soft consistency. There were almost 30% immediate increase in facial nerve palsy and 18 (64%) cases were solid tumors. Use of Ultrasonic aspirator (CUSA) was very helpful in soft tumor . Use of ultrasonic aspirator (CUSA) was not much of help in other hard or cystic schwannoma. Our objective of the operation was not only to maximum extent more than tumor removal but also to protect the function of facial and auditory nerves and other cranial nerves and reduce complications, the reason why in our series, gross total tumor resection could be achieved in 86% of all cases (Table 5). For residual tumor, we send the patient for Radiosurgery.

About 36 (17%) patients already had facial nerve paresis prior to surgery out of which 22 (10%) had HB grade II, 8(3.8%) had Grade III and 6(2.8%) had Grade IV facial palsy (Table 6a). In those 156 (74%) cases where Intra operative nerve monitoring (IONM) was not used, immediate (1 week) post operative facial palsy was seen in 48(27%) cases which remained in 16 (10%) cases by the end of 3 months (Table 6 b,c). Out of those 56 cases where IONM was not used, 29% reported overall increase in facial nerve palsy in 1 week, which later improved to 93% at 3 months (Table 7 a,b,c) . On comparing the facial nerve injury pattern with use of IONM versus without use of IONM, it was found that there was a significant difference in patient with use of IONM (p value- 0.029 in IONM group and p value-0.067 in non IONM group) (Table 8). But these differences were not apparent at one week post operatively (p valur-0.615 without IONM and 0.427 with IONM).We give steroids in all post op cases for 8 to 10 days. Usually all patients HB grade IV facial palsy needed tarsorrhaphy.

In this series, commonest complication after vestibular schwannoma surgery seen was chest infection followed by pseudomeningocele and lower cranial nerve paresis (Table 9). Chest infection managed with antibiotics, chest physiotherapy . Few cases needed tracheostomy due to weak gag reflex and persistent aspiration pneumonia. Pseudomeningocele were transient which was managed with pressure bandage.

Discussion

There are many factors which influences the facial nerve outcome after surgical removal of vestibular schwannoma. Among many factors initial size/staging of the tumor has predominantly affects in the outcome. Additional parameters which appeared to influence post operative facial function are consistency of the tumor and use of intra operative nerve monitoring (IONM).

Vestibular schwannoma (VS) develops from the Swan cells of vestibular branch of vestibulocochlear nerve [10,11]. Vestibular Schwannoma are benign tumors which grows in the internal auditory meatus and in the cerebellopontine angle (CPA). Vestibular Schwannoma (VS) accounts to 6-7% of all intracranial tumors, however, with 90% they are the most common lesion appearing in the cerebellopontine angle[12]. Vestibular Schwannoma (VS) are seen in every age of life, but the main manifestation is between 3rd and 5th decade. Regarding the gender distribution, there are many contradictory results can be found in different research article but in majority of the series, high incidences are found in females. Brown et al. mention a majority of female patients and assume a hormonal process for the development of this tumor[13]. In this series , Vestibular Schwannoma (VS) are commonly seen in females. Other authors do not find difference regarding the gender distribution [14,15,16]. The type of symptoms are closely correlated with tumor size. Most initial cause the triad of ipsilateral sensorineural hearing loss, tinnitus and balance difficulties. Larger tumor can cause facial numbness, weakness or twitching, and possibly brainstem symptoms.

The objective of the operation was not only to maximum extent more than tumor removal but also to protect the function of facial and auditory nerves and other cranial nerves and reduce complications.

Surgery for vestibular schwannoma are always very challenging as attempts to remove such tumor from cerebellopontine area can be complicated by intraoperative damage to the facial nerve, cochlear nerve, lower cranial nerves, along with other neurological and vascular injuries [17,18,19,20] . Even though there are so many advances in surgical techniques which have improved facial nerve outcomes, functional preservation is still an issue because injury to the facial nerve has significant physical, social and psychological impact for the patients. [21,22,23]

Tumor size is the most important predictor of facial nerve outcome. In this series also Stage III and Stage IV had higher incidence of facial nerve palsy as 22 cases (10%) already had preoperative facial nerve palsy which was high compared to other tumor stages. Facial nerve can tolerate a large degree of stretching, compression or distortion without obvious facial palsy [24,25]. What happens actually is as the tumor grows, the nerve comes under even greater tension, which increase the likelihood of stretch injury, and this may explain the high rate of facial palsy seen in patients with large sized tumor [24,25]. Facial nerve dysfunction can also occur as a result of poor vascularization of nerve segments that are effaced by large tumors [24,25]. Though larger tumors can cause greater risk to the nerve, however tumor size alone cannot predict the degree of adhesiveness, or the difficulty of dissection [26].

The consistency of vascular schwannoma also has an impact on the immediate post operative facial weakness. Tumor with soft consistency (61%) had comfortable surgery because in such tumor, it is a little bit easy to separate the tumor capsule from surroundings. Soft tumors are also easy to be sucked by ultrasonic aspirator (CUSA), and they are usually less vascular compared to solid tumors. One of the factors that helped us in gross total removal (53%) was the soft tumor consistency, where the functional preservation was higher with soft masses while lower with firm masses). Samii et al.[23] reported that the predictive factors for facial nerve preservation are tumor size, cystic consistency, previous surgery or radiosurgery, and a surgeon's operative experience [27]. Mehrotra et al. found that facial preservation was better (95%) with cystic lesions because of myxoid degeneration [28].

Principally and medicolegally, facial nerve monitoring is mandatory during vestibular schwannoma (VS) surgery, as it has been shown to significantly reduce the risk of iatrogenic facial nerve injury [29]. Basic principle and main goal of intraoperative facial nerve monitoring are early nerve identification and mapping within soft tissue, tumor, and bone, allowing also to evaluate the neural integrity and prognosis at the end of the surgery The value of intraoperative monitoring especially during resection of vestibular schwannoma comes from the anatomical fact that the facial nerve, from the brainstem to the internal auditory canal, has no epineurium [30, 31, 32].

Intra operative bleeding, intensity of suction machine, excessive heat produced by diathermy, peritumoral arachnoid dissection, and drilling of posterior wall of internal acoustic meatus (IAM) also has additional impact on facial nerve preservation.

Table 1: Tumor Size (Koos and Samii)

Grade		No (%)
I	Intracanalicular (0 mm)	-
II	Inferior to 20mm or less Inftra-/ Extrameatal	8 (3.7%)
III	20-40 mm Tumor reaches the brain stem	122 (57.5%)
IV	>40mm Tumor compressed the brain stem	82 (38.6%)

Table 2: House Brackmann (HB) Facial Grading System

Grade	Appearance
Grade 1 Normal	
Grade 2 Slight Dysfunction	Motion: Forehead – moderate to good function Eye – complete closure with minimum effort Mouth – slight asymmetry
Grade 3 Moderate Dysfunction	Motion: Forehead – slight to moderate movement Eye – complete closure with effort Mouth – slight weak with maximum effort
Grade 4 Moderate severe Dysfunction	Motion: Forehead – None, Eye – incomplete closure Mouth – asymmetric with maximum effort
Grade 5 Severe Dysfunction	Motion: Forehead – None, Eye – incomplete closure Mouth – slight movement
Grade 6 Total Paralysis	No movement

Table 3: Age distribution

Age(Years)	No
< 20	2
20-30	22
31-40	34
41-50	66
51-60	72
61-70	10
>70	6

Table 4: Presenting Symptoms and Signs

Symptoms	No (%)
Hearing loss (Sensorineural)	180 (85%)
Headache and Pappiloedema	176 (83%)
Balance disturbance	144 (68%)
Tinnitus	140 (66%)
Nystagmus	62 (29%)
Romberg Sign	46 (21.7%)
Facial nerve weakness	36 (17%)
Multiple Cranial Neuropathies	36 (17%)
Hoarseness	34 (16%)
Absent Corneal Reflex	26 (12%)
Facial Paresthesia	18 (8.5%)

Table 5: Extent of resection

Extent of resection	No (%)
Gross total resection	182 (86%)
Near total resection	17 (8%)
Subtotal resection	13 (6%)

No use of IONM:

Table 6a: Pre op facial nerve findings

Tumor Size	House and Brackman Grade					
	I	II	III	IV	V	VI
I						
II	1 (2.5%)					
III	80 (51%)	6 (4%)	2 (1.2%)	2 (1.2%)		
IV	46 (29%)	10 (6%)	4 (2.5%)	2 (1.2%)		
Total	130 (83%)	16 (10%)	6 (4%)	4 (2.5%)		

Table 6b: Post Op (1 week)

Tumor Size	House and Brackman Grade					
	I	II	III	IV	V	VI
I						
II	2 (2.5%)					
III	36 (46%)	6 (7.7%)	2 (2.5%)	1 (1.2%)		
IV	16 (20.5%)	11 (14%)	3 (4%)	1 (1.2%)		
Total	54 (69%)	17 (22%)	5 (6%)	2 (2.5%)		

Table 6c: Post op (3 months)

Tumor Size	House and Brackman Grade					
	I	II	III	IV	V	VI
I						
II	4 (2.5%)					
III	76 (48%)	8 (5%)	4 (2.5%)	2 (1.2%)		
IV	60 (21.8%)			2 (1.2%)		
Total	140 (89%)	8 (5%)	4 (2.5%)	4 (2.5%)		

Use of IONM

Table 7a: Pre op facial nerve finding

Tumor Size	House and Brackman Grade					
	I	II	III	IV	V	VI
I						
II	6 (10.7%)					
III	32 (57%)	4 (7%)				
IV	8 (14%)	2 (3.5%)	2 (3.5%)	2 (3.5%)		
Total	46 (82%)	6 (10.7%)	2 (3.5%)	2 (3.5%)		

Table 7b :Post op (1 week)

Tumor Size	House and Brackman Grade					
	I	II	III	IV	V	VI
I						
II	6 (10.7%)					
III	26 (46%)	10 (18%)				
IV	8 (14%)	2 (3.5%)	2 (3.5%)	2 (3.5%)		
Total	40 (71%)	12 (21%)	2 (3.5%)	2 (3.5%)		

Table 7c: Post op (3 months)

Tu-mor Size	House and Brackman Grade					
	I	II	III	IV	V	VI
I						
II	6 (10.7%)					
III	34 (60%)	2 (3.5%)				
IV	12 (21%)		2 (3.5%)	2 (3.5%)		
Total	52 (93%)	2 (3.5%)	2 (3.5%)	2 (3.5%)		

Table 8: Facial Nerve Injury Pattern (P Value

With IONM Group	0.029
Without IONM Group	0.067

Table 9: Complications

Complications	No (%)
Chest infection	22 (10.3%)
Pseudomeningocele	18 (8%)
Lower cranial nerve paresis	16(7.5%)
Hydrocephalus	16 (7.5%)
Meningitis	4 (1.9%)
Surgical site infection	2 (0.9%)

Figure:1

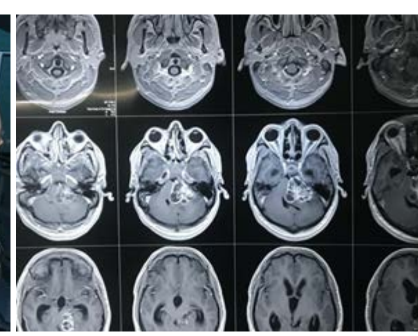

Figure:2

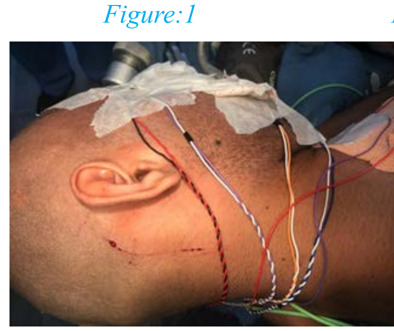

Figure:3

Figure:4

Conclusion

The incidence of post operative facial palsy is found to be correlated to tumor size and consistency. Improvement of the facial nerve outcome is detected in patients undergone simultaneous intraoperative monitoring (IONM).

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